A. H. DYSON.

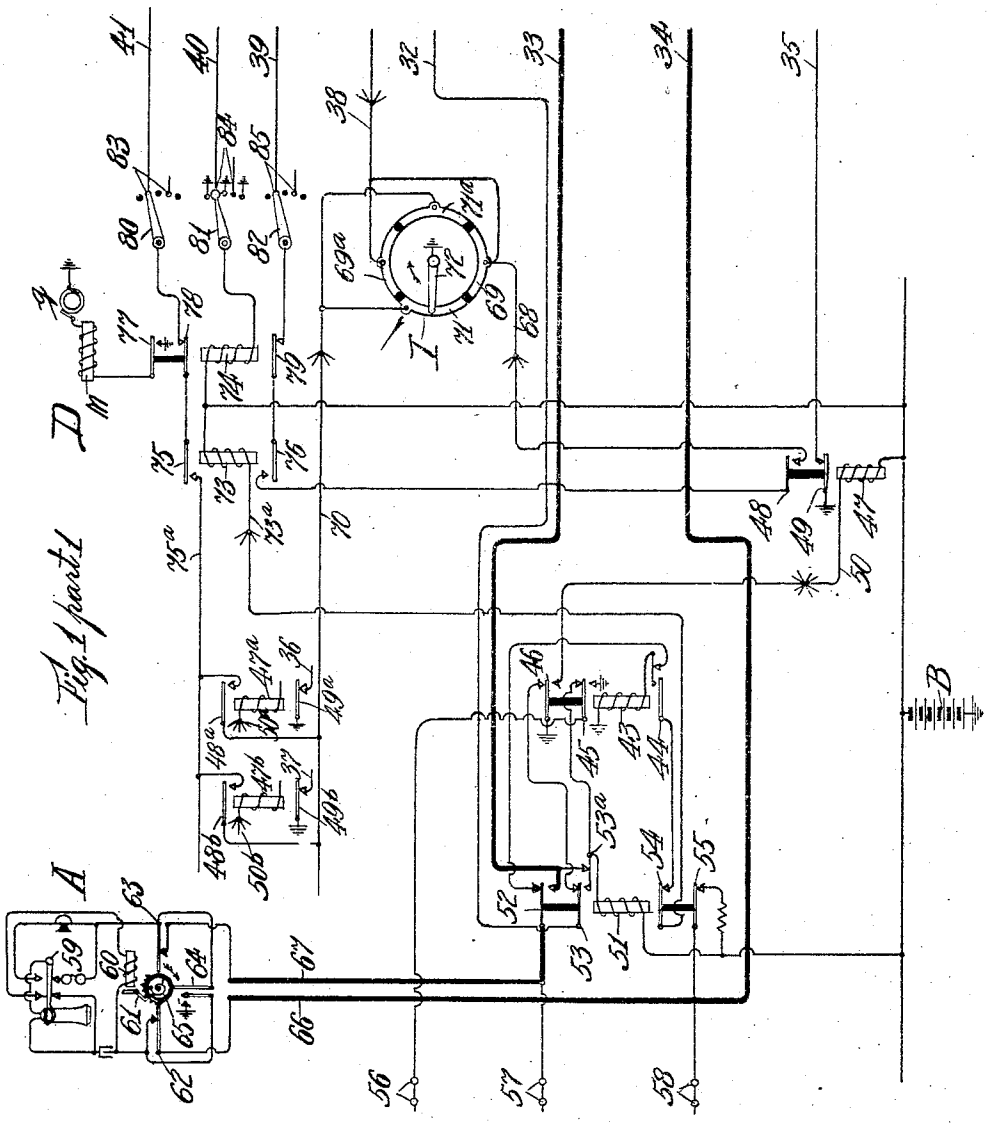
AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED APR. 15, 1908.

1,110,613.

Patented Sept. 15, 1914.

8 SHEETS—SHEET 1.



Witnesses

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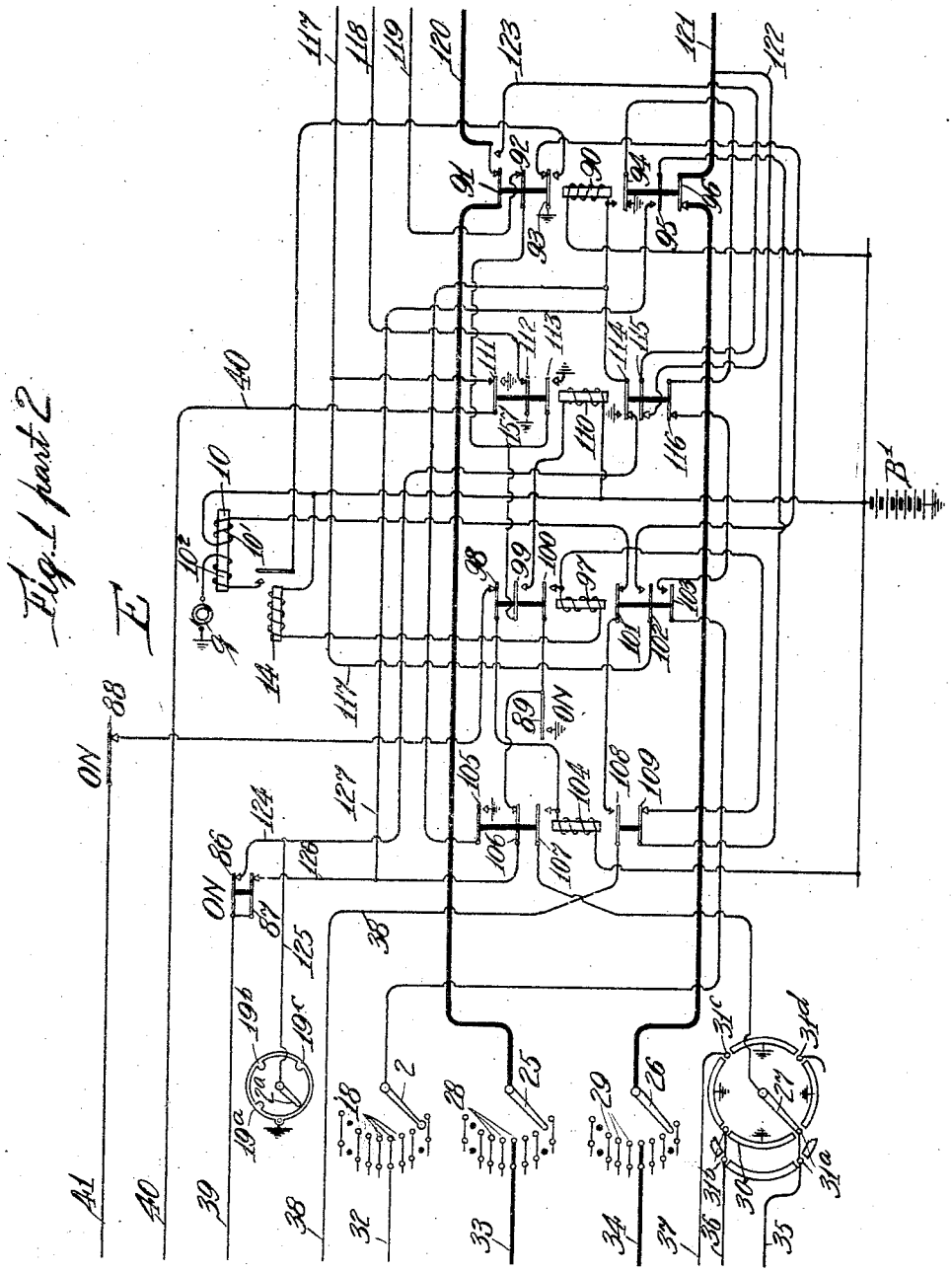

Fig. 1 part 2

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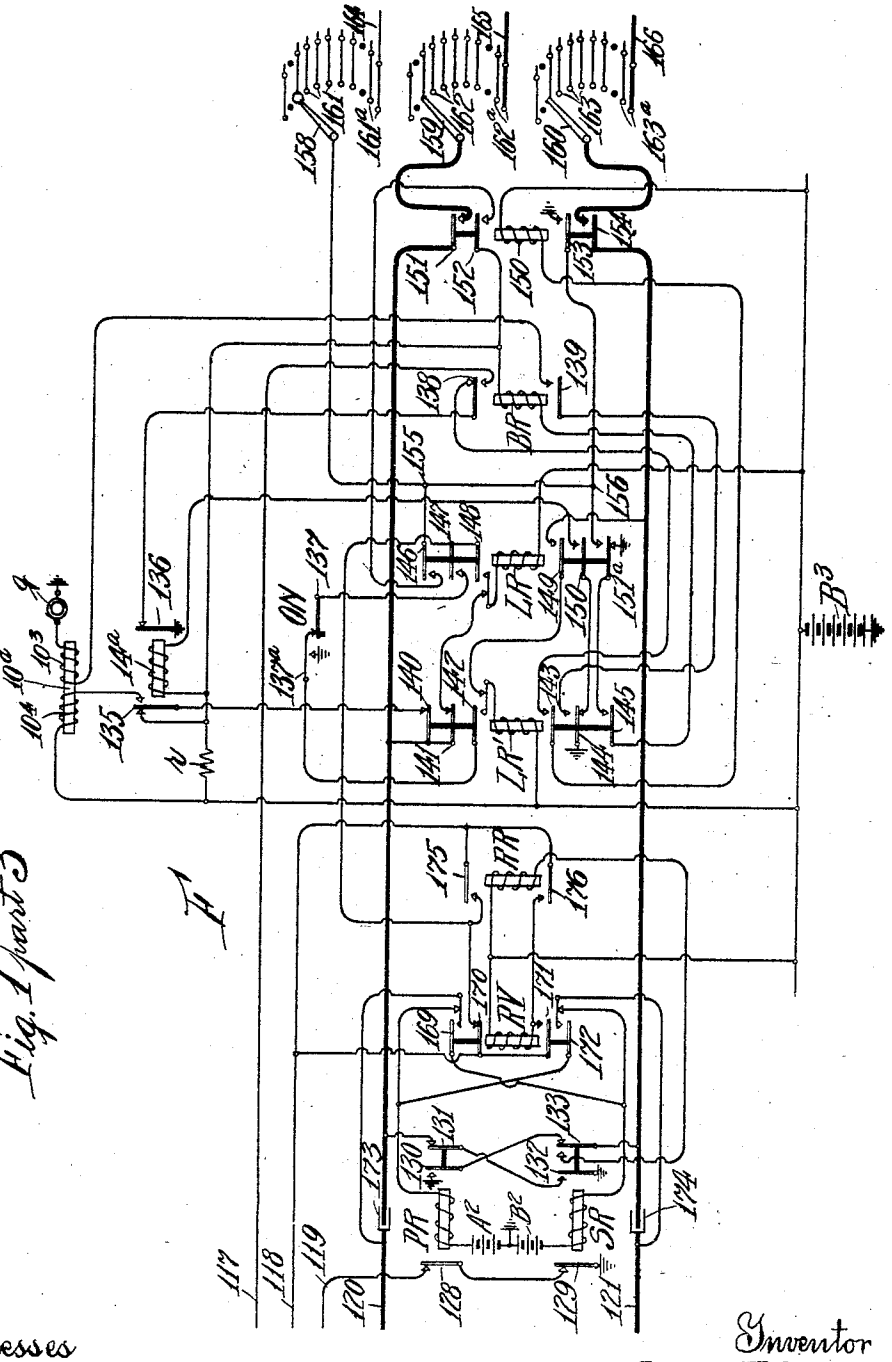

Fig. 1 part 3

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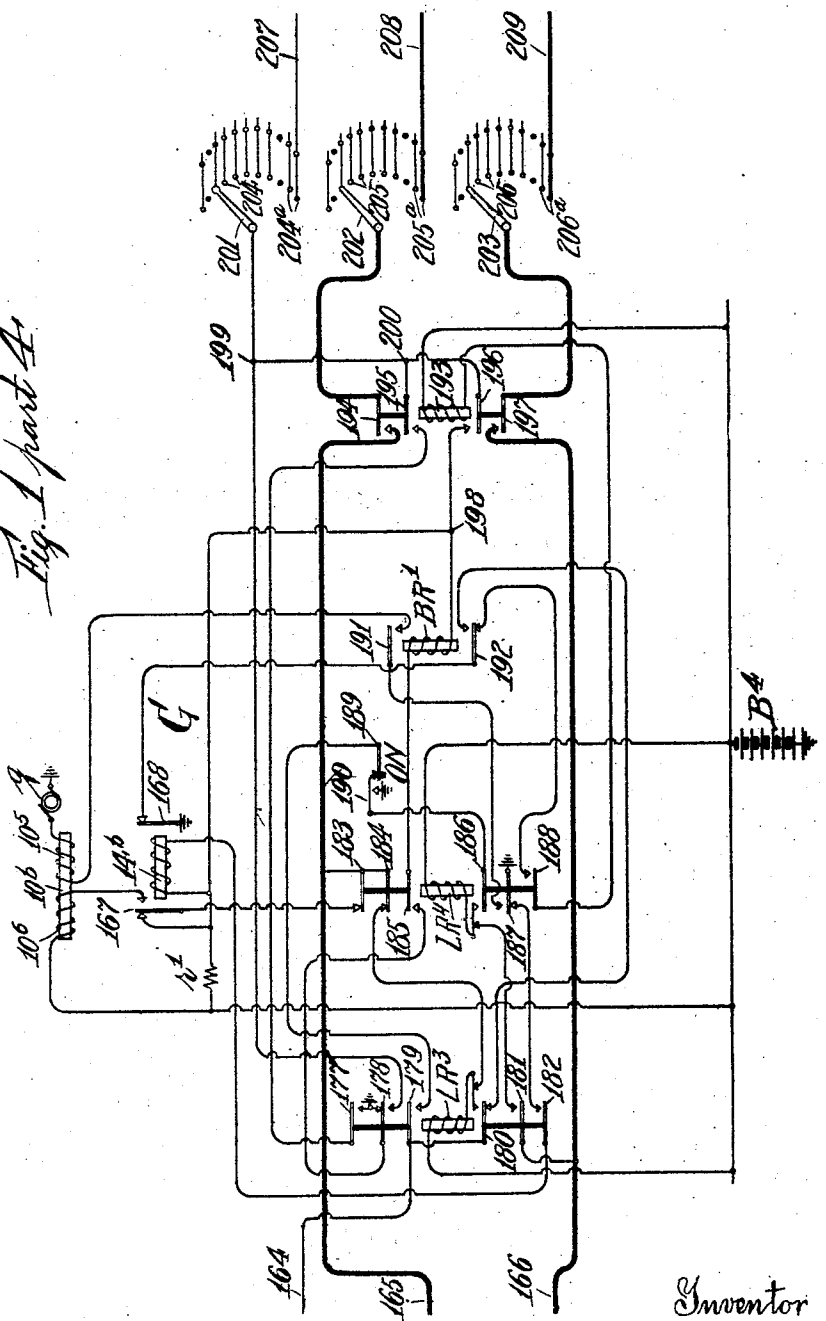

Fig. 1 part 4

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8 SHEETS—SHEET 5.

