A. H. DYSON.

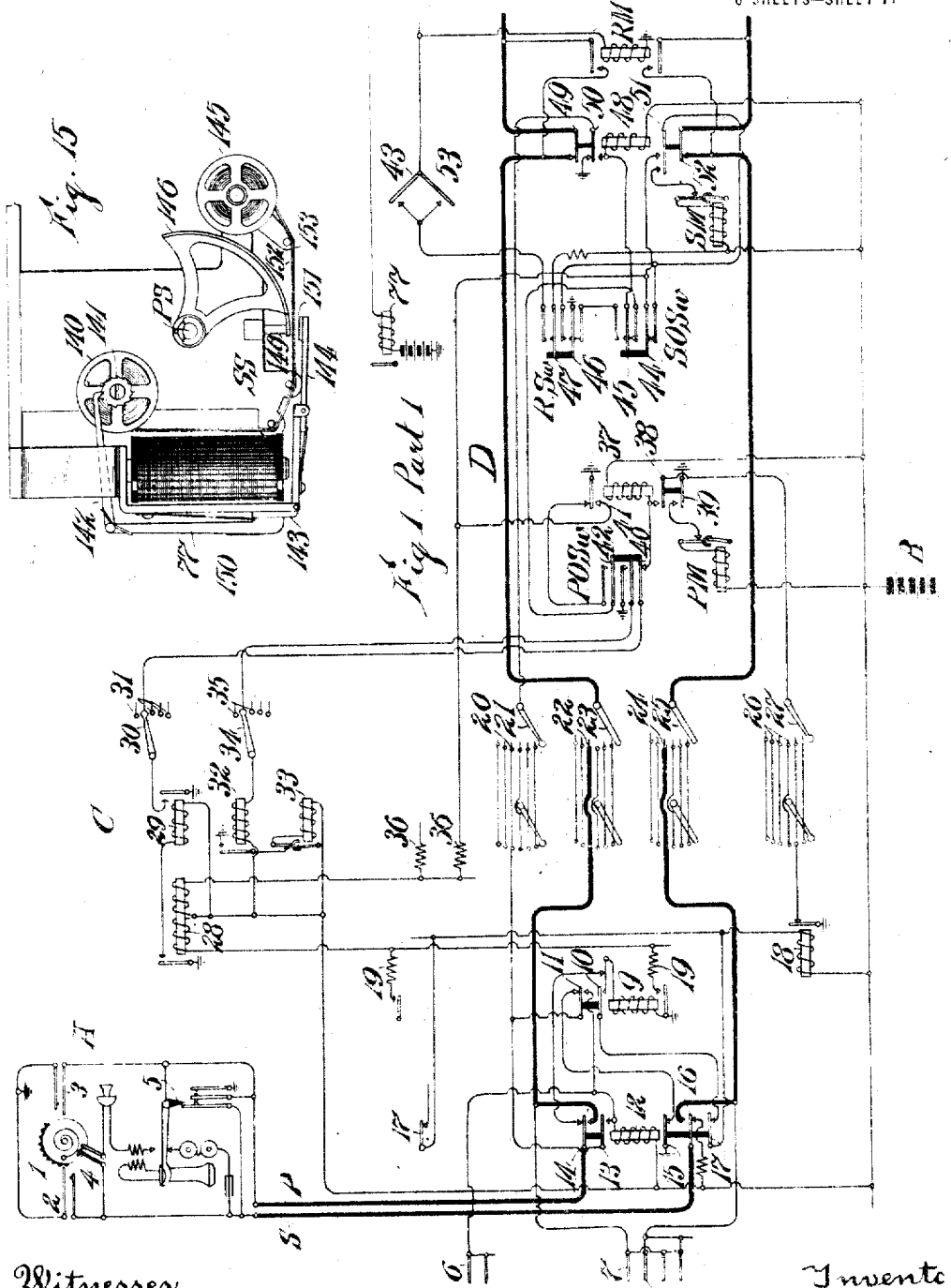
AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED NOV. 13, 1906.

1,260,971.

Patented Mar. 26, 1918.

6 SHEETS—SHEET 1.



Witnesses

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6 SHEETS—SHEET 2.

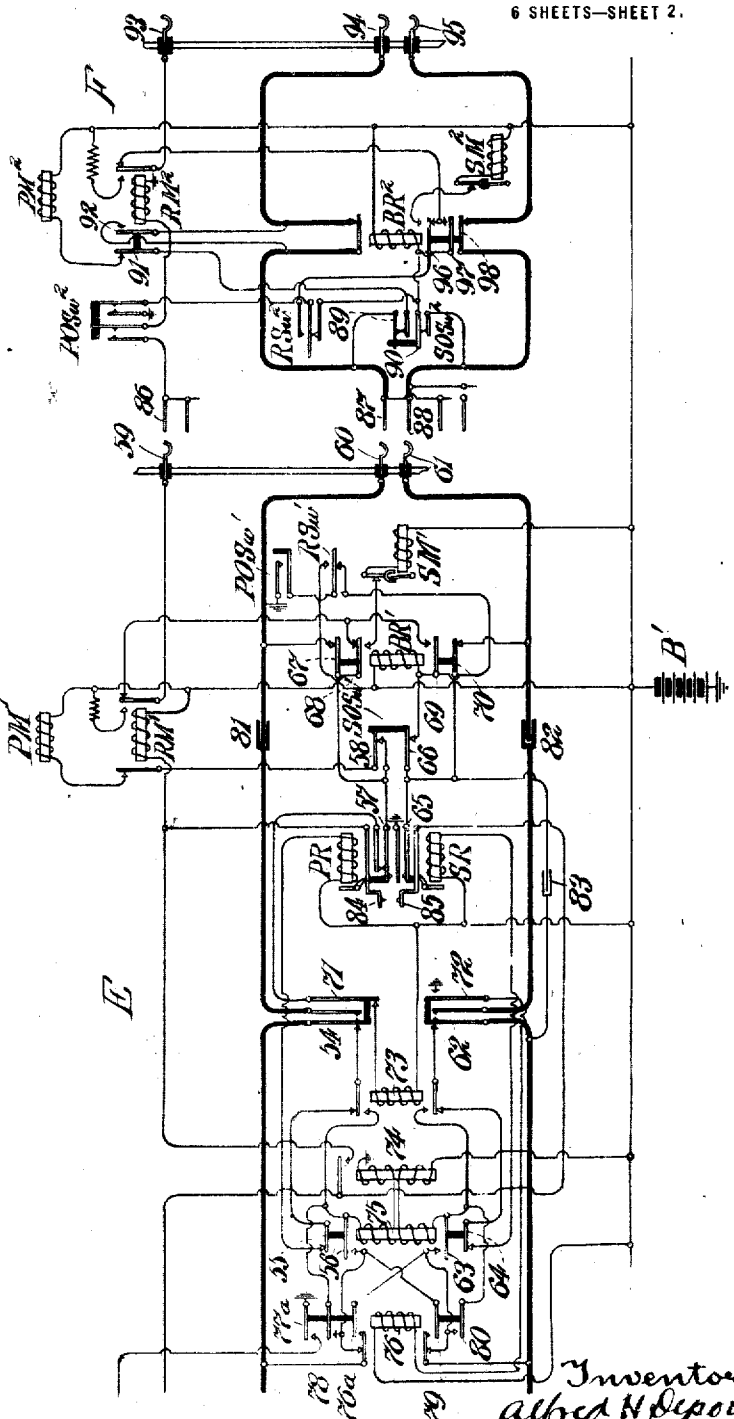

Fig. 1 Part 2

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6 SHEETS—SHEET 3.

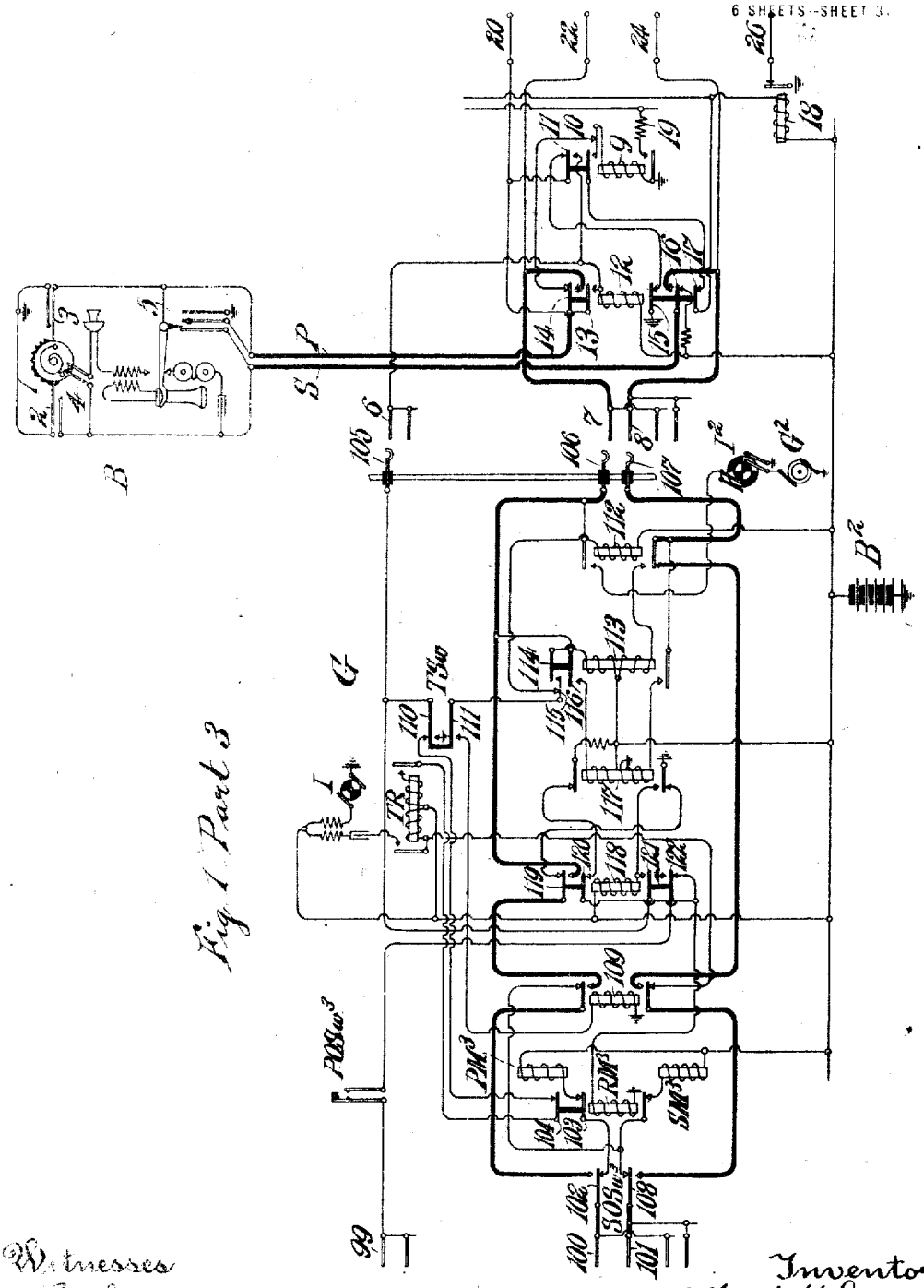

Fig. 1 Part 3

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6 SHEETS—SHEET 4.

