Nov. 6, 1928. 1,690,210

R. L. STOKELY

TELEPHONE SYSTEM

Filed May 5, 1927 4 Sheets-Sheet 1

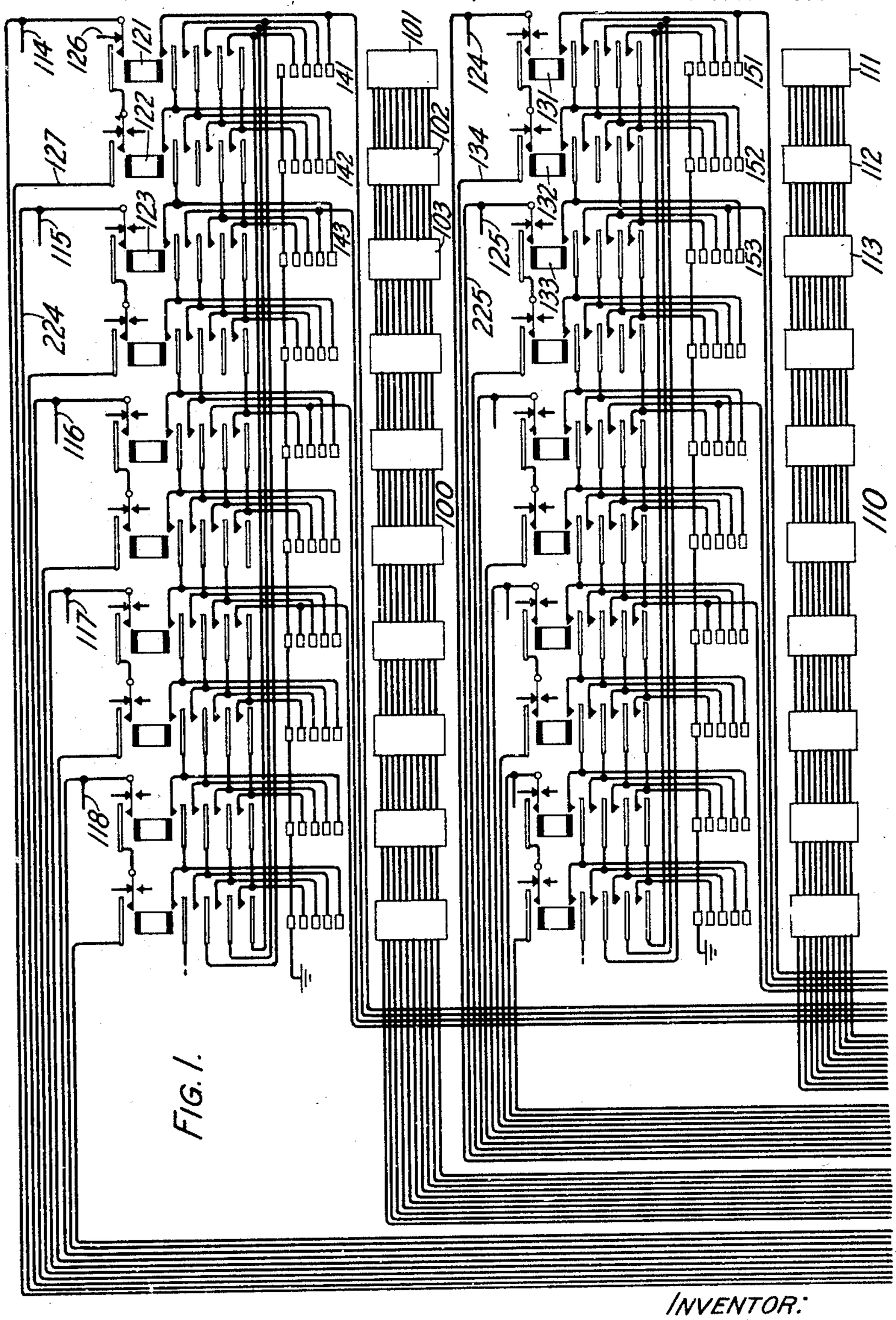

FIG. 1.

