A. H. DYSON.

TELEPHONE SYSTEM.

APPLICATION FILED NOV. 7, 1906. RENEWED SEPT. 27, 1913.

1,144,407.

Patented June 29, 1915.

5 SHEETS—SHEET 1.

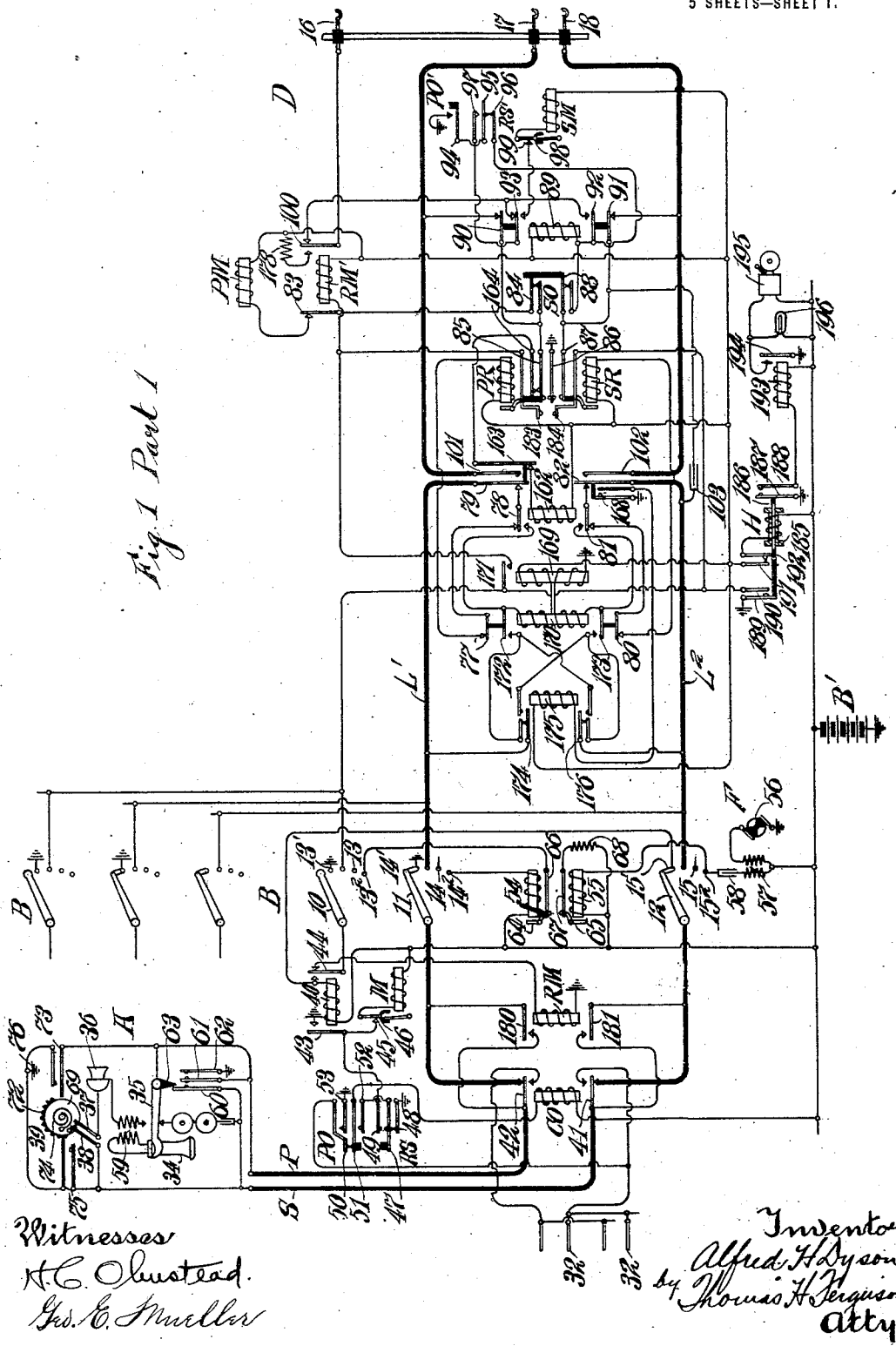

Fig. 1 Part 1

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5 SHEETS—SHEET 2.

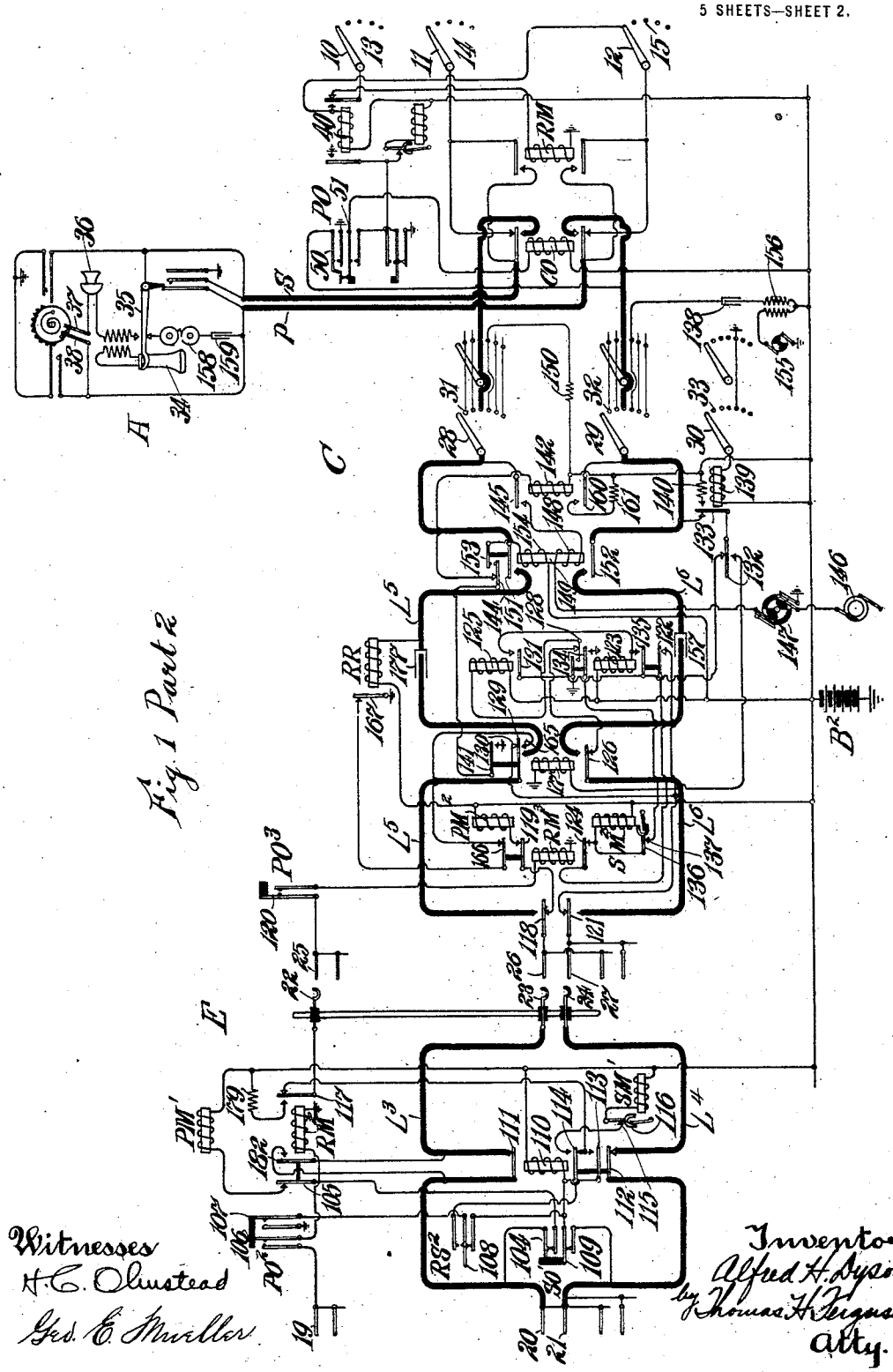

Fig. 1 Part 2

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5 SHEETS—SHEET 3.

Fig. 2.

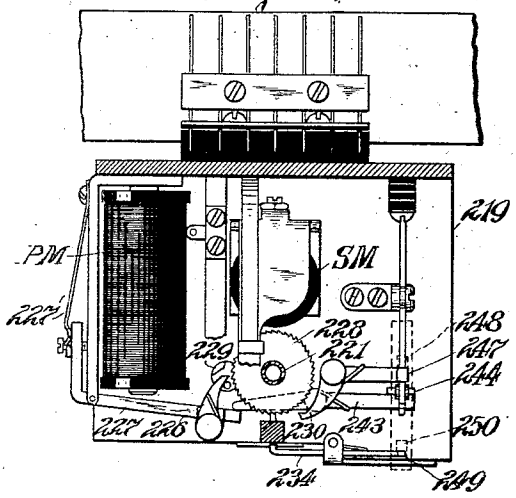


Fig. 3.

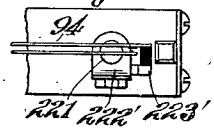


Fig. 4.

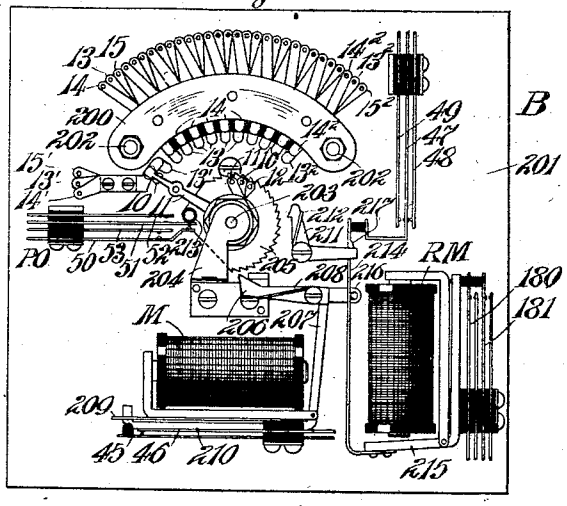
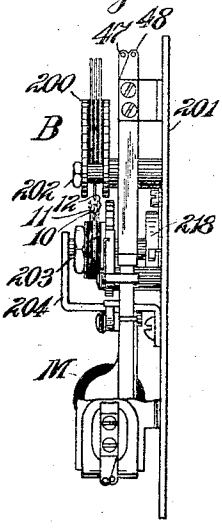


Fig. 5.



