

July 29, 1924.

1,503,095

H. D. CURRIER ET AL

TELEPHONE SYSTEM

Original Filed Feb. 24, 1919 5 Sheets-Sheet 1

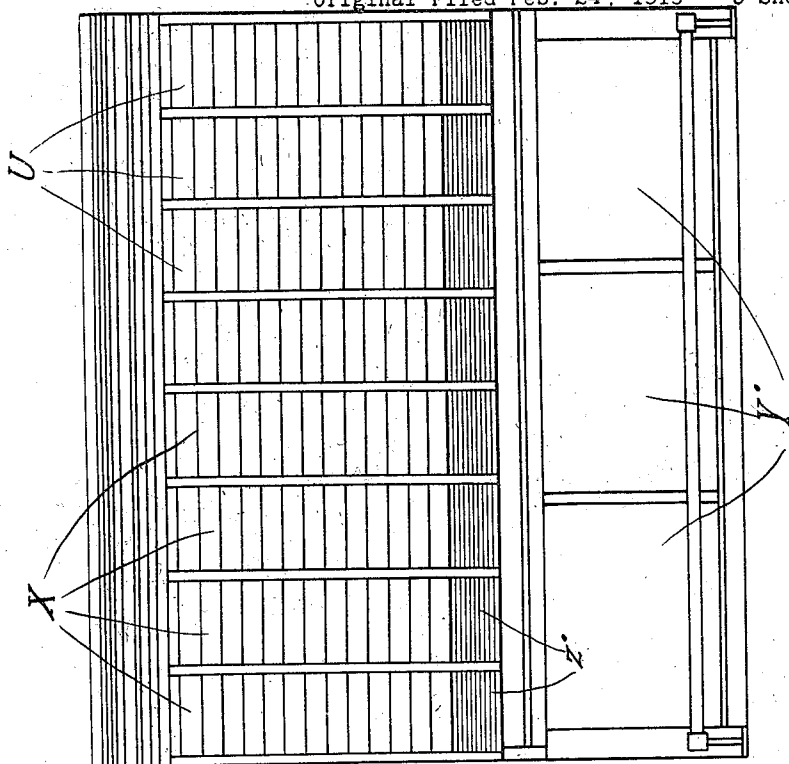


Fig. 2.

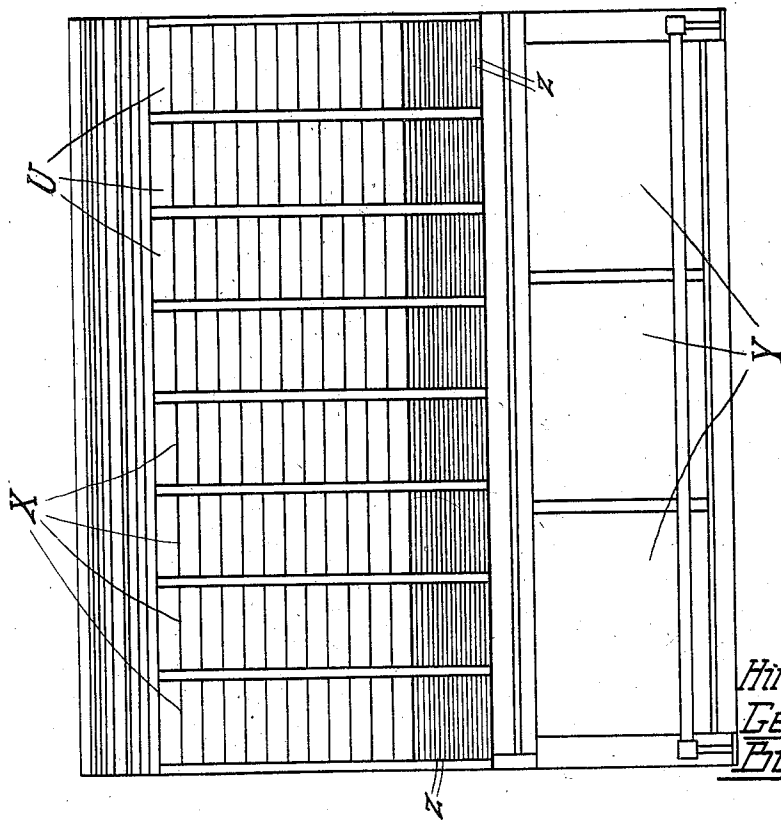


Fig. 1.

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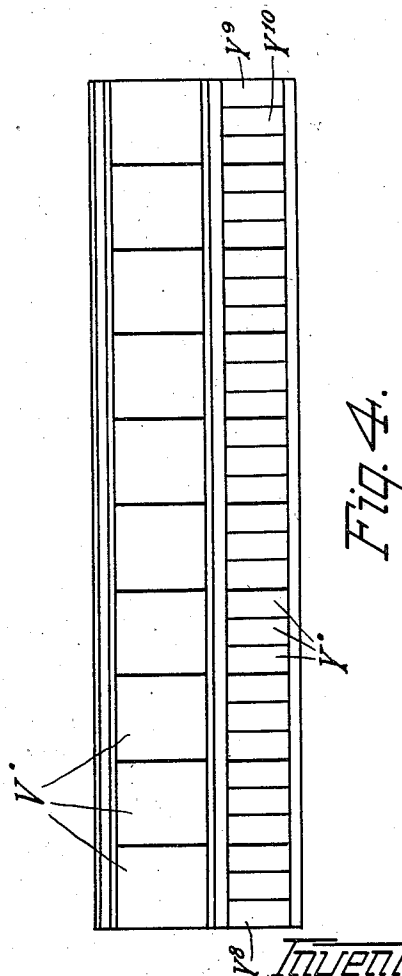
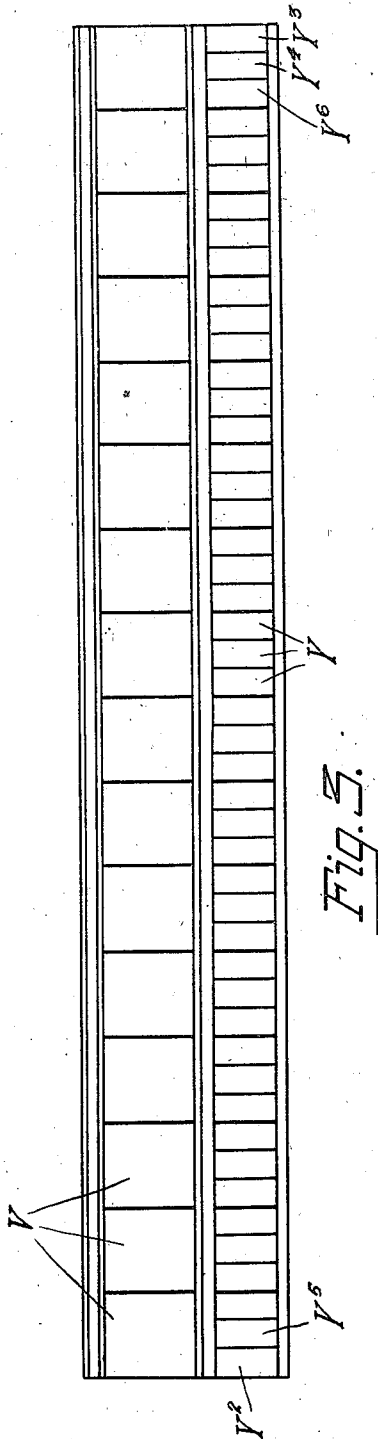
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TELEPHONE SYSTEM

Original Filed Feb. 24, 1919 5 Sheets-Sheet 2



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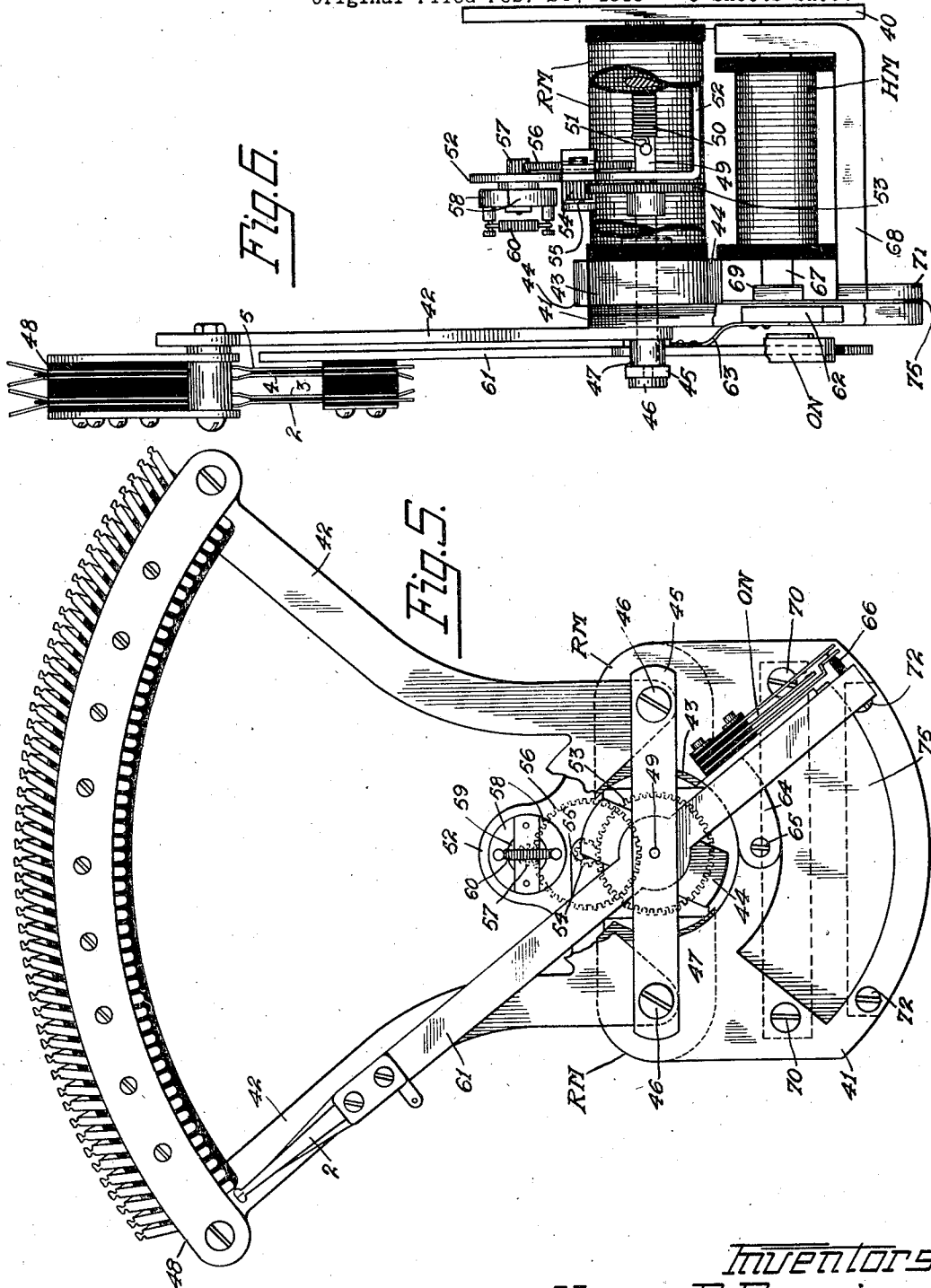
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TELEPHONE SYSTEM

