G. E. MUELLER.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED APR. 13, 1907.

1,179,741.

Patented Apr. 18, 1916.

5 SHEETS—SHEET 1.

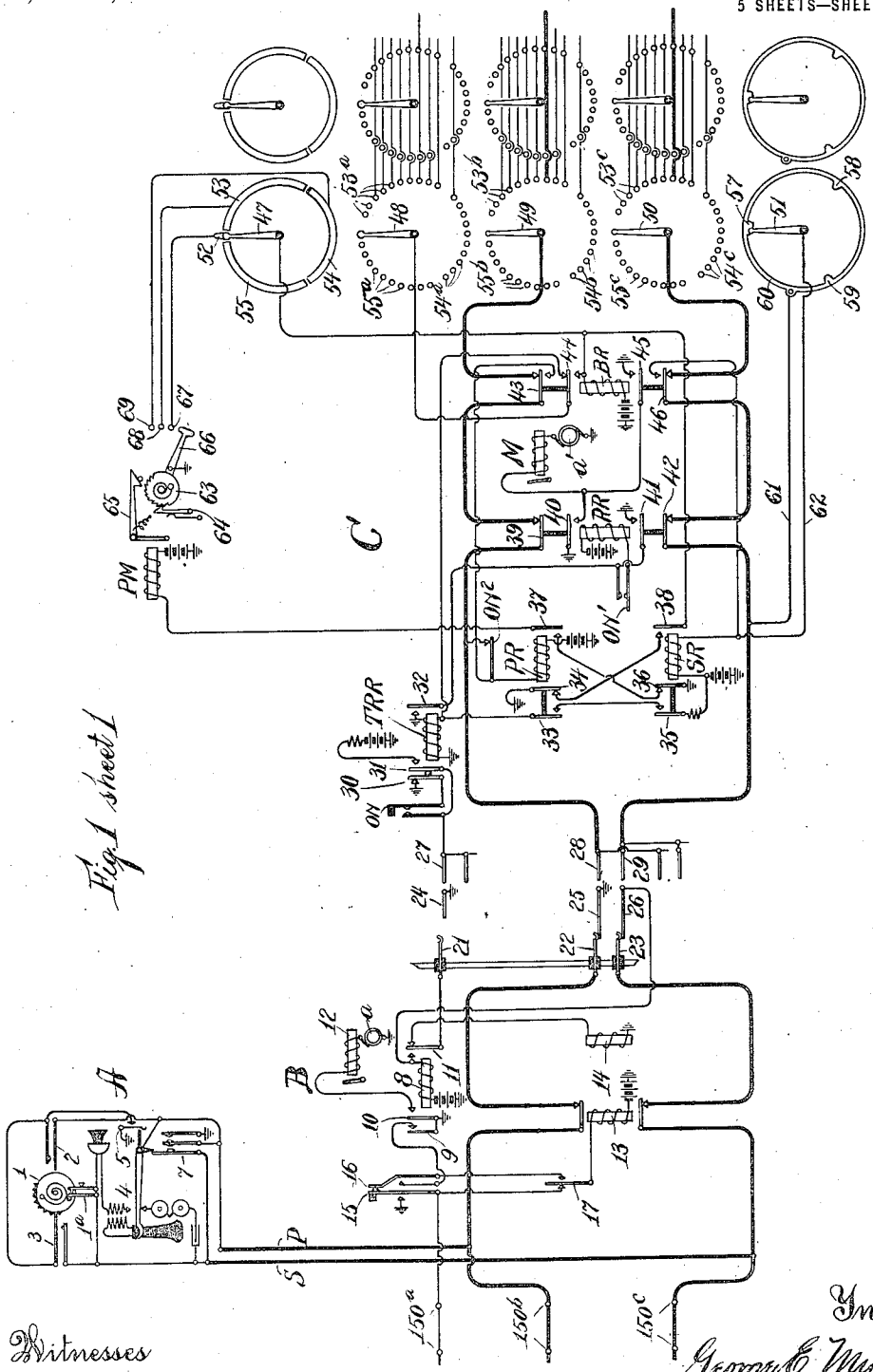

Fig. 1 sheet 1

Witnesses

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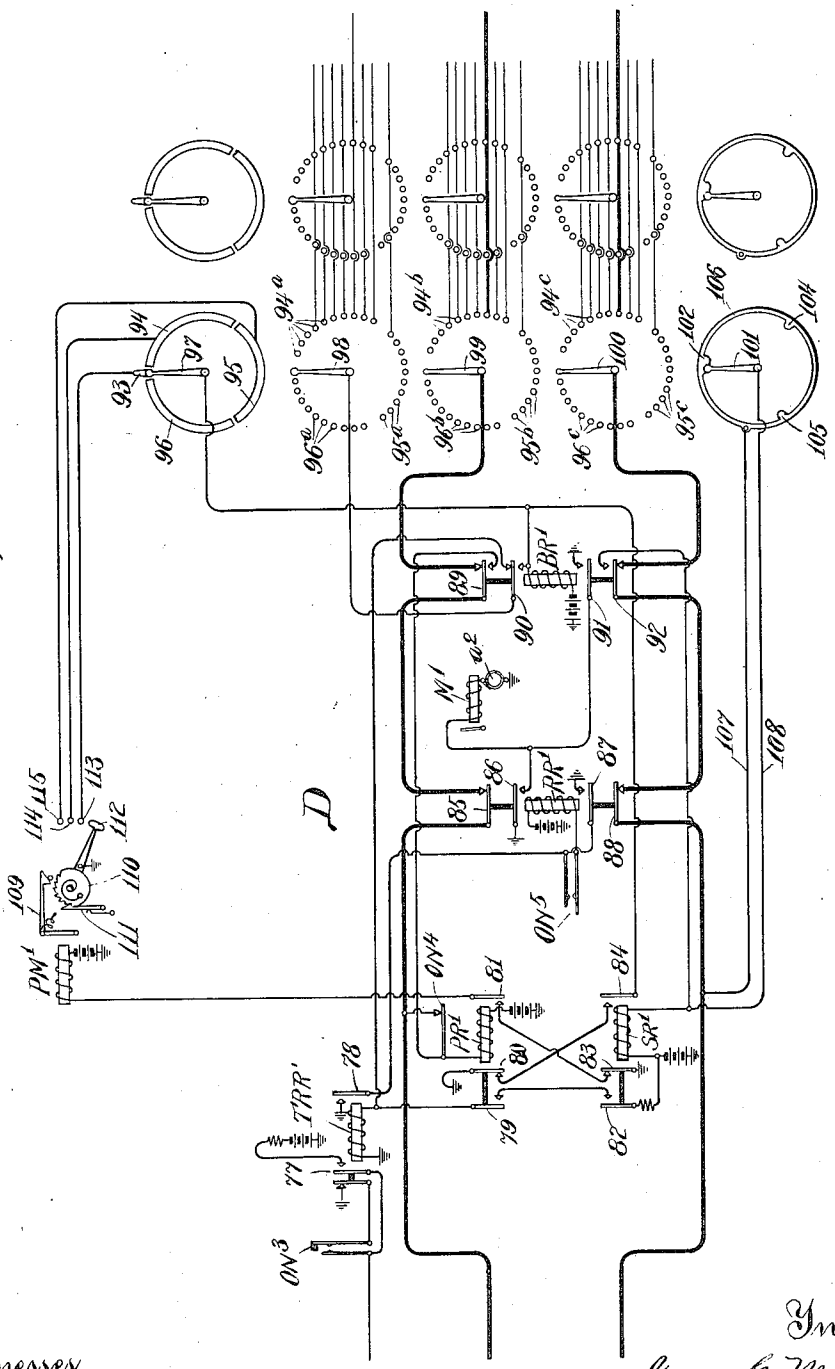
5 SHEETS—SHEET 2.

Fig. 1 sheet 2



Witnesses

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5 SHEETS—SHEET 3.

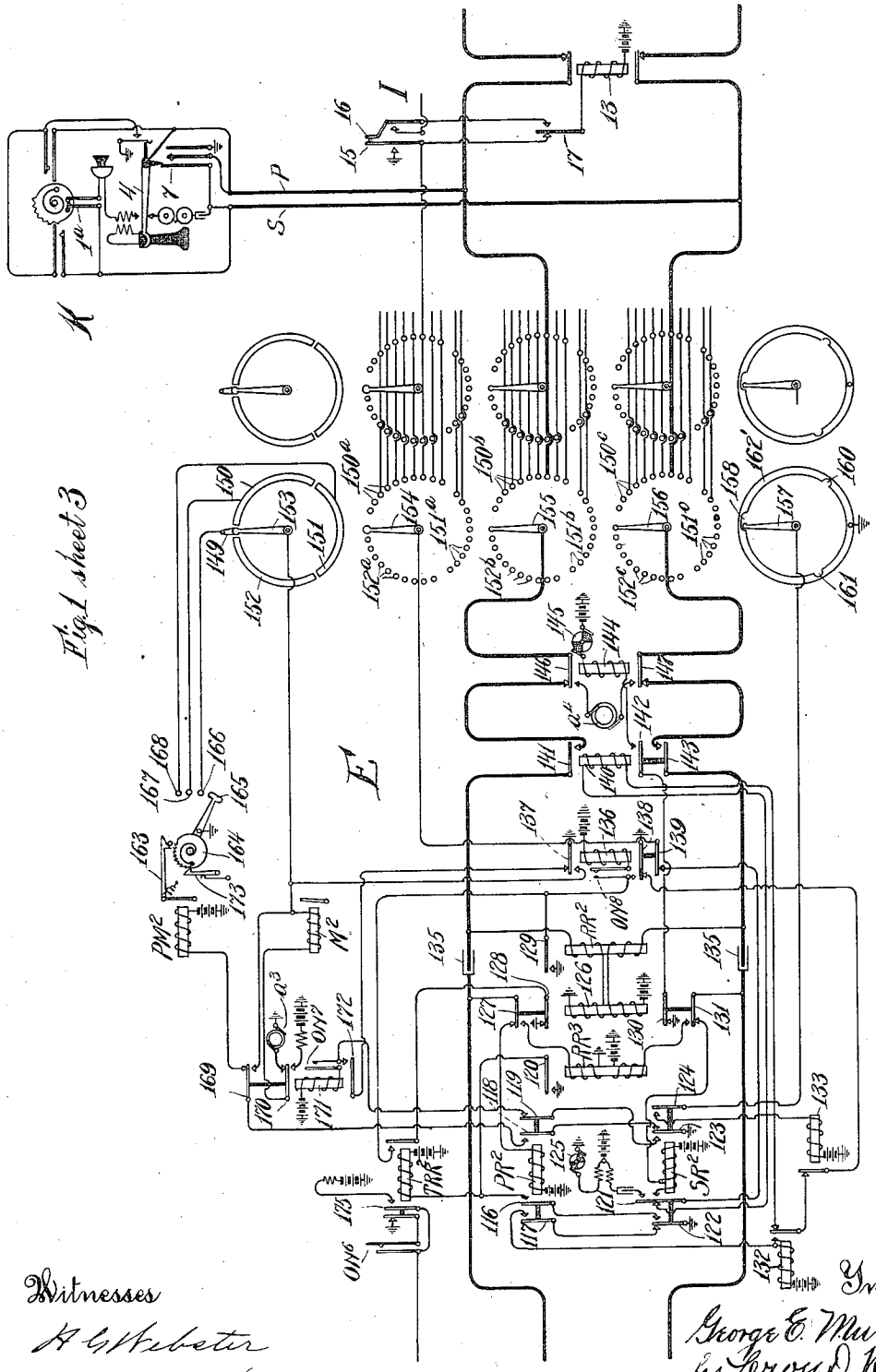

Fig. 1 sheet 3

Witnesses

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5 SHEETS—SHEET 4.