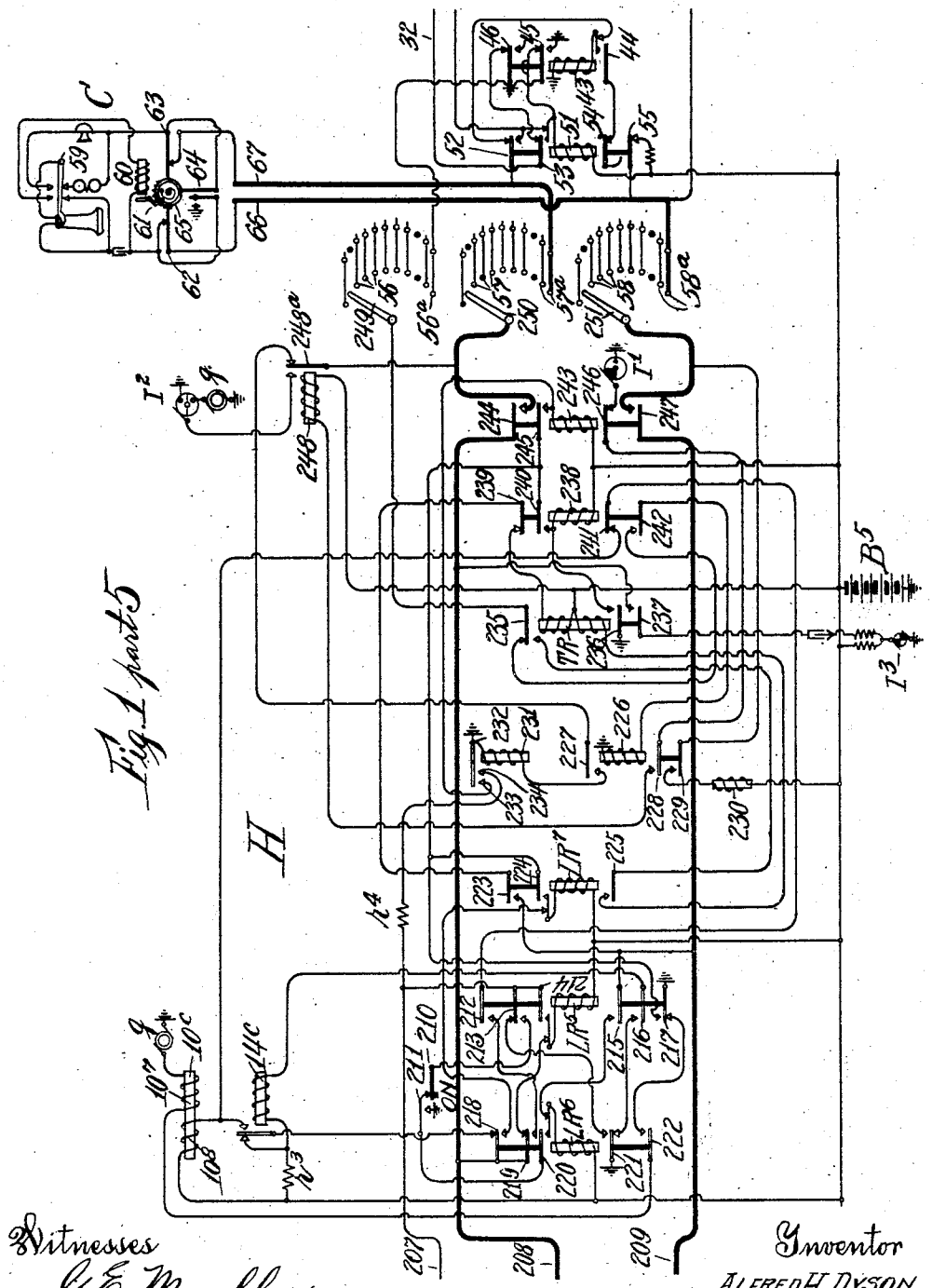

Fig. 1 part 5

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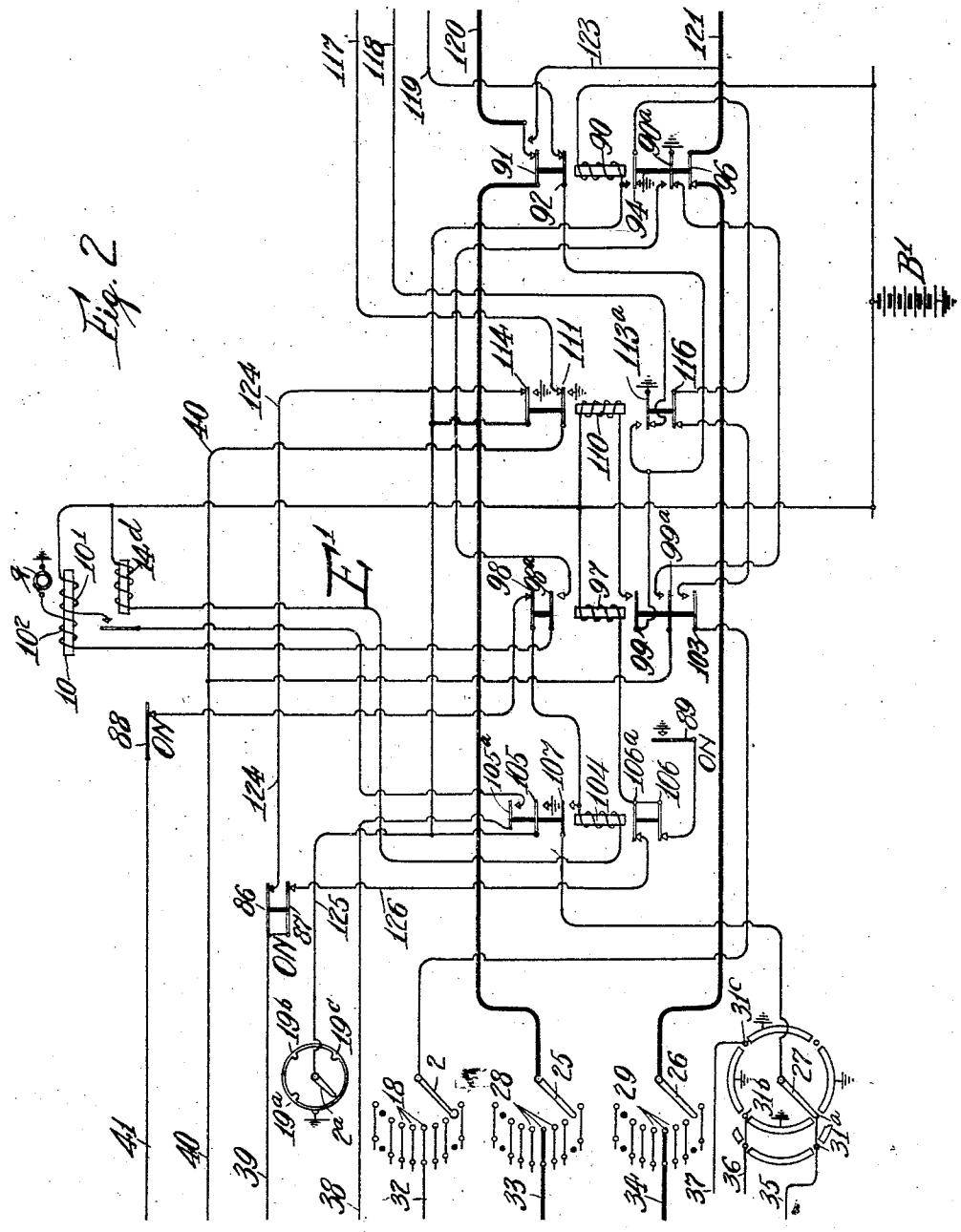
8 SHEETS—SHEET 6.

Fig. 2



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8 SHEETS—SHEET 7.

Fig. 3

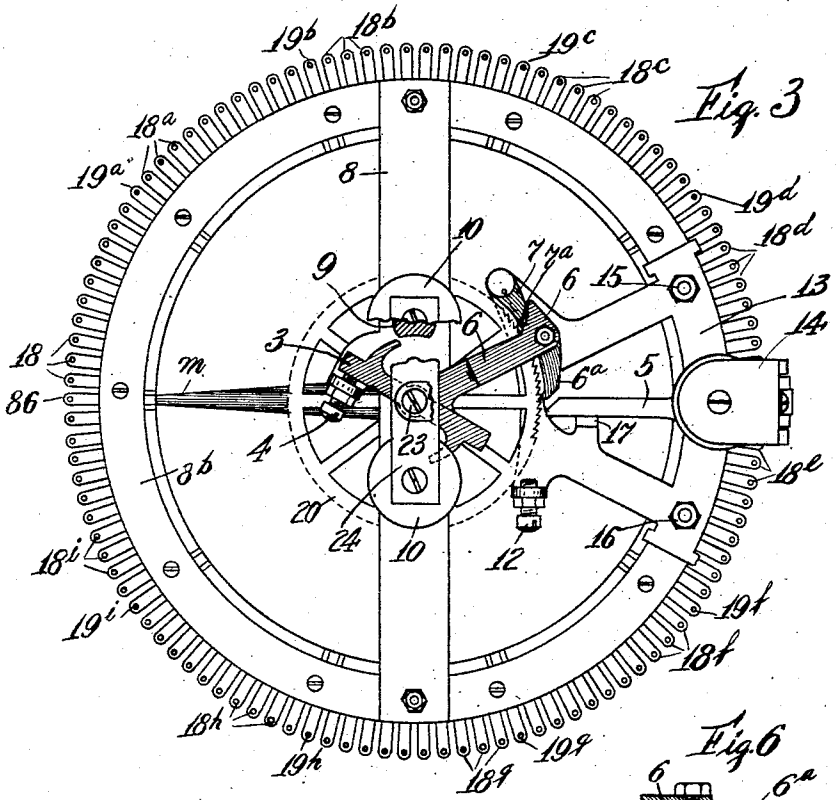


Fig. 6

Fig. 5

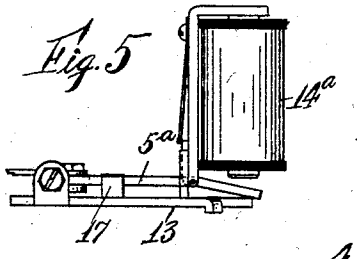
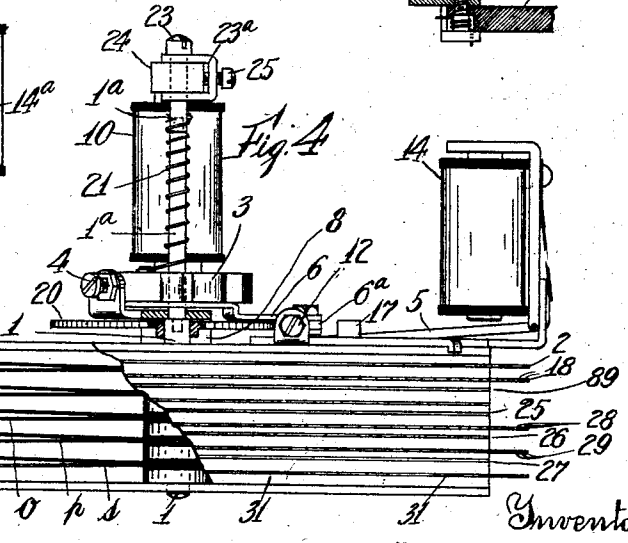


Fig. 4



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8 SHEETS—SHEET 8.

