

Dec. 5, 1944.

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2,364,146

AUTOMATIC TELEPHONE SYSTEM

Filed Jan. 8, 1944

7 Sheets-Sheet 1

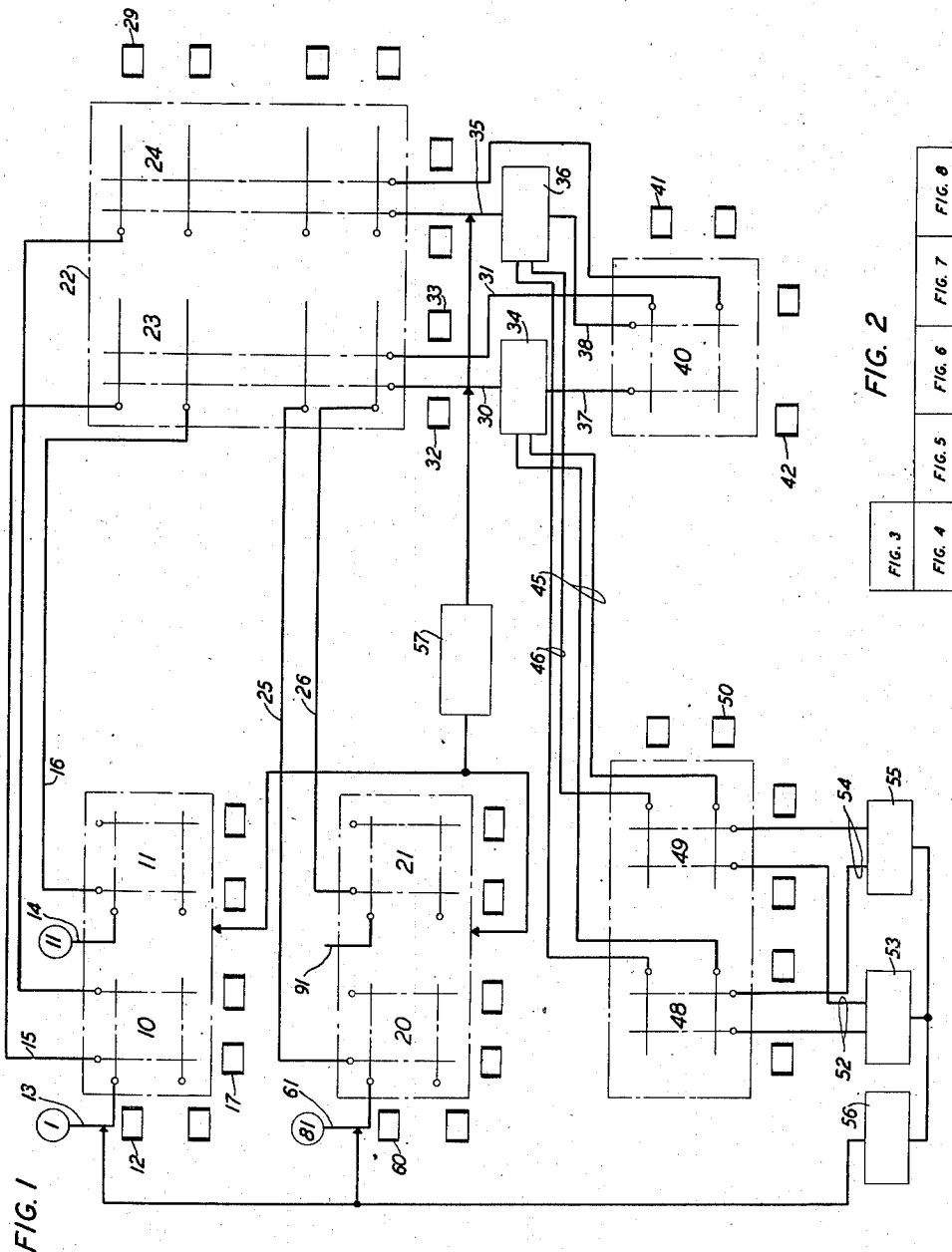


FIG. 2

FIG. 3	FIG. 4	FIG. 5	FIG. 6	FIG. 7	FIG. 8
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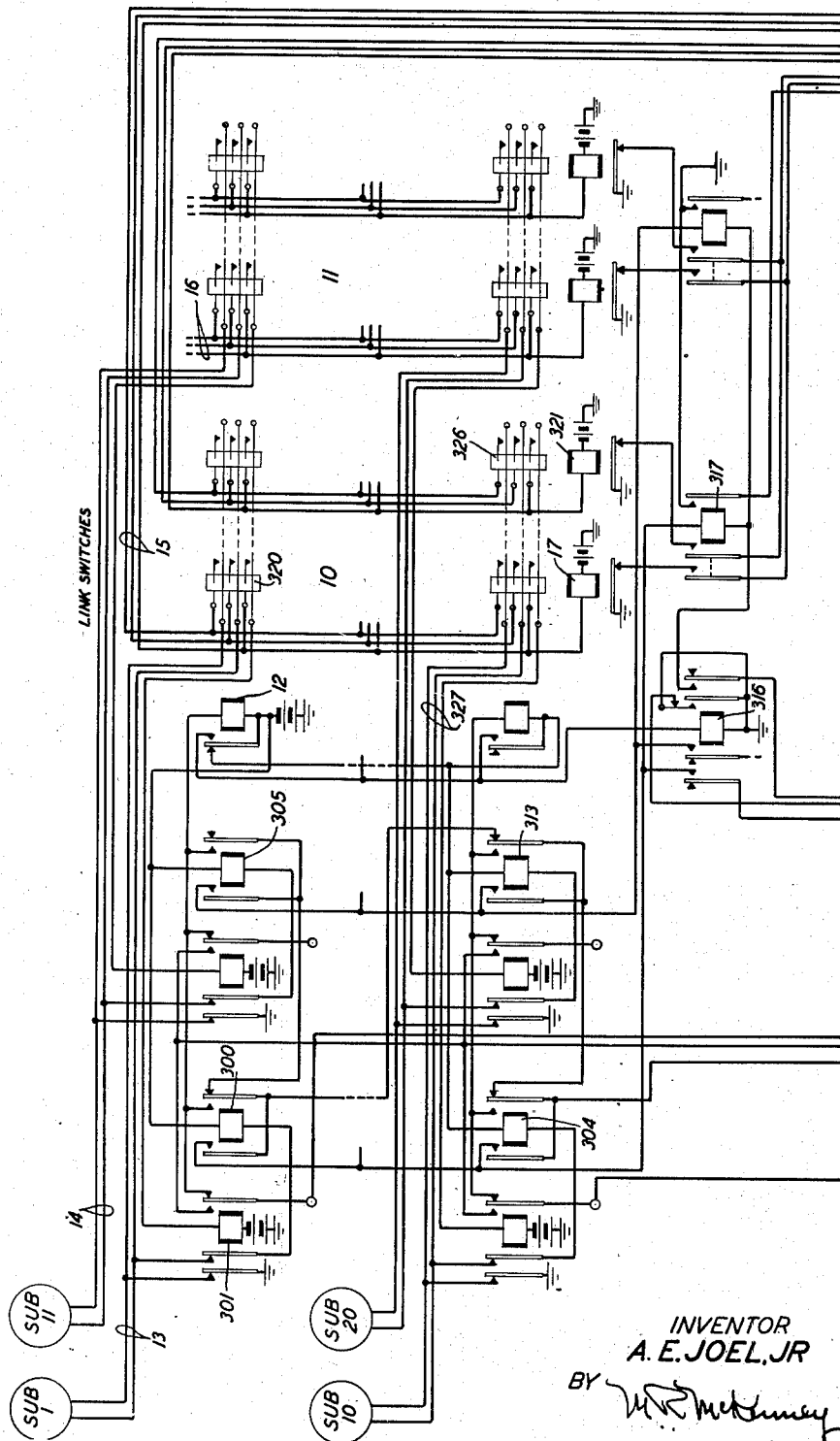
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FIG. 3



