H. G. WEBSTER.

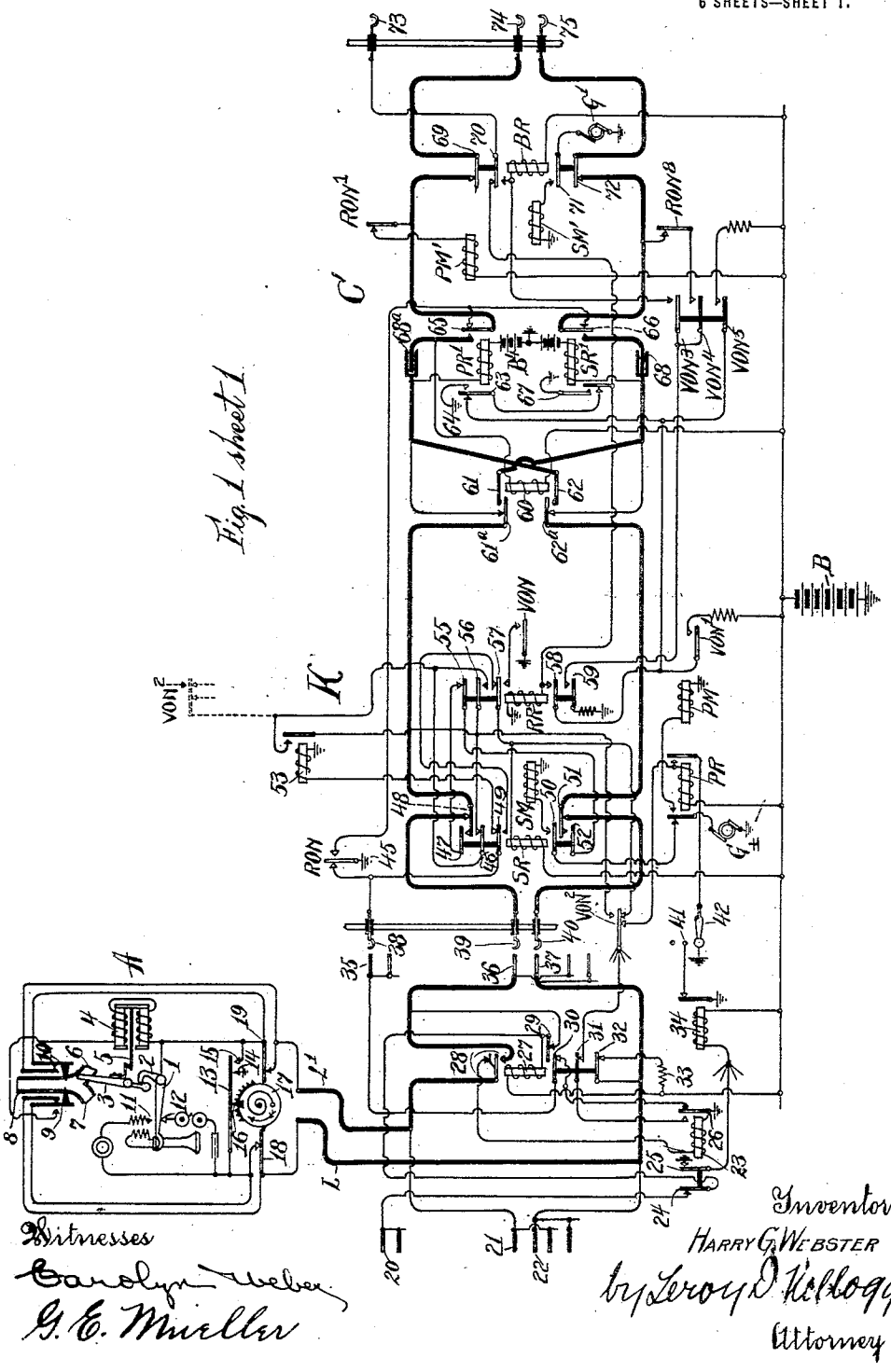
AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED FEB. 27, 1907.

1,169,894.

Patented Feb. 1, 1916.

6 SHEETS—SHEET 1.



Witnesses

Carolyn Weber

G. E. Mueller

Inventor

HARRY G. WEBSTER

by Leroy D. Kellogg

Attorney

H. G. WEBSTER.

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6 SHEETS—SHEET 2.

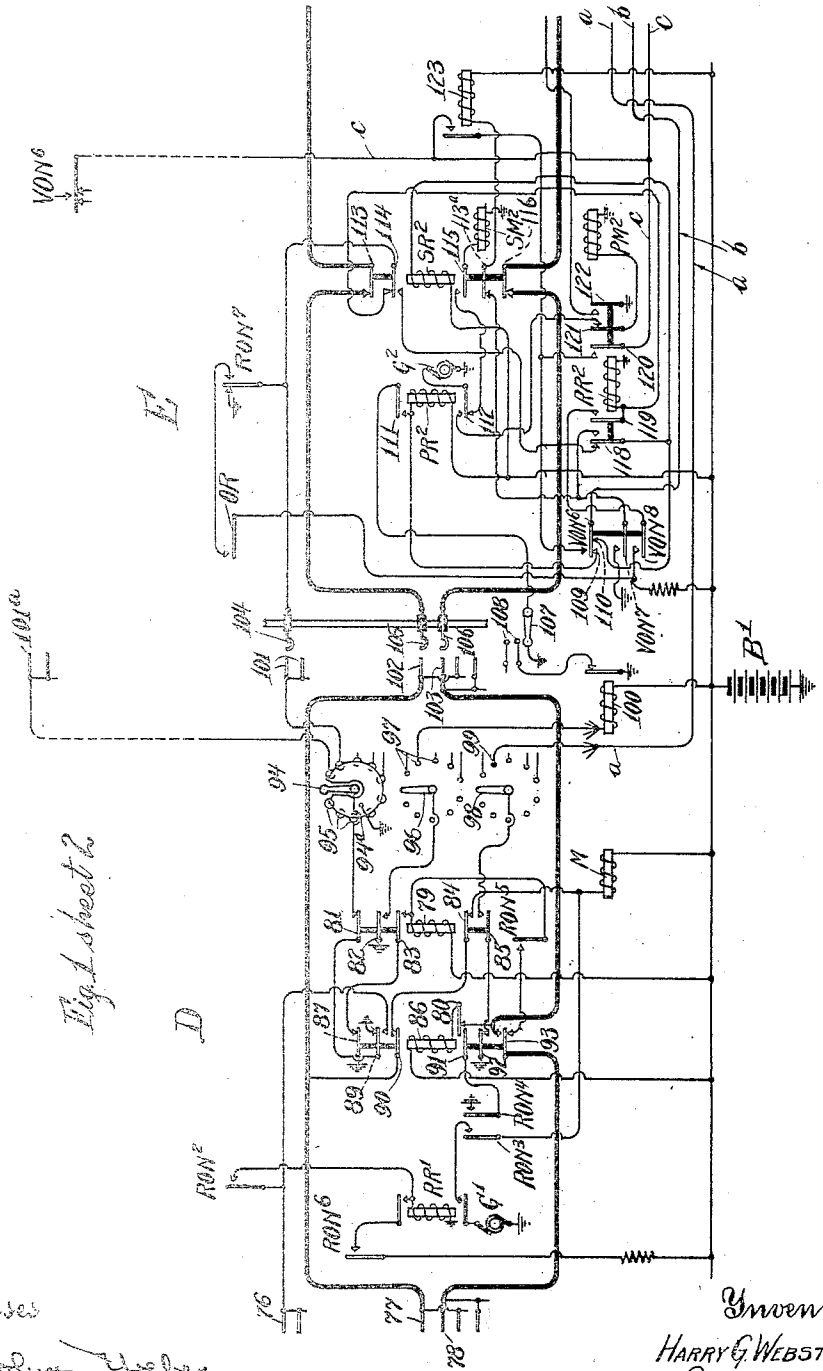

Fig. 1 sheet 2.

Witnesses

Carolyn Weber

G. E. Muller

Inventor

HARRY G. WEBSTER

by Lloyd D. Kellogg

Attorney

H. G. WEBSTER.

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6 SHEETS—SHEET 3.

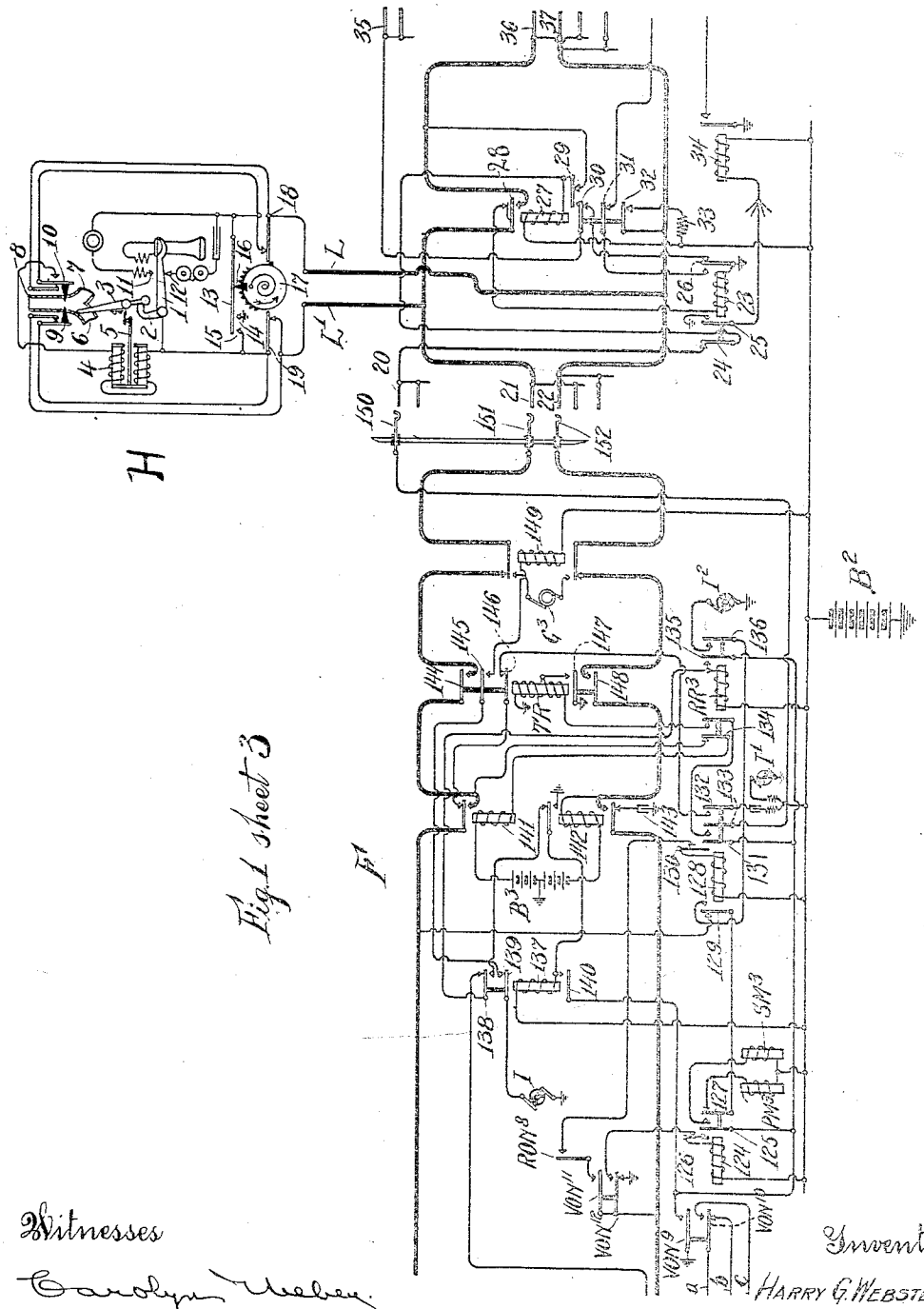

Fig. 1 Sheet 3

Witnesses

Carolyn Meloy.

G. E. Mueller

Inventor

Harry G. Webster

by Leroy D. Kellogg

Attorney.

H. G. WEBSTER.

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6 SHEETS—SHEET 4.

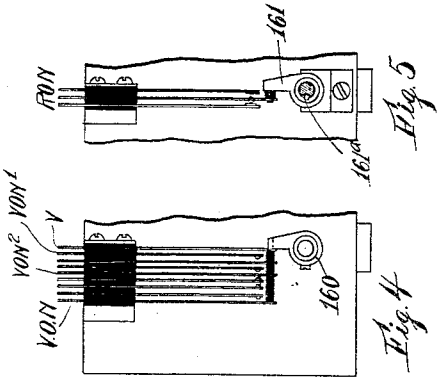

Fig. 5

Fig. 4

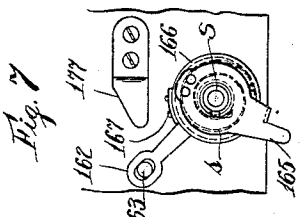

Fig. 7

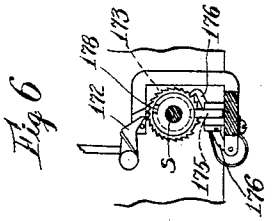

Fig. 6

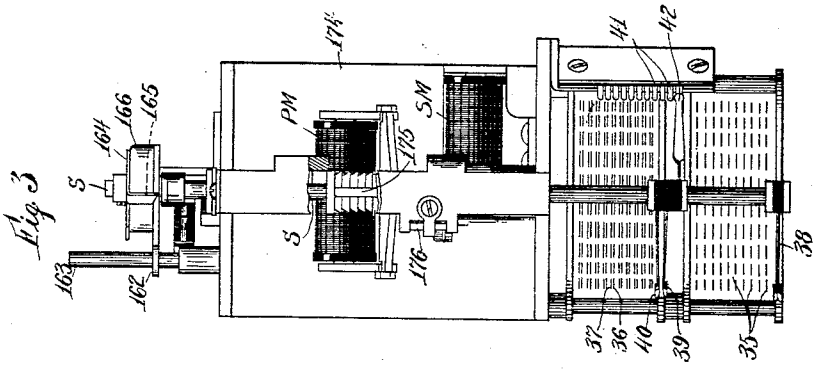

Fig. 3

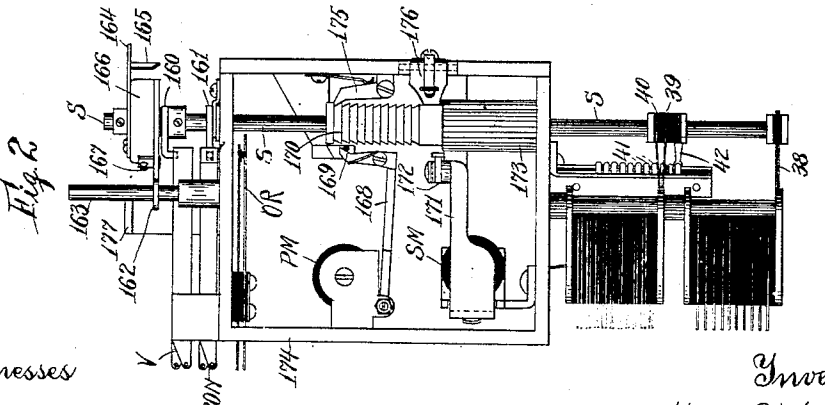

Fig. 2

Witnesses

Carolyn Weber.

G. E. Mueller

Inventor

Harry G. Webster

by Leroy D. Kellogg

Attorney

H. G. WEBSTER.

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6 SHEETS—SHEET 5.

Fig. 8

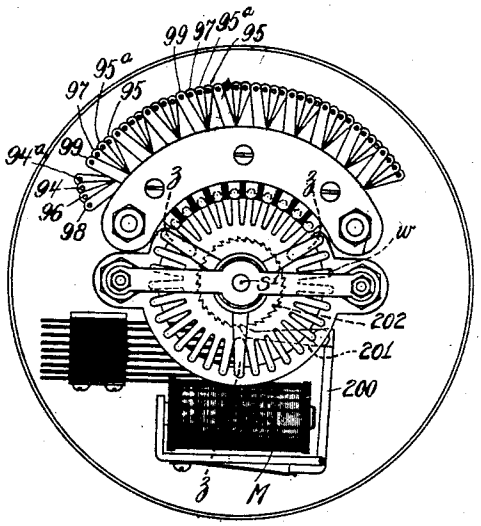

Fig. 9

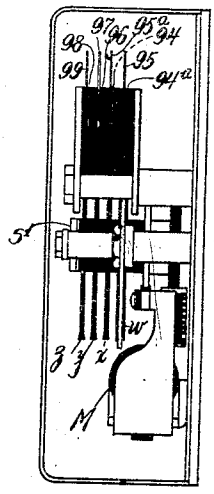

Fig. 10

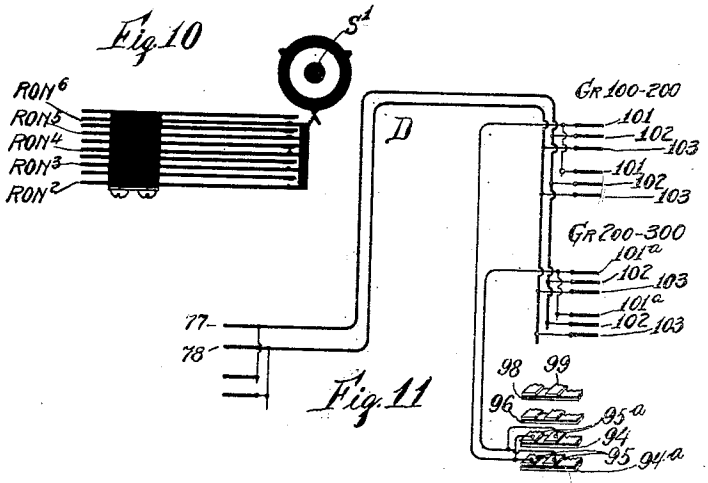

Fig. 11

Witnesses

Carolyn Weber

G. E. Mueller

Inventor

Harry G. Webster

by Leroy D. Kellogg

Attorney

H. G. WEBSTER.

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6 SHEETS—SHEET 6.

