

June 6, 1939.

R. E. COLLIS ET AL

2,161,456

TELEPHONE SYSTEM

Filed June 17, 1938

6 Sheets-Sheet 1

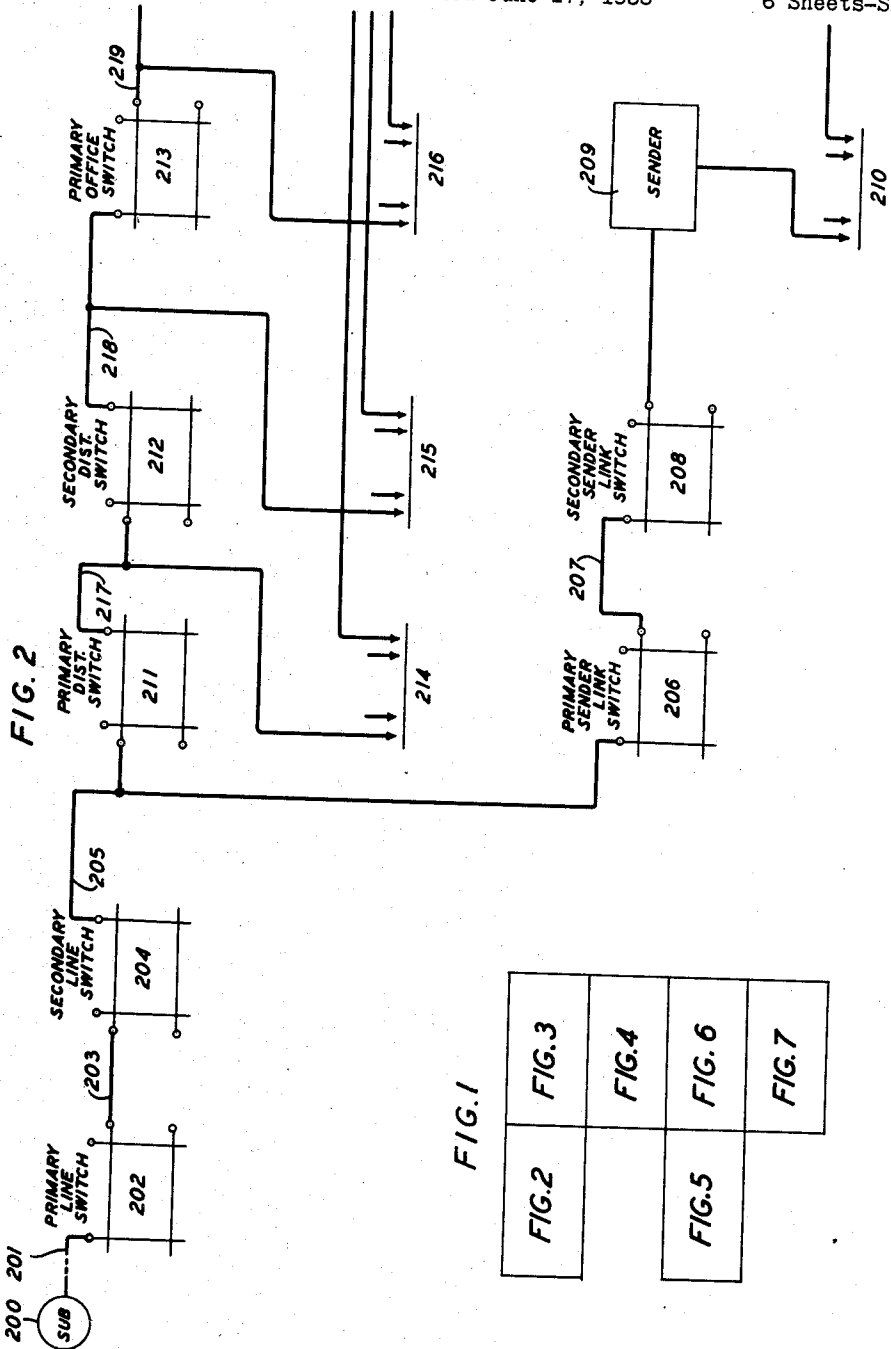


FIG. 2	FIG. 3
FIG. 4	FIG. 5
FIG. 6	FIG. 7

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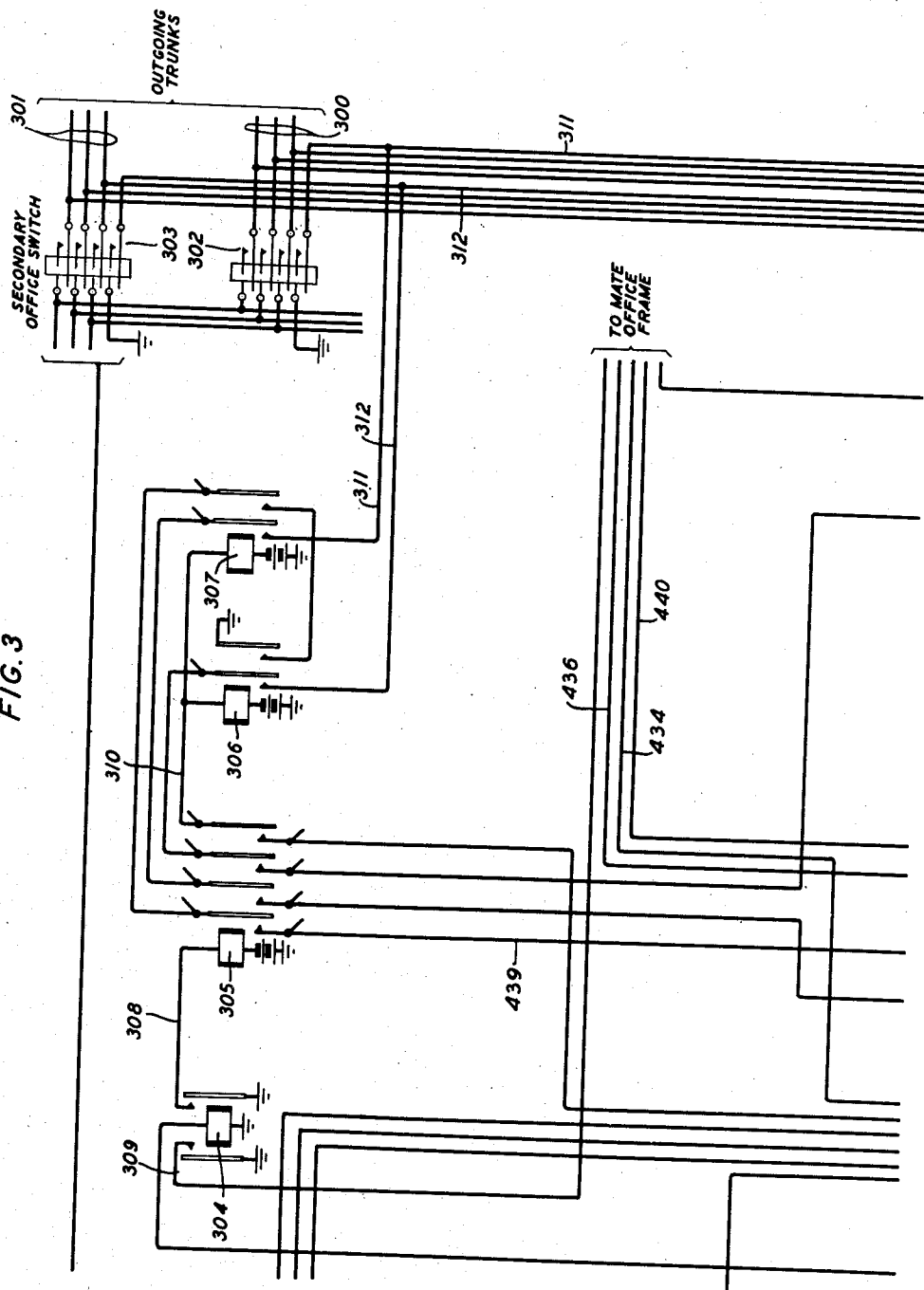