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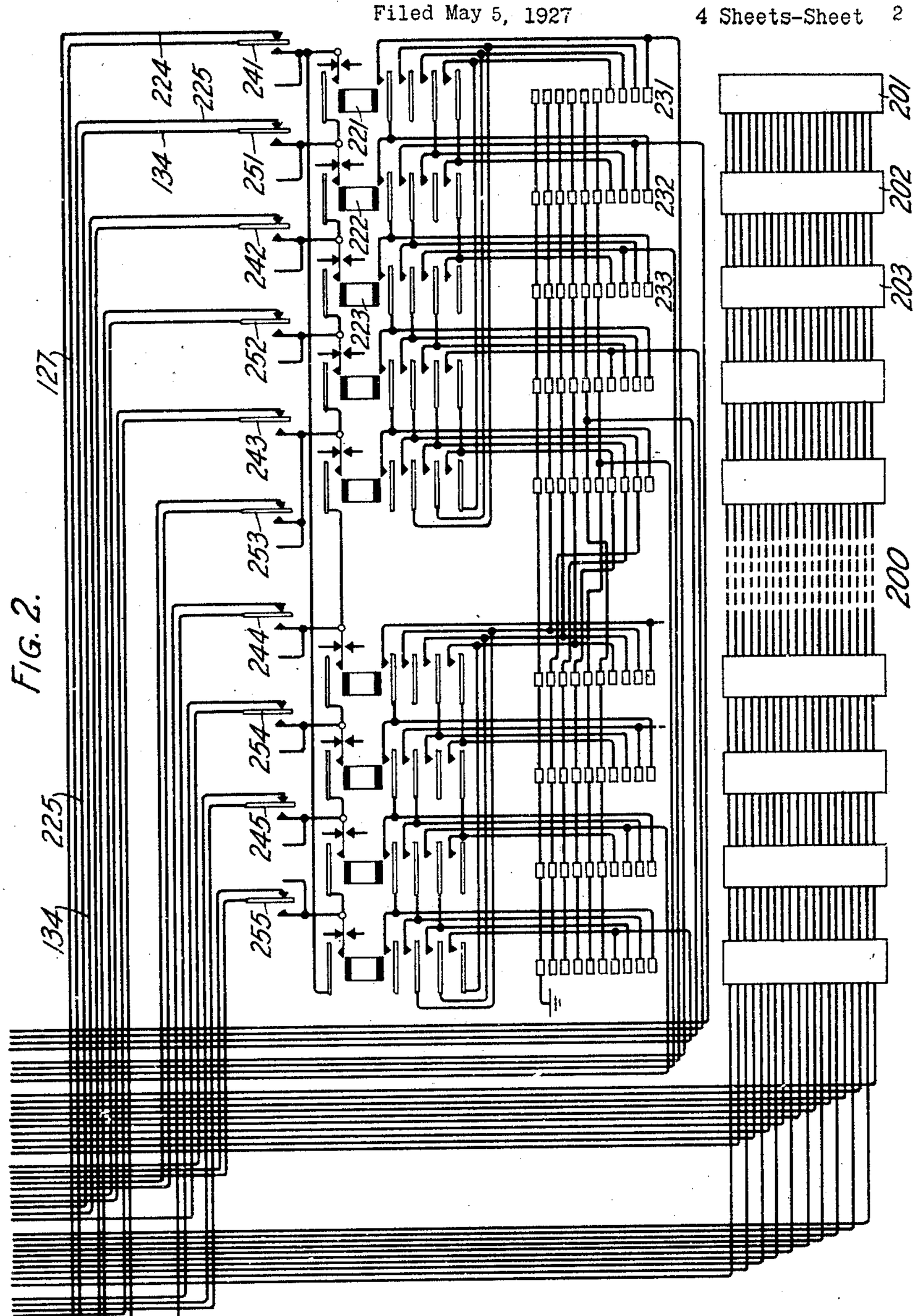

FIG. 2.