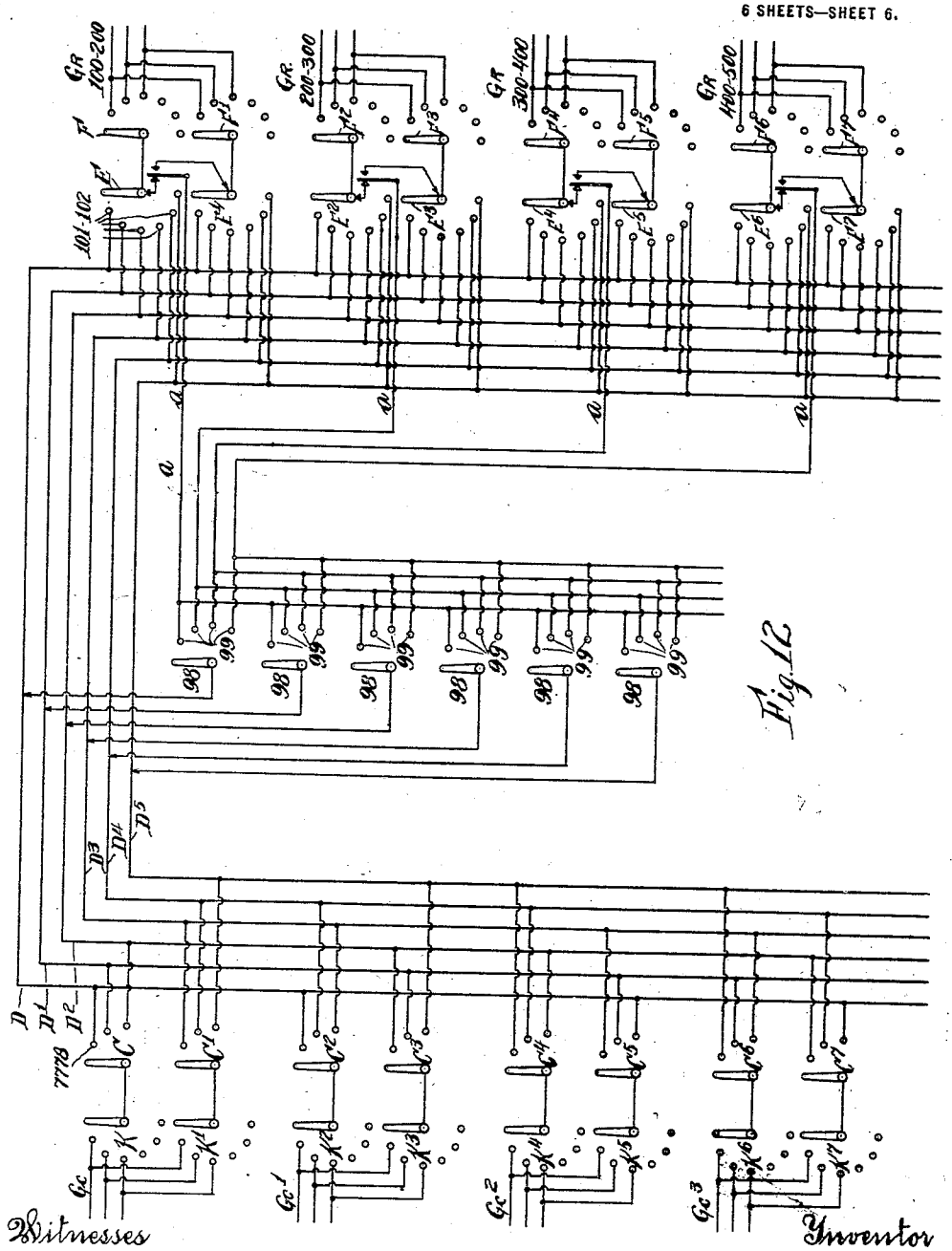

Fig. 12

Witnesses

G. E. Mueller

Inventor

HARRY G. WEBSTER

by Leroy D. Kellogg

Attorney

UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLOGG SWITCHBOARD & SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,169,894. Specification of Letters Patent. Patented Feb. 1, 1916.

Application filed February 27, 1907. Serial No. 359,625.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, residing in Chicago, in the county of Cook, State of Illinois, have invented new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems in which a central source of current is employed for operating the switches and for purposes of conversation, and in which the selective switching mechanisms, employed in establishing the connections between the calling and the called lines, are provided in numbers proportioned to the numbers of expected co-existing conversations, there being no selective switching mechanisms individual to subscribers' lines.

The general object of my invention is to provide improved circuit structures operating in connection with simplified mechanical switches, there being features of novelty and utility both in the said structures and the mechanical switches, the invention of the two having gone hand in hand and being mutually dependent and contributing to produce a single result.

In accordance with my invention, the subscribers' lines are provided at the exchange with multiple terminals of two different kinds, those of one kind appearing in the contact banks of connectors which make connection to the lines by means of these contacts as called lines. The terminals of the other kind appear in the contact banks of line selectors which make connection to the lines by means of said contacts as calling lines in order to place the directively operated step-by-step central office switches under the control of the substation calling devices of the calling lines. The line selectors are preferably not constantly operating mechanism but are normally at rest, the telephone lines having associated with them mechanisms operative, when calls are initiated over the lines, to distributively start into operation the line selectors. One such selector is started for each initiated call and when started, automatically seeks out and connects with contacts of the calling line.

I am aware that systems have heretofore been proposed embodying certain of the features above outlined. The structure of my invention, however, differs among other respects from these in that I do away with special apparatus apart from the line selectors and line circuits for starting line selectors, the arrangement of my structure being such that normally a single line selector is operatively associated with the lines which it serves; as soon as the first switch is started, an off-normal contact is operated to extend the common starting circuit past the started switch to the next switch of the group, which latter switch is placed under the control of the line circuits of the group of lines which the switches serve as soon as the first switch has completed its selection of the calling line.

Another feature of novelty found in my invention consists in the manner in which, after the calling subscriber has caused the operation of a first selector to pick the thousand wanted, the call is extended to the connector of the hundred wanted out of the s lected thousand. The first selectors and line selectors are linked together in permanently associated pairs, one switch of a pair, the line selector, operating to select the calling line as before indicated. The other switch of the pair has before it, arranged in groups, contact sets for each thousand in the exchange (assuming a ten thousand exchange), a first selector, after it is by the operation of the line selector placed in connection with the calling line, being directively operated from the substation to select the group of contacts representing the wanted thousand and then automatically operated to select the first idle contacts out of the said group. In the structure of my invention, the contact sets at the first selectors are not connected to second selectors having active terminals for selecting a group of contacts and then the idle contacts, but the said contacts at the first selector banks are connected to conductors extending to, and appearing before the contact wipers of automatically operated trunk selecting switches, each trunk selecting switch being permanently connected to a connector adapted to select terminal contacts of any line out of a particular hundred to which the connector is assigned. The contacts appearing in the banks of the first selectors are stationary contacts, and the wires connected to them extend to stationary contacts disposed in the banks of the trunk selecting switches. If

the usual ten per cent. ratio of trunking is preserved, there will be ten connectors for each hundred lines, and consequently ten trunk selecting switches, each joined to a connector, for each hundred, making for the thousand, ten groups of switch pairs of ten pairs each. Each contact set at a first selector pertaining to a particular one thousand, will, in such case, have its conductors multipled one hundred times, once at each trunk selecting switch of the one thousand. Included in the mechanism of the trunk-circuit connecting the stationary contacts of the first selector with the stationary contacts at the trunk selectors of the connectors of the thousand is a simple directively operated selective switch. The bank contacts at the trunk selecting switches are normally unselectable in character, the private contacts being connected to ground through the mechanism of the simple switch before mentioned. After the calling subscriber has extended his line, by the operation of a first selector to an idle trunk-circuit appropriated to the desired one thousand, he operates the switch of the trunk-circuit around to a position corresponding with the wanted one hundred of the thousand, the bank contacts of the trunk-circuit continuing in their unselectable condition. An impulse succeeding the directive impulses then operates to remove the ground from the private contacts of the selected trunk-circuit appearing in the banks of the trunk selecting switches pertaining to the wanted one hundred, while leaving the bank contacts of the trunk selecting switches of the nine other hundreds of the thousand in their busy or unselectable condition. The said impulse also operates to start an idle trunk selecting switch of the group of the corresponding hundred which then automatically proceeds in its operation to select and connect with its particular bank contacts of the trunk-circuit which have been rendered selectable, as before described. Since the sets of bank contacts of the trunk-circuit at the trunk selectors of the other hundreds of the thousand have been left unselectable, as before described, any trunk selecting switch of the other hundreds which may be started by some other calling subscriber, in putting through his call, will be unable to connect with the trunk-circuit in question, and no interference or improper selection can arise. I believe this method of trunking, including a selective switch controlling group-wise the private multiples of a trunk-circuit, and being adapted selectively and under control of substation mechanism to render one group of such terminals selectable while maintaining the others excluded from being selected or busy, to be novel. Its utility will be apparent from the consideration that it will permit a group of one hundred lines to which a large amount of incoming business goes to be provided with more than the usual ten connectors, without requiring for the purpose second selectors to be provided having more than the usual ten sets of contacts to a level or without requiring an especial distribution of the stationary multiple contacts of the connectors for the hundred at the second selectors, the arrangement last indicated consisting for instance, if twenty connectors were provided for the particular busy hundred, in multipling the stationary contacts of the trunk-circuits extending from the second selectors to these connectors one-half the number of times, or to one-half the usual number of second selectors. While the arrangement thus indicated will provide twenty connectors for the hundred lines as called lines, the calling subscriber having put his call through to a second selector, would have but ten chances of reaching the hundred wanted unless receiving the busy signal he were to hang up his receiver and on the second trial succeed in reaching a second selector having before it multiple contacts of the other ten connectors for the wanted hundred. In accordance with the structure of my invention, however, if twenty connectors were to be provided for a particular hundred, a trunk selector would be provided for each such connector, and each trunk-selector could be started from any trunk-circuit of the thousand and could connect any calling line through to its connector without rendering it necessary for the subscriber to hang up his receiver and make a call twice. These and other features of my invention will be more readily understood from the consideration of the drawings in which—

Figure 1 illustrates circuits of a 10,000 line system embodying my invention. Figs. 2 and 3 are respectively side and front elevations of the switch for the circuit of Fig. 1. Figs. 4 and 5 illustrate the off-normal combinations of said switch. Figs. 6 and 7 show respectively the rotary actuating mechanism and the rotary restoring spring arrangement of said switch. Figs. 8 and 9 are respectively top and side views of the trunk switch of the circuit at D in Fig. 1, Fig. 10 its off-normal combination and Fig. 11, a schematic view of the contacts of said switch and their multipling. Fig. 11 also illustrates schematically a trunk arrangement for the system of Fig. 1. Fig. 12 is a diagram indicating a trunking arrangemen for Fig. 1.

Referring first to Fig. 1 comprising Sheets 1, 2 and 3, I show at A and H two subscribers' stations connected with the exchange by limbs L—L′ of their respective telephone lines, which are provided with multiple terminals 20—21—22 adapted to be selected by connectors when the lines are

employed as called lines, and with the further multiple terminals 35—36—37 adapted to be selected by line selectors when the lines are employed as calling lines. Assuming a ten thousand line exchange, the subscribers' lines are preferably divided into groups of one hundred as called lines and as calling lines, their grouping as called lines being in conformity with the numbers assigned to the subscribers by the telephone company. The contacts 20—21—22 of the group of one hundred lines would appear in consecutive order in the banks of connectors adapted to connect with them. The contacts 35—36—37 adapted to be selected by the line selectors however, may be arranged in groups having no reference to the subscriber's number, and a distributing board of any of the well known types may be conveniently employed for changing the group relations of the contacts of the lines at the line selectors to average up the loads on the different groups of line selectors, as may be required in the operation of an exchange. At K, I show the circuits of a line selector which is permanently linked to the circuits of a first selector C. The wipers 38—39—40 of the line selectors have preferably, as indicated in Fig. 3, one hundred sets of contacts, each set consisting of a private contact 35 and the line contacts 36—37. The one hundred contact sets are preferably arranged in ten groups of ten each, the wipers 38—39—40 being adapted to first make vertical step-by-step movements to select a group, and then rotary step-by-step movements to select a contact set of a group. Each group of horizontally disposed contact sets has a group contact 41 over which the auxiliary wiper 42 is adapted to wipe, the vertical movements of the line selector being governed by the auxiliary wiper 42, which passing over the group contacts 41, tests them successively, the wipers 38, 39, 40 partaking of the vertical movements. When the auxiliary wiper 42 has a group contact 41, in an altered abnormal electric condition indicating that a line of the group is calling, the vertical movements are discontinued and the wipers 38—39—40 automatically begin their rotary movements selecting the particular contact set of the group belonging to the calling line, and resting in engagement with these contacts as soon as they are found. By this means, any line selector, of which ten may be provided for the group of one hundred lines, is enabled after being initially started by the removal of the receiver at a substation, to automatically proceed and select the individual contacts of the calling line whose electrical condition will have been changed by apparatus controlled by the removal of of the receiver. Thus a first selector C is brought under the control of the calling line and the calling subscriber, who is assumed to be A, may then cause transmission of directive currents to the mechanism of the first selector C.

The first selector C may be mechanically similar to the line selector illustrated in Fig. 1 except that the group contacts are not required. The first selector includes the wipers 73—74—75, corresponding to the wipers 38—39—40 of Figs. 2 and 3, and one hundred sets of multiple contacts 76—77—78 of trunk circuits such as D, which contacts are arranged in horizontally disposed groups of ten contact sets each, each level or group of contact sets being assigned for connection to a different thousand of the ten thousand line exchange. The wipers 73—74—75 are first lifted in response to directive impulses controlled at the substation to positions horizontal with the group of contact sets belonging to the wanted thousand, and are then automatically rotated over the contacts of the group, the wiper 73 coöperating with the private contacts 76 of the trunks D to select the first idle trunk of the group. The trunk circuit D includes a rotary switch diagrammatically shown as provided with the wiper 94, the grounded disk 94^a and the wipers 96 and 98. In the operation of the switch, the wipers 94—96—98 and disk 94^a have a step-by-step rotary movement imparted to them and move over the respective sets of contacts 95—97—99. Each set of contacts 95—97—99 pertains to trunk selectors E of a different one hundred group of called lines. Assuming ten connectors F for each hundred, and hence ten trunk selectors E, the trunk-circuit D is provided with ten multiple private contacts 101, connected to a contact 95 of the trunk-circuit, one of these contacts 101 appearing at each of the ten trunk selectors for the second one hundred. The trunk-circuit D also has ten private multiple contacts 101^a connected to the first contact 95, one of these ten contacts 101^a appearing at each of the trunk selectors pertaining to the first hundred of the thousand and the said trunk-circuit D has corresponding sets of ten private contacts connected to a contact 95 for each of the other hundreds of the thousand. At D the disk 94^a is shown in its normal position grounding each of the contacts 95, and therefore, all the one hundred private contacts 101—101^a, etc., are unselectable by the trunk-circuit selectors E in whose banks they appear. In the operation of the switch, the disk 94^a is rotated step-by-step, the wiper 94 moving along with it, which wiper, as will be seen by an inspection of D, is grounded via normal contacts 81 and 89. The first clock-wise step brings wiper 94 upon the first contact 95, the second step upon the second contact 95, and so on. When the proper contact 95 has been se-

lected, movement of the switch ceases and the ground connection is removed from the wiper 94, thus rendering the private multiples of trunk-circuit D in the banks of the trunk selectors pertaining to the connectors of a particular hundred, selectable in character by said trunk selectors. Simultaneously with the removal of ground from the wiper 94, the circuit connections of wipers 96—98, which meanwhile have been placed in connection with contacts 97—99 corresponding to the hundred whose contact 95 has been engaged by wiper 94 are altered, and with the removal of ground from said contact 94, current is caused to flow from wipers 96 and 98 to the contacts 97 and 99 engaged by them to start an idle trunk selector switch E to select its multiple of contact 101, and to operate the group relay 100 to render the group contact of the subgroup, in which the selected trunk-circuit D has its multiples, selectable in character. The trunk selector E may be similar in operation to the line selector shown at Fig. 2, its wiper 107 corresponding in function to wiper 42 of the line selector and its wipers 104—105—106 corresponding in function to wipers 38—39—40 of the line selector. The contacts 102—103 of the trunk-circuit D are multipled to each trunk selecting switch E of the one thousand which the circuit D serves. We thus have the trunk-circuit D having its main conductors connected to contacts 102—103 multipled one hundred times and having ten groups of ten private contacts each, one group including ten contacts, 101, the second group including ten contacts 101 etc., not multipled to all the switches containing multiple contacts 102—103, but the private contacts are groupwise, or as it might be expressed, distributively multipled among the one hundred switches having the multiple contacts 102—103.