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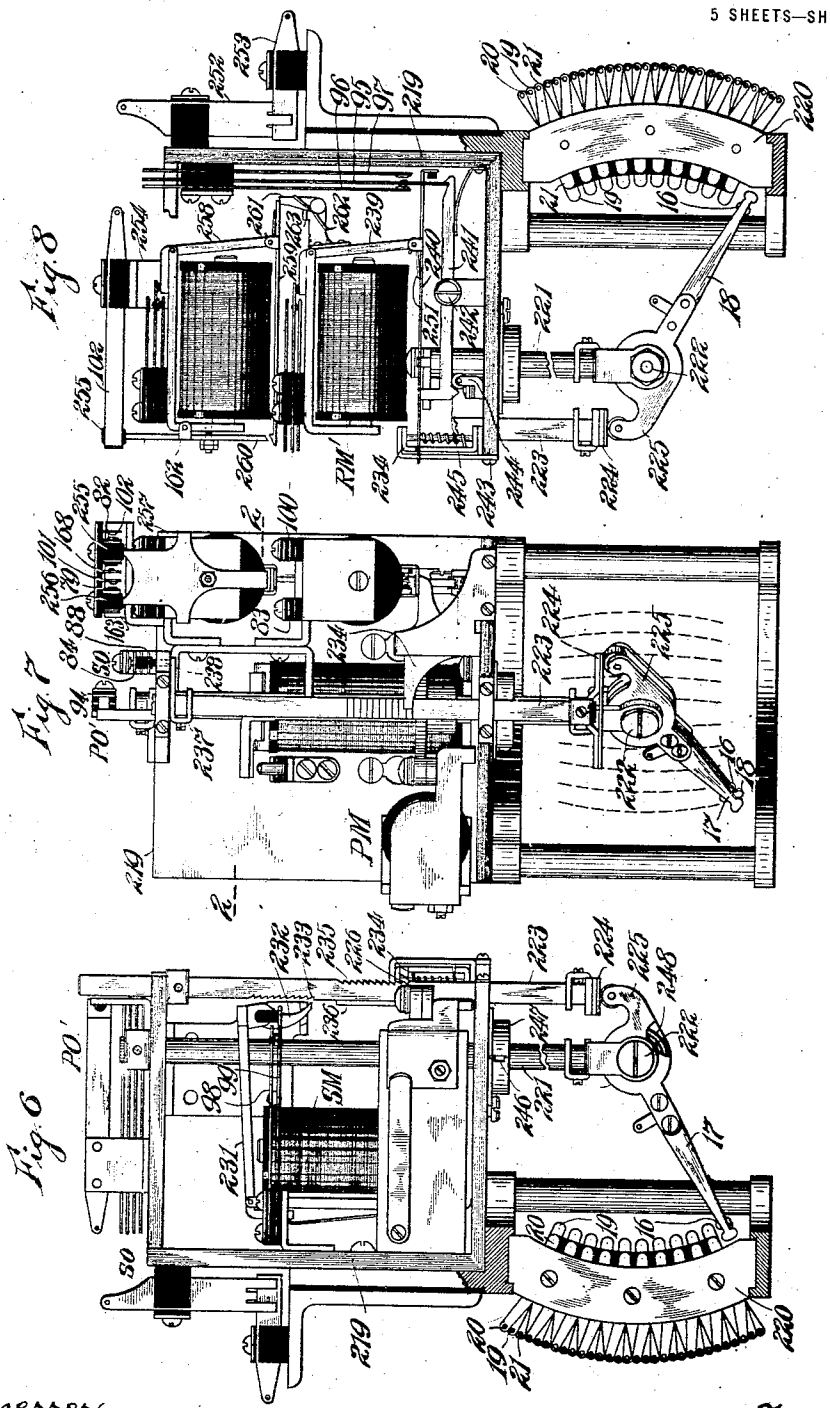
5 SHEETS—SHEET 4.



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5 SHEETS—SHEET 5.

Fig. 11

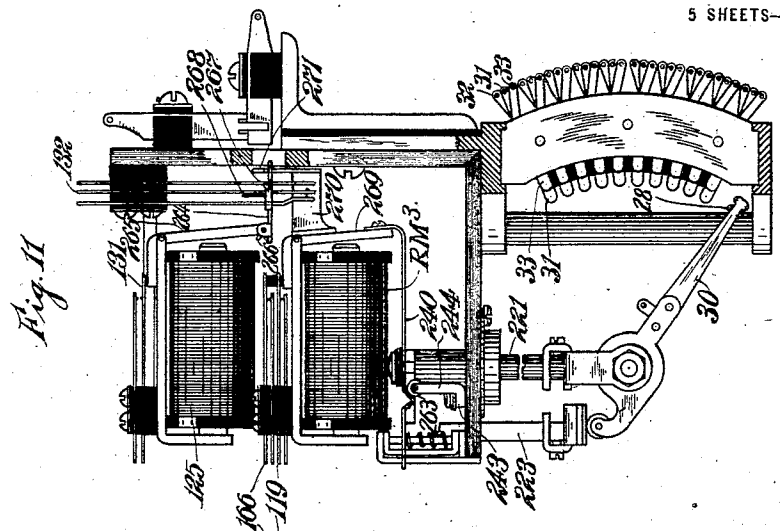


Fig. 10

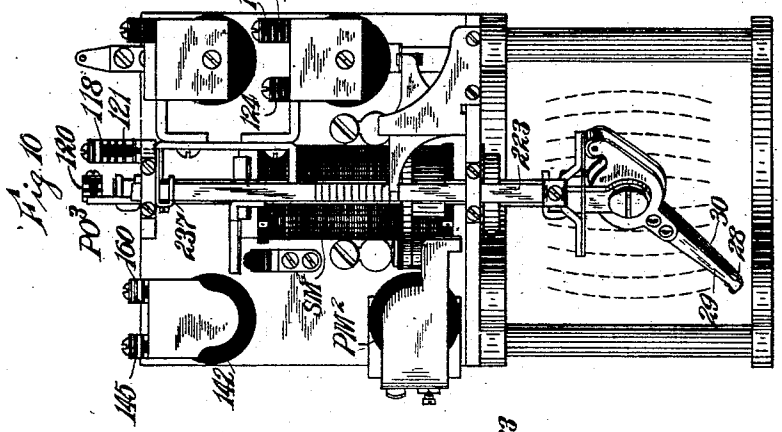
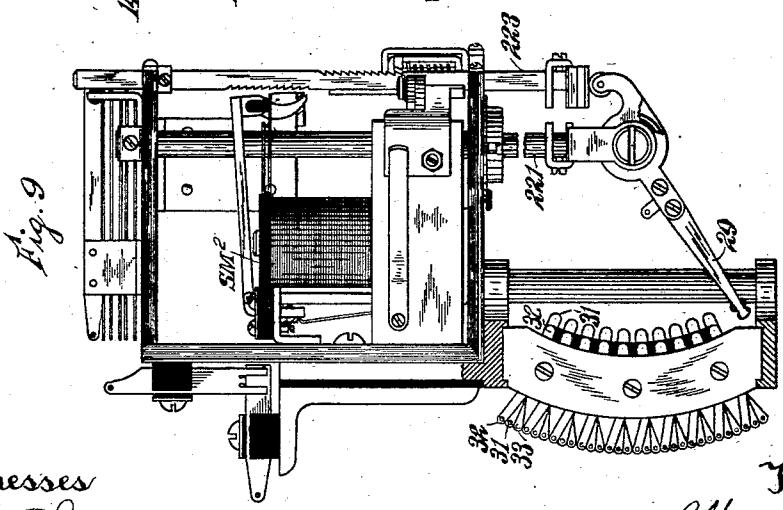


Fig. 9



Witnesses

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,144,407. Specification of Letters Patent. Patented June 29, 1915.

Application filed November 7, 1906, Serial No. 342,355. Renewed September 27, 1913. Serial No. 792,223.

To all whom it may concern:

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

The present invention relates to automatic telephone exchange systems of the type in which calling and called subscribers' lines are united for conversational purposes through the agency of link-circuits and electrically actuated switches controlled by current impulses over the calling line. In systems of this type, the electrically controlled switch which is first set in operation upon the initiation of a call is so constructed that it has access to a plurality of link-circuits to which the line circuit may be extended. In the system which I employ, this switch is set in operation upon the removal of the calling party's receiver from its switch-hook, and one object of my invention is to provide means for notifying the calling party, by a characteristic signal, of the busy condition of all of the link-circuits available to his line. Preferably this signal is transmitted to the calling party before he operates his substation call mechanism, so that he is promptly advised of the impossibility of obtaining a call at that time.

In systems of the type indicated, the electrically controlled switch which is last set in operation to complete a connection between calling and called lines, commonly called a "connector" switch, and which includes active contacts and a plurality of associated passive contacts, usually has one set of passive contacts for each line. In case a number of lines run to telephones occupying the same location or to a private exchange board, it is necessary to assign one number to each line and it is therefore necessary, in order to gain the advantage of all the lines running to the particular location, to call up several numbers.

Another object of my invention is to so construct a "connector" switch that a single number may be assigned to a plurality of lines extending therefrom and that the switch will operate in response to the reception of impulses corresponding to this number to automatically pick out the first idle line running to the distant location, and further to provide means by which the busy condition of all of these lines will be made known to the calling party.

Another object of my invention is to provide the improvements above indicated with a minimum number of relays and other parts, while maintaining satisfactory efficiency in operation and economy in construction, installation and maintenance.

These and other objects and features of my invention will be more fully understood upon reference to the following detailed description taken in connection with the accompanying drawings, and the scope of the invention will be particularly pointed out in the appended claims.

Referring to said drawings, Figure 1, which includes parts 1 and 2, is a diagram of a system constructed in accordance with my invention; Fig. 2 is a partial sectional view of a "selector" switch employed in the system illustrated and illustrating in plan the primary magnet and its associated parts by which the switch is given its primary movement, the section being taken on a plane indicated by the line 2—2 of Fig. 7; Fig. 3 is a detail of the off-normal switch associated with said "selector" switch; Figs. 4 and 5 are front and side elevations respectively of the "individual" switch; Figs. 6, 7 and 8 are elevations of a "selector" switch, each viewed from a different side; and Figs. 9, 10 and 11 are similar views of a "connector" switch employed in the system. Throughout these figures, like characters refer to like parts.

In the system which I have chosen to illustrate the application of the features of my invention, the substation equipment, designated generally A, is united by line limbs S—P to the active contacts or wipers of an "individual" switch B, and the passive contacts of a plurality of "connector" switches C at the exchange. The passive contacts of the "individual" switch are connected to a plurality of link-circuits L'—L^2 running to the active contacts or wipers of a first selector switch D whose passive contacts are again connected through other link-circuits L^3—L^4 to the active contacts or wipers of second selectors E, which in turn are adapted to establish connection through the link-circuits L^5—L^6 with the active contacts or wipers of the connector switches C. In an exchange having ten thousand subscribers' lines and constructed

for ten per cent. trunking, the number of switches employed would be as follows: ten thousand individual switches B, one thousand first selector switches D, one thousand second selector switches E, and one thousand connector switches C. With this apportionment, each line would be multipled to the passive contacts of ten connectors, each connector to one hundred second selectors, each second selector to one hundred first selectors, and each first selector to ten individual switches. It is of course to be understood that where an ultimate capacity of only one thousand lines is desired, one set of selector switches may be omitted. It should also be understood that the above figures are merely typical and may be modified to suit different conditions.

In operation, the calling party removes his receiver from its switch-hook and thereby sets the individual switch B, associated with his line, in operation to automatically seek out and establish connection with an idle link-circuit L′—L². The calling party then operates his call apparatus to transmit impulses corresponding to the digits of the number of the subscriber's line with which connection is desired. The first of these operates the first selector D associated with the selected link-circuit L′—L² to pick out an idle link-circuit L³—L⁴ extending to a second selector E associated with the thousand group to which the called line belongs. The second set of impulses operates the second selector E to pick out an idle link-circuit L⁵—L⁶ extending to a connector associated with the hundred group to which the called line belongs. The third set of impulses operates the connector to pick out that group of ten contacts to which the called line belongs, and the final set of impulses causes the connector to pick out the called line contacts in that group. The individual switch B comprises active contacts or wipers 10—11—12, coöperating with corresponding bank contacts 13—14—15 and actuated by a motor magnet M.

The first selector D comprises the active contacts or wipers 16—17—18, which cooperate with the corresponding bank contacts 19—20—21 in making connection between the link-circuit strands L′—L² and L³—L⁴ respectively. The wipers are given both a primary and secondary movement in response to the energization and deënergizations of the primary magnet PM and the secondary magnet SM respectively. By the primary movement, the wipers 16—17—18 are moved step-by-step to a desired group of passive or bank contacts 19—20—21, and by the secondary movement they are moved automatically over contacts of the selected group until the contacts of an idle link-circuit L³—L⁴ are encountered. The second selector E is similarly operated by means of its primary magnet PM′ and its secondary magnet SM′ to move its wipers 22—23—24 into engagement with the corresponding passive or bank contacts 25—26—27 of an idle-link-circuit L⁵—L⁶ extending to an idle connector C. In a similar manner, the connector C is operated by its primary magnet PM² and its secondary magnet SM² to move its wipers 28—29—30 into engagement with the passive or bank contacts 31—32—33 respectively, corresponding to the desired called line.