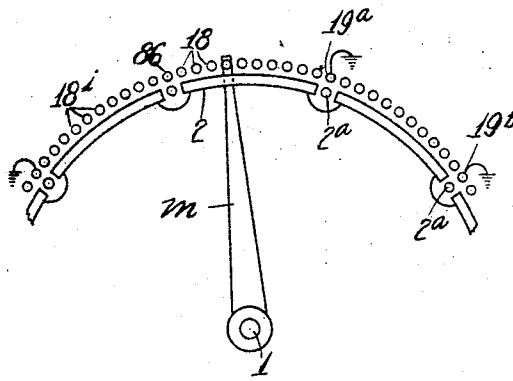

Fig. 7

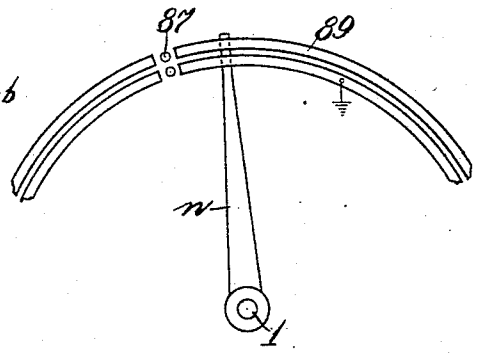

Fig. 8

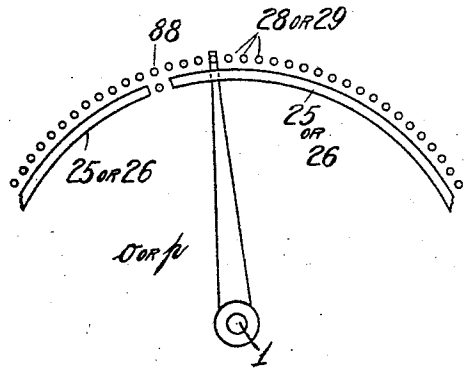

Fig. 9

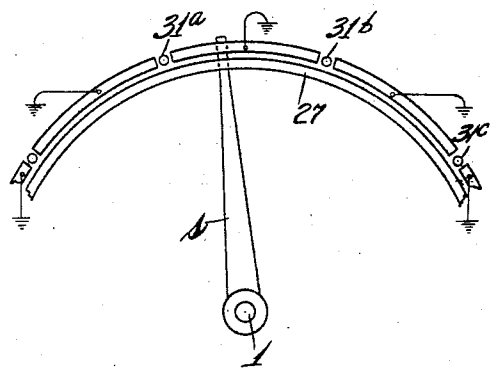

Fig. 10

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,110,613. Specification of Letters Patent. Patented Sept. 15, 1914.

Application filed April 15, 1908. Serial No. 427,222.

To all whom it may concern:

Be it known that I, ALFRED H. DYSON, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to telephone apparatus, and the means for working the same, of a character suitable for use in semi-automatic or automatic exchanges, and I have illustrated my invention as embodied in an automatic telephone exchange system.

My invention includes for its object the provision of certain operating features involving the selective switches which I employ, and of the circuits in conjunction with which said switches are employed.

One object of my invention is to provide a system of circuits and mechanism enabling me to use selective switches having groups of contacts arranged on one level as for instance circularly, in conjunction with which groups wipers are employed, suitable ratchet mechanism being provided for causing long steps of the wipers to select different groups of contacts, and further causing short steps of the said wipers from contact to contact of the selected group. A special improvement considered to exist in the present arrangement over those hitherto known consists in this, that a single driving magnet is employed to produce both the long and short steps of the ratchet and the wipers of the switch. The actuating magnet drives the shaft and wipers by an armature controlled pawl in the usual manner, the long steps being effected by allowing the armature of the magnet to make a long stroke thus driving the wipers over an entire group of contacts. An auxiliary magnet having its circuit condition changed when a group has been selected controls a stop which limits the stroke of the armature of the driving magnet when the short step travel of the switch is required.

Objects of the invention are to provide a suitable arrangement of circuits and mechanism for controlling the driving magnet of the switch, proper arrangements for controlling the operative position of the above referred to stop, and also the provision of suitable releasing or restoring arrangements when the switch wipers are to be restored to normal.

In organizing a system in accordance with my invention, I have provided, in addition to the first and second selectors, etc., and connectors whose functions are now so well known, certain additional switches which I call "line selectors" which serve to select and connect with the calling lines, when calls are initiated over them, in order to place the directively operable mechanism of the exchange in connected relation with the said calling lines. For these line selectors, as well as for the first and second selectors and connectors, I employ the above referred to long step and short step switches having a single driving magnet; and a further object of my invention is to produce a system embodying a solution of certain problems arising in the electrical control of switches of the described character when employed as line selectors.

Other features of the invention will be more particularly referred to in connection with more specific description and will be pointed out in the claims.

Referring to the drawings, Figure 1, consisting of Parts 1, 2, 3, 4 and 5 illustrates in diagrammatic form, circuits of an automatic telephone exchange system containing one embodiment of the invention. Fig. 2 illustrates a modified arrangement of line selector circuits. Fig. 3 is a front view of a long and short step switch. Fig. 4 illustrates a side view of the switch structure, one magnet spool being omitted and a portion of the contact bank being cut away to show the arrangement of the wipers. Fig. 5 illustrates a modified arrangement of the limiting stop. Fig. 6 illustrates a detail of the driving arm and pawl. Figs. 7, 8, 9 and 10 illustrate diagrammatically the arrangement of contacts and wipers when the switch shown in Fig. 3 is employed as a line selector.

As the circuit arrangement in Fig. 1 is drawn out, the system illustrated has a capacity of ten thousand subscriber's lines, first selectors F being provided for the purpose of selecting the thousands, second selectors G for selecting the hundreds, and connectors H for selecting the tens and units.

I preferably employ one hundred point switches having their contacts arranged in ten groups of ten contact sets each. Assuming ten thousand subscribers' lines, as called lines, the lines would be divided into one

hundred groups of one hundred lines each, and each such group on the usual 10 per cent trunking basis would be provided with their multiple called contacts appearing in the banks of ten connectors. The group to which any line as a called line is assigned, will be determined by the directory number which the line bears, so that all the lines having their multiple called contacts at a group of ten connectors would have directory numbers of the same hundreds value. Further, the multiple called contacts of the one hundred lines at their assigned connectors would be arranged in ten sub-groups of ten contact sets each, the position of each such sub-group as to the serial order in which their contacts will be engaged by the wipers of the connectors being determined by the tens value in the hundred.

For the one hundred groups of called lines there will, therefore, be one hundred groups of ten connectors each, making a thousand connectors in all. The one hundred connectors for the ten one hundred line groups constituting the first thousand lines of the exchange will have their contacts 204, 205, 206 multiplied at the banks of the second selectors G assigned for that thousand, and the multiple contacts of the connectors for the first hundred of the first thousand will constitute the first group of ten contacts of each second selector for that thousand; the contacts for the connectors for the second hundred of the first thousand will constitute the second group of contacts of the second selectors for that thousand, and so on for the other groups for the first thousand. Corresponding connections will be made from the different groups of ten connectors of the hundreds of the other thousands to the second selectors assigned to those thousands. On the usual ten per cent trunking basis, there will, of course, be one hundred second selectors G for each thousand of the exchange and the contacts of the connectors will, therefore, if uniform multiplying be observed, be multiplied one hundred times, once at each second selector for the respective thousand.

Each second selector G is provided with multiple contacts 161, 162, 163 appearing in the banks of first selectors F, which first selectors are, of course, common for connection with all subscribers in the exchange. On a ten percent basis there would be one thousand first selectors F and each such first selector would have before its wipers 158, 159, 160, ten groups of multiple contacts, the contacts of each group being connected to the second selectors G for a different thousand. There being one thousand first selectors F and one thousand second selectors G, there will be a total of one hundred thousand multiple contact sets 161, 162, 163 at the first selectors, so that each second selector G will have its contacts multiplied only at one-tenth of the first selectors F in the usual course of multiplying.

Each first selector F has permanently joined to it a line selector E before whose wipers 2—25—26 appear multiple contact sets 18—28—29 of one hundred lines, which sets of contacts may be called "multiple calling contacts." The lines of the exchange as calling lines are divided into groups of one hundred and on a ten percent basis, the multiple calling contacts of each one hundred line group will be multiplied before the wipers 2—25—26 of ten line selectors assigned to that group of lines as calling lines. Further, the multiple contact sets of each one hundred line group would be divided into ten sub-groups of ten contact sets each, and when any calling line initiates a call, a line selector E will operate to select the group in which the calling line has its contact set included and then will pick out the individual multiple contacts of the calling line whereby the line selector E will have caused its paired first selector F to be operatively connected with the calling line. After this, directive impulses will be transmitted from the calling line to cause the first selector to pick out a group of second selectors for the wanted thousand and then an idle selector out of such group; thereafter directive impulses will adjust the selected idle selectors to pick out the group of connectors wanted and then an idle connector out of such group; whereafter the selected connector will be adjusted to pick out the required group of lines and then the required line out of such group.

In the diagram, Fig. 1, Part 1, I have illustrated a calling substation A connected by the line conductors 66 and 67 with a suitable line circuit arrangement at the exchange. The substation at A includes the customary hook switch 59, normally holding the call-bell in an operative bridge of the line limbs and, adapted, on the removal of the receiver, to be lifted, disconnecting the call-bell and operatively connecting the talking set with the line. A calling device or dial 65 is provided, said calling device being normally locked by a pivoted pawl 61 controlled by the magnet 60 whose winding also serves as the impedance coil for the talking set. When the coil of 60 is energized, its armature is attracted and the pawl 61 withdrawn from engagement with the dial 65 so that the same may be rotated by hand in the direction of the arrow. The dial 65 has attached to it suitable teeth of insulating material which control the connections of the impulse springs 62 and 63, and the said dial also carries upon its lower part a stud of insulating material, which, when the dial is at normal, as shown, holds the spring 64 disengaged from its associated

spring. When the dial is rotated by hand in the direction of the arrow, the said stud frees spring 64 which, by its tension, engages its contact and makes connection with ground. When released, the dial rotates back to normal and when it reaches this point, the said stud restores spring 64 to its normal relation shown. It is obvious that the rotation of dial 65 in the direction of the arrow has no operative effect upon the springs 63 and 62. When, however, it is released, the teeth of insulating material operate to momentarily open contact 63 as many times as there have been teeth brought below said spring. After the last tooth passes above spring 63, the tooth at the extreme left causes a momentary opening of contact 62 whereafter the calling device reaches normal and its motion is arrested. While the openings of circuit were being made at contact 63 in the line limb 67, it is apparent that line limb 66 will be connected through contact 62 to ground through the contact of spring 64. Conversely, when the circuit of limb 66 is opened at contact 62, limb 67 will be grounded through contact 63 and spring 64. Also when the calling device reaches normal, a conductive bridge of line limb 66 and 67 will be established through the substation before contact 64 is opened, it being remembered that the dial 65 is only operable when magnet 67 is energized and magnet 60 can only be energized when hook switch 59 is in its alternate position.

It is thus apparent that by the operation of the dial 65, a calling subscriber can cause a number of sets of openings of line limb 67 at contact 63, while line limb 66 continues grounded, each set of openings of line limb 67 being necessarily followed by one opening of line limb 66, while limb 67 remains grounded. By successive actuations of the dial 65, the calling subscriber is enabled to count out the digit comprising the number of the called subscriber and the various openings of line limbs 66 and 67 coöperate with the directively operable switches at the exchange in completing the connection with the called-for line.

As before indicated, the lines as calling lines, are divided into groups of one hundred by having their multiple contacts grouped at the exchange before the line selectors. The ten line selectors E for each such group of one hundred lines are preferably not constantly operating devices, but are normally at rest, their wipers having a fixed or normal position. For starting an idle line selector E when a call is initiated, a master-switch mechanism D is provided, one for the one hundred lines, including wipers 80, 81, 82, having before them contacts 83, 84, 85, one such set being provided for each line selector of a one hundred line group. Each line of a group has its line relay 43; and a common conductor 73ª is provided, connected to the master-switch relay 73 and having branches, one to each of the line relays of one hundred lines whereby any calling line of the one hundred may control the master-switch D to start an idle line selector. Each line, in addition to its line relay 43 individual to it, has its cut-off relay 51, the latter being employed to render the line relay inoperative when the line is connected with.

As before indicated, the multiple contacts 18, 28, 29, of the one hundred lines of a group of calling lines, are divided into ten groups of ten contact sets each at the line selector banks, whereby the one hundred lines are divided into ten sub-groups of ten lines each. Each such sub-group has a sub-group relay 47, 47ª or 47ᵇ, etc., and a sub-group contact 31ª, 31ᵇ or 31ᶜ, etc., appearing before the group selecting wipers 27 of the line selectors E. The group relay 47 of each sub-group has an armature 49 controlling the electrical condition of the group contact 31 and an armature 48 which coöperates with the constantly traveling interrupter I and with the master-switch mechanism D in starting an idle line selector E. Each such group relay 47 is connected by a common conductor 50 having ten branches, one extending to each line relay of its sub-group, so that the line relay of any line of a sub-group can control the respective group-relay.