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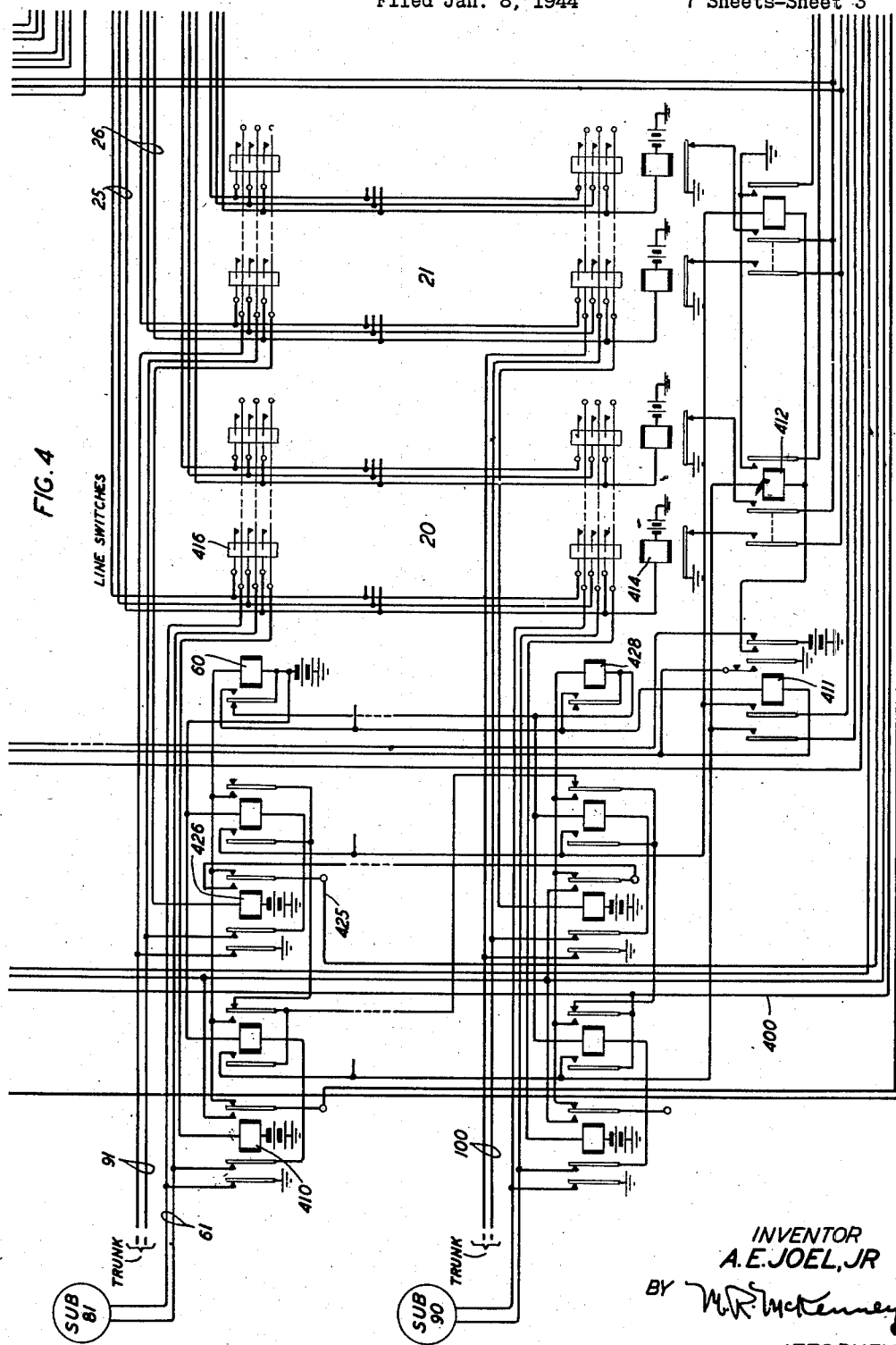
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AUTOMATIC TELEPHONE SYSTEM

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Dec. 5, 1944.

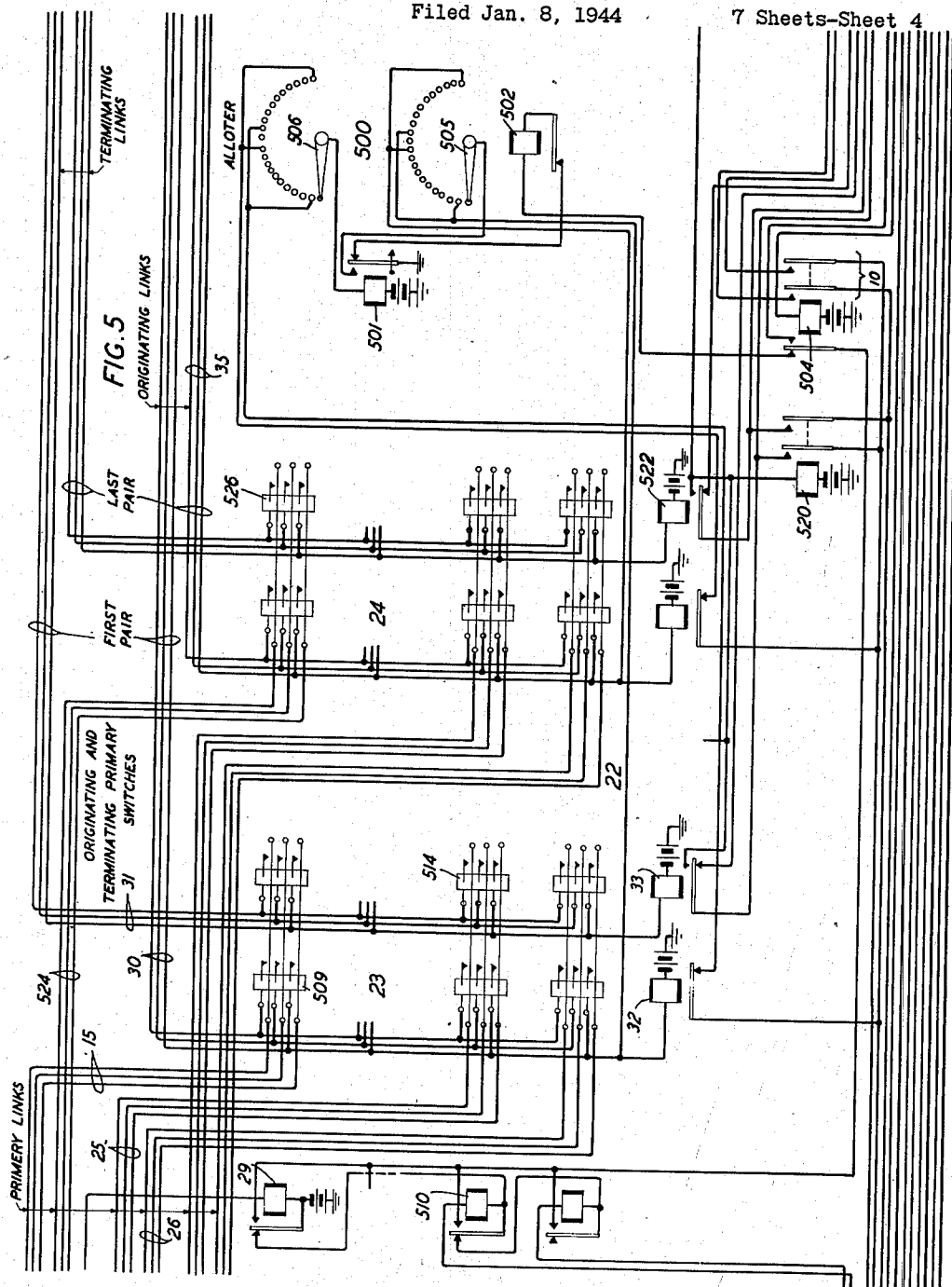
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7 Sheets-Sheet 4