Fig. 2

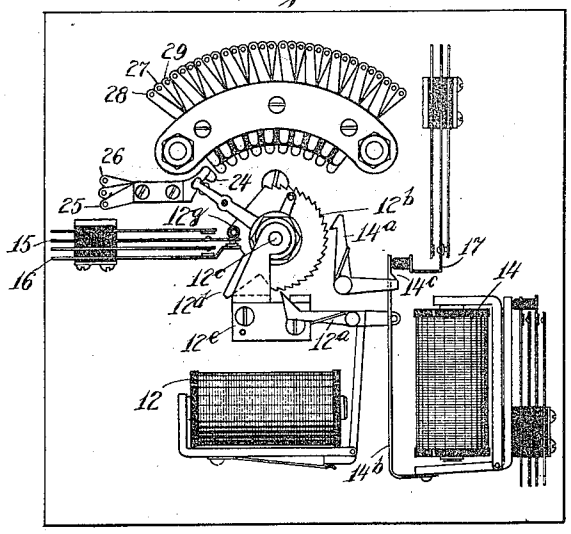


Fig. 3

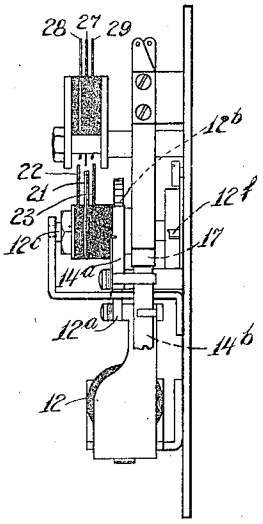


Fig. 4

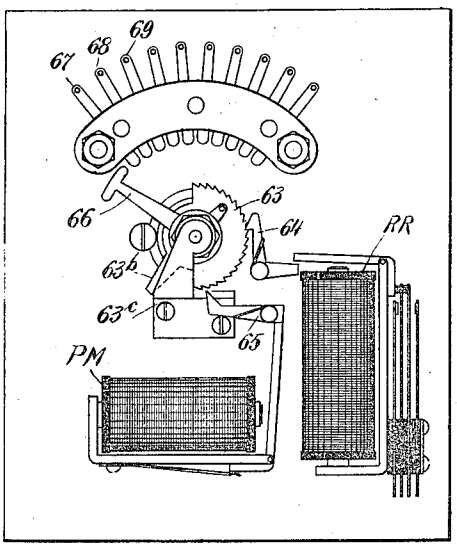
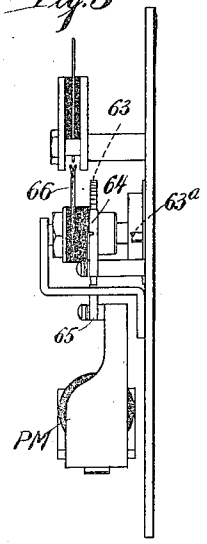


Fig. 5



Witnesses

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5 SHEETS—SHEET 5.

Fig. 6.

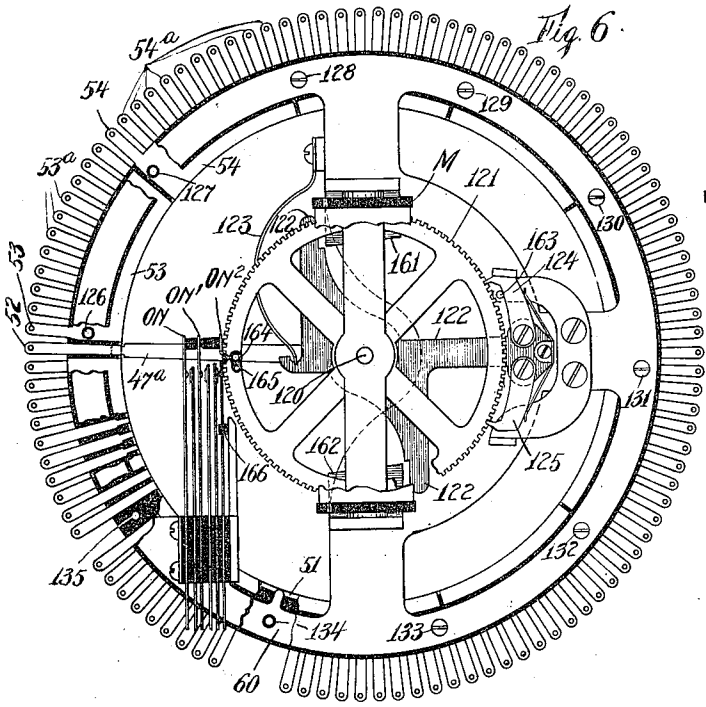


Fig. 7

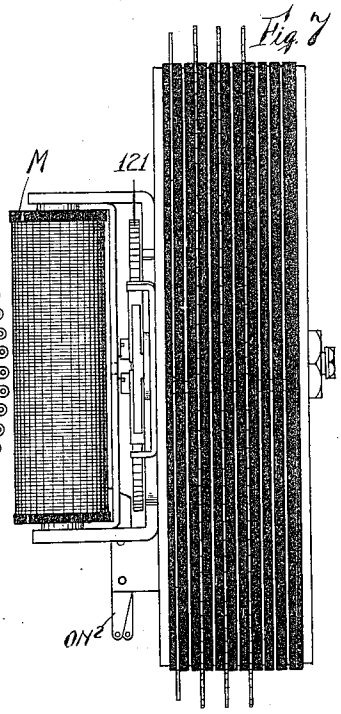


Fig. 8

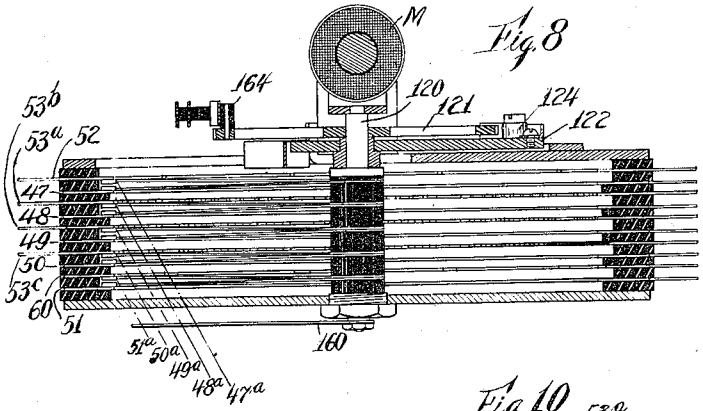


Fig. 9

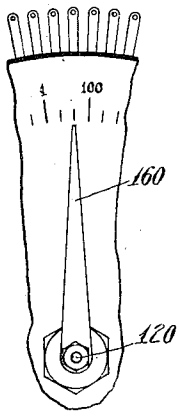
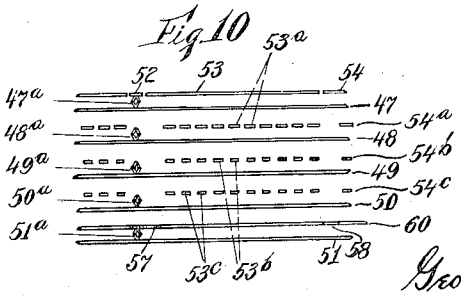


Fig. 10



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UNITED STATES PATENT OFFICE.

GEORGE E. MUELLER, OF AURORA, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,179,741. Specification of Letters Patent. Patented Apr. 18, 1916.

Application filed April 13, 1907. Serial No. 368,104.

To all whom it may concern:

Be it known that I, GEORGE E. MUELLER, a citizen of the United States, residing at Aurora, in the county of Kane and State of Illinois, have invented new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates more particularly to such systems in which a plurality of selective switches are successively employed in completing each connection, its object generally stated being to produce a system employing simplified switches and circuits.

As is generally known, in automatic telephone systems of the above-mentioned character, the switches through which the conversational circuit is completed have been of one or two characters, that is to say, either switches whose wipers are caused to move in two intersecting planes, or switches having ten sets of wipers, each set corresponding to a limited group of called subscribers, in the latter case an auxiliary switch being employed to select the desired set of wipers out of the ten.

In accordance with my invention, the switches through which the conversational circuit is completed, are provided with a single set of wipers, each having associated with them a plurality of groups of contacts, each group representing a limited group of called subscribers. The wipers in their motion pass first over the group of contacts of the first group of subscribers, then over the contacts of the second group and so on. In order that the calling subscribers may cause these switches to select the groups of contacts representing the desired groups of subscribers, they are provided each with an auxiliary switch operating groupwise by means of suitable circuits upon the contacts associated with the before-mentioned switches in order to determine how many groups of contacts the said switches (which are initially operated simultaneously with the auxiliary switches), shall pass over to select the required groups. By this means I avoid complexity found in the heretofore employed double-acting switches, and avoid using the large amount of power required to operate the switches having ten sets of wipers. This, and other features of my invention will appear at length in the detailed description of the drawings in which—

Figure 1, consisting of Sheets 1, 2 and 3, illustrates by means of conventional symbols, circuits for completing a single connection between a calling and a called subscriber. Figs. 2 and 3 are respectively front and side views of the switch individual to a line in the system of Fig. 1; Figs. 4 and 5 are similar views of an auxiliary switch adapted to be employed in connection with the circuits of Fig. 1. Figs. 6, 7 and 8 are respectively top, side and sectional views of a selector switch. Fig. 9 is a rear view showing the indicating arrangement of the switch. Fig. 10 is a diagrammatic view of a section of contacts of said switch and its wipers.

The three sheets of Fig. 1, when placed end to end in consecutive numerical order, form a single complete circuit diagram in which I have illustrated two subscribers' stations A and K, connected by limbs P and S of their telephone lines with the exchange and there provided with switches individual to them, respectively B and I, the said switches being in all respects similar to each other. The switch at B is shown in full, while only a portion of the switch I is indicated, as much as is necessary for understanding the method of making connection with the called line, which in the description, the line of K is assumed to be, the line of A being the calling line. The system illustrated in Fig. 1 may be regarded as a ten thousand line system in which first selectors are employed, operating in response to predetermined current impulses transmitted from the calling substation to select the thousand wanted, second selectors being employed to select the hundreds wanted, and connectors being employed to select the wanted line of the hundred, a switch of each class being, of course, employed in completing each connection. In organizing the system on the usual ten per cent. trunking basis, I have provided each telephone line

with an individual switch such as B or I whose wipers 21, 22 and 23 have access to multiple contacts of a group of ten first selectors, which contacts will be multipled altogether one hundred times, that is, to the individual switches of one hundred subscribers' lines. First selectors equal in number to ten per cent. of the total number of lines in the exchange, are thus divided, in the present assumption, making one thousand first selectors.

An equal number of second selectors, one thousand, are provided, one hundred of these being provided for connections to each thousand lines of the exchange as called lines. These second selectors, circuit of one of which is shown at D, have multiple terminals 53^a, 53^b and 53^c multiplied before wipers 48, 49 and 50 of first selectors. The wipers of each first selector have access to ten multiple contact sets connected to second selectors for each thousand. I have shown in Fig. 1, groups of multiple contacts associated with the wipers of the first selector C for three thousands only, in order to simplify the drawing. In a complete ten thousand line system, there would of course, be ten such groups. In the said Fig. 1, the multiple contacts 53^a, 53^b and 53^c are multiple contacts extending to second selectors for the first thousand, contacts 54^a, 54^b and 54^c are multiple contacts extending to second selectors of the second thousand, and multiple contacts 55^a, 55^b and 55^c are multiple contacts extending to second selectors of the last thousand. It will be observed that the contacts of the second selectors for each thousand are arranged in a group, a space being left between each group. For the ten thousand line system there will be ten such groups with intermediate spaces, this being indicated in the mechanical drawing hereafter described.

