Dec. 13, 1938. A. R. BONORDEN 2,139,800

TELEPHONE SWITCHBOARD SWITCHING SYSTEM

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FIG. 1

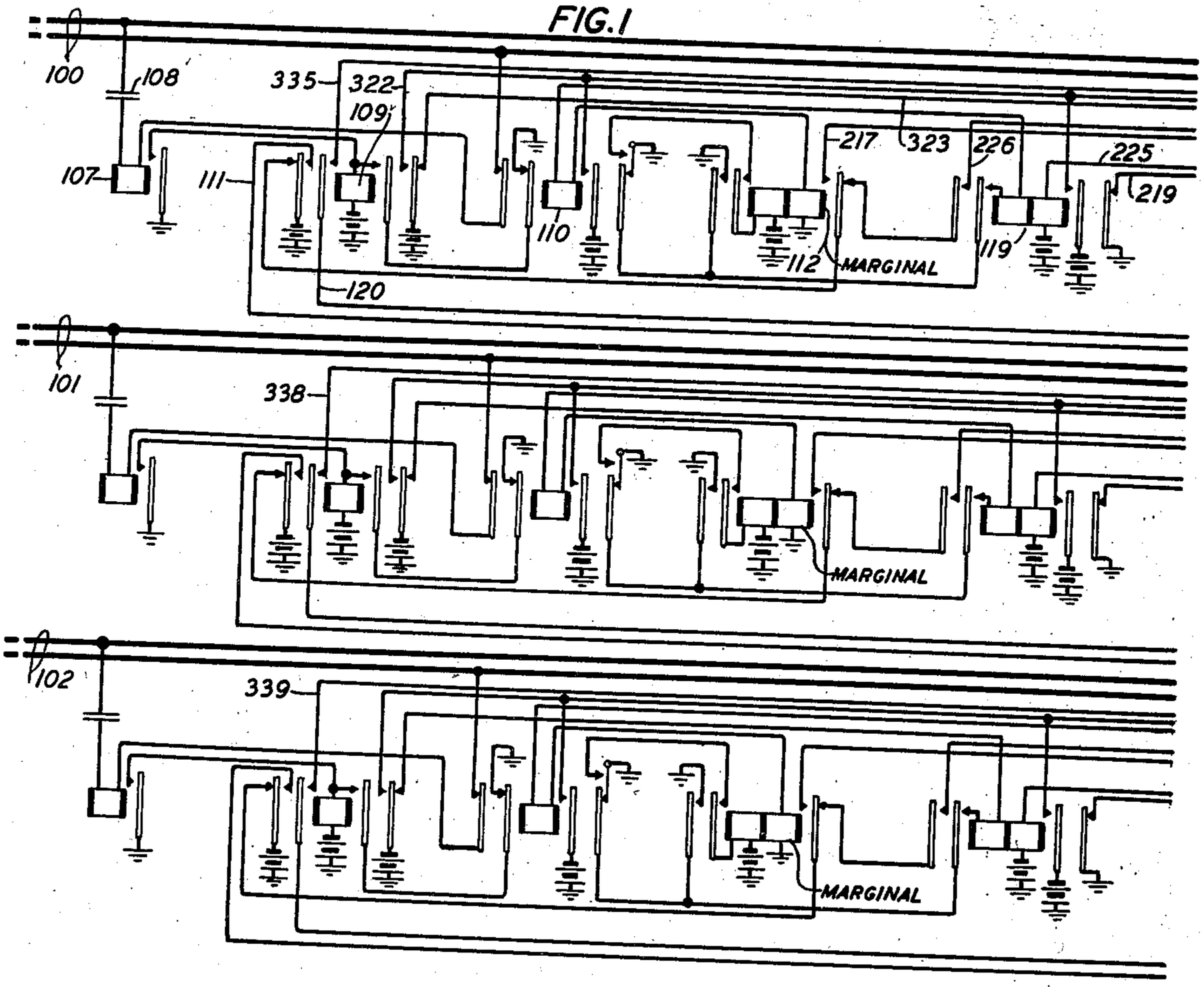

FIG. 1B

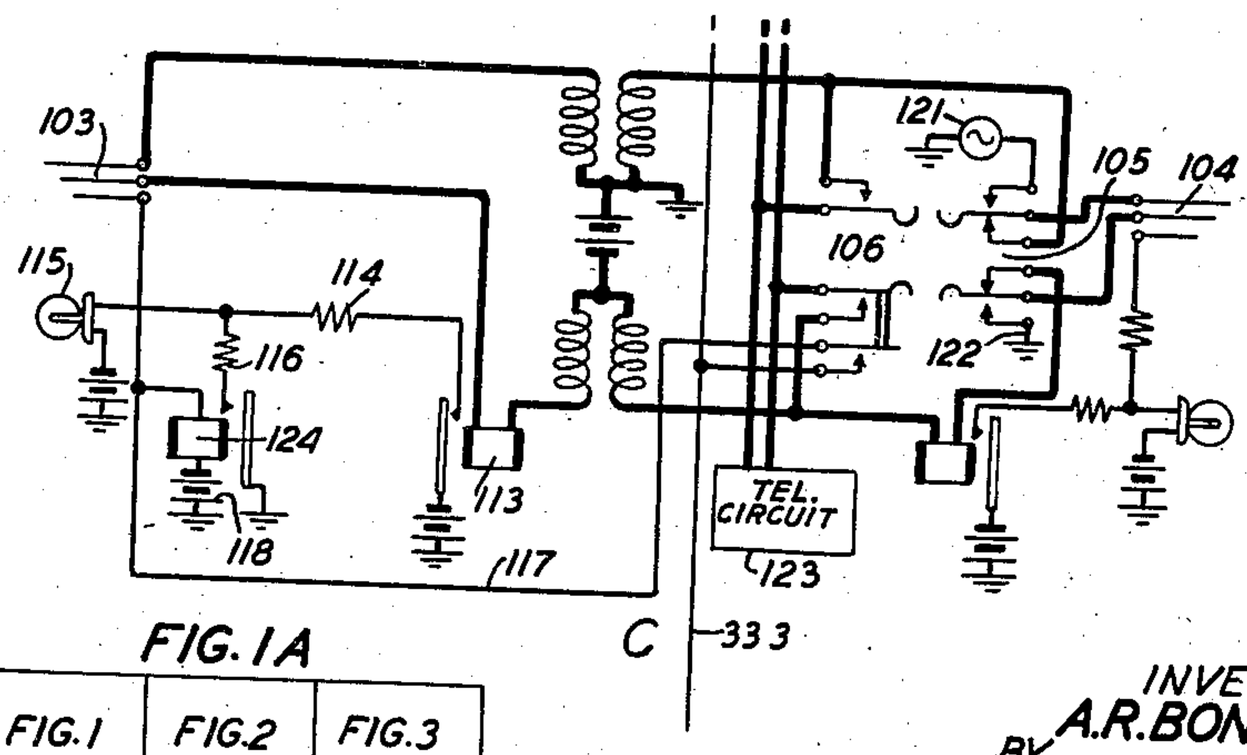

FIG. 1A

FIG. 1	FIG. 2	FIG. 3

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FIG.2

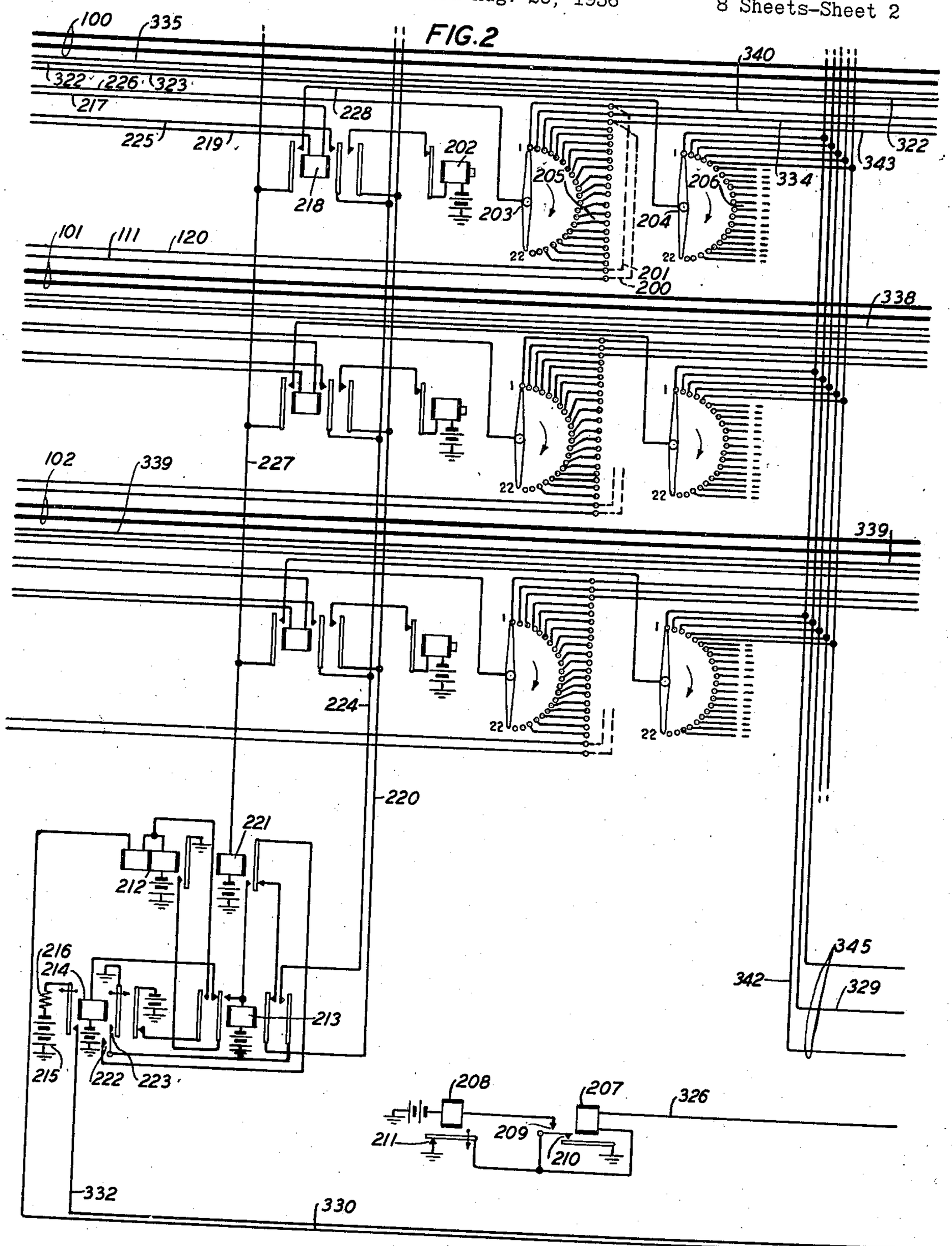

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FIG. 3

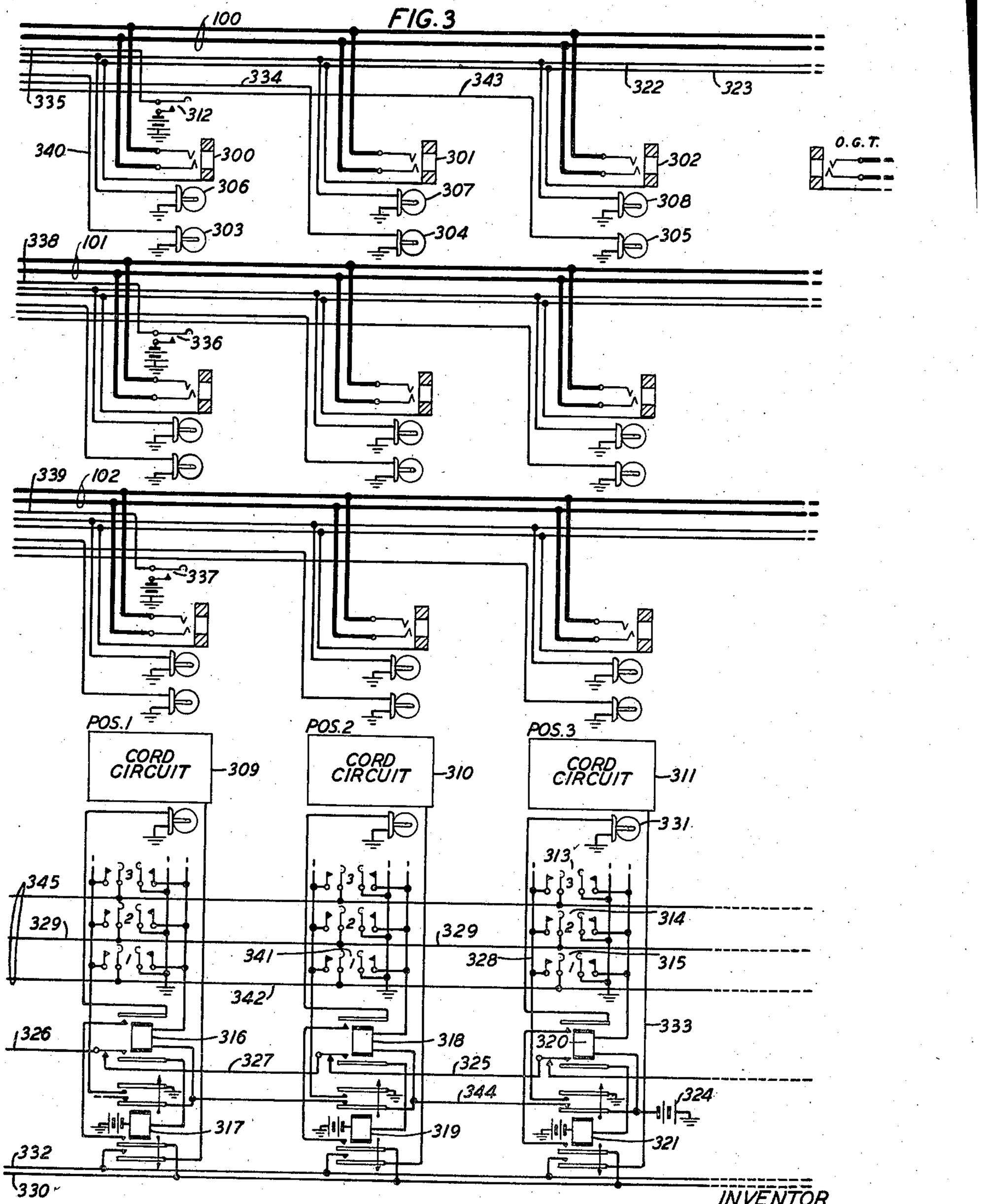

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FIG. 4

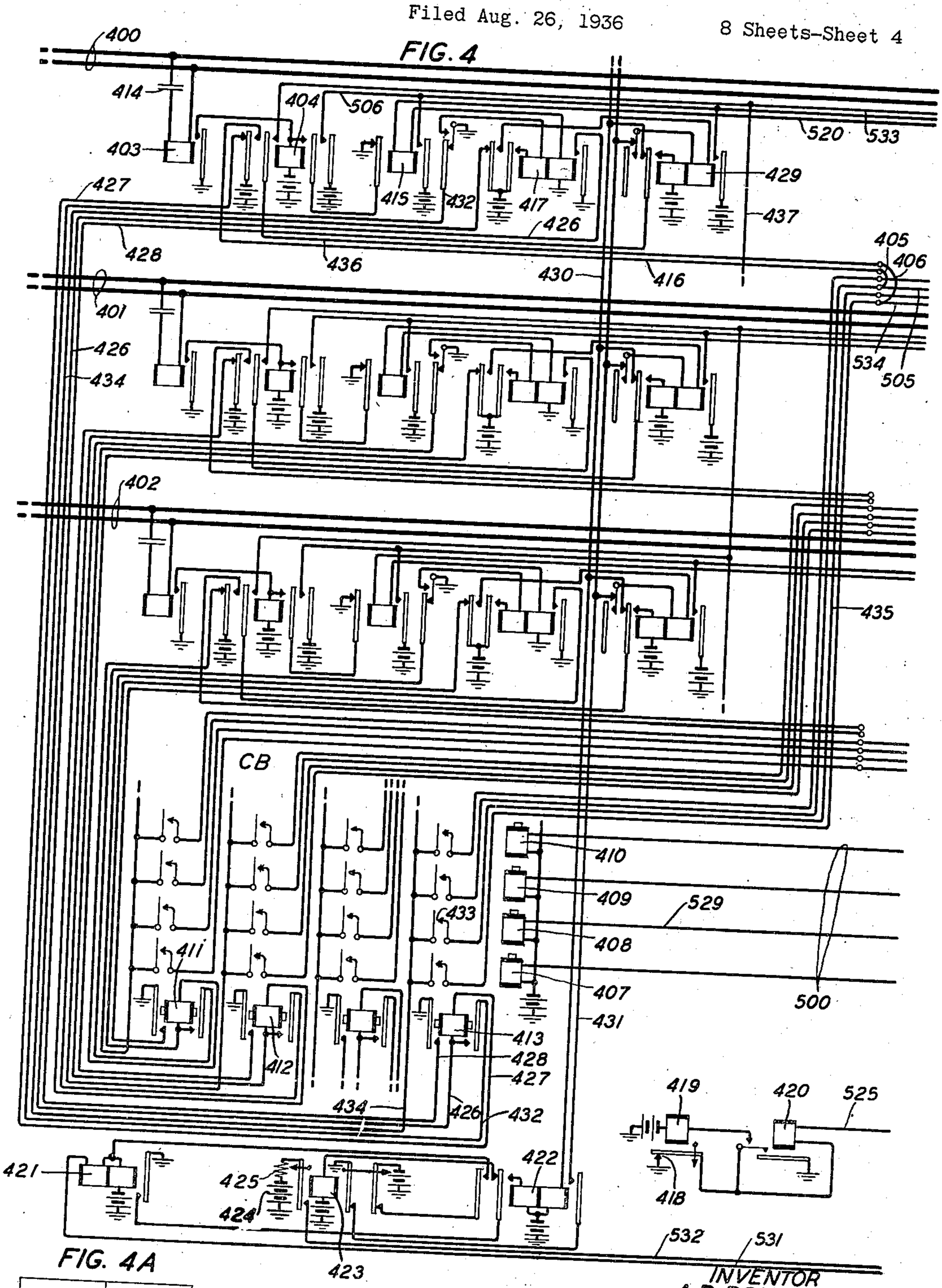

FIG. 4A

FIG. 4	FIG. 5

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FIG. 5

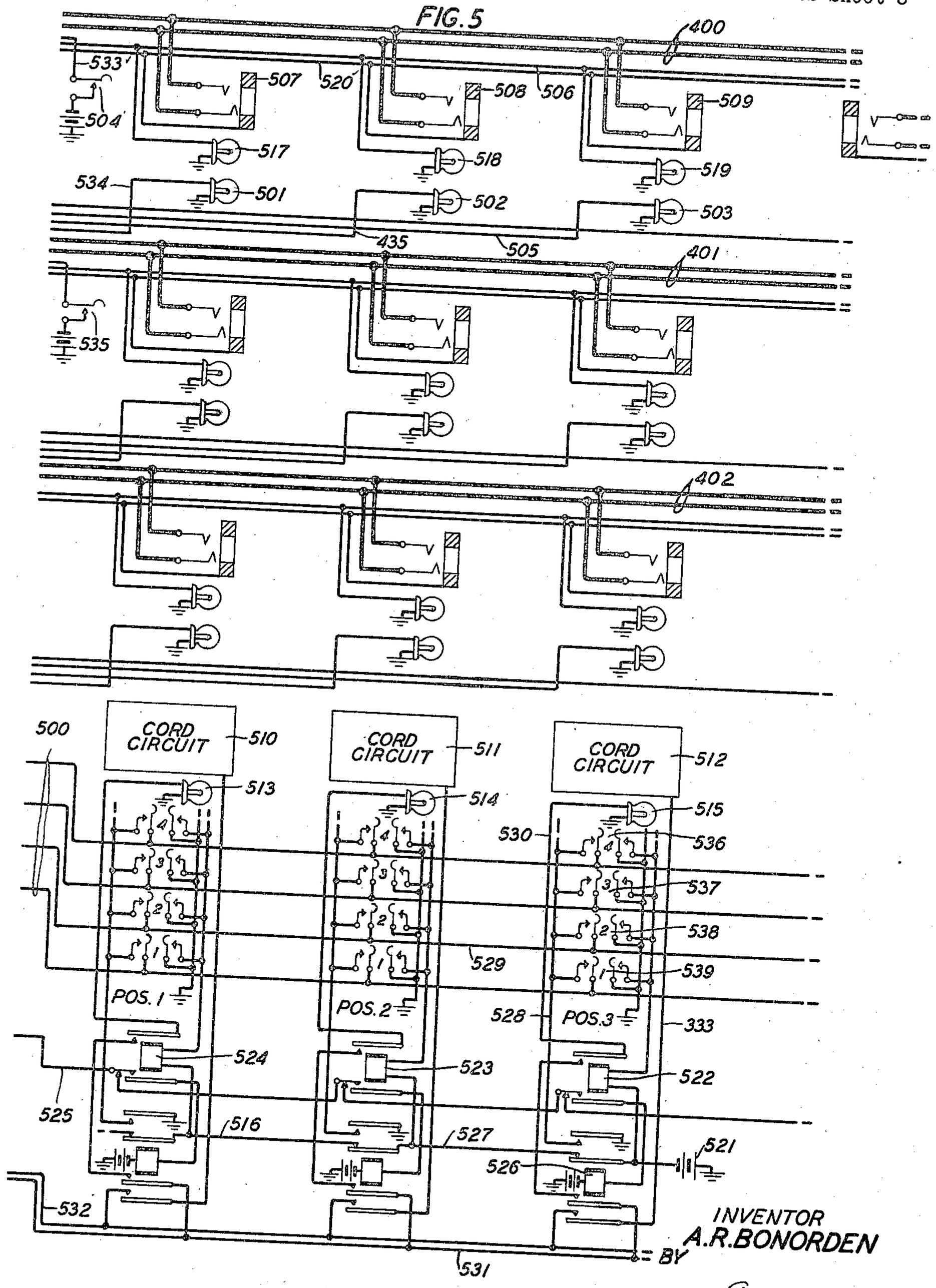

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FIG. 6

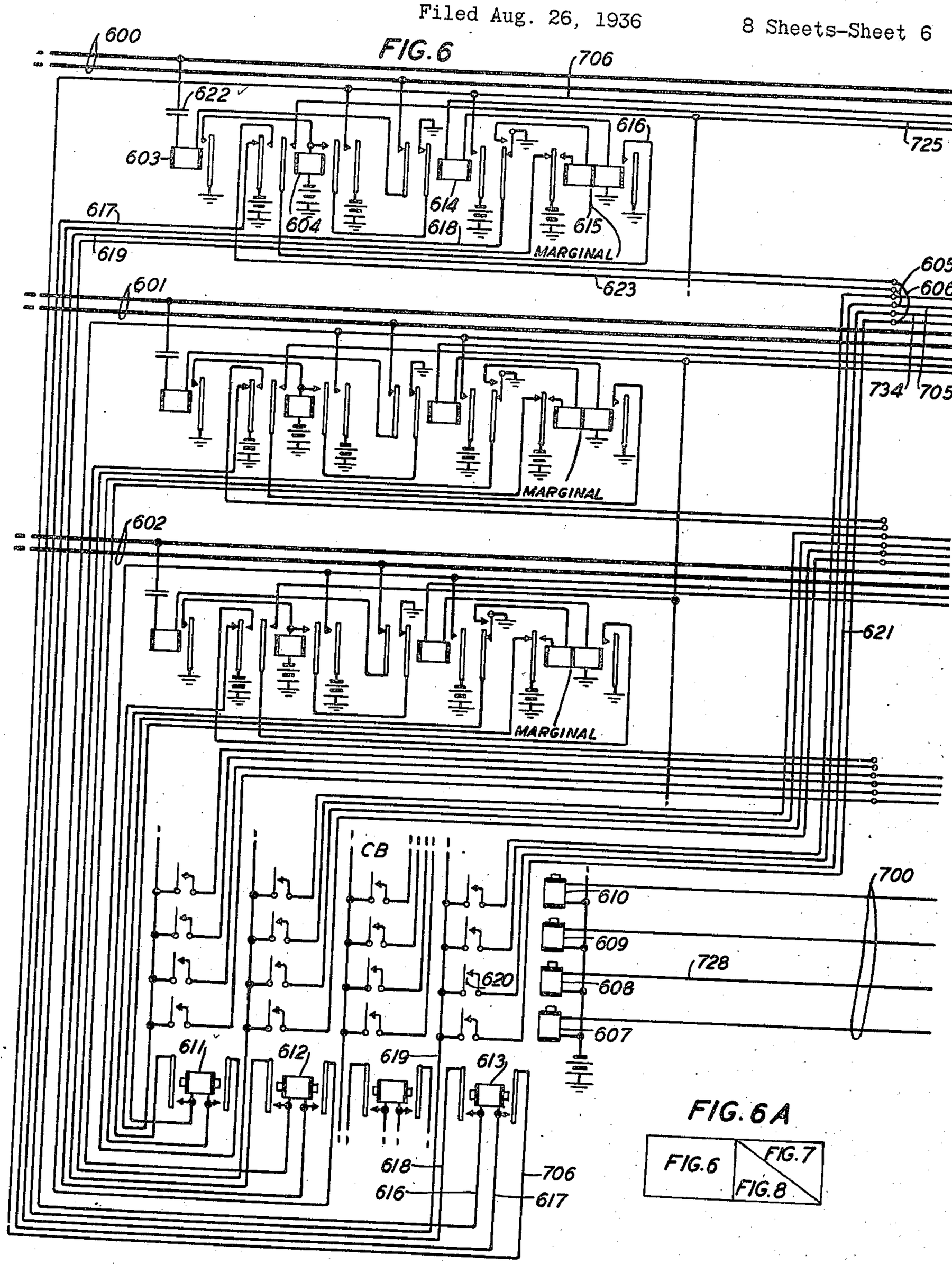

FIG. 6A

FIG. 6	FIG. 7 / FIG. 8

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FIG. 7

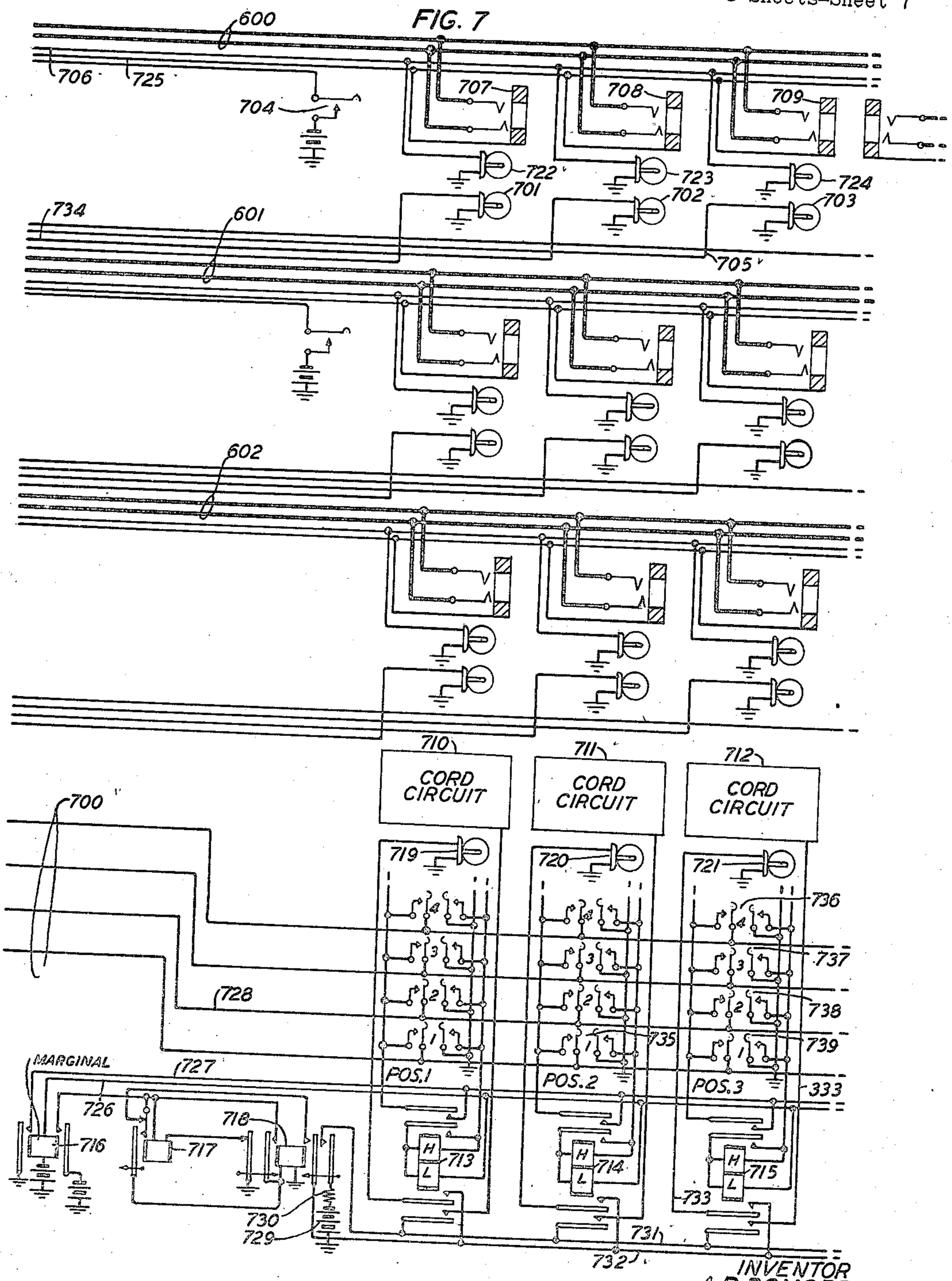

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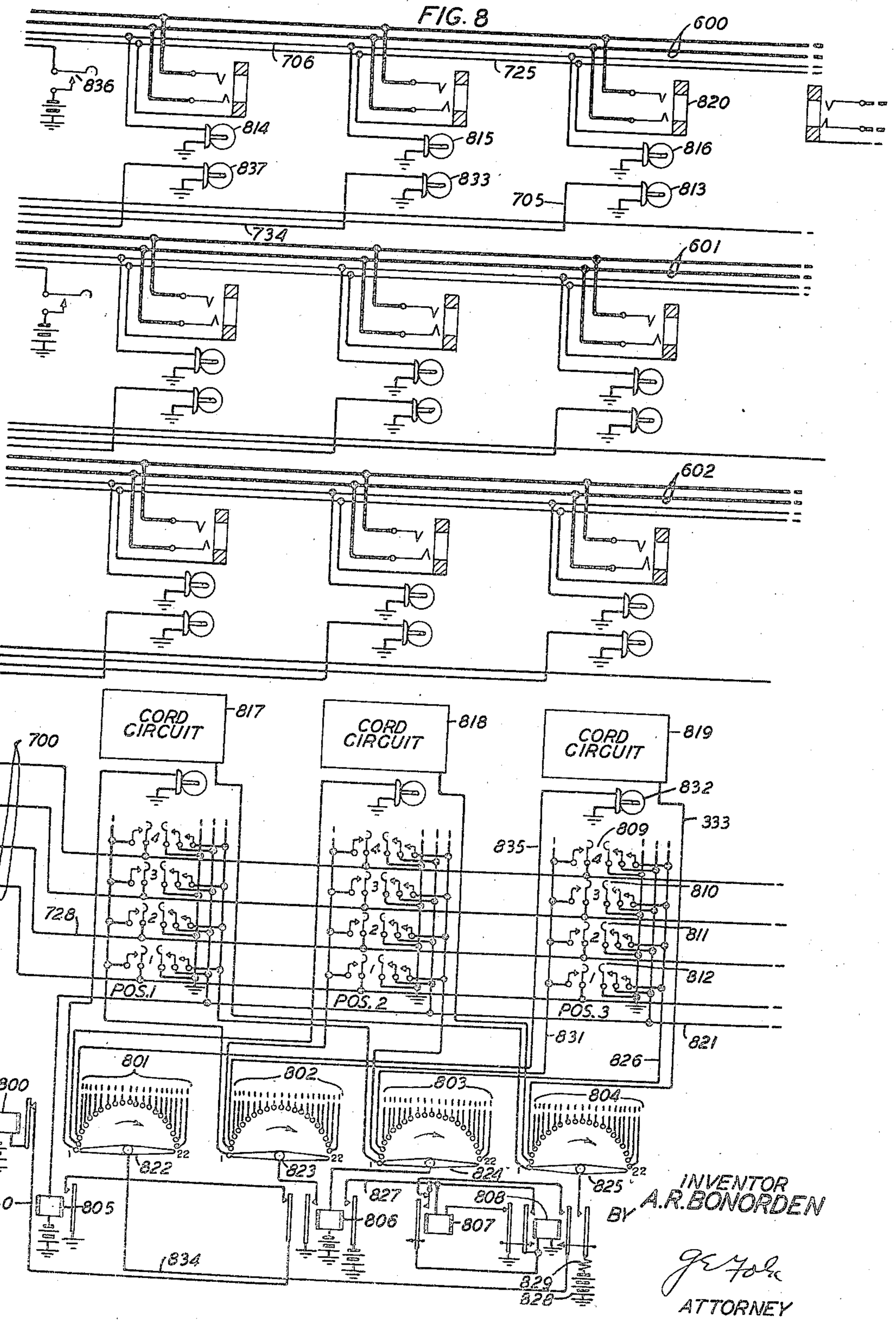
FIG. 8



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Patented Dec. 13, 1938 2,139,800

UNITED STATES PATENT OFFICE

2,139,800

TELEPHONE SWITCHBOARD SWITCHING SYSTEM

Allen Rudolf Bonorden, Fanwood, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

Application August 26, 1936, Serial No. 98,056

9 Claims. (Cl. 179—48)

This invention relates to communication systems and more particularly to supervising and maintaining private, or order, wire service over intercity communication trunk circuits between telephone test board attendants located in different cities.

An object of the invention is to permit an attendant at a telephone switchboard or test board in one locality to be connected with any one of a plurality of attendants at a telephone switchboard or test board in a different locality.

It is essential in telephone test board operation in telephone systems for attendants at different localities having charge of a particular service at their respective test boards to obtain direct communication with each other and consequently it is desirable to have an arrangement which will facilitate certain direct communication or permit of an incoming call being rapidly transferred to an attendant responsible for a particular service. In both toll and telephone practice heretofore known the transfer of calls, received over certain trunks or line circuits, is possible to a very limited extent, that is, the facilities at present permit the transfer to one or at the most two points in the office.