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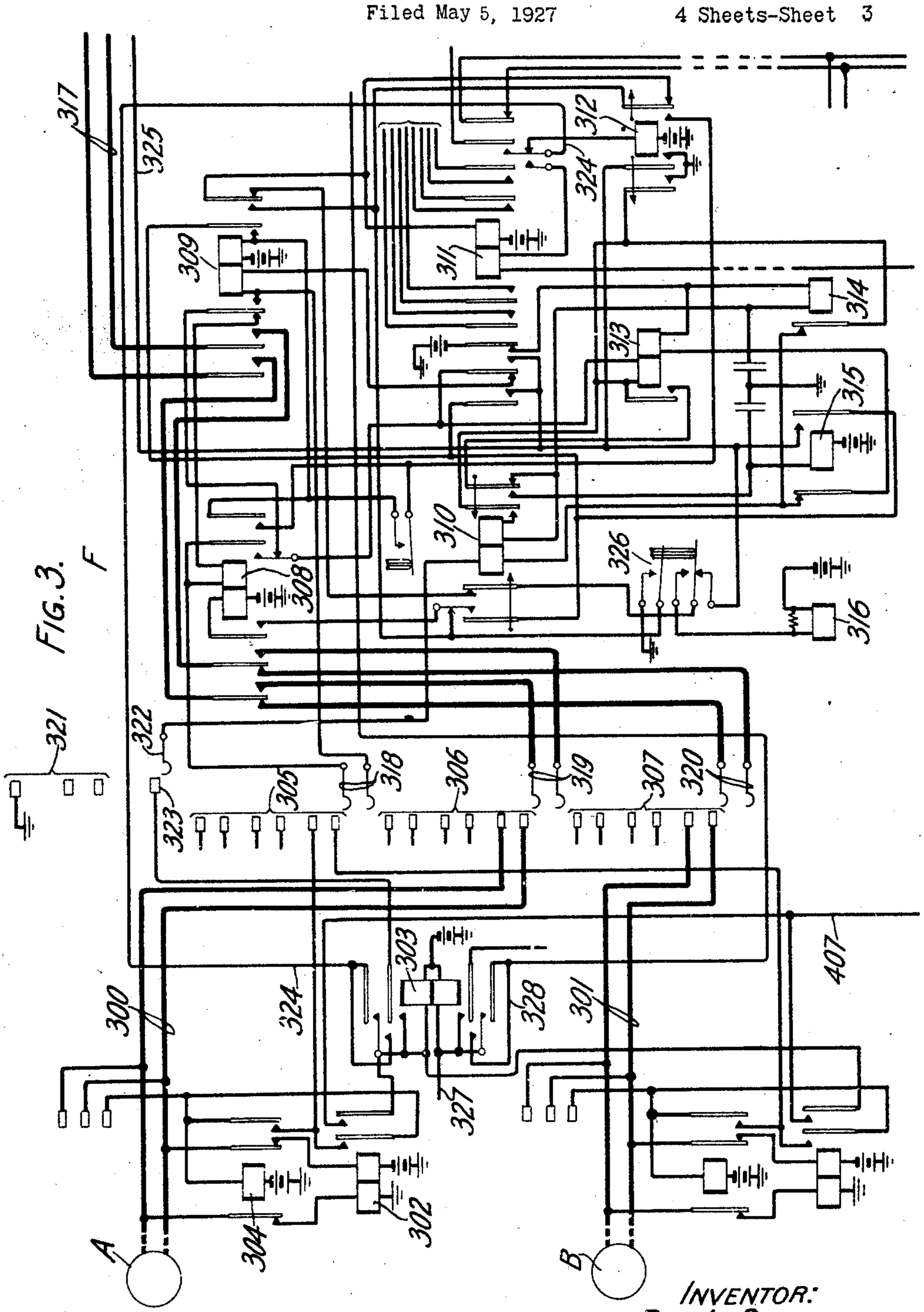

FIG. 3.