2,161,456

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FIG. 3



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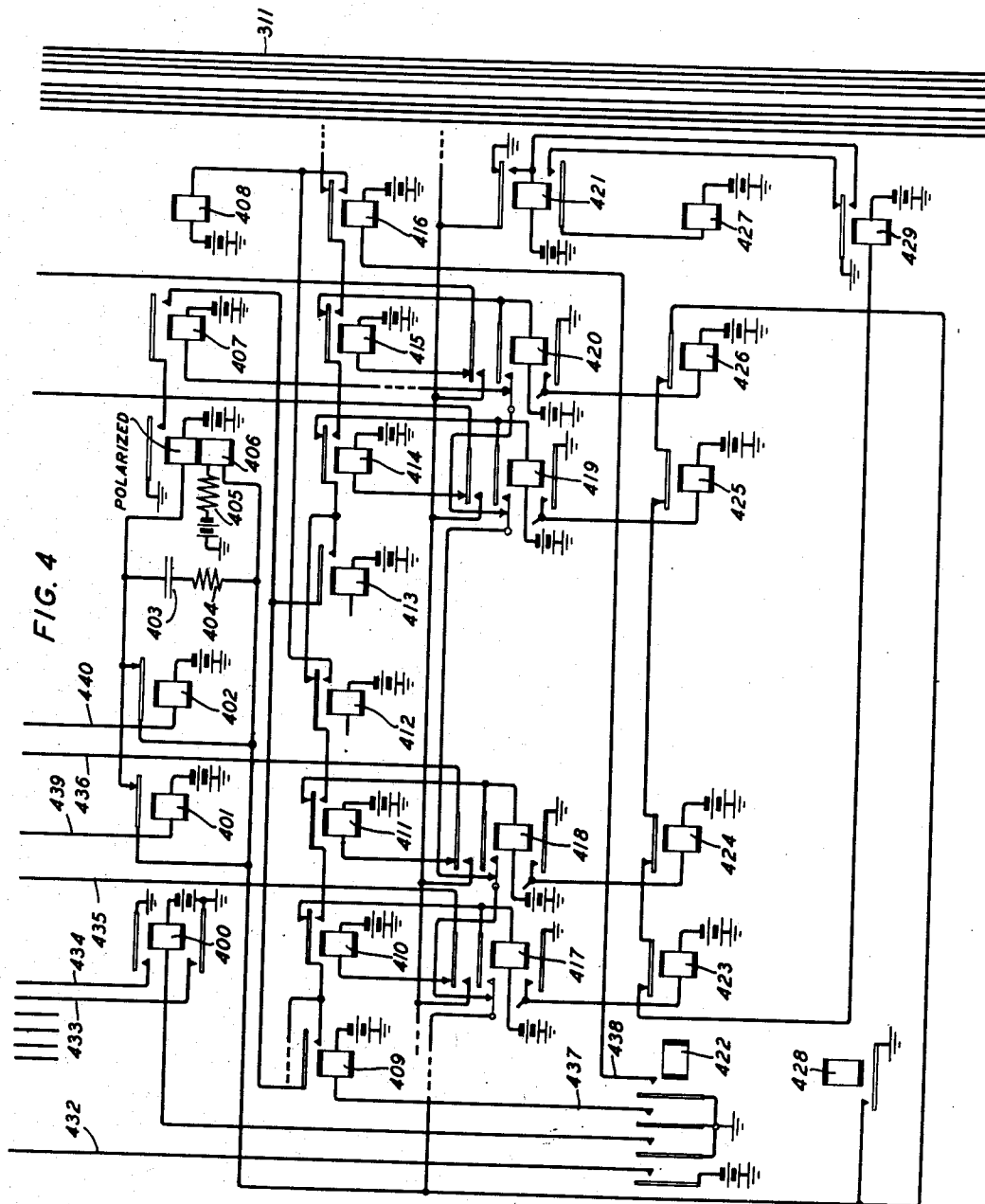
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TELEPHONE SYSTEM