According to the present invention the facilities provide for each position or section in a line of telephone test boards to become a potential transfer point and in the larger of said offices these facilities extend to arrangements for transferring a call to any one of a plurality of positions or sections. In other words an attendant at a multiple type of telephone switchboard may upon receiving an incoming call over an intercity communication trunk circuit, transfer the incoming call signal to any particular one of a plurality of trunk lamps, each of which is located at a different position or section in the switchboard. The multiple type of switchboard may comprise two or more sections, each section having one or more operators' or attendants' positions.

A feature of the present invention is that it provides a more flexible arrangement than heretofore known in that an incoming call signal may be transferred to a signal lamp at any one of even more than twenty positions.

Another feature is that an incoming call signal may be transferred to a lamp at any one of a plurality of telephone switchboard positions and then again transferred to another lamp at one of the other positions.

Still another feature is that the arrangement may provide by proper cross-connections for any trunk circuit to have either a primary or a secondary answering appearance at any position of the multiple type of telephone switchboard.

Another feature is the provision of having a sequence circuit associated with the trunk circuits or the positional keysets.

Another feature is the provision of recalling the attendant at a primary position after the signal has been transferred to another position and the attendant at the latter position has failed to answer.

Another feature is the provision of a transfer key so that for night operation all signals of different trunk circuits normally appearing in different primary positions may be caused to appear at some one position used as a night or light load position.

A more complete understanding of the invention may be obtained from the accompanying drawings in which

Figures 1, 2 and 3 represent an arrangement of the invention when interconnected in accordance with the block diagram Fig. 1—A, wherein Fig. 1 shows two-way communication lines and associated line equipment, Fig. 2 a control circuit for transferring calls, and Fig. 3 answering jacks and lamps, associated busy lamps, position transfer keys, position sequence circuit relays and cord circuits. The cord circuits are shown in detail by Fig. 1—B.