Original Filed Feb. 24, 1919 5 Sheets-Sheet 3



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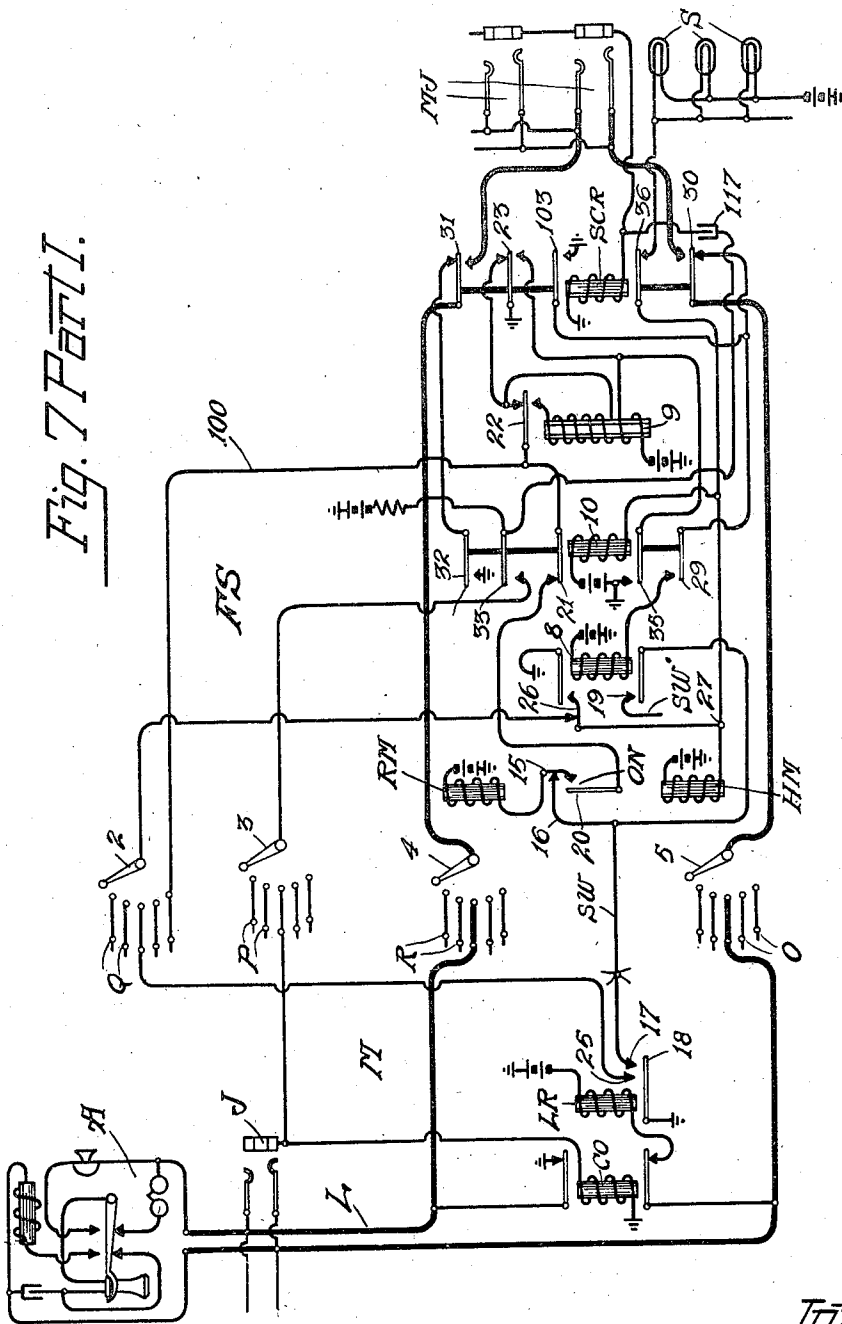
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TELEPHONE SYSTEM

Original Filed Feb. 24, 1919 5 Sheets-Sheet 4

Fig. 7 Part I.



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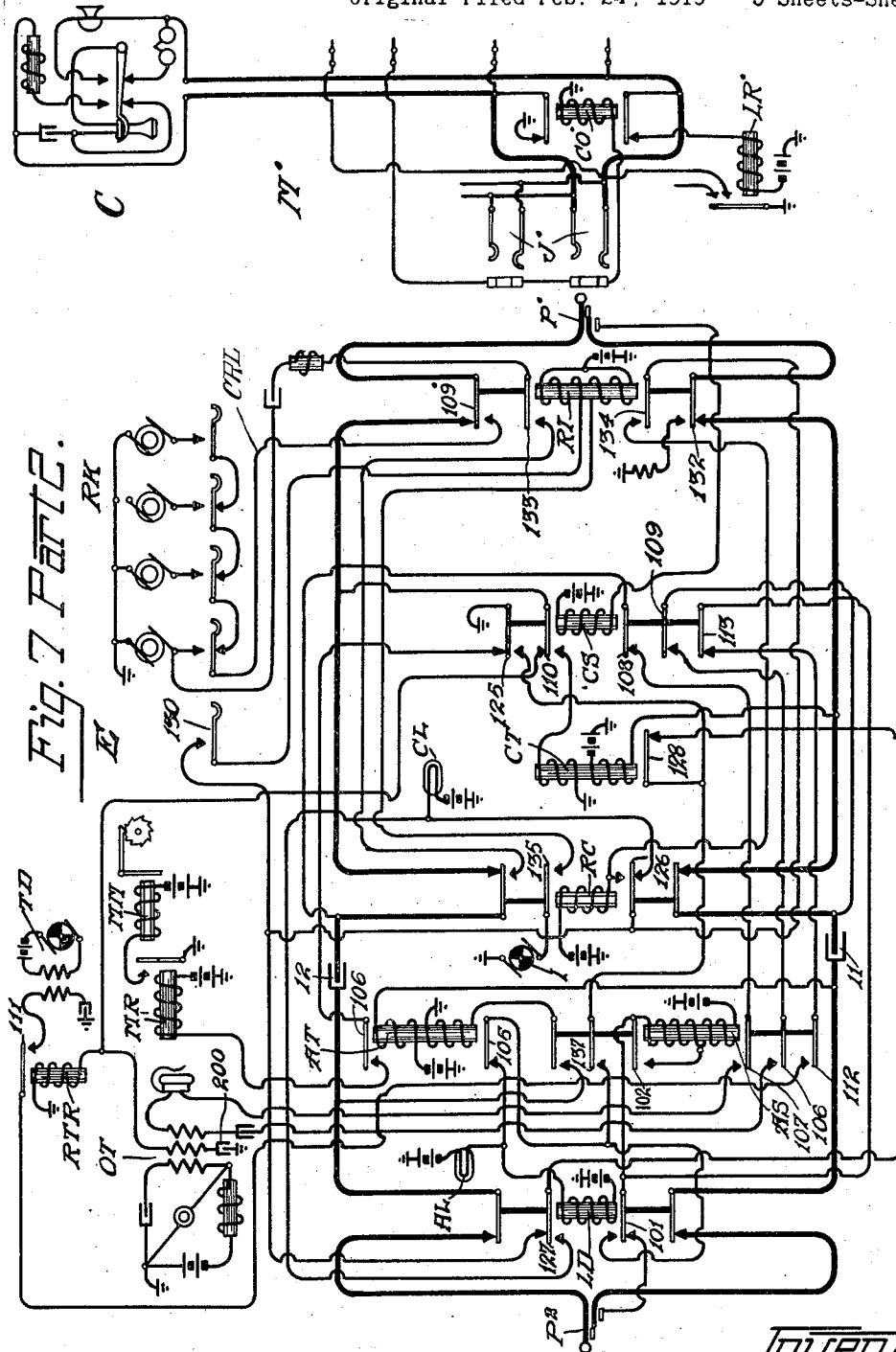
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TELEPHONE SYSTEM

Original Filed Feb. 24, 1919 5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed February 24, 1919, Serial No. 278,745. Renewed September 17, 1923.

To all whom it may concern:

Be it known that we, HIRAM D. CURRIER and GEORGE R. EATON, citizens of the United States of America, residing in Chicago, county of Cook, and Oak Park, county of Cook, respectively, in the State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

Our invention relates to telephone systems in which link or cord circuits are employed for interconnecting telephone lines, and has to do more particularly with that type of telephone systems employing manual switchboards.

At present there are a great many switchboards in use which have reached their maximum capacity in the number of lines that can be handled and in the number of calls that can be handled, and it is to this type of boards, as well as to new installations, that our invention particularly relates. It now becomes necessary to increase the capacity of these boards and it is impossible to do so, owing to the fact that the present multiple of the switchboard has been filled up to the limit, and in a great many cases new positions or sections can not be added owing to the fact that the switchboard entirely fills the room or office in which it is situated. We are thus confronted with these conditions and must find some way to rehabilitate a board of this character for the reason that the board may be practically new and in first-class working condition, making it undesirable to do away with the same and install an entirely new board.

An object of our invention is to increase the capacity of the so-called multiple line lamp boards in which the multiple jacks are not only used for answering purposes but are also used for calling purposes. In a board of this type the answering jacks and lamps which are individual to the subscriber's lines are multiplied, several times, through the board and these jacks are not only used for answering purposes but are also used for calling purposes. In view of the fact that the jacks and lamps are multiplied several times through the board, so that each operator can reach a jack of every line, the number of lines which may be installed in any one board is naturally limited to a certain number. It is a feature of our

invention to arrange a system whereby the multiple answering jacks and lamps are not individual to the lines, but are common to the lines thereby decreasing the total number of multiplied answering jacks and lamps required for a definite number of subscribers, and providing enough space whereby the usual multiple jacks, which require a great deal less space than answering jacks, may be multiplied through the different sections of the board. We provide a certain number of trunks terminating in multiple jacks and lamps for each group of subscribers. The number of trunks provided, which are common to the subscriber's lines, depends upon the amount of traffic out of any one group of lines. By this method of distribution and in conjunction with the so-called feature cord circuit, we are able to greatly increase the efficiency of operation, as well as to greatly reduce the cost of operation.