Fig 2

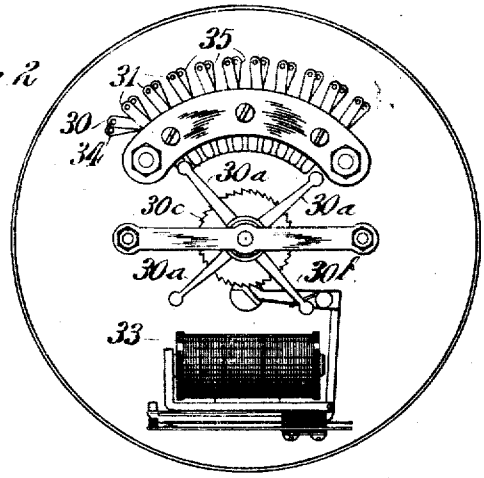

Fig. 3

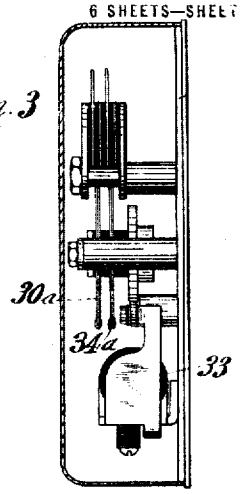

Fig 5

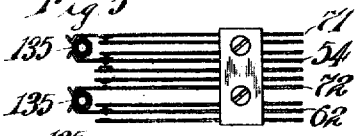

Fig. 4

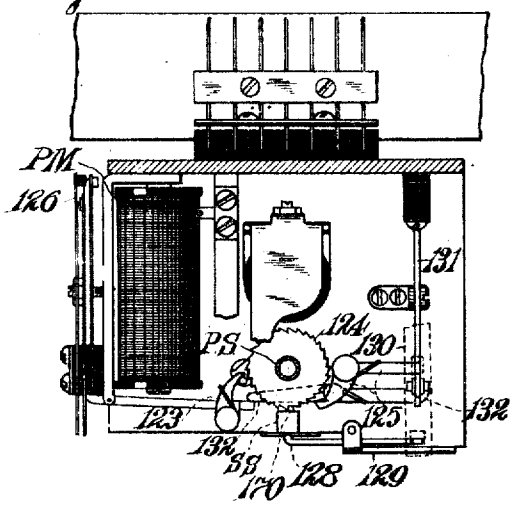

Fig 6

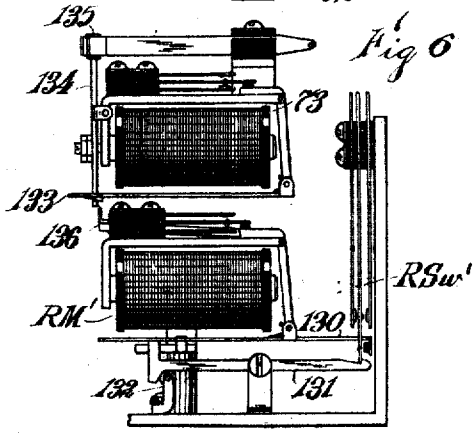

Fig. 8 P.S. 43a P.Sw

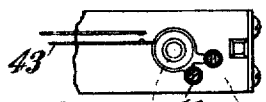

Fig. 7 P.S. P.Sw

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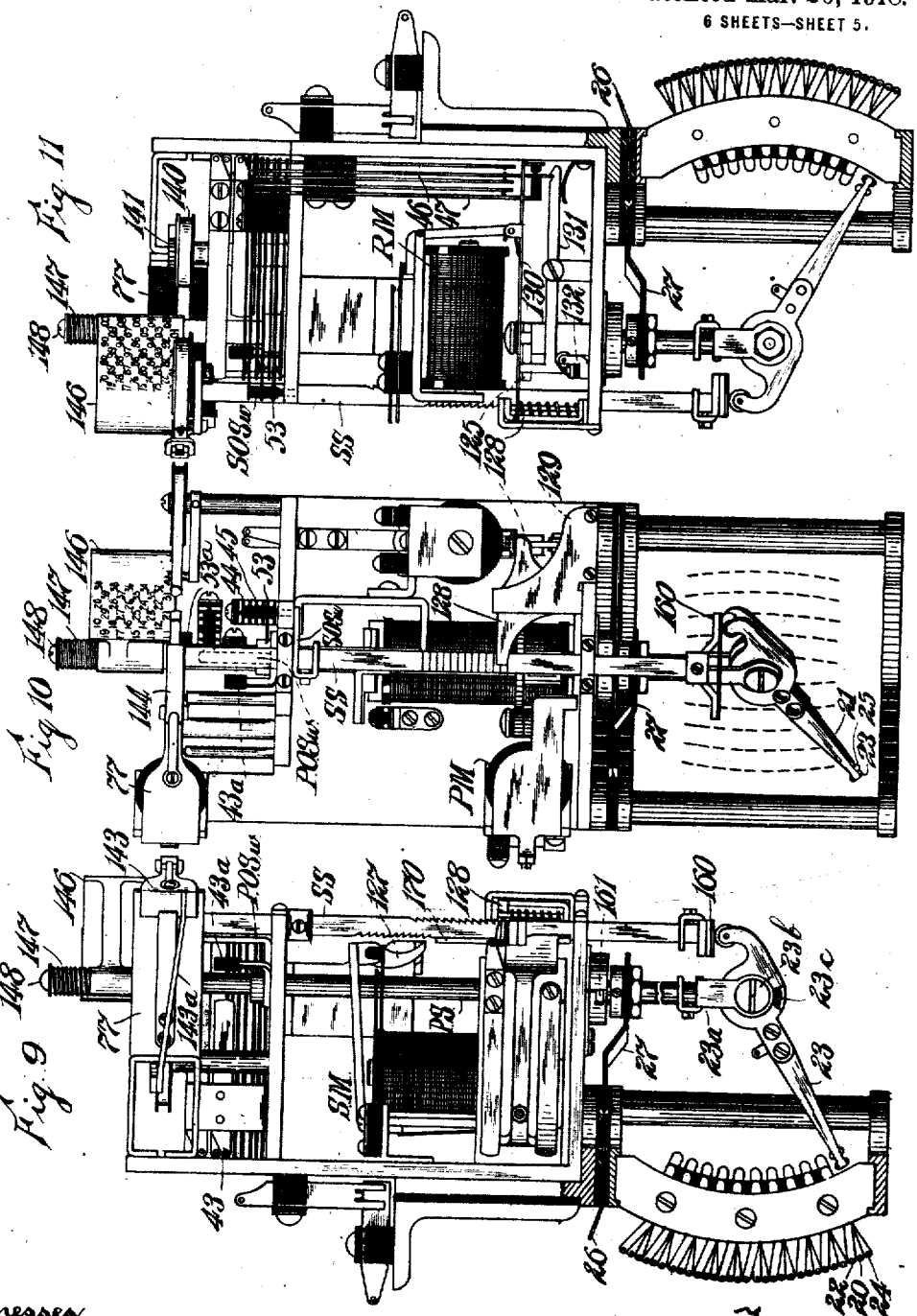
6 SHEETS—SHEET 5.



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6 SHEETS—SHEET 6.

Fig. 14

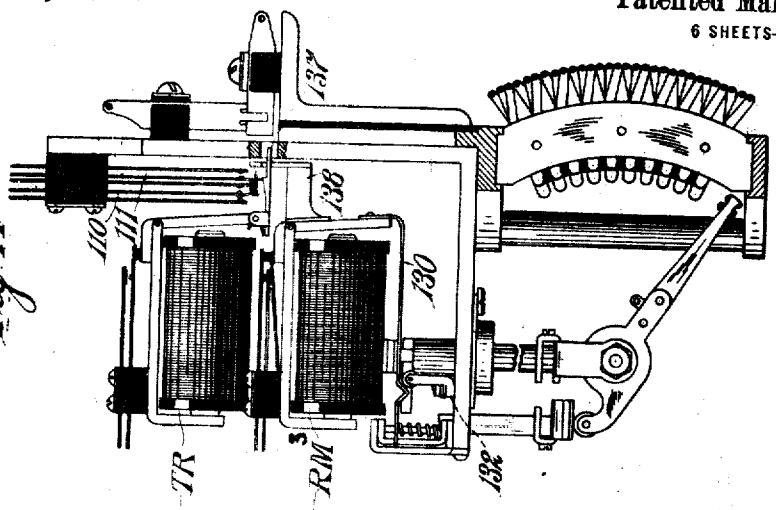


Fig. 13

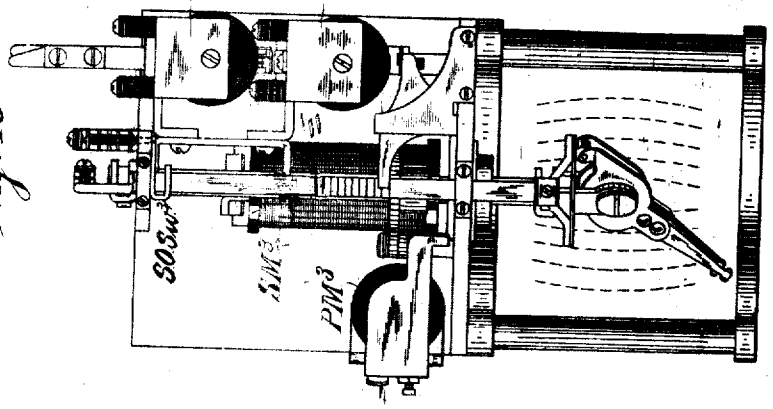
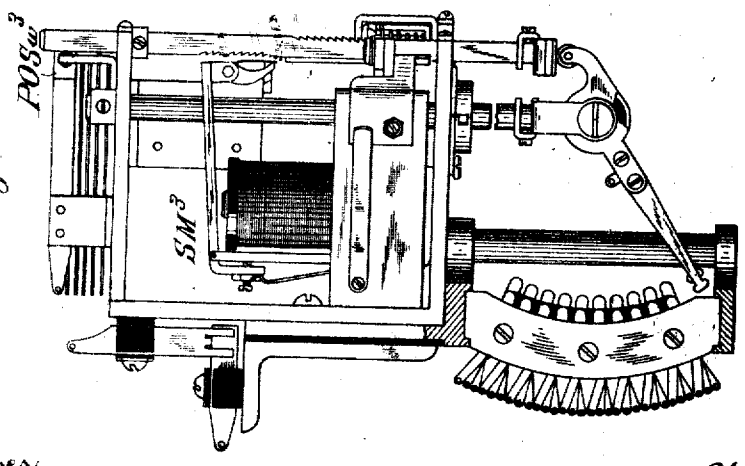


Fig. 12



Witnesses

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,260,971. Specification of Letters Patent. Patented Mar. 26, 1918.

Application filed November 13, 1906. Serial No. 343,255.

To all whom it may concern:

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

My invention relates to telephone systems of the specified character wherein a plurality of selective switches are employed successively in completing each connection.

In the system which I know in the accompanying drawings, first selector, second selector and connector switches are employed, and in addition, switches of a fourth class which I term "line selectors," the said line selectors being each connected to a first selector and having the function of temporarily associating the first selector with the calling line by means of automatically controlled apparatus.

In general, the object of my invention is to produce a simple and reliably operating structure of the described character. I have given special attention to the method whereby the various switches employed in the connection are released when conversation is finished, dividing the control of the releasing mechanism between the calling and called subscriber in such manner that the called subscriber has sole control of the release of the connector as soon as conversation between the subscribers has commenced; while the calling subscriber, under such circumstances, has sole control of the line selector, first selector and second selector. Previous to the commencement of conversation, however, the calling subscriber is enabled to release all switches including the connector.

Another object of my invention is to provide means included in the telephone system for registering the number of calls made over each line, as a calling line, to which a response of the called subscriber is received. This I accomplish by associating with each line selector mechanism, a printing magnet actuated when the called subscriber answers the call, together with an adjustable type-frame automatically adjusted by the operation of the line selector in connecting to the calling line so as to bring a type, bearing the number of the calling subscriber, into operative relation to the printing magnet.

The above, with other advantages of my improved system, will appear and be pointed out more specifically in the detailed description of the drawing and in the claims.

Figure 1, comprising parts 1, 2 and 3, illustrates diagrammatically a preferred circuit arrangement; Fig. 2 is a front view of a master-switch; Fig. 3 a side view thereof; Fig. 4 is a sectional view of a line selector, showing particularly the primary magnet and its associated mechanism; Figs. 5 and 6 show a first selector release magnet and associated mechanism; Figs. 7 and 8 show top views of an over-run and primary off-normal switch, respectively; Figs. 9, 10 and 11 are respectively left, front and right elevations of a line selector. Figs. 12, 13 and 14 show similar elevations of a connector. Fig. 15 is a top view of the registering mechanism of my invention.