The wipers 47—48—49—50—51 of the first selector C are mounted upon a common shaft provided, as shown in Fig. 8, with a suitable ratchet adapted to be driven by an armature pawl of magnet M in a clock-wise direction. A group contact 53 is provided for the group of contact sets of second selectors of the first thousand, and the groups of contact sets of the second and last thousands have similar group contacts 54—55, the group private wiper 47 being adapted to wipe over the respective group contacts 53, 54, 55, in selecting the wanted group of second selector contacts; after which the individual private wiper 48 is caused to wipe over the individual multiple private contacts of the second selectors of the selected group to pick out an idle second selector. The group private wiper 47 has a normal contact 52 connected to contact 67, and the private group contacts 53—54 are connected to contact 68—69 located adjacent to contact 67. Each group contact in a ten thousand line system will have connection to a contact before wiper 66 except the group contact of the last thousand. Electrical conditions of the contacts 67, 68, 69, determine which group of second selectors is to be selected by the wipers 47, 48, 49 and 50. A grounded wiper 66 is provided, adapted to be caused to wipe over the contacts 67, 68 and 69, by the magnet PM operating by its pawl 65 upon the ratchet 63 to which wiper 66 is fastened, the operation being in a general way as follows: Let it be assumed that the subscriber at A, by removing his receiver has caused his individual switch B to automatically select the multiple contacts 27, 28, 29, of the first selector C. The subscriber at A then transmits, by means of his calling device 1, impulses to primary relay PR in number corresponding to the wanted thousand, which relay PR operates the magnet PM a corresponding number of times to move wiper 66 over a corresponding number of contacts 67, 68, 69. As soon as wiper 66 engages the first contact 67, the group private wiper 47 is grounded and rotary movements of wipers 47, 48, 49 and 50 are started. If wiper 66 is moved two steps, it is apparent that as soon as group wiper 47 reaches group contact 53, which it does on the first step, it will there find ground, and rotary movements of the first selector will be continued at least until wiper 47 passes on to the private group contact 54 of the second thousand. If wiper 66 has been brought to engage contact 69 of this group private contact, wiper 47 will continue grounded and rotary movements of the switch wipers past this group contact on to the contact 55 will occur. The wipers 48, 49, 50 and 51 move with, and correspondingly to the wiper 47, and they will thus be caused to move for each group found grounded by wiper 47 past an entire group of multiple contacts of second selectors for a thousand.

As soon as group private wiper 47 reaches a group private contact which has not been grounded by wiper 66, further rotary movements of the switch wipers will be arrested until the customary secondary impulse is transmitted from the substation. This will have no effect upon private magnet PM, whereby the group private contact of the selected group of selected selectors will be left in its normal condition for the secondary impulse. The secondary impulse operating secondary relay SR, will be effective to cause the energization of busy relay BR which will then be operatively connected with the individual private wiper 48, the said busy relay then causing the wipers to pick out the contacts of the first idle second selector of the selected group. It is thus seen that the first selector operates upon the

general principle that the numerical impulses transmitted from the calling substation cause a number of group private contacts, corresponding in number to the transmitted impulses, to be grounded, that the rotary switch of the first selector by means of group wiper 47 passes over the groups whose group private contacts have been grounded, and that by means of a secondary impulse thereafter transmitted, an individual private wiper 48 selects an idle second selector of the selected group.

The single magnet M causes a stepping around of wipers 47, 48, 49, etc., in both the group selecting processes and in the idle switch selecting process. As the steps of the switch in selecting the contacts of an idle selector out of a group must be gaged in length by the distance from contact to contact in the group, it is apparent that, for the wipers to pass over the contacts of an entire group, whose group private contact has been grounded, ten steps of the wiper or ten actuations of magnet M will be required. As by the actuation of the calling device 1 at the substation, the secondary impulse follows soon after the last of the primary impulses, it is necessary that the wipers 47, 48, 49, etc., should approximately, keep step, as it were, in their travel over the group private contacts, with the primary impulses in response to which the wiper 66 is actuated. That is to say, for each impulse transmitted from the substation, operating upon the wiper 66, the magnet M should cause approximately ten steps of the wipers of the first selector. Approximation only, however, is necessary, the time ratio between the primary impulses and the actuations of magnet M being so gaged that the wipers in the group selection will lag slightly behind the movement of the wiper 66, the calling device 1 being so arranged that sufficient time elapses, between the transmission of the last primary impulse and the transmission of the secondary impulse, for the wipers in their group selection to make up the lag before the transmission of the secondary impulse occurs. I have shown the magnet M in association with an alternating current generator a' by whose current the magnet is actuated. The said generator may be run at a speed of sixty alternations per second and will then be effective to produce sixty actuations of the magnet M and sixty steps of the wipers per second. This speed has been found in practice to be a reasonable one for switches of the character which I preferably employ, it having been found that reliable operation of such switches may be effected at the rate of eighty or more steps per second. Assuming the beforementioned speed of sixty steps per second, the calling device at the substation may be arranged to operate at a speed of seven to eight steps per second for satisfactory results. If preferred, it will be understood that a higher speed, say, nine or ten steps per second of the calling device may be permitted, provided a sufficient interval is allowed between the last primary impulse and the secondary impulse. This interval is required because as will be understood from the description of the operation, a switch must have completed its group selection before the transmission of the secondary impulse. It may be said in passing that the speed before indicated of seven or eight steps per second of the calling device is one generally employed in automatic telephone systems in commercial use in this country. The impulses transmitted by the substation calling device are preferably of brief duration, lasting only long enough to insure the energization of the relay being operated, a large portion of the time between the beginning of one impulse and the beginning of the next being devoted to the "break".

The second selector shown at D in Fig. 1 is in its general aspects similar in construction and operation to the first selector C, the said second selector having the group private wiper 97 and the normal contact 93, the group private contacts 94, 95, 96, representing three groups of connectors for hundreds of the thousand to which the second selector is assigned. It will of course, be understood that for the ten thousand line system there will be ten group private contacts associated with wiper 97, one for each one hundred of the thousand. The second selector has also the private wiper 98 and individual private contacts 94^a for connectors of the first hundred, similar contacts 95^a for connectors of the second hundred, etc. Line wipers 99 and 100 have before them multiple talking contacts of the connectors of the various groups, and wiper 101 is mounted upon the shaft with the other switch wipers and moves with them. The normal contact 93 is connected to contact 113 and the group private contacts are connected to contact 114—115 in association with the grounded wiper contact 112, controlled by pawl 109 of magnet PM', operating upon the ratchet 110, the said magnet PM' being actuated in response to current impulses transmitted from the substation calling device through relay PR'. After the second selector D has been operated to select a group of contacts for a given hundred under the control of group private wiper 97, in a manner similar to that in which the first selector was operated, a secondary impulse is caused to flow through relay SR' to effect a further operation of the second selector D under the control of private wiper 98 to select contacts of the first idle connector of the selected group.

The operation of the connector shown at E to select the group of contacts, is, in a general way, similar to that of the first and second selector. It will be understood that multiple contacts of the called lines, to which a connector gives access, are arranged in groups before the wipers of the connector according to the tens values of the lines in their hundred. The wipers 153, 154, 155 and 156 of the connector wipe, when the switch is moved from normal, first over the contacts of the lines numbered from 11 to 20, then over those numbered 21 to 30, and so on. The first set of primary impulses transmitted from substation A operate upon the primary relay PR^2 of connector E, which relay causes the actuation of primary magnet PM^2 to ground normal contact 149 of the group private wiper 153 and group private contacts 150—151, etc., to cause operation of the connector E under control of group private wiper 153 to select the wanted group of called lines out of the hundred. When this has been effected, a secondary impulse transmitted through relay SR^2 alters the connections of the operating magnet M^2 of the connector so that a succeeding set of primary impulses transmitted from substation A causes a number of actuations of magnet M^2, equal in number to the number of transmitted impulses, the wipers of the connector being thus moved to select the multiple contacts of the particular line wanted out of the group of ten previously selected. In addition to the mechanism for selecting the wanted line out of the hundred provided at the connector, I also provide a suitable test relay for testing the called line; suitable connections from a centralized source of current for supplying talking current to the transmitters of the calling and called line, suitable ringing mechanism for notifying the called subscriber that his attention is desired, and also means for notifying the calling subscriber that the line called-for is busy, should such be the case. The remaining features of the circuit of Fig. 1 will best be understood in the following description.

Assuming that the calling subscriber at A desires his line to be connected with that of the called subscriber K whose number will be assumed to be 1118, the subscriber at A first removes his receiver whereupon hook-lever 4 engages its alternate contact closing a conductive bridge through the substation via the transmitter and normal contact 1^a. With the raising of the hook-lever 4 to engage its alternate contact, its insulated rearwardly extending projection engages the bent portion of spring 5 causing it to engage its contact thereby connecting ground to the operating springs of calling device 1. A path for flow of current may now be traced from ground through normal contact 25—22 of the individual switch B, upper armature of relay 13, over limb P through alternate contact 4, contact 1^a, returning over limb S, lower armature of relay 13, normal contact 23—26, and through relay 8 to battery, operating the said relay whose attracted armature 10 completes a circuit including generator *a* and operating magnet 12, which thereupon steps wipers 21, 22 and 23 a step, bringing wiper 21 to engage contact 24 which is a permanently grounded contact adjacent to the private contact 27 of the first first selector of the group associated with the line of subscriber A. The first actuation of the magnet 12 moves wipers 22 and 23 along one step upon the normal contacts 25 and 26, but not to disengage them. On the first step of the switch B, contacts 15 and 16 are shifted, the former to disengage contact 16 and to engage its alternate contact at the left, while spring 16 also moves, a less distance than spring 15, to engage its alternate contact. With the first step of the switch, spring 17 was also shifted to engage its alternate contact. A circuit is now closed from ground through attracted armature 9, alternate contact 16, alternate contact 17, relay 13 to battery, which relay is energized and by attracting its armatures, places line wipers 22 and 23 on open circuit in order that, while the switch B is seeking an idle first selector, in which operation it may be passing over multiple contacts 28—29 of busy first selectors, no interference with existing conversations may occur. The additional contact 24 is provided in order to insure the shifting of springs 16 and 17 and the energizing of relay 13 before wipers 23 and 22 are brought to engage the talking contacts 28—29 of the first first selector. When wiper 21 engages contact 24, relay 8 continues energized by current flowing through contact 24—21, attracted armature 11 and relay 8 to battery, so that circuit is continued through magnet 12 and a second impulse flowing from generator *a* causes a second actuation of the said magnet 12 which is effective to move wipers 21, 22 and 23 to engage multiple contacts 27, 28, 29, of the first first selector of the group. If this first selector is already in use, owing to its having been selected by the individual switch of another line belonging to the same group with that of subscriber A, the private contact 27 of the first selector will be grounded through the winding of the release magnet 14 of the other switch over a circuit extending through the retracted armature 11 of relay 8 of said other switch, its wiper 21 and a multiple of contact 27 now assumed to be engaged by wiper 21 of switch B in Fig. 1. In such case, upon closure of contact 21—27, a circuit will be continued through relay 8 from ground at release magnet 14 of the switch, render-

ing the first first selector busy; relay 8 will continue energized and a third current impulse will flow through magnet 12, moving the wipers of the switch B to engage contacts of the second first selector of the group. If this is busy, another locking circuit similar to that before described will be completed through relay 8 and the relay will continue operated; successive impulses flowing through magnet 12 cause successive steps of the wipers of the switch B until wiper 21 reaches a private contact 27 belonging to an idle first selector, in which case, said contact being on open circuit as indicated in Fig. 1, relay 8 will become deënergized and its armatures fall back. Armature 11 will connect ground through the winding of the release magnet 14 to the private contact 27 of the selected first selector and its multiples, rendering the same busy. Armature 10 in falling back opens the circuit of operating magnet 12, preventing further stepping of the switch, while armature 9 opens the circuit of relay 13 whose armatures then resume their normal positions and operatively connect wipers 22 and 23 with the limbs P and S of the calling line. The shifting of contact 15 as before described to engage its alternate contact, places ground upon multiple contacts 150^a of the calling line at the connectors, rendering said line busy to incoming calls. It should be stated that proportions of relays 8 and magnets 14 of the individual switches are so adjusted that when an operated relay 8 is placed in series with a magnet 14, as before described, enough current will not flow through the magnet 14 to cause its actuation, although enough current will flow through the operated relay 8 to prevent it from releasing its armatures.