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4 Sheets-Sheet 4

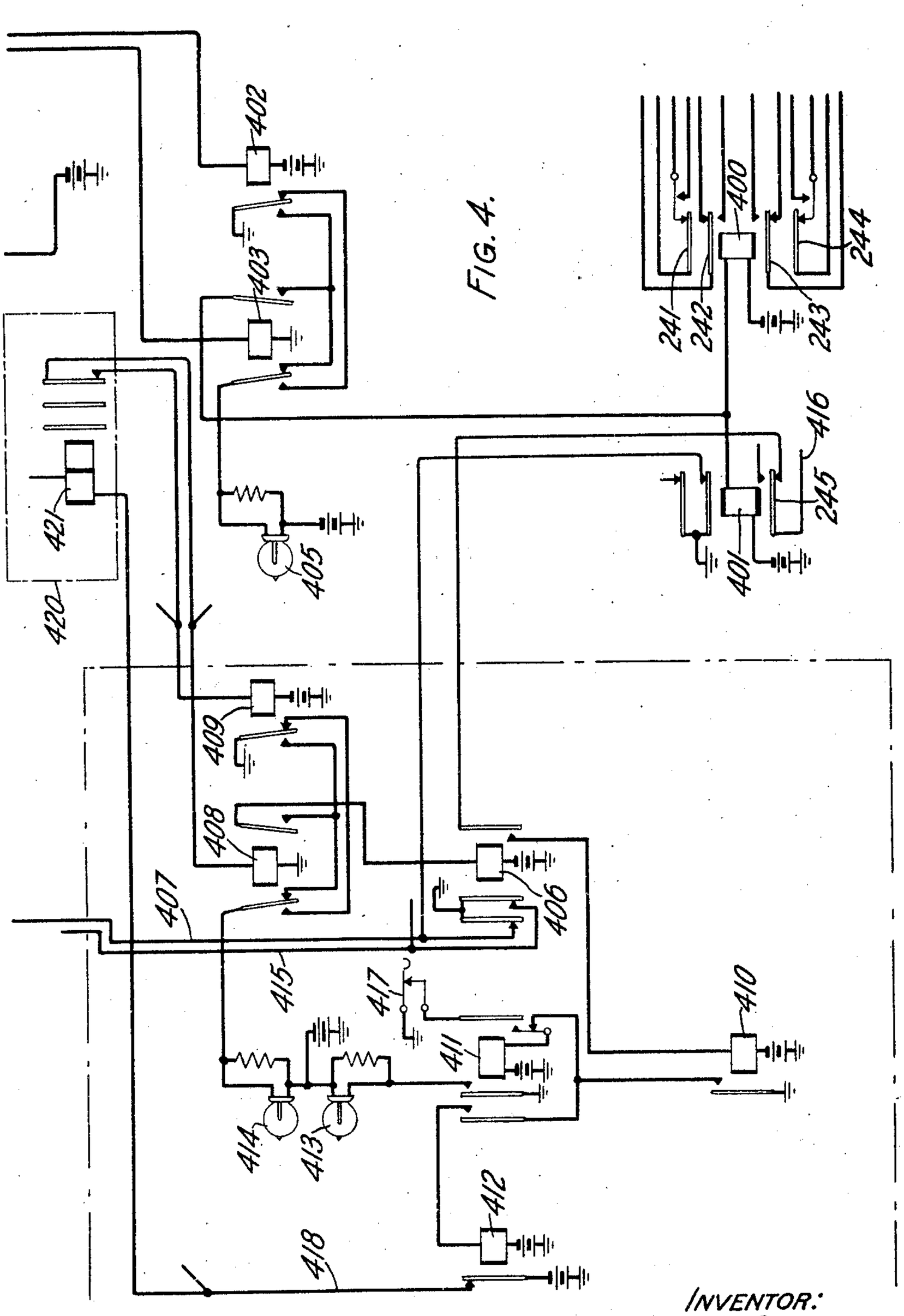

FIG. 4.

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed May 5, 1927. Serial No. 188,918.

This invention relates to automatic telephone exchange systems and more particularly to improvements in line finding switches.

According to this invention two groups of lines are normally served each by a line finder, which is arranged to simultaneously choose a number of sub-groups and the overflow traffic from both groups is handled by an overflow finder having capacity for all of said lines.

A feature of the invention is a starting arrangement wherein a collective test is made of all switches in advance of the extended start wire to determine if any one of such switches is idle before the start wire is extended further.

The invention is applicable to a system using step-by-step line finder switches and wherein the lines are divided into relatively large groups, say 200 lines each. In order to use switches having a capacity for 200 lines it becomes desirable to slip the line multiple from switch to switch to more uniformly distribute the hunting time. This is a costly and troublesome expedient. To avoid this multiple slip and retain the advantages of the larger grouping it is proposed to employ two separator groups of 100 point switches for normally serving two groups of 100 lines, the switches having two banks of fine levels each and two simultaneously operable sets of brushes. Since the maximum sub-group hunting operation takes only five vertical steps it is not necessary to slip the multiple. The number of switches in these two groups may be selected to care for the greater part of the traffic for the 200 lines. To handle the overflow calls in the more busy periods a group of 200 point switches is provided which serve any line in the group of 200 when the first choice switches are all busy.