Referring first to Fig. 1, the system there illustrated may be considered as a ten thousand line system. Assuming such to be the case, each subscriber's line such as those of substations A and B, extends to the exchange and is there provided with its individual passive multiple line contacts 20, 22 and 24 appearing with those of ninety-nine other lines in the contact banks of ten line selectors such as D. Inasmuch as ten thousand lines are assumed, there will have to be in all one hundred such groups of lines, each with its ten line selectors, making a total of one thousand such selectors. Each such line selector has permanent connection with a particular first selector such as E, which is automatically brought under the control of currents to be sent over the calling line by the operation of the line selector D. The first selector by its adjustable wipers, gives the calling subscriber access to one hundred second selectors, there being ten of these representing each one thousand lines of the exchange. Contacts of the second selector engaged by the first selectors are, of course, multipled in the usual manner, to a large number of first selector contact banks and would ordinarily be multipled one hundred times or to one hundred such banks.

Responsive to currents transmitted over the calling line by the subscriber, the first selector is caused to select the group of second selectors corresponding to the one thousand's digit of the called number; the first selector then automatically selects the first

idle second selector of the selected group, placing it under the control of the calling line.

The second selector, by its wipers, gives access to one hundred connectors divided in ten groups of ten switches each, the switches of each group being adapted to select out any particular line of a one hundred line group of subscribers to which the switches of the group are assigned. The contact terminals of the connectors are, of course, multipled a large number of times and would ordinarily be multipled in the present system one hundred times or to each second selector of a one thousand line group.

The second selector operating responsive to currents controlled at the calling substation, selects the group of connectors desired, and then the idle connector, thereby placing it under the control of the calling substation.

The connector, by its wipers, has access to contacts forming multiple terminals of subscribers' lines forming a one hundred line group, said contacts being multipled ten times to appear in the contact banks of ten connectors.

In an ordinarily busy exchange of ten thousand lines, one thousand line selectors with their one thousand first selectors, one thousand second selectors, and one thousand connectors, would be adequate to handle the business of the exchange.

As above indicated, line selector D by means of its wipers has access to one hundred sets of multiple contacts 20, 22 and 24 forming terminals of a group of one hundred subscribers' lines. The contacts of these lines are preferably arranged in ten groups of ten contact sets each, the motion of the wipers of switch D being first in a primary direction in one plane to select a group of contacts, and then in a secondary direction in another plane to select the calling line of the group. Each group of ten lines therefore, has a common or group contact 26 controlled by a common relay 18, which contact the wiper 27 engages. The said wiper 27 controls the primary movement of the switch D, the line wipers 21, 23 and 25 moving along with the said wiper 27. When the wiper 27 reaches a group contact 26 belonging to a group of lines among which a calling line is included, the primary movement of all the wipers is arrested and the line wipers 21, 23 and 25 then initiate their secondary movements to select the individual contacts 20, 22 and 24 of the calling line, wiper 27 remaining quiescent at this time and not partaking of the secondary movement.

As before stated, each group of one hundred calling lines has associated with it ten line selectors D, so that the contacts 20, 22 and 24 of each line and the group contact 26 of each group is multipled ten times, once to each such line selector bank. When the calling subscriber removes his receiver, he causes a line selector to start into operation to seek out his line and thereby connect the first selector with said line. This is effected through the agency of the master-switch C to whose relay 28 each calling line is enabled to transmit current by means of the switch contacts of its line relay 9. The said master-switch when operated at the initiation of a call as above indicated, causes an idle line selector to start its operation. The line selector then re-acts upon the master-switch in such manner that its wipers 30—34 move away from the switch contacts 31—35 of the line selector which they start, and then keep up an independent progressive movement via terminals 31—35 of busy line selectors until they reach terminals of an idle one, when the said wipers come to rest. The detailed relation of the different parts to one another will be best understood through the narrative of operation.

Assuming that subscriber A is to be connected with subscriber B whose telephone number will be assumed to be 3456, subscriber A first removes his receiver thereby completing a conductive bridge of limbs P and S by the usual elevation of the hook lever. Relay 9 is energized by current from ground therethrough, normal armature contact 14 over limb P through hook lever and transmitter at station A, limb S, normal armature contact 16, to battery B. Armature 10 is thereby attracted to engage its switch contact, (immediately thereafter breaking the normal contact of said switch contact whereby substation control of relay 9 is removed) to complete a locking circuit for said relay established from ground therethrough, contact 10, contact 17, relay 18, to battery. Relay 18 attracts its armature to remove ground from the multiple group contact 26 at each line selector of the ten. Armature 11 disengages its normal contact to remove ground from each of the individual private contacts 20 of the line at the ten line selectors, and the said armature engages its alternate contact operatively connecting relay 12 with the contacts 20. The lower armature of relay 9 engaging its contact, completes a circuit from ground through resistance 19, the left-hand winding of master-switch relay 28 to battery, causing said relay to attract its armature and complete an energizing circuit of relay 29 which latter attracts its armature and causes a flow of current as follows: from ground at its armature through contacts 30—31, contact 40, at an idle line selector D (wiper 30 when resting always engages contact 31 of an idle line selector as hereafter explained) through relay 37 of said line selector to battery. Relay 37 attracts its upper armature

and closes circuit from ground through resistance 36, right-hand winding of relay 28 to battery, whereby the armature of relay 28 is allowed to fall back, because the said relay is differentially wound, and resistances 36 and 19 are equal. It is apparent that relay 29 is thereon immediately deënergized and its armature retracted. Armature 39 of relay 37 is attracted closing circuit through vibratory primary magnet PM, which becoming energized, advances wiper 27 to engage the first group contact 26, wipers 21, 23 and 25 moving opposite the contacts of the first group but not engaging any contacts. Relay 37 has attracted its armature 38 and if the first group contact 26 engaged is in its normal condition, no line in the group then calling, the said contact will be grounded at the armature of group relay 18, and locking circuit is completed for relay 37 from battery through said relay, attracted armature 38, contact 27—26 to ground via armature of the first group relay 18. As armature 39 thus continues attracted, magnet PM is, on the retraction of its vibratory armature, again energized and moves wiper 27 to engage the second group contact. If this contact has its normal ground at the second group relay 18, relay 37 will continue energized and the preceding process is repeated; wiper 27 engaging the third group contact 26; and so on until the group contact of a calling line, that of subscriber A is found whose ground has been removed by the previously described operation of relay 18. No locking circuit for relay 37 is then completed and its armatures are retracted, the armature 39 preventing further operation of primary magnet PM whereby wiper 27 rests engaging group contact 26 of the ten line group including line A, while line wipers 21, 23 and 25 have moved along with wiper 27 to such a position that they are adjacent to the group of contacts including a line contact set of subscriber A.

On the first primary movement of the wipers, contacts 40—41—42 of the primary off-normal switch P. O. Sw were shifted to their alternate positions, contact 40 opening the original energizing circuit of relay 37. Contact 41 completes a circuit from ground, through contacts 35—34, relay 32 to battery B causing relay 32 to attract its armature whereby circuit is completed for magnet 33 of the master-switch, which, by its energization, advances wipers 30 and 34 a step to engage contacts 31—35, respectively, of the next line selector, it being understood that the said wipers have in front of them ten contacts 31 and ten contacts 35, belonging in pairs to ten line selectors. If the contact 35 now engaged by wiper 34 belongs to a busy line selector, that is, one in which spring 41 has been shifted, relay 32 will continue energized by current from this second line selector via its shifted spring 41; magnet 33 will step wipers 30—34 one step farther, when the above process will be repeated if that line selector is in use, and so on until wiper 34 engages contact 35 of an idle line selector, when its contact 41 will be as shown at D, namely, on open circuit whereupon relay 32 will become deënergized preventing further operation of magnet 33, and wipers 30 and 34 of the master-switch will remain on the contacts of an idle line selector waiting for another call to come in.

Returning now to primary off-normal switch contact 42, its shifting operatively connects the winding of relay 48 with the normal contact of the upper armature of relay 37, so that on the deënergization of said relay occurring as before described, circuit is completed from ground at said upper armature, through contact 42, normal contact 45, relay 48 to battery B. Relay 48 is thereby energized to initiate the secondary movement of wipers 21, 23 and 25 by means of its armature 51 which closes circuit from battery through secondary magnet SM, armature contact 51, to ground through alternate contact of switch spring 46, springs 46—47 of the release switch RSw having been previously shifted on the first energization of primary magnet PM. Wipers 21—23—25 engage contacts 20—22—24 respectively, belonging to the first line of the group. When it is at normal, that is, when the subscriber is not making a call, its multiple contact 20 will be grounded by way of the normal contacts 11 and 15 of its relays 9 and 12; hence, armature 50 of relay 48 being at this time attracted, a locking circuit will be closed from grounded contact 20, wiper 21, attracted armature 50, relay 48 to battery and armature 51 continuing attracted, secondary magnet SM, will, on the retraction of its armature, became again energized moving wipers 21—23—25 to engage contacts 20—22—24 of the second line of the group. If this line is not calling, its contact 20 will be grounded and relay 48 will continue to be locked as before described, a third deënergization and energization of secondary magnet SM resulting, advancing the wipers the third secondary movement, and so on until contact 20 of the line of subscriber A is reached, which contact on account of the attracted condition of armature 11 of relay 9, is ungrounded, whereby locking circuit of relay 48 is destroyed, its armature retracted, opening circuit of secondary magnet SM and preventing further movement of wipers 21—23—25 which remain in engagement with the multiple contacts of the calling line. Armatures 49 and 52 were held attracted during the secondary movement of the wipers in order that wipers 23 and 25, which were then wiping over line contacts of the various lines, might be in-

sulated so that no disturbance of existing conversations could occur. Upon the deënergization of the relay 48, they will of course be retracted to extend wipers 23—25 to connection with the circuits of the first selector E. Contact 50, upon the deënergization of the relay, falling back to its normal grounded contact, completes a circuit from grounded contact 50, contact 21—20 and alternate contact 11, cut-off relay 12 to battery B, energizing the said relay 12 which, by the operation of its armature 13, completes a locking circuit for itself to the same ground at contact 50, while armature 14 completes a circuit from limb P through to wiper 23. Armature 15 removes the ground from the normal contact of armature 11 of relay 9, thereby preventing a permanent locking of relay 12 which would otherwise occur when a connector engaged contact 6 of the line. Armature 16 in its operation, opens the normal connection of battery B to limb S and completes the circuit of said line limb through to wiper 25, while armature 17 opens the previously extending series circuit through relays 9 and 18, causing the deënergization of both of them and the retraction of their armatures, that of relay 18 again grounding group contact 26. Since ground at armature 50 of relay 48 is now connected to the private contact 20 individual to the line, its multiples are now non-selectable by any other line selector.

The secondary off-normal switch S. O. Sw contacts 44—45 were shifted at the first energization of the secondary magnet SM, spring 45 interrupting the original energizing circuit for relay 48, while spring 44 interrupts a neutralizing circuit including resistance 36 hereafter described, and said spring 45 by engaging its alternate contact, operatively associates relay 48 with the normal contact of release switch spring 46 for use in the restoration of the line selector, as hereafter described.

It will be observed that upon the retraction of the armature of relay 37, which in its attracted position originally completed the neutralizing circuit for relay 28, a new path for continuing such neutralization had been completed by the shifting of switch spring 46 occurring on the first actuation of primary magnet PM, the new neutralizing circuit extending from the ground of said switch spring 46, its alternate contact, normal contact of switch spring 44, and resistance 36. This circuit is of course broken on the first energization of secondary magnet SM by the shifting of spring 44, but before that occurred, a third circuit was completed from ground at switch spring 46, its alternate contact, attracted armature 51 of relay 48 and resistance 36. This last circuit continued until the deënergization of relay 48, when the circuit of resistance 36 in the right-hand winding of relay 28 is opened at contact 51; but simultaneously with the opening of this circuit, relay 12 was operated and relay 9 deënergized, the retraction of the lower armature of the latter opening the circuit through the left-hand winding of relay 28. Thus, it will be observed that from the time the line selector starts, armature of relay 28 will remain retracted as far as line A and switch D are concerned, first because of the neutralized condition of the relay windings continuing until selection of the line, and thereafter because of the practically simultaneous opening of the neutralizing circuits of its windings. Thus an untoward attraction of its armature is prevented which, should it occur or exist after wipers 30 and 34 have reached contacts 31—35 of an idle line selector, would cause the initial operation of said selector to no avail, as there would be no calling line for it to make connection with.