Figs. 4 and 5 represent another arrangement of the invention, when interconnected in accordance with the block diagram 4—A, wherein Fig. 4 shows two-way communication lines and associated line equipment including a crossbar switch and Fig. 5 shows answering jacks and lamps, busy lamps, position transfer keys, cord circuits of the type shown by Fig. 1—B and a relay type control circuit.

Figs. 6, 7 and 8 represent still another arrangement of the invention when interconnected in accordance with the block diagram 6—A, wherein Fig. 6 shows two-way communication lines and associated line equipment including a crossbar switch and Fig. 7 shows answering jacks and lamps, busy lamps, position transfer keys, cord circuits of the type shown by Fig. 1—B and a different relay type control circuit than that shown in Fig. 5.

Fig. 8 is an alternative arrangement of Fig. 7 which uses a control circuit consisting of a rotary type stepping switch.

Figures 1, 2 and 3

Referring to Figs. 1, 2 and 3, **100** is an interoffice line, which terminates in jacks **300, 301** and

302 of positions 1, 2, and 3, respectively. Associated with these jacks are answering lamps 303, 304 and 305 and busy lamps 306, 307 and 308, respectively. The attendant at each position is provided with a cord circuit, conventionally represented by the boxes 309, 310 and 311 and shown in detail by Fig. 1—B. Calls may be answered with plug 103 by plugging into the jack associated with the lighted answering lamp, or originated with plug 104 by plugging into the jack of the line selected for an outgoing call and ringing with key 105. Additional jacks, answering and busy lamps may be provided at additional positions, not shown. As shown in the drawings, position 3 is cross-connected by the conductor 200, so that the associated answering lamp 305 is lighted on an incoming call, that is, position 3 is a primary answering position. Position 2 is not thus cross-connected, its lamp 304 is lighted only on a transferred call, and is accordingly a secondary answering position. Position 1 is cross-connected by the conductor 201 so that when night key 312 is operated, it is then a so-called "night" position at which all calls incoming over line 100 and over all other