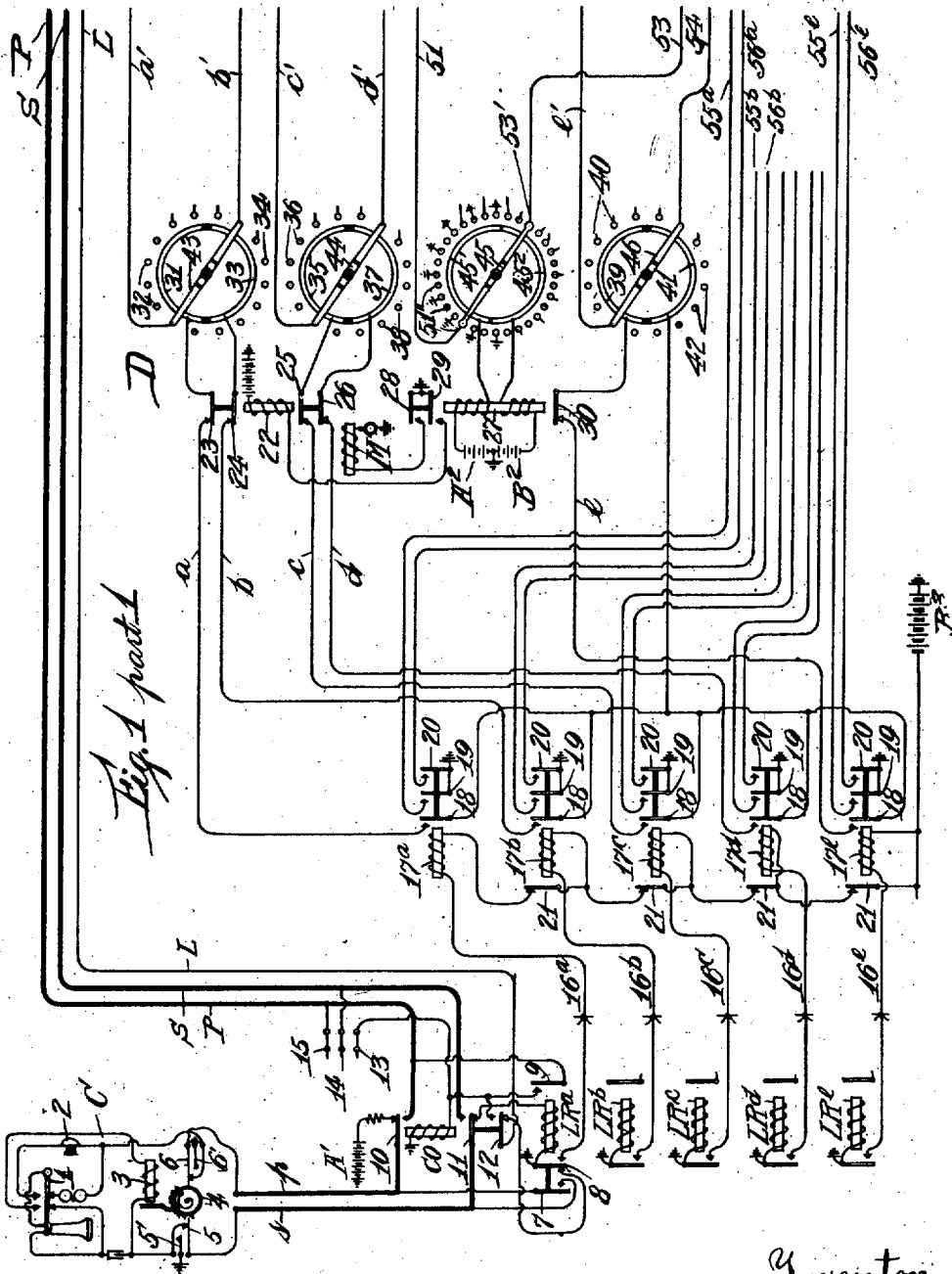


H. G. WEBSTER.
AUTOMATIC TELEPHONE SYSTEM.
APPLICATION FILED MAR. 6, 1909.

976,524.

Patented Nov. 22, 1910.