Considering the operation of the system somewhat more in detail, assuming that a party at substation A at the left of Fig. 1 desires to converse with a party at substation A at the right of said figure and that the latter party has three telephone lines running to his station to which have been assigned the number 3451, the party at the former station first takes down his receiver and by that act sets the individual switch B, associated with his line, into operation to automatically select an idle link-circuit and its associated first selector. The removal of the receiver 34 from its switch-hook 35 completes a bridge between the two line limbs S—P through the transmitter 36 and the normally closed contacts 37—38 of the calling device 39. At the same time, the wipers 11 and 12 of the individual switch are in engagement respectively with the grounded contact 14′ and the contact 15′ which is permanently included in circuit with the winding of the control relay 40 of said switch and the battery B′. Since the line limbs P and S are normally continued through the contacts of the cut-off relay CO to the wipers 11—12, it follows that, as soon as the calling party removes his receiver, circuit is completed from the live pole of the battery B′ through the winding of the control relay 40, contacts 15′—12, normal contact 41, line limb S, through the substation, line limb P, normal contact 42, wiper 11 and contact 14′ to the grounded side of the battery. The closing of this circuit will energize the relay 40 to move the armature contact 43 to its closed or grounded position, and the armature contact 44 to its alternate position. The closing of the contact 43 completes a circuit from the live pole of the battery B′ through the winding of the motor magnet M, which automatically interrupts its own circuit at the contacts 45—46, and, through the agency of the mechanism associated therewith and illustrated in Figs. 4 and 5, steps the wipers 10—11—12 of the switch over the associated bank contacts. The bank contacts 14′—15′ are of sufficient length to remain in engagement with the wipers 11 and 12 respectively after they have been moved one step, while the grounded contact 13′, which coöperates with the wiper 10, is not engaged thereby until

the switch has taken one step. Upon the first step of the individual switch B, the contacts of the release switch RS and of the primary off-normal switch PO are moved to their alternate positions, the spring contact 47 moving out of engagement with the grounded contact 48 and into engagement with contact 49, while the spring contacts 50 and 51, which are normally in engagement, are disengaged and moved into engagement respectively with the contacts 52—53, the latter of which is grounded. Thereupon, a circuit is completed from the live pole of the battery B′ through the winding of cut-off relay CO, contacts 51—52 of the primary off-normal switch PO, contacts 47—49 of the release switch RS, and contact 43 of the control relay 40 to ground. At the same time, the engagement of the off-normal contacts 50—53 places ground upon the passive contacts 32 of the various connector switches to which the line is multiply connected, thus establishing a condition which upon test by any connector switch, will prevent connection with the line.

The closing of the circuit through the cut-off relay CO, causes the movement of its armature contacts 41—42 to interrupt the normal connection of the line limbs P—S to the wipers 11—12, and thereby prevent possible interference with conversation over busy link-circuits having multiple contacts over which the wipers 11—12 are required to pass. Since the breaking of this connection interrupts the original circuit through the winding of the control magnet 40, it is necessary to provide a maintaining circuit for this winding. The original energizing circuit for the relay 40 exists long enough to permit the motor magnet M to advance the wipers 10—11—12 one step. Thereupon the relay 40 is maintained energized by a circuit extending from the live pole of the battery B′ through the winding of said relay, alternate contact 44, wiper 10, and contact 13′ to ground. Consequently, the magnet 40 remains energized at the time the wipers are in their second position and through the continued operation of the motor magnet M, the wipers are stepped to their third position in which they engage the first set of contacts 13—14—15 respectively. If the link-circuit connected to these contacts be in use, a multiple of the contact 13 will be connected to ground through the wiper 10, normal contact 44 and the winding of release magnet RM of another individual switch. Consequently, the circuit of the control relay 40 will be maintained and the wipers will be moved another step. This step-by-step movement will continue until the wiper 10 engages a contact 13 of an idle link-circuit. Upon such engagement, the circuit through the control relay 40 will be opened and its contacts 43—44 will return to their retracted positions, the former interrupting the circuit of the motor magnet M and the circuit of the cut-off relay CO, and the latter placing ground on the contacts 13 of the link-circuit thus connected, thus making it "busy" to other calling lines. From this it will be seen that the operation of the individual switch B resulting from the calling party's removal of his receiver from its hook, automatically connects his line to an idle link-circuit L′—L², places a ground on the contacts 32 of the connectors associated with the line and grounds the contacts 13 corresponding to the selected link-circuit L′—L². To maintain the drawing within bounds, the link-circuit L′—L² is shown multiply connected to only two individual switches B and only one of each of the link-circuits L′—L², L³—L⁴ and L⁵—L⁶ is shown.

Now in accordance with one of the features of my invention, one set of passive contacts coöperating with the wipers 10—11—12 and preferably the last set to be engaged, is not connected to conductors of the link-circuit, but to a busy-back mechanism F and to control relays 54—55. By this mechanism a characteristic signal is transmitted to the calling party in case all of the link-circuits L′—L² available for connection to his line are in use and the release of the actuated individual switch is placed under his control. Since the operation of the switch occurs in response to the removal of the receiver 34 from its switch hook 35 at the substation, the calling party will be advised of the busy condition of all of the link-circuits L′—L² before operating his call device 39, as in this operation, as soon as the wipers 10—11—12, engage the contacts 13²—14²—15², a circuit for the transmission of the busy signal is completed as follows: The primary circuit extends from the active or ungrounded pole of the interrupter 56 through the primary winding of induction coil 57 to the active pole of the battery B′; the secondary circuit extends from one terminal of the secondary winding 57, through condenser 58, contact 15², wiper 12, line limb S, contacts 38—37 at the substation, transmitter 36, primary winding of the induction coil 59, hook switch 35, line limb P, wiper 11, contact 14², winding of relay 54 to the other terminal of the secondary winding of the induction coil 57. The potential induced in this secondary circuit by the primary circuit including the interrupter 56, produced a similar effect in the local circuit of the receiver 34 with the consequent buzz as an indication to the calling party that he cannot obtain connection at that time. If in response to this signal he hangs up his receiver 34, he will momentarily ground both line limbs S and P at the substation. This is brought about through the agency of the

springs 60—61—62. Upon the removal of the receiver, an insulating projection 63 on the switch-hook passed over the upper end of the spring 60, and now upon the downward movement of the switch-hook, this projection by pressing against the spring 60, brings it and the springs 61—62 into engagement, and then slips over the end of the spring 60 into the position illustrated. The spring 62 is grounded so that by this replacement of the receiver upon its switch-hook, both line limbs are momentarily grounded. This momentary grounding of the line limbs completes a circuit for each of the relays 54—55, which, in the case of the relay 54, may be traced from the live pole of the battery B′ through the winding of said relay, contact 14^2, wiper 11, line limb P, contact springs 61—62, to ground; and in the case of relay 65, from the live pole of the battery B′ through the winding of said relay, contact 15^2, wiper 12, line limb S, contact springs 60—61—62 to ground. The simultaneous energization of the relays 54—55 through the agency of the wipers 64—65, and contact springs 66—67 which are thereby forced into engagement, completes a circuit for the release magnet RM which may be traced from the live pole of the battery B′ through the protective resistance 68, contacts 67—66, contact 13^2, wiper 10, normal contact 44, and winding of release magnet RM to ground. As will be hereinafter more fully pointed out, the momentary energization of the release magnet RM causes the restoration of the wipers 10—11—12 and the associated parts, to normal position.

In case all the link-circuits L′—L^2 were in use at the time a party called, and such party failed to put his receiver to his ear and thereby did not obtain the busy indication until after he had operated his calling device 39, the circuits would remain substantially the same until he had placed his receiver to his ear with the expectation of receiving a reply of the called party. Upon getting the busy indication at this time, he would then hang up his receiver and the actuated individual switch would be restored, as just described. In case the individual switch establishes connection between the calling line and an idle link-circuit L′—L^2, the subsequent operation of the calling mechanism 39 will cause the extension of the calling subscriber's circuit. Since it is assumed that the number of the telephone of the party wanted is 3451, the next step in the calling operation on the part of the calling party, will be to move the dial 69 of his call device 39 until three of the teeth 72 (corresponding to the thousand's digit in the number 3451) pass below the contact spring 73 and then allow it to return to normal under the tension of the spring 74. Upon its return, spring contact 73 will be closed three times, and this will be followed by a single closure of the contact spring 75, since in the normal position of the dial 69, one tooth lies below the spring 75. The three closures of the spring 73 send three impulses of current over the line limb P, while the single closure of the spring 75 sends a single impulse over the line limb S, both being effected through the agency of the substation ground at 76. At the time these impulses are being transmitted, the bridge through the transmitter 36 is interrupted at the contacts 37—38 which separate when the dial 69 is moved from its normal position. The three impulses transmitted over the line limb P, energize and deenergize the primary relay PR associated with the first selector D three times, while the following single impulse over the line limb S energizes and deënergizes the secondary relay SR, once. The circuit over which the impulse is transmitted in the case of the primary relay PR, extends from the live pole of the battery B′, through the winding of the heat coil H, the winding of the primary relay PR, closed contacts 77—78—79, link-circuit strand L′, contact 14, wiper 11, line limb P to ground at 76; and in the case of the secondary relay SR, from the live pole of the battery through the heat coil, the winding of said relay, closed contacts 80—81—82, link-circuit strand L^2, contact 15, wiper 12, line limb S, to ground at 76. Each impulse transmitted through the primary relay PR causes a corresponding impulse to be transmitted through the primary magnet PM of the first selector D. This circuit may be traced from the live pole of the battery B′, through the heat coil, the winding of primary magnet PM, closed contact 83 of the release magnet RM′ of said selector, closed contacts 84 of the secondary off-normal switch SO of said selector, and contacts 85—86 of the primary relay PR to ground. The selector switch, as previously indicated and as will be more fully explained hereinafter, is so constructed that its wipers 16—17—18 are given a primary movement in response to these current impulses, and are thereby brought opposite a group of bank contacts connected to a corresponding group of second selector switches. In the present case, the wipers, due to the three primary impulses, are moved to the third group of bank contacts which are assigned for connection to the third thousand group of subscribers' lines. The current impulse over the line limb S which follows the three impulses over the line limb P, and which we have seen, momentarily energizes the secondary relay SR, closes a momentary circuit from the grounded contact 86 of said relay, through contact 87, closed contact 88 of the secondary off-normal switch SO, the winding of the private relay 89 to the live

pole of the battery, thereby energizing said relay 89 to open normal contacts 90—91, to close normally open contact 92 and to move contact 93 from its normally closed position to its alternate position. By the first primary movement of the selector D, the contacts of the primary off-normal switch PO′ and the release switch RS′ are moved; contact 94 to connect with ground, contact 95 to move from engagement with contact 96 into engagement with contact 97. Consequently, as soon as private relay 89 is energized, current will flow over a circuit including the winding of the secondary magnet SM, its vibratory contacts 98—99, alternate contact 93, contacts 97—95 and closed contact 94 to ground. The magnet SM, by reason of its vibratory circuit and mechanical connection with the wipers 16—17—18, as hereinafter more fully explained, steps said wipers over the coöperating bank contacts 19—20—21.