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6 Sheets-Sheet 3



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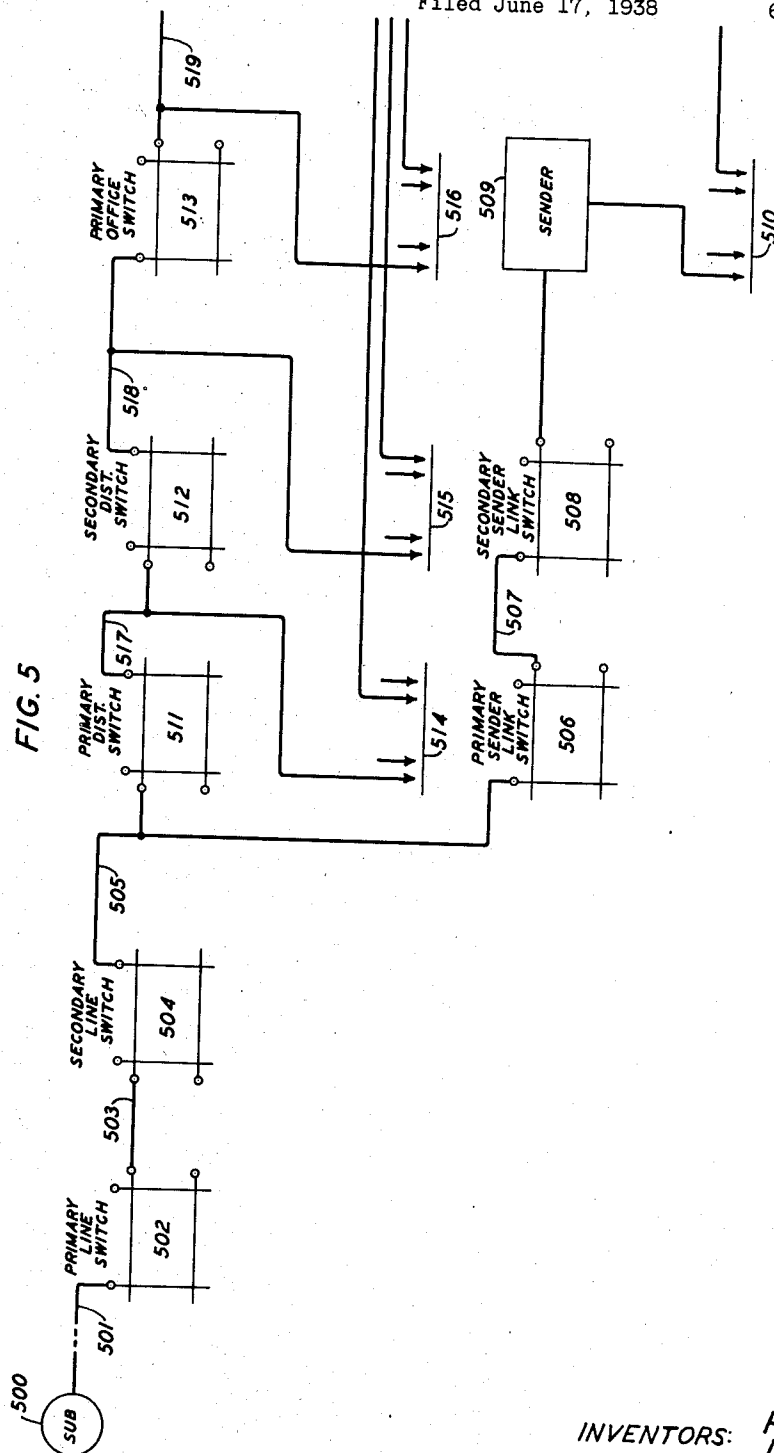
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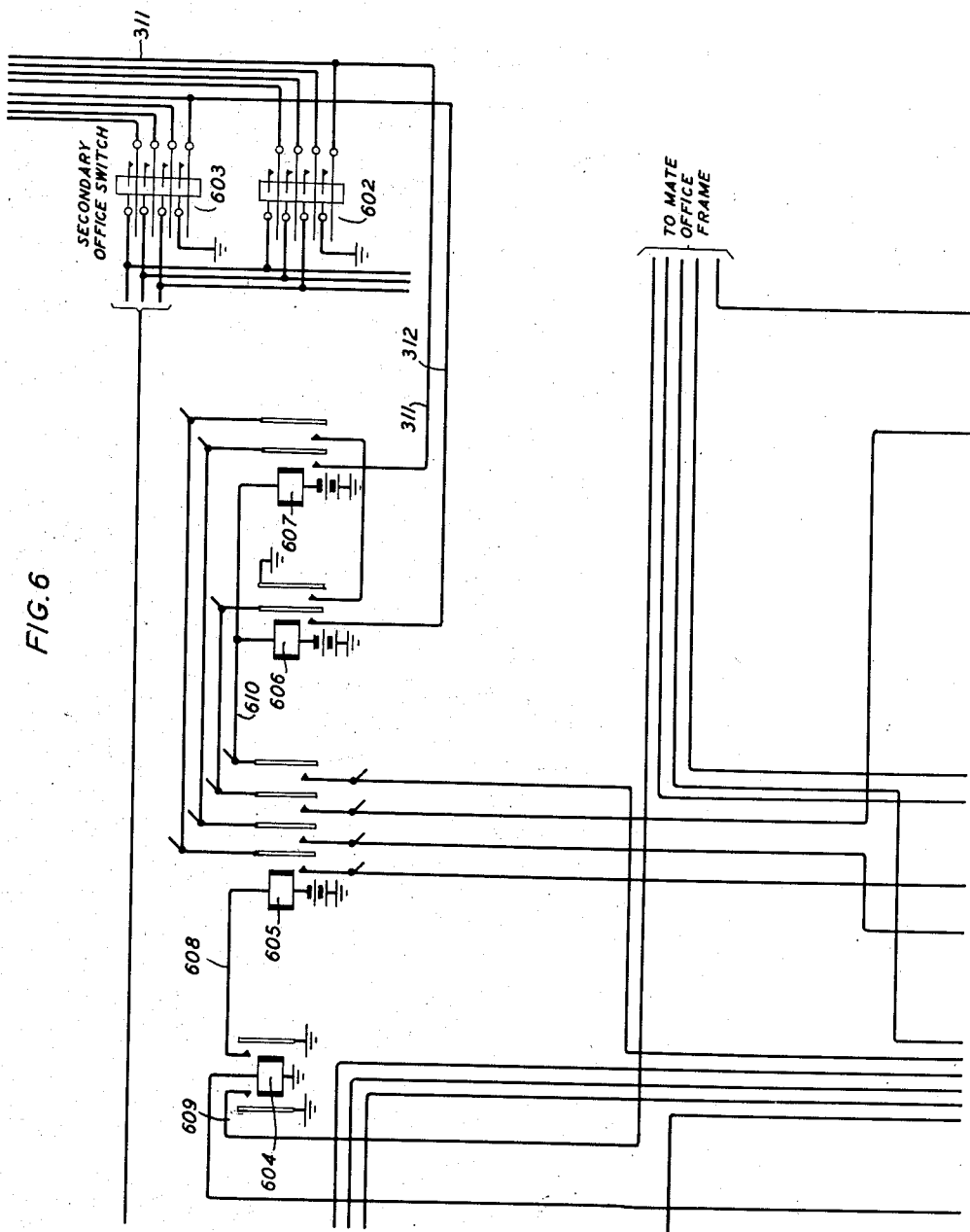
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6 Sheets-Sheet 5