6 SHEETS-SHEET 1.



Witnesses
A. H. Lyon
Sanford Urban

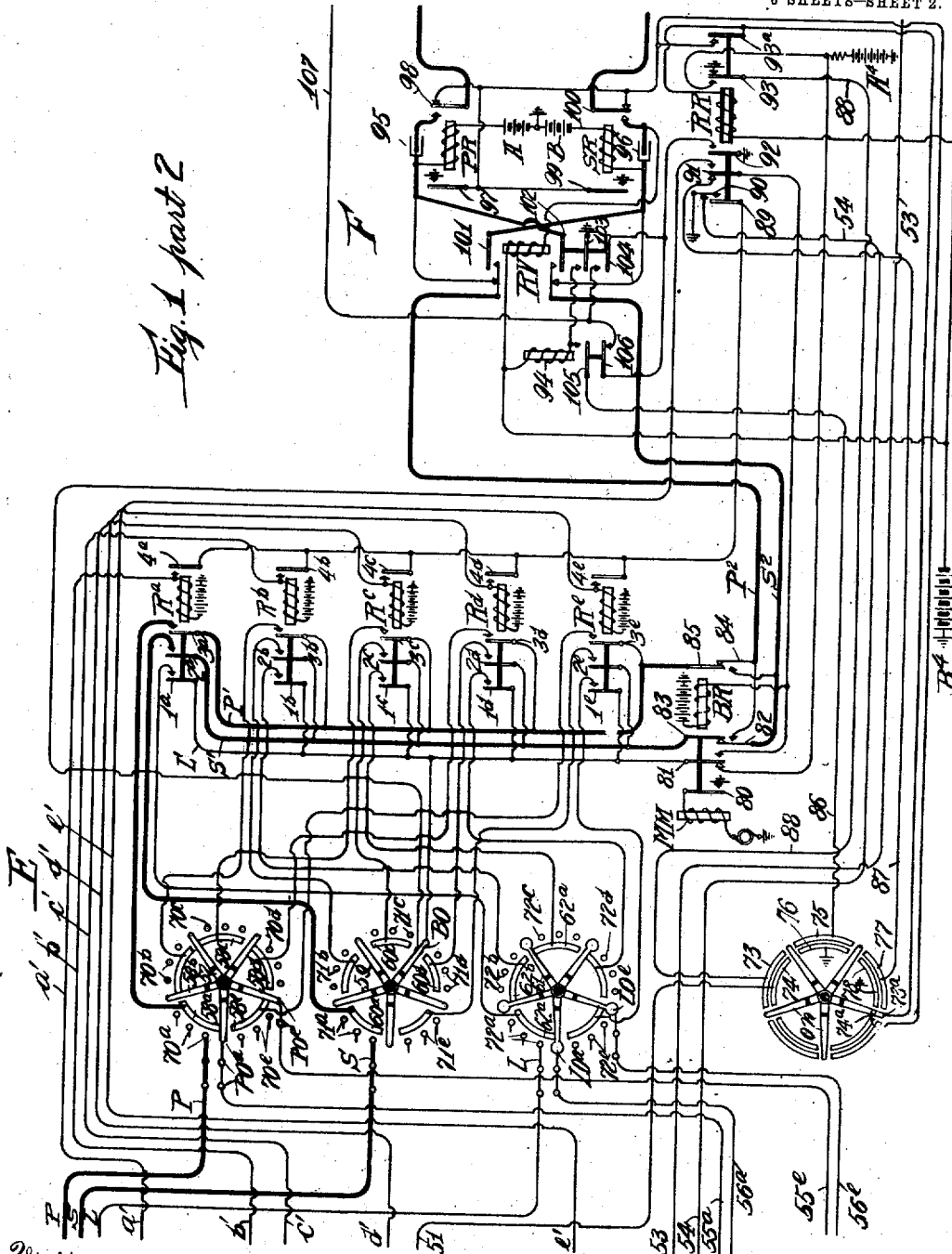
Inventor
Harry G. Webster
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6 SHEETS-SHEET 2.