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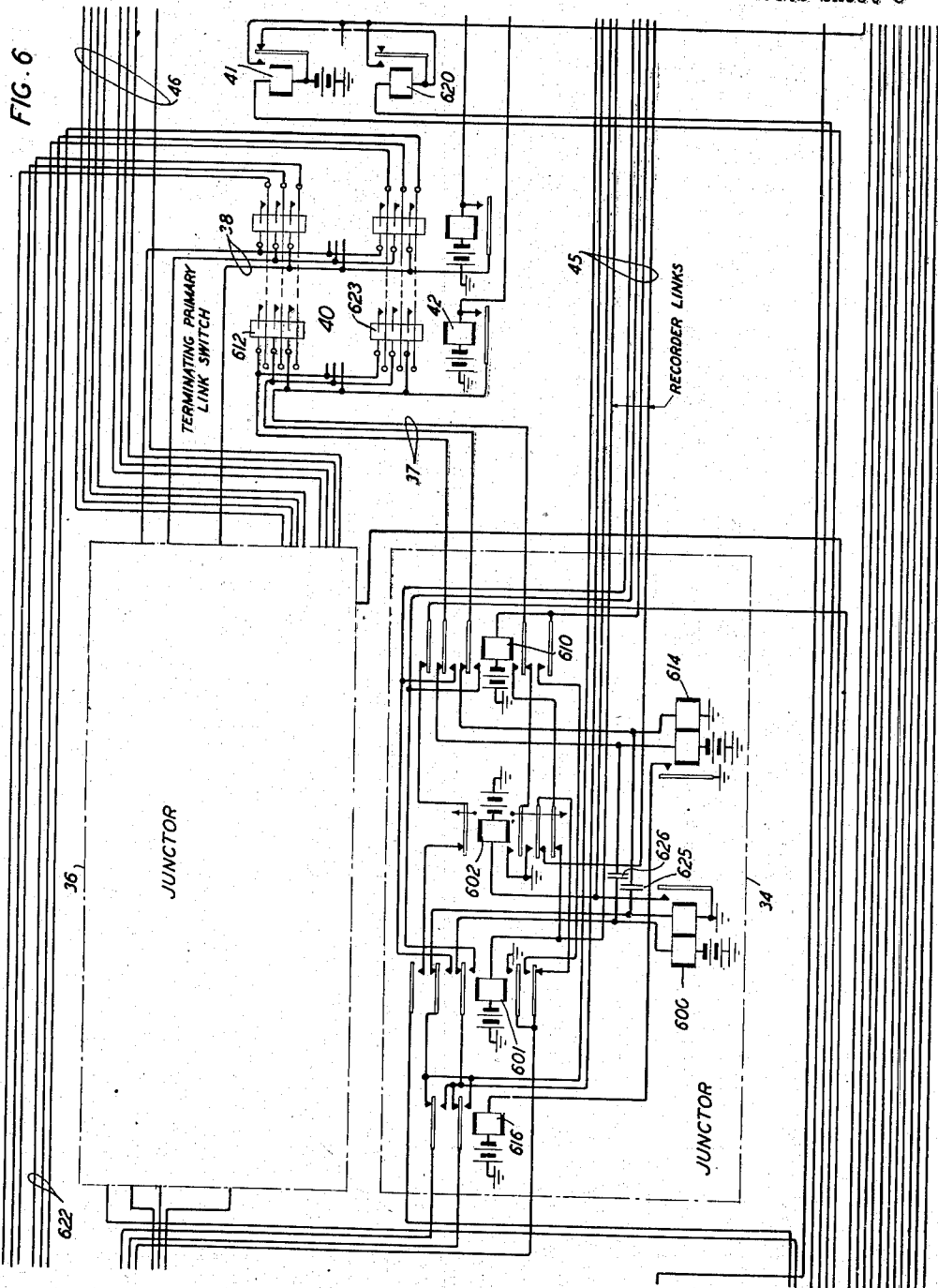
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AUTOMATIC TELEPHONE SYSTEM