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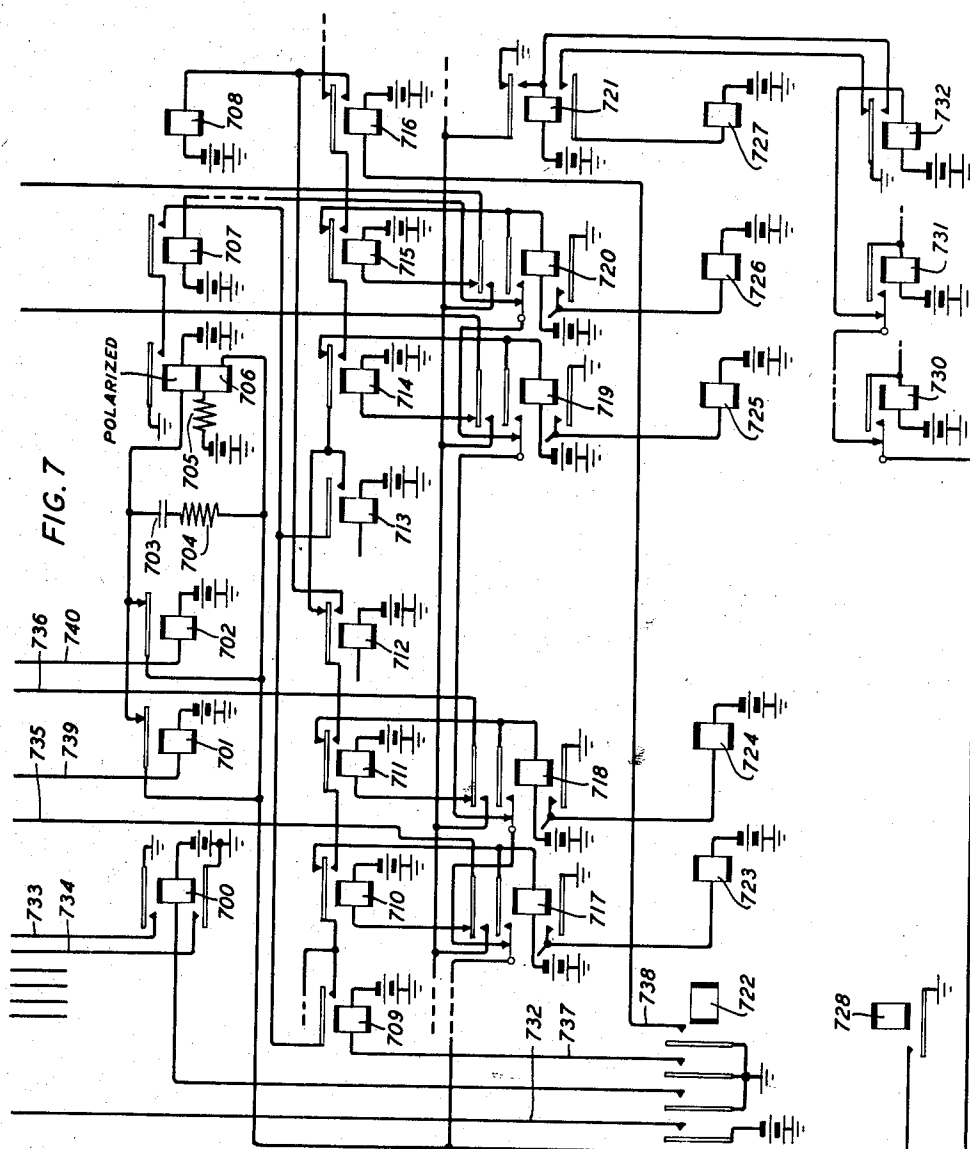
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TELEPHONE SYSTEM

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6 Sheets-Sheet 6



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2,161,456

TELEPHONE SYSTEM

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Application June 17, 1938, Serial No. 214,355

5 Claims. (Cl. 179—25)

This invention relates to telephone systems and particularly to those employing automatic switching equipment for establishing connections.