A connector F may be mechanically similar to the line selector, although the group contacts 41 and their auxiliary wiper 42 are not employed. The wipers 150, 151 and 152 of the connector are capable of being adjusted vertically to select a ten-line group, of lines out of its hundred, and of being then rotated to select the contacts of the particular line wanted out of the group, the contacts of the one hundred lines served by a connector being arranged according to their tens values, in horizontally disposed groups, in the usual manner.

In the circuit structure of Fig. 1, the usual release magnet for each switch is omitted, as I provide a mechanical structure such that I am enabled to restore the switch to zero or normal position without a special magnet for this purpose. This is accomplished by causing, when the restoration of the switch is to be secured, the rotary magnet to effect additional step-by-step movements of the wipers in the same direction as those caused in the original operation of the switch, until the switch wipers pass beyond the last contact set at the right of the bank, when the wipers may descend by gravity to their normal level and may then be automatically rotated in a reverse direction back to their normal positions. As I do not employ the so-called side-switch magnet in connection with the system of my invention, I use altogether but two magnets for each switch, one being a lifting or vertical magnet, the other being a turning or rotary magnet, and I thus reduce the switch mechanism very materially as compared with that employed in the systems heretofore generally employed; it being an object of my invention to accomplish as far as possible, by the employment of ordinary relay spring combinations, the circuit changes required for the operation of the system in order that, by the avoidance of relatively complicated electromagnetically actuated mechanical structures, the maintenance charges of a system constructed in accordance with my invention may be relatively low.

Referring to Fig. 1, let it be assumed that the subscriber, whose substation is shown at A, desires to have his line connected with that of the subscriber whose substation is shown at H, and whose number may be assumed to be 6254. In establishing the connection, the subscriber at A first removes his receiver from the hook-lever, whereupon hook-lever 1 disengages contact 12 and engages contact 11, completing a circuit from battery B, resistance 33, normal contact 32, limb L, contact 18, contact 11—1, contact 19, limb L', normal contact 28, line relay 23 to ground, operating the said relay whose attracted armature 24 disconnects private contacts 20 at the connectors from battery B via the winding of cut-off relay 27, in order that the line of the calling subscriber may test busy to incoming calls, as will be more fully explained hereinafter. The attraction of armature 25 completes circuit from ground through the common group relay 34 to battery, operating the said relay, whose attracted armature removes the normal ground connection from the group contact 41, it being assumed that the multiple contacts of the line of the calling subscriber A appear in the first levels of the first line selector K. An eleventh contact is preferably provided, as shown, for the auxiliary wiper 42, permanently grounded in order to insure a proper locking of the primary relay PR of the line selector. The attraction of armature 26 of line relay 23 removes ground from the individual multiple private contact 35 of the calling line, and its multiples, to render them selectable; and the said armature 26 by engaging its alter-

nate contact, completes a circuit from ground, alternate contact 26, normal contact 31, vertical off-normal switch VON^2; the circuit then branching, one portion extending through primary relay PR to battery, and the other portion through secondary relay SR to battery, the two relays being thereupon energized. Primary relay PR attracts its right armature to operatively connect the relay winding with auxiliary wiper 42, and its left armature to complete a circuit from generator G through primary magnet PM. Each impulse, transmitted by the generator through said magnet, causes the switch shaft, carrying wipers 38, 39, 40 and 42, to be raised a step; and such impulses will continue to flow as long as relay PR continues energized by current flowing from battery, through said relay, its attracted right armature, and to ground through successive contacts 42—41 to ground through the normal contacts of group relays 34. Inasmuch, however, as in the present case the calling line is in the lowest level of contacts, the first step of wiper 42 brings it to engage a contact 41, open at the armature of the first group relay 34; and the locking circuit through relay PR is opened and its armatures retracted as soon as one current impulse has passed through primary magnet PM to lift the wipers one step.

Vertical off-normal switch VON^2 was shifted on the first vertical step of the wipers to engage its alternate contact, which shifting would cause the starting of the second line selector assigned to the one hundred line group among which the line of A is included, were it not for the fact that relay SR, when operated as described, locked itself over a circuit extending from battery, through the relay winding, normal contact 57, alternate contact 49 to ground at rotary off-normal spring RON, thus holding open the circuit of the alternate contact of spring VON^2 at contact 46; the two other branch circuits of said alternate contact being open respectively at armature 56 of relay RR and at the armature of relay 53. The energization of relay SR also attracted armatures 47 and 52 to engage respectively their springs 48 and 51, then causing the said springs to disengage their normal contacts. Current then flows from the positive pole of battery B^4, primary relay PR′, normal contact 61^a, contact 48—47, normal contact 55, closed contact 52—51, normal contact 62^a, secondary relay SR′ to negative battery, operating the relays PR′ and SR′. The attraction of armature 50 of secondary relay SR closed a contact in the circuit of the secondary or rotary magnet SM in order that it may be operatively connected with generator G as soon as, on the deënergization of relay PR as described, the left armature of said relay engages its normal contact. When, therefore, the relay PR became deënergized, impulses begin flowing from generator G, normal contact of armature of relay PR, closed contact 50, magnet SM to ground, and said magnet, by its mechanical connections, turns wipers 38, 39 and 40 in a rotary direction, a step for each impulse received by it. With the first rotary step, rotary off-normal spring RON is shifted from its normal position shown to engage its alternate contact, and the locking circuit for relay SR is extended to wiper 38 and to successive multiple contacts 35, armatures 30, normal contacts 26 to ground, until wiper 38 reaches the contact 35 of a calling line assumed to be that of A, at which time the locking circuit of relay SR will be opened at normal contact 26 of relay 23 of the line of A, because the said relay is operated; and secondary relay SR will be deënergized and its armatures retracted, the retraction of 50 opening the circuit of secondary magnet SM and preventing further rotation of the wipers. Wipers 38, 39 and 40 are then resting in engagement with contacts 35, 36 and 37 of the calling line; and on the retraction of armatures 47 and 52 of relay SR, the relays PR′ and SR′ will be held operated over new circuits (established before the former ones are broken by the make-before break arrangements of springs 48 and 51) extending from battery B^4 through relay PR′, contact 61^a, normal contact 48, contact 39—36, normal contact 29, relay 27 to battery B, for relay PR′; and from battery B^4 through relay SR′, normal contact 62^a, normal contact 51, contact 40—37, line limb L, contact 11—1, line limb L′, and armature 28 through relay 23 to ground. The circuit before traced, including relays PR′ and 27, operates relay 27, and its armature 28 engages its alternate contact, establishing a new circuit for relays PR′ and SR′, holding them continuously energized, the circuit of relay SR′ now extending through alternate contact 28 and relay PR′ to positive battery, the armature 28 having a make-before-break contact for the purpose. The operation of armature 28 also opens the circuit of relay 23; armature 30 engages its alternate contact 29, causing the same to disengage its normal contact, and completes a locking circuit for relay 27, extending from battery B, through said relay 27, through contact 29—30, contact 35—38, normal contact 49, relay 53 to ground, operating the relay 53, whose attracted armature completes a connection from the alternate contact of vertical off-normal spring VON^2 to the vertical off-normal spring VON^2 of the second line selector pertaining to the same group of one hundred lines including that of A. This other line selector is, however, not operated at this time because relay 23 is deënergized and its armature 26 retracted. If, however, another

calling subscriber were now to remove his receiver, the resulting attraction of armature 26 of his line's relay 23 would complete a circuit from ground through contact 31 of his cut-off relay to the common off-normal spring VON^2 of the line selector K whose shifting has been described, the alternate contact of said spring, attracted armature of relay 53 and through the normal contacts of the vertical off-normal spring VON^2 of the second line selector to the relays SR and PR of that switch. That switch in its operation, on the first step, will shift its off-normal spring VON^2 to its alternate position; and as soon as it has completed its selection of the calling line, the third line selector will be operatively connected with the line relays 23 of the group of subscribers' lines via the shifted vertical off-normal springs VON^2 of the two operated line selectors, and so on in series through the ten switches serving the hundred line group. The vertical off-normal switch springs VON and VON′ of switch K were shifted on the first vertical movement of the switch, their functions being in connection with the release operations hereafter described.

The subscriber at A now rotates dial 17 from left to right until six teeth have passed below spring 19 and releases it. The arrangement of tooth 16 of the dial to spring 13 is such that when the dial is in other than normal position, the said spring 13 will rest in engagement with contacts 14 and 15; and during the manual rotation of the dial, the relays PR′ and SR′ at switch C are held energized over circuits extending from the two sides of battery B^4 to ground through contact 13—14, except when the circuits of the relays are interrupted by the teeth of dial 17 operating on springs 19 and 18, as hereafter described. On the release of the dial, its associated spring rotates in a reverse clockwise direction, the six teeth, which have been passed below spring 19, operating upon the said spring to cause six interruptions in the circuit of magnet PR′, causing its armatures to be released and attracted six times; while relay SR′ continues operated via contact 13—14. After the last interruption of normal contact 19 and the reenergization of relay PR′ following thereon, the single tooth at the left of dial 17 (shown just below spring 18) causes the spring 18 to disengage its contact momentarily; and as the dial reaches normal, as shown, and contact 18 is again closed, spring 13 disengages its contacts 14 and 15 and the relays PR′ and SR′ are then again held energized over the metallic circuit of the line. There being ten teeth on dial 17 adapted to operate upon spring 19 as described, the calling subscriber may, in successive operations of the dial, effect a series of breaks at contact 19 corresponding to the digits from one to nine and corresponding to the digit zero, which latter will be represented by ten breaks. The series of breaks representing any digit will, in each case, be succeeded by a single break of contact 18 and the opening of contacts 14, 15 and 16. It will be noted in the operation of the dial that, when the circuit of relay PR′ is being interrupted and the relay deënergized and energized, the relay SR′ is held operated; and that, when the circuit of relay SR′ is interrupted and its armature retracted and attracted, the relay PR′ is held energized, the arrangement at the substation being such that at no time are the two relays deënergized simultaneously in the operation of the calling device 17. The simultaneous deenergization of the two relays is only caused when the receiver is replaced upon the hook, the arrangement of the circuit at C being such that a simultaneous deënergization of the two relays is effective to cause the restoration of the switches. It will be noted, however, that to render the calling device 17 effective, a coin must, prior to its operation, have been deposited in the slot 8 of the pay-station device shown associated with the substation A, because unless this is done, the operation of spring 19 will be ineffective to cause the deënergization of primary relay PR′, since a circuit will be continued therefor to ground from limb L′, through normal contact 10 and contact 15—14—13. Similarly, unless a coin is deposited in the calling device, the operation of dial 17 upon spring 18 will be ineffective to cause a deenergization of secondary relay SR′, because a circuit for said relay will be continued from limb L, through normal contact 9 to ground via contact 13—14. To render his calling device effective, therefore, the calling subscriber must deposit a coin in the pay-station device after having removed his receiver and having thereby caused, with the resulting upward movement of hook-lever 1, the arm 2 upon said hook-lever to be moved to the right with respect to the pivoted arm 3 extending into the coin slide 8, so that the said arm assumes a vertical position, its upper extremity being then in a position such that it will serve to support a deposited coin. The coin deposited will thus be supported and will press outwardly the springs 9 and 10, shifting them to their alternate positions by its engagement with the buffers of insulating material upon the said springs. The resulting opening of normal contacts 9 and 10 renders the dial 17 operatively effective as described, while the shifting of spring 9 to engage its alternate contact, bridges the winding of the polarized relay 4 across the springs 19 and 18 so that it is operatively related to the line limbs L and L′ when springs 18 and 19 are at normal. The relay 4 is polarized and the cur-

rent, flowing from battery B^4 in the metallic circuit of the line and through the polarized relay 4, is at all times in one direction, or of one polarity up to the time the called subscriber answers the call—namely, of such direction or polarity as to tend to cause the armature of the polarized relay 4 to be tilted downwardly. Such operation will have no effect upon the arm 3, and the deposited coin will not be collected unless the called subscriber answers, when a reverse flow of current will be caused in the calling line to operate the pay-station device to collect the coin, as hereafter described. If the calling subscriber, at any time prior to the response of the called subscriber, replaces his receiver, arm 2 tilts arm 3 to normal and the deposited coin descends through orifice 7 and is returned to the subscriber, the subscriber being required to pay for such calls only as are completed and to which responses are made.

Each of the six retractions of armature 65 of relay PR′ causes a current flow from ground at 45, through alternate contact of spring RON, normal contact 65, rotary off-normal contact RON′, primary magnet PM′ to battery. The primary magnet is energized and deënergized six times and is effective to lift wipers 73, 74 and 75 six steps in a vertical direction, up to the sixth horizontal group of contact sets which group is connected to link-circuits D, assigned for connection to the sixth one thousand group of subscribers in the exchange, those numbered from 6000 to 6999. Simultaneously with the first vertical step of the wipers, vertical off-normal springs VON^3, VON^4 and VON^5 were shifted. When the single break in the circuit of relay SR′ is caused with the return of dial 17 to normal, armature 66 of said relay is retracted to close circuit from ground at 45, spring RON, normal contact 66, rotary off-normal spring RON^8, vertical off-normal springs VON^4 and VON^3, busy relay BR to battery, operating the said relay BR, whose attracted armatures 69 and 72 disconnect wipers 74 and 75 in order that they may be on open circuit while wiping over multiple contacts 77 and 78 in existing conversational circuits, while armature 71 completes circuit from generator G′, through secondary magnet SM′, which now has current impulses transmitted through it by said generator, causing successive energizations and deënergizations of the magnet to move wipers 73, 74 and 75 in a rotary direction over the contact sets of the selected group in search of idle contacts. The attraction of armature 70 of relay BR operatively connects its winding with wiper 73, which, engaging successive contacts 76 of busy circuits D, will hold the relay BR locked until the wiper 73 reaches the contact 76 of an idle circuit D, contacts 76 of busy circuits being characterized by ground connections, while contact 76 of an idle circuit is on open circuit. The deënergization of relay BR, occurring when wiper 73 engages the contact 76 on open circuit, allows the retraction of its armatures, of which 70 operatively connects wiper 73, now engaging the multiple contact 76 of the selected link-circuit D, with its alternate contact, which contact is always connected to ground at 64 through armature 63 of relay PR′, or to ground through armature 67 of relay SR′, since one or both of these relays are continuously held operated, as before indicated, until the switches are restored to normal. Thus contact 76 and its multiples of the idle trunk-circuit D are connected through a circuit of practically no resistance to ground and are rendered busy to any other first selector C whose wiper 73 may be brought to engage a multiple of contact 76 because in such case the operated relay BR of the other first selector will continue energized and its wipers 73, 74, 75, will pass over the contacts of switch D to test the contacts of the next switch of the group. Rotary off-normal springs RON′ and RON^8 were shifted with the first rotary movement of the wipers to disconnect magnets PM′ and BR from contacts 65 and 66. The subscriber at A now operates dial 17 to cause breaks at contact 19 corresponding to the second digit of the called subscriber's number—that is, two breaks—which will be followed by a break at contact 18. The said two breaks at contact 19 effect two successive deënergizations of relay PR′, whose armature 65 transmits two current impulses from ground 45 through shifted spring RON, contact 65, contact 69, contact 74—77, normal contact 90, contact 84, magnet M of switch D to battery B′. Disk 94^a and wipers 94, 96 and 98 are, by the resulting actuations of magnet M, turned in a clockwise direction, two steps, wipers 94, 96 and 98 then engaging contacts 95, 97 and 99 respectively, associated with the sets of multiples, 101, 102, 103, appearing at each of ten trun selecting switches E, paired with connectors assigned for connections to the second hundred group of lines of the sixth thousand, while disk 94^a continues ground to the sets of multiple contacts 101^a, etc., pertaining to the other contacts 95 and associated with the trunk selecting switches E, paired with connectors F of the nine other hundreds of the said sixth thousand. Rotary off-normal springs RON^2, RON^3, RON^4, RON^5 and RON^6 are all shifted to their alternate positions on the first movement of the switch at D.