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7 Sheets-Sheet 6

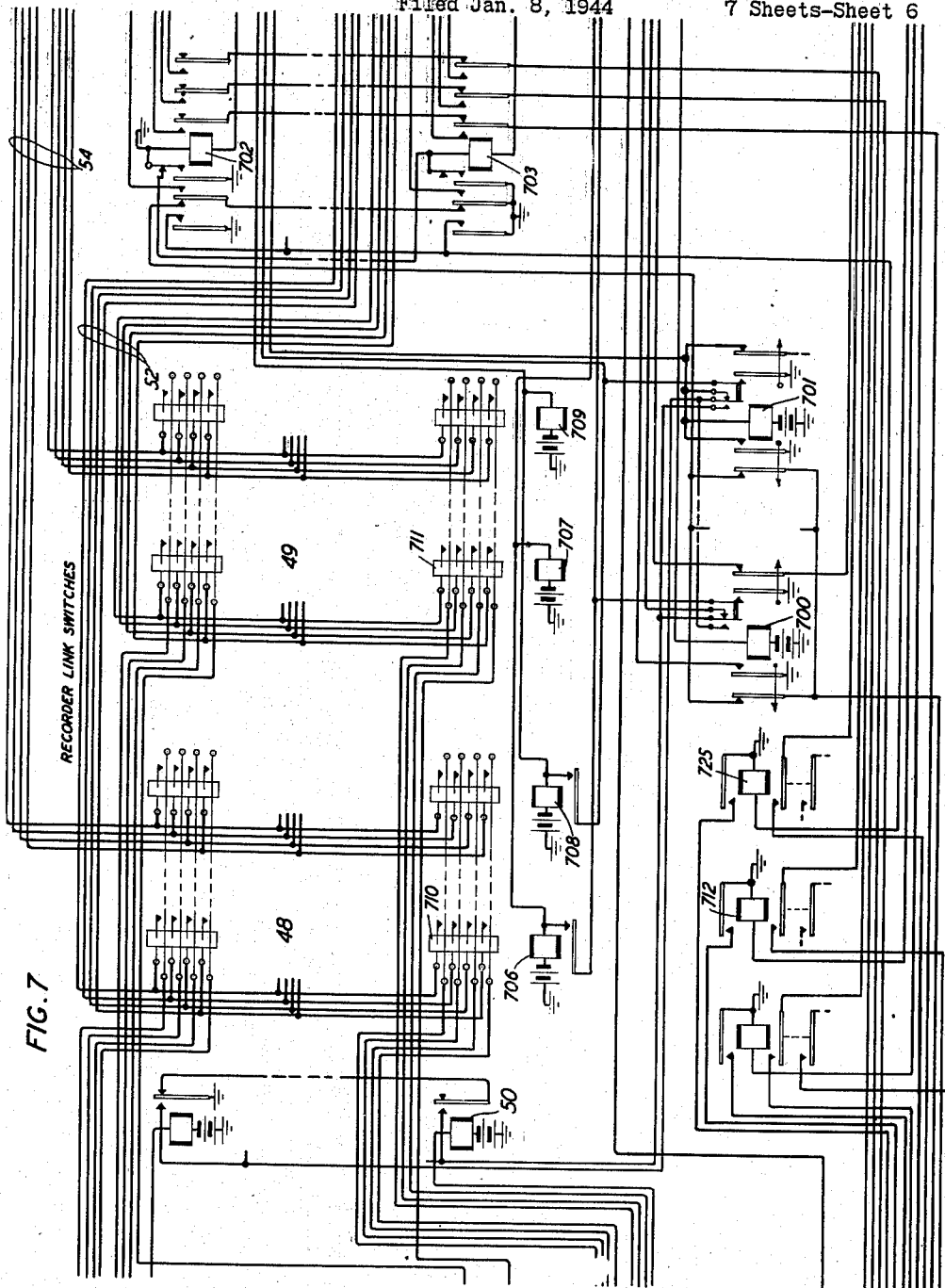


FIG. 7

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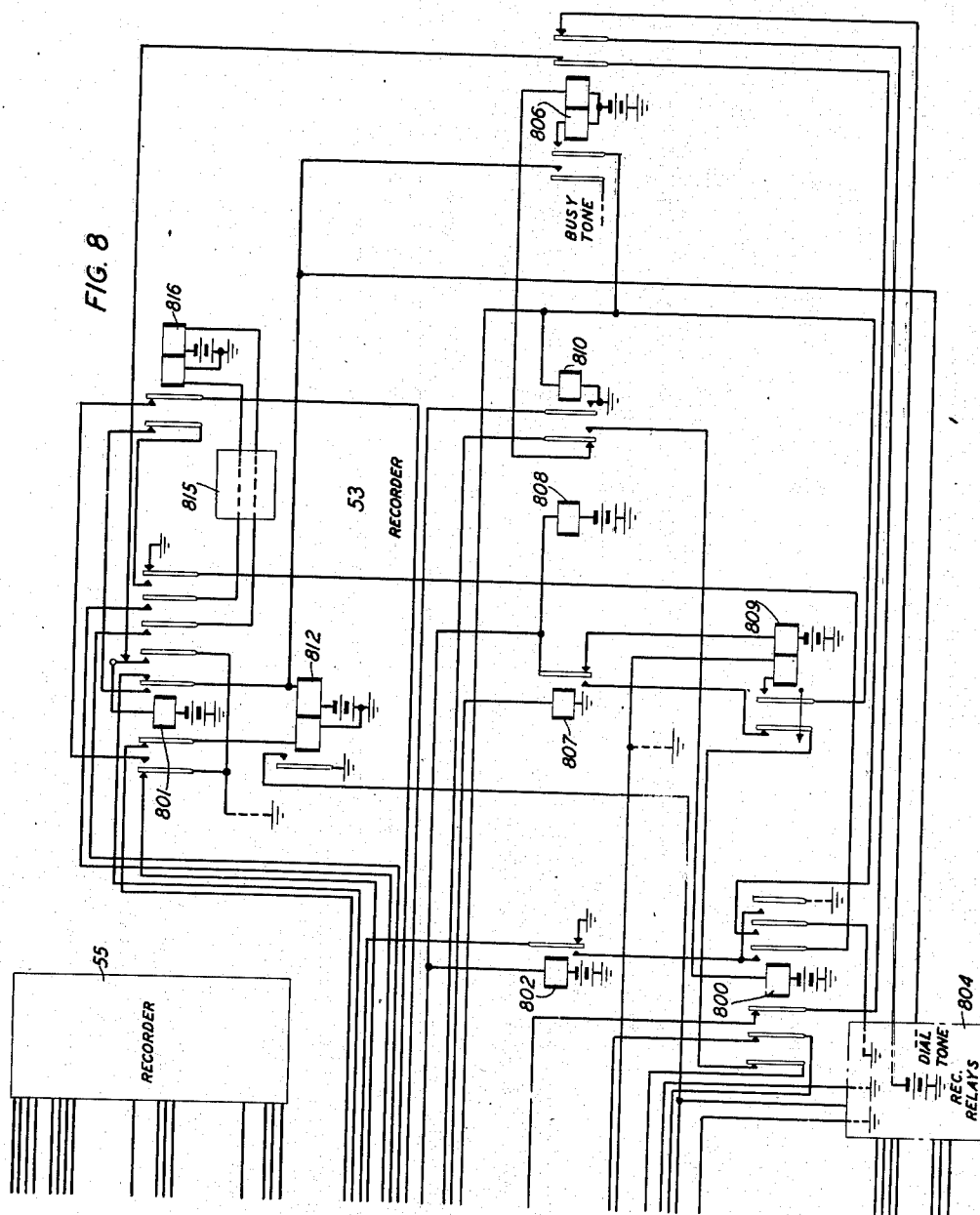
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AUTOMATIC TELEPHONE SYSTEM

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7 Sheets-Sheet 7



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2,364,146

AUTOMATIC TELEPHONE SYSTEM

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Application January 8, 1944, Serial No. 517,496

7 Claims. (Cl. 179—22)

This invention relates to telephone systems and particularly to small capacity automatic telephone systems.

An object is to simplify and improve the operating characteristics of such systems and to secure a maximum use of the various connecting circuits and switches in these systems.

Heretofore various systems have been used in which cross bar switches have been employed with linking circuits between them to establish connections between calling and called subscribers in small capacity systems of the so-called community dial office types. In such systems the connecting links between switches were not always used to the full capacity due to inherent characteristics of the sequence circuits for assigning paths for succeeding calls used in the past. In such prior systems it was also the practice in order to detect busy conditions to connect with the sleeves of the called lines directly; in the case of trunks to connect directly to succeeding trunks to test them until an idle trunk was found; and in the case of links between cross bar switches to detect busy conditions and detect complete idle paths by means of common marker circuits which seize and test all sleeve leads at a common point.

The present invention is applicable to small capacity automatic telephone systems of this general character in which cross bar switches are employed in various linking arrangements. If the invention is applied, for example, to a one-hundred line automatic system using cross bar switches it may take the following form. In such a case the system will include cross bar switches of the well-known type in which the connections are established between contacts arranged in a coordinate formation by operating one of a plurality of select magnets for selection in one coordinate direction and by operating one of a plurality of hold magnets for selection in the other coordinate direction to establish a connection between the contacts at the corresponding cross-point. The arrangement may include a line switch for each group of ten subscribers' lines, a secondary switch divided in ten sections, in each section of which a primary link terminates from each of the ten line switches, a group of ten junctor circuits each having its incoming branch terminating in a corresponding section of the secondary switch, while the outgoing branches of the junctor circuits terminate in a terminating switch through which connections may be established over terminating links to corresponding sections of the secondary switch.

The inventive features of this arrangement are as follows: In establishing a connection from a calling subscriber to a junctor circuit, the hold magnets of the line switches and secondary switch control the choice of a connecting path through an idle primary link and an idle junctor circuit, while the select magnets in the secondary switch are arranged to control the selection of a first idle pair comprising a primary link and an idle junctor circuit.

Another feature is a preference arrangement of the choice of a path from the junctor circuit to a called subscriber's line. In case the called line is in a line switch other than the one in which the calling line is located, a terminating link associated with the chosen incoming branch of the junctor circuit is employed for establishing the connection over a primary link to the called line. On the other hand if the called line is in the same line switch as the calling line this preference arrangement provides that any other first idle terminating link and primary link are chosen for the establishing of the connection to the called line. The advantage of using this preference scheme of connecting up called lines is that full use of all available connections may be had as distinguished from ordinary sequence preference switching schemes heretofore known.

The juncctors have access to a series of common registers for the establishing of connections to called lines and another feature relates to the establishing of a connection to a called line from a junctor circuit by having the chosen register select the cut-off relay of the called line. If this line is idle as indicated by the released condition of the cut-off relay the establishing of the connection is initiated from the line to the outgoing branch of the junctor. Thus, this arrangement is such that the called line is, in effect, made to originate a call to this particular junctor. If the cut-off relay is operated, indicating that the called line is busy, a busy signal will be transmitted through the register to the calling line.

If certain line switches are provided with groups of outgoing trunks or hunting line groups in place of single subscriber's lines, the register will select the cut-off relay of the first trunk in the desired group and if this trunk is busy, a connection will be extended through the operated cut-off relay to the next succeeding cut-off relay until an idle trunk is found when the connection to this idle trunk is established from the junctor circuit in the same manner as in the case of

single lines over the secondary and terminating switches.

This invention has been illustrated in the accompanying drawings in which

Fig. 1 shows in diagrammatic form a switching arrangement in accordance with the applicant's invention applied to a one-hundred line private branch exchange system.

Fig. 2 shows the plan of assembling the succeeding drawings, Figs. 3 to 8 which disclose the one-hundred line system circuit details to illustrate the applicant's invention applied thereto.

Referring now particularly to Fig. 1, the general arrangement of the switches and circuits of the system may be arranged as follows. Two 10 by 10 cross bar line switches 10 and 11 are arranged side by side with ten subscribers' lines terminating in the horizontals of each switch with a select magnet, such as 12, for the first pair of subscribers' lines 13 and 14 in the two switches and corresponding select magnets for all succeeding pairs in succeeding levels of the two switches. Each of the switches 10 and 11 is provided with ten primary links arranged in pairs such as the primary link 15 from switch 10 and primary link 16 from switch 11, and nine other identical pairs of primary links. Each link is controlled by a corresponding hold magnet, such as 17, for link 15. For this arrangement to accommodate one-hundred subscribers' lines there would be provided five additional pairs of line switches, the fifth pair being shown at 20 and 21. This would make a total of one-hundred primary links outgoing from the five pairs of line switches for the hundred subscribers' lines. These primary links terminate in a so-called originating and terminating secondary link switch 22 which is divided in ten vertical sections, the first section 23 and the last section 24 being indicated with one primary link from each line switch terminating in an individual vertical section. For example, the primary links 15 and 16 from the first pair of line switches 10 and 11 and corresponding links 25 and 26 from the last pair of line switches 20 and 21, respectively, and the corresponding three other pairs from the three intermediate pairs of line switches terminate in section 23. Similarly, the succeeding pairs of primary links terminate in the same manner in the succeeding nine sections. In this secondary link switch 22 each level is controlled by a corresponding select magnet such as 29, for example, for the first level. Each section of the secondary link switch 22 is provided with a pair of links appearing as verticals, one link for extending calls from the primary links and designated as an originating link such as 30 for the first section 23 and the companion link for extending calls to the primary link and designated as a terminating primary link such as 31 for the first section 23. Each originating link is controlled by an individual hold magnet such as hold magnet 32 for a link 30 and each terminated link is controlled by a corresponding hold magnet, such as 33 for terminating link 31. Each of these originating links terminates in an individual junctor circuit. For example, the originating link 30 from section 23 extends to junctor circuit 34 and the originating link 35 extends to junctor circuit 36. These junctor circuits have only been indicated by boxes and represent the first and the last junctor circuits of a possible group of ten. The originating links may also be called incoming branches to the junctor circuits which are also provided with outgoing branches such as, for example, branch 37 for junctor circuit 34 and