Another object of our invention is to materially increase the capacity of the present existing boards as well as to increase the efficiency, decrease the cost of operation, etc. of the board. In explaining our invention, we will refer to the existing type of board as it now appears, and as it will appear after we have rehabilitated the same. For example, we will consider the standard type of switchboard which has a capacity of 9600 lines, and assume that it has reached its capacity. A switchboard of this type is generally provided with eight panel sections and each panel is provided with 80 answering jacks and 80 line lamps, thereby making a total of 640 answering jacks and answering lamps per section. Each section of the board, of course, contains 9600 multiple jacks for the 9600 subscribers' lines, and further assuming that this switchboard is provided with the ordinary well-known cord circuit that was generally installed up until a few years ago which did not have the present automatic features contained in the cord circuits of to-day. In such a board each of the operators, at the three positions to a section, can handle an average of 240 calls per busy hour, thus making an average total of 720 calls per busy hour for any one section. That is a calling rate of 1.12 calls per line per busy hour of the lines in a section. It is necessary to provide this type

of board with 120 panels since each panel contains 80 answering jacks and 80 divided into 9600, the number of lines appearing in this board, gives 120 panels. There being 8 panels per section, it requires a 15 section board for the 9600 lines. Now, in view of the fact that the first operator and the last operator on the board would not be in a position to reach the entire 9600 multiples with only a 15 section board, it is necessary to provide 16 sections to take care of the 9600 lines, and an operator is not provided at the first position or at the last two positions on the 16 section board. To handle the traffic on this board at the busy hour, it would require 45 operators, that is, there would be 3 operators at each section, necessitating 45 operators at the 45 equipped positions. With the calling rate of 1.12 calls per line per busy hour, the total number of calls per busy hour from the 9600 lines would be 10,752 calls. So much for the old type of board which is not equipped with any of the present day automatic telephone features.

It is a feature of our invention to rehabilitate a board of this type or of any other standard type, and for the purpose of illustration and description, we have assumed a board of the above-described type. We will now describe our method of rehabilitating such a board. Now, by providing the cord circuits at the operators' positions with the well-known feature type of cord circuit including automatic listening, automatic disconnection, automatic ringing, automatic recall, call distribution, etc. it has been found that the average operator will be able to easily handle on the average 400 calls per busy hour instead of 240, as was the case with the old type of switchboard. Taking the total number of calls per busy hour, which we mentioned above as 10,752, we find that with the operator handling 400 calls an hour it will be necessary to provide approximately 27 operators to handle the said number of calls during the busy hour. It was necessary with the old board, as shown above, to place operators at 45 of the positions to handle the same number of calls, and now it is only necessary to place operators at 27 positions or at 9 sections of the board. Of course, we will have to provide an extra section as we did above in view of the fact that the operators can not be placed at the end positions of the board, thereby necessitating a board of 10 sections for the 27 operators to handle the 10,752 calls. By this method, it is at once apparent that we are able to handle the same number of calls with a board consisting of 10 sections instead of 16 sections. Now, in order to increase the capacity of the board we decrease the number of answering jacks and line lamps from 9600, as was previously

necessary when one answering jack was provided for each subscriber's line, to about 3500 or 3600 answering jacks, by the following method. We terminate the subscribers' lines in the banks of finder switches; each group of 50 subscribers' lines is multiply connected through the banks of 6 finder switches, making a total of 12 finder switches for 100 lines, or about 1152 finder switches for the 9600 lines. We then terminate the finder switches at their one end in multiple answering jacks and multiple line lamps, the answering jacks, being multiplied through different positions, thereby distributing the calls and permitting the operators to work at their maximum efficiency the entire time that calls are appearing upon the board, because the calls appear before a number of operators and can be answered by any one of the operators before which it appears.

We have arbitrarily divided this 10 position board into 4 different parts or zones having 2400 lines each, that is, 1/4 of the 9600 lines appear in each zone or part. We have multiplied the answering jacks associated with the finder switches 3 different times, that is, each answering jack and call lamp appears in 3 different positions in the switchboard. Now, with the required number, 9 sections, and 8 panels to the section, we need 72 panels of answering jacks. Dividing the 72 panels into 4 equal zones or sections, we have 18 panels to each zone or division of the board. For the 2400 lines in any one zone of the board we provide 24 times 12 switches or 288 switches, and assuming that each switch appears in 3 multiple jacks, it will require 3 times 288 or 864 answering jacks; for the purpose of calculation, we will say 900 answering jacks per zone of the switchboard. With 18 panels per zone, we have 1/18 part of 900 answering jacks or 50 answering jacks per panel. With this arrangement it is at once apparent that when a subscriber calls, an idle finder switch will connect his line to the associated answering jacks that appear 3 times in the 18 panels, thereby giving a plurality of operators an opportunity to seize the calling line. It is also at once apparent that at the idle hours one operator may be placed in each zone of the board and be able to reach and handle all of the calls that come in on the 6 panels in front of her without moving. By using only 50 answering jacks per panel, it is at once apparent that we have a saving of the space previously required for 30 answering jacks and line lamps per panel, that is, we have a saving of 8 times the space required for 30 answering jacks and line lamps per section of the switchboard or the saving of the space previously required for 240 jacks and lamps. In the space required for this number of answering jacks and answering lamps 1120

multiple jacks may be substituted, increasing the capacity of the board from 9600 to 10,720 lines. This, of course, is possible by being able to drop the multiple jacks down in the space that was saved by the decrease in number of answering jacks, and providing 1120 new multiple jacks in its place. With 1120 new subscribers' lines we will have to add extra positions to take care of these lines.

From the foregoing it will be seen that a feature of our invention resides in the means used for materially increasing the capacity or number of lines that may appear upon a given size standard switchboard.

A further feature of our invention is the provision of means for increasing the efficiency and the number of calls that an operator may handle per hour.

A still further feature of our invention is the means provided for terminating the finder switches in multiple jacks and lamps on the switchboard, thereby distributing the calls to the operators.

And still a further feature of our invention is the provision of a simplified automatic switch which is not provided with step-by-step mechanism and which is adapted to select on either a forward or on a backward movement.

These and other features will be more particularly pointed out in the ensuing specification and in the appended claims.

Referring to the accompanying drawings, Figure 1 shows a face view of a section of switchboard arranged with the old method of an answering jack and lamp per line, and with a capacity of 9600 multiple jacks;

Figure 2 shows a face view of a section of our improved switchboard provided with multiple answering jacks and line lamps which terminate in finder switches, and with an increased capacity of multiple jacks from 9600 to 10,720, multiple jacks;

Figure 3 shows a face view of the old switchboard with the 9600 line capacity and 16 sections;

Figure 4 shows our improved switchboard requiring only 10 sections, and with an increased capacity to 10,720 multiple jacks;

Figure 5 shows a top view of the finder switch of our invention;

Figure 6 shows a side view of the finder switch;

Figure 7, comprising parts 1 and 2, shows the complete circuit arrangement of a connection between a calling subscriber A and a called subscriber C, using our improved circuit arrangement.

Referring now to Figure 1 which shows a section of an ordinary switchboard of 9600 line capacity, the board comprises 8 panels X and is provided with 3 operators' positions Y, each of which positions is pro-

vided with the necessary operator's apparatus including 15 or 17 double-end operators' cord circuits, keys, etc. At Z is shown the individual answering jacks and lamps, as before mentioned, there being 80 answering jacks and line lamps per panel or a total of 640 answering jacks and lamps per section. At U is shown the 9600 multiple jacks, there being one multiple jack for each line in each section, each panel including 1200 multiple jacks, that is, 9600 multiple jacks for the 8 panels.

Referring now to Figure 2, we here show the same section of switchboard as shown in Figure 1, but after it has been rehabilitated. This section also comprises 8 panels X' and 3 operators' positions Y'. Each panel X' is provided with 50 answering jacks Z' which are multiplied 3 times through the 18 panels which comprises one zone of the switchboard. Each jack will appear in every sixth panel in the 18 panels. In each panel X' is shown 1340 multiple jacks U' there being 10,720 multiple jacks U' in each section.

Figure 3 shows a face view of the standard 9600 line capacity board being provided with 16 sections V and with 48 positions Y, positions Y², Y³ and Y⁴ not necessarily being equipped but so arranged that the operators at positions Y⁵ and Y⁶ can reach the entire multiple of 9600.

In Figure 4 we show the same board rehabilitated and provided with our new circuit arrangements. The board shown in Figure 4 is provided with 10 sections V' and with 30 positions Y'; only 27 of the positions Y' being necessary, the end positions Y⁸, Y⁹ and Y¹⁰ only being necessary for the reason mentioned above.

From the foregoing the great saving in the number of positions, equipment, operating expense, increased service and increased capacity that our invention permits of is at once apparent.

Referring now particularly to the switch structure as shown in Figures 5 and 6, it comprises a base plate 40 which supports a pair of rotary magnets RM and a mounting plate 41 which supports a frame member 42 that carries the bank contacts. The rotary magnets RM are fastened to the base plate 40 by means of screws extending up through the said base plate into the extended ends of the cores. Attached to the opposite end of the cores of the rotary magnets are a pair of soft iron pole-pieces 43, which extend inwardly and are provided with circular faces between which is mounted the rotary armature 44. Mounted immediately above and resting on the pole-pieces 43 is the mounting plate 41, which is of insulating material. The bank carrying frame 42, the mounting plate 41 and a bridge member 45 are all held in position by means of screws 46 that pass through these members and through collars

47 and have screw-threaded engagement with the cores of the rotary magnets RM. The bank carrying member 42 supports at its free end a semi-circular bank of contacts 48 including fifty-one sets of four contacts each, all of which contacts are suitably insulated from each other, and from the frame of the switch. Rotatably supported between the bridge member 45 and the base plate 40 is a rotatable shaft 49. The shaft 49 is held in its normal position by means of a coiled spring 50, which has its one end attached to the shaft by means of a pin 51, and its other end attached to the base plate 40. Secured to the shaft 49 is the armature 44 which normally rests at an angle to the bridge member 45 and is adapted, when the rotary magnets RM are energized, to rotate about its axis until it is substantially parallel to the said bridge member 45. Secured to the base plate 40 is an angular supporting plate 52 which carries the governing mechanism for regulating the speed of operation of the rotary armature 44 and shaft of the switch.

Attached to the shaft 49 is a gear wheel 53 which is adapted to be rotated therewith and to engage a pinion 54 suitably and rotatably supported by the angular mounting plate 52. Attached to the shaft 55 which carries the pinion 54 is a second gear wheel 56 adapted to mesh with a pinion 57 carried by a shaft rotatably supported by the angular plate 52. Attached to the shaft which carries the pinion 57 is a rotary governing device, which is adapted, as above mentioned, to control the speed of operation of the switch. The rotary governing device is of a well-known type and comprises a pair of weighted members 58 that are adapted to engage a circular drum 59 when the weighted members are rotated above a predetermined speed. A spring 60 tends to hold the weighted members in their normal positions. For a more complete understanding of the structure and operation of said governing means, reference may be had to Patent 1,262,352, issued to W. Kaisling April 9, 1918.

From the manner in which the governing device is connected to the shaft 49, it is at once apparent that said governing device is adapted to control, and regulate the speed of operation of the shaft 49 in both its forward and its retrograde rotary movements. Secured to the shaft 49 is a wiper carrying arm 61 and attached to the free extremity of the arm 61 are the contact wipers 2, 3, 4 and 5. These wipers are, of course, suitably insulated from each other and from the arm 61. Attached to the opposite end of the arm 61 is a soft iron holding member 62. This member is rivetally attached to a spring 63 which in turn is rivetally attached

to the said arm 61. A set of off-normal contacts ON are attached to an angular member 64 which in turn is secured to the plate 41 by means of screws 65. The arm 61 carries a buffer 66 which engages the off-normal contacts ON when the arm 61 is in its normal position, and holds them in their normal position.