The relation of the master-switch to the line selectors and the calling lines which it serves, is such that as many line selectors will be started to seek out calling lines as calls come into the exchange, and no more, except in certain rarely occurring instances. It will be observed that if three calls were to come in simultaneously, the resulting energization of the three relays 9, of the lines will cause three resistances 19 to be connected in circuit with the left-hand winding of relay 28, causing a greater current to flow therethrough than in the case of a single call. The starting of the first line selector throwing only one resistance 36 into circuit with the right-hand winding, will neutralize one only of these windings 19; therefore, the armature of relay 28 will continue attracted, and as soon as the wipers 30 and 34 reach contacts 31 and 35 of the next idle line selector, this switch will also be started; there will then be two windings 36 in circuit with the right-hand winding of relay 28, but there being three windings in circuit with the left-hand winding, its armature will continue attracted, and when wipers 30 and 34 reach the third idle line selector, this one will also be started in search of the third line. As soon as this switch starts, however, a third winding 36 will be included in circuit with the right-hand winding of relay 28. The three windings 36 will effectively neutralize the three windings 19, the armature of relay 28 will be retracted, and when wipers 30—34 engage contacts of a fourth idle line selector, this switch will not be started.

One of the rarely occurring instances above referred to where more than the required number of line selectors will be started may be imagined as follows: Suppose that the

positions of wipers 30 and 34 of the master-switch are such that the first and second steps will cause them to engage contacts of idle line selectors. Let it be also supposed that a call comes in from a line whose individual contacts are the 9th contact sets of the fifth rows in the line selector banks, and that a call simultaneously comes in from a line whose individual contacts are located in the seventh group or row of contacts. In such cases, a line selector D would start. Its starting would throw wipers 30—34 upon the contacts of the next line selector; relay 28 continuing energized owing to the inclusion of two windings 19, one for each calling line, would cause this second line selector to instantly start, and the two line selectors would be simultaneously performing their primary switching movements, the second one perhaps two steps behind the first one; relay 28 being then neutralized. The first line selector would reach group 5 and its wipers start their secondary movements along the group having nine steps to perform before reaching the calling line. Until the said line is reached, the selectable character of contacts 27 and 20 would of course continue. Obviously, the second line selector would reach the group contact of group five before the wipers of the first one reached the ninth contacts of the said group, and as a result, the wipers of the second line selector would begin wiping along the fifth row in search of the line contacts of the calling line. But the first line selector being two steps in advance would reach the contacts of the calling line first and render them unselectable so that the second line selector would continue, passing the said contacts to be released when it reached the end of the group by means of the switch spring 43, so arranged in the switch mechanism as to be shifted when the line selector is "over-run" on its secondary movement. In the meantime, wipers 30—34 have been moved to engage the contacts of the third line selector. This line selector has not been started since the armature of relay 28 was retracted. As soon however as the second line selector is released, its winding 36 is removed from circuit of relay 28 and winding 19 of the second calling line is therefore again effective to attract the armature of relay 28 and causes the operation of the third line selector, which proceeds in its orderly operation to select the second calling line. We thus have three line selectors operating to connect first selectors with the two calling lines. Taking into consideration the various factors necessary for the occurrence of the above described operation, it is apparent that even in the case of calls simultaneously coming in from a single group of one hundred lines to its master-switch, the above operation will very rarely occur.

The amount of time required for the operation of the line selector to connect with the calling line is exceedingly small requiring, (as will be more fully understood, when the mechanical features of the switches are described hereinafter) a maximum of thirty step-by-step movements under the most unfavorable condition, the switches being of such character that this number of steps can be performed in less than one second of time.

Subscriber A desiring his line to be connected with the line 3456, now operates calling device to transmit three impulses of current, by rotating the said device clockwise until three of its insulated teeth have passed below spring 3 and then releasing it whereon its associated spring turns the dial in the opposite direction, the three insulated teeth each causing spring 3 to engage and disengage its contact once. With the return of the dial to normal, its insulated tooth at the extreme left causes spring 2 to engage its associated contact a single time, thereby sending one impulse of current over limb S, but not until the last tooth at the right has sent the last impulse over limb P. While the dial is at any other than at normal position, the pin shown thereon is brought to such position that tension is removed from spring 4 which then disengages its associated contact temporarily conductively disuniting the two line limbs P and S at that point in order that impulses may be sent over the line limbs separately. The operation of the dial as described, sends three impulses of current from ground at the substation through spring 3 and its contact, over limb P of the line, through attracted armature 14, contact 22—23, armature 49, contact 54 at switch E, upper armature of relay 73, contact 55, through the winding of primary relay PR to battery causing the energizations and deënergizations of said relay whose thrice attracted armature, causes three impulses to flow from ground through armature spring 57 and its alternate contact, contact 58, primary magnet PM′, to battery. The three resulting energizations of PM′ move the first selector switch wipers 59—60—61 to positions adjacent to the third group of second selector contacts, terminals of second selectors belonging to the third thousand lines including those from 3,000 to 3,999. With the first primary movement of the wipers, the primary off-normal switch P. O. Sw′ contact, and the release switch RSw′ contact, are shifted to their alternate positions preparatory to the energization of the secondary magnet SM′.

With the return of the dial to normal, an impulse flows from ground at the substation through spring 2 and its contact over limb S of the line, through attracted arma-

ture 16, contacts 24—25, contact 52, through contact 62 at switch E, lower armature of relay 73, contact 64, winding of secondary relay SR, to battery, causing the attraction and release of said relay's armature and a flow of current from ground through spring 65 and its alternate contact, contact 66 and busy relay BR′, to battery. Contacts 67—70 are attracted to disconnect wipers 60—61 from battery while wiping over contacts of busy second selectors; armature 68 is attracted to close circuit from ground through the primary off-normal switch P. O. Sw′, the alternate contact of the release switch RSw′, alternate contact 68, secondary magnet SM′, to battery. The secondary magnet having a vibratory circuit, attracts and releases its armature, the operation being effective to move wipers 59—60—61 into engagement with contacts 86—87—88 of the first second selector of the group. With the first secondary movement of the wipers, the secondary off-normal switch S. O. Sw′ contacts 58—66 are shifted to operatively disconnect the windings of the primary magnet PM′ and of the busy relay BR′ from switch springs 57 and 65, respectively. If the second selector mentioned is idle, it will be in the condition shown in Fig. 1. Contact 86 being on open circuit, busy relay BR′ becomes deënergized, armature 68 opens the circuit of magnet SM′, and the wipers rest in engagement with the contacts of the first second selector; armatures 67—70 by their retraction render the said second selector responsive to current to be transmitted by relays PR and SR.

Armature 68 in engaging its normal contact, places direct ground through the primary off-normal switch P. O. Sw′ and release switch RSw′ contacts, normal contact 68, right-hand armature of RM′ and wiper 59 upon contact 86 of the second selector and its multiples to render the said second selector busy. It will therefore, result, that should the wipers of another first selector now be brought to engage multiples of contacts 86—87—88 of the first second selector switch F, busy relay BR′ of this other first selector then energized will have its circuit continued in this condition by current flowing from grounded contact 86 to its multiple engaged, the right armature contact of RM′, through attracted armature 69, of its busy relay BR′, through said relay to battery. The relay will therefore, continue to be energized. Secondary magnet SM′ by the retraction of its armature will have its circuit closed and become energized and deenergized a second time, moving the wipers 59—60—61 to engage the contacts of the second second selector of the group. If this be in use, another locking circuit for busy relay BR′ will be established as the preceding one is broken; SM′ advances the wipers a third step, and so on until contacts of an idle second selector are reached, when owing to the insulated condition of its contact 86, the deënergizing of BR′ ensues, preventing further operation of SM′, and the wipers come to rest.

Returning to the connection being established, subscriber A now operates dial I to transmit four impulses of current through relay PR over the above traced path, which said relay is operated four times transmitting four current impulses from ground through alternate contact 57, normal contact 67, contacts 60—87, normal contact 89, normal contact 91, primary magnet PM^2, to battery, causing four energizations of the said primary magnet. The said magnet thereby moves wipers 93—94—95 of the second selector adjacent to a group of contacts, terminals of connectors belonging to the fourth one hundred group of subscribers' lines of the third thousand, this including lines from 3,400 to 3,499. With the first movement of the wipers, the primary off-normal switch springs P. O. Sw^2, are shifted to their alternate positions and also the spring of the release switch RSw^2.

With the return of the dial to normal, a single impulse flows from ground at the substation through relay SR over the before traced path, said relay being energized and deënergized to transmit a current impulse from ground through spring 65 and its alternate contact, through normal contact 70, contact 61—88, contact 90, busy relay BR^2, to battery, energizing the said relay. Its upper armature and armature 98 place wipers 94 and 95 on open circuit, while armature 96 completes circuit from ground at the primary off-normal switch P. O. Sw^2 through the alternate release switch RSw^2 contact, attracted armature 96 and the winding of the secondary magnet SM^2, to battery, causing the energization of said magnet which is effective to cause wipers 93—94—95 to engage contacts 99—100—101 of the first connector of the selected group. If contact 99 belongs to an idle connector, it will be on open circuit as shown at C in Fig. 1. No locking circuit for relay BR^2 will result from the attraction of armature 97, and the armature of said relay falls back, the upper armature and armature 98, operatively connecting the circuits of the connector with relays PR and SR, rendering the connector controllable from substation A, while armature 96 opens the circuit of secondary magnet SM^2, leaving the wipers in engagement with the terminals of the first connector of the group, and, by the engagement of its alternate contact, said armature 96 places dead ground from the primary off-normal switch spring, alternate contact of release switch RSw^2, normal contact 96, normal contact of the right armature of release

magnet RM^2, contact 93—99 upon the multiples of the said contact 99 appearing at the other second selector banks, so that if another second selector F has its wiper 93 brought to engagement with a multiple of contact 99, its relay BR^2 will be locked by current from grounded contact 99 via alternate contact 97; secondary magnet SM^2, then advances the wipers to engage contacts, terminals of the second connector of the group. If this contact 99 belongs to an idle connector, the second selector will stop its secondary movement and the contact 99 will be rendered busy as described in connection with the second selector F, so that a third second selector seeking a connector in the same group will select the third connector of a group, and so on.

With the first secondary movement of the wipers 93, 94, 95, springs 89—90 of the secondary off-normal switch S. O. Sw^2 are shifted to operatively disconnect primary magnet PM^2 and busy relay BR^2 from relays PR and SR.

Subscriber A now operates dial I transmitting five impulses of current from ground at the substation through relay PR, causing five actuations thereof, which are effective to transmit five impulses of current from ground through alternate contact 57, contacts 67, 60—87, 94—100, normal contact 102, contact 103, through primary magnet PM^3 at the connector G to battery. Five resulting actuations of said magnet are effective to move wipers 105—106—107 to positions adjacent to a group of ten contact sets in their banks, forming terminals of the fifth group of the one hundred lines which the connector serves, namely: terminals of lines from 3451 to 3459 inclusive, followed by terminals of line 3450, it being understood that zero is represented by ten current impulses. With the first primary movement of the wipers, primary off-normal switch spring P. O. Sw^3 is shifted to operatively connect contact 99, via normal contact 122, with the winding of the release magnet RM^3 to place the same under control of the calling subscriber, as will be hereinafter more fully explained.

With the return of dial I to normal, a single impulse is transmitted after the last of the five preceding ones from ground over limb S through relay SR, traversing a before traced path, actuating relay SR a single time, whose armature is effective to transmit a single current impulse as follows: from ground, contacts 65, 70, 61, 88, 98, 95, 101, normal contact 108, lower armature of magnet RM^3 through secondary magnet SM^3, to battery. The secondary magnet SM^3 is thereby actuated a single time moving wipers 105, 106, 107 one step nearer the selected contact group, it being understood that the normal positions of the wipers of a connector are such that after any primary adjustment they are two steps distant from the first contacts of the group selected.