branch 38 for junctor circuit 36. As there are ten junctor circuits, there would be ten corresponding outgoing branches which, in turn, terminate in verticals in a so-called terminating primary link switch 40. In the switch 40 the terminating links 31 and 35 and intermediate links terminate as horizontals. This switch is therefore provided with ten select magnets such as, for example, select magnets 41 for the link 31 and a hold magnet is provided for each outgoing branch from a junctor circuit such as for example magnet 42 for the outgoing branch 37. From each junctor circuit there is arranged a series of leads, such as 45 from junctor circuit 34 and leads 46 for junctor circuit 36. These leads for each junctor circuit terminate as horizontals in a corresponding level in two recorder link switches 48 and 49. These switches have a common select magnet for each level, such as, for example, select magnet 50 for the level in which the leads 45 from junctor 34 terminate. Corresponding vertical leads from each recorder link switch terminate in a corresponding recorder such as verticals 52 from link switches 48 and 49 terminate in recorder 53 while verticals 54 terminate in recorder 55 thus providing five recorders for the two recorder link switches 48 and 49. This disposition of the leads in the two recorder link switches is necessary as each group in accordance with the present scheme contains four leads from each recorder link switch. Supplementary common control leads and relays are indicated by the box 56 and corresponding leads. A common allotter circuit and apparatus are indicated by the box 57 and corresponding leads.

In general, the operation of this system is as follows, referring solely to Fig. 1. If it is assumed that the subscriber of line 13 calls; the select magnet 12 is operated and if, for example, by testing it is determined that the junctor 34 is idle with its originating link 30 and the primary link, such as 15, is also idle, the select magnet 29 operates followed by the operation of hold magnet 32 which in turn is followed by the operation of the associated hold magnet 17. The hold magnet 17 in the primary line switch 10 and the select magnet 29 in the secondary link switch 22 are employed for the testing of this connection to the junctor circuit 34 as will be described hereinafter. An idle recorder is now automatically selected and connected, for example, recorder 53 over leads 52, through the recorder link switches 48 and 49 and leads 45 for connection to the junctor circuit 34. The usual dial tone is then transmitted to the calling subscriber of line 13. This subscriber will then dial a three-digit number representing the desired subscriber's line and the ringing code to be applied for calling this subscriber. As stated, the selection of the desired subscriber's line is effected by a novel preference arrangement whereby full use is made of all available paths and the operations are as follows: The first operation taking place after the recorder has received the digits is that a select magnet, for example 60, for line switches 20 and 21 is actuated as it would represent the level in which the desired subscriber's line is located, such as for example, line 61 which terminates in the corresponding horizontal level in line switch 20 this select magnet is operated over a test lead through a back contact of the cut-off relay of the called subscriber's line provided that this subscriber's line is idle. It should be observed that in this case the called line is located

in a line switch other than the line switch in which the calling line is located, that is, in the example chosen, the called line is located in line switch 20, while the calling line is located in line switch 10. Under these circumstances as will be described hereinafter, the path over which the connection from the junctor 34 to this subscriber's line 61 will extend over the outgoing branch 37 from the junctor through the terminating primary link switch 40, terminating link 31, through section 23 of the switch 22, the primary link 25 and through line switch 20 to the subscriber's line 61. This will be the preferred choice, provided the path through the terminating primary link 31 is idle, as the arrangement is such that the terminating primary link 31 which is the companion link to the originating link 30 and the associated primary link 25 will be tested first to determine if these paths are free for use. The purpose of this choice of paths is that if these paths were not used at this time it might happen that the terminating primary link 31 could not be used later for other calls to a subscriber in line switch 10 as the only available connection to this subscriber over section 23 is the primary link 15 which is already used and hence the terminating primary link 31 would remain idle and not available for other calls. If the test indicates that the terminating primary link 31 is busy the test will continue in a regular sequence circuit arrangement to test for an idle set of links comprising any other idle terminating primary link and its companion primary link in any other section of a switch 22 through line switch 20. On the other hand, if the called line had been located in the same line switch 10 as the calling line, it is evident that the corresponding primary link 31 could not be used as the companion primary link 15 is already used for the calling line connection, and in this case, any other free pair of a terminating primary link and a primary link in any other section of switch 22 will be used for the call to the subscriber in line switch 10 in accordance with the regular sequence circuit arrangement. This test for available paths will be controlled primarily by ground connections at the back contacts of the hold magnets in the associated line switch as will be described hereinafter.

As to the testing relating to the idle or busy condition of a called line it was stated that for the operation of the desired select magnet in the line switch the test was effected over a test lead through the back contact of the cut-off relay for the called line and that if the called line was idle the connection was established. However, if the called line is busy its cut-off relay is operated and in this case the test lead will be extended through a front contact of this cut-off relay and cause the usual busy signal to be transmitted back to the calling line.

In this system certain groups of lines may instead of being connected to individual subscribers' stations be arranged as trunks leading to a distant office or a hunting group of subscribers' stations. In this case if a connection is desired with such a distant office, trunk or line hunting is arranged so that when the first trunk in the group leading to this distant office is tested and found busy due to the associated cut-off relay being operated, the test lead is extended to the cut-off relay of the next succeeding trunk in this group and if this trunk is busy the test lead is further extended through the associated cut-off

relay to a next succeeding trunk. This testing arrangement is arranged so that the first idle trunk is immediately found by this means whereupon the connection is extended to the trunk in the same manner as to an idle called line, thus eliminating the actual seizing of a trunk for testing.

Referring now to the detailed circuit drawings of this system as disclosed in Figs. 3 to 8, the reference characters used in Fig. 1 are retained as far as applicable in these figures designating the various corresponding parts in Fig. 1, which are further identified by explanatory legends. A call will first be traced through these drawings from the calling subscriber No. 1 of line 13 to the called subscriber 81 of line 61 illustrating the connections established in the case where the called line is located in a line switch other than the one in which the calling line is located. This will be followed by a description relating to a case where both the calling subscriber (No. 1) and the called subscriber (No. 11) are located in the same line switch and this in turn will be followed by a brief description of a trunk or line hunting call from a calling subscriber.

If it is assumed that the subscriber No. 1 calls, a circuit is completed for the line relay 300 from battery, winding of this relay, contacts of the cut-off relay 301, over the calling subscriber's loop and line 13 to ground at contacts of cut-off relay 301. The operation of this line relay causes the operation of the associated select magnet 12 from battery through the winding of this magnet, a front contact of line relay 300 and corresponding back contacts of line relays for the subscribers terminating in line switches 10 and 11 such as line relays 303 and 304, with the exception of the line relay 305 for line 14 over the common lead 400 through contacts of one or all of the recorder circuit relays such as 700 and/or 701 over a chain circuit through contacts of relay 702 representing the fifth recorder 55 and relay 703 representing the first recorder 53 and contact of intermediate relays for intermediate recorders to ground. It should be observed, of course, that the select magnet 12 can only operate if a recorder is available and no other recorder is originating a terminating call through the switches at this time due to this chain circuit. Select magnet 12 closes an obvious circuit for the relay 316, common to the line switches 10 and 11, and this relay in turn closes a circuit for the operation of relay 317 which is individual to the line switch 10. This circuit may be traced from battery through the back contacts of relays corresponding to relay 316 for the intermediate four pairs of line switches and the front contacts of relay 316, winding of relay 317, contacts of line relay 300 and the chain circuit previously described to ground at contacts of recorder relay 703. Relay 317 closes a circuit for the operation of the select magnet 29 in the switch 22, which is associated with the level in which the primary links from the line switch 10 in which the calling line is located terminates. The circuit for this select magnet 29 may be traced from battery, winding of select magnet 29, contacts of relay 317, to ground. That is, any one of the primary links from line switch 10 such as for example link 15 terminating in section 23 of switch 22 may be used for extending a connection to subscriber No. 1 through line switch 10. The operation of the select magnet 29 closes the circuit for the allotter 500 for the allotting of a connection from the calling subscriber's line over