The momentary deënergization of relay SR′, caused by the opening of contact 18, causes an impulse of current to flow from ground 45 through spring RON, normal

contact 66, contact 72, contact 75—78, normal contact 93, shifted spring RON^5, relay 79 to battery, B′, operating the said relay 79, whose attracted armature 83 immediately locks said relay to ground through normal contact of armature 87 of relay 86. It will be observed that up to this time wiper 94 was connected to ground through normal contacts 81 and 89, so that the multiple contacts 101 have remained grounded, which is their normal condition. With the operation of relay 79, however, armature 81 was attracted to disconnect ground from wiper 94; and the multiple contacts 101, having their contact 95 engaged by wiper 94, are rendered selectable by any of the trunk selectors E of connectors F of the second hundred of the sixth thousand. The attraction of armature 82 caused a flow of current from ground through said armature, contact 96—97 of the switch of D, group relay 100 to battery B′, the group relay then attracting its armature to remove ground from the group contacts 108 with which it is associated, at the trunk selector switches to enable the trunk selector (to be started as hereafter described) to select the group or level of contacts including those of the link-circuit D, into connection with which the calling line A has been brought. The attraction of armature 85 of relay 79 completed a circuit from ground through armature 92 of relay 86, attracted armature 85, contact 98—99, over the common conductor *a*, through vertical off-normal spring VON^{10} at the connector F, returning over conductor *b*, vertical off-normal spring VON^6 at switch E; the circuit then branching, one branch extending through contact 109, relay PR^2 to battery, the other branch extending through contact 110, relay SR^2 to battery. By current traversing the above-traced paths, the two relays PR^2 and SR^2 are operated, attracted armature 111 of the former connecting its relay's winding with auxiliary wiper 107, while armature 112 completes a circuit from generator G^2 through alternate contact 112, normal contact 121 and primary magnet PM^2, which is now effective, under the influence of impulses transmitted by generator G^2, to raise wipers 104, 105 and 106 step-by-step until primary relay PR^2 becomes deënergized. As long as wiper 107 is passing over group contacts 108 pertaining to groups of circuits such as D which do not include a calling circuit, such contacts 108 will be grounded at the armatures of the group relays 100 because such relays will be unoperated. Thus relay PR^2 will continue locked; but as soon as wiper 107 engages the group contact 108 associated with link-circuit D of Fig. 1, relay PR^2 will become deënergized because its group relay 100 is operated. Armatures 111 and 112 will be retracted; and by the retraction of the latter, generator G^2 will be connected through armature 115, now attracted, operatively in circuit with the secondary magnet SM^2, and rotary step-by-step movements of the wipers of the trunk selector E will be started. These will continue as long as relay SR^2 holds its armature 115 attracted, which the relay will continue to do until wiper 104 reaches the ungrounded private contact 101 of the link-circuit D, the relay SR^2 continuing locked by current from battery B′ through the relay winding, normal contact 118, alternate contact 114, wiper 104 and successive contacts 101 of idle link-circuits D, through their respective disks 94^a. As soon, however, as wipers 104, 105 and 106 reach the contacts 101, 102 and 103 of the calling link-circuit D of Fig. 1, the circuit of relay SR^2 will be open at attracted armature 81 of relay 79; the relay SR^2 will become deënergized and its armature 115 will fall back, opening the circuit of secondary magnet SM and preventing its further operation, the wipers of switch E then resting in engagement with multiple contacts of link-circuit D of Fig. 1. After the initial energization of relay SR^2 until the deënergization of relay PR^2, the said relay SR^2 was locked to ground at the normal contact of rotary off-normal spring RON^7, which was shifted with the first rotary step of the wipers.

With the first vertical movement of the wipers, the vertical off-normal springs VON^6, VON^7 and VON^8 were shifted, VON^6 disengaging contacts 109 and 110, thereby operatively disconnecting relays PR^2 and SR^2 from the starting conductor *b*; and by engaging its alternate contact, said spring VON^6 closed a break in a circuit adapted to be thereafter completed extending from starting conductor *b* through vertical off-normal spring VON^6 of the next trunk selector assigned to the group of link-circuits D including the one shown in Fig. 1. During the operation of the switch E, this circuit was, however, open at the armature of relay 123 of switch E, and a second trunk selector E could not be started in response to the operation of another link-circuit D until the first trunk selector E had completed its operation as described. As soon, however, as, on the completion of the operation of the switch E of Fig. 1, armature 113^a of relay SR^2 engaged its normal contact, a circuit was completed, operating relay 123 whose attracted armature then placed the starting conductor *b* in conductive relation with the vertical off-normal spring VON^6 of the second trunk selector of the group. Should this second trunk selector be operated responsive to the operation of another trunk-circuit D, the shifting of the vertical off-normal spring VON^6 of the second trunk selector, and the operation of its relay 123, on the completion of

the operations of the said second switch, would, in a similar manner to that just described, connect starting conductor *b* operatively with vertical off-normal spring VON[6] of the third trunk selector E of the group; and by similar operations of succeeding trunk selectors, the starting conductor *b* may be continued on through a series of vertical off-normal contacts VON[6] to any of the ten trunk selectors assigned to the one hundred trunk-circuits including the trunk-circuit D of Fig. 1. The circuit operating relay 123 may be traced as follows: from battery through the relay winding, through armature 113[a] of secondary relay SR[2] and through vertical off-normal spring VON[7] to ground. With the retraction of armature 116 of relay SR[2], a circuit is completed from the normally grounded vertical off-normal spring VON[12] at connector F, over the lower strand of the talking circuit indicated by the heavily marked line, contact 116, contact 106—103, normal contact 80 and relay 86, to battery B′, operating the said relay 86, whose attracted armature 91 engages spring 80, thereafter breaking the normal contact of said spring, whereby the relay 86 is locked to ground at rotary off-normal spring RON[4]. Armature 87 unlocks relay 79 whose armatures are retracted, and armature 92 of relay 86 removes the ground from wiper 98, this occurring before the armature of relay 123 operatively engages its contact in order that a starting current flow may not reach the vertical off-normal spring VON[6] of the second trunk selector when the trunk selector E of Fig. 1 stops. Armature 81 of relay 79 being now retracted, and armature 89 of relay 86 being attracted, a connection is completed from wiper 94 through said armatures 81 and 89, contact 76—73, normal contact of armature 70, to ground at 64 or at armature 67; and since the said wiper 94 of the switch of D is engaging its contact 95 connected to the private contacts 101, the said contacts 101 are again rendered busy to the trunk selecting switches, other than the one then engaging them, having access to them. Armature 93 of relay 86, in leaving its normal contact, operatively disconnects relay 79 from armature 66 of relay SR′ at first selector C, and extends the circuit of said armature 66 through the alternate contact of armature 93 and contact 103—106 to the circuits of the connector A. Armature 90 of relay 86 maintains magnet M disconnected from contact 77, and retracted armature 82 of relay 79 deënergizes the group relay 100. The subscriber at A now operates the dial 17 to cause five breaks in the circuit of relay PR′ whose armature 65 is retracted and attracted five times to transmit five current impulses from ground 45 through armature 69, contact 74—77, contact 102—105, armature 113, normal contact of armature 129 of relay 128, normal contact of armature 127 of relay 124, through primary magnet PM[3] of the connector to battery B[2], operating the said magnet PM[3] five times and causing five vertical steps of the wipers 150, 151 and 152 of the connector F, bringing them horizontal with levels of contact sets including those of subscribers' lines numbered from 6251 to 6259, followed by the contact set of subscriber 6250, the zero being represented by ten impulses.

A single break, caused by the calling device in the circuit of relay SR′ as the device returns to normal, transmits a single current impulse by the retracted and attracted armature 66 from ground at 45, through contact 72, contact 75—78, attracted armature 93, contact 103—106, contact 116, through vertical off-normal spring VON[12], shifted on the first vertical step of the connector F to engage its alternate contact, through normal contact of spring 126, relay 124 to battery. The said relay 124 attracts its armatures 125 and 127, the latter shifting the connection of armature 129 of relay 128 from the winding of primary magnet PM[3] to the winding of secondary magnet SM[3], while armature 125 engages spring 126, thereafter breaking the normal connection of said spring, whereby the relay 124 is locked over a circuit extending from battery B[2], the winding of relay 124, contact 126—125, and vertical off-normal spring VON[9] of the connector to ground, it being understood that all the vertical off-normal springs VON[9], VON[10], VON[11] and VON[12] were shifted with the first vertical step of the switch. The shifting of spring VON[10] to engage its alternate contact operatively connected the common starting conductor *a* of the ten trunk selectors E of the group with conductor *c* extending to the vertical off-normal spring VON[6] of the second trunk selector E: the shifting of the spring VON[10] disconnecting the armature of relay 123 from the conductor *a*, the circuit heretofore traced through said armature being substantially an emergency circuit only, being of utility in case the calling subscriber, after having secured the connection of his line through to a trunk selector E and its connector should fail to transmit further impulses, in which case the connector would of course remain at normal; and vertical off-normal spring VON[10] remaining unshifted, other subscribers would, except for the relay 123, have no access to the other trunk selectors E. The subscriber at A now operates his dial 17 to cause four breaks in the circuit of primary relay PR′ whose armature 65 transmits four current impulses from ground 45 over the before traced path, through the back contact of armature 129 of relay 128, alternate contact 127, secondary magnet SM[3]

to battery B^2, operating the said magnet four times, which is effective to rotate wipers 150, 151 and 152 four steps to engage the fourth contact sets of the selected levels, which will be contacts forming multiple terminals of subscriber's line number 6254, or the line of H. A single break in the circuit of relay SR', caused with the return of dial 17 to normal, is effective to cause the transmission of an impulse from ground 45 through armature 66, over the before-traced path, through vertical off-normal spring VON^{11}, now shifted; thence to rotary off-normal spring RON^8, shifted with the first rotary movement of the wipers of the connector F, through the normal contact of spring 130 and through relay 128 to battery B^2, operating the said relay whose armature 131 engages spring 130, thereafter opening the normal contact of said spring, the relay 128 being then locked by current flowing through contact 130—131, vertical off-normal spring VON^9 to ground. The attracted armature 133 of relay 128 operatively connects the winding of test relay TR through the left-hand armature of release relay RR^3 and its normal contact and through attracted armature 133, with the testing wiper 150 of the connector, then engaging the private contact 20 of the called line. It being assumed, first, that the called line is idle, current will then flow from ground at test relay TR, over the before-traced connection, through contact 150—20, normal contact 24 of line relay 23 of the called line, through its cut-off relay 27 to battery B^2, operating test relay TR and cut-off relay 27. The former attracts its armatures, of which 147 immediately short circuits a portion of the relay's winding, substantially reducing the resistance of the circuit traced. The armatures of relay TR continue attracted but any other relay TR of another connector that may be brought in multiple with the shortcircuited winding will not receive enough current to operate it, as hereafter more fully explained. Armature 146 of the test relay is attracted, which prevents the interrupter I', now operatively connected with the normal contact of said armature 146 via attracted armature 132 of relay 128, from transmitting to the calling subscriber a busy signal; while armatures 144 and 148 close normally open contacts in the two strands of the talking circuit, indicated by the heavily marked conductors. Armatures 28 and 32 of the now operated cut-off relay 27 disconnect the limbs L and L' of the called subscriber's line from their normal connections to the two sides of battery B^2; armature 31 opens a contact in the starting conductor of the line circuit of the called subscriber H; while armature 30, in engaging its contact 29, completes a branch connection from ground at armature 147 of test relay TR to multiple private contacts 35 at the banks of the line selectors associated with the called line, in order that any line selector that may be started may, on engaging said contact 35 by its wiper 38, find a ground thereon to the end that the rotary relay SR of such line selector may continue operated to cause the line selector to pass by the busy called line.

Returning to the test relay TR, its attracted armature 145 now completes a circuit from battery B^2, through ringing relay 149, said armature 145, normal contact of armature 139 of relay 137 to ground through the constantly operating interrupter I. The inclusion of said interrupter in circuit causes the relay 149 to alternately attract and release its armatures, including and excluding ringing generator G^3 from circuit with the called subscriber's line, the generator current passing through contacts 151—21 and 152—22, over limbs L and L' of the called line, condenser and call-bell at the substation via contact 12—1 thereat, causing the bell to ring. The called subscriber, in answer to the signal, removes his receiver from the hook-lever, which then disengages contact 12 and engages contact 11, completing a circuit as follows: from battery B^3, through relay 141, through contact 144, upper armature of ringing relay 149, when retracted, contact 151—21, limb L', contact 19, contact 1—11, the substation transmitter supplying talking current thereto, contact 18, limb L, contact 22—152, retracted lower armature of relay 149, attracted armature 148 through relay 142 to the opposite pole of battery B^3, the two relays 141 and 142 being thereby operated and current being supplied through the impedances of these relays to the called line for talking purposes. The attracted armature of relay 141 closes a contact in the upper strand of the talking circuit, while the lower armature of relay 142 closes a contact in the lower strand of the talking circuit. The upper armature of relay 142 is attracted to close a circuit through relay 137 to battery, which relay 137 locks itself through attracted armature 140 to ground at shifted vertical off-normal spring VON^9. Armature 139 of said relay opens a contact in the circuit of relay 149, preventing its further operation. The attraction of the armature of relay 141 also completes a circuit from the positive pole of the battery B^3, to the left over the upper strand of the talking circuit, through contacts 105—102, 77—74, attracted armature 65, through reversing relay 60 to the negative pole of battery, operating the said relay 60, which, by its make-before-break armature combination, reverses the connections of the two poles of battery B^4 to the line conductors L—L' of the calling subscriber's line, the make-before-break combination, referred to, preventing

the deënergization of relays PR′ and SR′ while the connections are being shifted. The current now flowing over the calling subscriber's line is in the reverse direction to that previously flowing thereover. A portion of it passes over limb L′, through hook-lever 1, contact 11, through the transmitter returning over limb L, while the remainder flows in a branch path at the substation through the windings of polarized magnet 4, alternate contact 9, contact 18, returning over limb L. This current through magnet 4 tilts its armature 5 upward, which armature engaging the spring screwed to the arm 3, tilts the upper extremity of the said pivoted arm to the left, so that the coin deposited in coin slide 8 is free to descend by gravity through orifice 6 and be collected. When this occurs, the buffers upon springs 9 and 10 are no longer pressed apart by the coin and they return to a normal position, spring 9 opening the circuit of magnet 4, short-circuits from limbs L and L′ respectively being then established via normal contact 9 and 10 respectively, to contacts 18 and 19, so that the coin collecting mechanism does not in any way affect the flow of current through the substation. The two subscribers, A and H, are now in conversation, the talking circuit being traced from substation A through the exchange mechanism of Fig. 1 by the heavily marked conductors and to substation H by limbs L and L′.

When the called subscriber replaces his receiver after conclusion of conversation his act is effective to restore the connector F to normal. When the subscriber A places his receiver, his act is effective to restore switches K, C, D and E to normal. To trace in detail the release of the connector when H replaces his receiver, the restoration of his hook-lever 1 opens the conductive circuit of his substation and relay 142 is deënergized. The retraction of the upper armature of relay 142 closes a circuit from battery B^2 through release relay RR^3, attracted armature 138, retracted armature of relay 142, attracted armature 140 of relay 137 to ground at vertical off-normal spring VON^9, the relay RR^3 thereupon locking itself by the attraction of armature 135 to ground at said spring VON^9. Attracted armature 136 of relay RR^3 completes a circuit from ground through constantly operating interrupter I^2, closed contact 136, alternate contact 129, alternate contact 127, and secondary magnet SM^3 to battery B^2. The interrupter I^2 now causes current pulsations to be transmitted through magnet SM^3 which is effective to rotate wipers 150—151—152 additional steps from left to right until the wipers pass beyond the right edge of their contact banks shown in Fig. 3. When this occurs, the shaft of the switch and the wipers descend by gravity to the normal horizontal level, when the spring included in the switch mechanism hereafter described is effective to rotate the shaft and wipers from right to left back to their normal position, when the vertical off-normal springs VON^9, VON^{10}, VON^{11} and VON^{12} and the rotary off-normal spring RON^8 of the connector F will be restored. The restoration of VON^9 opens the locking circuits of relays 124—128, RR^3 and 137 which relays then allow their armatures to be retracted. It may be observed at this time that when relay RR^3 was operated, the attraction of its left armature maintained open the circuit of test relay TR so that it was deënergized as soon as the release began, and its armatures retracted, wipers 150—151—152 of the connector being all on open circuit while they were wiping over the contacts during the release. The shifting to normal of vertical off-normal spring VON^{10} operatively connects starting conductor *a* of the trunk selecting switches E with conductor *b*, but the said conductor *b* would be open at the armature 121 so that other subscribers would be prevented from starting the other trunk selectors E, were it not for the fact that relay 123 is operated. It will be observed that on the energization of release relay RR^3, its armature 134 opens the circuit of relay 141 causing its deënergization. When the calling subscriber replaces his receiver, the conductive disuniting of the line limbs at the calling station, caused thereby, effects the deënergization of two relays PR′ and SR′ and current flows from ground at release relay RR of line selector K, through said relay RR, through the normal contact of the spring of relay SR′, through the normal contact of armature 63 of relay PR′ through vertical off-normal spring VON′ to battery B through the protective resistance shown, the relay RR locking itself by its attracted armature 58 via off-normal springs VON′ at B and VON^5 at C. The attracted armature 57 of release relay RR completes a circuit from ground to shifted vertical off-normal spring VON, said attracted armature 57 and secondary relay SR to battery B. The secondary relay then attracts its armatures of which armature 50 completes a circuit for secondary magnet SM which is thereon operated by impulses transmitted by generator G until the switch wipers 38—39—40 pass beyond the right edge of their banks when they descend by gravity and are turned back to normal by the associated spring. The attractions of armatures 47 and 52 place wipers 39 and 40 on open circuit, but the attractions of said armatures do not cause relays PR′ and SR′ to be operated as was the case when relay SR was energized when the switch K was making its selection, because at the present time contact 55 of relay RR is open. With the attraction of arma-

ture 49 of relay SR, wiper 38 was placed on open circuit and the circuit of relay 53 was interrupted whose armature was then retracted, but a circuit extending from the common starting conductor of the line group, connected to vertical off-normal spring VON², was continued while the switch was being restored via attracted armature 56 to the vertical off-normal spring VON² of the first idle switch of the group of line selectors. When the line selector reaches normal, vertical off-normal springs VON, VON′, and VON² are restored to normal, the shifting of VON opening circuit through secondary relay SR and allowing the retraction of its armatures, VON′ opening a contact in the locking circuit of release relay RR which, however, will continue operated through vertical off-normal spring VON⁵ of the first selector unless the said switch has been restored. Spring VON² in engaging its normal contacts operatively connects the windings of secondary relay SR and primary relay PR with the common conductor connected to the said spring. Rotary off-normal spring RON was shifted to normal on restoration of the switch to disconnect ground 45 from the normal switch contacts of armatures 65 and 66.