Mounted immediately below the plate 41 is the holding magnet HM, which is provided with a core 67 and a heel iron 68. Attached to the free extremity of the core of the magnet HM is a soft iron strip 69, that in turn is attached to the mounting plate 41 by means of screws 70. Likewise attached to the heel piece 68 of the holding magnet HM is a soft iron strip 71 which is in turn attached to the plate 41 by means of screws 72. When the holding magnet HM is energized, the soft iron piece 62 carried by the arm 61 is adapted to be attracted by the strips 69 and 71 and frictionally engage the plate 75 which is mounted between the insulating plate 41 and the soft iron pieces 69 and 71, thereby holding the wiper shaft 61 and wipers in their advanced selected position. When the holding magnet HM is de-energized, the spring 63 removes the soft iron piece 62 from frictional engagement with the plate 75, thereby permitting the wiper shaft and wipers to return to normal under the influence of the spring 50, retarded by the governing mechanism connected to the switch shaft.

From the foregoing it is at once apparent that we have provided a device which is controlled by a rotary magnet and of a continuous motion instead of a step-by-step motion, which continuous motion is governed in both its forward movement and in its retrograde movement by means of a frictional governor, and which device is provided with a holding magnet that is adapted to maintain the switch shaft and wipers in their selected position by means of a frictional engaging member.

It may be well to mention at this point, that owing to the fact, in our system, that a finder switch is freed immediately upon the hanging up of the receiver at the calling substation and the immediate energization of the link disconnect relay LD of the cord circuit, the number of finder switches required to handle the traffic may be greatly decreased. This is, by releasing the finder switch for further use, the moment that the calling subscriber signals for disconnect, the time that the finder switch is held for use is greatly decreased over what it would be if it was necessary to wait for the operator to release the same. This feature of our invention is of particular advantage in a multiple line lamp system in which the line lamps are common to a plurality of sub-

scribers and it is desirable not to hold the common trunks longer than it is absolutely necessary to.

Our invention, of course, is applicable to new installations and is particularly applicable to call distribution systems and permits increasing the number of lines that may be conveniently handled in such a system on any one board by not making the multiple jacks and lamps individual to a subscriber's line, but by making them common to a plurality of subscribers' lines. It is to be understood one of the main features of our invention is the use of common trunks terminating in multiple answering jacks and lamps, in connection with a feature cord circuit having instantaneous disconnection.

Referring now in general to the preferred embodiment of our invention as illustrated in Figure 7, which comprises parts 1 and 2, it shows a calling substation A of the well-known Kellogg common battery type connected by the line limbs L to a common battery line circuit M which includes a line relay LR, a cut-off relay CO, multiple jacks J and multiple bank contacts O, P, Q and R, each subscriber's line appearing in the banks of 6 different finder switches. We have found under ordinary trunking conditions that 6 finder switches are sufficient to handle the traffic or calls from a group of 50 lines. Of course, we can increase the capacity of our finder switches to 100 or any other number of lines desired, and provide as many finder switches per group of lines as we find necessary and desirable to take care of the traffic.

The finder switch FS terminates at its one end in multiple jacks MJ and in multiple line lamps S, a jack MJ and lamp S appearing in every seventh panel in one zone of the switchboard, that is, the jacks and lamps associated with each finder switch appear in 3 different positions in the one zone of the switchboard. The conductor SW is the common starting wire and is connected to a contact on each of the line relays LR of the group of subscribers which is associated with the finder switch FS. The magnet RM is the rotary magnet of the finder switch FS and moves the wipers 2, 3, 4 and 5 over the bank contacts of the finder switch. The magnet HM is a holding magnet for retaining the wipers of the finder switch in a selected position. The relay SCR is a sleeve cut-off relay used for connecting the talking conductors and the finder switch wipers 4 and 5 to the multiple jacks MJ. The relay 8 extends the starting conductor SW through to the next finder switch FS (not shown) when the switch FS is taken for use. The finder switch FS also includes a double-wound slow-acting relay 9 and a single-wound quick-acting relay 10.

The cord circuit E comprises an answer-

ing plug P² and a calling plug P', the condensers 11 and 12 being interposed between the heavily marked conductors connecting the plugs P² and P'. Associated with the answering end of the cord circuit is an answering sleeve relay AS and an answering supervisory relay AT for controlling the circuit of answering supervisory lamp AL. Relay AS also acts as a test relay for controlling the connection of the operator's telephone set OT to the strands of the cord circuit. We also provide a link disconnect relay LD to make possible instantaneous disconnection and recall. Associated with the calling end of the cord circuit E we provide a calling supervisory relay CT and a calling sleeve relay CS for controlling the circuit of the calling lamp CL. The calling sleeve relay CS also controls the disconnection of the operator's set OT from the strands of the cord circuit. A party line ring key RK is provided for connecting one of a plurality of generators to the common ringing conductor CRL and for controlling the ringing control relay RC. The ringing control relay RC controls the ringing interrupter relay RI, which through the medium of the interrupter I applies ringing current from the common conductor CRL to the line of the called subscriber. Associated with the cord circuit is a service register device comprising a meter magnet MM and a meter control relay MR. Associated with the operator's set OT is a revertive tone relay RTR.

At the right of Figure 7, part 2, we show a called substation C similar to the calling substation A and terminating in line equipment M' similar to line equipment M including a line relay LR', cut-off relay CO', multiple jacks J' and multiple finder switch bank contacts.

Having described in general the apparatus shown on the accompanying sheets of drawings, we will now describe in detail the manner in which a call may be extended from the calling substation A to the called substation C.

Assuming that the subscriber at substation A wishes to initiate a call, upon the removal of the receiver thereat a circuit is closed through the line relay LR including the two sides of the subscriber's line circuit in series and the subscriber's instrument. The relay LR upon energization places a ground upon the starting wire SW and a ground upon a test contact, corresponding to the calling subscriber's line, in the banks of the finder switches having access to the calling subscriber's line. The placing of ground upon the conductor SW closes an energizing circuit for the rotary magnet of a first finder switch FS of the series of finder switches associated with the calling subscriber's line over a circuit extending

from battery through the magnet RM of the finder switch FS, off-normal contacts 15 and 16 of the finder switch FS and through contacts 17, 18 of line relay LR to ground. Had the finder switch FS (shown in Fig. 7, Fig. 1) been in use at the time that the subscriber's line relay LR was energized, off-normal contacts 15 and 16 would have been separated and the starting wire circuit would have been extended through alternate contact 19 of relay 8, through starting conductor SW' and to the rotary magnet RM of an idle finder switch. The starting conductor SW is adapted to be extended through each busy switch in the series of switches to the first idle switch in the series. The rotary magnet RM, upon energizing, starts to move the wipers 2, 3, 4 and 5 over the bank contacts of the finder switch in search of the calling subscriber's line. When the off-normal contacts ON are operated by the rotary magnet RM, a substitute circuit is closed for magnet RM over a circuit extending from battery through said magnet RM, off-normal contacts 15 and 20, contact 21 of relay 10, contact 22 of relay 9 and contact 23 of relay SCR to ground, thereby making the movement of the switch wipers of the finder switch FS independent of the starting circuit so that no matter if the calling subscriber should immediately replace his receiver, the finder switch FS will operate to move the wipers 2, 3, 4 and 5 over its bank contacts to the last contact thereof, unless a grounded contact is engaged.

As soon as the finder switch wiper 2 engages the grounded contact corresponding to the calling subscriber's line, which contact was grounded through contacts 18 and 25 of line relay LR, the holding magnet HM and the relay 10 are energized in multiple over a circuit extending from ground through contacts 18 and 25 of line relay LR, bank contact Q, wiper 2, normal contacts 26 of relay 8 to point 27 where the current divides and part flows through holding magnet HM to battery, and part through relay 10 and lamps S to battery. Magnet HM upon energizing stops the wipers in engagement with the bank contacts of the calling subscriber's line and holds the wipers in their advanced position. Relay 10 upon energizing opens the operating circuit of rotary magnet RM at its contact 21, and the magnet HM retains the wipers in their advanced position. A further result due to the energization of relay 10 is the closing of a circuit extending from battery through the winding of line relay 8, alternate contact 29 of relay 10, normal contact 30 of relay SCR, wiper 5 and its engaged bank contact, out through the calling substation and back through wiper 4 and its engaged bank contact, contact 31 of relay SCR, and contact

32 of relay 10 to ground. Relay 8 is thus energized over the calling subscriber's line circuit. A still further result due to the energization of relay 10 is the closing of a circuit for cut-off relay CO of the subscriber's line circuit M, extending from battery through alternate contact 33 of relay 10, wiper 3 and its engaged bank contact and the cut-off relay CO to ground. A busy potential is applied to the sleeve of the multiple jacks J over this circuit. Relay 10 upon energizing also closes a circuit for relay 9 extending from battery through the lower winding of said relay 9 and through alternate contact 35 of relay 10 to ground. Relay 8 upon energizing extends the starting wire through its alternate contact 19 to the next finder switch and closes a substitute circuit for the holding magnet HM and for the relay 10 and multiple line lamps S. The circuit for the multiple line lamps S extends from battery thru the said lamps S at their different operators' positions, normal contact 36 of relay SCR and through alternate make-before-break contacts 26 of relay 8 to ground. Relay 8 is now entirely dependent upon the circuit through the subscriber's instrument for its flow of current, and the relay 10 and magnet HM are dependent upon the relay 8 for their holding circuits.

The cut-off relay CO upon energizing disconnected the line relay LR from the subscriber's line and permitted the same to de-energize. Had a second subscriber removed his receiver at the same time that the first subscriber removed his, or before the finder switch FS connected to the calling subscriber's line and de-energized the subscriber's line relay LR, the instant that the relay 8 of the finder switch FS was energized, the starting circuit would be extended through to the next finder switch and it would start in operation to find the other calling subscriber's line that was not picked up by the first finder switch. As long as line relays LR are energized, finder switches FS will be started in search of calling subscriber's lines. Of course, the calling subscriber's line contacts appearing on the finder switch bank nearest to the normal position of the finder switch wipers will be the first to be selected. Likewise, if a finder switch should be restoring at the time that a call is being made, and the wipers of the finder switch restoring should contact with the contacts of the calling subscriber's line before the finder switch that has been started from a normal position in search of the calling subscriber's line engages the calling subscriber's line, then the finder switch that is restoring will connect to the calling subscriber's line and cause its multiple line lamps to be lighted and the finder switch started from its normal position, if it does not engage the contacts of a calling subscriber's line before it reaches its fully operated

position, will start to restore to normal and will restore thereto unless it engages the bank contacts of a calling subscriber's line that has been connected to by a finder switch.

From this it will be seen that our finder switches are adapted to select in both a forward and a retrograde direction.