The subscriber A now rotates calling device 1 until one tooth has passed below spring 2. As soon as the device has moved from normal, the pin of insulating material shown thereon frees spring 1^a which then disengages its contact, whereupon the limbs P and S are conductively disunited during the operation of the calling device, which being now released, is rotated from right to left by its associated spring, the tooth in its return operating to close and open contact between spring 2 and its associated spring, whereby an impulse of current is caused to flow from ground through closed contact 5, closed contact 2, over limb P of the line, upper armature of relay 13, wiper 22 to contact 28 of the selected first selector, through off-normal contact ON^2, primary relay PR to battery causing energization of the said relay PR, which, thereupon attracts its armature 37 to close circuit for a current impulse as follows: From ground through contact 36, attracted armature 37, primary magnet PM to battery, which magnet PM is actuated and attracts its armature, causing a thrust of pawl 65 which engages a tooth of ratchet 63 and turns the same one step, detent 64 engaging the next tooth of the ratchet and holding it against back movement. The stepping of ratchet 63 brings wiper 66 to engage the first contact (67) whereupon current will flow from ground through contact 66—67, normal contact 52 to the group private wiper 47, through busy relay BR to battery. Relay BR is actuated and attracts its armatures, of which 45 closes a circuit including magnet M and generator a'. The said generator now transmits an impulse, 19 actuating magnet M which is effective to step wipers 47, 48, 49, 50 and 51 a step in a clock-wise direction. This first step brings wiper 47 to rest upon group private contact 53. Wipers 48, 49 and 50 are brought closer to, but not engaging, the first contacts 53^a, 53^b and 53^c, of the group forming multiple terminals of second selectors of the first thousand. Wiper 51 normally engages the conducting ring 60, its end engaging the projection 57 of said ring. The first step of the wipers brings wiper 51 to the right edge of the projection 57, but not to a position wherein said wiper disengages the conducting ring 60.

Inasmuch as but one step of wiper 66 was caused, the group private contact 53 is left ungrounded and the first step of wiper 47, leaving grounded contact 52 and engaging ungrounded contact 53, opens the circuit of relay BR whose armatures fall back opening the circuit of magnet M, and further actuations of the said magnet are at this time thereby prevented. As calling device 1 returns to normal, its tooth of insulating material at the left, which, with the turning of the dial by hand is brought above spring 3, engages said spring and causes it to close and open contact a single time with its associated spring, whereby an impulse of current is caused to flow from ground through contact 5, closed contact 3, over limb S of the line through the lower armature of relay 13 to wiper 23, the multiple contact 29 of the selected first selector, thence over conductor 61, through conducting ring 60 to wiper 51, conductor 62, secondary relay SR to battery, causing actuation of the said relay SR whose attracted armature 38 completes a path for a current impulse from ground through the now retracted armature 34 of primary relay PR, contact 38, busy relay BR to battery, operating said relay again, whose attracted armature 45 completes a circuit for magnet M which is actuated to step the wipers of the switch a second clockwise step, whereby wipers 48, 49 and 50 are brought to engage the first contacts 53^a, 53^b and 53^c respectively of the group of second selectors for the first thousand. If another first selector operated from a different call-

ing substation has already selected the second selector connected to the first contacts of the group, the first contact 53^a shown in Fig. 1 will be grounded over a circuit extending to the multiple engaged by the other first selector through its normal contact 44 and its trunk release relay TRR to ground. Assuming this to be the case when the wiper 48 engages the grounded multiple of 53^a of the first second selector, a locking circuit will be completed for busy relay BR of the first selector, C, of Fig. 1, extending from the grounded multiple referred to, through wiper 48, attracted armature 44 and busy relay BR to battery and the relay will continue to hold its armatures attracted although sufficient current will not pass through relay TRR to actuate it and a second impulse from a' will flow through magnet M advancing the wipers to engage the contacts of the second second selector of the group, and if the same be busy, another similar locking path for busy relay BR of the first selector, C, will be completed, causing it to continue energized permitting another current impulse to flow through magnet M and successive similar locking paths for relay BR will be completed, causing the successive actuations of magnet M, and additional steps of the wipers, until the first idle second selector has its multiple contacts 53^a, 53^b and 53^c engaged by wipers 48, 49 and 50. As soon as this occurs, which is in the present case, assumed to be when the wipers engage the eighth multiple contacts 53^a, 53^b and 53^c, assumed to be connected to the idle second selector D, the contact 53^a engaged by wiper 48 will be on open circuit as shown in Fig. 1, busy relay BR will become deënergized, armature 45 then opening circuit through magnet M which ceases to receive impulses from generator a' so that the wipers 48, 49 and 50 rest upon the contacts 53^a, 53^b and 53^c connected to the idle second selector D of the first thousand.

It will be observed that while the wipers 48, 49 and 50 are being caused to rotate over their associated contacts, busy relay BR is always energized, and hence, armatures 43 and 44 attracted so that the line wipers 49 and 50 are on open circuit whereby interference with existing conversations is prevented. It should also be observed that the second step of the switch C moves wiper 51 so that its contact end is out of connection with the conducting ring 60 so that the secondary relay SR is immediately deënergized on the cessation of the secondary impulse. The off-normal springs ON and ON' are shifted to engage their alternate contacts with the first movement of the switch wipers while off-normal spring ON^2 is shifted to disengage its contact only on the second movement of the switch wipers. On the shifting of spring ON, ground is directly connected to multiple contacts 27 of the first selector through armature 30, so that after the first step of the first selector, the ground through magnet 14 is no longer exclusively relied upon to render the first selector busy.

The purpose for the delayed shifting of spring ON^2 is as follows: Let it be assumed that the subscriber A has operated his dial to transmit three primary impulses followed by a secondary impulse, which he would do if he desired to be connected with a subscriber included in the third one thousand. In such case, three actuations of primary relay PR would be caused and three actuations of primary magnet PM causing the grounded wiper 66 to engage contacts 67, 68 and 69 successively, resting upon contact 69. The first step of wiper 66 engaging contact 67 completes a before described circuit through busy relay BR, the said relay may be operated to cause an impulse to flow through magnet M, advancing the wipers a step, before the second primary impulse passes over the line which will occur say one-seventh or one-eighth of a second after the transmission of the first. The operating speed of the relays and magnets PM, BR and M operated over local circuits will be greatly in excess of the time allowed between the substation impulses: consequently it may well occur that wiper 47 will engage contact 53 some little time before the second impulse causes wiper 66 to engage contact 68. This being so, busy relay BR will become deënergized, allowing its armatures to be retracted. The second primary substation impulse flows through off-normal spring ON^2 and primary relay PR as before, this time causing wiper 66 to ground contact 68 whereupon circuit is again completed for busy relay BR from ground through contact 66—68, contact 53—47, busy relay BR to battery, operating the busy relay BR whose attracted armature 45 permits another impulse to flow through magnet M. Under these circumstances, before wiper 47 passes from the grounded contact 53, ten steps of the switch must be effected and, as a rate of sixty steps was assumed, this will consume one-sixth second of time, and as the impulses are transmitted from the substation at the rate of at least seven per second, the third impulse will be transmitted over the line to relay PR before the wiper 47 disengages grounded contact 53. This third impulse over the line will not flow through off-normal spring ON^2 which was shifted with the second step of the switch, but will flow through normal contact 39, alternate contact 43 of busy relay BR and primary relay PR to battery, causing wiper 66 to engage its third contact 68 to ground contact 54. With the speeds of operation indicated, if three or more impulses are transmitted over the line in succession, each one after the second

will find wiper 47 engaged in passing over a group contact 53 or 54, etc., grounded by the operation of a previous impulse, in which case, of course, busy relay BR will be operated and the succeeding impulses will find their way to relay PR through the attracted armature 43 of the busy relay BR.

Whenever the wiper 47 passes off one group contact to the next, which it does with each tenth step after the first, wipers 48, 49 and 50 will be resting between groups of their contacts and the wiper 51 will be engaging the conducting ring 60 at one of the projections 58—59, etc. As before indicated, when wiper 47 passes off one of its group contacts to another one which is ungrounded, the motion of the switch is stopped, the time elements of operation of the calling device and of the switch being so proportioned that enough time elapses between the transmission of the last primary impulse and the transmission of the secondary impulse for the wipers to catch up, as it were, with the last primary impulse transmitted, to come to rest in a position where wiper 47 rests upon the ungrounded group contact. Thus, before the secondary impulse will be transmitted, the wiper 51 will in every case of operation, have been brought to one of the projections and will have established engagement with the conducting ring 60, so that the secondary impulse will find its way through contact 61 to the secondary relay SR.

The last one of the group contacts 53, 54, etc., of which there would, of course, in practice be ten, would have, as the last group contact 55 in Fig. 1 as shown, no contact associated with the wiper 66, inasmuch as it would not be required in the operation of the system to ground such contacts by means of the wiper 66 because it would in no case be required that the switch, in operating to select the thousand, pass over and beyond the tenth group; that is to say, ten impulses would bring the wipers around to a point where wiper 47 would move off the ninth group contact on the tenth group contact which would be the maximum distance that would have to be desired to operate the switch so far as the primary impulses are concerned. There would, however, of course be ten contacts associated with the wiper 66 inasmuch as the normal resting contact 52 must be represented before the wiper 66.

Returning now to the connection being established, I will trace the operation through the second selector to the idle connector of the desired hundred. The called subscriber's number being assumed to 1118, the calling subscribed A now operates his dial 1 to transmit a number of primary impulses corresponding to the hundreds digit of the called number. In the present case, a single primary impulse will be so transmitted which will flow from ground through contact 5, contact 2 over limb P of the line, through contact 22—28, through armatures 39—43, wiper 49 to contact 53^b of the selected second selector, through its off-normal spring ON^4, its primary relay PR′ to battery. The primary relay PR′ is thereby operated and current will flow from ground through contact 83, contact 81, primary magnet PM′ to battery; which magnet attracts its armature to effect a thrust of pawl 109, turning ratchet 110 a step to bring wiper 112 to engage contact 113 connected to the normal contact 93 of the group private wiper 97 of the second selector D. Current then flows from grounded wiper 112, contact 113, contact 93—97, busy relay BR′ to battery, operating said relay whose attracted armature 91 completes a circuit including operating magnet M′ and generator a^2, which latter transmits an impulse through the magnet actuating it to move wipers 97, 98, 99, 100 and 101, one clockwise step, wiper 97 leaving contact 93 and engaging group contact 94, which contact 94 is ungrounded because but one impulse was caused to flow through the primary magnet PM′. Hence, the circuit of busy relay BR′ is opened at contact 114, the relay is deënergized, preventing for the time further actuations of magnet M′.