When relay RR was first operated it completed a circuit from ground through attracted armature 59, shifted off-normal spring VON³, busy relay BR of the first selector to battery B which relay attracted its armatures 69 and 72 to place wipers 74 and 75 on open circuit while the switch C was wiping over contact sets 76, 77, 78 to reach the right edge of its bank in order to be restored, armature 71 being attracted to complete a circuit for secondary magnet SM′ to effect the required rotation. The vertical and rotary off-normal springs are shifted to normal when C is restored.

It will be observed that the continued operation of secondary magnet SM′ to bring the switch wipers free of their contact banks, is dependent on the continued energization of busy relay BR, which latter depends upon the continued attraction of armature 59 of release relay RR. To take care of the contingency that the line selector K may reach normal before the first selector C, the locking circuit of relay BR of the line selector is carried through the vertical off-normal contact VON⁵ of the first selector, so that relay RR is only deenergized when both the line selector and the first selector have reached normal.

When the armatures of relays PR′ and SR′ were retracted before relay BR had time to be operated, a circuit was closed from battery B through vertical off-normal spring VON′, through the normal armature combinations of relays, PR′ and SR′, normal contact 70, contact 73—76, rotary off-normal spring RON², and release relay RR′ of link-circuit D to ground, this being a circuit of low resistance. The release relay RR′ is operated and its upper armature locks the relay to battery B′ through shifted rotary off-normal spring RON⁶, the lower armature of relay RR′ then including generator G′ in circuit with magnet M to cause a continued rotation of the switch D by said magnet in the direction in which it was initially operated around to its zero or starting point, at which time the rotary off-normal springs RON², RON³, RON⁴, RON⁵ and RON⁶ will be shifted to disengage their contacts, spring RON⁶ deënergizing release relay RR′ while spring RON³ opens a contact in the circuit of the magnet M, preventing further operation thereof. The shifting of spring RON⁴ opens the locking circuit of relay 86 and the relay then becomes deënergized inasmuch as switch E will, by the time the switch of circuit D is restored, have had its wipers 104—105—106 moved out of engagement with the multiple contacts of circuit D. It may be observed that while the switch of circuit D is being rotated around to normal, the ground upon contact 101 and its multiples is traced through armature contact 81, alternate armature contact 89, rotary off-normal spring RON² and to ground through the winding of release relay RR′.

It will be observed that while the first selector is having its wipers rotated to free the bank, the wiper 73 will be connected to battery B through the resistance of busy relay BR. While thus connected, wiper 73 may pass over multiple contacts 76 of trunk-circuits D which may be in use and hence have their release relays RR′ placed via their rotary off-normal springs RON² in circuit with battery B through relay BR. Such relays RR′ however, will not receive current to operate them, their windings being shunted by branch circuits practically devoid of resistance at the switch contacts of relays PR′ or SR′ of the first selectors respectively connected with their circuits.

As soon as battery B was, as described, on the retraction of the armatures of relays PR′ and SR′, connected through normal contact 70 and wiper 73 to contact 76, a branch path of the path operating relay RR′ was established through spring RON² attracted armature 89 of relay 86, normal contact 81, wiper 94, contact 95 connected to multiple contacts 101, contact 101—104, normal contact 114, release relay RR² to ground, operating the said relay RR², whose attracted armature 119 thereupon locked the relay to battery B′ through vertical off-normal spring VON⁸, while armature 118 in engaging its alternate contact completed a path for current from ground through shifted vertical off-normal spring VON⁷, at-

tracted armature 118, secondary relay SR^2 to battery B'. Relay SR^2 is thus operated, its armatures 113 and 116 place line wipers 105—106 on open circuit while the switch is being rotated until its wipers pass beyond the right edge of their banks responsive to current impulses flowing from generator G^2 through normal contact 112, attracted armature 115 and secondary magnet SM^2. When the switch is fully restored, vertical off-normal springs VON^6, VON^7 and VON^8 are restored, deënergizing the various relays held operated during the restoration of the switch, and rotary off-normal spring RON^7 is also restored. While the switch E is being restored to normal, armature 120 holds closed a contact in the circuit of starting conductor *b* extending to the vertical off-normal spring VON^8, through the next idle selector E of the group in order that it may be operatively associated with the other circuits D to which it is assigned. If at the time, the calling subscriber A replaces his receiver to initiate the release operation described as being caused by him, the called subscriber H has not answered, the closing of contact 122 resulting on the energization of relay RR^2 completes a circuit from ground through the operated contact 122, normal contact 138 of relay 137 through release relay RR^3 at the connector F which relay will cause the release and restoration of the connector in a manner similar to that before described.

Having now traced the operation of the system in completing a call and restoring its central office mechanism to normal in the case where the calling line was found idle, I will now describe the manner in which the connector F is enabled to test the called line, it being assumed to be busy, and in such case to cause the transmission of a busy signal to the calling subscriber.

Let it be assumed that the line of H is busy because some connector other than F of Fig. 1 has been caused by a calling subscriber to be placed in connection with multiple contacts 20—21—22 connected to those engaged, as before described, by wipers 150—151—152 of the connector F of Fig. 1. In such case, the circuit holding energized the test relay TR of the previously connected connector will be traced from ground at armature 147 of relay TR of the said connector through a portion only of its winding and through the cut-off relay 27 of the busy called line to battery B^2. Thus, when the relay TR of the connector of Fig. 1 is, by the before described operation of armature 133 of relay 128, placed in connection with the test contact 150, the relay TR of the connector of Fig. 1 will remain unoperated because its entire winding is at this time included in a branch of the circuit already existing which includes only a portion of the winding of the test relay TR of the previously connected connector. As a relatively low resistance shunt is thus placed about the winding of relay TR of Fig. 1, the said relay does not receive sufficient current to cause the actuation of its armatures, although the relay TR of the previously connected connector will continue to receive enough current to prevent its armatures from being retracted, the windings of the relays being properly proportioned to this end. Since the relay TR of the testing connector, that of Fig. 1, does not attract its armatures, a busy signal is transmitted from interrupter I' through attracted armature 132, normal contact of armature 146, armature of relay 141 to the left, over the upper talking conductor of the exchange indicated by the heavily marked conductor through condenser 68^a, normal contact of spring 61^a, thence following the upper talking conductor through contact 1—11 at the substation and the primary winding of the induction coil, causing an audible signal in the substation receiver, returning over line limb L and the lower talking conductor through the exchange, through normal contact 62^a, condenser 68 over the lower talking conductor, through the lower normal armature contact of relay 142 and to ground through condenser 143. The calling subscriber being thus advised that the called line is busy, replaces his receiver causing simultaneous deënergizations of relays PR' and SR' and all the switches including the connector are restored to zero as in the case where the calling subscriber was assumed to have replaced his receiver before the called subscriber answered, all as heretofore described. Inasmuch as relay 141 is not operated in the case when the called-for line is found busy, the reversing relay 60 at the first selector C is not operated and a reversed flow of current was not caused in the calling subscriber's line to operate the polarized magnet 4 to raise its armature 5. Hence the coin deposited in coin-slide 8 is not collected and when the calling subscriber replaces his receiver, the arm 2 of hook-lever 1 is effective to tilt the arm 3 to the right allowing the deposited coin to descend through orifice 7 and be returned to the calling subscriber.

Let it be assumed that the line of H is busy as a calling line at the time subscriber A attempted to place the line in connection therewith. If at that time the line has not already been selected by a line selector, its contact 20 will be on open circuit at armature 24 because line relay 23 will be then operated, and the test relay TR of the connector of Fig. 1 will necessarily remain inert and the busy signal will be transmitted as before described. If the said line of H is busy as a calling line and another line se-

lector like K has selected the said line, current will be flowing from battery B^2 through cut-off relay 27 of the said line, through closed contact 29—30 to private contact 35 at the line selector, through wiper 38 of the line selector connected with the line, which is similar to that at K, through relay 53 thereof to ground. In this case, when relay TR of the testing connector of Fig. 1 has its circuit completed through to the wiper 150 in engagement with multiple contact 20, the said relay TR will be placed in a branch circuit of the circuit just traced, extending to the common point at spring 29, and the test relay will in such case be shunted by the relay 53 of the line selector. The test relay will in such case remain inert, not receiving enough current to cause it to attract its armatures although the relay 53 will continue to receive enough current to hold its armature attracted. The calling subscriber in such case will receive the busy signal in the manner before indicated, and in replacing his receiver, will cause all the switches to be restored to zero.

It will be remembered that when the calling subscriber replaces his receiver first, the resulting simultaneous deënergizations of relays PR′ and SR′ are effective to cause the restorations of whatever switches may have been operatively connected with his line. He is thus able, after starting to make a call should he change his mind and not desire to complete it, to restore whatever switches have been operatively connected with his line by the replacing of his receiver.

I have shown at E an overrun switch OR adapted to have its contact closed, as indicated in Fig. 2 by the top of ratchet 170, when the switch shaft is stepped an eleventh step, when the overrun switch will close an opening circuit of relay RR^2 to release switch E. The overrun switch will come into play when the calling subscriber, not wishing to complete his call, hangs up his receiver while the trunk selector is making vertical steps.

It will be understood that batteries B^3 and B^4 may be a single source of current, and that the batteries indicated at B, B′ and B^2 may be another single source.

Referring now to Figs. 2 and 3, showing a two-dimension line selector mechanism adapted to perform the mechanical functions required of the circuit at K of Fig. 1, a main frame 174 is provided to which the shaft S is journaled above and below, the vertical and rotary ratchets 170 and 173 being attached to the shaft. Fastened to the shaft S, are also the wipers 38, 39 and 40 and the auxiliary wiper 42. The contact banks, of which a front view is included in Fig. 3, are suitably supported by the main frame, an upper bank comprising one hundred sets of contact pairs 36—37, arranged in ten horizontal groups of ten pairs each, the wipers 39 and 40 being adapted to be raised upward to select a horizontal group, when the wiper 38 will be moved a corresponding degree to be placed opposite the corresponding group of private contacts 35, of which one hundred are provided in the lower bank, arranged in ten groups of ten horizontally disposed contacts each. The auxiliary wiper 42 is also fastened to shaft S and is adapted, with the vertical movement of the shaft, to wipe over the group contacts 41, supported by the frame. When the rotary movements of the shaft are initiated, the wiper 42 is carried with the shaft away from the contact 41 selected by it. For lifting shaft S and its wipers, the primary or lifting magnet PM is provided, to whose armature 168 a suitable pawl 169 is pivoted, adapted to engage, with actuations of magnet PM, the teeth of ratchet 170, the retaining pawl 175 engaging successive teeth of ratchet 170 as the shaft is lifted step-by-step by pawl 169 to hold it against back movement. For rotating the shaft and wipers, a secondary magnet SM is provided, supported by the frame 174, having a driving pawl 172 carried by its armature 171, adapted, with the actuations of the magnet, to engage teeth of the ratchet 173 to rotate the shaft and wipers. A retaining pawl 176 is provided, normally engaging the base of ratchet 170, which has a smooth surface so that pawl 176 is ineffective to prevent the return movement of the shaft when the shaft is at its normal level. With the first upward step of the shaft, however, the ratchet 173 is brought into operative relation with pawl 176, and when the shaft is turned under the influence of magnet SM, the said pawl 176 engages successive teeth of ratchet 173 to hold the shaft against return rotary movement. Clamped to the upper portion of shaft S, is an arm 160 shown in Fig. 2 as extending to the left and having a downwardly bent portion normally engaging a spring V. With the first upward step of the shaft, the said arm 160 disengages spring V which is then free to move in its tension. The vertical off-normal switch springs shown in Fig. 1, VON, VON′ and VON^2, are connected by studs of insulating material to spring V, as indicated in Fig. 4, so that all of them will be simultaneously shifted to their alternate positions on the first step upward of shaft S. Fitted loosely about the shaft so as not to partake of its vertical movement, but keyed thereto at 161^a (see Fig. 5) in order that it may be rotated with the shaft, is the arm 161, normally engaging the rotary off-normal spring RON, as shown in Figs. 2 and 5, and adapted, with the first rotary movement of the shaft, to be carried away from the off-normal spring RON so

that the same will be shifted by its tension to engage its alternate contact. Mounted upon the top of frame 174, is a post 163 extending through an orifice in one end of the arm 162, as shown in Figs. 2 and 7, the said arm extending to the shaft which passes through an orifice in its other end, the shaft being adapted to move freely around in the orifice of the said arm 162 which rests just above the arm 160 of the vertical off-normal switch, as shown in Fig. 2. The spiral spring *s*, shown in Fig. 7, has one of its ends attached to arm 162 at a point close to the shaft S, while the other end of the spring is attached to the spring case 166, clamped to the shaft S, as best shown in Fig. 2. The said case 166 carries the stop 167, pressed against the arm 162 when the shaft is in its normal rotary relation, so that there is no tension exerted by the spring upon arm 162 to press it against the post 163. This is in order that the vertical magnet, in lifting the shaft, may not be required, in addition to its other work, to overcome friction between 162 and 163. When the shaft is rotated by the influence of magnet SM, the spring case 166 turns with the shaft, the stop 167 being moved away from the arm 162 and the tension of spring *s* is exerted against the turning movement of the shaft, but is unavailing to turn it back because of the engagement of retaining pawl 176 with the teeth of ratchet 173. In releasing the switch, additional actuations of secondary magnet SM are caused as hereinbefore explained in connection with Fig. 1, which cause additional rotary movements of the shaft until the wipers 38, 39 and 40 reach and pass beyond the right edge of their contact banks. When this occurs, which will of course be upon the eleventh rotary step, the arm 165 carried by spring 164, screwed to the top of spring case 166, is brought around to a position where it engages and passes over the top of arm 162, the spring 164 being raised slightly as the arm 165 passes over the top of arm 162 and then snapping down so that the arm engages 162 in a position corresponding to that held normally by the stop 167. Under these conditions, the tension of spring *s* will of course no longer press arm 162 against stud 163, so that the shaft and wipers are now free to descend by gravity without friction between 162 and 163 or any tendency on the part of spring *s* to rotate the shaft backward. The eleventh rotary step of the shaft brings the slot 178 of ratchet 170 (shown in Fig. 6) to a position such that the vertical retaining pawl 175 slips into it so that the pawl is ineffective to prevent the downward movement of the shaft. Just as the shaft and wipers are reaching their normal level, the piece 177, screwed to the top of frame 174, is engaged by spring 164 which is lifted, carrying with it arm 165, which then frees arm 162 and the tension of spring *s* is then effective to turn shaft and wipers in a rotary direction—the reverse of that in which they were initially moved in the operation of the switch—back to normal, the rotary retaining pawl 176 having been brought out of operative relation with ratchet 173 with the downward movement of the shaft. It will be observed that the off-normal arms 160 and 161 both turn with the shaft so that the rotary off-normal and the vertical off-normal switches are shifted back to the initial position only at the time when the switch is fully restored. Since, as will be understood from the description of Fig. 1, the operating circuit of the rotary magnet, when the release is being performed, is opened only when the off-normal switches are restored, a tooth is omitted from the ratchet 173 after the eleventh tooth engaged by pawl 172 in turning the shaft, in order that while the shaft is descending to its normal level, the continued operation of secondary magnet SM, effecting thrusts of pawl 172, may be ineffective to further turn the shaft.