The objects of the invention are to improve the testing mechanisms used to select trunks or other conversational circuits; to safeguard these circuits against the possibility of being selected simultaneously for more than one conversational connection; and to effect other improvements in systems of this kind.

Large central office systems have been proposed heretofore in which telephone connections are established from subscribers' lines to trunks by means of switches of the cross-bar type under the control of central office register senders and markers. The markers are common to the frames of switches on which the groups of outgoing trunks appear, and connecting means is provided for associating a marker having the registered information concerning a call with the switch frame having access to the desired group of trunks. The marker, when associated with the desired trunk group, makes a test of them and selects an idle one for use. The association of a marker with the switch frame for the purpose of testing a group of trunks lasts only for a brief interval of time, and during this period other markers are excluded from that particular frame. In some cases, however, where two central office units are located in the same building or in close relation to each other it is desirable that both central office units have access to the same group of outgoing trunks. Although the markers of the same central office unit exclude each other automatically from a connection to any one of the frames in that central office unit, the markers of one central office are entirely independent of those of the other office. It is possible, therefore, where both central offices have access to the same group of trunks, for two markers, one in each central office, to make connection simultaneously to the respective frames having access to the same group of trunks. If this association occurs at the same time, and if both markers test the same trunk in a group at about the same instant, it is possible that both of them may simultaneously seize the trunk, neither marker recognizing the fact that the other one is also testing and seizing the desired trunk.

The disadvantage above mentioned may be overcome according to a feature of the present invention by arranging the group of markers of one central office unit to make a double test of the trunks immediately following their initial test and seizure thereof and by arranging the

group of markers of the other central office unit to make a double test of the trunks after a substantial interval of time has elapsed following the initial test and seizure. Any one of the markers of either group on seizing the trunk following the initial test immediately applies a busy condition thereto, and a marker of the first group on making its double test immediately following its seizure will find the trunk busy in the event that a marker of the second group made a simultaneous initial test and seizure of the same trunk. The markers of the first group are so arranged that they will release the trunk if they find it idle on the second test and will proceed to bring about a second trial to extend the connection, leaving the trunk to the use of the marker in the second group. When, therefore, the marker in the second group subsequently performs its double test of the trunk, it will find the trunk clear, since the marker in the first group has already performed its double test and has released the trunk. Should the marker in the first group complete its double test before the marker in the second group applies the busy condition to the trunk, or, should the marker in the first group fail to detect the busy condition applied by the marker of the second group, the first marker would assume that the trunk was free and would proceed to establish the connection over it. When, therefore, the second marker performs its double test at a later time, it finds the trunk busy by reason of its seizure by the marker in the first group, and the second marker thereupon withdraws and brings about a second trial for the call with which it is dealing.

The foregoing and other features of the invention will be described more fully in detail in the following specification and will also be set forth in the appended claims.

Referring now to the drawings which accompany the specification, Figs. 2 to 7, inclusive, when taken in the order shown in Fig. 1, disclose schematically the manner in which two central office units, in the same building but independent except for the fact that they make common use of certain groups of outgoing trunks, are prevented from establishing simultaneous connections over one and the same outgoing trunk.

Fig. 2 shows in greatly simplified form a subscriber station, primary and secondary cross-bar line switches, district switches and sender link switches, a primary cross-bar office switch, a subscriber sender, links and junctors for connecting the subscriber's line through the switches and to the sender, and connectors for connecting the

sender and the district and office switches to originating markers.

Fig. 3 shows in more detail parts of a secondary cross-bar office switch, an office link connected to the primary office switch on Fig. 2, two outgoing trunks from the secondary office switch, and that part of the office frame connector which connects the test leads of the outgoing trunks to markers.

Fig. 4 shows part of an originating marker.

Figs. 5, 6 and 7 show the same equipment for another central office unit in the same building, as Figs. 2, 3 and 4 respectively. The circuits are the same except the markers, which differ in this respect, that the one shown in Fig. 4 is arranged to test an outgoing trunk for a double connection immediately after selecting such a trunk for use, whereas the one shown in Fig. 7 tests the selected trunk for a double connection at a later stage in its operation.

Hereinafter the equipment shown in Figs. 2, 3 and 4 will be referred to as the first central office unit, and the equipment shown in Figs. 5, 6 and 7 as the second central office unit. The switches, switch controlling circuits, register senders, switch controlling markers and the various connectors which serve to interconnect these devices in the establishment of a telephone connection may be of the types disclosed and described in detail in the patent to Carpenter, No. 2,093,117 of September 14, 1937, and in Carpenter application Serial No. 214,356, filed June 17, 1938. Many of the details of the system illustrated in the present drawings have been omitted for the reason that they are not essential to a thorough understanding of the invention. These details, however, may be substantially the same as those fully disclosed in said Carpenter application, and reference may be had thereto for an understanding of them. The automatic switches illustrated in this invention are of the cross-bar type and may in general be the same as the one disclosed in the patent to Reynolds 2,021,329, granted November 19, 1935.