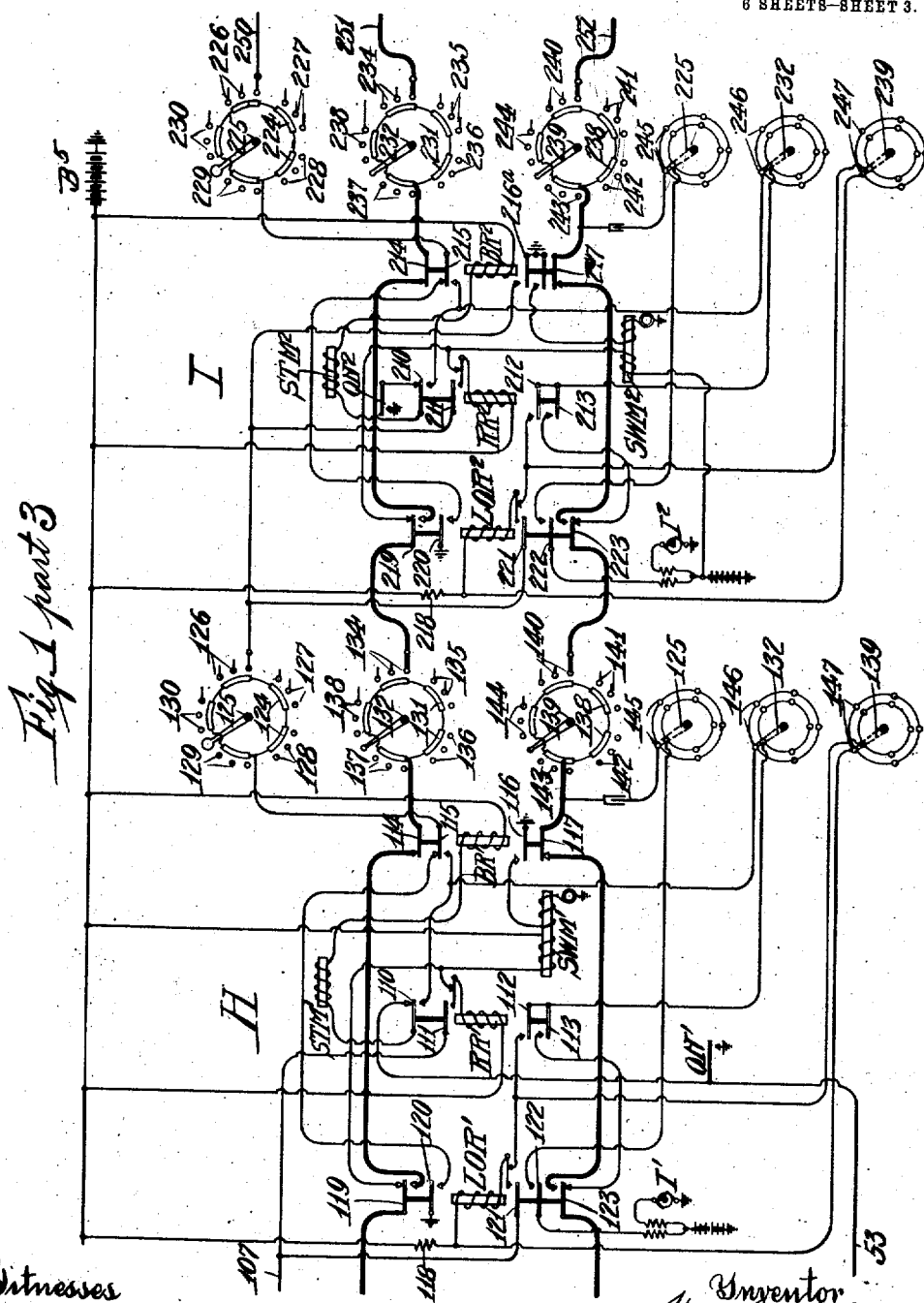


Witnesses
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976,524.

6 SHEETS-SHEET 3.



C. H. Byron

Carolyn Weber

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6 SHEETS--SHEET 4.