The common interrupter I is provided having two pairs of segments 69—69ª and 71—71ª, and the grounded wiper 72 is constantly traveling over the segments at a rapid rate, successively grounding them. The segments 69 and 69ª are connected to a common conductor 38 which has branches extending to armatures 108 of the relays 104 of the different line selectors E and the interrupter is employed, among other uses, to transmit currents over the conductor 38 to operate the windings 10′ of the driving magnets 10 to produce the long step travel of the switches E. In order to prevent a winding 10′ from being actuated by a partial impulse over a wire 38, whereby but a partial long step of a switch E might be produced, the circuit at each switch E is so arranged that its relay 104, which controls the contact 108 in the circuit of winding 10′, can be actuated only by current through one of the segments 71 or 71ª of the interrupter I. By this arrangement, no current can be passed through a winding 10′ upon the energization of the line relay 43 of a line and the consequent energization of the respective group relay, until the wiper 72 engages a contact 69 or 69ª after having first been in engagement with the contact 71 or 71ª, to operate the relay 104, since

the line and group relays were operated, whereby such operation of the line and group relays, which may occur at a time when the wiper 72 is about to pass off a segment 69 or 69ª, is ineffective to produce a wrong operation of the line selector E by causing it to make a partial long step.

Before going more specifically into the description of the circuit diagram, the preferred mechanical arrangement of the switch will be referred to. As indicated in Fig. 3, ten groups of ten contacts 18, 18ª, 18ᵇ, etc., to 18ʲ are provided arranged in a circle, making one hundred of such contacts, while between the group of contacts, contacts 19, 19ª, 19ᵇ, etc., to 19ʲ are located. A rotary shaft 7 is provided suitably journaled, as indicated in Fig. 4, to the circular base plate 8ª and to the bridge 8 upon which shaft are mounted the wipers *m*, *n*, *o*, *p*, *s*, and the ratchet wheel 20 which of course has one hundred and ten ratchet teeth.

The magnet 10, whose spools are mounted upon the bridge 8, has a pole piece 24 connecting the upper extremities of the cores, and through this pole piece extends a slotted stud 23 with which is associated the friction piece 23ª and the screw 25 threaded to the piece 23ª, the whole furnishing a convenient means for adjusting the tension of the spiral spring 21, one end of which is attached to the end of the armature 3 and the other to the stud 23. The armature 3 is supported by the auxiliary shaft 1ª which is journaled to the wiper shaft 1 and to the stud 23. The spring 21 serves of course as a retracting spring for the armature after each actuation of the magnet 10, being adjustable as described. The core of each spool of magnet 10 has, at its end adjacent to bridge 8, a pole piece of the shape indicated at 9, the transversely disposed armature 3 having the projections shown, best in Fig. 3, extending to proximity with the respective concave surfaces of the pole pieces 9, the whole producing an arrangement well calculated to give a strong initial pull upon the armature 3 when magnet 10 is operated, permitting along with this, a relatively great movement of the said armature. An adjustable stop 4 is provided to limit the back stroke of the armature away from the pole piece. The arm 6 carrying the driving pawl 6ª, which is provided with a suitable spring to hold it in engagement with the ratchet as indicated in Fig. 6, is fastened to the armature shaft 1ª so as to partake of the rocking movements of the armature, the pawl 6ª being by them effective to drive the ratchet wheel 20 step-by-step. The adjustable stop 12 is provided threaded to a projection of the piece 13 which is fastened by the bolts 15, 16 to the circular bank of the switch, and the said stop serves to limit the length of the stroke of the pawl 6ª and of the armature 3 when the switch is performing its long step travel. The piece 13 also has a projection to which is suitably pivoted the pawl 7 which engages the teeth of the ratchet 20 and serves to prevent back movement of the ratchet which might otherwise occasionally occur from the jar occasioned by the armature 3 when forcibly retracted by the spring 21 at the conclusion of one of its long strokes. The pawl 7 carries a pin engaged by the arm 6 so that when the latter is fully retracted, the two interlock and the pawl 7 is forcibly held in engagement with the ratchet 20. A further important function of this arrangement is to render impossible a between-contact position of the wipers. Thus, if the pawl 7 is, at the time pawl 6ª is retracted, not engaging a full tooth of ratchet 20, the impact of arm 6 will force the pawl 7 to fill the tooth upon whose surface it rests, whereby the wipers will be carried back to one of their definite operative positions. Upon the piece 13 is mounted the stop magnet 14, controlling, by its armature, the stop pawl 5 which, in the line selector Fig. 3, is shown as below the pawl 6ª being therefore normally out of engaging relation therewith. The said stop pawl 5 abuts upon the projection 17 of the piece 13 and when the magnet 14 is energized, is brought forward so that its upper extremity is in the path of the pawl 6ª, thus limiting the stroke of armature 3, piece 6 and pawl 6ª.

It is now apparent that when magnet 14 is deënergized, actuations of the magnet 10 will, by pawl 6ª, produce long steps of the switch wipers, and for each such long step, it will be understood that the wipers will be moved from a position engaging a between-group contact 19 over an entire group of contacts 18 to engagement with the next between-group contact 19. Thus, to select the group of contacts 18ᶜ, for instance, three actuations of the magnet 10 will be produced while magnet 14 remains inert and the wiper *m* and the others will then have advanced three long steps to rest in a position where wiper *m* engages the contact 19ᶜ. When, now, magnet 14 is energized, the movable stop 5 is substituted for the stationary stop 12 as the member limiting the stroke of the armature of the magnet 10, and successive actuations of magnet 10 will now obviously produce short steps of the wipers, each step moving them the space from one contact 18ᶜ to another. When the switch of Fig. 3 is to be restored to normal, this is effected by short step travel of the switch around in the initial direction of travel to the normal point to complete a circle of travel.

For the first and second selectors and for the connector, the stop magnet arrangement indicated in Fig. 5 is preferably employed, the said arrangement being one in which

the pawl 5^a is normally in engaging relation with the pawl 6^a. With this arrangement, in order to secure long step travel of the switch, the magnet 14^a must be energized to withdraw the stop pawl 5^a from the path of pawl 6^a, and then when short step travel is to be produced, magnet 14^a must be deënergized to allow the stop pawl 5^a to assume its normal engaging relation. This arrangement is, in some respects, a preferred one, since if the pawls 6^a and 5 be both made of magnetic material, there is a slight tendency to stick or freeze when the two pawls are in engaging relation, magnets 10 and 14 being simultaneously energized. Making one pawl of non-magnetic material or providing air gap spacers of course obviates any such effect.

While I have, in Fig. 1, at E, shown the circuit closers or wipers 2^a, 2, 25, 26 and 27 diagrammatically, as connected directly with the conductors of the line selector E, I have preferred, in the mechanical switch structure, to terminate the conductors, shown connected to the said wipers in Fig. 1, in stationary contacts while the switch wipers themselves in the mechanical structure have, in themselves, no circuit connection, but act merely to close conductive bridges between bank contacts with which they are associated. The electrical equivalency of the arrangement shown in Fig. 1 to those shown in Figs. 4, 7, 8, 9 and 10 will be apparent. In Fig. 4, five sets or pairs of wipers *m*, *n*, *o*, *p* and *s* are indicated, mounted one pair above the other upon the main switch shaft 1. Referring now to Figs. 7 to 10 inclusive, when the wipers are in their normal positions, they will be engaging respectively the contacts 86, 87, 88 and 31^a. By referring now to Fig. 1, it will be apparent that when wipers *m* are in their normal position, they close the off-normal contact 86 to its associated contact, thus producing the normal circuit condition of contact 86 shown in Fig. 1. Similarly, when wipers *n* and *o* are in their normal positions, they close respectively the off-normal contacts 87 and 88 to their respective associated contacts as indicated in Fig. 1. It is also apparent that when shaft 1 is caused to make its first step, each of these off-normal contacts 86, 87, 88 will be opened, wiper *n* then closing the off-normal contact 89 to ground, the said contact continuing closed to ground until the wiper has completed its revolution and is restored, while the other off-normal contacts remain open until the line selector reaches normal.

The private wiper 2 indicated in Fig. 1 is, in its mechanical embodiment as shown in Fig. 7 represented by the conductively joined segments 2, while the contacts 18, are those adjacent to the said segments. The between-group contacts 19^a, etc., are plainly indicated in Fig. 7 and the wiper 2^a is represented by the contact 2^a of Fig. 7, whereby the wiper *m*, in a between-group position, conductively bridges or closes a contact $19-2^a$.

In Fig. 9, the common strip 25 which extends circularly complete, except for the break at the off-normal contact 88, represents the wiper 25 while its adjacent sets of contacts 28 represent the multiple contact of Fig. 1 and the same arrangement as that shown in Fig. 9 is employed for the wiper 26 and the contacts 29 as indicated by the alternate reference characters given in Fig. 9. The ring 27 in Fig. 10 is the equivalent of wiper 27 in Fig. 1. The wiper *s* has a between-group position closing contacts 27—31, $27—31^b$ just indicated in Fig. 1, while the grounded segments of Fig. 1, Part 2 are plainly indicated in Fig. 10.

It will be understood that switches of the general character shown in the mechanical figures are used for the first and second selectors and connectors, commons being employed for the wiper contacts shown in Fig. 1, the switch wipers thus being, as in the case of the line selector, without circuit connections in themselves and being used to cross the commons to the private contacts and the line contacts. The off-normal switch arrangements of the first selector, second selector and connector will be secured in the manner obvious from the description given of the off-normal arrangements of the line selector and need not be specifically referred to.

The detail of the circuit arrangements of Fig. 1 will best be understood when explained in connection with a description of the operation of the system and will now be described, it being assumed that A is a calling subscriber and desires his line to be connected with that of the subscriber whose substation is indicated at C and whose number will be assumed to be 2222.

Subscriber A, by removing his receiver to initiate a call establishes a path for a flow of current from ground through line relay 43, through contacts 52, 63, the substation transmitter, the raised hook lever 59 through magnet 60, closed contact 62, over line limb 66, armature 55 to battery B, operating line relay 43, which, by armature 44, is locked to battery over the common conductor 73^a and relay 73 of master-switch D. The flow of current through the substation may momentarily actuate the magnet 60 to unlock dial 65, but as soon as relay 43 attracts armature 44, the circuit through the substation is interrupted, magnet 60 will be deënergized and pawl 61 will return to locking relation with dial 65 which now continues locked until a line selector E shall have selected the calling line. Thus the subscriber A will be prevented from

actuating his calling device until his line shall have been brought into operative relation with the first selector F.

It will be seen that the multiple contacts 18 of the calling line are grounded over conductor 32 and through normal contacts 53 and 46 as long as the line circuit of A is at normal, the said multiple contacts 18 being thus normally unselectable at the line selector. Attracted armature 46, however, removes ground from the contacts 18 thus rendering them selectable and grounds the common conductor 50 energizing the group relay 47, which, by armature 49, removes ground from the group contact 31^a. As soon as wiper 72 engages one of the segments 69 or 69^a, a circuit is completed from ground through attracted armature 48 over attracted armature 76, armature 79, wiper 82 of master-switch D (wipers 80, 81, 82 of master-switch D normally engaging contacts 83, 84, 85 of an idle line selector E) through contact 85 of such idle line selector, over conductor 39, closed off-normal contact 86, normal contact 114, and the relay 90 to battery B′, energizing the said relay 90. Since, as indicated by the location of the multiple contact 31^a normally engaged by the wiper 27, the calling line is included in the first sub-group of ten, no long steps of the line selector E are required to be made to select the calling line in the present case, so that the winding 10′ of magnet 10 is not employed, but the stop magnet 14 must be actuated at once and circuit must be closed through the short step winding 10^2 to initiate the short step travel of the switch. On the energization of relay 90, circuit is closed as follows: from battery B′ through magnet 14, through relay 97, contact 109, attracted armature 95, wire 127, normal contact 87, conductor 39 and to ground at segment 69 or 69^a through interrupter I. Attracted armature 93 has closed one break in the circuit of winding 10^2 and magnet 14 is now actuated to close the second break therein and to throw the stop pawl into operative relation with the mechanism of magnet 10. Circuit may now be traced from ground through generator g, winding 10^2, attracted armature of relay 14, alternate contact 93 to ground and magnet 10 will now be actuated by successive impulses from generator g until the relay 90 is deënergized, each actuation of winding 10^2 producing a short step of wipers 2, 2^a, 25, 26 and 27.