Assuming that one of the started finder switches does not find a grounded bank contact Q, then this finder switch will advance to its fully operated position, in which position a circuit will be closed through holding magnet HM and relay 10 in multiple and through normal contact 26 of relay 8, wiper 2, the last bank contact Q, conductor 100, contact 22 of relay 9 and contact 23 of relay SCR to ground. As soon as this circuit is closed, magnet HM and relay 10 immediately energize. The energization of relay 10 and magnet HM, however, is only momentary, but long enough to close a circuit for relay 9 extending from battery through the lower winding of said relay 9 and through alternate contact 35 of relay 10 to ground. Relay 9 upon energizing opens the circuit of rotary magnet RM, at its contact 22 and closes a substitute circuit for magnet RM, extending from battery, through magnet RM, off-normal contacts 15 and 20, normal contact 21 of relay 10, alternate contact 22 of relay 9, through its upper high resistance winding, and through normal contact 23 of relay SCR to ground. The winding of relay 9 is of such a resistance as to remain energized in series with magnet RM, but to cause magnet RM to de-energize. The energization of relay 9 opened the energizing circuit for magnet HM and relay 10 at its contact 22, permitting relay 10 to de-energize and to close the above-mentioned locking circuit through the upper winding of relay 9 before it had time to de-energize. Relay 9 is a slow-acting relay. Magnet RM becoming de-energized permits the wipers 2, 3, 4 and 5 to return to normal position and upon reaching normal position the off-normal contacts are restored to their normal positions, thereby opening the locking circuit for relay 9 and placing the apparatus in its normal position.

Returning now to the point where the finder switch had operated to select the calling substation A, and multiple line lamps S had been lighted at the different operators' positions, an idle operator noting the glowing of calling line lamps S inserts the plug P² of the cord circuit E into one of the multiple jacks MJ. The insertion of the cord circuit plug P² into the jack MJ closes an energizing circuit for relay AS of the cord circuit and relay SCR of the finder switch, extending from battery through the lower winding and through the upper test winding of relay AS in series,

normal contact 101 of relay LD, the sleeve contact of plug P² and of jack MJ and through the winding of relay SCR to ground. The relay AS energizing, providing that the cord circuit E is the first cord circuit to be connected to the jack MJ of the finder switch FS, closes a shunt about its upper high resistance winding at its contact 102, thereby placing its lower resistance winding in series with the relay SCR of the finder switch FS. This low resistance path extends through the lower winding of the relay AS to the sleeve of multiple jacks MJ and prevents the relay AS of other cord circuits from operatively energizing and connecting their associated operator's sets to the line circuit of the calling subscriber's line.

The relay SCR, upon energizing, connects the talking strands of the finder switch through to the tip and ring contacts of the jacks MJ at contacts 31 and 30 of said relay SCR, opens the circuit for multiple lamps S at its contact 36, opens the circuit for relay 8 at its contact 30 but closes a substitute circuit for said relay 8 at its alternate contact 103 before said relay 8 has had time to de-energize, and closes a substitute circuit for relay 9 at its alternate contact 23 before relay 9 has had time to de-energize. The substitute circuit for relay 8 extends from battery through the winding thereof, alternate contact 29 of relay 10 and through alternate contact 103 of relay SCR to ground, and the substitute circuit for relay 9 extends from battery through the lower winding thereof and through alternate contact 23 to ground. Returning now to the cord circuit E, a further result due to the energization of combined test and supervisory relay AS is the bridging of answering tip supervisory relay AT across the subscriber's talking circuit. The relay AT is immediately energized over the subscriber's line to prevent a premature operation of the supervisory lamp AL and disconnect relay LD by opening its normal contact 105, and closes its contact 106 to operate the meter relay MR and meter magnet MM. A still further result due to the energization of relay AS is the bridging of the operator's telephone set OT across the strands of the cord circuit by closing its alternate contacts 106 and 107. The operator's set is now connected across the strands of the cord circuit through alternate contacts 106 and 107 of relay AS and normal contacts 108 and 109 of relay CS. The operator now being in connection with the calling subscriber inquires the wants of the calling subscriber.

Assuming that it is a subscriber at the substation C that is wanted, the operator tests the line of the called subscriber and if it is idle, she then inserts the calling plug

P' into a jack J' connected to the line circuit of the called subscriber. If the line of the called subscriber is busy, the touching of the tip of the plug P' to the sleeve of a jack J' will close a circuit from the busy or battery potential upon the jack J', through the tip of the plug, through contact 109' of relay RI, through contact 110 of relays CS and through the tertiary winding of the operator's induction coil to condenser 200 and to ground, thus giving the operator a busy click in her receiver, notifying her of the busy condition of the called line. The operator thereupon notifies the calling subscriber that the called subscriber's line is busy.

Assuming that the called subscriber is a subscriber whose substation is connected to the line of the calling subscriber, the touching of a multiple jack of the calling subscriber's line by the plug P' closes a circuit from the battery or busy potential found upon the sleeve of multiple jack J, through the tip of plug P', through contact 109' of relay RI, through contact 110 of relay CS and through revertive tone relay RTR to ground. Relay RTR upon energizing closes a circuit from the tone device TD through alternate contact 111 of relay RTR, through contact 112 of relay AS, through normal contact 113 of relay CS, through normal contact 101 of relay LD to the sleeve of a multiple jack MJ, from the sleeve of multiple jack MJ, through the condenser 117, through alternate contact 33 of relay 10, wiper 3 and engaged contact P to a multiple jack J, thence through the jack J which is being engaged by the tip of plug P', through the tip of said plug and contact 109' of relay RI, through contact 110 of relay CS, through the tertiary winding of the operator's induction coil, and through the condenser 200 to ground, thereby giving the operator a revertive tone test. The operator then plugs into the jack of the subscriber's line and completes the connection in a manner to be hereinafter described.

Assuming that the called subscriber's line is idle, the insertion of the calling plug P' into the jack J' of the called subscriber's line closes an energizing circuit for the calling sleeve supervisory relay CS and the cut-off relay CO' over a path extending from battery through the winding of said relay CS, the sleeve contacts of the plug P' and jack J', and the winding of relay CO' to ground. Relay CO' upon energizing disconnects the line relay LR' from the line circuit of the called subscriber. The calling sleeve relay CS upon energizing disconnects the operator's set OT from the strands of the cord circuit at its contacts 108 and 109, opens the circuit of revertive test relay RTR at its contact 113, and closes a circuit through the calling supervisory lamp CL at its alternate

contact 125. The circuit for the lamp CL may be traced from battery through the said lamp, normal contact 126 of relay RC, normal contact 127 of relay LD, normal contact 128 of relay CT and alternate contact 125 to ground. A further result due to the energization of relay CS is the opening of the circuit for meter relay MR at normal contact 125 of relay CS. The relay MR de-energizing opens the circuit of meter magnet MM, thereby permitting the same to de-energize.

The calling lamp CL is the customary calling supervisory lamp for indicating to the operator whether or not the called subscriber at C has his receiver upon the switch hook. The operator next depresses one of the ringing key plungers to connect one of the ringing generators to the common ringing conductor CRL and to initiate the operation of the automatic ringing equipment. The operation of end spring 130 of the ringing key closes a circuit for interrupter relay RI extending from battery through the upper winding of said relay, closed contact 130 of the end springs, normal contact 127 of relay LD, normal contact 128 of relay CT and alternate contact 125 of relay CS to ground. Relay RI upon energizing disconnects the strands of the cord circuit from the ring and tip conductors of plug P' and connects the selected generator through alternate contact 109' of said relay RI to the called subscriber's line, through the call bell at the called substation and back through alternate contact 132 to ground, thus insuring a preliminary ring of the call bell at the called substation the instant that ring key RK is operated. A further result due to the energization of relay RI is the connection of an audible ringing tone to the calling subscriber's line through alternate contact 133 of said relay RI to indicate to the calling subscriber that the call bell at the called substation is being operated. A still further result due to the energization of relay RI is the closure of an energizing circuit for ring control relay RC extending from battery, through the winding of said relay RC, alternate contact 134 of relay RI, normal contact 127 of relay LD, normal contact 128 of relay CT and alternate contact 125 of relay CS to ground. The relay RC upon energizing closes a locking circuit for itself extending from battery through its winding, its alternate contact 126, normal contact 127 of relay LD, normal contact 128 of relay CT and alternate contact 125 of relay CS to ground. A still further result due to the energization of relay RC is the opening of the circuit of calling supervisory lamp CL at normal contact 126 and the closing of a circuit for interrupter relay RI, extending from battery, through the lower winding of relay RI and through

alternate contact 135 of relay RC to interrupter I. The ringing relay RI is thus intermittently energized to connect ringing current to the called subscriber's line to operate the call bell thereat.

Upon the response of the called subscriber, a circuit is closed through the calling tip supervisory relay CT, extending from battery through the lower winding of said relay, through contact 132 of relay RI, through the ring contacts of the plug P' and jack J' out over the called line, back through the tip contacts of the jack J' and the plug P', through contact 109' of relay RI, through alternate contact 110 of relay CS and through the upper winding of relay CT to ground. Relay CT upon energizing opens the locking circuit of relay RC at its contact 128, thereby preventing further application of ringing current to the called subscriber's line. The relay RC de-energizing closes the link strands through to the called subscriber and disconnects the interrupter I from the interrupter relay RI. The subscribers may now carry on conversation over the heavily marked conductors.

Assuming now that conversation is finished, the subscriber at substation A upon replacing his receiver upon the switch hook opens the energizing circuit of answering tip relay AT. Relay AT upon de-energizing closes an energizing circuit for the link disconnect relay LD at its contact 105. The circuit for link disconnect LD extends from battery, through its winding, through said contact 105 of relay AT, through alternate contact 137 of relay AS and through alternate contact 125 of relay CS to ground. Relay LD upon energizing opens the series energizing circuit for relay AS of the cord circuit and relay SCR of the finder switch at its normal contact 101 and closes a substitute circuit for relay AS extending from battery through the lower winding of said relay AS, alternate contact 102 of said relay AS, alternate contact 101 of relay LD, alternate contact 137 of relay AS and alternate contact 125 of relay CS to ground. A further result due to the energization of relay LD is the disconnection of the tip and ring conductors of the cord circuit E and the tip and ring conductors of jacks MJ, thereby operatively disassociating the calling subscriber's line and the finder switch FS from the link circuit E.

The relay SCR of the finder switch FS de-energizing opens the energizing circuit of relay 8, which relay upon de-energizing opens the holding circuit for holding magnet HM and for relay 10. The holding magnet HM and the relays 8, 9 and 10 de-energizing permit the wipers 2, 3, 4 and 5 of the finder switch FS to return to normal. The finder switch FS may now be used by another calling subscriber or by the same

calling subscriber in extending a call to the multiple jacks MJ and line lamps S even though the plug P² be left in connection with the multiple jacks MJ. It will be seen by this arrangement that we greatly decrease the length of time that the finder switch FS would be held in use if it was necessary to wait for the operator to remove the plug P² from the jack MJ of the finder switch. The called subscriber C upon replacing his receiver upon the receiver hook opens the circuit of the calling tip supervisory relay CT at the substation switch hook contacts. The relay CT upon de-energizing closes a circuit for the calling supervisory lamp CL. This circuit may be traced from battery through the filament of said lamp CL, through alternate contact 127 of relay LD, normal contact 128 of relay CT and through alternate contact 125 of relay CS to ground. The operator upon noting the glowing of the answering supervisory lamp AL and the calling supervisory lamp CL removes the answering plug P² from the jack MJ and the calling plug P' from the jack J'. The removal of the calling plug P' from the jack J' allows the cut-off relay CO' and calling sleeve relay CS to de-energize. The relay CS upon de-energizing opens its alternate contact 125, thereby opening the locking circuit for the link disconnect relay LD, answering sleeve relay AS and for the supervisory lamps CL and AL. Relay LD and the relay AS upon de-energizing restore the cord circuit apparatus to normal rendering it available for connecting other subscribers' lines.