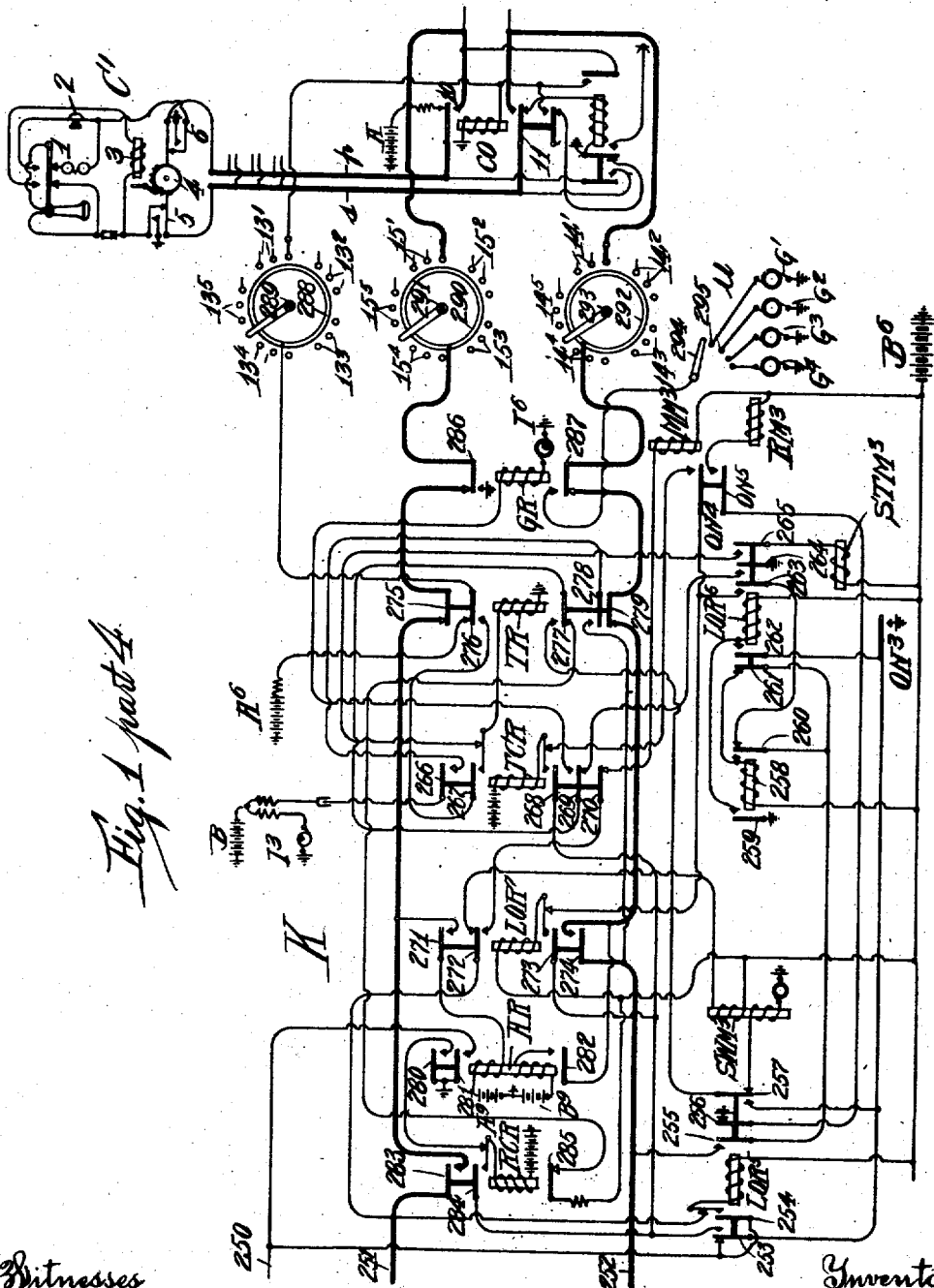


Fig. 1 part 4.

Witnesses
A. H. [Signature]
Carolyn Underhill

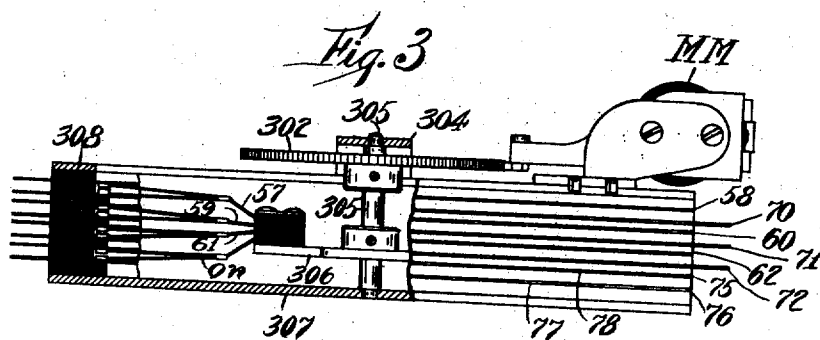
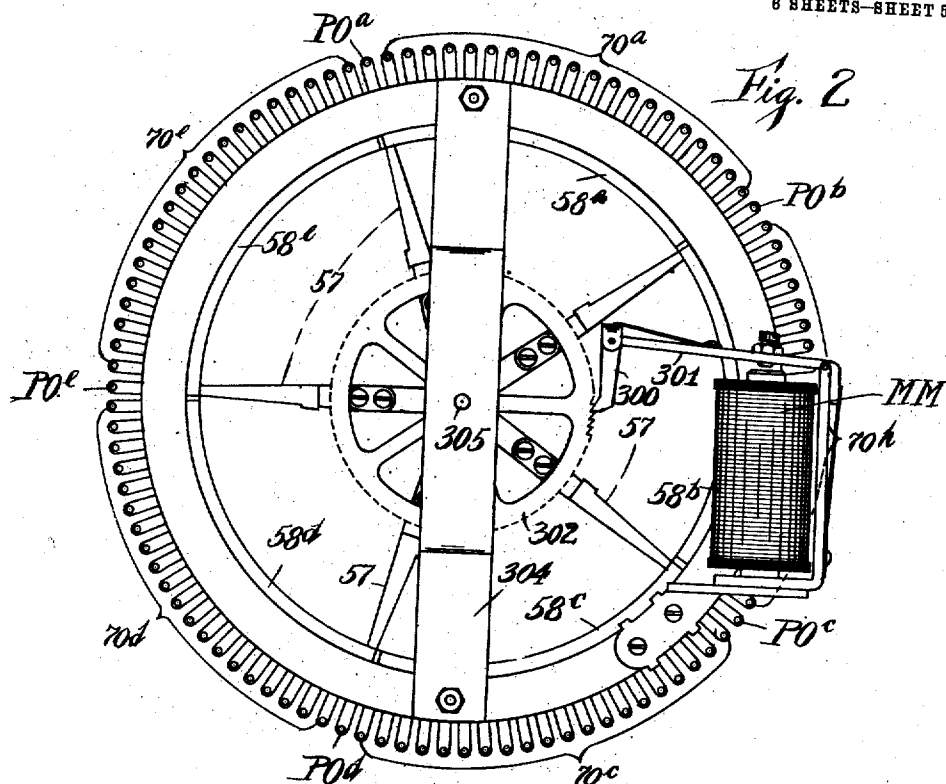
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Att'y

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6 SHEETS-SHEET 5.