It will be noted that on the first step of the switch E, the off-normal, ON, contacts were shifted to alternate position whereby electromagnets 14 and 97 were locked to ground via contact 89 by means of the attracted armature 100. Armature 103 of relay 97 has now connected the winding of relay 90 through alternate contact 94 and normal contact 116 with the private wiper 2 of the line selector, and since, on the first step of the line selector, contacts 86 and 87 are opened, the relay 90 now depends for its continued energization upon the grounded contacts 18 to be encountered by wiper 2 as the wipers progress in their short step travel. Contacts 18 of non-calling lines will be grounded at armature 46 of their respective line relays 43, and since wiper 2 engages a new contact 18 before leaving the previously engaged one, relay 90 will continue energized until the switch wipers in their travel have reached a point where wiper 2 engages an ungrounded contact 18, such being one pertaining to the calling line. At this time, circuit through relay 90 will obviously be opened, the relay will become deënergized and its armature 93 being retracted, will prevent further actuations of winding 10^2 of magnet 10 and the wipers of the line selector E will come to rest, the wipers 2, 25 and 26 engaging respectively the multiple contacts 18, 28 and 29 of the calling line, that of A. On the retraction of armature 93, ground is placed via normal contact 93, alternate contact 102 and contact 111 upon the conductor 40 extending to the private contact 84 at the master-switch D, through its private wiper 81 and to battery through operating relay 74, energizing said operating relay which opens contacts 78 and 79 to prevent any possible ground upon wipers 80 or 82. The armature 77 closes circuit for generator g through motor magnet M of the master-switch. Wipers 80, 81, 82 being mounted upon a rotary shaft in operative relation with the driving magnet M, are rotated step-by-step in search of contacts 83, 84, 85 pertaining to an idle line selector. Contacts 84 of line selectors in use will be connected to ground and relay 70 will continue energized, holding contact 77 closed until the master-switch wipers engage the contacts of an idle line selector, at which time the circuit for relay 74 will be open, the relay deënergized, its armature retracted and wipers 80, 81, 82, will rest engaging the contacts 83, 84, 85, of such idle line selector and ready to start the same when another call is initiated from one of the lines of the group that the master-switch D serves.

As soon as relay 90 was first operated, it closed alternate contact 91 whereby a flow of current was produced from the positive side of battery A^2, Fig. 1, Part 3, through relay PR, normal contact at 169, over conductor 120, conductor 123, normal contact 115, conductors 122—121, normal contact 172, relay SR to the active side of battery B^2, relays PR and SR being thereby energized. When now relay 90 is deënergized as described, current will find its way from battery A^2 through relay PR, normal contact 91, contact 25—28, conductor 33, normal contact 53^a, cut-off relay 51 of the calling

line A to battery, said relay 51 thereon energizing and by the closure of contact 53—53ª, locking itself to ground over conductor 32, contact 18—2, closed contacts 103, 116, and normal contact 94 to ground. The ground at 94 placed upon the multiple contacts 18 through the wiper 2 has made the contacts of the calling line unselectable to other line selectors. Since the armature 54 opens the circuit of relays 43 and 73, normal contact 45 is again closed and the ground on conductor 32 is extended through said normal contact 45 to the multiple private contacts 56 of the line A at the connectors, holding them grounded and unselectable. The said multiple contacts 56 were, on the initial operation of relay 43, grounded by attracted armature 45 so that the calling line was held busy against in-coming calls during the travel of the line selector E.

On the actuation of relay 51, a circuit for relay PR was continued over conductor 67, current finding its return through conductor 66, conductor 34, contact 29—26, contact 96, conductor 121 to battery B² through relay SR whereby relays PR and SR have a substitute circuit completed for them upon the deënergization of relay 90 at line selector E without either of them permitting at any time the retraction of their armatures.

It is now apparent that the calling line has, by the operation of the line selector E, had connected to it the relays PR and SR of the first selector F, paired with the line selector that was operated, and the said relays are now controllable by means of the dial 65 at the calling substation which dial was unlocked as soon as cut-off relay 51 operated, by the current holding relays PR and SR energized which traversed the magnet 60.

Before proceeding with a description of the operation of the first selector F and of the other directively operable switches, certain further explanation with respect to the line selector E is in order. The operation of this switch, when the calling line is in a sub-group other than the first, differs from that heretofore described in that the long step winding 10′ of the magnet 10 is employed to cause the line selector's wipers to select the sub-group in which the calling line is included; wherefore the short step winding 10 is employed to select the individual contacts of the calling line out of the selected group. The wire 39 employed to start the line selector E, when the calling line is in the first group as hereinbefore described, is not employed when the calling line is in any other sub-group than the first, the wire 41 being the starting wire for all other sub-groups.

I have shown at 47ª a sub-group relay for the second sub-group and at 47ᵇ a sub-group relay for the third sub-group. The common conductor 50ª has branches to alternate contacts 46 of the ten line relays of the second sub-group, and the common conductor 50ᵇ has branches to the alternate contacts 46 of the ten line relays of the third sub-group, and it will be understood that there will be other sub-group relays 50ᶜ, 50ᵈ, etc., for the fourth, fifth, etc., to the tenth sub-groups with corresponding connections similar to those of relays 47ª and 47ᵇ. The conductor 36 at relay 47ª connects with the conductor 36 of Fig. 1, Part 2, connecting to the multiple sub-group contacts 31ᵇ of the second sub-group; so the conductor 37, associated with relay 47ᵇ, connects to the conductor 37 of Fig. 1, Part 2, which is in connection with the multiple sub-group contacts 31ᶜ of the third sub-group; a fourth sub-group contact 31ᵈ of Fig. 1, Part 2, of the fourth sub-group is shown and it will be of course understood that although but four sub-group contacts are shown associated with the wiper 27, there will in fact be ten such contacts, a corresponding number of sub-group relays 47 and a corresponding number of grounded segments for the wiper 27; also, that although but three contacts 19 are shown associated with the wiper 2ª of Fig. 1, Part 2, there will be nine such between-group contacts.

It being now assumed that the calling line is in the third sub-group, the one having the sub-group relay 47ᵇ, the removal of the receiver at the substation will operate the line relay 43 of such calling line which relay will lock in series with the master-switch relay 73, as before. The armature 46 of such line relay will remove the ground from the individual multiple contacts 18 of the calling line in the third sub-group at the line selectors, and will close circuit to operate the sub-group relay 47ᵇ by current over the common conductor 50ᵇ, while armature 45 will ground the multiple private contacts 56 at the connectors to render them busy. The operated sub-group relay 47ᵇ, by armature 49ᵇ, removes ground from the conductor 37 and from multiple sub-group contacts 31ᶜ at the line selectors E. Armature 48ᵇ closes a bridge between conductors 70 and 75ª. As soon as the interrupter wiper 72 is disconnected from one of the segments 69 or 69ª and makes connection with one of the segments 71 or 71ª, circuit will be closed from ground over the conductor 70, closed contact 48ᵇ, conductor 75ª, contacts 75, 78, 80—83, conductor 41 of the line selector engaged by wiper 80, through contacts 88, 98, and relay 104 to battery B′, the relay 104 locking itself by armature 107 to ground via wiper 27, multiple contact 31ª of the first sub-group and contact 49, the relay being unoperated because the call is not that of the line of the first sub-group. With the operation of relay 104, the relay 90 is energized by current through attracted arma-

ture 105. The stop magnet 14 and relay 97 are, however, not operated at this time, contact 109 being open. When now wiper 72 of interrupter I passes over contact 69 or 69^a, current impulses will flow over the conductor 38 through contacts 108, 101 and winding 10′ of magnet 10 to battery and obviously, the continued travel of wiper 72 and successive actuations of winding 10′ will be produced as long as contacts 108, 101 remain closed. The first impulse through winding 10′ effects a long step of the wipers 2, 2^a, 25, 26 and 27 (the stop magnet 14 not having been energized as mentioned), and at the end of this first step, of course, the wiper 2^a will be engaging the grounded contact 19^a, the wipers 2, 25 and 26 will be between the first and second groups of their respective contacts 18, 28 and 29, and the wiper 27 will be engaging the multiple group contact 31^b of the second sub-group. Since a line of the second sub-group is not calling, relay 47^a will be inert, conductor 36 will be grounded at armature 49^a and the relay 104 will continue energized by current through attracted armature 107, contacts 27—31^b, conductor 36, contact 49^a to ground. With the continued rotation of interrupter arm 72, another impulse will be caused to flow through the winding 10′ of magnet 10 and a second long step of the wiper will be effected at which time wiper 2^a will engage contact 19^b, wiper 27 will engage contact 31^c and wipers 2, 25, 26 will be adjacent to the third group of multiple contact sets. Contact 31^c having been ungrounded by the operation of armature 49^b of relay 47^b of the third sub-group, circuit for relay 104 is opened and the relay is deënergized, its armature 108 preventing further actuations of winding 10′ of interrupter I.

It will be of course understood that the off-normal contacts 86, 87, 88 and 89 were all shifted to their alternate circuit conditions on the initial step of the switch, the opening of contact 88 making relay 104 entirely dependent upon circuit through wiper 27 for its continued energization after the switch started.

On the deënergization of relay 104, relay 90 continued energized by current through normal contact 114, over conductor 125 and to ground through contact 2^a—19^b. The closing of contact 109 will now complete an energizing circuit for stop magnet 14 and relay 97 extending through attracted armature 95, over conductor 127, closed contact 106 and 89 to ground, whereon armature 100 of relay 97 closes a locking circuit to ground at closed contact 89. As described in connection with the selection of the calling line in the first sub-group, magnet 14 has now thrown the stop into limiting position and has attracted its armature to close circuit from generator g through the short step winding 10^2 to ground through alternate contact 93. On the first actuation of winding 10^2, the resulting first short step of the wipers will open contact 2^a—19^b so that the relay 90 will thereon depend for its continued energization upon circuits extending through alternate contact 94, contact 116, contact 103, through the private wiper 2 and to ground upon multiple contacts 18 of non-calling lines. Relay 90 will therefore continue energized until wiper 2 engages the multiple contact 18 of the calling line, which contact will be ungrounded, due to the attracted condition of armature 46 of line relay 43 of such calling line, deenergizing the relay 90 and the armatures of said relay will be retracted whereof 93 will open the circuit of winding 10^2 and wipers 2, 25 and 26 will rest engaging the multiple contacts 18, 28, 29 of the calling line of the third sub-group. At this time of course the wiper 2^a will be somewhere between contacts 19^b and 19^c and wiper 27 will be in engagement with the grounded contact segment between contacts 31^c and 31^d, but since armature 107 was retracted before wiper 27 engaged such grounded segment, the relay 104 is inert.

It will be observed that the alternate contact at 91 caused the preliminary energizing circuit of relays PR and SR to be closed during both the long and short step travel of the line selector E. From the time the calling line in the third sub-group is selected, the operations involved in holding energized the relays PR and SR, the energization of cut-off relay 51 which results of course in the deenergization of relays 43, 73 and of sub-group relay 47^b, and the moving along of the master-switch wipers 80, 81, 82, proceed in the manner before described.

The selection of calling lines in the second, fourth, fifth and other sub-groups other than the first, will be effected in a manner apparent from the description of the selection of a line in the third sub-group, the operation being like that given except as to the point at which the relay 104 finds an ungrounded sub-group contact 31.

Returning now to the description of the connection between the calling line A in the first sub-group and the called line B, numbered 2222, the subscriber at A operates his dial 65 to cause two breaks in the circuit of line limb 67, while line limb 66 remains grounded, the two said breaks being followed by one break in the circuit of line limb 66 while limb 67 remains grounded. Each break in limb 67 deënergizes primary relay PR of Fig. 1, Part 3, relay SR remaining energized. On the first deënergization of relay PR, an impulse of current flows from ground through contacts 132—131, 141, locking relay LR to battery B^3, said relay LR,

by armature 148, locking itself to ground through contact 170, conductor 118 and contact 112. It will be remembered that in the directively operated switches such as first selector F, the winding of the stop magnet is normally in the stroke limiting position. On the energization of relay LR, the stop magnet 14^a has a terminal of its winding connected respectively to battery B^3 and to ground through contacts 150 and 144. Said magnet, is however, unenergized until after the relay PR is again operated at the conclusion of the first break in line limb 67 for the reason that the winding of magnet 14^a is, while relay PR continues deënergized, short circuited to ground through contact 135, contacts 140, 131 and 132. When, however, the break at contact 63 of substation A is closed and line limb 67 is thereby grounded via contacts 63, 64, relay PR energizes and the opening of contact 131 removes the short circuit about magnet 14^a and the said magnet energizes, withdrawing the stop and by armature 135, closing the long step winding 10^4 of the private magnet 10^a to connection via armature 140 with the contact of armature 131. The second deenergization of relay PR which now follows, closes circuit from ground through contacts 132, 131, 140, alternate contact 135, winding 10^4 to battery and the magnet 10^a thereon effects a long step of wipers 158, 159, 160 from engagement with the first set of multiple contacts 161, 162, 163, of ten such sets assigned for connection to the first thousand of the exchange, to engagement with the first contact set 161^a, 162^a, 163^a, of the second group of contact sets, such sets being connected to second selectors G for the second thousand of the exchange.

Having thus selected the group of second selectors, one of which is required to complete the desired connection to line 2222, the wipers 158, 159, 160, are now moved through short step travel to select the contacts of an idle second selector of the second group. This is effected in response to the opening of line limb 66 at substation A, while line 67 remains grounded, which immediately follows the last opening of limb 67, as described. Thereby relay SR will be deënergized while relay PR remains operated, and an impulse of current will flow from ground through contacts 130, 133, 149 and locking relay LR′ to battery, which relay, by armature 142 locks itself to ground at shifted off-normal contact 137^a. Armature 140 of course disconnects the winding 10^4 of magnet 10^a from the upper talking conductor while armature 145 connects the winding of relay BR via alternate contact 151^a, with the private wiper 158 of the first selector. Armature 144 deënergizes the stop magnet 14^a and the retraction of its armature ensues whereby the stroke limiting stop is placed in the path of the armature actuated pawl of magnet 10^a. Wipers 158, 159, 160, having, by the long step of the switch, been moved into engagement with the first contact step 161^a, 162^a, 163^a, short step travel of the switch F will be initiated only in case the first contact set 161^a, 162^a, 163^a has already been rendered busy by some other first selector, in which case the private contact 161^a will be grounded.