The switch illustrated in Figs. 2 to 7 is what I term a two-dimension switch. The switch shown in these figures is my preferred form although it is to be understood that other structures of the two-dimension type wherein groups of contacts are provided with means for selecting the contacts by groups and then individually may be employed. In certain of the claims elements are included directed to two-dimension switches but I do not desire to be limited to the specific form of two-dimension switch illustrated as by this term I include switches having groups of contacts with primary and secondary selecting means.

Referring now to Figs. 8 to 11 inclusive, showing a switch structure that may be employed in connection with trunk-circuit D, the movable elements 94ª, 94, 96 and 98 are represented in Figs. 8 and 9 by the common strips 94ª, 94, 96 and 98 forming the true terminals of the circuits shown at D in Fig. 1, while the movable contacts *w*, *x*, *y* and *z*, best shown in Fig. 9, have in themselves no circuit connections but serve merely to cross the contacts, of which there may be ten sets as shown at Fig. 8, 95, 95ª, 97 and 99 to the respective strips. The contacts 95 shown in Fig. 1 are represented mechanically by the two contacts 95—95ª connected together as indicated in Fig. 11, and to the multiple contacts 101 or 101ª. The movable contact-makers *w*, *x*, *y* and *z* are fastened to a suitably supported rotary shaft S′ which also carries the ratchet 202. The magnet M carries a pivoted armature 200 to which is attached the pawl 201 adapted, when the armature is at-

tracted, to turn ratchet 202 a step which carries with it the movable contact-makers w, x, y and z, a corresponding step. The movable contact-maker w has thirty arms, as indicated in Fig. 8, divided into three sets of ten, a space being left between each set. The movable contact-maker x for the common strip 94 consists of three angular arms which appear between the sets of contact-makers w. The contact-makers y and z for the common strips 96—98 also comprise each three angularly disposed arms which are superposed upon the arms of x in the view given in Fig. 8 where the angular arms of z alone are visible. From an inspection of Fig. 8 it will be apparent that a revolution of shaft 8 to the extent of one hundred and twenty degrees will suffice to bring each of the ten contact sets 95, 95^a, 97, 99 into connection with their respective common strips through the medium of the contact-makers w, x, y, z, and that as the switch is turned clock-wise from one of its normal positions as shown in Fig. 8, a contact-maker x will cross successive contacts 95^a to common strip 94, while the corresponding contact 95 is free from engagement with an arm of the contact-maker w. It will thus be observed that the switch shown in Fig. 8, which, as already indicated in connection with Fig. 1, has a continuous rotary movement in its operation and its return to normal, has three normal positions, one for each of the arms of contact-maker x and that the shaft is turned to the extent of one hundred and twenty degrees only each time the switch is operated and returned to normal. The rotary off-normal springs are shown in Fig. 10, springs RON^2, RON^3, RON^4 and RON^5 being mechanically connected by studs of insulating material with the spring RON^6. The shaft S′ carries a ring of insulating material having three projections as shown in Fig. 10, set at angles of one hundred and twenty degrees. In the three normal positions of the switch, one or the other of these projections engages a bent portion of spring RON^6 holding all the springs out of engagement with their associated contacts. With the first step of the shaft, the projection engaging spring RON^6 will be brought to the left, the spring RON^6 will ride down upon a periphery of ring and the various off-normal springs will engage their contact, remaining in engagement with them until the shaft is moved one hundred and twenty degrees to another normal position when another projection will engage the spring RON^6 and the springs will be shifted to normal disengaging their contacts.

In Fig. 12, I show a diagrammatic arrangement of trunks for a single thousand group of lines, with diagrammatic representations of the switches in connection with which they are employed. The six trunks D, D′, D^2, D^3, D^4, D^5, are shown multipled among eight first selectors C, C′, C^2, C^3, etc., which first selectors are, by their associated line selectors K, K′, K^2, K^3, etc., adapted for connection to the calling groups of lines Gc, Gc', Gc^2, Gc^3. The two first selectors of each group of calling lines are treated as a unit in the multiplying of the trunks, each trunk being multipled once to the group of first selectors of a calling group. As the trunks are assumed to be all for a particular one thousand group, their contacts at the first selectors are necessarily assumed to be on the same levels. The said trunks extend directly from the first selectors to the trunk selectors E, E′, E^2, E^3, etc., and all six trunks are multipled to each such trunk selector. The trunk selectors shown at the right of Fig. 12 pertain to four one hundred line called groups of the thousand; trunk selectors E and E′ being linked to connectors F and F′ for the group Gr 100 to 200; E^2 and E^3 linked to connectors F^2 and F^3 for group Gr 200 to 300; E^4 and E^5 linked to F^4 and F^5 for group Gr 300 to 400; and E^6 and E^7 linked to F^6 and F^7 for group Gr 400 to 500. At the center of Fig. 12, are diagrammatically indicated the group switches for the six trunks, by the respective wipers 98 and their associated contacts 99 connected to the common starting conductors a, of which there are four, multipled before each wiper 98, shown as extending, to correspond with Fig. 1, to the diagrammatically illustrated off-normal switches of the first trunk selectors of the respective called line groups. For the sake of clearness in Fig. 12, the talking multiple contacts of each trunk at the first selectors and at the trunk selectors are indicated by a single small circle, the private multiples being omitted.

In Fig. 11, I have diagrammatically indicated more in detail the multiple arrangement of the talking and private contacts of a trunk D at the trunk selectors for two called groups of a thousand. It will be seen that the multiple contacts 77 and 78, which correspond to the similarly designated contacts in Fig. 1, are shown as extending directly to, and being multipled at, contacts 102—103 four times—that is, at each of four trunk selectors. By the designation Gr 100 to 200, and Gr 200 to 300, I indicate that the trunk selectors, adapted to select the two upper sets of multiple contacts, pertain to a first one hundred group of lines; and the trunk selectors, adapted to select the two lower sets of multiple contacts, pertain to a second one hundred group of lines. It will be seen that the private contacts 10 of the trunk D, associated with the upper set of multiples, are connected to the first contacts 95 and 95^a of the trunk switch

while the private contacts 101ª of the trunk D, included in the lower sets of the multiple contacts, are multipled to the second set of contacts 95 and 95ª. Thus, if by the operation of the switch of Fig. 8, the normal ground of the first contact 95 is removed by the turning of the switch one step, and the normal ground then removed from the common 94, by the operation of relay 79 of Fig. 1, while wiper x is crossing said common to the first contact 95ª, the multiples 101 will be rendered selectable. Similarly, if two steps of the switch of Fig. 8 have been made so that the space between two sets of wipers w is opposite the second contact 95, the said second contact will no longer be crossed to the grounded common 94ª although, with the second step, the first contact 95 will have again been crossed to grounded common 94ª, by a wiper w. Under such circumstances, the wiper x will have crossed the second contact 95ª to grounded common 94; and the removal of ground from the common 94, which will occur with the operation of relay 79 of Fig. 1, will render the private contacts 101ª of the second group selectable.

It will be clearly seen, from an inspection of Fig. 12, that the switches employed in any completed conversational circuit will include a line selector, a first selector, a trunk selector and a connector, the trunk switches shown at the middle of Fig. 12 not having any of their wipers traversed by the voice currents, but being used only, as it were, to expose particular private contact groups at the trunk selectors E to selection and to start an idle trunk selector of the group.

In a ten thousand line system, there would be one hundred groups of lines as calling lines, each such group having ten line selectors adapted to select them. As these trunk selectors are linked each to a first selector, each one hundred group of calling lines would have ten first selectors common to them, any one of which may be employed in extending a connection from a calling line. Each first selector would have ten contact sets on each of ten levels, each contact set being connected to a trunk for a particular thousand, so that each first selector can reach ten trunks for each thousand. Ten per cent. trunking being employed and a ten thousand line exchange assumed, there would be one thousand such trunks altogether in the exchange, one hundred for each thousand. As there are one thousand first selectors linked with line selectors, and as each first selector has one hundred contact sets, making a total of one hundred thousand sets, each trunk would be multipled at the first selectors one hundred times, or, putting it a little differently, to one hundred first selectors. Inasmuch as ten per cent. trunking involves the employment of one thousand connectors for ten thousand lines, and hence of one thousand trunk selectors such as E, and as each trunk selector has one hundred contact sets, it is apparent that the trunks may be multipled at the trunk selectors one hundred times each. A trunk will of course be multipled at the trunk selectors E linked to connectors for the thousand to which the trunk is assigned only. As there are one hundred trunks altogether for a thousand, and one hundred connectors with an equal number of trunk selectors divided into groups of ten according to the hundred, each trunk for a thousand, extending from a first selector, may be multipled before the trunk selector of each and every connector for the thousand; and additional connectors may be provided for any hundred with their appropriate trunk selectors, without altering the apparatus installed in any way, except by extending the multiples of the trunks to the added trunk selectors and by extending the starting circuit of the trunk selector group to the added trunk selectors.

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

1. A telephone system including a selective switch having contact sets arranged in groups, a primary magnet for operating said switch to select a group, a secondary magnet for operating said switch to select a contact set of the selected group, means for operating said secondary magnet to effect restoration of said switch, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

2. In a telephone system, the combination with an electrical switch for automatic exchanges, of a main switch shaft adapted for reciprocal action, driving means for actuating said shaft, a spring for securing return movement thereof, means for preventing said return movement until the shaft is driven its full operative distance, mechanism for automatically temporarily relieving operative tension of said spring from said shaft effective as the shaft completes its operative distance, mechanism for thereafter automatically rendering said spring effective to cause return movement of said shaft, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

3. In a telephone system, a selective switch including a rotatable main switch shaft, a spring for securing return rotary movement of said shaft against whose tension the shaft is operated, means for turning said shaft from an initial fixed rotary position to a final fixed rotary position, means for automatically removing the tension of said spring from said shaft when it assumes either of said fixed rotary positions, said

spring being adapted to exert its tension upon said shaft in its other rotary positions, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

4. In a telephone system, the combination with a selective switch, of a main switch shaft, a spring-case mounted upon said shaft, a spring having one end attached thereto, an arm having an orifice at each end, one orifice fitting loosely about the shaft, the other orifice fitting about a suitably disposed post, the other end of said spring being attached to said arm adjacent to said shaft, means for rotating said shaft from a particular initial rotary position to a particular final rotary position, a stop carried by said shaft normally engaging said arm to render ineffective the rotary tension of said spring upon said shaft, when in its initial rotary position, a second stop carried by said shaft adapted to engage said arm only when the shaft reaches its final rotary position to again render ineffective said tension of said spring, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

5. In a telephone system, the combination with an electrical switch, of contact sets arranged in groups, adjustable contact makers for said switch adapted to engage said contact sets, mechanism for primarily operating said switch to select a group, mechanism for secondarily operating said switch to select a contact set of the selected group, an off-normal switch shifted when said switch is initially primarily operated, a second off-normal switch operated when said switch is initially secondarily operated, means for restoring said off-normal switches effective only when said contact makers are fully restored, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

6. In a telephone system, an electrical switch having a main shaft, mechanism for primarily adjusting said shaft in a longitudinal direction, said adjustment being made in a fixed normal rotary position of said shaft, mechanism for securing return longitudinal movement of said shaft, said return movement being made in a second fixed rotary position of said shaft, means for rotating said shaft after its primary longitudinal adjustment from said normal rotary position to said second rotary position and a spring for securing back rotary movement of said shaft, said spring being ineffective to exert tension on said shaft during its primary and return longitudinal movements, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

7. A telephone system including an electrical switch, movable contacts therefor adapted for adjustment in intersecting planes, a shaft for adjusting them capable of primary and secondary movements, an extreme operative position for said shaft in its secondary movements, means for moving said shaft beyond said extreme position to restore the switch, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

8. A telephone system including an electrical switch, switch contacts therefor arranged in groups, contact makers for said switch, means for moving said contact makers to select a group, means for moving said contact makers in an intersecting plane to select contacts of the selected group, mechanism operated when restoration is desired for moving said contact makers farther in said intersecting plane beyond the last contacts of the group whereby said switch is automatically restored, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

9. A telephone system including a selective switch having a contact bank containing contacts disposed in groups, a longitudinally and rotarily adjustable switch shaft, contact makers adjustable thereby adapted to engage said contacts, means for adjusting said shaft longitudinally to select a group of contacts while said contact makers are disengaged from said bank contacts, apparatus for turning said shaft to bring said contact makers to engage the first and successive sets of contacts of the selected group to select particular contact sets of the group, mechanism for rotating said shaft to bring said contact makers beyond the last contact set of the selected group when the switch is to be restored, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, a slot in said ratchet engaged by said dog when the shaft has been rotated for restoration, whereby said dog is then ineffective to prevent return longitudinal movement of said shaft, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

10. A telephone system including a selective switch having a contact bank containing contacts disposed in groups, a longitudinally and rotarily adjustable switch shaft, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, a slot in said ratchet engaged by said dog when the shaft has been rotated for restoration, whereby said dog is then ineffective to prevent return longitudinal movement of said shaft, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back rotary move-

ment when the switch is used, said return longitudinal movement of said shaft being adapted to bring said ratchet out of engaging relation with said dog, whereby said dog is then ineffective to prevent return rotary movement of said shaft, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

11. A telephone system including a selective switch having a contact bank containing contacts disposed in groups, a longitudinally and rotarily adjustable switch shaft, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, a slot in said ratchet engaged by said dog when the shaft has been advanced for restoration, whereby said dog is then ineffective to prevent return longitudinal movement of said shaft, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

12. A telephone system including a selective switch having movable contacts adjustable in intersecting planes, a shaft for adjusting said contacts capable of primary and secondary movements, a retaining pawl for preventing return secondary movement, a ratchet adapted for engagement thereby, a means for restoring said shaft as to its primary movement while said pawl is engaging said ratchet, said restoration as it approaches completion being effective to bring said ratchet out of engaging relation with said pawl, whereby said pawl is rendered ineffective to prevent return secondary movement of said shaft, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

13. In a telephone system, the combination with a selective switch including a contact bank containing contacts disposed in groups, of a longitudinally and rotarily adjustable switch shaft, contact makers adjustable thereby adapted to engage said contacts, means for adjusting said shaft longitudinally to select a group of contacts while said contact makers are disengaged from said bank contacts, apparatus for turning said shaft to bring said contact makers to engage the first and successive sets of contacts of the selected group to select particular contact sets of the group, mechanism for rotating said shaft to bring said contact makers beyond the last contact set of the selected group when the switch is to be restored, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, a slot in said ratchet engaged by said dog when the shaft has been rotated for restoration, whereby said dog is then ineffectve to prevent return longitudinal movement of said shaft, a spring for securing return rotary movement of said shaft, means for removing tension of said spring from the shaft while the same is being restored as to its longitudinal movement, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

14. In a telephone system, the combination with a selective switch including a contact bank containing contacts disposed in groups, of a longitudinally and rotarily adjustable switch shaft, contact makers adjustable thereby adapted to engage said contacts, means for adjusting said shaft longitudinally to select a group of contacts while said contact makers are disengaged from said bank contacts, apparatus for turning said shaft to bring said contact makers to engage the first and successive sets of contacts of the selected group to select particular contact sets of the group, mechanism for rotating said shaft to bring said contact makers beyond the last contact set of the selected group when the switch is to be restored, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, a slot in said ratchet engaged by said dog when the shaft has been rotated for restoration, whereby said dog is then ineffective to prevent return longitudinal movement of said shaft, a spring for securing return rotary movement of said shaft, means for removing tension of said spring from the shaft while the same is being restored as to its longitudinal movement, mechanism for automatically rendering the tension of said spring effective as the longitudinal restoration of said shaft is completed, a controlling station, and means for transmitting currents therefrom to operate and release said switch.

15. A telephone system including a telephone line, selective switching mechanism at the exchange responsive to currents over said line, contacts included in said mechanism arranged in groups, a magnet for operating said mechanism to select a group, a second magnet for operating said mechanism to select contacts of a selected group, relays one for each of said magnets, means for energizing both said relays when the mechanism is started, armature mechanism controlled by said relays for closing contacts in the circuits of their respective magnets when the relays are energized, an operating circuit for said first magnet including a source of current, a front contact of the relay of said magnet with suitable return, and an operating circuit for said second magnet including a source of current, a back contact of the relay of said second magnet, and a front contact of its own relay with suitable return.

16. A telephone system including selective switching mechanism at the exchange,

a telephone line, means for operating said mechanism responsive to currents over said line, multiple contacts included in said switching mechanism arranged in groups, a magnet for operating said mechanism to select a group, a second magnet for operating said mechanism to select contacts of the selected group, two relays for said mechanism for controlling said magnets, means for energizing both said relays when said mechanism is started, apparatus for causing deënergization of the relay controlling said first magnet when the group is selected, and means for thereafter causing deënergization of the relay controlling said second magnet when contacts of the group are selected.