Witnesses
ANDYRON
Caroline Webster

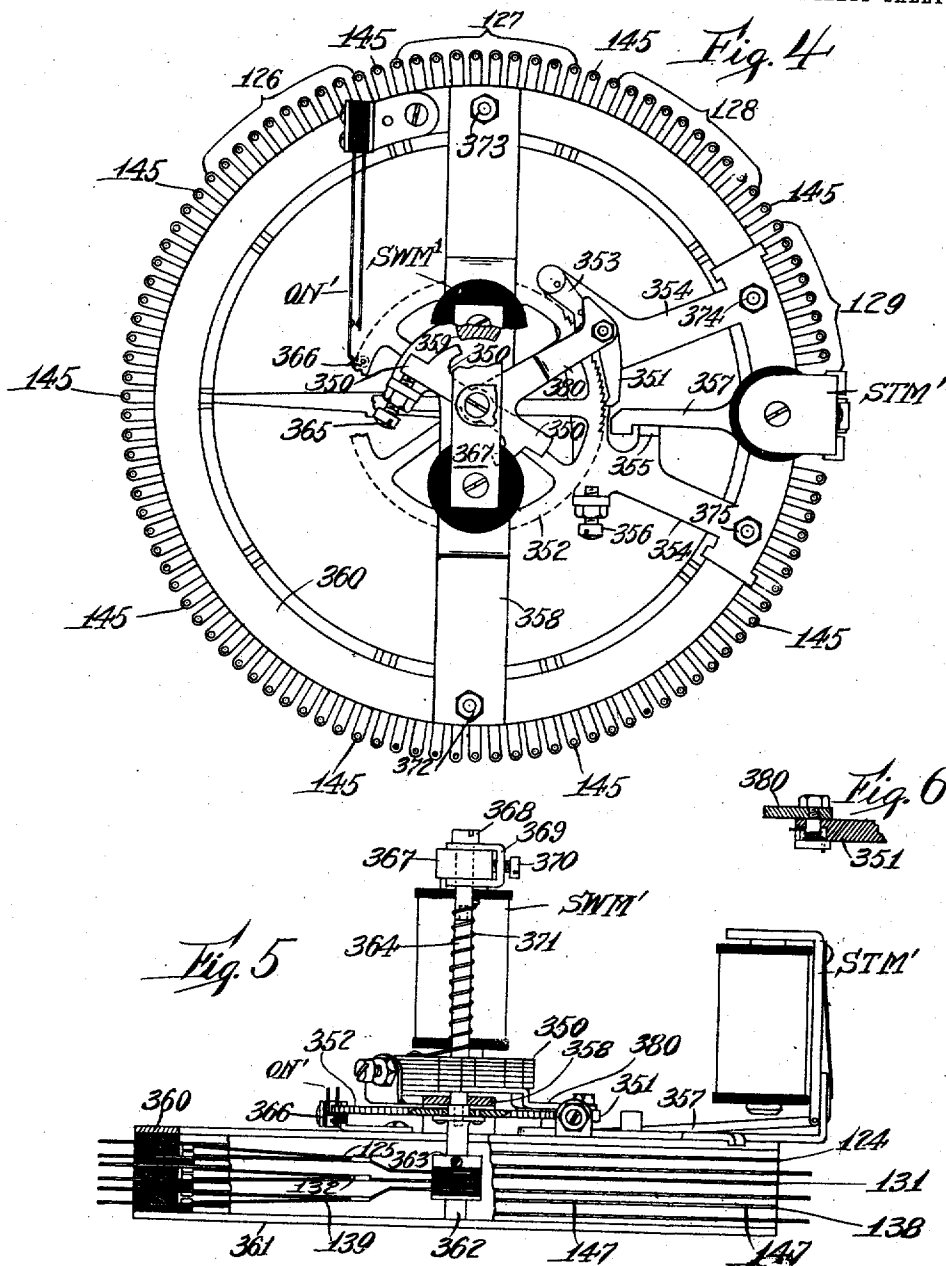
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(Att'y.)

976,524.

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Patented Nov. 22, 1910.
6 SHEETS—SHEET 6.



Witnesses
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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.

976,524.

Specification of Letters Patent. Patented Nov. 22, 1910.

Application filed March 6, 1909. Serial No. 481,792.

To all whom it may concern:

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

While the invention, as defined in the claims, may be employed for automatic or semi-automatic systems, I have elected to illustrate the same as embodied in the system of the former class, wherein first selectors, second selectors and connectors are employed for operation responsive to directive currents controlled at the calling substations, to interconnect subscribers' lines. Preferably, the first selectors, second selectors and connectors are provided in numbers proportionate to the numbers of co-existing calls to be expected, and automatic means are provided to interconnect the first selectors interchangeably with calling lines when calls are initiated from such lines.