Assuming first that the first contact set is busy, current will flow from the grounded multiple contact 161^a to wiper 158, attracted armatures 151^a, 145, relay BR and through resistance r to battery actuating the said relay BR before relay 150 has time to attract its armatures over a circuit which would be established, but for the energization of relay BR, via attracted armature 143, normal contact 138 to ground through normal contact 136. Attracted armature 139 has now connected the generator circuit of the short step winding 10^3 to ground via alternate contact 144, and stop magnet 14^a being deënergized and the stop "in," short steps of the wipers 158, 159, 160 will be produced as long as the relay BR remains energized by successive circuits established via wiper 158 and busy, that is, grounded contacts 161^a. As soon as the wipers of the first selector engage the multiple contacts of an idle second selector G, the contact 161^a will be ungrounded, relay BR will have its circuit opened and its armature will be retracted, armature 139 preventing further actuations of magnet 10^a while armature 138 will close a circuit as follows: from batter B^3 through relay 150, attracted armature 143, normal contact 138, normal contact 136, to ground whereby relay 150 is energized and attracts its armatures whereof armatures 151 and 154 extend the talking conductors of the first selector to wipers 159, 160 now at rest engaging contacts 162^a, 163^a of an idle second selector. Armature 153 places ground upon wiper 158 whereby the multiple private contacts of the selected second selector are held busy. A circuit is then established from ground through attracted armatures 153, 151^a, 145 and through relay BR and resistance r to battery but this circuit is ineffective to energize the relay BR because of a short circuit at this time extending from point 156 to point 155 through contacts 146 and 152, which prevents sufficient current flowing through the relay BR to energize the same.

Had the first set of contacts 161^a, 162^a, 163^a been idle instead of busy, the absence of ground upon private contact 161^a would have prevented the flow of energizing current for relay BR at the time its winding was, by the operation of armature 145, connected to the wiper 158. Owing to the continued deënergization of relay BR, no cir-

cuit for winding 10^3 is completed and relay 150 is at once operated via contact 143, normal contacts 138 and 136 to ground, the operation of the said relay 150 having the effects before mentioned, that of grounding the multiple contacts of the second selector engaged by wiper 158, that of closing circuit through relay BR, and that of establishing a short circuit about the one closed so that relay BR remains unoperated.

A clear circuit has now been established from condensers 173, 174, through contacts 151, 154 to the wipers 159, 160 and the idle contacts 162^a, 163^a and to the mechanism of the second selector G, assumed to be the one selected, which is now ready to be operated in response to the second set of deënergizations of relays PR and SR to be produced by subscriber A by the further actuation of its calling device.

Before proceeding with this, however, it is in order to refer to the operation of the first selector F when its wipers 158, 159, 160 are to be caused to select contacts of the first group of second selectors, those of the first thousand. This operation differs somewhat from that in which contacts of other groups are to be selected because no long step of the wipers 158, 159, 160 is produced, inasmuch as the normal position of wipers 158, 159, 160, is one in which they rest engaging the first contact set of the first group of second selectors. To cause selection of idle contacts of the first group, the calling subscriber would operate his dial to cause one deënergization of relay PR followed by one of relay SR. The deënergization of relay PR would, as before mentioned, result in the operation of locking relay LR and the locking thereof, as before described, and the actuation of the stop magnet 14^a would follow as soon as the short circuit about its winding at armature 135 was removed on the subsequent energization of relay PR. The deënergization of relay SR following the single deënergization of relay PR results in the energization of locking relay LR', as before described, the said relay now locking itself, however, via armature 142, contact 137^a—137, contact 147 and over conductor 118 to ground instead of to ground via alternate contact 137^a as before. The wipers of the first selector F have, in this case, remained at normal, and from this point on the initiation of short step travel of the switch is produced in the manner before described and the selection of idle contacts is effected in the same manner as that before described, in case the first contact set, that normally engaged by wipers 158, 160 has been rendered busy. However, if the first contact set is idle at the time the relay LR' is operated, relay BR receives no current and relay 150 is immediately energized, as before described, by its armature 153 placing ground upon the first contact set that is now assumed to be connected with a subscriber's line in the first thousand of the exchange, and if the first contact set of that thousand be idle, the first selector that is connected with the calling line is on a contact set of an idle second selector, and the impulses transmitted to the first selector, while producing the proper changes in the electrical circuit of the switch, do not cause any travel of the switch wipers at all.

The calling subscriber at A now actuates his dial 65 to produce breaks in the circuit of limb 67 corresponding to the second digit of the called subscriber's number, namely, two breaks, whereby relay PR will be twice deënergized and two impulses of current will be transmitted from ground through contacts 132—131, 151, 159—162^a, conductor 165, contact 184, locking relay LR^3 to battery B^4, relay LR^3 energizing and, by armature 180, locking itself to ground at the first selector F via conductor 164, contact 162^a—158 through points 155, 156 and armature 153. Armature 182 connects battery through resistance r', stop magnet 14^b to ground via normal contact 187, but magnet 14^b is not actuated by current over this circuit until after relay PR is operated at the conclusion of its first deënergization, a short-circuit about the winding of magnet 14^b extending via contact 183 and to ground through contacts 131 and 132 as long as relay PR is deënergized. With removal of this short circuit, however, magnet 14^b attracts its armatures and withdraws the limiting stop, armature 167 connecting the long step winding 10^6 of driving magnet 10^b to conductor 165 via contact 183. The first impulse transmitted from conductor 165 therefore produces no steps of the wipers 201, 202, 203, and they remain engaging the first contact set 204, 205, 206 of their first group of connectors, this being the normal position of the wipers. The second deënergization of relay PR transmits a current impulse over the before traced path through conductor 165 through normal contact 183, alternate contact 167, long step winding 10^6 and to battery B^4 whereby a long step of wipers 201, 202, 203 is produced and they are brought to engage the first set of contacts 204^a, 205^a, 206^a of the group connected to connectors for the second hundred lines of the second thousand.

After the second deënergization of relay PR, a single deënergization of relay SR will of course be produced and an impulse of current transmitted from ground through contacts 130, 133, 154, 160, 163^a over conductor 166, contact 181, and locking relay LR^4 to battery B^4, the said relay LR^4 then locking itself to ground at shifted off-normal contact 190. Attracted armature 185 connects the winding of relay BR', via al-

ternate contact 178 to wiper 201 and the engaged contact 204[a] of the first set of the second group. Assuming first that the set belongs to a busy connector, it will be understood that the relay BR′ will be operated and armature 192 will prevent actuation of the relay 193 upon the deënergization of magnet 14[b] which occurs as soon as armature 187 of the relay LR[4] was attracted. Stop magnet 14[b] being deënergized and its stop "in", short steps of the second selectors G will be produced by current pulsations through the short step winding 10[5], attracted armature 191 and alternate contact 187 to ground as long as relay BR′ remains operated, in which condition said relay will remain by current via wiper 201 and to ground through successive contacts 204[a], multiple terminals of busy connectors, until the wipers 201, 202, and 203 engage contacts 204[a], 205[a] and 206[a] of an idle connector. The contact 204[a] then engaged will be ungrounded, relay BR′ will be deënergized and its armature 191 will prevent further actuations of the winding 105 whereby the switch wipers stop. Relay 193 now operates by current through attracted armature 188, normal contact 192 and normal contact 168 to ground. Armature 195 of relay 193 connects ground to the private multiple contacts 204[a] of the selected connector of the second group, circuit being traced through wiper 201, points 199 and 200, attracted armature 195, attracted armature 177 of relay LR[3] to ground. The winding of relay BR′ is connected from battery at this time through alternate contacts 185, 178 and 200 with ground at attracted armature 177, but current over this path does not sufficiently energize the relay BR′ to cause it to attract its armature because of the short circuit extending around its winding from point 198 through attracted armatures 196 and 200 to ground.

Had the first contact set of the second group been idle, the private contact 204[a] would have been ungrounded and relay BR′ would have received no energizing current. The relay 193 would, therefore, have immediately operated upon the energization of locking relay LR[4] and the attraction of its armature 188, by current through normal contact 192 and to ground through contact 168 as soon as the magnet 14[b] deënergized, the relay 193 then placing ground upon the multiple contact 204, as before described, and closing circuit through relay BR′ with the accompanying short circuit to render it ineffective as described.

Had the calling subscriber desired his line to be connected with that of a subscriber included in the first hundred group of the second thousand, no long step of the wipers 201, 202, 203 would have been produced when relay PR was deënergized a single time. When relay SR was thereafter deënergized, the busy relay BR′ would have been connected to the private wiper 201, and if the first contact set of the first group had been busy, the first selector would have started on short step travel, in a manner obvious from what has preceded, to select idle contacts of the first group. If the first contact set of the first group had been idle, no travel of the wipers 201, 202, 203, would have been occasioned for reasons similar to those explained in connection with the first selector circuit diagram.

By the energization of relays LR[3] and LR[4] and 193, a clear circuit has been established from condensers 173, 174 at F over the conductors 165, 166 to wipers 202, 203, and the multiple contact 205[a], 206[a] of the selected connector assumed to be the one shown at H, and over its wires 208, 209 to the mechanism thereof.

The calling subscriber A now operates his dial 65 to produce two deënergizations of relay PR representing the third digit in the called subscriber's number, which deënergizations will be followed by the single deënergization of SR. On the first deënergization of relay PR, a current impulse is transmitted from ground over a before traced circuit to conductor 165 thence via contacts 194, 202—205[a], wire 208, normal contact 219, locking relay LR[5] to battery B[5] which relay operates and, by armature 214, locks itself to ground over the private conductor 207. Armature 216 of relay LR[5] connects battery B[5] through stop magnet 14[c] with ground, but the stop magnet cannot be energized to withdraw the stop pawl of driving magnet 10[c] until a short circuit at closed contact 132 of relay SR of the first selector F is removed on the energization of relay PR, the said short circuit being traceable from the normal armature contact of magnet 14[c] and normal contact 218. As soon, however, as the first impulse over wire 208 ceases, the short circuit will be removed and magnet 14[c] actuated to withdraw its stop from the path of the driving pawl. On the second deënergization of relay PR, therefore, the transmitted current impulse will flow over conductor 208, through normal contact 218, attracted armature of magnet 14[c], the long step winding 10[8] of magnet 10[c] and to battery B[5] producing a long step of the switch wipers 249, 250, 251 to a position adjacent to the second group of ten line contact sets of the second hundred of the second thousand, the said group comprising multiple contacts of lines numbered 2221 to 2229 consecutively, followed by contacts of line 2220.

After the second impulse over conductor 208, a deënergization of relay SR will transmit an impulse over conductor 209, through attracted armature 215, locking relay LR[6]

to battery, and said locking relay by armature 220 connects its winding to ground at the shifted off-normal spring contact 211. Attracted armature 221 immediately opens the circuit of stop magnet 14^e and the said magnet is deënergized, its retracted armature placing the stop pawl in the stroke limiting position.

The subscriber A now actuates the dial 65 to produce two openings in the circuit of line conductor 67 followed by one in the line conductor 66. The first break in conductor 67 of course deënergizes relay PR and an impulse is transmitted from ground over conductor 208, a part of the current flowing through alternate contact 218 and locking relay LR^7 which energizes, and by armature 224, locks to ground at alternate contact 217. The rest of this first impulse flows through alternate contact 219, contact 212, contact 241 and the winding 10^8 of magnet 10^c, causing an actuation thereof; and since stop pawl is "in", a first short step of wipers 249, 250, 251, is produced. A second impulse transmitted over conductor 208 by the second deënergization of relay PR passes over the last traced circuit including alternate contact 219 and the winding 10^8 of relay 10^c and a second short step of the wipers is produced, which will then engage the second contacts of the second group, the said contacts being multiple terminals of line 2222 connected to substation C. A final deënergization of relay SR occuring by the opening of line conductor 66 now transmits a current impulse over conductor 209, through contact 223, contact 239, the upper winding of test relay TR and to battery energizing the said relay. Upon the attraction of its armature 235, the lower winding of the relay TR is connected from battery through contact 225, alternate contact 235, to the test or private wiper 249, now engaging the multiple contact 56^a of the called-for line. When relay TR energized, armature 236 actuated the relay 238 which, by armature 240, locked itself to ground at alternate contact 217, the armature 239 opening the initial energizing circuit of relay TR. Assuming first that the called-for line is idle, the said multiple contact 56^a will be connected with the active side of battery B^5, as shown, and since the lower winding of relay TR is also connected with the active side of said battery, the relay becomes deënergized and its armatures are retracted. On the retraction of the armatures of relay TR, a circuit is completed as follows: from ground through the relay 226, attracted armature 242, normal contact 235, contact 249—56^a, normal contact 45 of the called line and to battery through cut-off relay 51 actuating the said relay which, by armature 53, puts ground from contact 56^a upon the conductor 32 leading to the private banks at the line selectors, whereby the called-for line remains unselectable at the line selectors. The ground upon the multiple contact 56^a from relay 226 renders the called multiple contacts 56^a, 57^a, 58^a of the called line busy with respect to the other connectors having access to them.