17. A telephone system including a group of telephone lines, a group of selective switches less in number than said lines, each adapted to automatically connect with any of said lines as a calling line, a starting circuit common to the lines of said group normally operatively related with the first switch of the group, an off-normal contact for said first switch controlling said circuit, an alternate contact adapted to be engaged by said first-mentioned contact to extend said starting circuit toward the second switch of the group, such extension being effective when said first switch is started, and a contact closed by said first switch on selection made to complete the operative extension of said starting circuit to said second switch.

18. A telephone system including a group of telephone lines, a group of selective switches less in number than said lines, each adapted to automatically connect with any of said lines as a calling line, a starting circuit common to the lines of said group normally operatively related to a switch of the group, and an off-normal circuit-changing device for said switch and a contact closed by said switch on selection made, said off-normal switch and said contact then coöperating to extend said starting circuit to another switch of the group.

19. An automatic telephone system including telephone lines, a line selector adapted to automatically connect with said lines as calling lines, a first selector linked to said line selector, a release relay controlling the restorations of both said switches, and a locking circuit for said relay including off-normal contacts of both switches.

20. An automatic telephone system including telephone lines, a line selector adapted to automatically connect with said lines as calling lines, a first selector linked to said line selector, a release relay controlling the restorations of both said switches, and a locking circuit for said relay jointly controlled by said switches.

21. The combination in a telephone system with a trunk circuit, of a plurality of groups of multiple contacts pertaining thereto, a selective switch for said trunk circuit having a contact for each said group of contacts, a contact maker for said last-mentioned switch adapted to select the contact of said switch for any group, and means for altering the normal electrical character of the contacts of any group selected by said contact maker.

22. The combination in a telephone system with a trunk circuit having talking contacts and private contacts, of a plurality of groups of trunk circuit selecting switches, a multiple distribution of talking contacts for said trunk circuit throughout the switches of all groups, a division of the private contacts of said trunks into groups corresponding to said groups of switches, a multiple distribution of the private contacts forming the groups to the corresponding groups of selective switches, and a selective switch for said trunk circuit for controlling groupwise the electrical conditions of said private contacts.

23. The combination in a telephone system with a trunk circuit having a plurality of multiple contacts, all of said contacts having definite normal electrical characters, of a selective switch associated with said trunk circuit for altering the normal conditions of a portion of said contacts while leaving the balance unaffected.

24. The combination in a telephone system with a trunk circuit, of multiple contacts therefor arranged in groups having definite normal electrical characters, a selective switch associated with said trunk circuit, means for operating said switch to select a particular group of contacts while maintaining all of said contacts in their normal conditions, and means for thereafter altering the normal characters of the selected group of contacts without affecting the contacts of the other groups.

25. A telephone system including a trunk circuit provided with multiple terminals arranged in groups, selective switches arranged in corresponding groups adapted to connect with said terminals, a selective switch associated with said trunk circuit capable of directive operation to select any predetermined group of terminals, and means controlled by said switch for altering the normal electrical conditions of the terminals of the selected group to render them selectable by the switches of the corresponding groups.

26. The combination in a telephone system with a trunk circuit of multiple contacts therefor arranged in a plurality of groups having normal electrical characters, and a selective switch controllable by currents transmitted over said trunk circuit adapted to alter the normal electrical characters of the contacts of a particular group while

having the contacts of other groups in their normal electrical conditions.

27. A telephone system including trunk selecting switches arranged in groups, a trunk circuit adapted for selection by any of said switches, talking contacts of said trunk appearing at all of said switches, a number of groups of private contacts of said trunk circuit, the contacts of one group being distributed among the switches of one group, and a selective switch for said trunk circuit adapted to alter the normal electrical conditions of the private contacts of one group of switches without altering those at the others.

28. A telephone system including selective switches arranged in groups, a trunk circuit having multiple terminals appearing at the switches of said groups, said terminals being unselectable in character with respect to said switches, a selective switch individual to said trunk-circuit, and means for transmitting directive currents to said last-mentioned switch to cause it to render selectable the multiple contacts of said trunk circuit at a predetermined group of switches.

29. A telephone system including a telephonic circuit, terminal contacts therefor, a plurality of selective automatic switches, said contacts being distributed among said automatic switches, a selective switch for said circuit, and means for operating the said selective switch to cause it to alter the normal electrical character of particular ones of said contacts to render them selectable without altering the normal electrical character of other contacts of said circuit.

30. A telephone system including a telephonic circuit, terminal contacts therefor, a plurality of selective automatic switches, said contacts being distributed among said automatic switches, a selective switch for said circuit, means for operating the said selective switch to cause it to alter the normal electrical character of particular ones of said contacts to render them selectable without altering the normal electrical character of other contacts of said circuit, a starting circuit controlled by said switch of said trunk circuit, and means for influencing the same to start one of said selective automatic switches capable of selecting the contacts rendered selectable.

31. The combination in a telephone system, with a trunk circuit, of multiple contacts therefor divided into groups, a plurality of groups of selective switches, said groups of contacts being multiply distributed among corresponding groups of switches so that each switch of a group has a contact of the corresponding group of contacts, other trunk circuits having similar contacts similarly distributed among said same switches, a selective switch for said trunk circuit having contacts corresponding to each of its groups of multiple contacts, electromagnetically adjustable contact makers for said switch, means for adjusting the same to engagement with the contacts representing any of its groups of multiple contacts, normal circuit conditions rendering the contacts of all said groups unselectable by the said selective switches, means for altering said normal circuit conditions of a group of multiple contacts of said trunk circuit whose contacts are engaged by the contact makers of said switch, to render said multiple contacts selectable by the switches associated with them.

32. The combination in a telephone system, with a trunk circuit, of multiple contacts therefor divided into groups, a plurality of groups of selective switches, said groups of contacts being multiply distributed among corresponding groups of switches so that each switch of a group has a contact of the corresponding group of contacts, other trunk circuits having similar contacts similarly distributed among said same switches, a selective switch for said trunk circuit having contacts corresponding to each of its groups of multiple contacts, electromagnetically adjustable contact makers for said switch, means for adjusting the same to engagement with the contacts representing any of its groups of multiple contacts, normal circuit conditions rendering the contacts of all said groups unselectable by the said selective switches, means for altering said normal circuit conditions of a group of multiple contacts of said trunk circuit whose contacts are engaged by the contact makers of said switch, to render said multiple contacts selectable by the switches associated with them, and a starting circuit for said trunk circuit operable to initiate travel of an idle selective switch of the group whose contacts have been rendered selectable.

33. The combination in a telephone system, with a trunk circuit, of multiple contacts therefor divided into groups, a plurality of groups of selective switches, said groups of contacts being multiply distributed among corresponding groups of switches so that each switch of a group has a contact of the corresponding group of contacts, other trunk circuits having similar contacts similarly distributed among said same switches, a selective switch for said trunk circuit having contacts corresponding to each of its groups of multiple contacts, electromagnetically adjustable contact makers for said switch, means for adjusting the same to engagement with the contacts representing any of its groups of multiple contacts, normal circuit conditions rendering the contacts of all said groups unselectable by the said selective switches, means for altering said normal circuit conditions of a group of multiple contacts of said trunk circuit whose

contacts are engaged by the contact makers of said switch, to render said multiple contacts selectable by the switches associated with them, a starting circuit for said trunk circuit operable to initiate travel of an idle selective switch of the group whose contacts have been rendered selectable, and mechanism for said idle switch to enable it to avoid contacts of said other trunk circuits in their normal electrical conditions to seek out and rest in engagement with the contacts of said trunk circuit.

34. A telephone system including subscribers' lines divided into groups, a plurality of connectors divided into corresponding groups, a group of connectors being assigned for connections to each group of lines, automatic selecting switches equal in number to said connectors, each being linked to a particular connector, said switches being arranged in groups corresponding to said groups of connectors, a group switch having adjustable contact makers, a telephonic circuit pertaining to said group switch, multiple contacts for said circuit at each selecting switch of each group and conductors connecting said contacts extending throughout all groups, other multiple contacts for said circuit at each selecting switch at each group, a conductor for each group interconnecting said last-mentioned contacts for its own group only, terminals adapted to be engaged by said group switch, one connected to each conductor last-mentioned, means for maintaining a normal electrical condition of said terminals to render said other multiple contacts unselectable by the switches of the groups to which they appertain, apparatus for transmitting selective switching currents to said group switch to cause it to select its terminals connected to the multiple contacts of a predetermined group of switches, and means for altering the electrical condition of the selected terminal to render the multiple contacts connected thereto at the switches of the particular group selectable.

35. A telephone system including subscribers' lines divided into groups, a plurality of connectors divided into corresponding groups, a group of connectors being assigned for connections to each group of lines, automatic selecting switches equal in number to said connectors, each being linked to a particular connector, said switches being arranged in groups corresponding to said groups of connectors, a group switch having adjustable contact makers, a telephonic circuit pertaining to said group switch, multiple contacts for said circuit at each selecting switch of each group and conductors connecting said contacts extending throughout all groups, other multiple contacts for said circuit at each selecting switch at each group, a conductor for each group interconnecting said last-mentioned contacts for its own group only, terminals adapted to be engaged by said group switch, one connected to each conductor last-mentioned, means for maintaining a normal electrical condition of said terminals to render said other multiple contacts unselectable by the switches of the groups to which they appertain, apparatus for transmitting selective switching currents to said group switch to cause it to select its terminals connected to the multiple contacts of a predetermined group of switches, means for altering the electrical condition of the selected terminal to render the multiple contacts connected thereto at the switches of the particular group selectable, mechanism for initiating travel of an idle switch of the group, and means for stopping the started switch when it reaches its contacts pertaining to said telephonic circuit, whereby a connector of a desired line group is connected to said circuit.

36. A telephone system including subscribers' lines divided into groups, a plurality of connectors divided into corresponding groups, a group of connectors being assigned for connections to each group of lines, automatic selecting switches equal in number to said connectors, each being linked to a particular connector, said switches being arranged in groups corresponding to said groups of connectors, a group switch having adjustable contact makers, a telephonic circuit pertaining to said group switch, multiple contacts for said circuit at each selecting switch of each group and conductors connecting said contacts extending throughout all groups, other multiple contacts for said circuit at each selecting switch at each group, a conductor for each group interconnecting said last-mentioned contacts for its own group only, terminals adapted to be engaged by said group switch, one connected to each conductor last-mentioned, means for maintaining a normal electrical condition of said terminals to render said other multiple contacts unselectable by the switches of the groups to which they appertain, apparatus for transmitting selective switching currents to said group switch to cause it to select its terminals connected to the multiple contacts of a predetermined group of switches, means for altering the electrical condition of the selected terminal to render the multiple contacts connected thereto at the switches of the particular group selectable, mechanism for initiating travel of an idle switch of the group, means for stopping the started switch when it reaches its contacts pertaining to said telephonic circuit, whereby a connector of a desired line group is connected to said trunk circuit, and mechanism for transmitting directive currents to said connector for establishing a desired connection.

37. A telephone system including subscribers' lines divided into groups, a plurality of connectors divided into corresponding groups, a group of connectors being assigned for connections to each group of lines, automatic selecting switches equal in number to said connectors, each being linked to a particular connector, said switches being arranged in groups corresponding to said groups of connectors, a group switch having adjustable contact makers, a telephonic circuit pertaining to said group switch, multiple contacts for said circuit at each selecting switch of each group and conductors connecting said contacts extending throughout all groups, other multiple contacts for said circuit at each selecting switch at each group, a conductor for each group interconnecting said last-mentioned contacts for its own group only, terminals adapted to be engaged by said group switch, one connected to each conductor last-mentioned, means for maintaining a normal electrical condition of said terminals to render said other multiple contacts unselectable by the switches of the groups to which they appertain, apparatus for transmitting selective switching currents to said group switch to cause it to select its terminals connected to the multiple contacts of a predetermined group of switches, means for altering the electrical condition of the selected terminal to render the multiple contacts connected thereto at the switches of the particular group selectable, mechanism for initiating travel of an idle switch of the group, means for stopping the started switch when it reaches its contacts pertaining to said telephonic circuit, whereby a connector of a desired line group is connected to said trunk circuit, a calling line connected to said telephonic circuit, and mechanism for controlling currents thereover to directively operate said connector to establish a desired connection.

38. A telephone system including telephone lines divided into groups, connectors in corresponding groups adapted for directive operation to select said lines as called lines, trunk selectors for extending the circuits of said connectors to calling lines arranged in similar groups, a calling line, a trunk circuit in connection therewith, contacts of said trunk circuit multipled throughout the trunk selectors of all said groups, other contacts of said trunk circuit distributively multipled to said trunk selectors by groups, means for maintaining a normal unselectable electrical condition of said last-mentioned contacts at all said groups, and a selective switch for said trunk circuit for altering the normal electrical condition of the last-mentioned contacts at the trunk selectors of a particular group only to render them selectable.

39. A telephone system including telephone lines, a calling line, trunk circuits arranged in groups at the exchange, selective switching mechanism at the exchange responsive to currents controlled at the substation of said calling line for selecting a predetermined group and then an idle trunk, multiple contacts for the trunk circuit of each group, trunk selectors having contact makers adapted to be placed in engagement with said multiple contacts, said selectors being divided into great groups corresponding to the groups of trunks, a division of each great group into a plurality of sub-groups, a distribution of certain multiple contacts of the trunks of each group throughout all the selectors of its corresponding great group, a distribution of other multiple contacts of the trunks of each group throughout the selectors of a single sub-group only, the selectors of each such sub-group thus having multiple contacts of said trunks not multipled to the selectors of the other sub-groups, a group switch for each trunk, means for operating the group switch of the selected trunk from the substation of said calling line to select a predetermined group of the said other multiple contacts of the selected trunk, and mechanism for altering the normal electrical conditions of said last-mentioned contacts to render them selectable by the trunk selectors of their sub-group.

40. A telephone system including telephone lines, a calling line, trunk circuits arranged in groups at the exchange, selective switching mechanism at the exchange responsive to currents controlled at the substation of said calling line for selecting a predetermined group and then an idle trunk, multiple contacts for the trunk circuit of each group, trunk selectors having contact makers adapted to be placed in engagement with said multiple contacts, said selectors being divided into great groups corresponding to the groups of trunks, a division of each great group into a plurality of sub-groups, a distribution of certain multiple contacts of the trunks of each group throughout all the selectors of its corresponding great group, a distribution of other multiple contacts of the trunks of each group throughout the selectors of a single sub-group only, the selectors of each such sub-group thus having multiple contacts of said trunks not multipled to the selectors of the other sub-groups, a group switch for each trunk, means for operating the group switch of the selected trunk from the substation of said calling line to select a predetermined group of the said other multiple contacts of the selected trunk, mechanism for altering the normal electrical conditions of said last-mentioned contacts to render them selectable by the trunk selectors of their sub-group, and apparatus for

starting an idle selector of the selected sub-group to select its multiple contact thus altered.

41. A telephone system including telephone lines, a calling line, trunk circuits arranged in groups at the exchange, selective switching mechanism at the exchange responsive to currents controlled at the substation of said calling line for selecting a predetermined group and then an idle trunk, multiple contacts for the trunk circuit of each group, trunk selectors having contact makers adapted to be placed in engagement with said multiple contacts, said selectors being divided into great groups corresponding to the groups of trunks, a division of each great group into a plurality of sub-groups, a distribution of certain multiple contacts of the trunks of each group throughout all the selectors of its corresponding great group, a distribution of other multiple contacts of the trunks of each group throughout the selectors of a single sub-group only, the selectors of each such sub-group thus having multiple contacts of said trunks not multipled to the selectors of the other sub-groups, a group switch for each trunk, means for operating the group switch of the selected trunk from the substation of said calling line to select a predetermined group of the said other multiple contacts of the selected trunk, mechanism for altering the normal electrical conditions of said last-mentioned contacts to render them selectable by the trunk selectors of their sub-group, apparatus for starting an idle selector of the selected sub-group to select its multiple contact thus altered, and connectors linked to said trunk selectors distributed for connections to particular called lines.

42. A telephone system including telephone lines, a calling line, trunk circuits arranged in groups at the exchange, selective switching mechanism at the exchange responsive to currents controlled at the substation of said calling line for selecting a predetermined group and then an idle trunk, multiple contacts for the trunk circuit of each group, trunk selectors having contact makers adapted to be placed in engagement with said multiple contacts, said selectors being divided into great groups corresponding to the groups of trunks, a division of each great group into a plurality of sub-groups, a distribution of certain multiple contacts of the trunks of each group throughout all the selectors of its corresponding great group, a distribution of multiple contacts of the trunks of each group throughout the selectors of a single sub-group only, the selectors of each such sub-group thus having multiple contacts of said trunks not multipled to the selectors of the other sub-groups, a group switch for each trunk, means for operating the group switch of the selected trunk from the substation of said calling line to select a predetermined group of the said other multiple contacts of the selected trunk, mechanism for altering the normal electrical conditions of said last-mentioned contacts to render them selectable by the trunk selectors of their sub-group, apparatus for starting an idle selector of the selected sub-group to select its multiple contact thus altered, connectors linked to said trunk selectors distributed for connections to particular called lines, and apparatus for starting an idle selector of the selected sub-group to select its multiple contact thus altered to connect a connector with the calling line.