The first selectors in the system illustrated are employed to select the thousands digits of the called numbers and consist of step-by-step switches having before them a number of groups of multiple contact sets which are terminals of second selectors assigned for connections to the different thousands of the exchange, an operating first selector being directly adjusted to select the required group of second selectors, then automatically to select an idle selector from the group. Each second selector is an automatic switch having before it groups of multiple terminal sets of connectors, those of each group being assigned for connections to a different hundred of the thousand which the second selector serves. A thousand first selectors, a thousand second selectors, and a thousand connectors may conveniently be assumed sufficient for adequately caring for its business in a ten thousand line exchange. The arrangement of the multiplying of the terminals of the connectors at the second selectors and of the terminals of the second selectors at the first selectors, may be of a customary well known character and need not be more specifically referred to. In the usual way, the lines as called lines are divided into groups of one hundred, according to the directory numbers of the lines, and each group of one hun-

dred lines has multiple called terminals arranged in ten groups of ten contact sets each multiplied before the wipers of a number of connectors, say, ten for one hundred lines. Each connector has contact wipers adapted to be adjusted responsive to directive impulses, representing the tens digit of the called number, to select the group of multiple terminals containing that of the called line; and to be thereafter adjusted responsive to directive impulses representing the units digit of the called line to select out of the group the individual contact set of the called line, whereafter the line will be tested and, if idle, its substation will be rung up, while if busy, a signal indicating that condition will be transmitted to the calling subscriber.

As calling lines, the lines are also divided into groups of one hundred and the multiple calling terminals of each such one hundred line group are multiplied before the wipers of a number of line selectors which are automatic switches capable of selecting the terminals of a calling line. The terminals of the lines of each one hundred line group may be multiplied at, say, ten line selectors and each such line selector may have paired with it one of the first selectors. Thus, assuming a ten thousand line exchange, there would be one hundred groups of calling lines with ten line selectors per group, making a total of one thousand line selectors, each line selector having paired with it one of the one thousand first selectors previously referred to.

The present invention is directed to an improved construction and method of operation of the line selectors, and to improved apparatus for controlling the mechanical switches employed for first selectors, second selectors and connectors. The mechanical switches employed in these latter capacities I do not claim as part of the invention.

I am aware that the use of automatic switches for selecting calling lines and so connecting central office link-circuits with them is not new. One class of systems of this character heretofore proposed has contemplated placing the multiple terminals of the calling lines at the line selectors in a single group. In such cases, the wipers of the line selectors, when selecting a calling line, may possibly have to pass over the entire number of contact sets provided in

order to reach the set of the calling line. As the calling line groups are preferably of quite large size, the selectors in such systems must in many cases take a rather longer time than is desirable to select a calling line, or must be operated at a speed so great as to tend to impart unreliability in the operation. In another class of systems wherein line selectors are employed, the terminals of the lines are multiplied in groups at the line selectors and these switches are first adjusted to select the group and then terminals of the calling lines much as the connectors are operated to select a group and then the terminals of the called lines.

In the first class of systems, obviously a simple rotary switch having one direction of travel may be employed and such switches are preferably arranged to operate step by step, each step being the same length. For systems of the second class, it has been proposed to use switches of well known character having wipers capable of adjustment in two intersecting planes, or switches having one set of wipers to select the group and other sets to select contacts of the group, or rotary switches arranged to make long steps when selecting the group and short steps for selecting contacts of the group.

An important part of the present invention is found in the arrangement provided whereby I am enabled to use as line selectors rotary switches operated step by step, all steps being of the same length while maintaining the group arrangement of the second class of systems above referred to so as to conserve the relatively rapid selection secured by the systems of the said second class.

Briefly, in the particular system shown, I secure the advantage aimed at by arranging the multiple contacts of a one hundred line group of calling lines in sub-groups before the wipers of the line selectors and provide as many sets of wipers as there are sub-groups of terminals. All such sets of wipers are normally in inoperative condition. For each set of wipers, a relay is provided which is common to that sub-group of lines with whose terminals its associated wipers are adapted to make contact. When a line of a particular sub-group initiates a call, the relay assigned to that sub-group of lines will energize and operatively connect the proper wiper contacts of the line selector with the other mechanism so as to render them "live" or effective to select a line from their sub-group, while the wipers of the line selector for the other sub-groups remain "dead" or disabled.

Thus assuming that the one hundred lines of a calling group are divided into five sub-groups of twenty lines each and the multiple terminals of the lines of each sub-group occupy approximately one-fifth of the circumference of a circular contact bank at

each line selector; there will then be five sets of wipers preferably rotatably mounted at the center of the bank and normally extending at angles of seventy-two degrees to positions between the different groups of contact sets. To operate and restore such a switch to a normal point, it will only be necessary for the wipers to be rotated through an arc of seventy-two degrees so that they respectively occupy adjacent between-group positions. By rendering one set of wipers "live" by the operation of its associated relay, and rotating a shaft to which all the wipers are attached, the set of wipers rendered "live" will at some point in their rotation engage the multiple contacts of the calling line and the mechanism will be stopped, the calling line being thus selected. When the selector is to be restored to normal, rotation is again set up in the original direction and when the wipers reach the next between-group position, the mechanism will be automatically stopped. To enable the use of a switch of this character, the terminals of the circuits of the line selector are common strips and the multiple terminals of the line are placed adjacent to them, the wipers of the selector being insulated one from the other and crossing a common to successive contact terminals as the switch is operated.