As soon as the circuit of the private relay 89 is interrupted, its contacts are returned to their normal positions; consequently, the circuit of the secondary magnet SM is interrupted and the further movement of the wipers in a secondary direction ceases. Upon the first secondary movement of the wipers 16—17—18, the contacts 84—88 of the secondary off-normal switch SO are broken. Consequently, the initial energizing circuit of private magnet 89 is interrupted, and in order that the wipers may not stop on busy contacts, an energizing circuit for the private relay must be maintained. This circuit extends from the battery through the winding of said relay, closed contact 92, normal contact 100, wiper 16, to ground. The ground connection of the wiper 16 extends over multiply connected contacts 19, the wiper 16 of another switch, normal contact 100, normal contact 93, contacts 97—95, and closed contact 94 to ground. Thus it will be seen that as long as the wiper 16 is passing over contacts associated with busy link-circuits, a circuit will be maintained for the private magnet 89, and in turn, a circuit will be maintained by said magnet for the secondary magnet SM by which the switch is given its secondary movement. As soon however, as an idle link-circuit is encountered, this maintaining circuit for the magnet 89 will be interrupted and the further movement of the switch wipers stayed, thus completing connection from the calling station over the heavily marked circuit including link-circuit strands L′—L², L³—L⁴ to the wipers 23—24 of an idle second selector switch E. It will be observed that at this time, the link-circuit strands are interrupted at the contacts 79—101—82—102. In the operation of the selector D, it will be observed that the wipers 17 and 18 are disconnected, as just indicated, at contacts 90—91 of the private relay 89 while passing over the contacts 20—21 of busy link-circuits. By this means, interference with conversation through contacts in multiple with the contacts 20—21 encountered by the wipers 17 and 18, is prevented.

The next step in the calling operation consists in again moving the dial 69 at the calling station, far enough to bring four teeth (corresponding to the hundreds digit in the number 3451) below the contact spring 73, and then allowing it to return to normal, thereby transmitting four impulses over the line limb P to actuate the primary relay PR four times. This, as before, will be followed by a single impulse over the line limb S which will actuate the secondary relay SR, once. These impulses will cause the second selector E to move its wipers 22—23—24 to the fourth group of bank contacts 25—26—27, which group is assigned for connection to the fourth hundred group of subscribers' lines, and thence into engagement with an idle link-circuit connected with an idle connector C having access to the called subscriber's line. The four energizations of the primary relay PR, cause four closures of a circuit from ground at the contact 86 of said relay, through contact 85, closed contact 90, wiper 17, contact 20, closed contact 104 of the secondary off-normal switch SO′, closed contact 105 of the release magnet RM² associated with the second selector E, primary magnet PM′ associated with said selector to the live pole of the battery B². The impulses transmitted through the magnet PM′ are instrumental in producing the primary movement of the wipers 22—23—24. The first movement from normal will cause the contact 106—107 of the primary off-normal switch PO² to close, and the contact 108 of the release switch RS² to move to its alternate position. The impulse transmitted by the secondary relay SR will close a circuit from ground at contact 86 through contact 87, closed contact 91, wiper 18, contact 21, closed contact 109 of the secondary off-normal switch SO′, through the winding of the private magnet 110 to the live pole of the battery B², thereby energizing said relay 110 and causing it to disconnect wipers 23—24 from circuit by opening contacts 111—112, while at the same time, closing contact 113 and moving contact 114 from its normal to its alternate position. By the movement of the latter contact, a circuit is completed for the secondary magnet SM′ which may be traced from the live pole of the battery B², through the winding of said magnet, its vibratory contacts 115—116, alternate contact 114, alternate contact 108, and closed contact 107 to ground. By reason of the vibratory character of this cir-

cuit, the secondary magnet SM' will step the wipers around over their associated bank contacts until its circuit is interrupted. This occurs, as previously indicated in connection with the description of the first selector D, when an idle link-circuit is encountered. At this time, as previously indicated, the wipers 23—24 are again included in circuit, thus projecting the circuit of the calling line to a connector C. In this connection, it may be noted that the maintaining circuit for the private magnet 110, while the wipers 22—23—24 are passing over the contacts of busy link-circuits L^5—L^6, extends from the live pole of the battery B^2 through the winding of said relay, closed contact 113, normal contact 117, the wiper 22 to ground. This ground connection as before, extends through multiply connected contacts 25, the wiper 22 of another second selector, normal contact 117 of its release magnet RM^2, normal contact 114, alternate contact 108 and closed contact 107 to ground.

The next step in the calling operation consists in moving the dial 69 at the calling station into a position to transmit five impulses over the line limb P through the primary relay PR, followed by a single impulse over the line limb S, through the secondary relay SR. The five primary impulses (corresponding to the tens digit in the number 3451) are extended from the primary relay over a circuit extending from ground at said relay to the wiper 17 of the first selector D, as previously traced, thence through link-circuit strand L^3, wiper 23, contact 26, normal contact 118, closed contact 119 of release magnet RM^3 associated with the selected connector, winding of the primary magnet PM^2 to the live pole of the battery B^2. In this instance, the five impulses of current transmitted through the primary magnet PM^2 will step the wipers 28—29—30 of the connector to the fifth group of bank contacts 31—32—33, to which subscribers' lines having numbers between fifty and fifty-nine inclusive, are adapted to be connected. Upon the first movement of the switch in response to the primary impulses, the contact 120 of the primary off-normal switch PO^3 is closed, thereby grounding the associated bank contact 25 through the winding of release magnet RM^3. The secondary impulse following these five primary impulses, closes a circuit from ground at the contact 86 of the secondary relay SR, to the wiper 18 of the first selector switch D, as previously traced; thence through link-circuit strand L^4, wiper 24, contact 27, normal contact 121, closed contact 122 of relay 123, closed contact 124 of release magnet RM^3, winding of the secondary magnet SM^2 to the live pole of the battery B^2. This causes a momentary energization of the secondary magnet SM^2 which is instrumental in advancing the wipers one step in their secondary direction. As indicated in Figs. 9 to 11 inclusive, the wipers are normally two steps distant from the first set of bank contacts, consequently this single step does not bring them into engagement, but is occasioned for the purpose of actuating the off-normal switch contacts 118—121. At this time, contact 118 is moved from its normal to its alternate position and at the same time contact 121 is moved out of engagement with its normal contact. The contact 121, however, is not moved into engagement with its alternating contact until the next step of the switch. This is to prevent the above secondary impulse, or a portion of it, from being transmitted through the winding of the relay 125 by way of the normal contact 126 of relay 127 and normal contact 128 of relay 123, which might occur if contact 121 were at once thrown over to its alternate position.

The next step in the calling operation consists in again moving the dial 69 so as to transmit one primary impulse (corresponding to the units digit of the number 3451) again followed by a single secondary impulse. In this case, the circuit under the control of the primary relay PR is the same as that heretofore traced, as far as contact 26; thence it extends through alternate contact 118, contacts 129—130 of relay 127, closed contact 122 of relay 123, closed contact 124 of release magnet RM^3, and the winding of secondary magnet SM^2 to the live pole of the battery B^2, thus, the secondary magnet is energized and deënergized once, thereby stepping the wipers 28—29—30 into engagement with the first set of contacts in the fifth group, thus establishing connection with the bank contacts 31—32— of one of the lines running to substation A shown at the right in Part 2 of Fig. 1. The secondary impulse which follows the single primary impulse, is extended by the secondary relay SR to contact 27 of the second selector E over a path the same as that heretofore traced. From this point its circuit is continued through alternate contact 121, normal contact 126, normal contact 128, winding of relay 125 to the live pole of the battery B^2. The completion of this circuit momentarily energizes relay 125 to close its contact 131. In case the first line running to the called party's station is in use, we have seen that its contacts 32 will be connected to ground by way of the contact 50 of its off-normal switch PO associated with that line. Consequently, if this particular called line be busy at this time, a path for current will be closed by the movement of the contact 131 which may be traced from the live pole of the battery

B^2 through relay 123, closed contact 131, normal contact 132, normal contact 133, wiper 29, and contact 32 to ground. At this point it may be mentioned, that by reason of the mechanical relation of the relay 125 and release magnet RM^3, the contact 132 is moved to its alternate position upon the release of relay 125 and subsequently returned to its normal position upon the energization of release magnet RM^3. The closing of the circuit of relay 123 causes it to open its contact 122, to close its contact 134 to ground, to close its contact 135 and to move its contact 128 to its alternate and grounded position. In the movement of the contact 128 to its grounded position, the alternate contact is made before the normal contact is broken, consequently the relay 125 is maintained energized, the former circuit being over the line limb S and the latter through alternate contact 128 to ground. The closure of contact 135 completes a locking circuit for relay 123 which is independent of the contact 131 of relay 125.

As previously indicated, the connector is specially connected for the purpose of caring for calls for parties having a plurality of lines running to the same location. Thus, in the illustration chosen, the first three contacts 31—32—33 are assumed to be connected to lines extending to the location of the equipment A at the right in Fig. 1. If, now, the first of these lines is found to be busy, it is necessary that the wipers be stepped into engagement with the second to see if it is busy, and then if that be busy, into engagement with the third, and if that also be busy, the calling party must be apprised of the fact. The closing of the contact 134 of relay 123 accomplishes this result by energizing the secondary magnet SM^2. The energizing circuit for this magnet extends from the live pole of the battery B^2 through the winding of the magnet, its vibratory contacts 136—137, closed contact 134 to ground. By reason of the vibratory character of this circuit and the mechanical relation of the parts, wipers 28—29—30 are given one step in a secondary direction, and if the second line is in use, the circuit of the relay 123, and consequently that of the secondary magnet SM^2 will be maintained. If an idle contact 32 is encountered, the circuit of the relay 123 will be interrupted since the contact 32 of an idle line will be disconnected from ground. If no such idle line is encountered, the wipers will be stepped into engagement with the fourth set of contacts 31—32—33. In the present case, these are the busy indicating contacts over which the busy condition of the three preceding lines is made known to the calling party. Where but a single telephone line runs to a subscriber's station, it must be followed by such a set of contacts. As soon as such a set of contacts is encountered, the locking circuit for the relay 123 will be interrupted at the condenser 138 and its contacts will thereupon be retracted. The return of contact 134 interrupts the circuit of the secondary magnet SM^2, and thereby prevents further movement of the switch wipers. The return of contact 128 to normal interrupts the circuit of relay 125, and as previously stated, upon the deënergization of this relay, contact 132 is moved to its alternate position. At the same time a ground is thrown upon wiper 30 so that an energizing circuit is completed for relay 139 and its contact 133 is moved to its alternate position, thereby completing a circuit for relay 127, which may be traced from the live pole of the battery B^2 through protective resistance 140, alternate contact 133, alternate contact 132 and the winding of the relay 127 to ground. The energization of relay 127 moves its contact 126 to its alternate position to thereby unite portions of the strand L^6 and disconnect the winding of relay 125 from said link-circuit strand. The energization of this relay also connects adjacent positions of the strand L^5 by moving its contact 129 to its alternate position. At this time a possible circuit from the strand L^5 through the winding of secondary magnet SM^2 is prevented by the separation of contacts 129—130. The energization of relay 127 also closes contact 141 to ground. As soon as this takes place, a circuit is completed through the winding of the ringing relay 142 over a path extending from the live pole of the battery through the winding of said relay, normal contact 144, closed contact 141, to ground. The energization of relay 142, by means of contact 145, connects a source of ringing current to the strand L^5. This connection extends from the grounded generator 146 through the interrupter 147 which alternately connects the strand to ground directly and through the generator, the winding 148 of relay 149 and closed contact 145 to strand L^5. This connection of the generator to the strand L^5 performs no useful function at this time since there is no closed circuit through the substation, but as the interrupter 147 rotates and alternately connects the winding 148 to ground, the relay 149 will be energized by current from the live pole of the battery through the protective resistance 150, engaged contact 31, wiper 28, closed contact 145, winding 148 to ground through the interrupter 147. The relay 149 being thus energized, connects the normally disconnected adjacent portions of the strands L^5—L^6 by means of its contacts 151—152 and through the agency of its contact 153 moves contact 144 from its normal position thereby making contact 144—153 and subsequently breaking normal contact 144. The

engagement of these contacts completes a locking circuit for the relay 149 which extends from the live pole of the battery B^2, through the upper winding of said relay, contacts 153—144, and closed contact 141 to ground. The relays 127—149 being now energized, a secondary circuit for the busy back interrupter 155 is completed from one terminal of the condenser 138, through engaged contact 32, wiper 29, link-circuit strand L^6, condenser 157, and thence over the heavily marked circuit to the substation via closed contact 91 and condenser 103, and thence returning over the line limb P, link-circuit strand L′, alternate contact 78, upper windings of relays 170—169, heat coil H, battery B′ to ground, and thence through battery B^2 to the other terminal of the secondary winding of the induction coil 156. As before indicated, the potential induced in this circuit produces a busy buzz in the calling party's receiver as an indication to him that he will be unable to obtain connection at that time.