43. An automatic telephone system including telephone lines, a connector adapted to make connection directly with said lines, groups of trunk circuits at the exchange for interchangeable use by calling lines in establishing connections, selective switching mechanism individual to said connector, means for starting the same from a calling line, and automatic group and individual trunk line test devices for said mechanism enabling it to automatically seek out and connect with an idle one of said trunk circuits, whereby said connector is connected with said trunk circuit.

44. A telephone system including a calling telephone line, a line finding switch in connection with said line, a plurality of selectors extending the circuit of said line, a release conductor separate from the talking conductors and extending conductively through the mechanisms of said switch and said selectors, electromagnets controlling the restoration of said switch and said selectors in circuit with said conductor, a battery and means controlled over the talking conductors and responsive to the opening of the line circuit at the subscriber's substation for supplying current from the said battery to the said conductor.

45. A telephone system having an automatic switch provided with movable wipers and groups of relatively fixed coöperating contacts, a primary relay for controlling the movement of the wipers to a definite group of contacts, a secondary magnet for controlling the further movement of said wipers to definite contacts in the said definite group, and an energizing circuit for said magnet controlled through normally closed contacts of said primary relay.

46. A telephone system including telephone lines, automatic switches for use in connecting said lines for conversational purposes, an electromagnet for controlling the release of said switches, and a maintaining circuit for said magnet jointly controlled by said switches.

47. A telephone system including telephone lines, automatic switches for use in

connecting said lines for conversational purposes, off-normal contacts on said switches, an electromagnet for controlling the release of said switches, and a maintaining circuit for said magnet including off-normal contacts of all of said switches.

48. A telephone system including telephone lines, a line selector for automatically connecting with said lines as calling lines, a first selector associated with said line selector, off-normal contacts on said selectors, a magnet for controlling the release of said switches, and a maintaining circuit for said magnet including off-normal contacts of both said selectors.

49. A telephone system including a calling telephone line, a line selector in connection with said line, a plurality of switches extending the circuit of said line, a release conductor separate from the talking conductors and extending conductively through apparatus of all of said switches and said selector, electromagnets for said selector and some of said switches multiply connected to said conductor for controlling the restoration of said selector and all of said switches, a battery, and means controlled over the said talking conductors and responsive to the opening of the said line circuit at the subscriber's substation for energizing said electromagnets over said conductor by current from said battery.

50. A telephone system comprising a pair of coupled automatic switches, means for advancing and releasing the wipers of said switches, a release relay, a control relay for each of said switches for disconnecting the wipers of said switches during their release movement, and adapted to be energized over a circuit including contacts of said release relay, said releasing means being controlled by said control relays.

51. A telephone system comprising a telephone line, a trunk, a line selector and a trunk selector, means for advancing and releasing the wipers of said selectors, a control relay for disconnecting the wipers of said trunk selector during its release movement, and a release magnet for controlling the release of said line selector, said control relay being actuated over a circuit including contacts of said release magnet.

52. A telephone system comprising a telephone line, a trunk, a line selector and a trunk selector, means for advancing said selectors to connecting positions, release means for restoring said selectors to normal, control relays for disconnecting the wipers of said selectors during their release movement, and a release magnet, said control relays being actuated over circuits including contacts of said release magnet and said release means being controlled by said control relays.

53. In a telephone exchange system, subscribers' stations provided with impulse sending devices, a central office provided with two-dimension automatic switching mechanisms controlled by impulses from said sending devices for effecting a talking connection between the substations, and interposed independently operable switching devices irresponsive to said impulses, certain of said switching devices operating to effect the connection of a calling line with one of said automatic switching mechanisms and other of said interposed devices operating to effect connections between said automatic switching mechanisms.

54. In a telephone exchange system, subscribers' stations provided with impulse sending devices, a central office provided with automatic switching mechanisms controlled by impulses from said sending devices for effecting a talking connection between the substations, and two-dimension interposed switching devices irresponsive to said impulses, certain of said switching devices operating to effect the connection of a calling line with one of said automatic switching mechanisms and other of said interposed devices operating to effect connections between the said automatic switching mechanisms.

55. In a telephone system, subscribers' stations provided with impulse sending devices, a central office provided with two-dimension automatic switching mechanisms controlled by impulses from said sending devices for effecting a talking connection between the substations, and interposed two-dimension switching devices irresponsive to said impulses, certain of said switching devices operating to effect the connection with the calling line with one of said automatic switching mechanisms and other of said interposed devices operating to effect connections between said automatic switching mechanisms.

56. In a telephone exchange system, subscribers' stations provided with impulse sending devices, a central office provided with automatic switching mechanism controlled by impulses from said sending devices for effecting a talking connection between the substations, and interposed two-dimension switching devices irresponsive to said impulses, said switching devices having groups of terminals to which said subscribers' stations are connected, means responsive to a call from one of said stations to cause a switching device to test said contacts by group and individually to effect connection with the calling substation and extend it to one of said automatic switching mechanisms, and other interposed switching devices irresponsive to said impulses for automatically interconnecting such a selective switching mechanism with another one of said switching mechanisms.

57. In a telephone exchange system, subscribers' stations provided with impulse sending devices, a central office provided with automatic switching mechanisms controlled by impulses from said sending devices for effecting a talking connection between the substations, interposed switching devices irresponsive to said impulses for connecting said substation and certain of said automatic switching mechanisms, trunk lines adapted to be connected with by said certain automatic switching mechanisms, other interposed switching devices irresponsive to said impulses, the last said switching devices having said trunk lines connected thereto in groups, and means for automatically operating the last said switching devices to connect said trunk lines with others of said switching mechanisms by testing said trunks by groups and individually to select a trunk connected with one of the first said certain switching mechanisms.

58. In a telephone exchange system, subscribers' stations provided with impulse sending devices, a central office provided with automatic switching mechanisms controlled by impulses from said sending devices for effecting a talking connection between the substations, interposed switching devices irresponsive to said impulses, certain of said switching devices operating to effect the connection of a calling line with one of said automatic switching mechanisms and other of said interposed devices operating to effect connections between said automatic switching mechanisms, and relays for said switching devices having contacts included in the talking connections for maintaining the talking connections thereof interrupted during the connecting operation of the switching devices.

59. A telephone system comprising telephone lines, two-dimension switches having primary and secondary operating mechanisms for extending the circuit of a calling telephone line, and means responsive to the interruption of the metallic circuit of a telephone line to bring about the operation of the secondary operating mechanisms to effect a release of connected switches.

60. A telephone system comprising telephone lines, two-dimension automatic switches having primary and secondary driving mechanisms, a calling device and means responsive thereto for operating said mechanisms to cause said switches to extend the circuit of a calling line, means responsive to the interruption of the metallic circuit of a telephone line to effect the operation of the secondary mechanisms of connected switches, and means for operating the secondary mechanisms to release the switches.

61. In an electrical switch for automatic exchanges including contact sets arranged in groups, a primary magnet for operating said switch to select a group, a secondary magnet for operating said switch to select a contact set of the selected group, together with means for operating said secondary magnet to effect restoration of said switch.

62. The combination in an electrical switch for automatic exchanges with a main switch shaft adapted for reciprocal action, of driving means for actuating said shaft, a spring for securing return movement thereof, means for preventing said return movement until the shaft is driven its full operative distance, mechanism for automatically temporarily relieving operative tension of said spring from said shaft effective as the shaft completes its operative distance, and mechanism for thereafter automatically rendering said spring effective to cause return movement of said shaft.

63. A switch for automatic exchanges including a rotatable main switch shaft, a spring for securing return rotary movement of said shaft against whose tension the shaft is operated, means for turning said shaft from an initial fixed rotary position to a final fixed rotary position, together with means for automatically removing the tension of said spring from said shaft when it assumes either of said fixed rotary positions, said spring being adapted to exert its tension upon said shaft in its other rotary positions, substantially as described.

64. In a switch for automatic exchanges, the combination with a main switch shaft, of a spring-case mounted upon said shaft, a spring having one end attached thereto, an arm having an orifice at each end, one orifice fitting loosely about the shaft, the other orifice fitting about a suitably disposed post, the other end of said spring being attached to said arm adjacent to said shaft, means for rotating said shaft from a particular initial rotary position to a particular final rotary position, a stop carried by said shaft normally engaging said arm to render ineffective the rotary tension of said spring upon said shaft, when in its initial rotary position, a second stop carried by said shaft adapted to engage said arm only when the shaft reaches its final rotary position to again render ineffective said tension of said spring.

65. The combination in an electrical switch for automatic exchanges, with contact sets arranged in groups, of adjustable contact makers for said switch adapted to engage said contact sets, mechanism for primarily operating said switch to select a group, mechanism for secondarily operating said switch to select a contact set of the selected group, an off-normal switch shifted when said switch is initially primarily op-

erated, a second off-normal switch operated when said switch is initially secondarily operated, and means for restoring said off-normal switches effective only when said contact makers are fully restored.

66. An electrical switch for automatic exchanges including a main shaft, mechanism for primarily adjusting said shaft in a longitudinal direction, said adjustment being made in a fixed normal rotary position of said shaft, mechanism for securing return longitudinal movement of said shaft, said return movement being made in a second fixed rotary position of said shaft, means for rotating said shaft after its primary longitudinal adjustment from said normal rotary position to said second rotary position and a spring securing back rotary movement of said shaft, said spring being ineffective to exert tension on said shaft during its primary and return longitudinal movements.

67. In an electrical switch for automatic exchanges, the combination with movable contacts adapted for adjustment in intersecting planes, of a shaft for adjusting them capable of primary and secondary movements, an extreme operative position for said shaft in its secondary movements, and means for moving said shaft beyond said extreme position to restore the switch.

68. In an electrical switch for automatic exchanges, the combination with switch contacts arranged in groups, of contact makers for said switch, means for moving said contact makers to select a group, means for moving said contact makers in an intersecting plane to select contacts of the selected group, together with mechanism operated when restoration is desired for moving said contact makers farther in said intersecting plane beyond the last contacts of the group whereby said switch is automatically restored.

69. An electrical switch for automatic exchanges including a contact bank containing contacts disposed in groups, a longitudinally and rotarily adjustable switch shaft, contact makers adjustable thereby adapted to engage said contacts, means for adjusting said shaft longitudinally to select a group of contacts while said contact makers are disengaged from said bank contacts, apparatus for turning said shaft to bring said contact makers to engage the first and successive sets of contacts of the selected group to select particular contact sets of the group, mechanism for rotating said shaft to bring said contact makers beyond the first contact set of the selected group when the switch is to be restored, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, and a slot in said ratchet engaged by said dog when the shaft has been rotated for restoration, whereby said dog is then ineffective to prevent return longitudinal movement of said shaft.

70. An electrical switch for automatic exchanges including a contact bank containing contacts disposed in groups, a longitudinally and rotarily adjustable switch shaft, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, a slot in said ratchet engaged by said dog when the shaft has been rotated for restoration, whereby said dog is then ineffective to prevent return longitudinal movement of said shaft, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back rotary movement when the switch is used, said return longitudinal movement of said shaft being adapted to bring said ratchet out of engaging relation with said dog, whereby said dog is then ineffective to prevent return rotary movement of said shaft.

71. An electrical switch for automatic exchanges including a contact bank containing contacts disposed in groups, a longitudinally and rotarily adjustable switch shaft, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, and a slot in said ratchet engaged by said dog when the shaft has been rotated forward for restoration, whereby said dog is then ineffective to prevent return longitudinal movement of said shaft.

72. An electrical switch for automatic exchanges including movable contacts adjustable in intersecting planes, a shaft for adjusting said contacts capable of primary and secondary movements, a retaining pawl for preventing return secondary movement, a ratchet adapted for engagement thereby, means for restoring said shaft as to its primary movement while said pawl is engaging said ratchet, said restoration as it approaches completion being effective to bring said ratchet out of engaging relation with said pawl, whereby said pawl is rendered ineffective to prevent return secondary movement of said shaft.

73. An electrical switch for automatic exchanges including a contact bank containing contacts disposed in groups, a longitudinally and rotarily adjustable switch shaft, contact makers adjustable thereby adapted to engage said contacts, means for adjusting said shaft longitudinally to select a group of contacts while said contact makers are disengaged from said bank contacts, apparatus for turning said shaft to bring said contact makers to engage the first and successive sets of contacts of the selected group

to select particular contact sets of the group, mechanism for rotating said shaft to bring said contact makers beyond the last contact set of the selected group when the switch is to be restored, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, a slot in said ratchet engaged by said dog when the shaft has been rotated for restoration, whereby said dog is then ineffective to prevent return longitudinal movement of said shaft, a spring for securing return rotary movement of said shaft, and means for removing tension of said spring from the shaft while the same is being restored as to its longitudinal movement.

74. An electrical switch for automatic exchanges including a contact bank containing contacts disposed in groups, a longitudinally and rotarily adjustable switch shaft, contact makers adjustable thereby adapted to engage said contacts, means for adjusting said shaft longitudinally to select a group of contacts while said contact makers are disengaged from said bank contacts, apparatus for turning said shaft to bring said contact makers to engage the first and successive sets of contacts of the selected group to select particular contact sets of the group, mechanism for rotating said shaft to bring said contact makers beyond the last contact set of the selected group when the switch is to be restored, a retaining dog and a ratchet of the shaft engaged thereby to hold the shaft against back longitudinal movement when the switch is used, a slot in said ratchet engaged by said dog when the shaft has been rotated for restoration, whereby said dog is then ineffective to prevent return longitudinal movement of said shaft, a spring for securing return rotary movement of said shaft, means for removing tension of said spring from the shaft while the same is being restored as to its longitudinal movement, and mechanism for automatically rendering the tension of said spring effective as the longitudinal restoration of said shaft is completed.

75. An automatic selector switch comprising contacts arranged in groups, mechanism for driving the wipers of the contacts to a group, mechanism for driving the wipers of the contacts to a contact in the group, and means whereby the last said mechanism causes restoration of the wipers.

76. An automatic selector switch comprising a bank of passive contacts, of a suitable active contact therefor, electromagnetic means for driving said active contact in two directions to engage one of said passive contacts, and means including part of said electromagnetic means for moving said active contact in two directions over a different path to restore it to a normal position.

77. An automatic selector switch comprising groups of passive contacts, a suitable active contact therefor, driving means for moving said active contact to a group, other driving means for moving said active contact to a passive contact of the group, and means whereby when said last driving means has moved said active contact beyond the last passive contact of the selected group said active contact is automatically restored to a normal position.

78. An electrical switch for automatic exchanges, a bank of contacts comprising groups of contacts arranged in parallel planes, a wiper for coöperation with said contacts, a second bank of contacts arranged in a plane intersecting the said first planes, a wiper for coöperation with said second bank of contacts, and means controlled by said last wiper for moving the said first wiper to a position opposite a group of said first contacts.

79. A switch for automatic exchanges comprising a bank of contacts arranged in parallel planes, a wiper for coöperation with said contacts, a second bank of contacts arranged in a plane intersecting said parellel planes, a wiper adapted for coöperation with said second bank of contacts, and means controlled by said second wiper for moving said first wiper into a position ready to cooperate with said first bank of contacts.

80. An electrical switch for automatic exchanges comprising a bank of contacts arranged in parallel planes, a second bank of contacts arranged in a plane intersecting said parallel planes, a two-motion shaft for said switch provided with a pair of wipers one of said wipers adapted to coöperate with said second bank of contacts to control the primary movement of said switch and a second wiper adapted to coöperate with the said first bank of contacts to control the secondary movement of said switch.

81. A switch for automatic exchanges comprising contacts arranged in groups in parallel planes, a second bank of contacts arranged in a plane at right angles to the planes of said first contacts, a two-motion switch shaft carrying wipers adapted to cooperate with said banks of contacts one of said wipers adapted to coöperate with said last bank of contacts to control the primary movement of the said switch and a second of said wipers adapted to coöperate with the first said contacts to control the secondary movement of said switch.

82. An electrical switch for automatic exchanges comprising a bank of contacts circumferentially disposed and arranged in groups in parallel planes, a wiper for testing the contacts of said groups, a second bank of contacts vertically disposed and arranged in a plane at right angles to the said first planes, a wiper adapted to test the contacts

in said second bank, and means controlled by the said last wiper for moving said first test wiper to a position opposite a group of said first contacts whereby the said wiper may then be operated to test a contact in the selected group of contacts.

In witness whereof, I hereunto subscribe my name this 25th day of Feby. 1907.

HARRY G. WEBSTER.

Witnesses:
CAROLYN WEBER,
THOMAS H. FERGUSON.