Referring to the drawing, Figure 1, comprising parts 1, 2, 3 and 4, illustrates diagrammatically circuits embodying one application of the invention; Figs. 2 and 3 are, respectively, plan and side views of a line selector, the latter view being partly in section; Figs. 4 and 5 are like views of a long and short step selector; and Fig. 6 shows in section a detail of the connection between the driving pawl of the selector and its actuating part.

At C in Fig. 1, I show a subscriber's station connected by its telephone line with a suitable line circuit arrangement at the exchange. At D is shown a master-switch circuit; at E a line selector circuit; at F a controlling circuit for effecting the switching operation of the first selector shown at H, the second selector shown at I, and the connector shown at K; C' indicates a second subscriber's station similar to that illustrated at C and assumed for purposes of description to be the called substation.

A calling line group will comprise one hundred telephone lines with arrangements like that indicated for substation C. They will be divided into five groups of twenty lines each. The mechanism illustrated in parts 1 and 2 of Fig. 1 includes apparatus pertaining to five different groups of lines. The reference characters *a*, *b*, *c*, *d* and *e* are employed alone and in conjunction with reference numbers for the apparatuses individual to the first, second, third, fourth and fifth groups, respectively. The line of sub-

station C is assumed to be in the sub-group of lines *a*. Each of the twenty lines of such sub-group will have its individual line relay LR^a and a cut-off relay CO. Common to the *a* sub-group, is provided a group relay 17^a, connected to a common wire 16^a having twenty branches, one of which will extend to each of the twenty line relays of the sub-group. The master-switch D is common to the entire group of one hundred lines and to the ten line selectors E of the line group. Said master-switch may be of the usual rotary switch construction including a step-by-step magnet M adapted to drive the four sets of wipers 43, 44, 45, 46, having their opposite ends insulated from each other, rotarily over their respectively associated common strips and stationary contact points. The master-switch controls mechanism for starting an idle line selector under the influence of a group relay 17 when such a relay is operated by the line relay of a calling line. Each line selector E is provided with five starting contacts at the master-switch D, namely, a contact 32, a contact 34, a contact 36, a contact 38, and a contact 40 for the *a*, *b*, *c*, *d* and *e* groups, respectively. Connected with the respective contacts mentioned, each line selector E has a starting relay, one for each sub-group, those for line selector E at Fig. 1 being indicated by reference characters R^a, R^b, R^c, R^d and R^e. The wires *a*, *b*, *c*, *d*, *e*, controlled by the armatures 18 of the different relays 17, lead to the segments 31, 33, 35, 37, 39, respectively, with which the contacts 32, 34, etc., already described, are adapted to be crossed by the wipers 43, 44, etc., when the latter are rotated. The normal position of the wipers is one wherein they engage contact sets 32, 34, etc., connected to an idle line selector E. Thus when a line of any of the five sub-groups initiates a call, the group relay 17 of that line group will be operated and its armature 18, assuming the calling line is of the *a* group, will close a circuit over the wire *a*, over some wire *a'* connected to an idle line selector, and through the relay R^a of that line selector, whose armatures will thereupon effect connections to render the wiper set for the *a* line group "live" to select any unselected calling line out of that group. The relay R^a also initiates the selective travel of its line selector which automatically continues till it connects with a calling line. If on the other hand, a line of some other sub-group, say, sub-group *d*, initiates a call, the group relay 17^d of that line group will be operated and will complete a circuit by its armature 18 over the wires *d*, *d'*, which will operate the R^d relay of the idle line selector and that line selector will start in search of a line of the *d* sub-group, the appropriate wiper set for that sub-group having been rendered "live." After one of the relays R at E has

been energized and travel of the line selector has been initiated in search of a calling line in a particular sub-group, no other relay R of that line selector can be operated. If another call is initiated before the first calling line has been selected, the second line must wait until the selection of a first has been effected, whereafter the master-switch D will start its travel, and when it has selected contacts of an idle line selector E, the group relay 17 of the other sub-group will be effective to operate the relay R of the appropriate group at the idle line selector selected by the master-switch D.