The secondary impulse, following the single primary impulse, flows from ground at substation A through contact 5, contact 3 over limb S through contact 23—29, armatures 42—46 to wiper 50, multiple contact 53^c of the second selector D, over conductor 107 to conducting plate 106, thence to wiper 101, now moved to the right edge of the projection 102, thence over conductor 108 and through the winding of the secondary relay SR to battery, operating the said relay whose attracted armature 84 closes a circuit from ground through contact 80, contact 84, busy relay BR′ to battery. The said busy relay is again actuated, armature 91 closing the circuit of magnet M′ which is actuated by an impulse from generator a^2, to move the wipers 97—98, etc., a step in a clockwise direction whereby wipers 98, 99 and 100 are brought to engage respectively the contacts 94^a, 94^b and 94^c of the first connector of the first hundred of the thousand. This connector being assumed to be busy, the contact 94^a engaged by wiper 98 will be connected to ground via the wiper 98 of some other second selector already connected to a multiple of contact 94^a through the wiper 98 of that second selector, its normal contact 90, and through the winding of its trunk release relay TRR′ to ground, so that a locking circuit will be completed from ground at said trunk release relay TRR′ of the other second selector of Fig. 1, through attracted arma-

ture 90 of relay BR′ and through said relay to battery, causing the relay to hold its armatures, including 91, attracted whereby another impulse is caused to flow from generator a^2 through magnet M′, the switch wipers of D being advanced another step. The contact sets 94^a, 94^b and 94^c of the first seven connectors of the selected group being assumed to have second selectors already connected to them, successive locking circuits similar to that before described, for busy relay BR′, will be established with successive steps of the switch D until the contacts 94^a, 94^b and 94^c of the eighth connector of the group is reached, assumed to be that shown at E in Fig. 1. This connector being assumed to be idle, its contact 94^a will be on open circuit as shown in Fig. 1, no locking circuit for relay BR′ will exist when contact 94^a of this connector is engaged by wiper 98, busy relay BR′ will be deënergized and its retracted armature 91 will open the circuit of magnet M′, preventing further stepping around of the second selector D, whereby wipers 98, 99 and 100 rest engaging the contacts 94^a, 94^b, 94^c, of the idle connector E of Fig. 1. On the deënergization of the relay BR′, armature 90 is retracted to connect the multiple contacts 94^a of the selected connector to ground via wiper 98, contact 90 and the winding of trunk release relay TRR′, whereby the connector E will test busy to other second selectors having access to it. It should be stated that the proportions of busy relays BR′ and trunk release relays TRR′ are so adjusted that when two such relays are connected in series in a locking circuit such as one of those before described, enough current will not be allowed to pass through the trunk release relay TRR′ to cause its actuation, although enough current will flow through the busy relay BR′ to enable it to retain attracted its already attracted armatures. The off-normal springs ON^2 and ON^5 are shifted with the first step of the second selector D, while off-normal spring ON^4 is shifted to disengage its contact only on the second step of the switch D. The said off-normal spring ON^4 bears the same relation to primary relay PR′ of switch D that spring ON^2 bears to primary relay PR of switch C, and the explanation heretofore given in regard to the said spring ON^2 applies in a general way to the spring ON^4 of the second selector D. It may be stated that the electrical features of the second selector D are substantially the same as those of the first selector C and they operate in exactly similar ways, correspondingly located structures in the two circuits having similar functions; although it will of course be understood, that in putting the connection through, the second selectors have different functions from the first selectors; the first selectors being employed to pick out the thousands and the second selectors to pick out the hundreds.

The calling subscriber A has now connected his line through to an idle connector E assigned for connection to the first hundred of the first thousand group of the exchange, or a one hundred group of lines including those of subscribers to whom have been assigned numbers 1100 to 1199 inclusive. The calling subscriber now operates, by means of currents transmitted from his substation the selected idle connector to pick out line 18 of its one hundred. It should be stated at this point that the line 18 will have its contacts positioned at the connectors in such manner that they will be the eighth contact set engaged by the wipers 154, 155 and 156 of the connector in their operation. This is because of the fact that in automatic telephone systems the zero is represented by ten impulses, and the contacts of lines 1101, 1102, 1103, etc., will be the last ten contact sets engaged by the switch in its rotation rather than the first to which their numerical value might apparently be supposed to entitle them.

The subscriber at A now operates his calling device 1 to transmit one primary impulse from ground through contact 5, contact 2, over limb P to contact 22—28, contact 49—53^b through armatures 85—89 at D, through contact 99—94^b, through normal contact 127 at connector E through primary relay PR^2 to battery, operating the said primary relay whose attracted armature 118 closes a circuit from ground through normal contacts 123, attracted armature 118, normal contact 169, primary magnet PM^2, to battery, operating the said primary magnet a single time, whose attracted and released armature effects a thrust of the pawl 163 to turn ratchet 164 one step, the said ratchet being held in its turned position by detent 173. The movement of the said ratchet brings grounded wiper 165 to engage contact 166 connected to normal contact 149 engaged by the group private wiper 153 of the connector. An impulse of current then flows from generator a^3, through normal contact 170, operating magnet M^2, contact 153—149, contact 166—165 to ground, operating magnet M^2 once and advancing the wipers 153, 154, 155, 156 and 157 a clockwise step, wiper 153 then resting upon group contact 150, wipers 154, 155 and 156 being moved adjacent to, but not engaging, multiple contacts forming terminals of line #1111. The other sets of contacts 150^a, 150^b and 150^c following the first set of said contacts are respectively the terminals of lines 1112, 1113, 1114, etc., followed by the terminals of line 1110. The single primary impulse transmitted as described, has therefore moved the wipers 154, 155 and 156 to select the group of contact sets of the ten

line group among which the line #1118, that of subscriber K, is included. But a single actuation of magnet PM^2 is caused because its circuit was opened on the first step of the switch, bringing wiper 153 to engage the contact 150, this being ungrounded because but a single actuation of the primary magnet PM^2 was caused and a single step of wiper 165 effected.

Returning now to primary relay PR^2, when it became energized as described, it attracted its other armatures as well as armature 118, of which 117 completed a circuit from ground, normal contact 122, attracted armature 117 and the relay 132 to battery, which relay attracted its armature thereby locking itself over a circuit extending through its attracted armature, through the retracted armature of relay 133, and through the normal contact of armature 138 to ground. This locked condition of relay 132 will continue until relay 133 is hereafter energized, which can only occur on the attraction of armature 124 of the secondary relay SR^2, which is to take place while the wiper 157 is engaging the grounded ring 162. As long as the relay 132 is energized, ground at 138 is disconnected from the normal contact of the armature of the said relay 132 which contact is connected, via the winding of relay 140, armature 121 and its normal contact, and normal contact 139 and the individual private wiper 154 of the connector. It is necessary to have this contact open for otherwise, while the private wiper 154 passes over contacts $\#150^a$ of lines not wanted, the relay 140 would be operatively connected in series with relays 13 of such lines, which would cause improper energizations of relays 13 of such lines, and by causing the operation of relay 140 of the connector would improperly effect the inclusion of generator a^4 in circuit with wipers 155 and 156 before the called line was reached.

Returning now to substation A, the secondary impulse, following the single primary impulse described, which caused the wipers to advance one step, passes from ground at the substation through contact 5, through contact 3 over limb S, contact 23—29, contact 50—53^c to second selector D, through contacts 88 and 92, through contact 100—94^c to the connector E through normal contact 131 at the connector and through the secondary relay SR^2 to battery. The said secondary relay SR^2 attracts its armatures of which 123 completes a circuit as follows: From ground through alternate contact 123, contact 119, off-normal spring ON^7 and its contact (which off-normal spring was shifted on the first step of the switch E), through relay 171 to battery. The said relay 171 now attracts its armatures of which 172 completes a locking circuit for the relay extending through off-normal spring ON^7 to ground at armature 137 of relay 136.

The armature 170 of the relay 171 disconnects the winding of M^2 from the generator a^3 and connects it to battery via its alternate contact; while armature 169 disconnects the armature contact of relay PR^2 from magnet PM^2 and connects the said contact with the winding of magnet M^2 to render the said magnet M^2 controllable by the next set of primary impulses transmitted from the substation. Attracted armatures 121 and 124 of relay SR^2, under the present circumstances produce no operative circuit changes because their circuits are respectively open at wiper 154 and wiper 157.

The subscriber A now operates the calling device 1 to transmit eight impulses over the primary side of the line, which are effective to cause eight energizations and de-energizations of relay PR^2, whose armature 118 causes eight current impulses to flow from ground through armature 123 and its normal contact, armature 118, armature 169 and its alternate contact, magnet M^2, attracted armature 170 to battery, actuating magnet M^2 eight times, which advances the wipers 153, 154, 155, 156 and 157 eight clockwise steps, when wipers 154, 155 and 156 will rest in engagement with the multiple contacts 150^a, 150^b and 150^c, forming multiple terminals of the called line No. 1118, or the line of K. With the first of these steps, wiper 157 is brought beyond the cut-away portion 158 of the grounded ring 162′; and with successive steps, continues passing along the ring, still resting thereon on the eighth step, the cut-away portion 160 being so placed that the wiper only reaches it and so disengages the ring on the twelfth step of the switch. The secondary impulse, flowing over limb S of the line after the transmission of the last of the eight primary impulses, energizes secondary relay SR^2 which now operates to test the called-for line.

Let it first be assumed that the called line is idle—the condition illustrated in Fig. 1. In such case, the ungrounded pole of battery is connected to the multiple contact 150^a engaged by wiper 154 via relay 13 and spring 17 of the line circuit of K. On its energization, attracted armature 121 of relay SR^2 connects the relay's winding from the undergrounded side of battery via armature 139 to wiper 154 and contact 150^a. As both terminals of the winding of relay SR^2 are thus connected to the ungrounded side of battery, no locking flow of current for relay SR^2 is possible and the relay's armatures are retracted as soon as the secondary impulse ceases. Before this occurs, however, the engagement of armature 124 with its contact completes a circuit for relay

133 extending from battery to ground via contact 157—162; and relay 133 draws up its armature, opening the locking circuit of relay 132, which thereupon allows its armature to be retracted. When the secondary relay SR^2 is deënergized, its armature 124 opens the circuit of relay 133, whose armature falls back; and armature 121 being then retracted, a circuit is completed as follows: from grounded armature 138 of relay 136 via armatures of relays 133 and 132 through the relay 140, through the back contact of armature 121 of relay SR^2, through armature 139 of relay 136, contact 154—150^a, through spring 17, and cut-off relay 13 of the called line to battery, operating the said relay 13 which attracts its armatures to disconnect the called line from the wipers of its individual switch. The described flow of current also operates relay 140 which attracts its armatures 141 and 143 to close normally open contacts in the connector's talking circuit and attracts armature 142 to complete a circuit from constantly rotating interrupter 145 through ringing relay 144 to ground through the back contact of armature 130. Relay 144 is now alternately energized and deënergized, attracting and releasing its armatures 146 and 147, first including ringing generator a^4 in circuit with the called-for line of K to ring the substation bell, and then excluding it, giving the periodic ringing customary in telephone practice, when automatic ringing is employed.

The called subscriber, in response to the bell signal, removes his receiver, the hook-lever then engaging its alternate contact, whereby a conductive bridge of the line limbs P and S at substation K is effected, establishing a path for the flow of current as follows: from ground through the upper winding of relay 126, through the upper winding of release relay RR^2, through attracted armature 141, through retracted armature 146 as soon as relay 144 is deënergized, through contact 155—150^b, over limb P of the line, returning over limb S, contact 150^c—156, retracted armature 147, attracted armature 143, lower windings of relays RR^2 and 126 to battery. This flow of current supplies battery to the called subscriber's station for talking purposes and effects the energization of relay 126 which is cumulatively wound, although said flow of current does not actuate relay RR^2, whose windings are differentially disposed. The said relay 126 therefore attracts its armatures, of which 127 and 131 disconnect relays PR^2 and SR^2 from the talking conductors of the connector and bridge the battery across the talking conductors of the connector at the left-hand sides of condensers 135 and 135, the said connection being through the impedances of the windings of differential relay RR^3, which relay is not operated at this time. Attracted armature 130 of relay 126 opens the contact, in the circuit before described, of ringing relay 144 so that further energizations thereof are prevented and generator a^4 is left excluded from the called substation line. The two subscribers A and K are now in conversation, the talking circuit being traced from substation A to substation K over the heavily marked conductors, the condensers 135 and 135 being interposed in the talking circuit at the connector E, battery being fed to the calling line by bridge connections through relay RR^3 at one side of these condensers, while battery is supplied to the called line through bridge connections extending to the opposite sides of said condenser.