The winding of relay 248 now has its circuit closed from ground through the constantly rotating interrupter I', attracted armature 228, said relay 248 to battery, and relay 248 will be alternately energized and deënergized with the travel of the interrupter I', alternately connecting wiper 250 with generator g when energized, and with relay 231 when deënergized. The substation bell will ring when generator g is connected with the wiper 250, the circuit being traced through contact 57^a over line limb 67, through call-bell and condenser at the substation, returning over conductor 66, contact 58^a, 251, armature 229 and impedence 230 to battery. The interrupters I' and I^2 are preferably mounted upon the same shaft so that their travel is synchronous and the interrupter I^2 will disconnect the generator g from the called line and substitute therefor a short circuit to ground a short period before each deënergization of relay 248 occurring with the rotation of the interrupter I'. This arrangement is to secure a discharged condition of the line circuit before the relay 231 is placed in connection therewith, in order to with certainty prevent said relay from being actuated by current discharges from the telephone line and before the called subscriber removes his receiver.

The called subscribed in answering his call removes his receiver and hook lever 59 is raised to alternate position closing a conductive bridge through the substation. As soon as this occurs and relay 231 is, by retraction of armature 248^a, connected with the wiper 250, circuit may be traced from ground through said relay, contact 227, normal contact 248^a, contact 250—57^a over conductor 67 through the transmitter and the inductance of magnet 60 of the substation, returning over limb 66, contact 58^a—251, impedance 230 to battery, this path supplying talking current to the called-for substation. The closing of contact 232—234 establishes a branch locking path for the relay LR^5, which serves as a release relay, and the connector H now depends for its restoration upon the called-for station C. The closing of contact 232—233 operates the relay 243, which, by armature 245, locks to ground at alternate contact 217. Attracted armatures 244 and 247 of this relay complete the circuit of the talking strands of the connector and armature 246 opens the circuit of interrupter I' so that the relay

248 continues unoperated and generator *g* excluded from the circuit with the called-for line.

As soon as the contact 247 was closed as described, current from ground at relay 231 passing over the limbs of the called-for line finds its way through closed contact 247 to the left over conductor 209 to conductor 166 and over the lower talking conductor at the first selector F, through alternate contact 133 and through release relay RR to battery B^3 whereon the attracted armature 176 closes circuit from ground at the line selector E over conductor 118 through reversing relay RV and to battery B^5, said reversing relay being operated, and, by armature 171, locking itself over conductor 118. Armatures 169 and 172 by their make-before-break arrangements reverse the connections of batteries A^2 and B^2 to the limbs of the calling line whereby the direction of current flow in said line is reversed. This reversal may be employed for the purpose of operating any of the well known forms of polarized call counting or coin controlled devices whereby measured service may be afforded.

The calling subscriber A and the called-for subscriber C are now in conversation through condensers 173 and 174, talking current to the calling line being supplied from the serially connected batteries A^2 and B^2, through the inductive resistances of relays PR and SR, while talking battery is supplied to the called-for line from battery B^5 through the impedance 230 and the impedance of relay 231

When the subscribers have finished their conversation they replace their receivers. When the calling subscriber A so does, all switches except the connector H will be restored to normal and the restoration of this switch will remain to be accomplished from the called substation. If the called subscriber first replaces his receiver, all the switches except the line selector E will be restored to normal, the latter remaining to be restored by the calling subscriber when he replaces his receiver.

Let it be assumed first that the calling subscribed A first hangs up his receiver. In such case, hook lever 59 opens the conductive circuit line limbs 66, 67, and the two relays PR and SR simultaneously are de-energized for the first time since they were initially operated. Retracted armatures 128, 129 close circuit from ground over release wire 119 through normal contact 92, attracted armature 99 and relay 110 to battery, the said relay immediately energizing and, by armature 114, operating the relay 90. It will be remembered that magnet 14 and relay 97 are locked over a series circuit including armature 100 and shifted off-normal contact 89 so that the stop pawl of magnet 14 is in the stroke limiting position. Generator current now passes through winding 10^2 of magnet 10, attracted armature of magnet 14, alternate contact 93 to ground. Since relay 110 has, by armature 113 locked itself to ground, it is apparent that short steps of switch E will continue to be produced. When the wipers of the line selector E have made enough short steps to reach normal, the off-normal contact 89 is opened, magnet 14 and relay 97 have their locking circuit opened and the retracted armature of magnet 14 will prevent the further actuations of winding 10^2. Retracted armature 99 of relay 97 deënergizes relay 110 and retracted armature 114 of the latter deënergizes relay 90 when the mechanism of the line selector will be at normal. As soon as the wipers of the line selector E left the multiple calling contacts of the line of A, the cut-off relay 51 of said line had its circuit opened and the line circuit of A was in its normal condition.

On the deënergization of relay SR as described, the retraction of armature 133 opened circuit of release relay RR, and the armatures of the said relay were retracted. Locking relay LR is now deënergized, contact 175 having been opened and ground having been removed from the conductor 118 by armature 112 at switch E. On its retraction, armature 151 energizes the relay BR by current through attracted armature 145, and, armature 138 of said relay BR, being attracted, deënergizes the relay 150 whose retracted armatures 151, 154 place the wipers 159, 160 upon open circuit during release. Armature 139 of relay BR now closes a circuit from generator *g* through winding 10^3 of magnet 10^a and through alternate contact 144 to ground. As long as relays BR and LR′ remain energized, it is apparent that successive short steps of the first selector F will be produced turning the wipers 158, 159, 160 around until they reach normal. When they do reach this point, the locking circuit for relay LR′, extending through alternate contact 137^a will be opened and retracted armature 144 will prevent further actuations of magnet 10^a whereby the switch wipers rest in their normal positions. On the retraction of armature 145, relay BR will be deënergized and the mechanism of first selector F is then at normal, the reversing relay RV, having had its locking circuit opened when ground was removed from conductor 118, on the initial restoring movement of line selector E.

It will be observed that the conductor 40 connected to the controlling contact 84 at the master-switch D is, during the release of the line selector E, held grounded at alternate contact 111 so that the master-switch

D will be prevented from stopping upon the contact 84 of the releasing line selector. In case the line selector E reaches normal before its paired first selector F reaches normal, the contact 84 is not rendered selectable until the selector F reaches normal. It will be seen that conductor 40 upon the retraction of armature 111 is connected to the wire 117 which extends to the first selector F and during the restoration thereof, is connected to ground via alternate contact 138 and normal contact 136. Thus, until the switch pair EF is fully restored, the contact 84 remains unselectable.

As soon as the first selector F started to be restored, the wiper 158 was placed on open circuit and consequently ground was removed from the private contacts 161^a of the second selector G. The locking circuit of relay LR^3, which serves as a release relay, is thereby opened and the relay deënergized. The closure of normal contact 178 operates relay BR′ by current through closed armature 185 of relay LR^4. Attracted armature 192 of relay BR′ deënergizes relay 193 so that the contact wipers 202, 203 are on open circuit at contacts 194, 197 during the release. The closure of alternate contact 192 places ground from armature 168 via normal contact 180 over conductor 164 upon the multiple private contacts 161^a of the second selector G, this circuit continuing closed until the second selector G reaches normal whereby its seizure by any other first selector prior to its complete restoration is prevented. Circuit may now be traced from generator g through winding 10^5, through attracted armatures 191—187 to ground, and successive actuations of magnet 10^a will be produced causing short steps of the second selector G until it reaches normal. Normal being reached, off-normal contact 190 is placed in its original condition and the locking circuit of relay LR^4 is opened and the relay deënergized. Its armatures are retracted, armature 185 deënergizing the relay BR′ and the mechanism of the second selector G is fully restored, the actuations of magnet 10^b having been previously terminated by the opening of alternate contact 187.

Since it has been assumed that the called subscriber C has not yet replaced his receiver, the relay 231 at connector H has continued operated and the continued closure of contact 232—234 prevented locking relay LR^5, which serves as a release relay for the connector, from being deënergized when ground was removed from conductor 207 by the initiation of the release of the second selector G. When, however, the called-for subscriber now replaces his receiver, relay 231 deënergizes and the opening of contact 232—234 deënergizes relay LR^5 whose retracted armature 217 terminates the flow of current through relays LR^7, 238 and 243. Said armature 217, by engaging its normal contact, now closes a circuit for generator g through winding 10^7 of driving magnet 10^c, through attracted armature 222 of relay LR^6 to ground. Short steps of the connector H will now be produced, continuing until the wipers 249, 250, 251 complete a revolution. The wipers being then at normal, alternate contact 211 opens, causing the deënergization of locking relay LR^6 whose retracted armature 222 prevents further actuations of magnet 10^c, the wipers then resting at normal. When relay 238 became deënergized by the opening of alternate contact 217, as before described, relay 226 had its circuit opened at contact 242 and the cut-off relay 51 of the called-for line also had its circuit opened whereby the line circuit of C was restored to its normal condition.

Let it be assumed that the called-for subscriber replaces his receiver in advance of the calling subscriber. In such case relays PR and SR at first selector F remain unaffected, but the opening of the conductive circuit between line limbs 66 and 67 at substation C opens the circuit of release relay RR at F. The said relay therefore deënergizes, but reversing relay RV remains operated because the conductor 118 is still grounded at E. The opening of contacts 175 and 176 will leave no path for the flow of current through the locking armature 148 of relay LR, the said relay consequently is deënergized and the release of the second selector F, second selector G and of the connector H proceed in the manner before described. When now the calling subscriber replaces his receiver, the relays PR and SR will be simultaneously deënergized, closing contacts 128, 129, whereby the energization of relay 110 at line selector E is produced in the manner before described, and the release of the line selector proceeds as before.

Let it now be assumed that the called-for line was found busy at the time the last impulse was transmitted from conductor 209 by secondary relay SR whereby relay TR was energized and connected to the test wiper 249. The called line being assumed busy, its multiple private contact 56^a engaged by wiper 249 will be grounded and current will find its way from the grounded contact 56^a, through wiper 249, alternate contact 235, contact 225, and through the lower winding of relay TR to battery B^5, the relay TR being thereby locked, and its energization continued. Since armature 235 continues attracted, the relay 226 remains unoperated. The busy interrupter I^3 is now held connected to conductor 208 through the continuance of the attracted armature 237 of relay TR and the busy sig-

nal is transmitted to the left over the upper talking conductor through the substation A giving the customary busy tone in the receiver, returning over the lower talking conductor and through the winding of relay SR to battery. Upon hearing the signal, the calling subscriber knows that the called for line is busy and replaces his receiver causing the restoration of line selector E, first selector F and second selector G, in the manner before described when the calling subscriber replaced his receiver before the called subscriber. In the present case however, the act of the calling subscriber restores to normal also the connector H. It will of course be apparent that since the relay 226 at connector H was not operated, the relay 231 has remained inert. Therefore, the locking relay LR^5, which serves as a release relay, depends for its continued energization entirely upon the ground connected to conductor 207 at the second selector G. When this ground is removed, upon the initiation of the release of the said second selector G, relay LR^5 deënergizes and the mechanism of the connector H is restored to normal in a manner similar to that before described, the test relay TR being, of course, deënergized, as soon as contact 225 is opened.

It is of course apparent that, had the called-for line had its contacts included in the first group of contacts before the wipers 249, 250 and 251, no long step of the wipers would have been produced, a single impulse over the wire 208 only having, in such case, been transmitted to represent the third digit of the called number. In such case, the relay LR^5 would have operated as before, and upon the trasmission of a secondary impulse over conductor 209, the relay LR^6 would have been operated as before except that under the present circumstances it would, by armature 220, have been locked via normal contact 211, 210 and alternate contact 213 to the private wire 207. Of course when thereafter the first adjusting impulse was caused to flow over wire 208 to produce short steps of the connector's wipers to select the contact of the line in the first group, alternate contact 211 would be closed on the first short step and the remaining operations would have been as before described.

As has been heretofore indicated, if the first selector F had been so operated as to select multiple contacts 161, 162, 163 out of its first contact group, and if the first contact set of the first group had been idle, there would have been no travel of the switch wipers 158, 159, 160. Similarly, if the second selector G has been caused to select idle contacts of its first group and the first contact set 204—205—206 of the first group had been idle, no movement of the switch wipers would have been produced. In such case, the locking relay LR′ at first selector F would have its locking circuit completed through contact 137^a—137, through attracted armature 147 and through armatures 170 and 175 over conductor 118 to ground, alternate contact 137^a having not been closed at all owing to the failure of the switch wipers to travel. Therefore, assuming this condition when ground was removed from conductor 118 at the initiation of the release of the line selector, relays LR and LR′ would both have been simultaneously deënergized. Since contact 145 would be opened before the closure of normal contact 151^a could energize the relay BR, the said relay BR would remain inert and accordingly no circuit for generator g through winding 10^3 would be closed and the switch wipers 158, 159, 160 would continue at normal. The opening of contact 143 would deënergize the relay 150 and the mechanism of the first selector F would be at normal. The wipers of the first selector would remain stationary no matter from which end of the talking circuit the release was initiated since if relay BR was deënergized from the called station, the relay LR would be deënergized and the opening of its contact 147 would deënergize the relay LR′ and the time relations of the break of contact 145 and the make of normal contact 151^a would of course be so adjusted as to prevent the operation of relay BR and the consequent complete circular travel of the switch wipers.