In case an idle called line is encountered by the wipers of the connector, a circuit is completed for the cut-off relay CO of the called line and the relay 127 which may be traced from the live pole of the battery B^2 through the winding of cut-off relay CO, normally engaged contacts 51—50, contact 32, wiper 29, normal contact 133, alternate contact 132, and winding of relay 127 to ground. This actuates both relays CO and 127, the former to connect the associated contacts 31—32 to the line limbs S and P respectively, and the latter, among other things, to successively close a circuit for relays 142 and 149 via closed contact 141, as previously traced. Wipers 28 and 29 now being in circuit with the line limbs S and P, the actuation of relay 142 connects ringing current generator 146 and the interrupter 147 to the wiper 28, and a ringing circuit is completed from said wiper over line limb S through the hook-switch 35, call-bell 158, condenser 159, line limb P, contact 32, wiper 29, closed contact 160 of relay 142, resistance 161 to the live pole of the battery B^2. During the application of this ringing current, battery is supplied to the wiper 29 over a path extending from the live pole of the battery B^2 through protective resistance 161 and closed contact 160. By this connection, current is supplied to the relay 127, in multiple with the winding of cut-off relay CO, to maintain it energized. The actuation of the cut-off relay CO in addition to connecting the contacts 31—32 to the line limbs, interrupts the normal connection of said line limbs to the wipers 11—12 of its individual switch. By reason of the wiper 29 being connected through normal contact 133, alternate contact 132, and the winding of relay 127 to ground, the multiple contacts of the selected called line are maintained in the condition to prevent the connection therewith of another connector. The relay 149 is also so constructed that the passage of ringing current from the generator 146 through the winding 148 and condenser 159 will not move its contacts from their normal position. In addition to applying ringing current to the called line by the closure of its contact 141, the energization of relay 127 completes a circuit for the control magnet 162, associated with the first selector D, over a path extending from the live pole of the battery B′ through the heat coil H, winding of magnet 162, closed contact 163, contacts 164—85, closed contact 90, wiper 17, contact 20, link-circuit strand L^3, wiper 23, contact 26, alternate contact 118, link-circuit strand L^5, contacts 129, 165, closed contact 166 and closed contact 167 of release relay RR to ground. The completion of this circuit energizes the control magnet 162 which has its actuated parts so related to the switch contacts 79—101—163 and 168—82—102 that they are thrown to their actuated positions upon the deënergization of said magnet.

As soon as the called party removes his receiver 34 from its hook switch 35 in response to the actuation of his call-bell 158, he completes a conductive bridge between the line limbs S and P through his transmitter, and a circuit is thereby completed from the live pole of the battery B^2, through protective resistance 161, closed contact 160, wiper 29, contact 32, line limb P, through the substation, line limb S, contact 31, wiper 28, closed contact 145, winding 148 of relay 149 and interrupter 147 to ground. This circuit will be completed as soon as the interrupter 147, or the interrupter and generator 146, grounds the winding 148. The flow of current over this path is sufficient to cause the relay 149 to close its contacts, thereby interrupting the circuit through ringing relay 142 at contact 144, completing a locking circuit through its winding 154 by the engagement of contacts 144—153 and connecting the adjacent portions to the strands L^5—L^6 at contacts 151—152. As soon as relay 149 is actuated, transmission current for the called line is supplied over a circuit from the live pole of the battery B^2, winding of release relay RR, strand L^5, wiper 28, contact 31, line limb S, switch-hook 35, transmitter 36, closed contacts 37—38, line limb P, contact 32, wiper 29, normal contact 133, alternate contact 132, winding of relay 127 to ground. Upon the completion of this circuit, the relay RR is energized to break the circuit through the control magnet 162 at contact 167, thereby allowing said magnet 162, upon its deënergization, to move the contacts 79—101—163 and 168—82—102 to their actuated positions thereby again interrupting the circuit of the magnet 162 at

contact 163, conductively uniting the adjacent portions of the strands L′—L² at contacts 79—101 and 82—102 respectively, and interrupting the normal circuit through the primary and secondary relays PR and SR at contacts 79 and 82 respectively.

As soon as the relay 162 is energized, a path for the supply of transmission current to the calling line is provided. This path extends from the live pole of the battery B′ through the upper windings of relay 169—170, alternate contact 78 of relay 162, normal contact 79, link-circuit strand L′, line limb P, through the hook-switch 35, transmitter 36, closed contacts 37—38 at the substation, line limb S, link-circuit strand L², normal contact 82, alternate contact 81 of relay 162 and the lower windings of relays 170—169 to ground. The arrangement of the windings on 169 is differential, and consequently at this time its contact 171 is not closed, whereas the arrangement of the windings on relay 170 is cumulative and said relay is energized to open its contacts 77—80 and close its contacts 172—173. The closure of these latter contacts provides an additional path for transmission current extending through the upper windings of relays 169—170, closed contact 172, normal contact 174 of relay 175 to link-circuit strand L′, and thence upon return from link-circuit strand L² through normal contact 176, closed contact 173, and the lower winding of relays 170 and 169 to ground. Thus, as soon as relay 170 has been energized, a path for transmission current is provided which is independent of the condition of the relay 162. Since the deënergization of relay 162 and consequent movement of the contacts by which the adjacent portions of the link-circuit strands L′ and L² are united, is dependent upon the response of the called party, it will be seen that a talking circuit, which is that shown in heavy lines, is not completed until the called party responds. At this time, it will be noted that contact 168 grounds the winding of relay 175 thereby energizing the latter to move its contacts 174—176 to their alternate positions, thereby reversing the direction of current flow to the called substation. This is occasioned for the purpose of operating pay-station and other devices which may be used at the substation. From the above it will be seen that a talking circuit is thus established between the calling and called lines and that this circuit is conductively divided and inductively united by the condensers 157—177 in the link-circuit strands L⁶—L⁵ respectively.

It has already been pointed out how the individual switch mechanism would be restored to its normal position in case all the link-circuits L′—L² were in use. If however, the calling party has obtained connection with the desired called party, the occupied individual, selector and connector switches will be released at the end of conversation in the following manner: As previously indicated, when the receiver of either party is hung upon its switch-hook, both line limbs S and P of the corresponding line are grounded at the substation. It will also be remembered that during conversation, the circuit for supplying transmission current to the calling station extends from the live pole of the battery B′ through the upper windings of relays 169—170 through the substation and back through the lower windings of said relays, to ground. Therefore, if it be assumed that the calling party first restores his receiver to its switch-hook, it will be observed that by providing a ground at the substation, the lower windings of the relays 169—170 will be short circuited and the normal balance of the windings of the relay 169 will be thereby destroyed and said relay will close its contact 171. Thereupon, a circuit will be completed through the release magnet RM of the individual switch B and the release magnet RM′ of the first selector D which may be traced from ground at the release magnet RM, through the winding of said magnet, normal contact 44, wiper 10, contact 13, closed contact 171 of relay 169, winding of the release magnet RM′ to the live pole of the battery B′. On the other hand, it will be remembered that a circuit for supplying transmission current to the called line extends from the live pole of the battery B² through the winding of release relay RR, link-circuit strand L⁵, line limb S, through the substation and back over the line limb P, through contact 32, wiper 29, normal contact 133, alternate contact 132, and the winding of relay 127 to ground. Therefore, if the called party first restores his receiver to its hook, he will interrupt the circuit at his switch-hook and thereby deënergize release relay RR. Upon such deënergization, grounded contact 167 will be closed. The closing of this contact will complete an additional path to ground from the upper windings of relays 169—170 which may be traced from said windings through closed contact 172, contact 176, link-circuit strand L², contact 15, wiper 12, line limb S, through the substation, line limb P, wiper 11, contact 14, strand L′, wiper 17, contact 20, strand L⁵, wiper 23, contact 26, a portion of strand L⁵, contacts 129—165, closed contact 166, and grounded contact 167. The closing of this path of contact 167 again destroys the normal balance of the windings in relay 169 and causes the closure of its contact 171 with the consequent energization of release magnets RM and RM′, as just pointed out.

The energization of release magnet RM′ closes a circuit from the live pole of bat-

tery B′, through resistance 178, alternate contact 100, wiper 16, contact 19, closed contact 106, winding of release magnet RM² of the second selector E to ground. The energization of the release magnet RM² in turn completes a circuit from the live pole of the battery B² through resistance 179, alternate contact 117, wiper 22, contact 25, closed contact 120, and winding of release magnet RM³ of the connector to ground. From this it will be seen that it is necessary to maintain the unbalanced circuit of the magnet 169 from the calling station until the release magnets RM, RM′, RM² and RM³ have attracted their armatures. The energization of release magnet RM of the individual switch B closes its contacts 180 and 181, which are connected in bridge of the cut-off relay contacts 41—42, and, as will appear more fully hereinafter, returns the release switch contacts 47—48—49 to their normal positions, thereby completing a circuit from the live pole of the battery B′ through the winding of cut-off relay CO, contacts 51—52 and 47—48 to ground. The cut-off relay CO is thus energized to break the circuit through contacts 41—42, but the contacts 180—181 of the release magnet RM maintain the line limbs in circuit with the wipers 11—12, thereby maintaining the unbalancing circuit from the calling station for the magnet 169. As soon as ground is removed at the calling station, the contacts of relay 169 are restored to normal, and each of the release magnets RM, RM′, RM² and RM³ is deënergized. Upon the deënergization of release magnet RM, wipers 10—11—12 are restored to their normal positions. In so doing, they pass over the multiple contacts of other link-circuits, but by reason of the disconnection of the wipers from the line limbs at both contacts 41—42 of the cut-off relay CO and contacts 180—181 of the release magnet RM, interference with conversation over any of these link-circuits is prevented. As soon as the wipers reach their normal positions, the contacts 50—51—52 and 53 of the primary off-normal switch PO, are returned to their normal positions and the circuit of the cut-off relay CO is thereby interrupted and the normal connection of the line with its wipers again established. At the first selector switch D, the energization of release magnet RM′ causes the restoration of the switch contacts 95—96—97 to their normal positions, thus, energizing the private magnet 89 over a circuit extending from the live pole of the battery B′, through the heat coil, the winding of said magnet, contacts 96—95, and closed contact 94 to ground. The energization of the private magnet disconnects the adjacent portions of the strands L′—L², and the wipers 17 and 18 at contacts 90—91. Upon the deënergization of the release magnet RM′, the contacts 79—101—163 and 168—82—102, which were actuated upon the release of relay 162, are restored to their normal positions. Upon the release of the release magnet RM′, by reason of the mechanical construction to be hereinafter more fully pointed out, the wipers 16—17—18 are restored to their normal positions. During this restoring movement of the wipers, interference with conversations over the multiples of contacts 20—21 which the wipers 17—18 may engage, is prevented, since the wipers 17 and 18 are disconnected at this time. Upon the restoration of the wipers in a secondary direction, the contacts 84—88 of the secondary off-normal switch SO are returned to the position illustrated, while upon the restoration of said wipers to their initial position, the contact 94 of the primary off-normal switch PO′ is restored to the position illustrated, thereby interrupting the circuit of the private magnet 89 and allowing its contacts to return to normal. In a similar manner, wipers 22—23—24 of the second selector E are restored to normal. Thus, upon the energization of release magnet RM², contact spring 108 of release switch RS² is thrown to its alternate position thereby completing a circuit for the private relay 110, extending from the live pole of the battery B², through winding of said relay, normal contact 108, alternate contact 107 to ground. The completion of this circuit energizes the private relay to disconnect wipers 23—24 at contacts 111—112, but in order that the unbalancing circuit for relay 169 may be maintained until it is time to deënergize the various release magnets, the release magnet RM² is provided with a contact 182 in bridge of contact 111 which is closed during the energization of release magnet RM². Upon the deënergization of release magnet, by reason of the mechanical relation of the parts, the wipers 22—23—24 are restored to their normal positions, the springs of the secondary off-normal switch SO′ being returned to normal position during this restoring movement of the wipers, and the springs of the primary off-normal switch PO² being returned to normal at the end of such restoring movement. As before, the return of the latter interrupts the circuit of the private magnet 110 and allows its contacts to assume their normal positions. Where the balance of the relay 169 is destroyed by the return of the called subscriber's receiver to its hook, the unbalancing circuit is interrupted at contact 166 of release magnet RM³ as soon as the energizing circuit is completed through said magnet by the action of the release magnet RM² of the second selector.