a primary link and an originating link to a free junctor circuit. This circuit for the starting of the allotter extends from ground, contacts of relay 501 self interrupting contacts and winding of the stepping magnet 502, contacts of relay 504, to battery at contacts of select magnet 29. This causes the stepping magnet 502 to operate and release under control of its self-interrupting contacts to advance the brushes 505 and 506 to search for an idle path to an idle junctor. This path is found by the idle condition of a hold magnet in line switch 10 and a hold magnet in the switch 22. If, for example, the hold magnet 17 and the hold magnet 32 are idle, a circuit will be complete as follows: From battery winding of relay 501, brush 506 after it has taken one step, over the first terminal, contacts of the hold magnets 32, contacts of relay 317, to ground at contacts of the hold magnet 17. Relay 501 in operating opens the stepping circuit for the magnet 502 which now stops and permits the brushes 505 and 506 to remain on their respective terminals. The hold magnet 32 is now operated from battery through the winding of this magnet, the connection at the first terminal through brush 505, contacts of relay 501, to ground. Magnet 32 in operating opens the stepping circuit for the magnet 502 and closes a connection through the section 23 of switch 22 at the cross-point 509 to connect the primary link 15 to the originating link 30 to establish a connection to the idle junctor 34 and another circuit for the operation of the hold magnet 17 from battery through the winding of this magnet over the sleeve connection established at the point 509, contacts of relay 501 to ground. The operation of hold magnet 17 closes a connection at the cross-point 320 to connect the calling line 13 to the junctor 34 over the links 15 and 30. This connection also causes the operation of the cut-off relay 301 from battery through the winding of this relay over the sleeve connection at points 320 and 509, contacts of relay 501 to ground. It should be noted that the relay 501 is slow to release and remains operated after its circuit is opened at contacts of the hold magnet 32 to permit relay 301 to operate and to thereafter permit line relay 600 in the junctor 34 to operate from battery and ground through the windings of this relay over contacts of relay 601 and the top and ring conductor over cross-points 509 and 320 and links 30 and 15 and line 13 through the loop at the subscriber's station No. 1, and to permit this relay to operate relay 602 over an obvious circuit to provide a holding ground for hold magnets 32 and 17 and cut-off relay 301 over the sleeve connection through cross-points 509 and 320. The cut-off relay 301 opens the circuit for the line relay 300 and also the circuit for select magnet 12 which now releases. Select magnet 12 causes the release of relays 316 and 317 and select magnet 29.

It should be observed that the circuit for closing the connection for operating the hold magnet 32 also extended over the sleeve of link 30 to the recorder link switches 48 and 49 for the extending of a connection to an idle recorder. As the junctor 34 is the one chosen by the link 30, a circuit for the select magnet 50 in these recorder link switches is therefore established at this time, that is, before relay 602 is operated, this circuit extends from battery, winding of magnet 50, contact of relays 602 and 601, the sleeve connection over link 30, brush 505 and the connected terminal to ground at contacts of relay 501. This circuit is maintained long enough to permit

a recorder to be selected by the operation of a hold magnet in the recorder link switches as will presently be described. If there are as assumed five recorders provided for the ten junctors the recorder preference relays 700 and 701 and three intermediate relays are provided and wired so that the ten outgoing branches such as 45 and 46 and others are divided in pairs for the selection for each pair of a preferred recorder and if this recorder is busy any other idle recorder may be chosen in a sequence chain arrangement provided by these relays. This selection is initiated when this select magnet 50 in the recorder link switches 48 and 49 is operated. In this case therefore when this select magnet is operated and the preferred recorder is idle as indicated by the preference relay 700 being released the recorder 53 will be chosen by the operation of the hold magnets 706 and 707 which will then connect this recorder to the outgoing branch 45 of junctor 34 over leads 52. The circuit in this case will be from battery windings of these hold magnets 706 and 707 contacts of relay 800 in recorder 53, contacts of relay 700 and select magnet 50 to ground as supplied when this select magnet 50 is operated through a chain circuit extending through contacts of the remaining select magnets of switches 48 and 49. On this basis the same recorder 53 would have been chosen also as a preferred recorder by the next succeeding select magnet while the other four pairs of select magnets would have chosen a corresponding preferred recorder. In case this preferred recorder 53 had been busy relay 700 would have been operated and the next recorder such as for example recorder 55 would have been chosen if the associated preference relay 701 had been released by operating the corresponding hold magnets such as 708 and 709 connecting the junctor 34 to that recorder over leads 54. If it is assumed then that the recorder 53 is seized relay 700 is immediately operated to make this recorder busy and to provide an obvious holding circuit for hold magnets 706 and 707 and select magnet 50 releases on the operation of relay 602 as described hereinbefore. Circuits are now completed for preparing this recorder for reception of the desired subscribers numbers. The immediate effect of the closing of the connection through the cross-points 710 and 711 is the operation of relay 601 from battery winding of relay 601 through cross-point 710, contacts of relay 801 to ground. Relay 601 in operating releases relay 600 but relay 602 is maintained operated over the sleeve lead through cross-point 710 to ground at contacts of relay 802. Relay 601 supplies a substitute ground at its contacts for holding the established connections through to the recorder in place of the ground supplied by relay 602. The recorder circuits have not been shown in completed form as it seems unnecessary to burden the description with anything but the essential parts for a clear understanding of the applicant's invention. Suffice to say at this time is that on the seizure of the recorder changes take place to cause the above mentioned recorder busy relay 700 to be operated from battery winding of this relay to a ground at the recorder circuit indicated merely by a box 804.

A dial tone is now transmitted to the calling subscriber over the ring conductor from the recorder box 804 over the contact of relay 801. As the calling subscriber line is now connected directly to the recorder 53, pulse relay 812 will operate over contacts of relay 801 and through the calling subscriber's loop. The subscriber No.

1 may now dial the desired number comprising a tens and a units digit and a ringing digit by operation and release of relay 812 to control the usual recorder relays in box 804. Dial tone is removed from the ring conductor after the first digit is dialed. When all digits have been dialed, the associated relay 703 for this recorder is operated over a circuit from battery at the box 804 through contacts of relays 806 and 800, winding of relay 703 over the chain circuit of other corresponding relays of other recorders such as 702 to ground. The operation of relay 703 now causes the operation of a number of relays such as 808 from battery through the winding of this relay to a ground at contacts of relay 703. Relays 802 and 809 are also operated over the same circuit. Relay 802 now releases relay 602 in preparation for the selection of a path to the called line. Relay 504 is also operated over an obvious circuit on the operation of relay 703. If it is assumed that for example the line 61 for subscriber No. 81 accessible through line switch 20 is called, the corresponding tens relay 712 is operated from battery applied at box 804 over the corresponding tens lead and in addition a ground is applied at this box for unit lead 1 through contacts of relay 712 to this subscriber's line for the operation of the associated select magnet 60 from battery through the winding of this magnet, contacts of the cut-off relay 410 through contacts of the tens relay 712 and unit lead No. 1 to the ground in box 804. It may be noted that subscribers' lines need not be connected to line switches in numerical order since each such line number lead may be cross-connected from relays 712 and 725 to any cut-off relay such as relays 301 and 410. Select magnet 60 in operating closes an operating circuit for the associated relay 411 and this relay in turn closes a circuit for the relay 412 which identifies the line switch in which the called line is located. The circuit for relay 412 may be traced from battery through the contacts of relay 411, winding of relay 412, contacts of relay 411, contacts of relay 712 to ground. It will now be noted that as the called subscriber's line is located in a line switch other than the one in which the calling line is located, the terminating link 31, which is the companion link to the originating link 30 used by the calling line connection will be chosen for the extension of the connection to the called line as well as the primary link 25 from which the connection may be extended through switch 20 to the called line provided of course that these links are idle. If these links are idle, which is indicated by the released condition of hold magnets 414 and 512 a circuit is now closed on the operation of relay 412 from ground at the hold magnet 414, which represents the link 25 for the operation of the select magnet 41, which represents the terminating link 31 in switch 40. This circuit may be traced from battery through the winding of this select magnet 41, contacts of the hold magnet 33, contacts of relay 610, 602 and 601, contacts of relay 504, contacts of relay 412 to ground at contacts of hold magnet 414. This causes the operation of relay 810 from battery, armature and front contact of the select magnet 41, contacts of relay 703, winding of relay 810 to ground. It should be observed also that the select magnets 510 of switch 22 is operated on the operation of relay 412 from ground through contacts of this relay, winding of select magnet 510, to battery through a chain circuit through other select magnets of switch 22 which indicates that the primary link 25 will be used. This select