With the first secondary movement of the wipers, springs 102—108 of the secondary off-normal switch S. O. Sw^3 are shifted; 102, to engage its alternate contact, while 108 is shifted only sufficiently to disengage its normal contact; a second step of the wipers being required to shift it sufficiently to engage its alternate contact. This arrangement of spring 108 is for the following purpose: to prevent an otherwise possible premature operation of test relay TR which would occur were spring 108 completely shifted to engage its alternate contact before secondary relay SR had its armature retracted; current would then pass from grounded spring 65 of relay SR through alternate contact 108, lower armature of relay 109, left-hand winding of relay TR to battery, which would cause the energization and deënergization of relay TR and the consequent shifting of switch springs 110 and 111 of the test switch. The shifting of 111 would cause ringing relay 112 to be energized to include generator in circuit with wipers 106—107 which should properly be on open circuit during the other secondary movements to connect with the called line.

Subscriber A now operates dial I to transmit six current impulses from ground at the substation through primary relay PR, causing six actuations thereof and six current impulses to be transmitted from ground via spring 57, over the before traced path, contact 102, the impulses then passing via alternate contact 102, normal switch contact of upper armature of relay 109, lower armature of magnet RM^3, secondary magnet SM^3 to battery. The first resulting actuation of secondary magnet SM^3 moves wipers 105—106—107, now on their normal open circuit, to engage contacts 6, 7 and 8 of the first line of the group, or line 3451, and with this movement, the complete shifting of secondary off-normal switch spring 108 is accomplished. The succeeding five actuations of SM^3 are effective only to move wipers 105—106—107 successive steps, the sixth actuation causing them to engage contacts 6—7—8, multiple terminals of the called line 3456 belonging to subscriber B.

After the transmission of the last of the six impulses, a single impulse is, in the usual manner, caused to flow from ground at the substation over limb S to secondary relay SR whose actuation transmits an impulse from ground through contact 65 over the before traced path to contact 108, thence via its alternate contact and the normal contact of the lower armature of relay 109 through the left-hand winding of test relay TR, to battery, causing the said relay to attract its armatures. Let it be first assum

that the called line B is idle, in which case as shown, contact 6 is connected to battery B^2 through the winding of cut-off relay 12, there being no ground connection to the said contact except through battery. The attraction of the right-hand armature of test relay TR connected its right-hand winding from battery through said attracted armature, normal contact 104, normal contact 110, wiper 105, to contact 6, but since this contact is already connected to battery, upon the cessation of the impulse transmitted by secondary relay SR, test relay TR is deënergized, its armatures falling back, this being effective to shift springs 110 and 111 of the test switch TSw. The shifting of spring 110 connects ground to wiper 105, contact 6 and its multiples, completing circuit through cut-off relay 12 of called line B to battery. The resulting attraction of armatures 14 and 16 completes the circuit over limbs P and S of the called-for line to contacts 7 and 8. That of 14 also disconnects line relay 9 from limb P of the line, so that when the called subscriber B removes his receiver, the act is ineffective to operate relay 9 which would otherwise cause a line selector to select his line. The placing of ground just described upon contact 6 and its multiples from spring 110, renders the called lie busy with respect to other connectors as will be hereafter more fully explained, ground from contact 6 being also connected via armature 13 to contacts 20 of the called line keeping them unselectable in character.

The shifting of test switch (TSw) spring 111, completes circuit through relay 109 from ground, spring 111, contact 115, ringing relay 112, to battery B^2. On the resulting attraction of the armatures of relay 109, a circuit is completed from ground through normal contact of the lower armature of relay 117, normal contact 119, attracted armature of relay 109, alternate contact 102, contacts 100—94, 87—60, contact 67, normal contact 57, contact 71, magnet 73 to battery, causing the energization of said magnet 73 whose attracted armatures complete a bridge of battery B′ in the line of subscriber A from ground through upper windings of relays 74 and 75, attracted upper armature of relay 73, contact 54, to the left over the heavily marked conductor, to limb P through the transmitter at the substation, returning over limb S and the other heavily marked conductor, contact 62, attracted lower armature of relay 73, lower windings of relays 75 and 74 to battery. Differentially connected relay 74 is not energized, the flow in its two windings being equal but cumulatively connected relay 75 attracts its armatures of which 56 and 63 complete parallel paths from ground and battery to limbs P and S respectively, while contacts 55 and 64 disconnect relays PR and SR from the talking circuit.

Having explained the effect of the shifting of spring 111 at G with respect to the first selector, I will now describe its effect with respect to the called line. Its shifting energizes ringing relay 112 over a before traced circuit and the attracted armatures of said relay cause alternating current to flow from generator G^2, upper armature of relay 112, contact 106–7, alternate contact 14, limb P of the line of B, normal hook switch contact, bell and condenser, limb S, alternate contact 16, contact 8, 107, attracted lower armature of relay 112, lower winding of relay 113 through battery B^2. The interrupter I^2 is provided in the circuit of generator G^2 so arranged as to periodically connect the said generator in and out of circuit with said line, in the well-known manner. It will be observed however, that the brushes of I^2 are so arranged that at all times during the ringing, ground is connected to limb P of the rung line either through generator or the grounded brush of the interrupter.

It should be observed that the character of relay 113 is such that the flow of generator current through the substation condenser does not actuate the relay. As soon, however, as the called subscriber answers the call by removing his receiver, the substation hook lever engages its alternate contact completing a conductively continuous circuit from ground through generator G^2 or interrupter I^2, as the case may be, to limb P over the before traced path for ringing current, the alternate contact of the hook lever and through the transmitter, returning over the limb S and thence over the before traced path and the lower winding of relay 113 to battery B^2. Current flowing over this conductive circuit, energizes relay 113 whose attracted armature 114 first completes, by engaging spring 115, a locking circuit including serially the already energized relay 109 and the upper winding of relay 113 causing both relays to remain energized, the said armature immediately thereafter breaking the normal contact 115, thereby effecting the deënergization of ringing relay 112 and the immediate exclusion of generator G^2 from connection with the called line. The attraction of the lower armature and armature 116 of relay 113 bridges relay 117 across the called-for line, which relay is immediately energized by current flowing over said line. The lower armature of relay 117 disengages its normal contact whereby the before traced circuit through magnet 73 at E is interrupted and the said magnet is deënergized, the consequent retraction of its armature shifting springs 54—71 and 62—72 to their alternate positions. The deënergization of 73 does not effect the continued energization

of relay 75 on account of the parallel path of current before indicated through said relay. Springs 54 and 62 in disengaging their normal contacts prevent relays PR and SR from again being connected to the calling line by the retraction of the armatures of 73, and in engaging their alternate contacts, said springs 54—62, complete the talking circuit of switch E. Spring 72, in engaging its alternate contact completes a path for energizing relay 76, which relay by the attraction of its armatures 76^a and 79 to engage their associated contact springs, thereafter breaking the normal contacts of said springs reverses the connections of battery B to the calling line, causing a reverse flow of current thereover through the substation. This reversal of direct current over the calling line occurring when the called subscriber answers the call, may profitably be employed for various purposes, as for instance, in connection with the polarized structure shown in Fig. 5 of my United States Letters Patent, #830,653, issued September 11, 1906.

The attraction of armature 77^a energizes printing magnet 77 which thereupon by the aid of its associated mechanism prints the number of the calling line recording a completed call against it.

Returning now to relay 117 at G, having explained the effect of the lower armature of said relay in disengaging its normal contact, it will be observed that the said armature engaging its alternate contact, completes a circuit from ground through relay 118, said relay 118 by the attraction of armature 121, establishing a locking circuit for itself through switch spring 110 of the test switch TSw to ground. Armature 119 completes the talking circuit to wiper 106; armature 120, closes a break in the circuit of release magnet RM^3, while armature 122 in leaving its normal contact removes the previously existing control of release magnet RM^3 from the calling substation, and by engaging its alternate contact, places an independent ground upon contact 99 and its multiples, so that the connector is now rendered unselectable by any other second selector until both subscribers have replaced their receivers, which will be hereafter more fully explained.

The two subscribers A and B are now in conversation, circuit being traced from substation A to substation B by means of the heavily marked conductors and condensers 81—82 through the exchange, talking battery being supplied to the calling line through the impedances of relays 74—75 and to the called line through the impedances of relay 117 at the connector.

When the subscribers have finished their conversation, they replace their receivers upon the hook levers, the act of subscriber B in so doing restores the connector G to normal, while the act of subscriber A in so doing, restores line selector D, first selector E and second selector F to normal. The purpose of dividing the control of the release in this manner may be seated as follows: Primarily, it is of course desirable that each subscriber be able to free his line from any switch connected to it lest, should one subscriber have sole control of the release, he might by carelessly or maliciously failing to hang up his receiver, hold the other line busy preventing its use. The control of the release of the connector by the calling subscriber, after the called subscriber has answered, is preferably prevented because were it allowed, when the calling subscriber replaced his receiver first thereby causing wipers 105—106—107 of connector G to leave contacts 6—7—8 of the called line, it would result that upon the breaking of contact 105—6, cut-off relay 12 of the called line would be deënergized and upon the retraction of its armatures, the substation receiver at B being off the hook, relay 9 of the called line would be energized causing the selection of the line by one of the associated line selectors. The called subscriber B, would of course be replacing his receiver at about this time, and if he replaced it before the line selector completed the selection, the said selector would come to rest in connection with the line, and so remain rendering the line busy against in-coming calls, etc.

Were the called subscriber enabled, by replacing the receiver, to restore all of the switches used in the connection including the line selector connected to the calling line, the inconvenience pointed out in the preceding paragraph would be duplicated.

In consequence of the division of the release operations indicated, the armature 122 and its grounded alternate contact is provided which is effective as soon as a called subscriber answers, to place a second ground upon contact 99 of the connector and its multiples, in addition to the ground already placed upon said contacts by the operation of the second selector lest, should the calling subscriber release the second selector, (thereby opening contact 99—93 before the called-for subscriber B replaces his receiver), another line selector F in connection with another calling line, seeking an idle connector in the same group, might select the connector already connected to called line B. It will be thus seen that although subscriber B has independent control of the restoration of switch G and subscriber A has independent control of the release of the other switches, D, E and F, the coöperation of both is required to remove the busy potential from the private contact 99 of the connector.

I will now trace in detail the release operation occurring when the subscribers replace their receivers. When subscriber B does so,

the operation of arm 5 of the hook lever upon its associated contact springs, momentarily grounds limbs P and S in the usual manner, but this operation is not used to cause the release at the called substation. The replacing of the receiver causes the hook lever to disengage its alternate contact opening circuit through relay 117, held energized by current over the line during conversation. The upper armature of relay 117 then falls back, and completes a circuit through release magnet RM^3 from ground through contact 120 of relay 118, upper armature contact of relay 117 to battery, effecting the energization of the release magnet whose armature is thus attracted, shifts the switch springs 110—111 to normal, opening the circuit of relays 109, 113 and 118 causing their deënergizations. The deenergization of relay 118 opened the circuit of the release magnet RM^3 whose armature thereupon is retracted and wipers 105—106—107 allowed to return to normal, their restoration causing, on its completion, the shifting to normal of the primary off-normal switch P. O. Sw^3 the secondary off-normal switch springs S. O. Sw^3 being restored at the time the wipers have been restored as to their secondary movements. When the calling subscriber replaces his receiver, arm 5 temporarily grounds limbs P and S of the line, the grounding of limb S short-circuiting the upper winding of differential release relay 74, and, current continuing through the lower winding of said relay to ground at the substation, its armature is attracted to complete circuit through release magnet RM at switch D; from ground, attracted armature of relay 74, release magnet RM′ of switch E to battery. The attracted right-hand armature of release magnet RM′ closes circuit through release magnet RM^2 at second selector F from ground through the shifted primary off-normal switch P. O. Sw^2 contact, contact 86—59, attracted armature of RM′ to battery. The release magnets of all the switches D, E and F, are now energized and their energizations shift to normal the various release switches RSw, RSw′ and RSw^2, the shifting of said switches causing respectively the energizations of relays 48, BR′ and BR^2, whereby the wipers of the various switches are disconnected from battery and so held during the release of the switches. In the restoration of the hook lever at substation A, arm 5 passing from the top of its associated contact spring, removes ground from the two limbs of the line and the armature of relay 74 returns to normal deënergizing release magnets RM and RM′, the deënergization of RM′ opening the circuit of RM^2. The deënergizations of the various release magnets RM, RM′ and RM^2, cause the restoration of the wipers of the various switches with which they are associated. When the switches have reached normal as to their secondary movements, the secondary off-normal switches S. O. Sw, S. O. Sw′ and S. O. Sw^2 are restored; when the wipers have been restored as to their primary movements, the primary off-normal switches P. O. Sw, P. O. Sw′ and P. O. Sw^2 are restored. The restoration of the primary off-normal switches respectively cause the deënergizations of relays 48, BR′ and BR^2, reëstablishing the normal connections of the wipers. It should be noted that the armatures of RM when attracted keep the line limbs P—S connected to the windings of relay 74, while the energization of relay 48 by armature 50 holds relay 12 energized.