The mechanical construction of the connector switch is such that wipers 28—29—30

are restored to their normal positions upon the deënergization of the release magnet RM^3. As previously pointed out, during connection there is a circuit from the live pole of the battery B^2 through the cut-off relay CO, contacts 51—50, contact 32, wiper 29, normal contact 133, alternate contact 132, and the winding of relay 127 to ground. As soon as contact 132 returns to its normal position upon the energization of release magnet RM^3 this circuit is interrupted and the cut-off relay contacts are allowed to return to normal to establish connection between the called line and the wipers 11 and 12 of its individual switch B. The contacts of relay 127 also return to normal at this time, and thereby interrupt a circuit through the winding 154 of relay 149 thus deënergizing said relay. It should be noted that if the above releasing operation takes place in response to the busy signal transmitted from interrupter 155 to the calling line, then upon the movement of the wiper 30 from the grounded contact, the circuit of relay 139 will be interrupted and the transmission of the busy signal to the calling line thereby discontiued.

If the calling party desires to restore the mechanism at the exchange to normal at any time prior to the completion of the connection with the called line, and after the selection of link-circuit L'—L^2, the restoration of his receiver to its hook will simultaneously energize primary and secondary relays PR and SR over circuits which have been previously traced, and which it will be remembered remain intact until connection is established with the line of the called party. Upon the simultaneous energization of these relays, their contacts 183—184 will be moved into engagement and a circuit thereby completed from the live pole of the battery B′ through the heat coil H, releases magnet RM′, relay contacts 183—184, contact 13, wiper 10, normal contact 44, release magnet RM to ground. Upon the deënergization of the release magnets RM and RM′, both the first selector and the individual switch will be restored to normal, as previously indicated, and as before, the release of this first selector D will occasion the release of the second selector E and the connector C, in case they be in circuit at the time.

By the use of the heat coil H and its associated parts, I am enabled to protect the circuits of an associated switch in case of undue flow of current therein. By the operation of the heat coil, the particular switch in which the trouble exists may be rendered "busy" so as to prevent its selection by other switches, and its supply of current may be cut off. The heat coil H may be of any preferred construction, and is herein shown as comprising a winding on a spool 185 through which passes a rod 186 which is soldered in place by some readily fusible material. This rod controls contacts 187—188—189—190—191—192. Upon the melting of the soldering material, due to the excessive heating of the winding of the heat coil, the rod 186 is moved to the right, due to the tension of the associated spring contacts, and the contacts 191—192 by separating open the conductor by which current is supplied to the switch from battery B′. The engagement of contacts 189—190 grounds the contacts 13 of the switch in trouble and thereby renders it busy to other switch mechanism. The engagement of contacts 187—188 completes a circuit for relay 193 which in turn, by its armature 194, completes a circuit for bell 198 and lamp 196, either or both of which may be used to indicate to attendants the trouble condition. This heat coil may be used in connection with the second selectors and connectors for like purposes.

Obviously in the practice of the system above outlined, the apparatus employed may be varied considerably in mechanical construction, and I therefore do not wish to be limited to the specific forms of switch mechanism hereinafter described, but preferably I employ the mechanism illustrated in Figs. 2 to 11 inclusive.

Referring first to the individual switch B which is illustrated in Figs. 4 and 5, I preferably mount the bank contacts 13—14—15, 13′—14′—15′ and 13^2—14^2—15^2 in an arcuate frame 200 securely fastened to a base 201 by bolts 202, the contacting ends of the bank contacts are presented to the wipers 10—11—12 in the arc of a circle and securely clamped in the frame 200 with suitable intervening insulation for rendering them electrically independent, while the wipers are mounted upon the shaft 203 journaled in the base 201 and in a bracket 204 carried thereby. The wipers are suitably insulated from each other, and are held in place upon the shaft by suitable clamping nuts. As clearly shown, the wiper 10, which is a private wiper, is composed of two strips which are adapted to wipe over the middle row of passive contacts 13, while the outer wipers 11 and 12 are composed of single strips adapted to engage the outer faces of the contacting ends of the strips 14 and 15 respectively. The wipers are given their rotary movement through the agency of a circular ratchet 205 mounted on the shaft 203. The ratchet is adapted to be engaged by a driving pawl 206 carried upon the armature 207 by the motor magnet M. A spring 208 tends to force the driving pawl 206 into engagement with the ratchet teeth. Upon each energization of the motor magnet M, the pawl 206 engages a tooth of the ratchet 205 and moves it and the wipers one step. Its advance movement is limited by its engagement with the bracket 204. The armature

207 is returned upon the deënergization of the magnet by a suitable spring 209 carried by the magnet frame and acting against the end 210 of the armature 207. The contact springs 45—46, normally in engagement, are interrupted upon each energization of the magnet M, and these contact springs are included in a circuit of the motor magnet, as previously described. The ratchet 205 is retained in its various positions by retaining pawl 211 mounted upon the base 201 and pressed into its engaging position by a spring 212. The contacts 50—51—52—53 of the primary off-normal switch PO are suitably secured to the base 201, and by reason of their inherent tension, normally occupy the position illustrated, but are adapted to be moved from such position by the insulated projection 213 carried by the ratchet 205. This movement from normal occurs upon the first rotary step of the ratchet. The base 201 also carries the release magnet RM and contacts 180—181 and contacts 47—48—49 of the release switch RS actuated thereby. Normally the contacts 47—48—49 are held in the position illustrated, through the pressure of the spring arm 214, carried by the armature 215 of the release magnet. The inherent tension of this spring is such that upon the movement of the spring arm 214 to the left, spring 47 will disengage spring 48 and engage spring 49. Upon the first movement of the armature 207 of the motor magnet M, the spring arm 214 is moved in this direction by reason of an engaging projection 216 carried by the armature 207. As soon as this takes place, the retaining pawl 211 has its tail freed from a projecting shoulder 217, carried on the spring arm 214, and through the tension of the spring 212, is moved into engaging position. By reason of the angular end on the tail of the pawl engaging the outer or right-hand face of the projection 217 on the spring arm 214, after this first actuation of the motor magnet M, the arm 214 is prevented from forcing spring contact 47 out of engagement with spring 49 and into engagement with spring 48. In the operation of the mechanism upon the subsequent energization of the release magnet RM, the attraction of its armature 215 causes the projecting shoulder 217 on the arm 215 to pass beyond the angular projection on the tail of the retaining pawl 211, and to engage its upper side whereby, upon the retraction of the armature 215, the pawl 211 is again moved to the non-engaging position, as illustrated. While the release magnet RM remains energized, the contact springs 180—181 are moved to their engaging positions. These springs also serve to retract the armature upon the deënergization of the magnet. Upon the removal of the retaining pawl 211, the wipers 10—11 and 12 are free to return to the normal position under the action of a spiral spring 218 secured at one end to the base 201, and at the other to some part movable with the wipers.

Referring now to the construction of the selector, preferably the first selector switch D which is illustrated in Figs. 2, 3, 6, 7 and 8, 219 designates a suitable supporting frame for the mechanism which includes the primary magnet PM, secondary magnet SM, and the release magnet RM′. The frame also carries fixed contacts 19—20—21 which are arranged in a bank 220 with their free ends adapted for the attachment of suitable conductors, and have their contacting inner ends terminating in a spherical surface. These contacts are suitably insulated from each other and coöperate with the wipers 16—17—18 which are pivoted at the center of rotation of the spherical surface to the lower end of a rotary shaft 221, carried by the frame 219. The wipers are rotatable with the shaft 221 in a horizontal direction, and in addition, may be rotated vertically about a pivot 222 through the agency of an additional longitudinally movable shaft 223, having a broad foot 224 which engages a rearward projection 225 on the wipers. Thus, by rotating the shaft 221, the wipers may be given their primary movement to the desired group of bank contacts, and by subsequently giving the shaft 223 a longitudinal movement, the wipers may be moved to the desired bank contact in the selected group. The foot 224 on the shaft 223 is made sufficiently large to engage the projection 225, no matter what the position of the wipers may be. The mechanism associated with the primary magnet PM, by which the shaft 221 is given its primary or rotary movement, comprises an actuating pawl 226, carried by the armature 227, adapted to engage the teeth of the ratchet wheel 228, to step the shaft around. The advance movement of the pawl 226 is limited by the beveled stop 229. The armature 227 is retracted upon the deënergization of the magnet, by a suitable spring 227′ which engages the angular end of the armature. The shaft 221 is retained in its various positions by the retaining pawl 230 which is adapted to engage the teeth of the ratchet wheel. The upper end of the shaft 221 carries a member 222′, as illustrated in Fig. 3, having a projection 223′ which normally maintains the spring contact 94 of the primary off-normal switch PO′ in its open position, but which, upon the first movement of the shaft, allows it to close under its inherent tension. The secondary magnet SM, through the agency of its armature 231, actuating pawl 232 and the ratchet teeth 233 on the shaft 223, steps the latter downward to carry the contacting ends of the wipers 16—17—18 into their desired positions. A suitable retaining pawl 234 engages the teeth

235 on the shaft 223 to hold it in its different operating positions. The shaft 223 is also provided with a suitable spline 236, which, after the first movement of the shaft, engages a tooth of the ratchet wheel 228 to lock the shaft 221 against rotation. Contact springs 84—88 of the secondary off-normal switch are normally held against their spring tension in the position illustrated in Fig. 1, through the agency of a projection 237 carried at the upper end of the shaft 223. The outer end of this projection normally engages a pin 238 to hold the contacts in this position. The vibratory circuit of the secondary magnet SM is completed through the contacts 98—99 which are actuated by the armature 231 of said magnet. Upon the energization of the release magnet as previously pointed out, contact 83 is opened, contact 100 is moved to its alternate position and the contact spring 95 is restored to its normal position, that is, brought into engagement with contact spring 96; the armature 239 of release magnet RM′ directly engages the contact springs 100 and 83 to give them the desired movement and it is provided at its lower end with a member 240 which extends beyond the contact spring 95 into a position to draw it to its normal position upon the attraction of the armature 239. This spring has a tendency to move to its alternate position, but is normally held against such movement by the catch 241 pivoted at 242 to a post projecting from the frame 219. The catch 241 is moved from its retaining position, so as to allow the spring 95 to move to its alternate position, upon the first energization of the primary magnet PM. This is brought about through the agency of a lever 243 pivotally supported near its center upon the frame 219 and having one end lying in the path of movement of the armature 227 of the primary magnet PM. Its opposite end is provided with an upturned projection 244 which bears against the under side of the catch lever 241. Upon the first movement of the armature 227, the lever 243 is rocked about its pivot and its upturned end rides over the inclined surface 245 on the under side of the lever 241 so as to rock the latter on its pivot 242 and thereby releases the spring 95 and allows it to move to its alternate position.