Assuming that a call is originated by the subscriber at station 200, whose line 201 terminates on primary line switch 202 in the first central office unit, a train of operations is started which selects an available path to an idle sender, and operates select and hold magnets on the primary and secondary line switches and sender link switches to close that path from the subscriber's line to the sender. This connection is shown through line link 203, secondary line switch 204, district junctor 205, primary sender link switch 206, sender link 207 and secondary sender link switch 208 to sender 209. District junctor 205 also terminates on primary district switch 211.

The subscriber dials the office code of the desired terminating office, and when the code is registered in the sender the latter causes itself to be connected by connector 210 to an idle originating marker, such as the one a part of which is shown in Fig. 4.

The office code is transmitted from the sender to the marker, resulting in the operation of off-normal relay 428 to supply certain operating and locking ground connections in the marker while it is engaged on this call, and of a certain route relay, such as relay 422. The operation of this particular route relay, among the numerous route relays of the marker, locates the group of outgoing trunks leading to the desired terminating office, among all the outgoing trunks connected to the secondary office switches on all the office

frames of the first central office unit. This locating is done in two steps; first by selecting a test group of forty trunks including perhaps groups to several destinations, and which are connected, one trunk to a level, to two certain levels on each of the ten secondary switches of each of a certain pair of office frames; and then by marking two trunks in the group of forty, one the first and the other the last of a block of trunks which lead to the desired destination. For the purpose of determining the idle or busy state of each of the trunks of a test group of forty, the marker has forty trunk test relays, of which only four are shown, namely relays 410, 411, 414 and 415. There are also forty relays, one of which will be operated to designate the trunk selected for use, and of these also only the four are shown which correspond with the four trunk test relays shown, namely, relays 417, 418, 419 and 420. Upon the operation of relay 422, one of its contacts connects battery through conductor 432 and the winding of relay 304 to ground, operating that relay. Relay 304 is common to a pair of office frames and individual to the particular marker. The operating circuits of the similar relays for the several markers, associated with one pair of office frames, are wired in a preference chain which is not shown, to prevent any two operating together, so that at any one time only one marker can deal with a particular pair of office frames. By grounding conductors 308 and 309, relay 304 operates relay 305 for the office frame partly shown in Fig. 3, and a similar relay for the other frame of the pair, which may be called the mate frame, these relays also being individual to the particular marker. Another contact of relay 422 causes relay 400 to operate, this last being associated with the particular pair of levels on the twenty secondary office switches, ten per frame, to which the forty trunks of the test group are connected. The bottom contact of relay 400 connects ground through conductor 433, a contact of relay 305, conductor 310 and the windings of relays 306 and 307 in parallel to battery, operating relays 306 and 307, which are associated respectively with the two levels in all the secondary switches. The top contact of relay 400 connects ground through conductor 434 to the mate frame, where it operates relays corresponding to 306 and 307. Relays 305, 306, 307 and the corresponding ones in the mate frame connect the windings of the forty trunk test relays to the test conductors of the forty trunks. Thus the winding of relay 410 is connected through break contact of relay 417, conductor 435 and make contacts of relays 305 and 307 to conductor 311, which is the test conductor of outgoing trunk 303, connected to cross-point 302 and multiplied to nine or nineteen other cross-points in the same level of the same secondary office switch, and also multiplied to cross-point 602 and other cross-points in the same level of the corresponding switch in the second central office unit. The winding of relay 411 is connected through break contact of relay 418, conductor 436 and make contacts of relays corresponding to 305 and 307 in the mate frame to the test conductor of the next higher numbered trunk, which is connected to the same level of the corresponding switch in the mate frames in both central office units. The windings of relays 414 and 415 are connected through similar circuits to the test conductors of two trunks connected to the next higher level in the same switch in both frames in both central office units, trunk

301 being the second higher numbered trunk above trunk 300. There are sufficient contacts on relays 305, 306 and 307, besides those shown, to accommodate the full set of twenty trunks per office frame. The multiple straps shown connected to the contact springs of relay 305 indicate that the connected conductors multiple to corresponding relays associated with the same marker but other office frames which are not mate frames. Those shown connected to the armature springs of relay 305 indicate multiplying to corresponding relays in the same frame but associated with other markers. Those shown connected to the armature springs of relays 306 and 307 indicate multiplying to corresponding relays in the same frame but associated with other levels, to which are connected other test groups of forty trunks each. If outgoing trunk 300 is busy on a connection previously established, it is made so by cross-point 302 or one of the others on the same level in the same switch, or cross-point 602 or one of the others on the same level in the same switch, being closed. That grounds the test conductor 311 and causes trunk test relay 410 to operate, it having battery connected to the other end of its winding. In the same way all of the forty trunk test relays which are connected to busy trunks will operate.

Two other contacts of the operated route relay 422, by grounding conductors 437 and 438, block out of the forty trunks those which constitute the trunk group to the desired destination. This trunk group may contain any even number of trunks from two to forty. There are twenty relays similar to relays 409 and 413, and by connecting conductor 437 to the winding of one of them and thereby causing it to operate when route relay 422 operates, the first trunk of the group is marked. There are also twenty relays similar to relays 412 and 416, and by connecting conductor 438 to the winding of one of them and thereby causing it to operate when route relay 422 operates, the last trunk of the group is marked. Connecting conductor 437 to relay 409, and conductor 438 to relay 416, as shown, identifies the trunk group as consisting of the four trunks which are now connected to the windings of the trunk test relays 410, 411, 414, and 415, that is, the first of the group is trunk 300, the second is the one corresponding to 300 in the mate frame, the third is 301, and the fourth and last is the one corresponding to 301 in the mate frame.