Assuming now that, at the time wipers 105, 106 and 107 came to rest engaging contacts 6, 7 and 8 of the called line, this line was a busy line. In such case, ground will be connected to contact 6 and its multiples via the shifted test switch TSw, contact 110 of another connector (if the busy line be a called line), or via armature 13 pertaining to the busy line, its contact 20, wiper 21 of a line selector then connected thereto, to ground through contact 50 at the said line selector (if the busy line be a calling line). In either case, upon the energization of the test relay TR at switch G, as before described, the said relay, instead of being thereon deënergized, will have its armature locked in their attracted positions by current from grounded contact 6, wiper 105, normal contact 110, contact 104, right armature of relay TR, its right winding to battery. The test switch contacts therefore remain at normal and a busy signal is transmitted to the calling subscriber from interrupter I through the induction coil and condenser, left armature of relay TR, normal contact of lower armature of relay 109, to the left over the talking circuit indicated by heavy lines to switch E, via normal contact 70, condenser 83, to the left over the heavily marked talking conductor, limb S of the line of A, through the transmitter and the primary of the induction coil, causing an audible signal in the receiver, returning over limb P, to the right over the upper talking conductor, normal contact 54, normal contact of relay 73, armature 55, relay PR through battery B. The calling subscriber, in response to this signal, replaces his receiver, momentarily grounding the two limbs of his line. Inasmuch as relay 73 has not been energized, relays PR and SR are still operatively connected to line limbs P and S respectively and they are therefore, on the grounding of the line limbs, both simultaneously energized to close contact 84—85. Circuit is then completed from ground at release magnet RM of the line selector, contact 85—84, release magnet RM′ of the first se-

lector to battery. RM' attracts its armature, closing circuit from ground at release magnet RM^2 of second selector F, through alternate contact of primary off-normal switch P. O. Sw^2, contact 86—59, attracted armature of RM' to battery. The attracted armature of RM^2 closes circuit from ground through RM^3 at the connector, normal contact 122, the shifted contact of primary off-normal switch P. O. Sw^3, contact 99—93, attracted armature of RM^2 to battery. The armatures of all the release magnets are now attracted; and when ground is removed from the two line limbs at substation A, the resulting deënergization of relays PR and SR allows contact 84—85 to be opened, deenergizing RM and RM'; the deënergization of the latter deënergizing RM^2; the deënergization of RM^2 deënergizing RM^3; and each switch is restored as its release magnet RM, RM', etc., is deënergized. Thus it is seen that until the called subscriber answers the call, the release of the connector remains under the control of the calling subscriber; the instrumentality controlled by the called subscriber for removing the calling subscriber's control of RM^3, consists of armature spring 122 of relay 118, which, when actuated, by disengaging its normal contact, opens a contact in the circuit of RM^3 and thereafter puts the second busy potential upon contact 99, as before described.

From the release operations already described, it is apparent that as soon as the line selector has selected his line, the calling subscriber may by grounding the two line limbs simultaneously cause the closure of contact 85—84, which will be effective to release whatever switches are connected to his line, so that, whatever stage of completing a connection may have been reached, the release of all switches so far operated may be secured.

As before indicated, it may sometimes happen that a line selector will over-run on its primary or secondary movement through accident or certain rarely occurring combinations of circumstances. To take care of these occurrences, I have provided the two switch springs 43 and 53; the former being so related to the switch mechanism that, if the switch shall make an eleventh primary movement, the contact 43 will be closed; while if the switch makes an eleventh step in its secondary movement, the contact of 53 will be closed. In either case, a circuit will be completed from ground through the release magnet RM, contact 43 or 53, as the case may be, alternate contact 47 of the release switch RSw to battery, energizing release magnet RM, upon whose energization the release switch RSw will be shifted to normal, spring 47 then opening the circuit of release magnet RM, whose deënergization causes the restoration of the line selector.

Referring to armatures 78 and 80 of switch E controlled by relay 76: Their function is to take care of certain difficulties which might occur were they omitted, being as follows: Assuming that the called subscriber has answered the call, causing the energization of relay 76, then it will be remembered that current flows from ground at E, upper windings of relays 74—75, attracted armature 56, attracted armature 79, over the talking circuit to limb S, returning over limb P, attracted armatures 76^a and 63, to battery through the lower windings of relays 75 and 74. It is thus seen that the circuit energizing relay 75 is traced through its own armatures 56 and 63 and the calling line. Assuming that during conversation the calling subscriber accidentally moves his dial 1 from normal, the resulting opening of his line circuit at contact 4 would deënergize relay 75; its armatures 56 and 63 would fall back; and when the line at A was again closed conductively, relay 75 would continue deënergized so that when the subscriber replaced his receiver, differential release relay 74 would be out of operative relation with his line. Armature contacts 78 and 80 are therefore provided, controlled by relay 76 (which is only deënergized when the release of the first selector actually occurs) establishing, when attracted, a parallel path for current through the windings of relays 74 and 75, the armatures 56 and 63 being excluded from this circuit so that an accidental opening of the line circuit at the substation of the calling subscriber, causing temporarily the deënergization of relay 75, does not put the central office apparatus in such condition as to prevent the said relay 75 from becoming again energized when the substation circuit is again closed.

Referring now to the mechanical drawings, as shown in Fig. 2, a preferred form of the master switch, the contacts 31 and 35 are the terminals of the line selectors, while the contacts 30 and 34 extend around under the respective rows of contacts 31 and 35, the wipers 30^a and 34^a (Figs. 2 and 3) having in themselves no circuit connections, being employed only to successively cross the individual contacts 31 and 35 to the respective common contacts 30 and 34, leading (as shown in Fig. 1) to the armatures of relays 29 and to relays 32. The said wipers 30^a and 34^a are fastened to a rotatable ratchet 30^c adapted to be driven, step-by-step, by the armature-actuated pawl 30^b of magnet 33, the magnet being provided with an interrupter actuated by its armature, as shown.

A line selector (Figs 4, 7, 8 to 11 inclusive), comprises essentially ten group contacts 26 and a group wiper 27, making primary movements only, a contact bank including one hundred sets of contacts 22, 20,

24, arranged in ten groups of ten sets of contacts each, a set of wipers 23, 25, 21, capable of primary movements to select a group and secondary movements in an intersecting plane to select a contact set of a group, a primary off-normal switch P. O. Sw comprising switch springs shifted on the first primary movement of the wipers, a secondary off-normal switch S. O. Sw comprising switch springs shifted on the first secondary movement of the wipers, a release switch RSw comprising springs shifted on the first primary movement of the wipers, a primary over-run switch shifted when an eleventh primary movement takes place and a secondary over-run switch shifted when an eleventh secondary movement takes place.

A sectional view of a bank seen from the left is given in Fig. 9 and a front view in Fig. 10, a contact set 22, 20, 24 (Fig. 9) being indicated by a single short line in Fig. 10. The one hundred sets of contacts, as indicated in Fig. 10, are arranged as if projecting through the inner surface of a section of a hollow sphere.

In their primary movements, the wipers 23, 25, 21 are rotated step-by-step from left to right, each step bringing them opposite a different group or upright section of ten contact sets; and in their secondary movements, the wipers are rotated step-by-step upward over the contact sets of the selected row, successively engaging them.

The wipers are pivoted at 23^b to a bearing 23^a, clamped to a rotatable primary shaft PS suitably journaled to the main frame; while a rearwardly extending portion of the wipers, provided with a roller, engages a broad piece 160 fastened to the secondary shaft SS, the secondary movements of the wiper ends being effected by the downward movement of shaft SS, piece 160 rotating the wipers about the pivot at 23^b.

A suitable spring 161 is fastened to the primary shaft PS against whose tension it is turned, while spring 23^c is fastened to the wipers against whose tension the secondary movements are performed. These springs serve, when the switch (by the withdrawal of the retaining detents hereafter described) is released, to restore the primary and secondary shafts and consequently the wipers.

The auxiliary or group selecting wiper 27 is fastened to the primary shaft, being solely controlled thereby, and has its row of group contacts 26.

The primary off-normal switch P. O. Sw comprises an arm fastened to the primary shaft and provided with a stud of insulating material, as best shown in the top view (Fig. 8), holding springs 42, 41 and 40 in their normal positions, shaft PS under the influence of spring 161 pressing the stud against spring 42. The first step of the shaft, which is clockwise, moves the stud away from spring 42 and the three springs 42, 41 and 40, by their own tension, are shifted to the alternate position.

The operation of the primary over-run switch will be understood from an inspection of Fig. 7, wherein shaft PS is at normal. The movement of the shaft in the operation of the switch is clockwise, and stud 43^a on the eleventh clockwise step of shaft PS comes against and presses the spring 43 of the primary over-run switch to engage its alternate contact.

The secondary off-normal switch is best shown at S. O. Sw in Fig. 10 comprising an arm clamped to secondary shaft SS extending to the right to hold, in its normal raised position, a stud of insulating material extending through the switch frame and engaging the secondary off-normal switch springs 44 and 45. With the first step of secondary shaft SS, downward in direction, the arm of the secondary off-normal switch is brought downwardly so that springs 44 and 45 press the stud down and engage their alternate contacts.

The secondary over-run switch comprises the stud 53^a fastened to secondary shaft SS and so placed that on the eleventh secondary movement it engages spring 53 and presses it into engagement with its associated contact.

For rotating the primary shaft PS, a circular ratchet 124 (Fig. 4) is provided, adapted to be turned step-by-step by the armature-driven pawl 123 of primary magnet PM, whose vibratory circuit-breaker is indicated at 126.

As well shown in Fig. 9, the secondary shaft SS has cut on its inner surface a ratchet adapted to be engaged by the armature-driven pawl 127 of secondary magnet SM, by successive thrusts of which the shaft may be moved downwardly. The secondary magnet has, like the primary magnet, its armature-actuated circuit-breaker.

A pivoted retaining detent is provided for each shaft, that of the primary shaft being indicated at 125 of Fig. 4 and that of the secondary shaft at 128 (Figs. 4 and 11). These detents have rearwardly extending portions normally engaged by orifices in release arm 130 (Figs. 4 and 11) and are by said arm normally held away from their respective ratchets. On the first actuation of primary magnet PM, its armature effects movement of the pivoted member 132 (see Fig. 4) whose roller end (see Fig. 11) tilts pivoted arm 131 to lift arm 130 to disengage detents 125 and 128 when their associated springs move them to engage their ratchets. They then serve to hold their respective shafts against back movement, keeping them

in whatever position they may be placed by the primary or secondary magnets.

The release switch springs 46 and 47 (Fig. 11) are held in their normal positions by a hook at one end of arm 131. The first actuation of primary magnet PM, by operating arm 132, tilts the right end of arm 131 down, spring 46 is released and the two springs 46 and 47 by their tension move to engage their alternate contacts.

The release magnet RM has (as best shown in Fig. 11) a pivoted arm 130 whose left end an associated spring tends to depress. On attraction of the armature of RM, arm 130 is drawn to the left, two orifices therein (shown in the top view, Fig. 4) slipping over the rearwardly extending portions of detents 125 and 128. At the same time, the button of insulating material on the right end of arm 130 restores springs 46 and 47 by engaging spring 46 to move it to be caught and held by the hook of arm 131. When magnet RM is now deënergized, its retracted armature draws arm 130 to the right, which, keeping its hold on detents 125 and 128, moves them away from their shaft ratchets so that the shafts are now free to be restored, shaft SS by spring 23ᶜ fastened to the wipers, and shaft PS by spring 161.

A spline 170 (Figs. 4 and 9) is provided on the secondary shaft engaging with the first movement thereof any adjacent tooth of ratchet 124 to hold the primary shaft against return movement, to the end that on the restoration of the shafts as described, the secondary shaft may be first completely restored clearing the wipers from the bank, whereon spline 170 releases the primary shaft and permits its restoration.