lines with night keys similarly operated, are answered. Under this condition it is a primary position; when the night keys are not operated it is a secondary position. The night key 312 may be multipled with a number of lines in a predetermined group so that all these grouped lines may be answered at position 1 when said key is operated. It is to be understood that any position in the switchboard line up may be arranged as either a primary or secondary answering position by suitable cross-connection. Any position may also be a "night" position.

In order to transfer incoming calls from one position to another, line 100 is provided with a rotary type stepping switch, for which 202 is the stepping magnet. This magnet causes the brush arms 203 and 204 to move around the contact banks 205 and 206, respectively.

Each terminal of bank 205 is connected to a conductor leading to an answering lamp at the respective positions whereby each lamp may be selectively lighted as required. Each contact of bank 206 is connected to a conductor to which ground is selectively connected by one of the positional transfer keys as 313, 314, 315, which in effecting a transfer identifies the position to which the call is to be transferred. The line being transferred is identified by the insertion of the plug 103 of cord circuit C in the associated line jack and by then operating listening key 106. In order to use a transfer circuit arrangement common to all positions, a so-called sequence circuit is used. This consists of relays 316, 317, 318 and 319, 320 and 321, which are arranged in a manner similar to the relays of an automatic listening, straightforward trunking system, which is well known in the telephone art. Thus arrangement makes the common transfer equipment available to only one position at a time and thereby avoids the possibility of interference if two attendants should attempt to transfer calls simultaneously. Another feature of the sequence circuit is the arrangement whereby calls awaiting transfer are handled progressively through the sequence, but not necessarily in the order in which transfers are attempted.

In the description before given, particular reference was made to the line 100 and its associated apparatus. A similar description also applies to the other lines 101 and 102. A more complete understanding of the operation of the arrangement of Figs. 1, 2 and 3 may be obtained from the following detailed description.