The next step is to operate one of relays 417, 418, 419 and 420 to select for use the first one of the four trunks which happens to be idle. When relays 306, 307 and the corresponding relays in the mate frame have operated to connect the forty trunk test relays to the forty trunks, a circuit is closed from ground through make contacts of relays 306, 307 and 305, conductor 439 and the winding of relay 401 to battery, and a similar circuit from the mate frame over conductor 440 to the winding of relay 402. Relays 401 and 402 thereupon operate. Up to this time condenser 403 and resistance 404 in series have been short-circuited and the condenser-timed polarized relay 406 has had opposing currents through the two windings, and the upper winding being stronger has held the armature on its back contact. One circuit is from ground through make contact of relay 428, break contacts of relays 401 and 402 in parallel, and the upper winding of relay 406 to battery. The other circuit is from ground through make contact of

relay 428, the lower winding of relay 406, and resistance 405 to battery. When relays 401 and 402 have both operated, the direct ground connection to the upper winding of relay 406 is broken, but current continues through it for a time, charging condenser 403. As the condenser charges up this current dies down, until the lower winding overpowers the upper and the relay operates. This slow operation allows time for the trunk test relays, such as relay 410, to operate. Relay 407 has been operated from the beginning by a circuit from ground through make contact of relay 428, break contacts of the forty trunk selecting relays including 417 to 420 inclusive, and winding of relay 407 to battery. If all four trunks of the group are busy, relay 408 will operate by a circuit from ground through make contacts of relays 406, 407, 409, 410 and 411, break contact of relay 412, make contacts of relays 414, 415 and 416, and the winding of relay 408 to battery. This will result in the marker abandoning the attempt to complete the call over this route, and trying instead to complete it over an alternate route or to an overflow trunk. If, however, the first two trunks are busy and the third idle, with relay 414 normal, relay 419 will operate by the same circuit through the break contact of relay 412, and thence through break contact of relay 414 and the winding of 419 to battery. Relay 419 operating locks up through the back contact chain to its left, and at the same time breaks the back contact chain to its right, thereby releasing relay 407. This breaks the circuit which operated relay 419 and thereby prevents the operation of any earlier relay of the same kind, such as 417 or 418, in case an earlier trunk test relay such as 410 or 411 should release upon its trunk becoming idle. Relay 419 operating also transfers the connection of the test conductor 312 of the idle and selected trunk 301 from the winding of trunk test relay 414 to ground through top make contacts of relays 421 and 429, thus immediately marking the trunk as busy, in case a marker of the second central office unit should test it. Relay 429 has been operated from the beginning by a circuit from ground through make contact of relay 428, break contacts of relays 426, 425, 424 and 423, and winding of 429 to battery. Relay 421 operated from the front contact of relay 429.

Relay 419 operating also causes relay 425 to operate, the winding of the latter being multiplied to the grounded bottom make contact of relay 419 and every fourth relay of the same kind to the left or right. Relay 425 operating causes relay 429 to release, which breaks the operating circuit of relay 421. If at this moment there is any other ground connection to test conductor 312, relay 421 will hold operated through its top make contact, although its operating circuit has been broken by the release of relay 429. Such a ground connection apparently did not exist when the forty trunks were tested, and it can exist now only because of interference by a marker of the second central office unit, or because the trunk was busy all the time and that fact was not disclosed during the test of the forty trunks on account of some break in the wiring. If it does exist and relay 421 holds operated, relay 427 will operate by a circuit from ground through break contact of relay 429 and make contact of relay 421. This will cause the marker to send a so-called trouble release signal to the sender, resulting in the dismissal of the marker and the calling of another marker for another trial. Bar-

ring such interference or trouble condition, relay 421 will release and by its break contact immediately restore a busy ground connection to test conductor 312 of the selected trunk 301, momentarily removed when relay 429 released.

Relay 425 operating also starts a chain of operations, or relay 423, 425, or 426 operating in case another outgoing trunk had been selected would do the same, which if not blocked by a trouble release involves the operation of district and office frame connectors 214, 215 and 216 to connect the marker to various parts of the district and office switches; the testing of all possible paths from primary district switch 211 to the secondary office switch to which is connected outgoing trunk 301; the selection of an available path such as the one shown through district link 217, secondary district switch 212, office junctor 218, primary office switch 213, and office link 219; the operation of select and hold magnets in the primary and secondary district and office switches to close through this path, thus completing a connection from subscriber station 200 to outgoing trunk 301; and the release of the marker from service on this call, all in the manner disclosed and described in said Carpenter Patent No. 2,093,117 of September 14, 1937.

Assume now that a call is originated by the subscriber at station 500, connected to the second central office unit, instead of by a subscriber connected to the first unit. The subscriber's line being connected to a sender such as sender 509, through line switches 502 and 504 and through sender link switches 506 and 508 and the sender to a marker such as the one shown in Fig. 7, through connector 510 all in the same manner as described above, that marker will proceed just as described above, testing the same forty outgoing trunks and may select for use the same trunk 301 by operating relay 719, which in turn operates relay 725. Relay 725 starts a chain of operations culminating in the completion of a connection from the calling subscriber to outgoing trunk 301, unless blocked by a trouble release, just as did relay 425 in the first call described. In that call relay 425 operating also caused the release of relay 429 and thereby the breaking of the operating conductor to the winding of relay 421, but this marker has no relay corresponding to relay 429, and the operating lead to the winding of relay 721 which corresponds to relay 421 is not broken at this time and so it does not now release under any conditions. In this marker the operating conductor to the winding of relay 721 is wired to ground through a make contact of relay 732, which has been operated from the beginning through a chain of break contacts on a set of relays represented by relays 730 and 731. Relays 730, 731 and 732 have their counterparts in the marker shown in Fig. 4, serving the same principal function of selecting a path, but they are not shown there because they have no function with regard to releasing relay 421.