As previously indicated, after the wipers have been given their primary and secondary movements, they are retained in their connected position by means of the primary retaining pawl 230 and secondary retaining pawl 234. In giving the wipers their primary movement, the shaft 221 is rotated against the tension of a spiral spring 246 contained in a suitable casing carried by the frame 219. Similarly, in giving the wipers their secondary movement, they are rotated against the tension of a spiral spring 248 located about the pivot 222 and coöperating between the lower end of the shaft and said wipers. In view of this, it is only necessary in order to return the wipers and their switch parts to their normal positions, to disconnect the retaining pawls 230 and 234. As previously indicated, this is brought about upon the deënergization of the release magnet RM′. Upon such release, the retraction of the armature 239 draws the member 240 with it, and this member is arranged to engage the retaining pawls at this time, and therefore, moves them out of engaging position. This will be more apparent from inspection of Figs. 2 and 8 in which it will be seen the primary retaining pawl 230 is provided with a tail having an upturned end 247 which is adapted to pass through a coöperating opening 248 in the member 240. Similarly, the secondary retaining pawl 234 is provided with a tail having a similar upturned end 249, similarly adapted to pass into an opening 250 in the member 240. Upon the attraction of the release magnet armature 239, the member 240 passes over the upturned ends 247 and 249 until the openings 248—250 come into registration therewith. The member 240 then, by the action of the spring 251, moves downward far enough to engage the projecting ends of the pawls; then upon the retraction of the armature 239 these pawls are moved out of engaging position and, through the agency of the springs 246—248, the wipers are returned to their normal positions. For convenience in establishing connection between the various switch terminals and the incoming leads, connecting strips 252—253 are carried by a suitably insulating frame 219 of the switch.

As obviously indicated, certain contacts are thrown to their abnormal positions upon the deënergization of relay 162 and subsequently returned to their normal positions upon the deënergization of release magnet RM′. The contacts so actuated are designated 79—101—163—168—82—102. The mechanical arrangement of the parts by which this movement is accomplished, is clearly illustrated in Fig. 8. The contacts 79—101—163—168—82—102 are suitably carried upon, and insulated from, the main frame 219 by means of a supporting bracket 254, and their free ends lie in proximity to one end of the magnet 162. They are forced from their normal positions by the insulating spacers 255—256, carried at the upper ends of lever 257, pivoted intermediate of its length to the magnet frame.

In operation, as soon as the force by which the lever 257 is moved, is withdrawn, the tension of the springs engaging the spacers 255—256 forces the upper end of the lever 257 toward the right into the position illustrated, thereby allowing the springs to as-

sume their normal positions. The armature 258 of the magnet 162 carries a spring pressed arm 259 which is provided with a catch 260 at its outer end, adapted to engage the lower end of the lever 257. Normally the catch lies in non-engaging position, but upon the attraction of the armature 258, the arm 259 is moved far enough to allow the catch 260 to engage the lever 257 and upon the retraction of the armature the lever is rocked about its pivot so as to force the spacers 255—256 against the pressure of the co-acting contact springs and thereby move the latter to their abnormal positions. Co-operating with the arm 259 is a member 261 carried by the armature 239 of the release magnet RM′ and acted upon by the spring 262. This member normally rests in engagement with the stop 263. With the spring contacts 79—101—163 and 168—82—102 in their abnormal positions, the end of the arm 259 adjacent to the armature 258 will engage the side of the member 261. With the parts in this position, upon the attraction of the armature 239 of the release magnet, member 261 will be moved downward past the end of the arm 259 so as to engage the underside of its adjacent end. Then upon the retraction of the armature 239, the member 261 will rock the arm 259 about its pivot, and thereby release the lever 257 which will thereupon return to its normal position, thereby permitting the springs also to return to their normal positions.

The second selector E is substantially the same in construction as the first selector D just described, but as will be apparent, the primary magnet PM, secondary magnet SM, release magnet RM′ will be replaced by the magnets PM′, SM′ and RM² of the second selector, while the release springs 95—96—97 of the first selector will be replaced by the contact spring 108 and its coöperating contact springs. Likewise, contact 94 of the primary off-normal switch PO′ and contacts 84—88 of the secondary off-normal switch SO of the first selector D, will be replaced by contacts 106—107 of the primary off-normal switch PO², and contacts 104—109 of the secondary off-normal switch SO′ of the second selector E; and in the second selector, the relay 162 with its associated parts will be omitted. The connector C also partakes of the general construction of the first selector heretofore described in detail.

Referring to Figs. 9 to 11 inclusive which illustrate a connector, it will be seen that the bank contacts 31—32—33 and the coöperating wipers 28—29—30 are arranged and actuated in the manner previously described, the primary movement being given by the primary magnet PM², and the secondary movement by the secondary magnet SM². In this instance, the release magnet RM³ operates through the agency of a member 240′ to release the primary and secondary retaining pawls in a manner similar to that heretofore described but the catch lever 241 of the selectors is omitted and the upturned end 244 of the lever 243 coöperating with the primary magnet armature 227 engages directly with the inclined surface 263 formed on the member 240′. In the case of the connector, the projection 222′ at the upper end of the primary shaft 221 controls the movement of the single contact 120 of the primary off-normal switch PO³, while the projection 237 at the upper end of the secondary shaft 223 controls the movement of the contacts 118—121. As previously indicated, contact 118 moves to its alternate position upon the first downward step of the shaft 223, while the contact 121 moves from its normal position upon the first downward step of said shaft, but does not move to its alternate position until said shaft has taken a second step. This is brought about by properly spacing the spring contacts 118—121 and their coöperating contact springs, as illustrated in Fig. 9. Likewise, in the connector, contact spring 132 and its coöperating contacts are under the joint control of release magnet RM³ and magnet 125. As previously indicated, contact 132 is moved to its alternate position upon the deënergization of relay 125 and is again restored to its normal position upon the subsequent energization of release magnet RM³. The tension of the spring 132 and its coöperating springs is such that they normally occupy the position illustrated. This movement of the contact is brought about through the agency of an arm 264 carried by the lower end of armature 265 of the relay 125 and having its outer end forced upward by the spring 266. Upon the attraction of the armature 265, a projection 267 on the arm 264 passes to the left of an insulating block 268 carried by the spring 132, and upon the retraction of the armature 265, the right-hand shoulder of the projection 267, by engaging the left face of the block 268, forces the spring 132 against its inherent tension to its alternate position. In order to release the parts, the armature 269 of the release magnet RM³ is provided with an arm 270 whose outer end 271 overhangs the outer end of the arm 264, so that upon the attraction of the armature 269, the outer end of the arm 264 is drawn downward so as to free the projection 267 from the block 268 to allow the return of the spring 132 to its normal position. The relay 125 has associated with it suitable contact springs arranged so that when the armature is attracted the spring contact 131 is closed. Similarly, the release magnet RM³ has associated with it suitable spring contacts co-operating with the armature 269, so that upon its attraction, contacts 119—124—166

are opened. Obviously, the frame of the connector may carry any of the other associated relays such as the ringing relay 142. As previously indicated, the wipers of the connector are placed two steps distant from the first set of bank contacts, while in the selectors, the wipers are distant only one step. It will be apparent that the connector illustrated may be ordinarily connected in circuit in the manner shown in Fig. 1 of the drawing.

Obviously in carrying out the invention many alterations and modifications may be made in the mechanical construction of the switch mechanism herein disclosed, as well as many alterations and modifications in circuit connections, without departing from the spirit and scope of the invention. In the diagram of Fig. 1, I have illustrated a plurality of batteries whereas it should be understood that these may be replaced by a single battery, as would ordinarily be the case in actual practice. I therefore, do not wish to be limited to the exact matter disclosed, but aim to cover by the terms of the appended claims all such alterations and modifications.

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

1. A telephone exchange system comprising a subscriber's telephone line, an active switch contact in which said subscriber's line terminates, coöperating passive contacts adapted to be engaged by said active contact, a plurality of link-circuits extending from said passive contacts, means responsive to removal of the receiver at the calling substation for causing said active contact to automatically select and stop in engagement with the passive contact of an idle one of said link-circuits, and means for sending a characteristic signal over said subscriber's telephone line in case all of said link-circuits are in use.

2. A telephone exchange system comprising a subscriber's telephone line, an active switch contact in which said subscriber's line terminates, coöperating passive contacts adapted to be engaged by said active contact, a plurality of link-circuits extending from said passive contacts, means responsive to removal of the receiver at the calling substation for causing said active contact to automatically select and stop in engagement with the passive contact of an idle one of said link-circuits, means for sending a characteristic signal over said subscriber's telephone line in case all of said link-circuits are in use, and means whereby the subscriber may then restore said active contact to normal.

3. A telephone exchange system comprising a subscriber's telephone line, an active contact in which said subscriber's line terminates, coöperating passive contacts adapted to be engaged by said active contact, electrically operated signal transmitting apparatus associated with the last of said passive contacts to be engaged, a plurality of link-circuits extending from the remaining passive contacts, means responsive to removal of the receiver at the calling substation for causing said active contact to pass over said passive contacts, means for arresting said movement in case an idle passive contact is encountered, means for operating said signal transmitting apparatus in case its passive contact is engaged by said active contact and signal receiving means associated with said telephone line.

4. A telephone exchange system comprising a subscriber's telephone line, a plurality of associated link-circuits, interconnecting switch mechanism comprising an active contact, coöperating passive contacts adapted to be engaged by said active contact, means responsive to removal of the receiver at the calling substation for causing said active contact to pass over said passive contacts and means for arresting said movement in case an idle passive contact is encountered, electrically operated signaling apparatus associated with the last of said passive contacts, and means for operating said signaling means as soon as its passive contact is engaged by said active contact.

5. A telephone exchange system comprising a subscriber's telephone line, a plurality of link-circuits extending therefrom, automatic switching means for establishing connection between said line and an idle one of said link-circuits, means for restoring said switching means to normal position, and means for placing said restoring means under the control of the subscriber in case all of said link-circuits are in use.

6. A telephone exchange system comprising a subscriber's telephone line, a plurality of link-circuits, electrically controlled switching means for automatically establishing a connection between said line and the first encountered idle one of said link-circuits, means for restoring said switching means to normal position, and means for placing said restoring means under the control of the subscriber in case all the encountered link-circuits are in use.

7. A telephone exchange system comprising a plurality of subscribers' telephone lines, multiple interconnecting link-circuits, automatic switching means for selecting an idle one of said link-circuits and completing connection therethrough between a calling line and a called line, means for restoring said switching means to normal position, and means for placing said restoring means under the control of the subscriber in case all of said multiple link-circuits are in use.

8. A telephone exchange system comprising a subscriber's telephone line, a plural-

ity of link-circuits, electrically controlled switching means for automatically establishing connection between said line and the first encountered one of said idle link-circuits, means for restoring said switching means to normal position, relay mechanism for controlling the operation of said restoring means, and means for placing said relay mechanism under the control of the subscriber in case all the encountered link-circuits are in use, whereby the subscriber may then restore said switching means to normal.

9. A telephone exchange system comprising a subscriber's telephone line, an active contact in which said line terminates, coöperating passive contacts adapted to be engaged by said active contact, a plurality of link-circuits extending from said passive contacts, relay mechanism associated with one of said passive contacts, means for causing said active contact to move over said passive contacts, means for arresting said movement in case an idle link-circuit passive contact is encountered, means under the control of said relay mechanism for restoring said switching means to normal position, and means for placing said relay mechanism under the control of the subscriber in case said active contact engages the passive contact associated with said mechanism, whereby the subscriber may restore said switching means to normal.