Let it be assumed that an attendant at a distant telephone test board desires to communicate with the attendant located at position 2 and selecting the line 100, applies ringing current thereto. Ringing relay 107 then operates through condenser 108 and the left outer break contacts of cut-off relay 110 and closes an obvious circuit through the winding of relay 109, which operates and locks through its inner right contacts to ground on the left inner contacts of relay 110. Relay 109, in operating connects battery with its left outer front contacts to conductor 111, thence through cross-connection 200 and over conductor 343 to ground through lamp 305. The usual audible alarm and auxiliary position pilot lamp may be operated by inserting a low resistive relay between all lamps in a position and this ground. Also, relay 109 connects battery with its right outer front contacts to conductor 322, lighting busy lamps 306, 307 and 308, and busy lamps at other positions not shown. The attendant at position 3 now responds by inserting the answering plug of a cord circuit which is conventionally represented by a box 311, into jack 302. This cord circuit, as before stated, is represented in detail by Fig. 1—B, to which the description now refers. A circuit is closed from battery through the winding of sleeve relay 124 over sleeve conductor of plug 103 and jack 302, over conductor 323, through winding of relay 110 and right winding of marginal relay 112 to ground. If the line is arranged for supervision, supervisory relay 113 operates, thereby connecting resistance 114 in shunt with supervisory lamp 115 which remains dark. If line 100 is not arranged for supervision, relay 113 does not operate and lamp 115 is lighted in a circuit from battery through resistance 116 to ground on the contacts of sleeve relay 124, which, operated, when plug 103 was inserted into jack 302. Relay 110 operates but relay 112 does not operate at this time. In operating, relay 110 disconnects the circuit of relay 107 from the conductor of line 100, opens the locking circuit of relay 109 which releases, connects battery with its right inner contacts to conductor 322 thereby maintaining the lighting of the busy lamps after the release of relay 109, and with its right outer front contacts connects ground to the left inner front contacts of relay 112 so that relay 112 may lock when it subsequently operates. The release of relay 109 disconnects battery from conductor 111, thereby extinguishing lamp 305. The attendant at position 3 now operates listening key 106, thereby establishing communication over line 100 with the attendant at the distant office. Having been informed that communication with the attendant at position 2 is desired, the attendant at position 3 now transfers the call by operating the position transfer key 314, which is the key at position 3 assigned to the transfer of calls to position 2. A circuit is now closed from battery 324, through the winding of relay 320, and right operated contacts of key 314 to ground. Sequence circuit relay 320 operates and a circuit is closed from battery through the winding of relay 321, lower operated front contacts of relay 320 to conductor 325. If neither relay 318 or 316 of positions 1 and 2 is operated, due to the previous engagement of the sequence circuit by these positions, the circuit before traced is extended over conductor 325, through lower back contacts of relay 318, over conductor 327, through lower back contacts of relay 316, over conductor 326,

through winding of relay 207 to ground 211 on the break contacts of relay 208. Relays 207 and 321 operate in this circuit. Relay 207 closes a circuit from battery through the winding of slow releasing relay 208 and contacts 209 and 210 to ground. Relay 208 in operating disconnects ground 211, and the circuit is maintained through contacts 210 of relay 207 which is locked operated. If either relay 316 or 318 were previously operated, then the circuit through the winding of relay 321 is open at the back contacts of either relay 316 or 318. If relay 316 is operated its winding is connected to battery 324 through the upper inner break contacts of relays 319 and 321; if relay 318 is operated, battery 324 is connected through the upper inner break contacts of relay 321.

A general description of the operation of the sequence circuit, which as before stated is used in the telephone art for straightforward trunking will now be given. Relay 316 may be said to be in the first, relay 318 in an intermediate and relay 320 in the last position. If relays 318 and 319 are operated, and lines are awaiting service in the last and first positions, relay 320 is operated but relay 316 is not operated, since its operating path is disconnected by the lower break contacts of relay 318. When relay 318 releases, conductor 327 is transferred from the winding of relay 319 to conductor 325 by the continuity contacts of relay 318, thereby holding relay 207 operated through the lower operated contacts of relay 320 and the winding of relay 321, which operates. Relay 316 does not operate since its circuit, previously opened at relay 319 is also opened by the upper inner break contacts of relay 321 before relay 319 releases to close its portion of said path. Relays 317, 319 and 321 are slightly slow to release to assure this feature. When relay 320 releases, releasing relay 321, the circuit through relay 207 is opened and this relay releases, releasing in turn slow releasing relay 208, which after an interval reconnects ground 211. During this open interval, relay 316, and also relay 318, if this relay is again awaiting operation, now operate. Relay 316, however, disconnects conductor 327, so that now relay 317, and not relay 319 or 321, operates. Thus, lines awaiting connection are served by the sequence circuit sequentially in accordance with their numbered position in the sequence, and not in accordance with the order of their call for service. In Fig. 3 only three pairs of sequence relays are shown corresponding to positions 1, 2 and 3 respectively. For additional positions, sequence relays may be added establishing the same interconnections between positions as are shown, battery 324 being connected to the relays of the last position as it is shown connected to relays 320 and 321.

Relay 321 operating in response to the operation of key 314 and relay 320 as before described connects ground through its upper outer contacts to conductor 328, thence through the left contacts of key 314 to conductor 329 and the second terminal of hunting switch bank 206. This is for the purpose of marking the stopping point for brush arm 204 and associated arm 203, as will hereinafter be described. Relay 321 in operating also disconnects conductor 344, with its upper inner contacts, from battery 324, thereby preventing the operation of relays 318 and 316, if a transfer key at positions 1 or 2 should now be operated, and also with its lower inner contacts closes a circuit which is traced from battery through the right and left series connected windings of relay 212, over conductor 330, through lower inner contacts of relay 321, upper contacts of relay 320 to ground through the positional release lamp 331. Relay 212 operates in this circuit but lamp 331 does not light because of the high resistance of the right winding of relay 212. Relay 212 in operating closes a circuit from ground through its contacts, left inner back contacts of relay 213, and winding of slow releasing relay 214 to battery. Relay 214 operates and closes a circuit from battery 215 through resistance 216, left contacts of relay 214, over conductor 332, through lower outer operated contacts of relay 321, to conductor 333, which is also indicated on Fig. 1—B to which reference should now be made. From conductor 333 the circuit continues through the lower outer operated contacts of listening key 106, over conductor 117, through sleeve conductors of plug 103 and jack 302 and thence over the sleeve circuit before traced. Since battery 215 is of higher voltage than the regular sleeve circuit battery 118 marginal relay 112 now operates through its right winding and locks through its left winding and left inner contacts to ground on the right outer front contacts of sleeve relay 110. Relay 112 in operating closes a circuit from battery through the left outer back contacts of relay 109, through right front contacts of relay 112, over conductor 217, through winding of relay 218, over conductor 219 to ground on the right outer contacts of relay 119. Relay 218 operates and closes a circuit from battery through the winding and break contacts of stepping magnet 202, right outer contacts of relay 218, over conductor 220, through right inner contacts of relay 213, back contacts of relay 221 to ground through operated contacts 222 and 223 of relay 214. Magnet 202 by means of its self-interrupting contacts rotates brush arms 203 and 204 around their respective contact banks in the direction indicated by the arrows. The brush arms 203 and 204 are shown resting normally on bank contacts No. 1; it should be understood, however, that these brush arms may rest normally on any one of the contacts, the position depending on the particular set of contacts required by the last selection. Relay 218 also closes a circuit from battery through the winding of relay 221, over conductor 227, through left contacts of relay 218, over conductor 223 to brush arm 204. When brush arm 204 reaches contact 2 of bank 206 the circuit is continued over the path previously traced to ground on the upper outer operated contact of relay 321. Relay 221 operates opening the operating path of magnet 202 thus causing the selector brush arms 205 and 206 to remain on contact 2 of their respective banks. Relay 221 operated also, closing a circuit traceable from ground on the operated contacts 223 and 222 of relay 214, front contacts of relay 221, to battery through the winding of relay 213, which operates and locks through its left inner front contacts to ground on the contacts of relay 212. Relay 213 also opens the circuit of relay 214 which releases after an interval, but before releasing a circuit is closed from ground through contacts 223, right outer contacts of relay 213, over conductor 224, right inner contacts of relay 218, over conductor 225, and through right winding of relay 119 to battery. Relay 119 operates and locks through its left winding and inner contacts to ground on the left outer operated contacts of relay 112. The circuit of relay 218 is opened and this relay releases, releasing relay 221. When relay 213 operated

and relay 214 released as before described a short-circuit was closed around the right winding of relay 212, which is traced from the common terminal of the two windings of relay 212, through left outer contacts of relay 213 to battery on the right normally closed contacts of relay 214. Relay 212 now holds on its left winding, and the resistance of its circuit being reduced lamp 331 is now lighted, which is an indication to the attendant at position 3 that the transferring apparatus has functioned. Key 314 is accordingly released, effecting the release of relays 212, 213, 320 and 321, and plug 103 is withdrawn from jack 302. Sleeve relay 110 now releases also releasing relay 112. Relay 119, however, remains operated through the right outer back contacts of relay 110, and with its right inner contacts maintains battery on conductor 322, the busy lamps at all positions remaining lighted. The release of relay 112 closes a circuit from battery on the left outer contacts of relay 109, right back contacts of relay 112, left outer front contacts of relay 119, over conductor 226, over brush arm 203, contact 2 of bank 205, over conductor 334 and to ground through answering lamp 304 at position 2.

The attendant at position 2 now responds by inserting into jack 301 the plug of cord circuit 310, thereby operating over the sleeve circuit sleeve relay 110, but not the marginal relay 112. The circuit through the left winding of relay 119 is opened, and this relay releases opening the circuit, before traced, for lamp 304, which is extinguished. The busy lamps, however, remain lighted, due to battery being reconnected to conductor 322 by the right inner contacts of relay 110. When the listening key of cord circuit 310 is operated, the attendant at position 2 is then in communication with the distant office over the line 100. The flexibility of the transferring feature of my invention is such, that now, should the attendant at position 2 desire to transfer the call, this may be done in the same manner as the original call was transferred from position 3 to 2. If, for instance a transfer to position 1 is required, the attendant at position 2 operates key 341, thereby causing sequence relays 318 and 319 to function in connection with the common relays 208, 207, 212, 221, 214 and 213 in the same manner as did relays 320 and 321. In this case ground is connected over conductor 342 to terminal No. 1 of bank 206 and stepping magnet 202 rotates brush arm 204 until this grounded terminal is found. Lamp 303 is lighted over conductor 340, terminal No. 1 of bank 205, brush arm 203, over conductor 226 and the circuit previously traced for lamp 304.