In the drawings Figs. 1 and 2 taken together comprise a diagram showing both the regular and overflow finders serving a group of 200 lines.

Figs. 3 and 4 taken together illustrate the details of a line finder switch and its controlling circuits.

Considering the diagram in Figs. 1 and 2, a group of 100 subscriber's lines appear in the multiple terminals of a group of line finder switches 100. The group 100 comprises 10 line finders 101, 102, 103, etc., each having a capacity for 100 lines. Each of these switches has two separate line banks and two sets of brushes, each bank having 5 levels of terminals. The line finders are provided with group selecting commutators 141, 142, 143, etc., and also with start wire controlling relays 121, 122, 123, etc.

The second group of 100 lines in the major group of 200 appears in the multiple terminals of a plurality of line finders 110. The group 110 is made up of 10 line finders 111, 112, 113, etc., of the same construction as those illustrated in the group 100. These finders also have group hunting commutators 151, 152, 153, and start wire controlling relays 131, 132, and 133, etc.

Normally the calls occurring in the line groups are served by their finder switches 100 and 110. Since, however, there may not be enough of these switches to handle the traffic in busy hours, a group of overflow finder switches 200 is provided to take care of all overflow calls in either of the 100 line groups. To this end the overflow finders 201, 202, 203, etc., are 200 point switches each having two 100 point banks and two sets of brushes. The lines in both 100 line groups are connected as illustrated to the multiple terminals of the overflow finders 200. The overflow finders are likewise equipped with commutators 231, 232, 233, each having 10 segments instead of 5 and start wire controlling relays 221, 222 and 223, etc.

The armatures 241 to 245 inclusive are controlled by a make busy relay associated with the finders of one 100 line group and which operates whenever all finders in that group are busy. Similarly the armatures 251 to 255 inclusive are controlled by a group busy relay associated with the line finders of the other 100 line group.

Each group of 100 lines has 5 different start wires, one for each sub-group of 20 lines for example. The start wires of the first 100 line group enter at points 114 to 118 inclusive. Likewise the start wires for the second 100 line group enter at points 124, 125, etc. If a call arises in the first sub-group of 20 lines the start circuit extends over conductor 114, normal contact of relay 121 (if the first line finder 101 is idle) conductor 126 to the start relay not shown. If the first finder 101 is busy the start wire extends through the front contact of relay 121 and thence over the back

contact of relay 122 (if the second finder 102 is idle) to the start relay of that finder. If, however, both finders 101 and 102 are busy at the time, the start wire extends through the front contacts of relays 121 and 122 and thence over conductor 127, armature 241 and its back contact, conductor 224, thence over the back contact of relay 123 (if the third finder is idle) to the start relay. It will be noted that the start wire after extending through two busy finders in the group passes through the contact 241 of the make-busy relay before it is extended to a subsequent finder. This is to make sure that there is an idle finder in the group for if all finders are busy it will be useless to extend the start wire through the controlling relays of all finders in the series. By analyzing the start wire it will be found that after being extended through each succeeding pair of switches a collective test is made through the contacts of the make busy relays to determine whether there is an idle finder in advance of the point to which the start wire has been extended. The extension of the start wire will continue so long as each test reveals an idle finder somewhere beyond. If, however, any one of these tests shows that all finders beyond are busy the extension ceases and an overflow finder is set in motion. If all finders are busy the start wire is extended as explained over conductor 127 and thence through the armature 241 of the make busy relay and its front contact to the armature and normal contact of relay 221 (if the finder 201 is idle) and thence to the start relay of finder 201. Thus, whenever a call originates in the group 100 and all the finders are busy the start wire after testing out two finders is extended to the overflow group and initiates the operation of one of these overflow finders to take care of the call. If the first finder 201 in the overflow group is busy the start wire leads through the front contact of relay 221 to the relay 222 of the next switch. In like manner the start wire is extended from switch to switch in the overflow group until an idle finder is encountered.