When the subscribers have finished their conversation, they replace their receivers upon the hook-levers, the act of subscriber K in so doing being effective to restore to normal the connector E, while the act of subscriber A is effective to restore to normal his individual switch B, the first selector switch C and the second selector switch D. To trace these operations in detail, when subscriber K replaces his receiver, the downwardly projecting arm of insulating material fastened to his hook-lever 4, which upon the removal of his receiver passed to the left over the top of spring 7, presses against the said spring, causing it to be momentarily conductively united with its two associated springs, the arm then passing over the top of spring 7 to the position shown. The two limbs P and S of the called line are thereby simultaneously grounded for a short period of time, whereby the upper winding of relay RR^2 is short circuited, while current continues flowing through the lower winding of the said relay whose core is, by the resulting unbalanced condition of the windings, magnetized and armature 129 is attracted to close circuit from ground, through off-normal spring ON^8 (which spring was shifted on the first movement of the switch E), through relay 136 to battery. The said relay 136 attracts its armature 138 to establish a locking circuit for itself. The off-normal spring ON^8 does not disengage its associated contact until a complete revolution of the switch wipers has been effected, at which time the switch will be at normal. Attracted armature 137 opens the locking circuit of relay 171, which thereby becomes deënergized; and the said armature 137, in engaging its alternate contact, establishes a circuit from generator a^3, through the now retracted armature 170, magnet M^2, attracted armature 137 to ground. The magnet M^2 is now operated, responsive to impulses transmitted by generator a^3, moving the wipers step by step in the clockwise direction in which they

were originally operated until the armature 137 is allowed to fall back, which will occur as soon as the wipers reach their normal position illustrated, when off-normal spring ON^8 opens the locking circuit of relay 136. At this time, spring ON^7 is also shifted back to normal. When relay 136 was energized, its armatures 138 and 139 were attracted, opening the series circuit, before traced, through relays 140 of E and 13 of the called line. Relay 140 is therefore deënergized and its armatures retracted so that the line wipers 155 and 156 are on open circuit while the switch is moving around to normal.

The called subscriber having replaced his receiver first, relay 140 will have become deënergized and circuit will have been opened through the relay 126, whose retracted armatures 127 and 131 will have connected relays PR^2 and SR^2 to the talking conductors of the connector before the calling subscriber replaced his receiver. He now replaces it, grounding simultaneously the two limbs of his line by the resulting movement of spring 7, and simultaneous energizations of relays PR^2 and SR^2 are thereby caused, whereupon current flows from ground through attracted armatures 122 and 116, and trunk release relay TRR^2 to battery, operating the said relay whose attracted armature 175 completes a circuit from battery through contact 94^a—98, through normal contact 90, trunk release relay TRR′ at the second selector to ground. The now attracted armature 78 of said relay completes a circuit from ground through off-normal spring ON^5, release relay RR′ to battery, operating the said relay, which disconnects wipers 99 and 100 at armatures 85 and 88, placing them on open circuit, the said relay locking itself by its attracted armature 87. Attracted armature 86 of release relay RR′ completes a circuit for magnet M′ which is now actuated by successive impulses transmitted by generator a^2, moving the wipers 97, 98, 99, 100 and 101 clockwise around to normal. When this point is reached, off-normal spring ON^5 is shifted to disengage its contact, relay RR′ is deënergized, its armatures are retracted, and further actuations of magnet M′ are prevented.

When trunk release relay TR′ was actuated as before described, its attracted armature 77 completed a circuit from battery through said armature, through contact 53^a—48, normal contact 44, trunk release relay TRR of the first selector C, to ground, operating the relay TRR, whose attracted armature 32 closed circuit through off-normal spring ON′ and release relay RR to battery, the relay locking itself at armature 41. Attracted armatures 39 and 42 place line wipers 49 and 50 on open circuit, while armature 40 completes a circuit of magnet M which is actuated responsive to impulses transmitted by generator a', moving the wipers 47, 48, 49, 50 and 51 around to normal. As soon as this point is reached, spring ON′ is shifted, relay RR deënergized, and its armatures retracted, of which 40 prevents further actuations of magnet M, so that the switch wipers remain at normal. When relay TRR is energized, its attracted armature 31 completes a circuit from battery through contact 27—21, normal contact 11, release magnet 14 to ground. This is a circuit of relatively low resistance and release magnet 14 is actuated, attracting its armature to engage a retaining dog, which on the ensuing deënergization of magnet 14 is withdrawn from engagement with the ratchet of the switch B, the spring of the switch being then effective to rotate the wipers back to normal. When magnet 14 is energized it shifts spring 17 to normal, but springs 15—16 are not shifted back until the wipers reach normal. Hence while the wipers 22, 23 are being restored they are disconnected from the line limbs P and S at the armatures of relay 13, said relay being operated by current over alternate contact 17, alternate contact 15 to ground. It should be stated that relay 136 at the connector is mechanically associated with the detent 173 of ratchet 164, so that when the relay 136 is actuated, detent 173 is withdrawn from engagement with the ratchet and the said ratchet is rotated back to normal by its associated spring. Relay RR′ at the second selector bears similar mechanical relations to detent 111, being employed to release it, and the same is true of relay RR at the first selector with respect to detent 64.

If the calling subscriber A replaces his receiver before the called subscriber K does so, the grounding of limb P of his line short-circuits the upper winding of differential relay RR^3 which attracts its armature to operate trunk release relay TRR^2 whereupon the restorations of switch B, C and D proceed as before. Connector E is, however, not released because, the called subscriber having not yet replaced his receiver, armature 128 is still attracted and the attracted right armature of TRR^2 fails to complete a circuit for relay 136.

Let it now be assumed that the line of K was busy when the before described last secondary impulse energized relay SR^2. In such case, private contacts 150^a of the line K will be grounded at alternate contact 15 if the line is busy because calling, or at armature 138 of another connector if such connector has made the line busy as a called line, circuit being traced from a multiple contact 150^a through wiper 154 of the other connector, its contacts 139, 121, its relay 140,

armatures of relays 132, 133 and armature 138 to ground. Therefore, when the last secondary impulse energizes relay SR^2, the said relay will be locked by current over its alternate contact 121 to wiper 154 and to ground via the multiple 150^a of the busy line. Relay SR^2 thus holds its armatures attracted and the calling subscriber A hears in his receiver the busy signal from interrupter 125, its impulses being transmitted over alternate contacts 121, normal contact 131, to the left over the heavily marked talking conductors through the primary of the induction coil at A, returning over the upper heavily marked talking conductor and normal contact 127 to battery through relay PR^2. Being thus advised that the called line is busy, A replaces his receiver grounding the two line limbs as before described. Relay PR^2 is therefore energized, and as SR^2 is also energized, current flows from ground, through alternate contact 122, armature 116, trunk release relay TRR^2 to battery, operating TRR^2, whose right armature energizes relay 136 by current from ground at armature 128, said attracted right armature, contact ON^8, relay 136 to battery, and on the consequent energization of relay 136, the connector is restored as before described. Armature 175 of TRR^2 energizes relay TRR', the latter energizes relay TRR which operates release magnet 14, and the various switches are in consequence restored as before described.

Suppose subscriber A after transmitting the first set of directive impulses, decides not to complete the connection. In such case, the replacing of his receiver, grounding the two line limbs, will simultaneously energize relays PR' and SR' when their attracted armatures 82 and 79 will operate relay TRR' which will operate relay TRR and the latter will operate magnet 14, the switches being respectively restored. Also, if while first selector C is being operated, subscriber A replaces his receiver, the switches will be restored because relay PR is while C is rotating connected to limb P through alternate contact 43, and relay SR is connected to limb S through alternate contact 46, and the grounding of the two line limbs operating the said relays PR and SR will be effective to energize relay TRR by current over attracted armatures 35 and 33. Similarly if subscriber A replaces his receiver while second selector D is rotating, relays PR' and SR' will be in circuit with limbs P and S respectively through alternate contacts 89 and 92 and their simultaneous energizations will cause operation of relay TRR' and the restorations before described.

In Figs. 2 and 3, illustrating the subscriber's individual switch, the wipers 21, 22 and 23 are rigidly attached to a suitably supported rotary shaft 12^c which also carries the ratchet 12^b adapted to be driven in a clockwise direction by thrusts of pawl 12^a, attached to the armature of magnet 12. Stud 12^g of insulating material upon the ratchet 12^b normally holds spring 15 engaging spring 16 as shown. The spring 17 has at its end a piece of insulating material normally engaged by spring arm 14^b of the armature of magnet 14 whereby the said spring 17 is held engaging its normal contact. With the actuation of the switch, a first impulse through magnet 12, actuating pawl 12^a, turns ratchet 12^b, shaft 12^c, and the switch wipers, a clockwise step, whereby wipers 22 and 23 are moved along upon their normal contacts 25 and 26 and wiper 21 is brought to engage the contact 24. Ten sets, each comprising contacts 27, 28, 29, are provided, arranged in an arc which contact sets form terminals of ten first selectors. A second actuation of magnet 12 starts the wipers moving over the contact sets in search of a set belonging to an idle first selector, as described in connection with Fig. 1.

The first actuation of magnet 12 causing the attraction of its armature, brings the pin on the right end of its armature to the left, whereby detent 14^c upon spring arm 14^b is freed from retaining pawl 14^a, which is then rotated by its spring to engage ratchet 12^b to hold the same in its actuated position after each step. The movement of said pawl 14^a brings its right end so that it engages with detent 14^c, holding the spring arm 14^b drawn to the left, in which position spring 17 is free to be moved by its tension to engage its alternate contact.

The first step of ratchet 12^b brings stud 12^g to disengage spring 15, and the two springs 15 and 16 now engage their alternate contacts.

Successive actuations of magnet 12, after the first, merely effect further step-by-step movements of the switch wipers.

When the switch is to be released, an impulse of current is caused to flow through magnet 14, whose attracted armature lifts spring arm 14^b to a position where detent 14^c is brought above the upper surface of the rearwardly extending arm of pawl 14^a, whereupon the tension of spring arm 14^b moves said arm to the right, which movement is effective to cause the restoration of spring 17. As soon as magnet 14 is deenergized, its retracted armature, in drawing arm 14^b downward, turns pawl 14^a to disengage ratchet 12^b. The said ratchet 12^b, shaft 12^c and the wipers are now free to return to normal under the influence of spring 12^f (shown in Fig. 3), against whose tension this switch was operated. As soon as the switch reaches the normal position shown in Fig. 2, the stud 12^g causes spring 15 to

engage spring 16, the said springs then leaving their alternate contacts and all parts of the switch are at normal. As soon as the switch reaches zero in its return movement, the arm 12^d of ratchet 12^b engages the piece 12^e and the switch is stopped in its normal position.

Referring now to Figs. 4 and 5, illustrating the mechanism associated with the primary magnet PM of a first selector, it will be understood that similar mechanical devices may be provided for the primary magnet PM′ of the second selector and primary magnet PM^2 of the connector. The wiper 66 is fastened to a suitably supported rotary shaft which also carries the ratchet 63. Pawl 65, carried by the armature of magnet PM, is adapted to engage the ratchet 63 and turn it step by step in a clockwise direction, the retaining pawl 64 holding the switch in actuated position after each step, wiper 66 being thus moved step by step over the contacts 67, 68, 69. I have shown the contact end of wiper 66 broad enough to engage three of its contacts, which will be sufficient to take care of the lag of the selecting switches proper with the speeds which I have indicated in the description of Fig. 1. The contact end of the said wiper may, however, be of any desired width.

The switch is actuated against the tension of spring 63^a, shown in Fig. 5; and when relay RR is actuated its armature rotates pawl 64 to disengage ratchet 63, the ratchet, shaft and wiper being rotated back to zero by spring 63^a. When zero is reached, arm 63^b engages the piece 63^c, stopping the return movement.