magnet in turn operates relay 807 from the battery contacts through chain circuit over other select magnets, contacts of relays 504 and 703, through the winding of relay 807 to ground. The operation of relay 807 would now release the relay 809 but as this relay is slow in releasing, it will be held over long enough so that on the operation of the select magnet 41 and relay 810 the battery from contacts of select magnet 41 will have time to establish the holding circuit for this relay 809 over the circuit traced for relay 810 and through the armature and front contact and the locking winding of relay 809 to ground at contacts of relay 700. Consequently, relay 809 will be held operated even through relay 807 is operated. An operating circuit is now closed by relay 810 for the hold magnet 42 for switch 40 to establish a connection to the outgoing branch 37 of junctor 34. This hold magnet circuit may be traced from battery through the winding of this hold magnet through the cross-point 711 contacts of relay 810 to ground. This ground from relay 810 now extends through the cross-point 612 for the link 31 over the sleeve circuit to battery through the hold magnet 33 of switch 22 to establish a connection at the cross-point 514 over link 25 to the line switch 20. The same ground is also extended at the cross-point 514 over the sleeve for the operation of the hold magnet 414 in the line switch 20 to close a connection between the link 25 and the called subscriber's line 61 at the cross-point 416. Thus in this case the link 31 which is the companion of link 30 is chosen for the establishing of a connection to the called line as the called line is located in a line switch other than the one in which the calling line was located.

If we now pause in tracing the succeeding circuits under these circumstances to consider the condition under which this companion link 31 cannot be used which will be the case if the called line was located in the same line switch as the calling line. It is evident that this link cannot be used in this connection as there will only be one available path to the switch 10 over the switch 22 through section 23 under these circumstances and as this path has already been used by the calling subscriber. That is, the link 15 was used to extend a connection from the calling subscriber to the junctor 34 over the originating link 30. It will be recalled that in tracing the previous connection for choosing the terminating link 31 that the relay 809 was held energized. If the called line is located in the same line switch as the calling line, the corresponding select magnet 41 will not operate as there will be no ground for this select magnet supplied at the hold magnet 17 of the line switch 10 as this magnet is already operated. Consequently the test must be made for other hold magnets in switch 10 to provide another primary link and another terminating primary link.

There will therefore be no circuit for relay 810 to operate this relay before relay 809 has chance to release on the operation of relay 807. When this takes place, a circuit is completed for the operation of relay 520 from battery, winding of this relay, contacts of relays 800, 809 and 807 to ground at the relay 703. When this relay 320 is operated, a circuit may now be traced for the choice of other paths to be determined by the operation of another select magnet in the terminating primary link switch and the operation of relay 810. For example, if the hold magnet 321 for another link in the switch 10 is idle, there

will be a ground from the armature and back contact of this magnet through contacts of relay 317, contacts of relay 520, contacts of hold magnet 522 in section 24 of switch 22, winding of select magnet 620 to battery through the chain circuit through other select magnets in switch 40. When this select magnet 620 operates, the circuit formerly closed from battery at contacts of select magnet 41 for the operation of relay 810 now extends through contacts of select magnet 620 to cause the relay 810 to operate and this relay now completes the connection for the new path by the operation of the hold magnet 42; and in this case the connection extends over the terminating link 622 through cross-point 623 to operate the hold magnet 522 in the section 24 of switch 22. This magnet closes a circuit at cross-point 526 for the operation of the associated hold magnet 321 for the primary link 524 through cross-point 36 to the calling subscriber's line which may in this case be for example the called subscriber No. 10 over the called line 327. Thus it will be seen that under these circumstances another idle connecting path including a terminating link and a primary link are chosen by the operation at switch 40 to the branch 37 of the junctor 34.

In either case, of the above two types of connections the completion of the call from this point on is the same, for example, if the first case where line 61 was chosen as the called line is considered the operations will proceed as follows: It will be noted that when the hold magnet 414 was operated, the associated cut-off relay 410 for subscriber No. 81 is operated from the ground on the sleeve circuit at the cross-point 416 as applied by relay 810. The operation of this cut-off relay now causes the release of the select magnet 60 which in turn causes the release of relays 411 and 412 and the select magnet 510, the select magnet 41 for the switch 40 and also the relay 810. However, before relay 810 has a chance to release the operation of cut-off relay 410 closes a circuit for the starting of the ringing of the called subscriber and for releasing the recorder. To this end this circuit causes the operation of relay 800 from battery through the winding of this relay, contacts of relay 810, contacts of relays 703, 410 and 712 over the unit lead to ground in the recorder box 804. Relay 800 now locks over its own armature and contact to a common ground in the recorder and the ringing pick-up relay 801 is now operated from battery through the winding of this relay and its own make-before-break contacts of the busy relay 806 and relay 800 to the common ground to start the ringing. Ringing now takes place over the tip and ring conductors over contacts of relay 801 in the usual manner over circuits not shown but, indicated by the box 815. Ringing trip relay 816 is associated with tip and ring conductors in the usual manner through box 815. The relay 800 also releases the relay 703 which releases relay 802, which in turn reoperates relay 602 in the junctor. The pick-up relay 801 also closes a circuit for the operation of the relay 610 in junctor 34 from battery winding of this relay through the cross-points 711 in switch 49, contacts of trip relay 816 and pick-up relay 801 to ground. Relay 610 connects the tip and ring conductors from the recorder through the junctor to the called line for the transmittal of the ringing current over the tip and ring conductors to the called line 81. The relay 601 now also releases due to the operation of the pick-up re-

lay 801 and this causes the line relay 600 to re-operate from the calling line and this relay closes a holding circuit for the relay 602 and also for line relay 812 in the recorder, from battery through a winding of relay 812, contacts of relays 801, 816, 801, 800, 802 through the cross-point 710 of switch 48, contacts of line relay 600 to ground. The incoming branch of the junctor from the calling line is now being held from ground on relay 602 through relay 601. When the called subscriber No. 81 answers this call, trip relay 816, operates to discontinue the ringing which causes line relay 812 to release and in turn causes the release of relay 610 which now connects line relay 614 to the called line causing this relay to operate which in turn operates relay 616. This relay in operating reverses the polarity of the tip and ring conductors of the calling subscriber to permit equipment well known in the art but not shown to start charging for a completed call. The calling subscriber No. 1 and called subscriber No. 81 are now connected respectively in the junctor for talking over the condensers 625 and 626. The outgoing branch of the junctor from the called line is now being held from ground on relay 602 through relay 610. Relay 812 in releasing causes the release of the remaining relays in the recorder and the hold magnets in the recorder link switches 48 and 49 and returns this apparatus to normal. When the calling party hangs up his receiver, relay 600 of the junctor releases in turn releasing relay 602 which releases hold magnets 318, 508, 42, 512 and 414. Considering now the conditions arising if the called subscriber No. 81 had been busy the operations would have been as follows: At the time the recorder has set up the circuits preliminary to the selection of available paths from the junctor to this line the cut-off relay 210 would have been found operated. Thus when the unit ground was applied at the recorder due to the operation of the tens relay 712 this ground would under these circumstances close a circuit for the operation of the busy relay 806 over a circuit from battery through one winding of this relay, contacts of relays 810 and 703, contacts of cut-off relay 410, back over the unit lead for this subscriber through the tens relay 712 to ground at the recorder. This busy relay 806 would then have released relay 703 and thus returned the recorder to normal and apply the busy tone from a busy tone source through contact of relay 801 to the ring conductor of the calling line 13 to the calling subscriber No. 1.