So in the case of the second selector G when it employs the first contact set of its first group in establishing connection, the relays LR^3 and LR^4 both depend for their locking circuits upon the private conductor 164 whose grounded condition is controlled at the first selector F, since contact 190—189 remains closed and alternate contact 190 has remained opened therefore. The removal of ground from the private wire 164 at the beginning of the release operations of the first selector F will therefore deënergize both relays LR^3 and LR^4 and no operation of relay BR′ will result so that no actuating circuit for magnet 10^b will be produced, the switch wipers 201, 202, 203, therefore remaining at rest.

Referring now to Fig. 2 which illustrates a modified line selector E′. The circuits illustrated in Fig. 2 are, to a considerable extent, like those illustrated in Fig. 1, part 2, and need not be described in full, like parts in Fig. 2 having corresponding reference characters to like parts in Fig. 1, part 1. A principal difference in line selector E′ as compared with line selector E consists in this that the stroke limiting stop pawl of

stop magnet 14^d is normally, that is when the stop magnet is deënergized, in the stroke limiting position, that being the position illustrated in Fig. 5. In this respect, the line selector E′ is therefore like the first and second selector and the connector. From this it follows that when a calling line in the first sub-group is to be selected, the stop magnet is permitted to remain inert while when a calling line in any other sub-group than the first is to be selected, it is necessary to actuate and to hold actuated the stop magnet 14^b of line selector E while the long steps are being made in case the calling line is in a group other than the first. Accordingly in E′, the relay 97 is not connected to battery B′ in the series with the stop magnet 14^d but has its winding connected directly to battery, the opposite end of the said winding being connected through normal contact 106^a with the off-normal contact 87. Thus, when the group relay 47 of the first sub-group is actuated, current from ground at wiper 72 of interrupter I will flow through contact 48 over conductor 39, branching at contacts 86 and 87, a part flowing over conductor 124 and normal contact 114 through relay 90; the remaining current will flow through contact 87 over conductor 126, contact 106^a and through relay 197 to battery so that relays 97 and 90 are now operated while magnet 14^b remains inert. The closing of contacts 98^a and 90^a complete the actuating circuit for the winding 10^2 of magnet 10 and short steps of the switch will be produced in the before described manner as long as relay 90 finds locking circuits extending through alternate contact 94, normal contact 116, contact 103, wiper 2 and to ground over contact 18, conductors 32 of non-calling lines; but when the contact 18 of a calling line is reached, relay 90 is deënergized and winding 10^2 ceases to receive actuating impulses. The relay 97 will, of course, be locked on the first step of the switch through normal contact 106 and shifted off-normal contact 89, and will remain energized until the switch is fully restored.

The following are characteristics of the operation of the line selector E′ when the calling line has its multiple calling contacts in a group other than the first. In such case as before, the impulses for starting the line selector E′ will flow from interrupter I over conductor 70 through the attracted armature 48^a or 48^b, conductor 75^a, conductor 41, closed off-normal contact 88, contact 98 and through the long step controlling relay 104; at this point, however, the circuit differs, the current instead of flowing directly to battery B′ as in E, flows serially through the magnet 14^d and to battery whereby the relay 104 and magnet 14^d are simultaneously operated, magnet 14^d of course withdrawing its stroke limiting pawl. As long as the wiper 27 in the steps of the switch continues grounded, which it will of course do until it engages a sub-group contact 31 pertaining to a group having a calling line, magnet 14^d and relay 104 will continue energized by current through attracted armature 107 and wiper 27. While these continue energized, interrupter I will be transmitting current impulses from ground through segments 69 and 69^a, alternately, over conductor 38 through attracted armature of magnet 14^d and the long step winding 10′ of magnet 10^2.

As soon as wiper 27 engages a group contact 31 of a group containing a calling line, magnet 14^d and relay 104 will be deënergized owing to the ungrounded condition of such contacts. The opening of contact 105^a instantly deënergizes magnet 10′ and the driving pawl retracts before the stop of magnet 14^d can come into engaging position. If, however, the time elements between magnet 14^d and magnet 10′ should be such that the armature of 14^d should retract and the stop 5^a impact upon the pawl 6^a before the latter retracted, no harm is done since the circuit of magnet 10′ is open at contact 105^a and the pawl 6^a slips back along stop 5^a, and when it reaches the retracted position the stop comes into its limiting relation. The relay 90, as in the previous case, is operated by ground at armature 105 on the initial energization of relay 104 and, when relay 104 subsequently deënergizes, relay 90 will momentarily continue operated by ground over conductor 125, wiper 2^a and some engaged contact 19. On the deënergization of relay 104, relay 97 is operated by current through contacts 106 and the shifted contact 89 and the generator circuit for winding 10^2 is accordingly closed through contacts 98^a and 90^a, and short step travel of the line selector E′ ensues, as before, continuing until relay 90 deënergizes, which occurs when wiper 2 encounters contact 18 of the calling line. In the present case, the ground upon the master-switch wire 40 connected thereto when selection of the calling line is made, to cause the master-switch D to move along is traced through attracted armature 99^a of relay 97 and normal contact 90^a of relay 90. The restoration to normal of the line selector E′ is substantially the same as that of line selector E, the battery impulse going over release wire 119 through normal contact 92, closed contact 99, and the relay 110, which relay locks at self through attracted armature 113′ to ground. Armature 114 closed circuit through relay 90 whereby a generator circuit of the short step winding 10^2 of magnet 10 is closed and short steps of switch E′ are produced until the switch reaches normal, when the opening of contact 89 deënergizes

relay 97 opening the generator circuit of winding 10^2 whereafter the deënergizations of relays 110 and 90 are occasioned as in the previous case.

It will be seen from the foregoing that the system of my invention is characterized by an extreme simplicity of mechanism, the switches used having a very small number of parts. Especially is it noticeable that the interlocking of different mechanical devices is avoided in the switch structures and that many of the mechanical complications which have been objections to prior known systems of the art are obviated. It will be of course apparent from the foregoing that one important thing that has been considered in devising the present system is to so arrange the system that as many as possible of the functions required to be performed in the system as a whole are performed by means of simple relays which are of course less liable to disadjustment than the more complicated mechanical means that have been employed in some automatic systems more extensively than in the present system. In fact, I have endeavored in the present invention to, as far as possible, reduce an automatic telephone system to a relay circuit structure using for the selecting mechanism merely a simple pawl and ratchet employing a continuously forward motion, this being in itself practically the simplest mechanical movement that can be employed.

It is of course apparent that changes may be made in the circuit arrangements and in the various switch devices, as in fact is indicated by the variety of circuits illustrated, without departing from the scope of the invention. It is therefore my intention not to be limited to the specifically described and illustrated structure, but

What I claim is:

1. A telephone system including a calling line, a line selector to make connection therewith, a relay for said selector, an actuating magnet therefor controlled by said relay, stroke-limiting stop means associated with said magnet and normally in limiting position with respect thereto, means controlled by current over said line to effect a step toward energizing said relay, independently actuated means for thereon actuating said relay and magnet in proper sequence, and means effective to move said stop means from limiting position.

2. A telephone system including telephone lines having contacts at the exchange arranged in groups, a line selector for selecting said lines, a conductor for starting said line selector responsive to initiation of a call from a line of the first group, and a common conductor for the other groups for starting said selector responsive to calls initiated from other groups.

3. In a telephone system, a trunk selecting switch including multiple terminal contacts of trunks arranged in groups, means for causing long steps of said selector to select the group, means for causing short steps of the selector to select contacts of the group selected, contact wipers for said selector normally resting at the first group of contacts, and means for initiating short step travel of said wipers while preventing a preliminary long step selection when contacts of the first group are to be selected.

4. A telephone system including a trunk selecting selector, multiple terminals of trunks included in said selector and arranged in groups, contact wipers of said selector normally engaging the first multiple contact set of the first group, and means for causing said selector to alter the electrical condition of said first contact set to render it busy without changing the selective position of said wipers when a trunk of the first group is to be selected and the first trunk of said group is idle.

5. The combination with telephone lines, of a line selecting switch adapted to select the calling line, a driving magnet for causing long steps of said switch to select the group and short steps thereof to select the calling line from the group, an electrically adjustable stop adapted to limit the stroke of said magnet and thereby produce short steps of said switch, said stop being normally in stroke limiting position, means for causing a flow of current to withdraw said stop from limiting position when long step travel is to be initiated, and means for terminating said flow to place said stop in its normal limiting position after the group has been selected.

6. In a telephone system, the combination with trunk lines, of multiple terminals therefor, a trunk selecting switch having movable contacts adapted to engage said terminals, said terminals being arranged in groups before said contacts, a magnet and a switch driving armature therefor, means for actuating said armature by long strokes to select the group, means for actuating said armature by short strokes to select contacts of the group, an electrically adjustable stop for preventing long strokes of said armature, said stop being normally in limiting position, and a magnet for energization to withdraw said stop from limiting position to permit said long strokes when travel of said switch to select a group is initiated.

7. In a telephone system, a first selector, trunk lines having multiple contacts at said selector arranged in groups, an impulse transmitter adapted to be connected with said selector to transmit directive impulses to said selector to select the group, means including a stepping magnet for producing

long steps of said selector to select the group responsive to said impulses, and automatic circuit selecting means also including said magnet for thereafter producing short steps of said selector in the same direction to select contacts of the group.

8. A telephone system including telephone lines, a line selector to select said lines, having a wiper adapted to be adjusted by long and short steps, a magnet for said selector to adjust the same, a stop magnet normally limiting said magnet to produce short steps, a controlling relay for said magnet, a common interrupter for transmitting impulses to said magnet, and means controlled by said interrupter for energizing said relay and producing a time interval between said energization and the beginning of the first impulse transmitted to said magnet.

9. A telephone system including trunk lines having multiple contacts arranged in groups, a rotary trunk selector to select the group and then idle contacts therefrom, a magnet for said selector, an armature for said magnet for causing long steps of said selector to select the group, said armature also serving to cause short steps to select contacts of a selected group, a stop for changing said armature from its long step relation to its short step relation, an electromagnet for adjusting said stop, and circuit means for controlling said electromagnet.

10. A telephone system including a pair of connected telephone lines, a rotary line selector switch in connection with the calling line, a rotary called line connector switch in connection with the called line, a plurality of rotary trunk selector switches between said line selector switch and said connector switch through which the talking circuit extends, and means controllable from each line effective to cause said switches, other than the one in connection with the other line, to complete their cycles of rotation in initial direction to normal.

11. A telephone exchange system comprising subscribers' lines and a plurality of associated interconnecting link-circuits and directively controlled long and short step travel switches for uniting calling and called lines into conversational circuits, said switches including means having single driving magnets for producing both long and short steps.

12. A telephone exchange system comprising subscribers' lines, and directively controlled switches and link-circuits for uniting calling and called lines into conversational circuits, said switches each having long primary and short secondary movements and means including a single driving means for giving it both movements.

13. A telephone system comprising telephone lines, a switch for interconnecting said lines, terminals of said lines connected to fixed contacts of said switch arranged in groups, a coöperating movable contact, a driving magnet and mechanism normally positioned so as to drive said movable contact from contact to contact, and means for changing its position so that when actuated it will drive said movable contact from group to group.

14. A telephone system comprising selector and connector switches for interconnecting the lines thereof, talking conductors having multiple contacts at said switches arranged in groups, an impulse transmitter adapted to be connected with said switches to transmit impulses to said switches to select a group, means including a stepping magnet for producing long steps of said switches to select the group responsive to said impulses, and means also including said magnet for thereafter producing short steps of said switches in the same direction to select contacts in the group.

15. A telephone system comprising telephone lines, a connector switch for connecting calling and called lines, said switch having terminals of said lines arranged in groups and an electromagnet and associated ratchet mechanism and control circuits therefor for producing long step travel of said switch to select a group and short step travel to select a contact in a group.

16. A telephone system comprising telephone lines, connector switches for connecting calling and called lines, said switches having terminals of said lines multiply connected and arranged in groups, and an electromagnet and associated ratchet mechanism and control circuits therefor for producing long step travel of said switches to select a group and short step travel to select a contact in a group.

17. A telephone system including multiple contacts arranged in groups, a selective switch to select the group and then contacts of the group, a magnet for adjusting said switch, a circuit for said magnet, a relay having a switch contact included in said circuit, means for causing said magnet to produce long steps of said switch, when operated responsive to said relay, to select the group, a second relay having a contact in a circuit of said magnet, and means for causing said magnet to produce short steps of said switch, when operated responsive to said second relay, to select contacts of a group.

18. A telephone system including multiple contacts arranged in groups, a selective switch to select the group and then contacts of the group, a magnet for adjusting said switch, a circuit for said magnet, a relay having a switch contact included in said circuit, a second relay having a contact in a circuit

of said magnet, means for causing said magnet to produce long steps of said switch, when operated in response to said first relay to select the group and to produce short steps of said switch, when operated responsive to said second relay, to select contacts of a group, a subscriber's telephone line, and means responsive to current over said line to cause operation of said relays.

In witness whereof, I hereunto subscribe my name this 13th day of April, 1908.

ALFRED H. DYSON.

Witnesses:
CAROLYN WEBER,
BESSIE SKINNER.