Referring now to Figs. 6, 7, 8, 9 and 10 illustrating a form of mechanical switch which may be employed in connection with the circuit diagram of Fig. 1 for continuing the calling line circuit from the first selector to the second selector, from the second selector to the connector and from the connector to the called line, the driving mechanism for the switch (best shown in Fig. 6), comprises a magnet M provided with pole pieces 161 and 162. Journaled to the suitably supported rotary shaft 120 is the armature 122, its ends extending adjacent to the said pole pieces. Two pawls 124 and 125 are pivoted to the said armature and are provided with suitable springs for pressing them against the ratchet 121, securely fastened to the shaft 120. Rigidly attached to the shaft 120 are the wipers 47^a, 48^a, 49^a, 50^a and 51^a. The said wipers have in themselves no circuit connections but serve to cross the common strips 47, 48, 49, 50 and 51, shown in Figs. 8 to 10, to the respective contacts associated with them. Referring to the first selector C in Fig. 1, the common strips of the mechanical Figs. 8 and 10 are the true terminals of the conductors connected to wipers 47, 48, 49, 50 and 51 of Fig. 1.

In the operation of the switch of Fig. 6, when magnet M is energized, the ends of armature 122 are attracted toward pole pieces 161 and 162, the armature turning freely about shaft 120. The pawl 125 is thereby brought downwardly effecting a step of ratchet 121 with which the shaft and wipers move. When the impulse ceases through magnet M, spring 123 turns armature 122 back to its normal position and pawls 124 and 125 then engage teeth of ratchet 121 adjacent to those previously engaged by them. A pin 163 associated with pawl 124 is so disposed that the said pawl 124, continues in engagement with the tooth of ratchet 121 when armature 122 is attracted until pawl 125 is just completing its stroke, at which time pawl 124 will be brought to a position with respect to the pin 163 such that the said pawl will be lifted from engagement with the tooth of ratchet 121. The arrangement of pawls 124 and 125 provide means for preventing a half step of ratchet 121 in case armature 122 should be partially attracted by magnet M and then released. In such case, pawl 124 will not have disengaged the tooth of ratchet 121 and the operation of spring 123 in restoring the armature to normal will be effective by pawl 124 to turn the ratchet 121 back to the position from which it was moved by the partial attraction of armature 122. Successive actuations of magnet M will, of course, move ratchet, shaft and wipers step-by-step in a clockwise direction.

The off-normal springs ON, ON′ and ON^2 are controlled by the studs of insulating material 164–165 fastened to ratchet 121. On the first step of the ratchet from the normal position shown, the bent portion of spring ON^2 rides down upon the smaller stud 165, whereupon springs ON and ON′, by their tension, are permitted to engage their contacts. The contact of spring ON^2 follows the said spring when it engages stud 165, continuing in engagement with the said spring ON^2. On the second step of the ratchet 121, however, stud 165 moves free of spring ON^2 whose tension then moves it to a position where it disengages its associated contact whose following motion is arrested by the stud 166. On a complete revolution of ratchet 121, stud 164 will be brought around to normal, and by engaging the bent portion of ON^2 will cause the off-normal springs ON, ON′ and ON^2 to resume their normal positions.

As indicated in Fig. 8, a sectional view of the switch, the various contacts and common strips are insulated from each other by rings of insulating material, their contact ends projecting inwardly so that they are adapted to be engaged by the contact-makers or

wipers 47^a, 49^a, 50^a and 51^a. In Fig. 10, I have indicated diagrammatically the arrangement of wipers, contacts and common strips of a little more than one section of a contact bank of the switch. The wipers are shown as at normal, wiper 47^a engaging the normal contact 52. In the said Fig. 10, the movement of the wipers is assumed to be from left to right. If it be remembered that 47 and 47^a considered together perform the function of wiper 47 of Fig. 1, that 48 and 48^a together that of wiper 48 in Fig. 1, 49 and 49^a that of wiper 49 in Fig. 1, 50 and 50^a that of 50, 51 and 51^a that of 51, the electrical identity of the mechanical structure of Fig. 10 in the diagrammatically illustrated structure of Fig. 1 will be readily understood. Regarding the switch illustrated in Fig. 6 as the first selector for the ten thousand exchange, the contacts for the first thousand will be included between 126 and 127, those of the second thousand between 127 and 128, those of the third thousand between 128 and 129, and so on for the ten thousands of the exchange.

The mechanical structure of Figs. 6 to 10 inclusive is used for the rotary switch of the second selector and connector, as before stated. In this employment for the connector, however, the ring 162 illustrated in Fig. 1 which will take place of the ring 60 shown in Fig. 10, would of course, be provided with cut-away portions 158–160, etc., instead of projections 57–58, etc., as shown in Figs. 1 and 10, the ring 162 being made somewhat wider than the ring 60, in order that the wiper may engage it at all times except when its end is opposite one of the cut-away portions. In Figs. 8 and 9 I have shown a pointer 160 fastened to shaft 120 at the back of the switch which, turning with the shaft, will indicate on what contacts the wipers are resting.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. An automatic telephone system including contacts arranged in groups, a wiper adapted to engage all of said contacts, a ratchet for causing travel of said wiper to select a group, said ratchet also serving to continue travel of said wiper in the same direction to select a contact of the selected group and means dependent upon the connections of the contacts encountered by said wiper for automatically causing the said continued travel of said wiper.

2. An automatic telephone system including subscribers' lines, circuit selecting switches at the exchange, means for interchangeably connecting said switches with calling lines, auxiliary selective switches one for each selecting switch, means for directively operating said auxiliary switches, means controlled by said auxiliary switches for automatically causing travel of said selecting switches to correspond to the extent of travel of their respective auxiliary switches, and mechanism for thereafter continuing the travel of said selecting switches independently of said auxiliary switches.

3. An automatic telephone system including link-circuits arranged in groups, a selective switch having multiple terminals of said link-circuits arranged in corresponding groups, group contacts at said switch one for each group, movable contact members adapted to connect with said multiple terminals, apparatus for causing travel of said contact members to select a group, mechanism sensitive to the electrical condition of said group contacts determining the selection of the group, and means for thereafter continuing travel of said members in the same direction to select terminals of the selected group.

4. An automatic telephone system including link-circuits arranged in groups, a selective switch having multiple terminals of said link-circuits arranged in corresponding groups, group contacts at said switch one for each group, means for altering the normal electrical conditions of said group contacts, means for altering the normal electrical conditions of said multiple contacts, a magnet for causing travel of said switch, and a relay controlling said magnet sensitive to the altered electrical conditions of said group contacts and said multiple contacts.

5. An automatic telephone system including link-circuits arranged in groups, a selective switch, multiple terminals individual to said link-circuits included in said switch and arranged in corresponding groups, group terminals included in said switch one for each group, an auxiliary switch having contacts connected to said group terminals, and electromagnetic means for operating said auxiliary switch to alter the normal electrical conditions of said group terminals.

6. An automatic telephone system including trunk lines having multiple terminals arranged in groups, group contacts one for each group, a selective switch having contact members adapted to engage said contacts and said terminals, a magnet for driving said switch, a relay for controlling said magnet, means for primarily energizing said relay, a controlling circuit for said relay when primarily energized sensitive to the electrical conditions of said group contacts, means for thereafter causing another energization of said relay, and a controlling circuit for said relay when so energized sensitive to the electrical conditions of said multiple terminals.

7. An automatic telephone system including a selective switch, an auxiliary switch therefor, a contact wiper for said auxiliary

switch, stationary contacts adapted to be engaged thereby, stationary contacts of said selective switch, connections between the contacts of said two switches, a contact wiper for said selective switch adapted to engage its said stationary contacts, means for causing travel of said contact wiper of said auxiliary switch, and mechanism including said stationary contacts of both switches for automatically causing travel of said contact wiper of said selective switch corresponding to the travel of the auxiliary switch.

8. An automatic telephone system including a selective switch, an auxiliary switch therefor, a contact wiper for said auxiliary switch, stationary contacts adapted to be engaged thereby, stationary contacts of said selective switch, connections between the contacts of said two switches, a contact wiper for said selective switch adapted to engage its said stationary contacts, a calling telephone line operatively connected with said switches, mechanism for transmitting directive currents over said telephone line, apparatus responsive to said currents for causing travel of the contact wiper of said auxiliary switch, and mechanism including said stationary contacts of both switches for automatically causing travel of said contact wiper of said selective switch corresponding to the travel of the auxiliary switch.

9. An automatic telephone system including trunk circuits having multiple terminals arranged in groups, group contacts one for each group, a selective switch, a group private wiper therefor adapted to move over said group contacts, an individual private wiper therefor adapted to engage the multiple terminals of all said groups, mechanism for altering the normal electrical conditions of said group contacts, and mechanism for altering the normal electrical conditions of said multiple terminals.

10. An automatic telephone system including trunk circuits having multiple terminals arranged in groups, group contacts one for each group, a selective switch, a group private wiper therefor adapted to move over said group contacts, an individual private wiper therefor adapted to engage the multiple terminals of all said groups, mechanism for altering the normal electrical conditions of said group contacts, mechanism for altering the normal electrical conditions of said multiple terminals, and an electromagnet for controlling the operation of said switch.

11. An automatic telephone system including trunk circuits having multiple terminals arranged in groups, group contacts one for each group, a selective switch, a group private wiper therefor adapted to move over said group contacts, an individual private wiper therefor adapted to engage the multiple terminals of all said groups, mechanism for altering the normal electrical conditions of said group contacts, mechanism for altering the normal electrical conditions of said multiple terminals, an electromagnet for controlling the operation of said switch, and a circuit for said electromagnet including said group private wiper for determining operation of said switch to select a group.

12. An automatic telephone system including trunk circuits having terminals arranged in groups, group contacts one for each group, a selective switch, a group private wiper therefor adapted to move over said group contacts, an individual private wiper therefor adapted to engage the multiple terminals of all said groups, auxiliary switch mechanism for altering the normal electrical conditions of pre-determined group contacts, and mechanism for altering the normal electrical conditions of said multiple terminals.

13. An automatic telephone system including trunk circuits having multiple terminals arranged in groups, group contacts one for each group, a selective switch, a group private wiper therefor adapted to move over said group contacts, an individual private wiper therefor adapted to engage the multiple terminals of all said groups, auxiliary switch mechanism for altering the normal electrical conditions of pre-determined group contacts, mechanism for altering the normal electrical conditions of said multiple terminals, and an electromagnet for controlling the operation of said switch.

14. An automatic telephone system including trunk circuits having multiple terminals arranged in groups, group contacts one for each group, a selective switch, a group private wiper therefor adapted to move over said group contacts, an individual private wiper therefor adapted to engage the multiple terminals of all said groups, auxiliary switch mechanism for altering the normal electrical conditions of pre-determined group contacts, mechanism for altering the normal electrical conditions of said multiple terminals, an electromagnet for controlling the operation of said switch, and a circuit for said electromagnet including said group private wiper for determining operation of said switch to select a group.

15. An automatic telephone system including a subscriber's line, a selective switch, multiple terminals associated therewith arranged in groups, controlling mechanism for said switch operatively related to said line, including an auxiliary switch, means for transmitting directive currents over said line to operate said auxiliary switch to determine selection of a group, and means for automatically causing travel of said se-

lective switch determined by the travel of said auxiliary switch to place said selective switch in operative relation with the selected group.

16. An automatic telephone exchange including a selective switch, an auxiliary switch therefor, magnets for causing travel of said switches, one for each switch, a subscriber's line operatively connected with said switches, means for transmitting directive currents thereover, mechanism for operating the magnet of said auxiliary switch responsive to a first set of directive impulses transmitted over said line, apparatus automatically responsive to the operation of said magnet for actuating the magnet of said selective switch, and means for thereafter rendering effective the magnet of said selective switch to respond to a second set of directive impulses over said line independently of said auxiliary switch.