Should the calling subscriber desire to recall before plug P² is removed from the jack MJ, he may do so. The subscriber upon removing his receiver for a recall again energizes line relay LR, thereby grounding the common start wire SW and starting another finder switch FS or the same finder switch in search of the calling subscriber's line. As soon as the finder switch finds the calling subscriber's line, the connection is completed the same as heretofore described. If the same finder switch is started that was used in the previous connection, the finder switch upon finding the calling subscriber's line will again cause the lamps S to glow and either the same operator or another operator may seize the recall.

If the wipers of the finder switch FS should be restoring to normal and a grounded contact Q be engaged by wiper 2 of the finder switch, a circuit will immediately be closed through the holding magnet HM and the relay 10 in parallel, which circuit extends through contact 26 of relay 8 and test wiper 2 to the grounded bank contact Q. The magnet HM upon energizing, of course, stops the retrograde movement of the wipers and holds them in engagement

with the contacts of the calling line. Relay 10 upon energizing closes circuits for relay 8 and relay 9 as before described, and causes the multiple lamps S to glow. This call
 5 will be attended to by an idle operator in the regular manner and the connection completed as before described. The calling subscriber when he replaces his receiver, as before mentioned, causes the link disconnect
 10 relay LD of the cord circuit E to be energized, operatively disassociating the cord circuit C from the multiple jacks MJ, thereby freeing the finder switch FS for further use. The finder switch FS restoring opens
 15 the circuit of the cut-off relay CO of the calling subscriber's line.

In describing our invention we have shown a certain form of finder switch and a specific feature of cord circuit, but it is to be understood that various types of finder switches
 20 and various types of cord circuits may be used with our invention.

In working out our invention we have employed preferred circuit arrangements all
 25 of which tend to make an efficient operating system, but it is to be understood that various changes and modifications may readily be made without parting from the spirit and scope of our invention. Therefore, we do
 30 not desire to be limited to the exact arrangement shown and described, but aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

35 What we claim as new and desire to secure by United States Letters Patent, is:

1. A telephone system including subscribers' telephone lines, connection circuits less in number than said telephone lines,
 40 automatic means for connecting a calling subscriber's line and an idle one of said connection circuits, a link circuit having a manually operated connection plug for use in extending connection from said connection circuit, and subscriber-controlled
 45 means individual to said link circuit for operatively disassociating said link circuit from said connection circuit whereby said calling subscriber's line is disconnected
 50 from said connection circuit.

2. A telephone system including subscribers' telephone lines, a manual switchboard, link circuits, multiple jacks and multiple lamps in which said link circuits
 55 terminate, said multiple jacks and multiple lamps appearing before a plurality of operators at said manual switchboard, automatic means for connecting one of said link circuits to one of said calling subscribers' lines and for causing the multiple
 60 lamps associated with said link circuits to glow, operators' cord circuits for connecting to said link circuits, and subscriber-controlled means for automatically disasso-

ciating one of said cord circuits from one
 of said link circuits.

3. A telephone system including subscribers' telephone lines, link circuits terminating in multiple jacks and multiple
 lamps before a plurality of operators at a
 70 manual board, automatic means for connecting one of said link circuits to one of said calling subscribers' lines and for causing the multiple lamps associated with
 said link circuit to glow, operator-controlled
 75 cord circuits, any one of which may be used for extending the connection from said link circuit to a called subscriber's line, and subscriber-controlled means individual to
 each of said cord circuits for automatically
 80 disassociating said cord circuit from said link circuit.

4. A telephone system including subscribers' telephone lines, link circuits terminating in multiple jacks before a plural-
 85 ity of operators at a manual board, multiple line lamps associated with said jacks, automatic means for connecting one of said link circuits to one of said calling subscriber's
 lines and for causing the multiple lamps
 90 associated with said link circuit to glow, cord circuits, any one of which may be used for extending the connection from said link circuit to a called subscriber's line, and
 means individual to each of said cord cir-
 95 cuits for preventing the operative association of more than one of said cord circuits with said link circuit.

5. A telephone system including a plurality of subscribers' telephone lines, a link
 100 circuit common to said telephone lines and terminating in a plurality of multiple jacks, multiple line lamps associated with said jacks, a plurality of operators' positions at
 which said jacks and lamps appear, auto-
 105 matic means for connecting said link circuit and a calling one of said subscribers' lines and for causing the multiple lamps associated with the link circuit to glow, an
 operator's cord circuit for extending the
 110 connection from said link circuit, and subscriber-controlled means for automatically disassociating said cord circuit from said link circuit whereby said calling sub-
 115 scriber's line is disconnected from said link circuit.

6. A telephone system including a plurality of subscribers' telephone lines, a link
 circuit common to said telephone lines, a
 120 plurality of multiple jacks in which said link circuit terminates, multiple line lamps associated with said jacks, a plurality of operators' positions at which said jacks and
 lamps appear, automatic means for connecting said link circuit and a calling one
 125 of said subscribers' lines, an operator's cord circuit for extending the connection from said link circuit, and subscriber-con-

trolled means associated with said cord circuit for operatively disassociating said cord circuit from said link circuit.

7. A telephone system including a manual switchboard provided with answering jacks and with multiple jacks for calling purposes, and means including an automatic rotary switch for increasing the number of lines appearing upon said board by decreasing the number of answering jacks appearing upon the same and increasing the number of multiple jacks appearing upon the same, said automatic switch operable when a call is initiated to pick out and make connection with the line on which said call is initiated.

8. A telephone system including a manual switchboard, subscribers' answering jacks and multiple jacks entirely filling the space in the face of said switchboard, means including automatic rotary switches for increasing the number of lines appearing upon said switchboard by arranging the answering jacks in groups common to groups of subscribers' lines, thereby decreasing the number of answering jacks and permitting an increase in the number of multiple jacks, said automatic switches being associated with said groups of subscribers' lines and operable when calls are initiated to pick out and make connection with the lines on which said calls are initiated to extend said lines to the answering jacks associated with said automatic switches.

9. A telephone system including a manual switchboard provided with multiple answering jacks common to the subscribers' lines, and with multiple jacks individual to the said subscribers' lines and means including automatic rotary switches common to said multiple answering jacks and said lines for decreasing the number of answering jacks, thereby permitting an increase in the number of multiple jacks, said automatic switches operable to select said subscribers' lines as calling lines and to operatively extend the same to said multiple answering jacks.

10. A telephone system including a manual switchboard having multiple answering jacks and lamps for subscribers' lines for answering purposes, multiple jacks for said subscribers' lines for calling purposes, and means including automatic switches for decreasing the number of answering jacks and permitting the number of calling jacks to be increased, said switches operable in a progressive or retrograde direction to select said lines as calling lines and to associate the same with said multiple answering jacks and lamps.

11. A telephone system including a manual switchboard provided with multiple answering jacks and lamps common to subscribers' lines, automatic means including automatic switches operable in a progres-

sive or retrograde direction for connecting said subscribers' lines and said answering jacks, multiple jacks through which said subscribers' lines may be called as called lines, and means for decreasing the number of answering jacks and permitting an increase in the number of multiple jacks.

12. A telephone system including a group of subscribers' lines, a group of link circuits for said subscribers' lines, multiple answering jacks and lamps upon a manual switchboard in which said link circuits terminate, and automatic means controlled by the subscribers for interconnecting said link circuits and subscribers' lines and for causing the said multiple lamps to glow, operators' cord circuits common to said subscribers' lines, and means in said cord circuits for preventing the operative association of more than one of said cord circuits with one of said link circuits at the same time.

13. A telephone system including a group of subscribers' lines, a group of link circuits for said subscribers' lines terminating in multiple answering jacks and lamps upon a manual switchboard, automatic means controlled by the subscribers for interconnecting said link circuits and subscribers' lines and for causing the said multiple lamps to glow, operators' cord circuits, and means in said cord circuits for preventing the operative association at the same time of two of said cord circuits with a calling subscriber's line.

14. A telephone system including a group of subscribers' line circuits, link circuits common to said line circuits, automatic switches adapted to interconnect said link circuits and said subscribers' lines, said automatic switches being provided with individual driving mechanism and arranged to select during either a forward or a retrograde movement, and means for returning said switch to normal position.

15. A telephone system including subscribers' telephone lines, link circuits common to said lines, and automatic switches adapted to select upon either a forward or upon a retrograde movement, for interconnecting said subscribers' lines and said link circuits, individual driving mechanism for advancing said automatic switches, and spring means for returning said automatic switches.

16. A telephone system including subscribers' telephone lines, link circuits, automatic progressively movable switches for interconnecting said link circuits and said subscribers' telephone lines, cord circuits for extending connections from said link circuits to called subscribers' lines, revertive test means for said cord circuits for testing a multiple contact of a calling subscriber's line, and automatic disconnect means for said cord circuits for disassociating said

cord circuits from said link circuits, although a physical connection remains between said cord circuits and said link circuits whereby said switches are permitted to restore to normal.

17. A telephone system including a plurality of subscribers' telephone lines, link circuits common to said subscribers' telephone lines, multiple jacks and multiple lamps upon a multiple line lamp switchboard in which said link circuits terminate, finder switches for connecting an idle one of said link circuits to a calling one of said subscribers' lines and for causing the multiple lamps associated with said link circuit to glow, a plurality of operators' cord circuits situated at different operators' positions adapted to extend a call from any of the multiple jacks associated with said link circuit towards the called subscriber's line, and subscriber-controlled means in said cord circuits for operatively disassociating the connected cord circuits from one of said multiple jacks.

18. A telephone system including a plurality of subscribers' telephone lines, link circuits common to said subscribers' telephone lines, multiple jacks and multiple lamps upon a multiple line lamp switchboard in which said link circuits terminate, finder switches for connecting an idle one of said link circuits to a calling one of said subscribers' lines and for causing the multiple lamps associated with said link circuit to glow, a plurality of operators' cord circuits situated at different operators' positions adapted to extend a call from any of the multiple jacks associated with said link circuit towards the called subscriber's line, and means individual to each of said cord circuits for preventing the operative association of more than one of said cord circuits with said link circuit at the same time.

19. A telephone system including a plurality of subscribers' telephone lines, link circuits common to said subscribers' telephone lines, multiple jacks and multiple lamps upon a multiple line lamp switchboard in which said link circuits terminate, finder switches for connecting an idle one of said link circuits to a calling one of said subscribers' lines and for causing the multiple lamps associated with said link circuit to glow, a plurality of operators' cord circuits situated at different operators' positions adapted to extend a call from any of the multiple jacks associated with said link circuit towards the called subscriber's line, means individual to each of said cord circuits for preventing the operative association of more than one of said cord circuits with said link circuit at the same time, and multiple jacks for said subscriber's lines

whereby the said cord circuits may be used to extend connections to the subscribers' lines as called subscribers' lines.