Likewise a call originating in any subgroup of lines in the second group of 100 causes the extension of the start wire over one of the leads 124, 125 to determine if there is an idle finder in the group 110. The start wire 124 for instance leads through the armature and front contacts of relays 131 and 132 if both finders 111 and 112 are busy thence over conductor 134 to the armature 251 on the make busy relay associated with the second group of 100 lines. If some succeeding finder in group 110 is idle the armature 251 will be resting on its back contact and the start wire returns over conductor 225 to the armature of relay 133. If, however, the finders are all busy in this group then the make busy relay is operated and the start wire now leads over the armature 251 and its front contact to the armature of relay 222.

From this it will be noted that the first, third, fifth, etc., overflow finders are preferred when a call overflows from the first group of 100 lines and that the second, fourth, sixth, etc., overflow finders are preferred for calls overflowing from the second group of 100 lines. Obviously as many finders both in the regular and overflow groups may be provided as is necessary to handle the traffic.

Fig. 3 shows one of the regular line finders serving a group of 100 lines. This switch has two sets of line brushes 319 and 320 and a set of test brushes 318 all mounted on the same shaft. The brushes 319 cooperate with the bank 306 having 5 levels of lines, each level accommodating 10 lines. Likewise the brush set 320 cooperates with a bank 307 having 5 levels of lines. The test brushes 318 cooperate with a separate test bank 305. At each vertical step of the brush shaft, the brushes 320, 319 and 318 are positioned opposite the corresponding levels of lines in the respective banks. In this way for each vertical step the switch chooses two levels of lines or a subgroup of 20 lines. The lines 300 and 301 are seen to appear in corresponding levels of the two banks 306 and 307.

The switch is also equipped with a vertical group hunting commutator 321 and a commutator brush 322 the purpose being to enable the selection of two levels of lines, one of which contains a calling line.

The controlling relays shown to the right of the broken line in Fig. 4 are common to the finder F and all other finders serving the same group of 100 lines. Relays 400 and 401 are the group busy relays previously referred to and in fact are the relays which control the armatures 241 to 245 inclusive shown in Fig. 2 of the diagram.

The relays shown at the left of the broken line in Fig. 4 are common to the entire group of 200 lines and certain of these relays relate to the overflow finder switches as will be explained in greater detail hereinafter.

There is a group relay 303 provided for each 40 subscriber's lines. The upper winding of the relay 303 relates to 20 lines whereas the lower winding relates to another 20 lines. These group relays, when energized by a calling condition on any one of the related lines, cause the line finder switches to perform their line hunting operations.

In describing the detailed operation of the switch assume that a subscriber at substation A initiates a call. The line relay 302 operates in an obvious circuit and completes a circuit from ground through the left contact of relay 406, conductor 407, contact of relay 302, upper winding of group relay 303 to battery. Relay 303 through its inner upper contact places ground potential on the commutator segment 323 corresponding to

the level containing line 300 in the bank 306 and also containing the line 301 in the bank 307. Relay 303 also closes a start circuit from the grounded conductor 407, contact of relay 302, upper contacts of relay 303, conductor 324, normal contact of start wire control relay 311, winding of the start relay 312 to battery. Relay 312 in operating places ground on the sleeve conductor 325 of the trunk 317 leading to the first selector.

Relay 312 also operates the relay 313 in a circuit from ground through the outer left contact of relay 312, contact of the vertical magnet 314, left contact of the rotary magnet 315, right winding of relay 313, contact of relay 311 to battery. Relay 313 closes a circuit for the vertical magnet 314 from battery through the contact of relay 311, winding of magnet 314, outer right back contact of relay 310, contact of relay 313 to ground at the contact of relay 312. The magnet 314 operates the brush shafts and steps the brushes 318, 319 and 320 in operative relation to the first level of terminals. It also advances the commutator brush 322 into engagement with the first segment 323. Magnet 314 at its contact opens the circuit of relay 313 which releases and opens the circuit of the magnet permitting it to release. Magnet 314 again closes the circuit of relay 313 which is arranged to operate and reclose the circuit of the magnet to give the switch its next step. In this way the brushes are advanced from level to level to search for the level of lines containing the calling line.