Position 1, (or any position) as before stated may be arranged to be used as a night position. Night key 312 is shown associated with line 100, over conductor 335. Other lines may be grouped with line 100 for night answering by connecting conductor 335 to the corresponding conductors of these lines.

In a similar manner night keys 336 and 337 are associated with lines 101 and 102, over conductors 338 and 339. When key 312 is operated and relays 107 and 109 operate, as before described, in response to incoming ringing current, a circuit is traced from battery through the contacts of key 312, over conductor 335, through left inner operated contacts of relay 109, over conductor 120, cross-connecter 201, conductor 340 and to ground through lamp 303, which lights. The lamps at the primary positions also light, but are not answered, since these positions are unattended at this time.

The operation of the arrangement of Figs. 1, 2 and 3 have been described for an incoming call. This arrangement may also be used for outgoing calls. The attendant at position 3, for instance, may originate a call by plugging into jack 302, with calling plug 104 of cord circuit C. Cut-off relay 110 is operated and the busy lamps at all positions are lighted as before described. The attendant now operates ringing key 105, connecting thereby, ringing current source 121 to the tip conductor and ground 122 to the ring conductor. When the distant attendant answers, communication is established by operating listening key 106, connecting thereby the telephone circuit 123.

Figures 4 and 5

Referring to another arrangement of the invention disclosed by Figs. 4 and 5, in Fig. 4 are shown three intercommunication lines 400, 401 and 402, which are arranged to cooperate with a crossbar switch CB which is of the same general construction as that described in Patent No. 2,021,329, issued November 19, 1935 to J. N. Reynolds, from which patent a complete description may be obtained. The function of switch CB is to cooperate over transfer trunk 500 with positional transfer keys, as 536, 537, 538 or 539 of Fig. 5 in order to transfer calls to various positions in a telephone switchboard line-up. The switch CB is shown with lines 400, 401 and 402 connected to cooperate with verticals 1, 2 and 10, respectively. Intervening verticals, 3, 4, 5, 6, 7 and 8 are omitted as being unnecessary for the purpose of this description, and are symbolized by vertical 9, which is shown unconnected. Only four horizontals are shown, each of which represents positions respectively 1, 2 and 3 of Fig. 5, and position 4, not shown. Horizontals 5, 6, 7, 8, 9 and 10 are not shown since these are not necessary in describing the invention. By means of the switch CB ten lines, as 400, 401, 402, etc., may be served, and transferred to any one of ten positions. By using two switches any one of twenty lines or trunks may be transferred to any one of ten positions, or alternatively, any one of ten lines may be transferred to any one of twenty positions.

When a call is initiated over one of the lines, say line 400, relays 403 and 404 operate so as to light answering lamp 503 at position 3 over conductor 505, and the busy lamps at all positions are lighted over conductor 506. Assuming that the night key 504 is operated, answering lamp 501 at the position will also be lighted. This is in accordance with cross-connections 405 and 406. The answering lamps for line 400 at position 1, when key 504 is not operated and at position 2 are lighted only on transferred calls. Any position may be cross-connected so as to function as either a primary or secondary position. In response to a lighted answering lamp, the attendants plug into the answering jacks 507, 508 or 509 with a cord circuit 510, 511 or 512, conventionally represented by a box but shown in detail by Fig. 1—B, thereby extinguishing the lighted answering lamps. In order to transfer a call from one position to another, a position transfer key, as 536, 537, 538 or 539, corresponding to the position to which the transfer is to be made is operated. This causes the sequence circuit shown at the bottom of Fig. 5 to function, provided it is not already in use at some other position. In operat-

ing, the sequence circuit causes a horizontal or selecting magnet 407, 408, 409 or 410, corresponding to the position to which the transfer is to be made, to be energized and then also a vertical or holding magnet 411, 412 or 413, corresponding to the line 400, 401 or 402, which is to be transferred. The contacts of switch CB, corresponding to the intersection of the operated vertical and horizontal, are now closed. When the transfer apparatus has completed its operation a signal is given to the attendant by the lighting of the positional release lamp 513, 514 or 515. The operated position key is then released, and when the plug of the cord circuit, which was used to answer the call, is withdrawn from the answering jack, the lamp at the position to which the transfer is to be made is lighted. In the description hereinbefore given, particular reference was made to the line 400 and its associated apparatus. A similar description also applies to the other lines 401 and 402. A more complete understanding of the operation of the invention may be obtained by tracing the progress of a call as hereinafter described.

Let it be assumed that an attendant at a distant switchboard desires to initiate a call over the line 400 for the attendant located at position 2, which is accessible to line 400 only as a secondary answering position. Relay 403 operates on incoming ringing current through condenser 414 and operates relay 404 through an obvious circuit. Relay 404 locks through its right inner contacts to ground on the left contacts of cut-off, or sleeve, relay 415, and connects battery with its right outer contacts to conductor 506, thereby lighting busy lamps 517, 518, 519 and lamps at other positions not shown. With its left outer front contacts relay 404 connects battery to conductor 416, thence over cross-connecter 405 and conductor 505 to ground through answering lamp 503, which lights at position 3. The attendant thereat answers by inserting the plug of cord circuit 512, that is, plug 103 or the cord circuit shown by Fig. 1—B, into jack 509, thereby closing a circuit over the sleeve conductors of plug 103, jack 509 and conductor 520 through the winding of cut-off relay 415 and the right winding of marginal relay 517. Relay 415 operates but not relay 517. Relay 415 opens the locking circuit of relay 404, which releases, and connects battery with its right inner contacts to conductor 506 maintaining the lighting of the busy lamps. The release of relay 404 removes battery from conductor 416, extinguishing lamp 503. The attendant at position 3 is now in communication with the distant attendant over line 400, when listening key 106 is operated. On being informed that a transfer to position 2 is desired, position transfer key 538 is accordingly operated, closing thereby a circuit from battery 521 through the winding of sequence relay 522 to ground on the right operated contacts of key 538. Relay 522 operates, and assuming that neither relay 523 nor 524 is operated a circuit is closed from ground 418 through normally closed contacts of slow releasing relay 419, through winding of relay 420, over conductor 525, through normally closed lower contacts of relays 524 and 523, lower operated front contacts of relay 522 and winding of relay 526 to battery. Relays 420 and 526 operate. Relay 420 in operating closes an obvious circuit through the winding of relay 419 and locks to ground on its own contacts. Relay 419 operates and disconnects ground 418. Relay 526 disconnects with its upper inner contacts battery 521 from conductor 527, thereby preventing the operation of relays 523 or 524, if an attendant at position 1 or 2 should now attempt to transfer a call; connects ground on its upper outer contacts to conductor 528, whence it is extended through the left operated contacts of key 538, over conductor 529 to battery through the winding of horizontal selecting magnet 408, which is energized. Another circuit is closed from ground through lamp 515, over conductor 530, through upper contacts of relay 522, lower inner contacts of relay 526, over conductor 531, and through the series connected windings of relay 421 to battery. Relay 421 operates but due to the high resistance of its right winding lamp 515 is not lighted. Relay 421 closes a circuit from ground through left inner back contacts of relay 422 to battery through the winding of slow release relay 423, which operates and connects with its left contacts battery 424 in series with resistance 425 to conductor 532, thence through lower outer contacts of relay 526 to conductor 333. Referring now to cord circuit C of Fig. 1—B the circuit continues through lower outer contacts of operated listening key 106 to sleeve conductor 117, thence over the sleeve conductors of plug 103 and jack 509 through the windings of relays 415 and 417 as herein before traced. Due to the higher voltage of battery 424, marginal relay 417 now operates and locks from battery through its left winding and inner contacts to ground on the right outer front contacts of relay 415 and connects ground on its right contacts to conductor 426, thence through winding of vertical holding magnet 413 over conductor 427 to battery on the left outer back contacts of relay 404. Magnet 413 operates and connects ground with its left contacts to conductor 428, whence the circuit continues through left inner back contacts of relay 429 over conductor 430 and through the right winding of relay 422 to battery. Relay 422 operates and locks through its left winding and inner contacts to ground on the operated contacts of relay 421 and releases relay 423. Relay 423 in releasing connects ground through its right inner contacts and right contacts of relay 422 to conductor 431, thence through left outer break contacts and right winding of relay 429 to battery on the left outer operated front contacts of relay 417. Relay 429 operates and locks through its left winding and inner front contacts to ground on conductor 428. The left outer contacts and left inner front contacts of relay 429 are arranged so that the latter close before the former break, thereby assuring the locking up of relay 429 before its operating circuit is broken.

When relay 423 released as herein before described it closed a circuit from battery through its right outer break contacts, left outer operated contacts of relay 422 to the junction point between the left and right windings of relay 421. This is equivalent to short-circuiting the right winding of relay 421 and lamp 515 now lights, relay 421 holding on its left winding. The attendant now knows that the selection has been completed and releases key 538, which releases relays 522, 526, 420, 419, 421, 422 and magnet 408. The plug 103 is now withdrawn from jack 509 which releases relays 415 and 417. Because of the right outer continuity contacts of relay 415 ground is connected to conductor 432, before ground is removed from the left locking winding of relay 417. Consequently, relay 417 does not release removing ground from conductor 426

until the locking circuit through the right contacts of magnet 413 is established.

With magnets 408 and 413 operated consecutively as herein before described, contacts 433 of the crossbar switch CB are closed and when relay 417 released a circuit was closed from battery on its left outer contacts over conductor 434, through contacts 433, over conductor 435 to ground through lamp 502, which lights. Battery is connected to conductor 506 by the right contacts of relay 429, thereby maintaining the lighting of the busy lamps. The attendant at position 2 now responds with the answering plug of cord circuit 511, thereby again operating relay 415, but not marginal relay 417. The operation of relay 415 releases magnet 413, opening the switch contacts 433 and extinguishing lamp 502. As in the case of the arrangement of Figs. 1, 2 and 3 the attendant at position 2 may now, if such is required re-transfer the call to any other position.