17. A telephone system including a directively operable selector, a telephone line, a relay associated with said selector operable responsive to impulses transmitted over said line, a normal circuit connection for said relay for receiving an impulse from said line, and means effective in response to an impulse received for substituting an alternate connection for transmission of subsequent impulses to said relay from said line.

18. A telephone system including a directively operable selector, a calling device operatively connected with said selector, a selector controlling relay adapted to be energized and deënergized responsive to digit impulses transmitted by said device, a normal circuit connection for said relay, and switching means actuated on an operation of said device to open said normal connection and close a substitute connection whereby said relay continues sensitive to said device.

19. An automatic telephone system including terminal contacts arranged in groups, a selective switch having movable members for engaging said contacts, group contacts at said switch, one for each group, means for altering the normal electrical condition of a group contact, means for altering the normal electrical condition of terminal contacts, an electromagnet sensitive to the electrical condition of said group contacts for controlling travel of said members to select a group, and means for continuing travel of said members in the same direction to select contacts of a selected group.

20. A telephone system including contacts arranged in groups, a selector having movable members for selecting said groups, and means for automatically causing as many steps of said members as there are contacts in a group to select an adjacent group.

21. A telephone system including contacts arranged in groups, a selector having movable members for selecting said groups, means for causing as many steps of said members as there are contacts in a group to select an adjacent group, and circuit connections for automatically adjusting said members to select definite contacts of a previously selected group.

22. A telephone system including contacts arranged in groups, a selector having movable members for selecting said groups, means for causing as many steps of said members as there are contacts in a group to select an adjacent group, circuit connections for automatically adjusting said members to select definite contacts of a previously selected group, and a release controlling circuit for continuing the travel of said members to normal.

23. A telephone system including contacts arranged in groups, a selector having movable members for selecting said groups, means for causing as many steps of said members as there are contacts in a group to select an adjacent group, circuit connections for adjusting said members to select contacts of a previously selected group, a release controlling circuit for continuing the travel of said members to normal, and automatic switching means for opening said release controlling circuit when normal is reached.

24. A selector for automatic telephone systems including multiple contacts forming terminals of trunk lines arranged in groups, movable members adapted to engage said contacts, means for adjusting said members to select a group and then contacts of a group, circuit connections controlling means for continuing travel of said members in the initial direction of travel to a normal point, and means for automatically altering said circuit connections when normal is reached to stop said travel.

25. A selector for automatic telephone systems including contacts arranged in groups, a wiper for said selector having a definite normal position, means including a magnet for adjusting said wiper to select a group, circuit connections for the selector and thereupon effective whereby said magnet may be operated for adjusting said switch to select contacts of the group, and circuit connections whereby said magnet also serves to restore said wiper to normal.

26. A selector including contacts arranged in groups, movable members to make connection with said contacts, said members having a definite normal position, mechanism for adjusting said members to select a group, and circuit connections thereupon effective whereby said mechanism also serves to continue travel of said members in the same direction, to select contacts of the group, and, when disconnection is desired, to restore said members to normal, and circuit connections controlling said mechanism.

27. A telephone system including multiple contacts arranged in groups, an electromagnetically driven selective switch having a continuous rotary direction of travel, means for transmitting directive currents to select a group of contacts, and means for setting up an independently progressive travel of said switch to automatically select definite contacts of a group.

28. A telephone system including multiple contacts arranged in groups, a selective switch, means for setting up an independent progressive travel of said switch for selecting a group of contacts, means for setting up an independent progressive travel of said switch to automatically select definite contacts of a selected group, and electromagnetic driving means for advancing the said switch to a normal point.

29. A telephone system including multiple contacts arranged in groups, a selective switch, means for selecting a group of contacts, means for setting up an independent progressive travel of said switch to automatically select definite contacts of a selected group, and electromagnetic driving means for continuing said independent progressive travel to a normal point.

30. An automatic telephone system including switch wipers, conductors leading to said wipers, a set of coöperating contacts for each wiper, multiple connections from each contact of one set to the corresponding contacts of the other sets, conductors leading from said multiple connections, means for transmitting current impulses over said conductors leading to wipers, means responsive to a single such impulse to cause the associated wiper to move over a plurality of the associated set of contacts step by step, and means responsive to other such impulses to cause said wiper to move over said contacts one step in response to each impulse.

31. An automatic telephone system including switch wipers, conductors leading to said wipers, a set of coöperating contacts for each wiper, multiple connections from each contact of one set to the corresponding contacts of the other sets, conductors leading from said multiple connections, means for transmitting current impulses over said conductors leading to wipers, means responsive to a single such impulse to cause the associated wiper to move over a plurality of the associated set of contacts step by step, and subsequently operative means dependent upon the condition of encountered contacts to cause said wiper to move step by step to a definite one of said contacts.

32. An automatic telephone system including a plurality of sets of switch wipers; a telephone line for each said set, having two limbs; a set of coöperating contacts for each wiper; multiple connections from each contact of one set to the corresponding contacts of the other sets, conductors leading from said multiple connections; means for transmitting current impulses independently over both limbs of said line; a driving magnet; means responsive to impulses over one limb to operate said magnet to move said wipers step by step over a group of the asscciated contacts, one group in response to each impulse; means responsive to an impulse over the other limb to change the connections of said magnet, and means subsequently responsive to impulses over said former limb to operate said magnet to move said wipers step by step over the associated contacts, one step in response to each of said impulses.

33. An automatic telephone system including a plurality of sets of switch wipers; a telephone line for each said set, having two limbs; a set of coöperating contacts for each wiper; multiple connections from each contact of one set to the corresponding contacts of the other sets, conductors leading from said multiple connections; means for transmitting current impulses independently over both limbs of said line; a driving magnet; means responsive to impulses over one limb to operate said magnet to move said wipers step by step over a group of the associated contacts, one group in response to each impulse; means responsive to an impulse over the other limb to change the connections of said magnet, and means subsequently responsive to the condition of encountered contacts for causing said magnet to move said wipers step by step to definite ones of the associated contacts.

34. In an automatic telephone system, the combination with a calling subscriber's telephone line, of a primary relay, a secondary relay, a release relay, a plurality of groups of contacts and a wiper adapted to coöperate with said contacts, a driving magnet for operating said wiper, operating circuit connections for said magnet controlled by said relays, and means controlled from the calling substation for operating said relays in their proper sequence whereby, through said circuit connections, said primary relay actuates said magnet to advance said wiper to select a group, said secondary relay then actuates said magnet to operate said wiper to select a contact in a group, and thereafter said release relay operates said magnet to restore said wiper.

35. In an automatic telephone system, the combination with a selective switch having a plurality of groups of contacts and a coöperating wiper, of a primary relay, a driving magnet, means for actuating said primary relay whereby said driving magnet operates to move said wiper to select a group of contacts, means for actuating said secondary relay responsive to which said magnet moves said wiper to connect with a con-

tact in a group, a release relay, and means for actuating said release relay whereby said magnet is operated to restore said wipers, and circuit connections for said magnet controlled by said relays for effecting said operations of the magnet.

36. In an automatic telephone system, the combination with a calling and a called telephone line, of a two-dimension connector switch having primary and secondary selective movements and connected to said calling line, a primary relay and a secondary relay for controlling the primary and secondary operation respectively of said switch for extending the circuit of the calling to the called line, means for holding said secondary relay in an energized condition when said switch connects to said line when busy, and means for transmitting a characteristic busy signal to the calling subscriber actuated responsive to the continued energization of said secondary relay.

37. A telephone system comprising an automatic switch, means for transmitting current impulses from a control point, a starting device individual to said switch set by said impulses in a position dependent upon the number of impulses transmitted, and electromagnetic driving means for advancing said switch to a position dependent upon the position at which said starting device is set.

38. A telephone system comprising automatic switches for interconnecting telephone lines, starting devices for said switches, each of said devices adapted to be set in any one of a plurality of positions, and means for advancing said switches to positions dependent upon the positions at which the said starting devices are set.

39. A telephone system comprising an automatic switch capable of primary and secondary adjustments, means for transmitting current impulses from a control point, a starting device for said switch set by said impulses in a position dependent upon the number of impulses transmitted, means actuated thereby to adjust said switch to a primary position dependent upon the position at which said starting device is set, and means for giving said switch its secondary adjustment.

40. A telephone system comprising an automatic switch, means for transmitting current impulses from a control point, a starting device for said switch having a member set by said impulses in a position dependent upon the number of impulses transmitted, said switch being adapted to travel to positions corresponding to positions of the starting device, and means for starting the advance of said switch upon the intial movement of said member and discontinuing it when it has traveled according to the adjusted position of the starting device.

41. A selector switch comprising contacts arranged in groups, an auxiliary switch for said selector having contacts corresponding to said groups, said auxiliary switch being adapted to be operated to select any of said groups, wipers common to and adapted for coöperation with each of said groups, and means for automatically moving said wipers to the selected group.

42. A selector switch comprising contacts arranged in groups, an auxiliary switch for said selector having contacts corresponding to said groups and connected therewith, said auxiliary switch being adapted to be operated to select any of its contacts and thus the corresponding group, a set of wipers adapted for coöperation with all of the contacts of said groups, and automatic means for moving said wipers to the selected group.

43. A telephone system comprising a telephone line and connected selector switch, said switch including contacts arranged in groups, a wiper for traversing said contacts, mechanism adapted for primarily moving said wiper to a group, then secondarily to a contact of the group and thereafter restoring said wiper, an electromagnet for operating said mechanism, and means including primary secondary and release relays controlled from the connected substation for effecting such order of operation of said magnet.

44. A telephone exchange system comprising subscribers' lines and automatic switches and link-circuits for uniting calling and called lines into conversational circuits, said switches each provided with a shaft having primary movements to select a group of contacts and secondary movements to select a contact in a group and means including a single driving means for producing both movements.

45. A selector comprising a movable switch member, electromagnetically driven control mechanism individual to the selector, an electromagnetic step-by-step device responsive to selective impulses for adjusting said control mechanism, a source of motive power, means operated by the said power to advance the said switch member, and means controlled by said control mechanism according to its completed selective adjustment, for rendering the motive power ineffective to further advance the said switch member.

46. A telephone system including an automatic selector switch, an electromagnetically driven control device individual to the said switch and adapted to be set in any one of a plurality of positions, and means for advancing said switch to a selective position dependent upon the position at which said control device is set.

47. A telephone system including an automatic switch provided with a normally at

rest contact maker, means for transmitting current impulses from a control point, a control device individual to said switch set by said impulses in a position dependent upon the number of impulses transmitted, and means for advancing said contact maker to a selective position dependent upon the position at which said control device is set.

48. A selector comprising a normally at rest movable switch member, preselector mechanism individual thereto, an electromagnetic step-by-step device responsive to selecting impulses for adjusting said mechanism, a source of motive power for advancing said switch member, said mechanism being effective according to its selective adjustment for cutting off the application of motive power from said switch member.

49. A selector comprising contacts and a normally at rest movable switch member, driving means for said switch member, an electromagnetically adjusted step-by-step device individual to said member and responsive to selecting impulses transmitted from a control point, and means for causing said driving means to adjust and stop said switch member according to the adjustment of said device.

50. In a telephone system, a calling and a called subscriber's line, automatic switches for uniting said lines for conversation, each of said switches being provided with a shaft having primary movements to select a group of contacts and secondary movements to select a contact in a selected group of contacts, and means including a single driving means for producing both movements.

51. A selector comprising a movable switch member, adjustable control mechanism, an electromagnetically controlled step-by-step device responsive to selective impulses for adjusting the said control mechanism, a source of motive power, means operated by said motive power to advance the said switch member, means controlled by said control mechanism according to its completed selective adjustment for disconnecting the motive power from said member, and a centralized source of current for furnishing all necessary operating current for said selector.

In witness whereof, I hereunto subscribe my name this 11 day of April, 1907.

GEORGE E. MUELLER.

Witnesses:

T. H. FERGUSON,

J. G. KELLOGG.