Since the calling line 300 is assumed to be in the first level a circuit is closed over the commutator brush 322 to hold the relay 313 energized at the end of the first step thus preventing the reclosure of the stepping magnet circuit. The holding circuit for relay 313 may be traced from battery over the contact of relay 311, right winding of relay 313, left contact of the rotary magnet 315, left winding of relay 310, brush 322 to the grounded segment 323. The relay 310 operates slowly to allow an interval between the vertical and rotary stepping movements. The relay 310 closes a locking circuit for itself to battery through the contact of relay 311, winding of the vertical magnet 314, right winding and contact of relay 310 to ground at the contact of relay 312.

With relays 310 and 313 operated, a circuit is closed for the rotary stepping magnet 315 traceable from battery through the winding of said magnet, the outer right front contact of relay 310, contact of relay 313, to ground at the contact of relay 312. Magnet 315 advances the brushes into engagement with the first set of terminals in the respective levels. The magnet 315 in opening its left contact severs the operating circuit of relay 313 which releases in turn opening the circuit of the magnet 315. Magnet 315 closes its contact, reclosing the circuit of relay 313 which operates and again closes the operating circuit of the magnet. In this way the brushes of the finder are advanced from terminal to terminal in search of the calling line.

The test for the calling line is made by the relays 308 and 309. If the calling line is in the upper bank 306 relay 308 operates and incidentally causes the operation of relay 309, whereas if the calling line is in the lower bank 307 relay 309 operates. One branch of the test circuit may be traced from ground at the contact of relay 312, left winding of relay 313, inner right hand normal contact of relay 308, inner left back contact of relay 309, right winding of relay 308, to the upper test brush 318. The other branch of the test circuit after passing through the left winding of relay 313 leads through the back contact of relay 311, left winding of relay 309 to the lower test brush 308. Since line 300 is the one calling, the first mentioned test circut is closed through the upper brush 318 and the correspondng terminal, inner contact of line relay 302, winding of the cut-off relay 304 to battery. Relay 308 operates in this circuit and relay 313 is held operated to prevent any further stepping by the magnet 315. Relay 308 in operating closes a circuit for the relay 309 from battery through the right winding of the latter relay, outer right contact of relay 308, right front contact of relay 312 to ground at the upper contact of the offnormal spring combination 326. Relay 309 operates the relay 311 in a circuit from battery through the right winding of relay 311, outer right front contact of relay 309 to ground at the upper contact of springs 326. Relay 311 extends the sleeve conductor 325 from the first selector through to the sleeve conductor of the line 300. This circuit may be traced from conductor 325, left front contact of relay 311, inner right front contact of relay 308, upper test brush 318 to the sleeve conductor of the line. The cut-off relay 304 is maintained operated in this circuit.

Relay 311 transfers the start circuit 324 to the next switch as illustrated in Figs. 1 and 2, and releases relays 312, 313 and 310. Relay 312 is slow to release to provide an interval for ground potential to be placed on the conductor 325 at the first selector switch in the usual manner. The relay 308 is maintained energized from battery through its left winding and contact, normal contact of relay 310 to ground at the spring combination 326. Relay 309 is held in a circuit from battery through its right winding and front contact, outer left contact of relay 311 to the sleeve conductor 325. The relays 308 and 309 extend the tip and ring conductors of the trunk 317 through to the upper set of brushes 319 resting on the terminals in the calling line 300.

When it is desired to release the connection the ground potential is removed from conductor 325 and relay 309 releases. The release magnet 316 now operates in the circuit from battery through the winding of said magnet, closed contact of the spring combination 326, inner left contact of relay 310, outer right back contact of relay 309, outer right contact of relay 312 to ground through closed contact of spring combination 326. When the switch is restored the off-normal spring combination 326 is opened and the release magnet 326 deenergizes. Relays 308 and 304 are also released.

Had the call originated on the subscriber's line 301, the same group relay 303 is operated over its upper winding. Should a call originate on any one of twenty other lines (not shown in Fig. 3) ground potential is connected to the conductor 327 and the relay 303 operates over its lower winding to extend the start wire 328. The start wire 328 starts a line finder in operation in the manner already explained.

The equipment shown to the left of the broken line in Fig. 4 is common to a group of 200 lines and accordingly relates to the overflow finders. One of the overflow finders has been illustrated by the broken rectangle 420. The relay 421 within this rectangle is the start wire controllng relay corresponding to the relay 311 in Fig. 3.