Position 1, (or any other position) as before stated, is arranged to be used as a night position. When key 504 is operated, battery on the contacts of this key is extended over conductor 533 to the left inner contacts of relay 404 so that when this relay operates on an incoming call over line 400, battery is connected to lamp 501 over conductor 436, cross-connection 406 and conductor 534. Other lines, not shown, in the same group as line 400 may be multipled with line 400 over conductor 437 so that their respective lamps are also lighted on incoming calls, when key 504 is operated. In like manner another night key 535 may be arranged to connect for night answering, another group of lines, of which group, lines 401 and 402 are shown.

The operation of the arrangement of Figs. 4 and 5 has been described for an incoming call. It may also be used for outgoing calls in the same manner as was described for the arrangement of Figs. 1, 2 and 3.

Figures 6, 7 and 8

Referring now to another arrangement of the invention as disclosed by Figs. 6, 7 and 8, the combination of Figs. 6 and 7 will now be discussed. In Fig. 6 are shown three intercommunication lines 600, 601 and 602 which are arranged to cooperate with a cross-bar switch CB similar to that of Fig. 4. The function of switch CB is to cooperate over transfer trunk 700 with positional transfer keys, as for instance, 736, 737, 738 or 739, of Fig. 7, to transfer calls to various positions in the switch board line up. The switch CB is shown with lines 600, 601 and 602 connected to function with verticals 1, 2 and 10, respectively. Intervening verticals 3, 4, 5, 6, 7 and 8 are omitted as being unnecessary for the purpose of this description, and are symbolized by a vertical 9, which is shown unconnected. Only four horizontals are shown, each of which represents positions, respectively, 1, 2 and 3 of Fig. 7, and position 4 not shown. Horizontals 5, 6, 7, 8, 9 and 10 are not shown since these are not necessary in describing the invention. By means of the switch CB ten lines as 600, 601, 602, etc., may be served and transferred to any one of ten positions. By using two switches any one of twenty lines may be transferred to any one of ten positions or alternatively, any one of ten lines may be transferred to any one of twenty positions. Furthermore, by using an N number of cross-bar switches connected together horizontally there is provided space for ten times N number of trunk circuits to ten positions of switchboard; by using M number of cross-bar switches connected together vertically there is provided space for ten trunk circuits to ten times M positions; and by using N number of cross-bar switches connected together horizontally and M number of cross-bar switches connected together vertically there is provided by the joint arrangement ten times N number of trunk circuits to ten times M number of positions, N and M being any desired numbers.

When a call is initiated over one of the lines, say line 600, relays 603 and 604 operate so as to light lamp 701 at position 1 of Fig. 7, assuming that the night key 704 is operated so that this position is also a primary answering position. The answering lamp at position 3 is lighted over conductor 705, and the busy lamps at all positions are lighted over conductor 706. This is in accordance with cross-connections 605 and 606. The answering lamps for line 600 at positon 1, when key 704 is not operated and at position 2 are lighted only on transferred calls. Any position may be cross-connected so as to function as either a primary or secondary position. In response to a lighted answering lamp, the attendants plug into the answering jacks 707, 708 or 709, with a cord circuit 710, 711 or 712, conventionally represented by a box but shown in detail by Fig. 1—B, thereby extinguishing the lighted answering lamps. In order to transfer a call from one position to another, a position transfer key such as 736, 737, 738 or 739, corresponding to the position to which the transfer is to be made, is operated. This causes the relay control circuit, consisting of positional relays 713, 714 and 715 and common relays 716, 717 and 718 to function, provided it is not already in use. In operating, the control circuit causes a selecting magnet 607, 608, 609 or 610, corresponding to the position to which the transfer is to be made to be energized and then also a holding magnet 611, 612 or 613 corresponding to the line 600, 601 or 602 which is to be transferred. The contacts of switch CB corresponding to the intersection of the operated vertical and horizontal are now closed. When the transfer apparatus has completed its operation, a signal is given to the attendant by the lighting of the positional release lamp 719, 720 or 721. The operated position key is then released, and when the plug of the cord circuit, which was used to answer the call is withdrawn from the answering jack, the lamp at the position to which the transfer is to be made is lighted. A more complete understanding of the invention may be obtained by tracing the progress of a call as hereinafter described.

Let it be assumed that an attendant at a distant switchboard desires to initiate a call over the line 600 for the attendant located at position 2, which is accessible to line 600 only as a secondary answering position. Relay 603 operates on incoming ringing current through condenser 622 and operates relay 604 through an obvious circuit. Relay 604 locks through its right inner contacts to ground on the left inner contacts of cut-off or sleeve relay 614, connects battery with its right outer contacts to conductor 706, thereby lighting busy lamps 722, 723, and 724 and lamps at other positions not shown. With its left outer front contacts relay 604 connects battery to conductor 623, thence over cross-connection 605 and conductor 705 to ground through answering lamp 703, which lights at position 3. The attendant thereat answers by

inserting the plug of cord circuit 712, that is, plug 103 of the cord circuit shown in Fig. 1—B into jack 709, thereby closing a circuit to ground over the sleeve conductors of plug 103, jack 709 and conductor 725 through the winding of cut-off relay 614 and the right winding of marginal relay 615. Relay 614, but not relay 615, operates. Relay 614 opens the locking circuit of relay 604, which releases, and connects battery with its right inner contacts to conductor 706, maintaining the lighting of the busy lamps. The release of relay 604 removes battery from conductors 623 and 705 connected in series, thereby extinguishing lamp 703. The attendant at position 3 is now in communication with the distant attendant over line 600, when listening key 106 is operated. On being informed that a transfer to position 2 is desired, position transfer key 738 is accordingly operated, closing thereby a circuit from battery, through the winding of marginal relay 716, over conductor 726, through serially connected windings of relay 715, to ground through the right operated contacts of key 738. Relay 715 now operates in this circuit, provided relay 713, 714 or another similar relay, at some other position not shown, is not operated. A discussion of the means whereby the control circuit functions so as to avoid interference, when a simultaneous attempt to transfer a call is made, is discussed hereinafter. Relay 715 with its upper inner contacts short circuits its high resistance upper winding which so reduces the resistance of the circuit that marginal relay 716 operates. Relay 715 continues to hold on its lower winding. Relay 716 operated, closes a circuit from ground on its left contacts over conductor 727, through upper outer operated make contacts of relay 715, left operated contacts of key 738, over conductor 728, and to battery through winding of horizontal selecting magnet 608, which operates. Another circuit is closed from battery through the right contacts of relay 716, winding of relay 717 to ground on the left outer break contacts of relay 718. Relay 717 operates relay 718 in a circuit from ground through the winding of relay 718, operated front contacts of relay 717 to battery on the operated right contacts of relay 716, to which relay 718 locks through its left inner contacts. Relay 718 in operating, opens the operating path of slow release relay 717 and with its right outer contacts connects battery 729, through resistance 730 to conductor 731, through lower outer contacts of relay 715 to conductor 333, which is identical with conductor 333 of the cord circuit of Fig. 1—B. The tracing of the circuit is now continued through lower outer contacts of listening key 106 to sleeve conductor 117, thence over the sleeve conductors of plug 103 and jack 709, through the windings of relays 614 and 615 as before traced. Due to the higher voltage of battery 629, marginal relay 615 now operates and locks from battery through its left winding and inner contacts to ground on the right outer operated front contacts of relay 614 and connects ground on its right contacts to conductor 616, thence through winding of vertical holding magnet 613, over conductor 617 to battery on the left outer back contacts of relay 604. Magnet 613 operates.

When relay 718 operated and slow release relay 717 releases, a circuit is closed with the inner right contacts of relay 718 from battery on the right contacts of relay 716 through back contacts of relay 717, over conductor 732 through lower inner contacts of relay 715, over conductor 733 to ground through release lamp 721, which is lighted, indicating to the attendant that the transferring apparatus has functioned. Key 738 is then released, releasing relays 715 and 716 and in turn magnet 608 and relay 718. The plug of the cord circuit is now withdrawn from jack 709, thereby opening the sleeve circuit and causing the release of relays 614 and 615. The original operating circuit of magnet 613 is opened by the removal of ground from conductor 616 but magnet 613 remains energized from ground on conductor 618 through its left contacts and winding to battery over conductor 617. By reason of the continuity contacts of relay 614 ground is connected to conductor 618 before ground is removed from conductor 616 by the release of relay 615, thereby assuring the holding of magnet 613. A circuit is now closed for lighting lamp 702 at position 2, which is traceable from battery on the left back contacts of relay 615, over conductor 619, through operated switch contacts 620, over conductors 621 and 734, through lamp 702 to ground.

If the attendant at position 2 should delay in answering, the attendant at position 3 may be recalled, relays 603 and 604 functioning as before described to light lamp 703. In this case relay 604 is adjusted so that battery is connected to conductor 706, by its right outer contacts before battery is removed from conductor 617 by its left outer back contacts, magnet 613 remaining operated thus maintaining lamp 702 lighted. When either attendant at position 2 or 3 answers by plugging into jack 708 with the plug of the cord circuit 711, relay 614 is operated releasing relay 604 thereby extinguishing lamp 703, removing ground from conductor 618 releasing magnet 613, opening contacts 620 and thereby extinguishing lamp 702.

The means whereby interference is avoided if attendants at different positions attempt to transfer calls simultaneously will now be discussed. When key 738 was operated as before described it was assumed that the common control circuit was not then in use. Suppose, however, that the circuit is being used at position 2, that the associated relay 714 is operated and the upper high resistance winding of relay 714 is short-circuited and connected to ground through the operated right contacts of key 735. Under this condition the two serially connected windings of relay 715 are accordingly shunted by the low resistance lower winding of relay 714. Relay 715 is marginal under this condition and does not operate. Consequently position 2 encounters no interference from position 3. If key 735 should be operated simultaneously with key 738, relays 714 and 715 would then operate together. If each relay should close its upper inner front contacts simultaneously and short circuit its upper winding then the individual current flow through the respective lower windings of relays 714 and 715 would be so small that these relays would immediately release. If now one of the relays, say relay 714 should release before relay 715, then the low resistance shunt on the lower winding of relay 715 is removed and relay 715 holds, and at the same time shunts effectively the two serially connected windings of relay 714, which continues in the released condition.