20. A telephone system including calling subscribers' lines, multiple answering jacks for said subscribers' lines located upon a manual switchboard at different positions thereof, automatic progressively and backwardly movable means for interconnecting said jacks and said telephone lines, operators' cord circuits for extending connections from said answering jacks to multiple jacks of called subscribers' lines, and spring means for returning said automatic means to normal.

21. A telephone system including subscribers' telephone lines, a manual switchboard, answering jacks for said subscribers' lines less in number than said lines, said answering jacks being multiplied and appearing in a plurality of positions in said manual switchboard, subscriber-controlled means for interconnecting said subscribers' lines and said answering jacks, and operators' cord circuits for extending connections from said answering jacks to called subscribers' lines, said cord circuits being provided with calling subscriber controlled means for operatively disassociating said cord circuits from said answering jacks.

22. A telephone system including a group of calling subscribers' lines, a manual switchboard, answering jacks for said subscribers' lines less in number than said subscribers' lines, said answering jacks being multiplied at a plurality of positions on said manual switchboard, individual multiple jacks for said subscribers' lines appearing upon said switchboard, subscriber-controlled means for interconnecting said answering jacks with said subscribers' lines, cord circuits for answering calls from said subscribers' lines and for extending calls to said subscribers' lines through the multiple jacks thereof, and test means individual to each of said cord circuits for preventing the operative association of more than one of said cord circuits with one of said calling subscribers' lines at the same time.

23. A telephone system comprising a number of telephone lines, a number of signals arranged in groups, the signals of a group distributed to various operators and the number of groups less than the number of lines and common to them, automatic selecting and connecting switch mechanism responsive to line controlled currents to temporarily individualize to a line a group of said signals and display them before the various operators, and switching apparatus to enable any operator of a plurality to operatively connect her position with the line causing the display of her signal and to prevent other operators whose

signals are displayed from operatively connecting to said line causing the display of said other operator's signal.

24. A telephone system including lines and a pair thereof in conversational relation with each other, an operator controlled plug and spring jack contact in the talking circuit, a link circuit having a signal for indicating a call at the position of said operator, said circuit included in the connection between said operator's position and said calling line and normally available to any of a plurality of lines, selecting and connecting mechanism between said link circuit and said lines for automatically individualizing said link circuit to any calling line, and now individualizing said circuit to the calling line of said pair, and substitution controlled means operated over a circuit including a portion of the talking circuit between said connected lines for automatically and without the aid of the operator rendering said link circuit and its signal available for individualization to another line of said plurality.

25. A telephone system including telephone lines, and a less number of link circuits, selecting and connecting mechanism between said link circuits and lines for automatically connected idle link circuits with calling lines, operators' positions and plug and jack connections thereat for extending the connections of said link circuits, and means controlled over a calling line for automatically causing a link circuit connected thereto to become idle while the plug and jack connection extending the connections of said link circuit remains complete.

26. A telephone system including telephone lines, a pair thereof connected for conversation, a link circuit having a plug connector at one end and automatic selecting and connecting switch mechanism at the other and normally available for interchangeably associating said link circuit with various lines, said link circuit being included in the connection between said pair of lines, and means controlled over one of said connected lines independently of the operator for automatically dividing said link circuit and rendering the end toward said switch mechanism available for association with other lines.

27. A telephone system including telephone lines and a less number of groups of signals, the signals of each group distributed among various positions of the switchboard, automatic mechanism enabling any calling line to individualize to itself one of said groups and display the signals thereof and apparatus enabling any of the operators at whose positions the signals are displayed to individualize the call to her position, and release means actuated over a connected line

independently of the operator to render the group no longer individualized to such position.

28. A telephone system including telephone lines, and groups of signals common to said lines, the signals of each group distributed among various positions of a switchboard, automatic mechanism for interchangeably individualizing said groups to different lines, and displaying the signals of an individualized group, operator established plug and jack contacts extending the circuits of lines, and disconnect apparatus operable over a line to restore an individualized group of line signals so as to be common to said lines while the plug and jack contact extending said line is intact.

29. A telephone system including a group of telephone lines and a switchboard having multiple jacks for outgoing calls and answering jacks for incoming calls, the answering jacks arranged in groups and the jacks of a group located before different operators and each answering jack having an associated call indicating signal, a calling line and apparatus operable responsive to current thereover to individualize to itself any idle group of answering jacks and display the signals of such groups, a cord circuit having an answering plug for connecting to an answering jack connected to the calling line and a calling plug for connecting to a multiple jack for extending the call toward the called line, and disconnect apparatus operable responsive to current changes produced in said calling line to de-individualize the associated group of answering jacks and render said group common to said group of lines while the answering and calling plugs are in said jacks.

30. In combination with the calling telephone line, a plurality of multiple connecting terminals located at a central office switchboard, an automatic switch for selecting said calling line and for extending the same to said multiple connecting terminals, a cut-off relay for said switch having its coil connected to one of said multiple terminals, operators' link circuits distributed among operators' positions of said switchboard and means initially operated through a circuit including the coil of said cut-off relay whereby any one of said link circuits may be connected to any one of said multiple terminals when answering a call to the exclusion of the remaining link circuits that attempt to answer the call.

31. A telephone call distributing system comprising a plurality of subscribers' telephone lines, a central office switchboard, a plurality of answering terminals and associated calling signals, said lines distributed among operators' positions at said switchboard, an automatic switch for selecting said

lines as calling lines and for extending the same to said answering terminals and said associated calling signals, a cut-off relay for said switch having its coil connected to similar contacts throughout the plurality of answering terminals, and means including the coil of said cut-off relay whereby any one of a plurality of operators may connect with one of the answering terminals to which a calling line has been extended, and prevent other operators from operatively connecting with said line to extend the circuit thereof.

32. A telephone system including telephone lines, a central office switchboard, an automatic switch, a cut-off relay for said switch, a plurality of connecting terminals and associated line signals, the connecting terminals and associated signals being distributed among operators' positions of the switchboard, means controlled at the substation of said lines for causing the operation of said switch to extend the line of said substation to said terminals and to cause the operation of said associated signals to extend a call to a number of said operators' positions, link circuits at each of said positions for extending the calls, and means included in said link circuit and initially operated through the coil of the cut-off relay of said switch whereby when one of the link circuits is connected to a calling terminal, a second one of said link circuits cannot be operatively connected to another terminal of the same calling line.

33. A telephone system including telephone lines, a central office switchboard, a line relay for each line, an automatic switch, a cut-off relay for said switch, a plurality of connecting terminals and associated line signals common to said lines, the connecting terminals and associated signals being distributed among operators' positions of said switchboard, means controlled at a substation of said lines for operating said line relay whereby said switch operates to extend the line of said substation to said terminals and to operate the associated signals to extend a call to a number of said operators' positions, link circuits at each of said positions having answering terminals adapted for connection with said connecting terminals, and means initially operated through the coil of said cut-off relay whereby when one of said answering terminals is connected to a connecting terminal to which a calling line is extended, a second one of said link circuits cannot be operatively connected by its answering terminal to another connecting terminal in circuit with the same calling line.

34. A telephone system including telephone lines each having a line relay, a plurality of connecting terminals, an automatic switch common to said telephone lines and adapted to select any one of said lines when

its line relay is operated to extend the same to said connecting terminals, a cut-off relay for said switch, link circuits having manually operated answering terminals for connection with said connecting terminals, and means including a test circuit through the cut-off relay of said switch for preventing the operative association of more than one answering terminal with the connecting terminals to which one of said lines has been extended.

35. A telephone system including telephone lines, an automatic switch, a cut-off relay for said switch, a plurality of connecting terminals common to said lines but less in number than said lines, said switch adapted to extend any one of said lines as a calling line to said connecting terminals, link circuits having manually operated answering terminals adapted for connection with said connecting terminals, and means to initially operate through the coil of the cut-off relay when one of said answering terminals is connected to a connecting terminal having a calling line extended thereto to prevent the operative association of a second link circuit when the answering terminal of such second link circuit is connected to another connecting terminal to which the same line has also been extended.

36. A telephone system comprising telephone lines each terminating in bank contacts of a plurality of automatic switches, multiple jacks distributed among a plurality of positions on a central office switchboard, said switches operable to select said lines as calling lines and to extend the same to said multiple jacks, operators' manual link circuits at each of such position for connecting to said multiple jacks in answering calls, and test means included in said link circuits automatically operable upon connection of a link circuit with a terminal having a calling line extended thereto in answering a call for determining its answered or unanswered condition, and supervisory means for said link circuits operable when disconnection is signalled for.

37. A two-conductor telephone system comprising a telephone line, an automatic switch, said line terminating in the bank contacts of said switch, multiple jacks at a central office switchboard, said switch operable to extend said telephone line to said multiple jacks, a line signal for each of said multiple jacks, link circuits for connection to said multiple jacks, means whereby, when a link circuit is connected to one of said multiple jacks when said line has been extended to said jacks, and the substation on said line is operated for disconnection, the conductors of the link circuit are disconnected from said multiple jacks and said line and switch are available for use in operating said signal for calling before or

after said link circuit is disconnected from said multiple jacks, and means for permitting a second link circuit to be operatively connected to any one of said multiple jacks to extend a second call before said first link circuit has been restored to normal and for preventing the operative reconnection of the first link circuit to said multiple jacks during the period that the second link circuit is operatively connected thereto.

38 A call distributing system comprising a plurality of telephone lines, a central office switchboard, a plurality of answering jacks and associated signals individual to each of said answering jacks, said jacks being regularly grouped and multiply connected and distributed among operators' positions of said switchboard, an automatic switch for selecting said lines as calling lines and for extending the same to said answering jacks, link circuits having terminals which may be simultaneously and continuously connected to the multiple jacks to which the same line has been extended and so arranged that only one operator at a time may operatively connect to one of said answering jacks to answer a call thereat and extend connection to a jack of another line as a calling jack, an automatic disconnecting means for said link circuits for disassociating a connected link circuit and an automatic switch and a telephone line when the subscriber of said line retires, whereby said switch and telephone line are available for calling or called purposes.

39. In a telephone system including a calling two-conductor telephone line, a non-numerical automatic switch, a connecting jack at a central office switchboard, said switch operable to operatively associate said calling telephone line with said connecting jack, a called telephone line and operator's link circuit having a manual answering terminal normally connected with the conductors of the link circuit for connecting to said connecting jack, a calling terminal for said link circuit for connecting to said called telephone line, and means under the sole control of the substation on said calling line for operatively disassociating said link circuit from said automatic switch and calling line after the conversational circuit between calling and called lines has been completed.

40. In combination with the calling telephone line a plurality of connecting terminals for said line located at operators' positions of a central office switchboard, an automatic switch for operatively associating said telephone line with said connecting terminals, operators' link circuits having associated operators' telephones, said link circuits including means effective whereby, when one of said link circuits and asso-

ciated operators' telephone is connected to one of said terminals, a second link circuit which is physically connected to another terminal operatively associated with said line cannot be operatively connected to another operator's telephone, and automatic means for rendering the connection of said first link circuit ineffective and to permit the connection of said second link circuit to be operatively effective to connect another operator's telephone.