In case the call had been directed to a distant exchange over an idle outgoing trunk in place of to a subscriber such as No. 81 or No. 10, the procedure would be the same except when a ground is applied on a unit lead this unit lead would represent the whole group of trunks which may appear on horizontal levels of any of the line switches which have their relays corresponding to relays 412 and 317 operated over the same lead 713 or 714 from the tens relays. If, for example, trunk No. 91 is busy when lead 425 receives ground due to the operation of the tens relay 725 which represents the tens digits of the first trunk in the group, the associated cut-off relay 426 is operated. Hence this ground lead 425 is extended to the contacts of the cut-off relays of the next succeeding trunks and further extended over the contacts of succeeding cut-off relays if the associated trunks are busy until an idle trunk is found. When such a trunk is found this grounded lead causes the operation

of the associated select magnet, for example, if all but the last trunk No. 100 are busy, the select magnet 428 will operate in the same manner as any other select magnet. From this point on the procedure is the same as in the case of the selection of a connection to a called subscriber's line, that is, the particular trunk selected will be connected in the same manner through a line switch, for example, 21. In this case therefore the testing of the trunks is done without actually preparing a path to the trunks but merely tests whether or not the associated cut-off relay is actuated and if it is not actuated then the connection is established in the usual manner.

What is claimed is:

1. In a telephone system, cross bar line switches, a cross bar secondary switch divided in sections, a cross bar terminating primary switch, registers, groups of lines, each group appearing in a separate line switch, a group of primary links originating in each line switch, each link terminating in a separate section of said secondary switch, junctors each having an incoming branch originating in a separate section of said secondary switch and having an outgoing branch terminating in the terminating primary switch, terminating links originating in said terminating primary switch and each terminating in a separate section of the secondary switch for connection to a companion primary link in each group of said links, means responsive to the seizure of a calling line for establishing a connection from said line through the associated line switch and over an idle primary link and the companion incoming branch of an idle junctor through the corresponding section of the secondary switch, and through said junctor to an idle register, means responsive to dial pulses received in said register over said connection for selecting and connecting a desired called line to said calling line, the connection extending over the outgoing branch of the chosen junctor through the terminating primary switch over the terminating link and primary link appearing in the same section of the secondary switch through which the connection from the calling line to the seized junctor extends if said links are idle and said means being operative if said links are busy to extend the connection through any other first idle pair of terminating and primary links in any other section of the terminating switch while in either case said means is operative to thereafter extend the connection to the called line, through the corresponding line switch.

2. In a telephone system, cross bar line switches having select magnets and hold magnets, cross bar secondary switches having select magnets and hold magnets, groups of lines, each group appearing in a different line switch, a group of links originating in each line switch and terminating in separate sections of said secondary switch, junctors each having an incoming branch originating in a separate section of said secondary switch and an outgoing branch, means responsive to the seizure of a calling line for establishing a connection from said line over a link and a corresponding incoming branch of a junctor through the associated line switch and associated section of the secondary switch, said means including circuits controlled by the hold magnets of the two switches for establishing a connection over a pair comprising an idle link and the associated incoming branch of an idle junctor and circuits controlled by the select magnets of the secondary

switch for selecting a first idle such pair for the establishing of said connection.

3. In a telephone system, cross bar line switches, a cross bar secondary switch, a cross bar terminating switch, a group of lines appearing in each line switch, primary links outgoing from each line switch, one of said links from each line switch terminating in a separate section of the secondary switch, junctors each provided with an incoming branch terminating in a separate section of the secondary switch and having an outgoing branch terminating in the terminating switch, terminating links each originating in the terminating switch and terminating in a separate section of the secondary switch, means responsive to the seizure of a line for establishing a connection over a first idle pair comprising an idle primary link and the incoming branch of an idle junctor through the corresponding line switch and section of the secondary switch, means controlled by impulses received from the calling line over the path to the chosen junctor comprising said primary link and incoming branch for establishing a connection from the outgoing branch of the junctor, over a terminating link and a primary link to a called line through said terminating switch, secondary switch and associated line switch, means operated during the establishing of said last connection for directing it over a path including the terminating link terminating in the same section of the secondary switch as the incoming branch of the chosen junctor if this terminating link is idle, and the called line is located in a line switch other than the one in which the calling line is located while if this terminating link is busy or if the called line is located in the same line switch as the calling line, said last-mentioned connection is directed over a path including a first idle terminating link of the remaining such links.

4. In a telephone system, cross bar line switches having select magnets and hold magnets, a cross bar secondary switch divided in sections having a set of select magnets common to all sections and two hold magnets per each section, a primary terminating cross bar switch having select magnets and hold magnets, registers, a group of lines appearing in each line switch, primary links outgoing from each line switch, each link from a line switch terminating in a different section of said secondary switch, junctors each provided with an incoming and an outgoing branch, the incoming branches terminating in different sections of the secondary switch, the outgoing branches terminating in the primary terminating switch, terminating links originating in the primary terminating switch and each terminating in a separate section of the secondary switch, means responsive to the seizure of a calling line for establishing a connection from said line over a primary link and the corresponding incoming branch of a junctor through the associated line switch and associated section of the secondary switch to the junctor and through said junctor to a register, said means including circuits controlled by the hold magnets of the two switches involved for the establishing of said connection over a pair comprising an idle incoming link and the incoming branch of an idle junctor, and circuits controlled by the select magnets of the secondary switch for selecting a first idle such pair for the establishing of said connection, means controlled by impulses received over said calling line in said register for establishing a connection from said junctor to an idle called line, said means

including circuits controlled by hold magnets of the line switch in which the called line is located and of the secondary switch to select a path including the terminating link in the same section of the secondary switch in which the incoming branch of the junctor employed is located if this path is idle and if the called line is located in a line switch other than the line switch in which the calling line is located, while if this path is busy or if the called line is located in the same line switch as the calling line another idle path for the establishing of this connection is chosen including another terminating link and another primary link.

5. In a telephone system, cross bar switches, lines, a cut-off relay associated with each line operative if the associated line is busy, junctor circuits, registers, means responsive to the seizure of a calling line for actuating said cross bar switches to establish a connection from said calling line to an idle junctor and from this junctor to an idle register, means responsive to impulses received in said register from said calling line for establishing a connection to the cut-off relay of a called line, means operative if the called line is busy as indicated by the operated condition of the associated cut-off relay to transmit a busy signal to the calling line, means in said register operative if the called line is idle as indicated by the released condition of said cut-off relay to actuate said cross bar switches to establish a connection from the chosen junctor to said called line.

6. In a telephone system, cross bar switches, calling lines, trunks arranged in groups, a cut-off relay associated with each trunk operative if the associated trunk is busy, junctor circuits, registers, means responsive to the seizure of a calling line for actuating said cross bar switches to establish a connection from said calling line to an idle junctor and from said junctor to an idle register, means responsive to impulses received in said register from said called line for establishing a connection to the cut-off relay of a first trunk in any desired group, contacts on said cut-off relays for extending said connection from the first cut-off relay if the associated trunk is busy as indicated by the actuated condition of said cut-off relay to contacts of the next succeeding cut-off relay until an idle trunk is found as indicated by the released condition of the associated cut-

off relay, means operative as indicated by the released condition of the cut-off relay of a first idle trunk to actuate said switches to establish a connection from the chosen junctor to the said first idle trunk.

7. In a telephone system, cross bar line switches, a cross bar secondary switch divided in sections, a cross bar terminating primary switch, registers, groups of lines, each group appearing in a separate line switch, a group of primary links originating in each line switch, each link terminating in a separate section of said secondary switch, junctors each having an incoming branch originating in a separate section of said secondary switch and having an outgoing branch terminating in the terminating primary switch, terminating links originating in said terminating primary switch and each terminating in a separate section of the secondary switch for connection to a companion primary link in each group of said links, means responsive to the seizure of a calling line for establishing a connection from said line through the associated line switch and over an idle primary link and the companion incoming branch of an idle junctor through the corresponding section of the secondary switch, and through said junctor to an idle register, means responsive to dial pulses received in said register over said connection for selecting and connecting a desired called line to said calling line including means for causing the said register to seize the selected called line to originate a connection to the outgoing branch of the chosen junctor with the connection extending from the line switch associated with the called line and primary link appearing in the same section of the secondary switch if the called line is located in a line switch other than the line switch in which the calling line is located, through the terminating link and terminating primary switch if said links are idle or if the called line is located in the same line switch as the calling line or if said links are busy to extend the connection over any other first idle pair of primary and terminating links in any other section of the secondary switch while in either case the same said means as used for establishing a connection from the calling line to the incoming branch of the junctor is operative to extend the connection from the called line to the chosen junctor.

AMOS E. JOEL, JR.