Among the chain of operations following the operation of relay 725 are those involving the test of all possible paths from the primary district switch to the secondary office switch and the selection of an available path. This results in the operation of one of the set of relays represented by relays 730 and 731, that marking the selection of a particular path. The operation of this relay causes relay 732 to release, and that breaks the operating conductor to the winding of relay 721. As described in the case of relay 421 in the other marker, relay 721 will release and permit

the marker to proceed to a successful completion of a connection from the calling subscriber to the outgoing trunk 301, unless it is held up by a ground on test conductor 312. Such a ground can exist only because of interference by a marker of the first central office unit, or because the trunk was busy all the time and a trouble condition prevented that fact from appearing when the forty trunks were tested. If relay 721 does not release, relay 727 will operate and cause a trouble release signal as described in the case of the other marker, and with the same results.

Now suppose that the subscribers at stations 200 and 500 originate calls for the same terminating office at the same time. The two markers will function independently and without possibility of mutual interference up to the time that they both test the group of forty trunks. If either marker arrives at this stage much before the other, it will select an outgoing trunk such as trunk 301, operate its relay 419 or 719 as the case may be, and thereby ground test lead 312 and so operate relay 714 or 414 in the other marker, which will cause that marker to pass over trunk 301 and select a higher numbered trunk. But if both markers coincide very closely in time of testing the forty trunks, relays 419 and 719 may both operate and lock up, meaning that both markers have selected the same trunk 301, and resulting in their both connecting ground to the test conductor 312.

What will usually occur in this event is that the first or Fig. 4 marker, making an immediate attempt to release relay 421 by releasing relay 429, will fail to do so because the second or Fig. 7 marker, making no such attempt at this time, continues to hold a ground connection on test conductor 312. The first marker will send a trouble release signal and will be dismissed, breaking its hold on the test conductor, before the second marker is ready to attempt to release relay 721 by releasing relay 732. When the second marker does make that attempt, it will find the test conductor clear and will proceed to establish a connection to the trunk.

Possibly it may occur that relay 421 will release before the test conductor is grounded by the operation of relay 719. In such a case the first marker will establish a connection to the trunk, and the second marker, when it attempts to release relay 721, will fail to do so and send a trouble release signal.

What is claimed is:

1. In a telephone system, a group of trunks, two markers having simultaneous access to said group, each marker provided with means for testing the trunks and for selecting an idle one for use, means in one of said markers effective upon selection of a trunk for making a test to determine if another marker has selected the same trunk, means in a second one of said markers effective after an interval following the selection of a trunk by said second marker for making a test to determine if another marker has selected the same trunk, and means in the marker that is first to perform the said test for causing it to release the trunk which it has selected if the test indicates that another marker has selected the same trunk.

2. In a telephone system, a group of trunks, two markers having simultaneous access to said group, each marker provided with means for testing the trunks and for seizing an idle one thereof for use, means in each of said markers for applying a busy condition to a trunk as soon

as it is seized by such marker, means in one of said markers effective upon testing and seizing a trunk for immediately performing a second test of said trunk to determine if another marker has seized the same trunk, means in the second one of said markers effective after an interval has expired following its testing and seizure of a trunk for making a second test of the trunk to determine if another marker has seized the same trunk, and means in each one of said markers effective to cause it to release a trunk when it finds the same busy as a result of the second test thereof.

3. The combination in a telephone system of a group of conversational circuits, a first testing mechanism and a second testing mechanism having simultaneous access to said group of circuits, both of said mechanisms provided with means for testing the circuits and for seizing an idle one thereof for use, means in each of said mechanisms effective when said mechanism seizes an idle circuit to apply a busy condition to said seized circuit, means in the first one of said mechanisms for removing the busy condition it has applied to a seized circuit following the seizure thereof and for making a second test of said circuit to determine whether it has been seized by another mechanism, means in said first-mentioned mechanism for causing the same to release a seized circuit if it finds the circuit busy on said second test, and means in said second mechanism effective after an interval of time has elapsed following the seizure of a circuit for removing the busy condition applied to the seized circuit by said second mechanism and for performing a second test of said circuit to determine whether it has been seized by another mechanism.

4. The combination in a telephone system of a group of trunks, a first group of markers, any one of which may have access to said group of trunks, a second group of markers, any one of which may have access to said group of trunks simultaneously with any one of the markers of said first group, means in each of said markers for testing and seizing any one of the trunks in

said group, means in each one of the markers of said first group effective upon the selection of a trunk by one of such markers for making a second test to determine if a marker of said second group has selected the same trunk, means in each of the markers of the second group effective after an interval of time has expired following the seizure of a trunk by one of said second markers for making a second test of the trunk to determine if it has been selected by a marker of the first group, and means in each one of said markers effective to cause such marker to release a trunk that it has seized if it finds the trunk busy on performing the second test thereof.

5. The combination in a telephone system of a group of trunks, a train of automatic switches for extending a connection to said trunks, a second train of automatic switches for extending a connection to said trunks, a first marker and a second marker, both of which have access simultaneously to said group of trunks, means in said markers for testing said trunks and for seizing an idle one thereof for use, means in said first marker for making a second test of a seized trunk to determine whether the trunk has been seized by said second marker, means in said first marker for releasing the trunk if it is found busy on said second test and for proceeding to prepare the switches of said first train for operation if said trunk is found idle on said second test, means in said second marker effective after it has tested and seized an idle trunk for preparing the switches of said second train for operation, means in said second marker effective after it has prepared said switches for performing a second test of the trunk seized by said second marker to determine whether said trunk has been seized by said first marker, and means in said second marker for causing it to release the trunk if it finds the trunk busy on said second test and for causing said second marker to proceed with the establishment of a connection if it finds the trunk idle on said second test.

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