41. A combination with a two-conductor calling telephone line, a connecting jack, a non-numerical automatic switch for extending said calling telephone line to said connecting jack, a link circuit at the exchange for connecting to said jack and to a called telephone line, means under the sole control of the substation of said calling line to disassociate the calling line and automatic switch from said link circuit and to render the calling line and automatic switch available for recall when signalling for disconnection at all times prior to the time when the called subscriber signals for disconnection.

42. A call distributing system comprising telephone lines, a plurality of jacks at the central exchange, signals for said jacks, automatic switches common to said lines and jacks and operable to select said lines as calling lines and extend the same to said jacks, operators' link circuits divided into groups, an operator's telephone associated with each group of link circuits, and means responsible to simultaneous connection of two or more link circuits to the jacks having a calling line extending thereto to connect the operator's telephone associated with one of said link circuits and thereby to prevent the operative association of a second operator's telephone with the remainder of said link circuits.

43. In a telephone system, a telephone line, an automatic switch, a plug-ended link circuit, an operator's telephone, means for connecting said link circuit to said line through the medium of said plug and automatic switch, means under the control of the substation on said line for disconnecting said line from said plug, and means for reconnecting said line and switch and said link circuit prior to the withdrawal of the said plug and for connecting the operator's telephone to the said telephone line.

44. In a telephone system, a telephone line, an automatic switch, a plug-ended link circuit, means for connecting said link circuit to said line through the medium of said plug and automatic switch, an operator's telephone, means under the control of the substation on said line for disconnecting said line and automatic switch from said link circuit, and automatic means for

reconnecting said line and automatic switch to said link circuit prior to the withdrawal of the said plug and for connecting the operator's telephone to the calling line.

45. In a telephone system, a calling subscriber's line and a called subscriber's line, multiple answering jacks, an automatic switch for extending said calling line to said multiple answering jacks, calling jacks for said called line, a link circuit for connecting said lines through the medium of said automatic switch and a multiple jack and a calling jack, means controlled from the substation of a calling line for disconnecting the link circuit from the said multiple jack whereby said automatic switch and calling line restore, and means responsive to the disconnection of the said called line from the said link circuit for causing the automatic switch to be again connected to said link circuit.

46. In a telephone system, a calling subscriber's line, a connecting terminal, an automatic switch for extending said calling line to said connecting terminal, a called subscriber's line, a link circuit for connecting said calling line through the medium of said terminal and switch to said called subscriber's line, an operator's telephone adapted to be automatically connected to and disconnected from said link circuit upon connection to the calling and called lines respectively, means responsive to the replacing of the receiver at the substation of one of said lines for freeing said line and switch from the said link circuit, and means responsive to the disconnection of the link circuit from the other of said lines for again associating the operator's telephone with the said link circuit.

47. A telephone system including subscribers' lines appearing in multiple calling jacks, multiple answering jacks and calling lamps common to said lines, automatic rotary switch mechanism for selecting and connecting a calling one of said lines to a set of said multiple answering jacks and causing the associated calling lamps to glow, and operator controlled means for connecting said multiple answering jacks to a multiple calling jack of another of said lines.

48. A telephone system including a manual switchboard, subscribers' telephone lines, multiple calling jacks for said subscribers lines, multiple answering jacks common to said subscribers' lines and appearing in a plurality of operator's positions on said manual board, automatic rotary switches for selecting and connecting a calling one of said subscribers' lines to said multiple answering jacks, and a link circuit controlled by an operator for connecting said multiple answering jacks to a multiple calling jack of a called subscriber's line.

49. A telephone system including sub-

scribers' telephone lines, individual multiple calling jacks for said lines, multiple answering jacks and multiple calling lamps common to said lines, subscriber controlled automatic mechanism for connecting a calling one of said lines to said multiple answering jacks and for causing said lamps to glow, an operator's link circuit for exclusive connection to one of said multiple answering jacks and to a multiple calling jack of another of said subscribers' lines to establish connection between said lines, and subscriber controlled means in said link circuit for automatically freeing said calling line and said switch mechanism from said link circuit.

50. A telephone system including a called subscriber's line having multiple calling jacks, a calling subscriber's line, multiple answering jacks common to said lines, automatic mechanism controlled by the calling subscriber for connecting the calling subscriber's line to said multiple answering jacks, an operator's link circuit for connecting said multiple answering jacks to a multiple calling jack of said called subscriber's line to complete a connection between said lines, a supervisory signal, signaling means, means for effacing said signal when said signaling means is operated, and subscriber controlled means in said link circuit for automatically freeing said calling line and said automatic mechanism from said link circuit.

51. A telephone system including a switchboard having a plurality of operators' positions, subscribers' lines, multiple calling jacks individual to said lines and appearing in a plurality of positions upon said board, multiple answering jacks common to said lines and appearing in a plurality of positions upon said board, automatic switching means for interchangeably connecting said multiple answering jacks and said subscribers' lines, link circuits for use by different operators in interchangeably connecting said multiple answering jacks and said multiple calling jacks to establish connections between subscriber's lines, and subscriber controlled means for each of said link circuits for automatically freeing a calling line and a multiple answering jack associated therewith from the link circuit connected to said multiple answering jack.

52. A telephone system including a switchboard having a plurality of operators' positions, subscribers' telephone lines, multiple calling jacks for said lines appearing in a plurality of said operators' positions, multiple answering jacks appearing in a plurality of said operators' positions and common to said subscribers' lines, subscriber controlled means for interchangeably connecting said multiple answering jacks and said subscribers' lines, operators' link circuits at said operators' positions, and au-

automatic means for each of said link circuits for preventing effective connection of two of said link circuits to a calling subscriber's line.

53. A telephone system including a switchboard having a plurality of operators' positions, subscribers' telephone lines, multiple calling jacks for said lines appearing in a plurality of said operators' positions, multiple answering jacks appearing in a plurality of said operators' positions and common to said subscribers' lines, subscriber controlled means for interchangeably connecting said multiple answering jacks and said subscribers' lines, operators' link circuits at said operators' positions, and automatic means for each of said link circuits for preventing effective connection of two or more of said link circuits to a subscriber's line in response to a call therefrom.

54. A telephone system including a switchboard having a plurality of operators' positions, subscribers' telephone lines, multiple calling jacks for said lines appearing in a plurality of said operators' positions, multiple answering jacks appearing in a plurality of said operators' positions and common to said subscribers' lines, subscriber controlled means for interchangeably connecting said multiple answering jacks and said subscribers' lines, an operator's link circuit at one of said operators' positions for connection to said lines via said answering jacks, and relay means for said link circuit for preventing a second operator from effectively connecting a link circuit to a calling subscriber's line after another operator has established connection therewith.

55. A telephone system including subscribers' telephone lines, multiple calling jacks for each of said lines, multiple answering jacks common to said lines, automatic means for interchangeably connecting calling ones of said lines and said multiple answering jacks, operators' link circuits for establishing connections to said calling lines via said answering jacks and to called ones of said lines via said calling jacks, an operator's set, and automatic means for connecting and disconnecting said operator's set and said calling subscribers' lines to provide secret service.

56. A telephone system including subscribers' telephone lines, multiple calling jacks for each of said lines, multiple answering jacks common to said lines, automatic means for interchangeably connecting calling ones of said lines and said multiple answering jacks, operators' link circuits for establishing connections to said calling line via said answering jacks and to called ones of said lines via said calling jacks, an operator's set, automatic means for connecting and disconnecting said operator's set and said calling subscribers' lines to provide se-

cret service, and automatic ringing means for signaling the called subscriber.

57. A telephone system including subscribers' telephone lines, multiple calling jacks for each of said lines, multiple answering jacks common to said lines, automatic means for interchangeably connecting calling ones of said lines and said multiple answering jacks, operators' link circuits for establishing connections to said calling lines via said answering jacks and to called ones of said lines via said calling jacks, an operator's set, automatic means for connecting and disconnecting said operator's set and said calling subscribers' lines, automatic ringing means for signalling called subscribers, and automatic means in each of said link circuits for freeing the calling subscribers' lines from said link circuits.

58. A telephone system including subscribers' telephone lines, multiple calling jacks for said subscribers' lines, multiple answering jacks common to said subscribers' lines, subscriber controlled means for connecting said multiple answering jacks to a calling one of said subscribers' lines, an operator's link circuit for establishing connections from said calling line to a called one of said lines via one of said calling jacks, and subscriber controlled means in said link circuit for freeing the calling subscriber's line from said multiple answering jacks whereby other subscribers' lines may be connected to said answering jacks, prior to the disassociation of the operator's link circuit from said multiple answering jacks.

59. A telephone system including subscribers' telephone lines, multiple calling jacks for said subscribers' lines, multiple answering jacks common to said subscribers' lines, subscriber controlled means for connecting said multiple answering jacks to calling ones of subscribers' lines, an operator's link circuit for establishing connections from said calling lines to called ones of said lines via said multiple calling jacks, subscriber controlled means in said link circuit for freeing calling subscribers' lines from said multiple answering jacks whereby other subscribers' lines may be connected to said answering jacks, prior to the disassociation of the operator's link circuit from said multiple answering jacks, and means for permitting another operator to establish connection with a second calling subscriber's line.

60. A telephone system including subscribers' telephone lines, multiple calling jacks for said telephone lines, multiple answering jacks common to said telephone lines, subscriber controlled switch mechanism for connecting said multiple answering jacks and a calling one of said subscriber's line, an operator's circuit for establishing connection to said calling line via

one of said multiple answering jacks and for connecting to a called one of said lines via one of said calling jacks, subscriber controlled means in said link circuit for freeing the calling subscriber's line from said multiple answering jacks, thereby permitting a second calling subscriber's line to connect to said answering jacks, prior to a disassociation of said link circuit from said answering jacks.

61. A telephone system including subscribers' telephone lines, multiple calling jacks for said telephone lines, multiple answering jacks common to said telephone lines, subscriber controlled switch mechanism for connecting said multiple answering jacks and a calling one of said subscribers' lines, an operator's circuit for establishing connection to said calling line via one of said multiple answering jacks and for connecting to a called one of said lines via one of said calling jacks, subscriber controlled means in said link circuit for freeing a calling subscriber's line from said multiple answering jacks, and means for then permitting the connection of another operator's circuit via another of said answering jacks.

62. A telephone system including a plurality of subscribers' telephone lines, automatic switches common to said lines, test circuits for said switches, a starting circuit

for said automatic switches common to all of said lines, and means individual to each of said switches adapted to be operated when a switch connects to a calling subscriber's line for opening the test circuit of the associated switch and for extending the starting circuit through to another of said switches.

63. A telephone system, including a calling subscriber's line and a called subscriber's line, a plurality of lamps and jacks distributed among different operators' positions, a switch having a single driving magnet for automatically selecting and connecting to said calling line and to extend the same to said lamps and jacks, a circuit for said driving magnet including a contact controlled by said magnet, a link circuit for interconnecting said calling line and called line via one of said jacks, an operator's set for said cord circuit but normally disconnected therefrom, means for automatically connecting said set to said cord circuit when said cord circuit is connected to one of said jacks, and automatic means for disconnecting said set from said cord circuit when said cord circuit is connected to said called line.

Signed by us at Chicago in the county of Cook and State of Illinois, this 21st day of February, 1919.

HIRAM D. CURRIER.
GEORGE R. EATON.