10. A telephone exchange system comprising a subscriber's telephone line, a plurality of link-circuits extending therefrom, automatic switching means for establishing connection between said line and an idle one of said link-circuits, means for restoring said switching means to normal position, means for sending a characteristic signal to the subscriber and for placing said restoring means under his control in case all of said link-circuits are in use.

11. A telephone exchange system comprising a subscriber's telephone line, an active contact in which said line terminates, coöperating passive contacts adapted to be engaged by said active contact, a plurality of link-circuits extending from said passive contacts, means for causing said active contact to automatically select and stop in engagement with the passive contact of an idle one of said link-circuits, means for restoring said active contact to normal position, and means for sending a characteristic signal to the subscriber and for placing said restoring means under his control in case all of said link-circuits are in use.

12. A telephone exchange system comprising a subscriber's telephone line, an active contact in which said line terminates, coöperating passive contacts adapted to be engaged by said active contact, electrically operated signal transmitting mechanism and relay mechanism associated with the last of said passive contacts to be engaged, a plurality of link-circuits extending from the remaining passive contacts, means for causing said active contact to pass over said passive contacts, means for arresting said movement in case an idle passive contact is encountered, means for operating said signal transmitting means and for placing said relay mechanism under the control of the subscriber in case said last passive contact is engaged, and signal receiving means associated with said telephone line at the substation.

13. A telephone exchange system comprising a plurality of subscribers' telephone lines, multiple interconnecting link-circuits, automatic switching means for selecting an idle one of said link-circuits and completing connection therethrough between a calling line and a called line, means for restoring said switching means to normal position, and means for sending a characteristic signal to the calling party and for placing said restoring means under his control in case all of said link-circuits are in use.

14. A telephone exchange system comprising a plurality of subscribers' telephone lines, multiple interconnecting link-circuits, switching mechanism including active and passive contacts for selecting idle link-circuits and completing connection therethrough between a calling line and a called line, the active contacts being associated with the subscribers' lines and each passing over a plurality of passive contacts associated with said link-circuits, means for restoring said switching mechanism to normal position, electrically operated signal transmitting mechanism and relay mechanism associated with the last passive contact of each set, means for causing an active contact associated with a calling line to pass over the associated passive contacts, means for arresting said movement in case an idle passive contact is encountered, means for operating said signal transmitting means and for placing said relay mechanism under the control of the calling party in case the said last passive contact is engaged, and signal receiving means associated with the calling line at the substation.

15. A telephone exchange system comprising subscribers' telephone lines, "selector" switches responsive to removal of the receiver at a calling substation for extending the circuits of calling lines, a plurality of link-circuits connected to each "selector" switch and available for connection with a calling line, and means for sending a characteristic signal over the calling line in case all of the link-circuits available to said line are in use.

16. A telephone exchange system comprising subscribers' telephone lines, "selector" switches for extending the circuits of calling lines, a plurality of link-circuits connected

to each "selector" switch and available for connection with a calling line, means for restoring an actuated "selector" switch to normal, and means for placing said restoring means under the control of the calling party in case all of the link-circuits available to his line are in use.

17. A telephone exchange system comprising subscribers' lines, a "selector" switch individual to each line and responsive to the removal of the receiver at the substation thereof for extending its circuit, a plurality of link-circuits connected to each "selector" switch and available for connection to its line, and means for sending a characteristic signal over the calling line in case all of the link-circuits available to said line are in use.

18. A telephone exchange system comprising subscribers' lines, a "selector" switch individual to each line for extending its circuit, a plurality of link-circuits connected to each "selector" switch and available for connection to its line, means for restoring an actuated "selector" switch to normal, and means for placing said restoring means under the control of the calling party in case all of the link-circuits available to his line are in use.

19. A telephone exchange system comprising subscribers' telephone lines, "selector" switches for extending the circuits of calling lines, a plurality of link-circuits connected to each "selector" switch and available for connection to a calling line, "connector" switches for extending the calling line circuits to called lines, means for sending a characteristic signal over a calling line in case all the link-circuits available to it are in use, means for causing a "connector" switch to pick out and stop in engagement with an idle one of a plurality of called lines, and means for sending a characteristic signal over the calling line in case all of said called lines are in use.

20. A telephone exchange system comprising subscribers' telephone lines, "selector" switches for extending the circuits of calling lines, a plurality of link-circuits connected to each "selector" switch and available for connection to a calling line, "connector" switches for extending the calling line circuits to called lines, means for actuating a "connector" switch to pick out and engage an idle one of a plurality of called lines, and means for sending a characteristic signal over the calling line in case all of said link-circuits available to a calling line are in use and, if the connection is continued to a called line, in case all of said called lines are in use.

21. A telephone exchange system comprising subscribers' telephone lines, active contacts of "selector" switches adapted for connection to said lines, a plurality of groups of passive contacts coöperating with each of said active contacts, a link-circuit extending from each of said passive contacts, a signal transmitting apparatus operatively connected to the last passive contact of each group so as to transmit a signal over a calling line in case its passive contact is engaged by its coöperating active contact, active contacts of "connector" switches adapted for connection to said link-circuits, a plurality of passive contacts coöperating with said active contacts and adapted to be connected to called telephone lines, means for causing the active contact of a "connector" switch to pick out and stop in engagement with an idle one of a group of passive contacts associated with called lines, and a signal transmitting apparatus connected to a passive contact associated with each of said groups of passive contacts and operative to transmit a signal over the calling line in case all of the passive contacts in its group are in use.

22. A telephone system including a telephone line, selective switching mechanism at the exchange, contacts individual to said line at said mechanism, first selectors at the exchange, multiple terminals of said selectors at said mechanism, means effective on removal of the receiver at the substation of said line to connect contacts thereof with contacts of an idle selector, and apparatus effective to extend a busy signal over said line in case said selectors are busy.

23. A telephone system including a telephone line, a selective switch at the exchange, contacts of said line at said switch, link-circuits associated therewith and having multiple contacts at said switch, means for altering the electrical conditions of said multiple contacts to render them busy, mechanism responsive to removal of the receiver at the substation of said line to cause contacts of said line to register with contacts of an idle link-circuit, and means whereby a busy condition of all said multiple contacts will be manifested over said line.

24. A telephone system including a telephone line, a plurality of link-circuits at the exchange, means responsive to removal of the receiver at the substation of said line to automatically connect an idle one of said circuits with said line, and apparatus for extending a busy signal over said line when said circuits are all busy on initiation of a call.

25. A telephone exchange system comprising a traveling switch having a plurality of wipers and coöperating sets of passive contacts, means for advancing said wipers over said contacts from a normal position, electrically controlled means for restoring said wipers to normal, a control relay in circuit with the last passive contact of one of said sets, a release circuit including a contact of said relay and the last passive contact of an-

other of said sets, and means for closing the circuit of said control relay and said release circuit.

26. A telephone exchange system comprising a traveling switch having three wipers and three sets of coöperating passive contacts, means for advancing said wipers over said contacts from a normal position, electrically controlled means for restoring said wipers to normal, a release circuit therefor extending through the last passive contact of one of said sets, means for completing said release circuit, and control circuits for said latter means including the last passive contact of each of the remaining sets.

27. A telephone exchange system comprising a traveling switch having three wipers and three sets of coöperating passive contacts, means for advancing said wipers over said contacts from a normal position, electrically controlled means for restoring said wipers to normal, a pair of relays each connected in circuit with the last passive contact of two of said sets, and a release circuit for said electrically controlled means extending through contacts of said pair of relays and the last passive contact of the third set.

28. The combination with a telephone station, and a switching mechanism connected thereto, of means responsive to the removal of the receiver at the calling substation for operating said switching mechanism so as to automatically connect said station to an idle member of a group of similar switching mechanisms, a pair of wipers through which said connection is completed and through which any talking circuit for said station must pass, and means by which upon no idle switch being found by said operation a busy signal current will flow through said wipers to said station.

29. A telephone system comprising substation telephone lines each having a pair of talking conductors, selector switches, a plurality of link circuits connected to each selector switch and available for connection with a calling line, means responsive to the closure of the talking conductors in series of a calling line to cause the selector switch to seek connection with one of said link circuits, and means for sending a characteristic signal over the calling line in case all the said link circuits extending from an operating selector are in use.

30. A telephone system comprising substation telephone lines each having a pair of talking conductors, individual switches for said lines, link circuits multiply connected to said individual switches and adapted for extending the circuit of said line, means controllable over the talking conductors of a calling line in series to cause the associated individual switch to seek connection with an idle one of said link circuits, and means for sending a characteristic signal over the calling telephone line in case all of said link circuits are in use.

31. A telephone system comprising telephone substation lines, individual switches for said lines, and link circuits multiply connected to said switches and adapted for extending the circuit of said line responsive to the removal of the receiver at the calling substation which causes the switch to seek connection with an idle one of said circuits, and means for sending a characteristic signal over the calling line in case all of said link circuits are in use.

32. A telephone system comprising substation telephone lines, each having a pair of talking conductors, a plurality of link circuits common thereto, automatic switch mechanism responsive to the closure of the metallic circuit of the talking conductors of a calling one of said lines to connect said line with an idle one of said link circuits, and means for sending a characteristic signal over the calling line in case all of said link circuits are in use when said line calls.

33. A telephone system comprising substation telephone lines each having a pair of talking conductors, a contact maker for each of said lines, a plurality of link circuits multiply connected to terminals before each of said contact makers, means responsive to the closure of the metallic circuit of the talking conductors of a calling one of said lines to cause its contact maker to connect said line with the terminals of an idle one of said link circuits, and means for sending a characteristic signal over the calling line in case all of said link circuits are in use when said line calls.

34. A telephone system comprising substation telephone lines each having a pair of talking conductors, a plurality of link circuits less in number than said lines and common thereto, automatic switch mechanisms equal in number to the number of lines, means for operating one of said switch mechanisms responsive to the closure of the metallic circuit of the talking conductors of a calling one of said lines to connect said line with an idle one of said link circuits, and means for sending a characteristic signal over the calling line in case all of said link circuits are in use when said line calls.

35. A telephone system comprising substation telephone lines, a plurality of link circuits common thereto, automatic switch mechanism responsive to the closure of the metallic circuit of a calling one of said lines to connect the calling line with an idle one of said link circuits, connector switches, means for connecting a selected link circuit with an idle one of said connector switches, means for operating said connector switch to pick out and stop in engagement with an

idle one of a plurality of called lines, and means for sending a characteristic signal over the calling line in case all of said called lines are in use.

36. A telephone system comprising substation telephone lines, a plurality of link circuits common thereto, switch mechanisms individual to said lines and responsive to the removal of the receiver upon initiation of a call to connect the calling line with an idle one of said link circuits, connector switches, means for connecting a selected link circuit with an idle one of said connector switches, means for operating said connector to pick out and stop in engagement with an idle one of a plurality of called lines, and means for sending a characteristic signal over the calling line in case all of said called lines are in use.

37. A telephone system comprising substation telephone lines, a plurality of link circuits common thereto, automatic switch mechanism responsive to the closure of the metallic circuit of a calling one of said lines to connect the calling line with an idle one of said link circuits, connector switches, means for connecting a selected link circuit with an idle one of said connector switches, means for operating said connector switch to pick out and stop in engagement with an idle one of a plurality of called lines, means for sending a characteristic signal over the calling line in case all of said called lines are in use, and means for providing talking current from a central source.

38. A telephone system comprising substation telephone lines each having a pair of talking conductors extending to a central office, a plurality of link circuits for extending the talking circuits of said lines and common thereto, automatic mechanism responsive to the closure of said line conductors of a calling line in series to connect said line with an idle link circuit, directive switches for extending the selected link automatically into connection with the first idle one of a plurality of called telephone lines, and a central source of current and control circuits for supplying talking current to the connected pair of lines.

In witness whereof, I hereunto subscribe my name this 5th day of November, 1906.

ALFRED H. DYSON.

Witnesses:

L. D. KELLOGG,

J. G. KELLOGG.