The primary and secondary off-normal switches are of course restored by the respective shafts when they reach normal, the restoration of the secondary one occurring first.

Recapitulating the principal operations; the first actuation of primary magnet PM rotates the wipers a step, shifts the primary off-normal switch, releases the primary and secondary shaft detents and shifts the release switch. Subsequent actuations of said magnet serve only to advance the wipers successive primary steps, until a possible eleventh step when the over-run switch is shifted.

The first actuation of secondary magnet SM advances the line wipers a secondary step, shifts the secondary off-normal switch, and interlocks spline 170 with ratchet 124. Additional actuations of said magnet merely advance the line wipers additional secondary steps until a possible eleventh step when the secondary over-run switch will be shifted.

The release magnet when energized shifts the release switch to normal, and when deenergized withdraws the shaft detents, restoring the switch.

The mechanism associated with magnet 77 of Fig. 1, Part 1, is shown in detail in the top view (Fig. 15). It includes the suitably pivoted feed-spool 145 carrying a supply of inked ribbon 153 and record ribbon 152 which may be of paper in alternate layers, and the receiving-spool 140 to which is fastened ratchet 141, operated, to wind the ribbons off the feed-spool onto the receiving-spool, by the pawl 142 fastened to arm 150 upon armature 143, the attraction of said armature serving to draw pawl 142 to the left to engage the next tooth of ratchet 141, so that, on the retraction of the armature, pawl 142 rotates ratchet 141 and spool 140 a step.

Armature 143 carries a hammer piece 144 whose momentum is effective, on the attraction of 143, to give a rebounding blow upon the portions of ribbons 153 and 152 that are adjacent to the hammer, printing upon record ribbon 152 whatever number upon the curved type frame 146 may, by the operation of the line selector, have been brought opposite the hammer 144.

The general conformation of type frame 146 and its association with the primary and secondary shafts will be seen in Fig. 15 and Figs. 9, 10 and 11.

The cylindrical bearing of frame 146 is splined to primary shaft PS (as shown in Fig. 15) so that it is rotated with the shaft, but is free to move down and up thereon. The lower edge of the frame 146 is pressed against a projection 149 on secondary shaft SS (Fig. 15) by a spiral spring 147 shown in Figs. 9, 10 and 11, to the end that when shaft SS is worked downwardly in the operation of the line selector, spring 149 may move the type frame 146 a corresponding extent downward.

The type numbers corresponding to the respective tens and units values of the subscribers' lines in their respective hundreds are to secure greater spacing, preferably arranged in ten vertically disposed double columns, as indicated in Figs. 10 and 11, numbers 11, 12, 13, 14, etc., comprising a double column.

Assuming that subscriber 9924 makes a call, the primary shaft SS of the line selector, Fig. 12, makes of course two rotary steps which bring the column of numbers including 21, 22, 23, etc., to a position directly above the hammer end 151, (Fig. 15). The secondary shaft SS then makes four downward steps to bring the wipers to connect with the contacts of the line, and spring 147 causes the type frame to descend correspondingly, number 24 being thereby

brought directly opposite the end 151 of hammer 144. Similarly, if any other subscriber makes a call, the line selector operating will, with the adjustment of its wipers, move its type frame so that the type number corresponding to the number of the calling line is adjusted to the hammer. When a line selector is restored, its shafts of course restore the type frame to normal.

Telephone subscribers on measured service are usually charged only for such calls as are answered, and to conform to this practice I have so arranged the circuits of my system that printing magnet 77 is only operated in case and at the moment when the called subscriber responds. At that time it will of course record the number of the calling subscriber on ribbon 152. When the calling subscriber at the end of conversation causes the first selector to be restored, magnet 77 is deënergized and pawl 142, turning spool 140, brings fresh spaces of ribbon in front of hammer end 151 ready to print the next number.

Since the line selectors belong to a particular one hundred lines, it is necessary, in order to get a permanent printed record of each completed call over a line, to place upon the type frames of the ten line selectors only the last two digits of each subscriber's number, the line selector itself indicating the thousands and hundreds digit.

It is apparent that only one thousand call recorders are required for ten thousand subscribers' lines, a material saving over recorders individual to lines.

The mechanism of the first selector is, in general, similar to that of the line selector. The vibratory interrupter of the primary magnet and the measured service mechanism are omitted.

The primary off-normal, secondary off-normal and release switches are controlled in a manner similar to those of the line selector, and the adjustment of the line wipers is mechanically similar. The spring combinations of the various off-normal and release switches correspond of course to those indicated at E in Fig. 1.

In Figs. 5 and 6 is shown the mechanism associated with the first selector for shifting springs 71, 54 and 72, 62, described in connection with Fig. 1. Said springs are mounted as indicated in Fig. 5, the view showing the springs at normal. The two insulated studs 135 are drawn to the left to shift the springs, and when they are freed the tension of the springs restores the studs and springs. The studs 135 are fastened to an arm 134 (Fig. 6), pivoted as shown, and having a small projection on its lower extremity adapted to be engaged by the hook of arm 133 when the armature of magnet 73 is attracted. When said magnet is thereafter deënergized on the response of the called subscriber, its retracted armature causes arm 133 to draw the lower portion of member 134 to the right, whereby studs 135 move to the left to shift their springs.

The operation of release magnet RM′ is similar to that of magnet RM of the line selector, except that its armature carries an arm 136 adapted, when the armature is attracted, to engage and lift hooked arm 133 free of member 134, thus allowing the restoration of studs 135.

It will be remembered that the shifting of spring 72 (see Fig. 1) energizes relay 76, whose energization causes that of the printing magnet 77. The latter should preferably not be operated when a calling subscriber has connected his line with an idle called line and fails to secure an answer. Under such circumstances, magnet 73 is energized as soon as connection is made with the called line, and its deënergization follows when the calling subscriber replaces his receiver, causing the energization of release magnet RM′, which, by shifting spring RSw′, energizes relay BR′ whose armature opens the circuit of magnet 73. The previous energization of 73 has caused arm 133 to engage member 134 (see Fig. 6). The energization of magnet RM′, preceding the deënergization of magnet 73, is effective to cause arm 136 to lift arm 133 free so that the deënergization of magnet 73 (occurring while magnet RM′ remains energized) is ineffective to move member 134; spring 72 and the other associated springs remaining at normal, whereby an improper operation of magnet 77 is avoided.

The second selector is mechanically similar to the first selector, except that magnet 73 is not employed, the various off-normal and release spring combinations being arranged as indicated at F in Fig. 1.

The connector shown in Figs. 12—13—14 inclusive is generally similar to the first selector. No vibratory circuit-breaker of the secondary magnet SM^3 is provided and the positions of the wipers with respect to the contact bank is such that two secondary steps are required to cause the wipers to engage the first contact set of a selected row for the purposes hereinbefore indicated.

The mechanism of test relay TR is best shown in Fig. 14. The test switch springs 110—111 are preferably vertically disposed and arm 137, carried by the armature of relay TR, has a raised portion adapted, when the armature is attracted, to clear spring 111, the spring associated with arm 137 then causing the upraise to engage said spring 111. On the deënergization of relay TR, the springs 111 and 110 are of course shifted by arm 137 for the purposes hereinbefore indicated. When release magnet RM^3 attracts its armature, piece 138 fas-

tened thereto draws arm 137 down so that its upraise frees spring 111 and the two springs 110, 111 by their tension return to normal. Moreover it will be observed that when test relay TR is locked because the switch wipers have engaged terminals of a busy line, the energization of the release magnet RM^8 (occurring when the calling subscriber replaces his receiver) will be effective by piece 138 to withdraw arm 137 from engagement with spring 11 so that the springs remain unshifted.

It is to be understood that Fig. 1 is a purely symbolical diagram, the various conductors, relays, armatures, etc., being indicated by conventional signs, no attempt being made to indicate mechanical structures therein or particular types of apparatus, as those skilled in the art will readily supply the mechanisms best adapted for practising the invention.

Similarly, any known or approved mechanical combinations may be employed in place of the particular combinations I have elected to illustrate in the mechanical drawings, and I do not intend to limit my invention to switches having movements in intersecting planes.

The various batteries illustrated at B, B' and B^2 may, if desired, be a single battery.

It is my intention not to limit the scope of my invention, as defined in the claims, to the particular structures and circuits herein illustrated, nor to a purely automatic telephone system, but what I claim is:

1. A telephone system including a group of telephone lines, a line relay for each of said lines at the exchange, a group relay common to the lines of the group, a further division of said groups into sub-groups, a sub-group relay common to the lines of a sub-group, means for operating the line relay of a line initially by currents controlled at the substation, a circuit for said group relay controlled by said line relay, and a locking circuit for said line relay including said sub-group relay.

2. A telephone system including a group of telephone lines, a line relay for each of said lines at the exchange, a group relay common to the lines of the group, a further division of said groups into sub-groups, a sub-group relay common to the lines of a sub-group, means for operating the line relay of a line initially by currents controlled at the substation, a locking circuit for said line relay including said sub-group relay, a plurality of line selectors each adapted to connect with any of said lines, mechanism responsive to said line relay for operating the group relay, and apparatus controlled thereby for starting an idle one of said line selectors.

3. A telephone system including a pair of telephone lines, a link-circuit connecting said lines for conversation, a multiple terminal associated with said link-circuit, two connections thereto each rendering said terminal independently busy, two manually controlled switches requiring to be operated to free said lines from said circuit, and means responsive to the operation of each switch for removing one of said connections.

4. In a telephone system the combination with a multiple terminal contact at the exchange, of two connections each rendering the multiples of said contact independently busy, a substation, a manually controlled switch thereat, mechanism responsive thereto for removing one of said busy connections, a second substation, and a manually controlled switch thereat for controlling the removal of the other of said busy connections.

5. In a telephone system the combination with a multiple terminal contact, of two connections each rendering the multiples of said contact independently busy, a substation, a manually controlled switch thereat, mechanism responsive thereto for removing one of said busy connections, a second substation and means thereat for controlling the removal of the other of said busy connections.

6. In a telephone exchange system, a link-circuit, multiple terminals at one end thereof, an automatically operated connection terminal adapted to be temporarily applied to a multiple terminal of said link-circuit, means for thereby altering the electrical condition of said multiple terminals to render them busy, a line circuit having a manual switch associated with the other end of said link-circuit, and means responsive thereto for holding said multiple terminals in their altered or busy condition after said connection terminal is removed therefrom.

7. A telephone system including telephone lines and terminals therefor at the exchange, a link-circuit having a connection terminal adapted to be applied to terminals of a called line, multiple terminals for said link-circuit, means including a selective switch for connecting said link-circuit with a calling line, apparatus pertaining to said selective switch for completing a connection to establish a changed electrical condition of said multiple terminals to render them busy, and means pertaining to said link-circuit for establishing, when said circuit is used, an additional connection to said multiple terminals to render them independently busy.

8. A telephone system including a pair of connected telephone lines switched to conversational relation, a plurality of selective switches employed in connecting said line, means whereby the calling subscriber may restore a portion of said switches, means

whereby the called subscriber may restore another portion of said switches, and a multiple contact at the dividing point of said portions having a busy indication removable only by the restoration of both said portions.

9. A telephone system including a calling line and a called line, a plurality of selective switches at the exchange adapted to be successively operated responsive to currents over the calling line to connect said lines, a selector included among said switches, a connector included therein having multiple terminals adapted to be engaged by said selector and thereby rendered busy, mechanism associated with said connector adapted to place a busy indication upon its said multiple terminals, and apparatus to render said mechanism effective on the response of the called subscriber.

10. A telephone system including a calling line and a called line, a plurality of selective switches including a directively controlled selector and a directively controlled connector adapted to be successively operated responsive to currents over the calling line to connect said lines, means responsive to the replacing of the receiver upon its switchhook at the calling substation prior to a response being had from the called substation for releasing said selector and connector, and apparatus to remove the control of the restoration of said connector from the calling subscriber and turn said control to the called subscriber effective when the call is answered.

11. A telephone system including a calling line and a called line, a plurality of selective switches including a selector and a connector adapted to be successively operated responsive to currents over the calling line to connect said lines, multiple terminals for said connector, mechanism associated with said connector adapted to place a busy indication upon its said multiple terminals, and apparatus to render said mechanism effective on the response of the called subscriber.