Referring now to the alternative arrangement in which Fig. 6 cooperates with Fig. 8, trunks 600, 601 and 602 are associated with jack and lamp equipment in Fig. 8, identical with that of Fig. 7. Also, the cord circuits 817, 818 and 819, are the

same as in Fig. 7. However, in Fig. 8, instead of a relay type of control circuit, a control circuit of the stepping switch type is used, which consists of a stepping magnet 800 and associated contact banks 801, 802, 803 and 804. In cooperation with the stepping switch are four relays 805, 806, 807 and 808. When one of the positional transfer keys as 809, 810, 811, 812 is operated, start relay 805 is operated which causes the control circuit to operate and associate itself with the position from which the desired transfer is to be made. The transferring apparatus of Fig. 6 is then caused to function in the same manner as it did in cooperation with Fig. 7. A more complete understanding of this arrangement of the invention may be obtained from the following detailed description.

Let it be assumed that a call over line 600 causes the apparatus of Fig. 6 to function as hereinbefore described, connecting battery to conductors 706 and 705, lighting thereby busy lamps 814, 815, 816 and busy lamps at positions not shown, and answering lamp 813 at position 3. The attendant at position 3 responds by inserting the plug of cord circuit 819 into jack 820. Relay 614 operates, but relay 615 does not operate. Lamp 813 is extinguished and the busy lamps remain lighted as before described. When the listening key 106 of the cord circuit of Fig. 1—B, which shows cord circuit 819 in detail, is operated communication over line 600 is established. Assuming now that the attendant at position 3 is requested to transfer the call, as in the case of the arrangement of Figs. 6 and 7 to position 2, position transfer key 811 is accordingly operated, thereby closing a circuit from battery through the winding of relay 805, over conductor 821, through right inner contacts of key 811 to ground. Relay 805 operates and closes a circuit from ground on its contacts, through left outer contacts of relay 806 to battery through the interrupting contacts and winding of magnet 800. Magnet 800 now causes brush arms 822, 823, 824, 825 to rotate in the direction indicated, beginning the rotation from any terminal on which by chance they may rest as a result of a previous operation. When brush arm 824 makes contact with terminal 3 of bank 803, corresponding to position 3, ground is connected through the right contacts of key 811 over conductor 826, through said terminal 3, over brush 824 to battery through winding of relay 806, which operates and opens the circuit through the winding of stepping magnet 800, thereby stopping the switch with all brush arms resting on the third terminals. If brush arm 824 should happen to rest on the third terminal as a result of a previous operation then relay 806 would operate immediately preventing any movement of the switch. Relay 806 in operating also connects ground with its left inner contacts to brush arm 823, also resting on terminal 3 of its associated bank 802. The circuit is continued over conductor 831, through left contacts of key 811, over conductor 728, and thence through the circuit before traced in connection with the description of the operation of Figs. 6 and 7. Relay 806 also closes a circuit with its right contacts from battery over conductor 827 through the winding of relay 807 to ground on the left outer contacts of slow operating relay 808. Relay 807 operates and closes a circuit from battery on conductor 827 through the front contacts of relay 807 and winding of relay 808 to ground. Relay 808 operates, releases relay 807, and locks with its left inner contacts to battery on conductor 827. Relay 808 in operating also connects battery 828 through resistance 829 and its right outer contacts to brush arm 825, which is resting on terminal 3 of bank 804, which terminal is connected with conductor 333 which corresponds to conductor 333 of the cord circuit C of Fig. 1—B. Marginal relay 615 operates over the sleeve circuit, including sleeve conductor 725, as before described in connection with Fig. 7. This is because battery 828 has a voltage higher than that of the regular sleeve battery 118 of cord circuit C of Fig. 1—B. All apparatus of Fig. 6 now functions as before described, and contacts 620 of switch CB are closed. A circuit is also closed from battery on conductor 827 through back contacts of relay 807, right inner contacts of relay 808, over conductor 834 and brush arm 822 through terminal 3 of bank 801 and over conductor 835 to ground through position release lamp 832, which lights. The attendant at position 3 is accordingly informed that the transfer has been completed and on removing the plug of the cord circuit from jack 820, the circuit is completed through lamp 833 at position 2, and the invention now functions as before described. When the key 811 is released, relays 805, 806 and 808 release, and lamp 832 is extinguished. If the attendant at position 2 should find it necessary to transfer the call to still another position this can be done by operating the proper position transfer key at position 2, the invention then functioning as in the case of an original call.

Position 1 of Fig. 8 is, like position 1 of Fig. 7, arranged as a night position, so that, when night key 836 is operated, all calls incoming over line 600 cause the lamp 837 to light. Other lines may be grouped with line 600 so that key 836 is effective for these lines also.

The operating of the arrangement of Figs. 6, 7 and 8 has been discussed on the basis of calls incoming over trunks 600, 601 and 602. This arrangement is also equally well adapted to handle outgoing calls, which may be initiated as described for the arrangements of Figs. 1, 2 and 3 and of Figs. 4 and 5.

In all of the above disclosures, it will be noted that after the incoming signal has been transferred, the attendant at the distant end can, by re-ringing, cause the primary signal lamp to relight, provided the secondary signal has not yet been answered. In the case of lines 100 and 400, such a recall will cause the lighted secondary signal to be extinguished. In the case of line 600 it will not be extinguished. Either arrangement is to be considered as being applicable to lines 100, 400 or 600.

What is claimed is:

1. In a manually operated telephone switching system arranged for providing different kinds of service, a telephone switchboard divided into a plurality of sections, a plurality of two-way circuits for incoming and outgoing messages terminating at said switchboard, a primary signal lamp path and a plurality of secondary lamp paths connected to each of said circuits and respectively having appearances at different sections, a signal lamp in each of said paths constituting an appearance, a cord circuit at each of said sections, a telephone set connectable to each of said cord circuits, means associated with each of said lamps for permitting a connection between said cord circuit and each of said circuits, a keyset at each section comprising keys for initiating in response to a request for a particular service the transfer of an incoming call signal to a lamp in

any desired secondary lamp path, switching means associated with each of said circuits for automatically completing the transfer of an incoming call signal appearing in one section to any one of the other of said sections.

2. In a manually operated telephone switching system, according to claim 1, wherein the keyset at each of said sections and the switching means individual to each of said circuits comprising auxiliary circuits arranged to transfer an incoming call signal transferred to a secondary signal lamp to one of the other secondary signal lamps at any other of the other of said sections as desired.

3. In a manually operated telephone switching system, according to claim 1, whereby means are provided for cross-connecting each of said circuits so that any one of said plurality of secondary signal lamp appearances may function as a primary signal lamp.

4. In a manually operated telephone switching system arranged to provide different kinds of service, a telephone switchboard divided into a plurality of sections, a plurality of trunk circuits for incoming and outgoing messages, terminating at said switchboard, a primary signal lamp path and a plurality of secondary lamp paths connected to each of said circuits and respectively having appearances at different sections, a lamp in each of said paths constituting an appearance, a cord circuit at each of said sections, a telephone set connectable to each of said cord circuits, means associated with each of said lamps for permitting a connection between said cord circuit and each of said trunk circuits, a keyset at each of said sections comprising means for initiating and completing in response to a request for a particular kind of service the transfer of incoming call signals to any desired secondary signal lamp, and a cross-bar switch common to each group of ten trunk circuits and a group of transfer trunks interconnecting said cross-bar switch and said keysets arranged to transfer an incoming call signal transferred to a secondary signal lamp to one of the other secondary signal lamps at any of the other of said sections as desired.

5. In a manually operated telephone switching system, according to claim 4, wherein connections are provided between an N number of said cross-bar switches connected together horizontally for transferring when one of said initiating keys is operated, an incoming call signal received over any one of ten times N number of trunk circuits from one of said primary signal lamp appearances respectively associated with said trunk circuits to any one of ten positions of said switchboard.

6. In a manually operated telephone switching system, according to claim 4, wherein connections are provided between an M number of said cross-bar switches connected together vertically for transferring when one of said initiating keys is operated, an incoming call signal received over any one of ten trunk circuits from one of said primary signal lamp appearances respectively associated with said trunk circuits to any one of ten times M number of positions of said switchboard.

7. In a manually operated telephone switching system, according to claim 4, wherein connections are provided between an N number of said cross-bar switches connected together horizontally and an M number of said cross-bar switches connected together vertically for transferring when one of said initiating keys is operated, an incoming call signal received over any one of ten times N number of trunk circuits from any one of said primary signal lamp appearances respectively associated with said trunk circuits to any one of ten times M number of positions of said switchboard.

8. In a manually operated telephone switching system arranged to provide different kinds of service, a telephone switchboard divided into a plurality of primary positions and into a plurality of secondary positions, a plurality of two-way trunk circuits for two-way messages, each trunk circuit having an appearance in said switchboard at each of said primary and each of said secondary answering positions, primary trunk signals individual to each of said trunk circuits appearing in each of said primary positions, secondary trunk signals individual to each of said trunk circuits appearing in each of said secondary positions, a cord circuit at each of said sections, a telephone set connectable to each of said cord circuits, means associated with each of said lamps for permitting a connection between said cord circuit and each of said trunk circuits, a keyset at each of said positions for transferring in response to a request for a particular kind of service any signal, primary or secondary, to another of said positions, primary or secondary.

9. In a manually operated telephone switching system, a telephone switchboard divided into a plurality of primary positions and into a plurality of secondary positions, a plurality of trunk circuits for two way messages, each trunk circuit having an appearance at each of said primary and each of said secondary positions of said switchboard, primary trunk signals individual to each of said trunk circuits, appearing at each of said primary positions, secondary trunk signals individual to each of said trunk circuits appearing at each of said secondary positions, means associated with each of said trunk circuits for selectively actuating the associated trunk signal at any one of said primary or secondary positions, transferring means associated with each of said positions for initiating the transfer of a secondary or primary signal to any selected position, and for initiating the transfer of a secondary or primary trunk signal to any selected position and for causing the functioning of the selecting means aforesaid, a transfer trunk circuit common to all trunk circuits and to all switchboard positions interconnecting said selecting means and said transferring means, and means whereby said transfer trunk circuit is effected for the transfer of only one signal at a time thereby avoiding interference between trunk circuits.

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