The relays 402 and 403 relate to the group of 100 lines served by the finder switch F. A circuit may be traced for these relays from battery through the winding of relay 402 thence through normal contact of relay 311 to ground through the winding of relay 403. There will also be a parallel circuit for these relays extending through normal contacts of each of the relays corresponding to relay 311 for the remaining line finders of the group. As long as any line finder in the group is idle the relays 402 and 403 are held operated.

When all finders of the group become busy all parallel paths for the relays 402 and 403 are opened and these relays will release. The group busy relays 400 and 401 now operate in a circuit from battery through their windings through back contacts of relay 403 and 402 to ground. The group busy relays shift the start wire as explained in connection with Figs. 1 and 2, to the overflow finders.

Should either positive or negative potential be accidentally applied to the start wire the relays 402 and 403 are released in different combinations according to the point at which the potential is applied. With either relay released and the other relay operated, a circuit may be traced from signal lamp 405.

The relays 408 and 409 and the lamp 414 serve the same purpose as relays 402 and 403 and lamp 405 with respect to the group of overflow finders.

When all of the overflow finders are busy and both relays 408 and 409 release a circuit is closed from battery through the winding in relay 406 to ground through the back contacts of relays 408 and 409. Relay 406 operates and disconnects its grounded armatures from the start conductors 407 and 415. If a call exists in the group while all of the overflow finders are busy and ground potential occurs on the start conductor 416, the relay 410 is operated through the right contact of relay 406. Relay 410 closes an obvious circuit for relay 411 which locks through the key 417. Relay 411 lights the signal lamp 413 and also closes an obvious circuit for relay 412 so long as relay 410 remains energized. Relay 412 removes battery potential from the conductor 418 which controls all relays similar to relay 421.

What is claimed is:

1. In combination, two groups of lines, each divided in sub-groups, two finder switches, each serving one of said groups as first choice, means for operating one of said finders to simultaneously select a plurality of sub-groups, means for further operating the finder to select a line in one of the selected sub-groups, a third finder serving all of the lines in both said groups, and means for operating said last finder to select a sub-group of lines and a line therein when the first choice finder is busy.

2. In combination, first and second groups of lines divided in sub-groups, a plurality of finders serving the first group as first choice finders, a plurality of finders serving the second group as first choice finders, means for operating any one of said finders to simultaneously select a plurality of sub-groups, means for further operating the finder to select a line in one of the selected sub-groups, a plurality of third finders serving all of the lines in both said groups, and means for operating said last finders to select a sub-group of lines and an individual line therein when the first choice finders are all busy.

3. In combination, first and second groups of lines divided in sub-groups, a plurality of finders serving the first group as first choice finders, a plurality of finders serving the second group as first choice finders, means dependent on the location of the calling line in a group for determining the order in which the finders are started, means for operating any finder to choose a plurality of sub-groups simultaneously, means for further operating the finder to select a line in one of the chosen sub-groups, a plurality of second choice finders serving all of the lines in both said groups, and means for operating any one of said last finders to select a calling line when all of the first choice finders are engaged.

4. In a telephone system, first and second groups of lines divided in sub-groups, a series of finder switches serving the first group as

first choice, a series of finder switches serving the second group as first choice, a start wire for each series, means for extending the start wire from one finder to the next when busy, means for testing collectively all finders in advance of the extended start wire, and a group of overflow finders serving as second choice to the lines in both groups.

5. In a telephone system, a group of lines, a series of finder switches serving said lines, a start wire for said finders, means to extend the start wire from switch to switch when busy, and means for testing collectively all switches in advance of the extended start wire to determine if there be an idle one.

6. In a telephone system, a group of lines, a series of finder switches serving said lines, a start wire for said finders, means to extend the start wire from switch to switch when busy, and means to repeatedly test all switches collectively in advance of the extended start wire to determine if there be an idle switch.

7. In combination, a plurality of groups of lines, finder switches for each group serving as first choice switches for said groups, levels of terminals in said switches in which the lines appear, a plurality of sets of brushes for each switch, means for advancing all brush sets on any one of said switches into engagement simultaneously with respective levels of terminals, means for choosing a calling line in one level only, a plurality of overflow switches serving all said groups of lines, and means for operating an overflow switch when all switches normally serving the calling group are busy.

In witness whereof, I hereunto subscribe my name this 28th day of April A. D., 1927.

RAY L. STOKELY.