12. A telephone system including a calling line and a called line, a plurality of selective switches at the exchange adapted to be successively operated responsive to currents over the calling line to connect said line, a selector included among said switches, a connector included therein having multiple terminals adapted to be engaged by said selector and thereby rendered busy, mechanism associated with said connector adapted to place a busy indication upon its said multiple terminals, apparatus to render said mechanism effective on the response of the called subscriber, means whereby the calling subscriber controls the restoration of said selector and connector prior to a response of the called subscriber, and apparatus to render said mechanism effective and to remove the calling subscriber's control of the restoration of said connector when the called subscriber responds.

13. An automatic telephone system including a connector, a multiple terminal thereof, a selector temporarily applied to said terminal rendering its multiples busy, a called subscriber's line operatively connected with said connector, switching mechanism associated with said connector adapted to render the multiples of said terminal additionally busy, and means controlled at the called substation to render said mechanism effective.

14. An automatic telephone system including a pair of telephone lines, a plurality of selective switches successively employed by the calling subscriber and connecting said lines, a multiple contact pertaining to one of said switches, a busy indication placed thereon by the calling subscriber in the process of establishing the connection, and mechanism included in said one of said switches for placing an additional busy indication upon said contact.

15. An automatic telephone system including a pair of telephone lines, a plurality of selective switches successively employed by the calling subscriber and connecting said lines, individual driving mechanism for each of said selective switches for use in establishing said connection, means to enable the calling subscriber to restore all of said switches by replacing the receiver at the calling substation upon its switchhook, and apparatus operated by the response of the called subscriber to remove the power from the calling subscriber of restoring one of said switches and to appropriate the same to the called subscriber.

16. An automatic telephone system including a pair of telephone lines, a plurality of selective switches successively employed by the calling subscriber and connecting said lines, a multiple contact pertaining to one of said switches, a busy indication placed thereon by the calling subscriber in the process of establishing the connection, means to enable the calling subscriber to restore all of said switches, mechanism included in said one of said switches for placing an additional busy indication upon said contact, and apparatus operated by the response of the called subscriber to remove the power from the calling subscriber of restoring said one of said switches and to appropriate the same to the called subscriber.

17. An automatic telephone system including a pair of telephone lines, a plurality of selective switches successively employed by the calling subscriber and connecting said lines, a multiple contact pertaining to one of said switches, a busy indication

placed thereon by the calling subscriber in the process of establishing the connection, mechanism included in said one of said switches for placing an additional busy indication upon said contact, and mechanism for preventing the removal of the busy condition of said multiple contact until both subscribers replace their receivers.

18. An automatic telephone system including a pair of telephone lines, a plurality of selective switches successively employed by the calling subscriber and connecting said lines, a multiple contact pertaining to one of said switches, a busy indication placed thereon by the calling subscriber in the process of establishing the connection, mechanism included in said one of said switches for placing an additional busy indication upon said contact, and means operative only on the restoration of all said switches to remove the busy condition of said multiple contact.

19. A telephone system including a pair of telephone lines connected for conversation, a plurality of automatic selective switches employed in establishing the connection through which the conversational circuit extends, multiple contacts pertaining to one of said selective switches, a double busy indication on said contacts, and means whereby each connected subscriber can at will remove a portion of said busy indication.

20. In a selective switch having contact wipers and passive multiple terminals previously rendered busy in character, apparatus included in said switch adapted at a definite stage of its operation, to place an additional busy indication upon its own multiple terminals.

21. A telephone system including a pair of telephone lines, a link-circuit connected to both lines, a multiple contact therefor, means rendering said contact busy, mechanism for rendering said terminal idle effective only when said circuit is disconnected from both said lines. and means for disconnecting said circuit from each line at a different time.

22. An automatic telephone system including two telephone lines connected for conversation, multiple terminals for each of said lines rendered temporarily busy during conversation, mechanism controlled from the station of each line for rendering the terminals of its own line only idle, independently of the other line, a link-circuit temporarily included in the connection between said lines, a multiple terminal thereof temporarily rendered busy, and means for holding said terminal busy until the terminals of both said lines are rendered idle.

23. A telephone exchange system including a calling line, a selector operatively connected thereto, a connector adapted to have its terminals automatically selected by said selector, means operated by said selector for impressing a busy potential on said terminals on selection made, and means controlled by the called subscriber after connection is made with his line for impressing an additional busy potential on said terminals.

24. In combination, a telephone circuit, multiple terminals therefor, an automatic switch to select said terminals when idle and change their condition to render them busy, a manually controlled switch and mechanism operating responsive thereto to render said terminals additionally busy.

25. A telephone system including a calling subscriber's line and a called subscriber's line, a selector switch and a connector switch at the exchange, each capable of selecting groups of lines and lines in the groups, switch contacts for said switches through which said lines are connected in conversation, motor magnets individual to said selector switch and motor magnets individual to said connector switch for moving said switch contacts to establish said connection, means under the sole control of the called subscriber and responsive to the replacing of the receiver upon the switch hook at the called substation for releasing said connector switch, and means under the sole control of the calling subscriber and responsive to the replacing of the receiver at the calling substation for releasing said selector switch.

26. A telephone system including a calling and a called subscriber's line switched to conversational relation at the exchange, a selector and a connector at the exchange through which the conversational circuit extends, a release magnet for said connector having a relay switch contact in its circuit actuated only when the called subscriber has responded to remove the calling subscriber's prior control over said magnet.

27. A telephone system including a calling line and a called line, a normally at rest connector operatively connected with the calling line, contact members of said connector temporarily applied to said called line, a release magnet for restoring said connector controllable from the calling substation and actuated responsive to the replacing of the receiver at said calling substation upon the switch hook, and mechanism operating responsive to the removal of the receiver at the called station to render said magnet thereafter uncontrollable from the calling station.

28. A telephone system including two subscribers' lines switched to conversational relation, a pair of selector switches, each capable of selecting groups of lines and lines in the groups, one switch connected to each line, normally at rest individual driving magnets for each of said selective switches, switch contacts for each of said switches

adapted to be moved by said driving magnets to effect said conversational relation between said subscribers' lines, a link uniting said switches and continuing the conversational circuit from line to line, and a a release magnet for restoring each switch controlled solely at the substation of the line to which the switch is connected.

29. A telephone system including a plurality of lines, a calling line selector for connecting with any of said lines when calling and a movable overrun switch for automatically restoring said selector when in its operation it fails to select a line.

30. In a selective switch, passive contacts arranged in groups, means for selecting a desired group, advancing terminals adapted to select contacts of any of said groups, a switch contact common to said groups, and a second switch contact common to said groups adapted to engage said first contact to effect restoration of said selective switch when it overruns.

31. A step-by-step selective switch, comprising advancing contact members for purposes of selection, an additional advancing member for closing an overrun release circuit for said switch, and a centralized battery for furnishing all necessary operating current.

32. A two-dimension selective switch comprising terminals, electrically controlled mechanism for engaging said terminals, in the process of selection, and other mechanism including movable contacts for closing a release circuit for said switch, effective when the operated switch fails to select in either its primary or secondary movement.

33. Selective switch mechanism comprising subscribers' line terminals arranged in groups, means for causing switching movements of said mechanism to select a group of said line terminals, and a movable switch contact solely for releasing said mechanism should it fail to select a group of said terminals.

34. Selective switch mechanism comprising terminals arranged in groups, means for causing switching movements of said mechanism to select a group, means for causing switching movements of said mechanism to select contacts of a group, a movable switch contact solely for releasing said mechanism should it fail to select a group, and a second movable switch contact for releasing said mechanism should it fail to select contacts.

35. In a telephone system, a trunk circuit having multiple terminals at one end, an adjustable connecting device at the other end of said circuit, a called telephone line in contact with said device, and means operated responsive to a flow of current over said line to render said terminals busy.

36. In a telephone system, a trunk circuit having multiple terminals at one end, a called subscriber's line temporarily connected to the other end of said circuit, and means controlled by the response of the called subscriber to establish a busy connection to said terminals.

37. In a telephone system, a trunk circuit having multiple terminals at one end, a called line, a terminal contact individual to said line, a contact individual to said link-circuit at its other end, said two contacts being temporarily connected, means for rendering said terminals busy, and a circuit for controlling said means including said two contacts.

38. A telephone system including a connector having multiple terminals, a called telephone line, a non-multiple terminal of said connector applied to said line, release control means, and means controlled by a response over said line to place a busy indication on said terminals and shift the release control of said connector.

39. A telephone system including telephone lines, central office link circuits, automatic selecting devices for interchangeably connecting said link circuits with calling lines, additional link circuits and directively operable selective switches provided with individual driving magnets adapted to be operated to connect a calling line with a called line, said selective switches being operable in one direction to select groups of lines and in another direction to select lines in the groups, individual release magnets for said selective switches controllable by a calling subscriber over the calling line, and means for preventing improper operation of said automatic selecting devices, said means including a circuit changer for automatic operation to withdraw release circuit control from the calling line and turn it to the called line.

40. A telephone system comprising an interconnecting link circuit having multiple terminals at one end thereof, a second link circuit having a connection terminal adapted to be temporarily applied to a multiple terminal of the first said link circuit, means for thereby altering the electrical condition of said multiple terminals to render them busy, means for connecting said first link circuit with a called line, and means controlled from the substation of said line for holding said multiple terminals in their altered or busy condition after said connection terminal is removed therefrom.

41. A telephone system including a calling line and a called line, selector and connector switches adapted for connecting said lines for conversation, means for operating said switches to effect such connection, means controlled over the calling subscriber's line and responsive to the replacing of the receiver at the calling substation upon its switch hook for releasing said selector and

connector switches prior to a response being had from the called line, and means effective upon response from the called line to place the release of the connector under control of the called line only.

42. A telephone system including a calling and a called line, selector and connector switches having motion in one plane to select groups of lines and in another plane to select lines adapted for connecting said lines in conversation, an individual driving magnet for each of said switches, means for transmitting impulses of current to operate said switch magnets to effect such connection, means controlled over the calling subscriber's line and responsive to the replacing of the receiver at the calling substation for releasing said switches prior to a response being had from the called line, and means effective upon response from the called line to remove the control of the restoration of the connector from the calling line and place the release of the connector under the control of the called line.

43. A telephone system comprising telephone lines, selector and connector switches provided with individual driving magnets adapted for interconnecting said lines for conversation, means for operating said switches to effect connection between calling and called lines, means controlled by the replacing of the receiver upon its switch hook at the calling substation for releasing said connector switch prior to a response being had from the called line, and means effective upon response from a called line to place the release of an associated connector under control of the called line only.

44. A telephone system comprising telephone lines, selector and connector switches for use in interconnecting said lines in conversation, an individual driving magnet for each of said switches, means for transmitting impulses of current to the driving magnets of said switches to effect connection between calling and called lines, means controlled by the replacing of the receiver upon its switchhook at a calling substation for releasing the switches used in establishing the connection prior to a response being had from a called line, and means effective upon response from the called line to remove the control of the restoration of the connector from the calling line and place the release of the connector under the control of the called line.

45. A telephone system including a calling subscriber's line and a called subscriber's line, step-by-step selector and connector switches provided with contact makers adapted to be moved in one direction to select groups of lines and in another direction to select an idle line in a group for use in connecting said lines in conversational circuit, individual driving mechanism for each of said switches, the release of said selector and connector switches being normally under the control of the calling subscriber, means effective upon response of called subscriber to place the release of the connector under the control of the called line only, and means controlled over said calling subscriber's line for releasing said selector switch.

46. A telephone system including a calling telephone line and a called telephone line, directively controlled step-by-step selector and connector switches provided with contact makers for use in establishing a conversational circuit between said lines, a pair of driving magnets for each of said switches for moving said contact makers to establish said conversational circuit, means controlled over the calling subscriber's line for releasing said selector and connector switches prior to a response being had from said called subscriber, and means effective upon the response of the called subscriber to place the release of the connector switch under the control of the called line only.

In witness whereof, I hereunto subscribe my name this 10th day of November, 1906.

ALFRED H. DYSON.

Witnesses:

L. D. KELLOGG,

GEO. E. MUELLER.