The line selector E may comprise mechanically four sets of wiper contacts indicated at 57, 59, 61 and *on*. Each set of wipers preferably comprises five contact members insulated one from the other and extending at angles of seventy-two degrees. All the wiper members may be mounted on a single rotary shaft, which shaft may carry a ratchet adapted to be driven step by step by the motor magnet MM. No return movement to a normal point of this switch is required, the restoration being effected by further driving of the switch parts in the initial direction of travel. Each of the one hundred lines of the line group is provided with a multiple contact set at each of its ten associated line selectors. Each such set will include a primary line contact, a secondary line contact, and a private or local line contact. At 70^a, are indicated the multiple primary line contacts of the *a* sub-group. Although but three such contact sets are shown, it will be understood that the primary segment 58^a, associated with the contacts 70^a, will have, adapted to be crossed to it by the wipers 57, twenty such primary line contacts 70^a, one for each line of the *a* sub-group. 70^b, 70^c, 70^d and 70^e indicate the multiple primary line contacts of the sub-groups *b*, *c*, *d*, *e*, three in each case representing twenty, as in the case of the contacts 70^a. 71^a, 71^b, 71^c, 71^d and 71^e indicate secondary line contacts of the *a* to *e* groups respectively, three representing twenty as before. 72^a, 72^b, 72^c, 72^d and 72^e represent the local or private multiple contacts of the *a*, *b*, *c*, *d*, *e*, etc. sub-groups respectively. It will be seen that for each group of primary line contacts, a contact segment 58^a, 58^b, 58^c, 58^d or 58^e is provided which form the terminals of the conductor of the line selector, the wipers being merely devices to cross the segments to their respective contacts as the wipers are rotated. A corresponding arrangement is provided for the secondary line contacts 71 and the local contacts 72. It will be observed that the off-normal *on* wipers serve, when the switch is operated, to merely close three "make" off-normal contacts which will be broken as soon as the switch is rotated through an arc of seventy-two degrees

to a normal point, and to break an off-normal contact 73°—74° which will be again closed when normal is reached. Associated with the primary wiper set 57, each sub-group of lines has multiplied to each line selector a primary "break" off-normal contact PO^a to PO^c, the connection of two of these alone being shown in full. Further, each sub-group of lines has multiplied to each line selector a local off-normal "break" contact EO^a to LO^c, respectively, the two whose reference characters are mentioned alone being indicated with their connections.

The circuit connection at F for controlling the adjustments of the directly operated switches includes a pair of conductors to which are bridged the primary relay PR and the secondary relay SR, respectively, having the serially connected batteries A and B connected between them, said batteries being grounded at their intermediate point. A release relay RR is provided, jointly controlled by the relays PR and SR, a reversing relay RV, and a release control relay 94 for cooperating in the restoration of the mechanism.

The remaining connections concerned in the control of the line selectors E to select calling lines will best be understood from the following narrative of operation.

Assuming that the calling subscriber C wishes to start a call, the removal of his receiver, by allowing the hook-lever 1 to rise, establishes a conductive bridge between the two limbs of his telephone line which results in the passing of current through line relay LR^a individual to the line C, the connection from the opposite sides of battery through the relay and to the line limbs being traced through normal contacts 10 and 11. By armature 7, the relay LR^a locks itself and operatively short-circuits line limbs p, s, whereby magnet 3, energized by the initial current flow over the line, deenergizes instantly, calling device 4 being then locked until magnet 3 re-operates, when the line selector selects the calling line. By armature 8, relay LR^a ungrounds local wire L and closes ground to its branch of the common wire 16^a, whereby the relay 17^a is energized. It being assumed that master-switch D is in the position shown, engaging the contacts of the line selector whose circuit is illustrated at E, the attraction of armature 18 completes a circuit as follows: from ground at F (Fig. 1, part 2), through normal contact 90, over the wire 54 individual to line selector E (the contacts 42 being individual to the respective line selectors), through wiper 46 to segment 41, thence through contact 18, over wire a, contact 23, segment 31, wiper 43, contact 32 of line selector E, wire a', relay R^a to battery, energizing said relay, whose armature contacts immediately assume their alternate positions. On the closure of contact 3^a, a circuit

is closed for primary relay PR at F, extending from battery A, over the wire P², contact 84—85, wire P', contact 3^a, segment 58^a, primary off-normal contact PO^a, wire 55^a, closed contact 19 to ground. Current over this path instantly operates relay PR, whose armature 97 in turn energizes the release relay RR over a circuit extending from ground through contact 97 of relay PR, off-normal contact 73^a, 74^a and the winding of release relay RR to the live pole of battery B¹. On the energization of relay RR, the busy or test relay BR has an initial energizing circuit closed as follows: from battery, through said relay BR, alternate contact 91, the busy off-normal contact BO, thence up through wire L', contact 1^a of relay R^a, the local off-normal contact LO^a, wire 56^a, and through closed contact 20 to ground. The relay BR attracts its armatures, whereof 80 closes an alternating current circuit for motor magnet MM, which immediately begins stepping the wipers 57, 59, 61 and on step by step in a clockwise direction. By armature 81, the relay BR has connected its winding, through contact 1^a, with the segment 62^a of the a sub-group of lines. It will be observed that the individual local contact sets 72^a of non-calling lines are grounded over the respective wires L_i via normal contacts 8 at the line relays. Until the segment 62^a is, with the travel of a wiper 61, connected to the individual local contact 72^a of a calling line whose line relay LR^a will then have ungrounded the contacts 72^a, the relay BR will continue energized by current flowing through the segment 62^a, a wiper 61 and via successive engaged contacts 72^a of non-calling lines of the a sub-group to ground, whereby the armatures of relay BR will continue attracted and successive alternations will flow through magnet MM, causing its armature to be successively vibrated, so driving the wipers of the line selector E. It will be observed that the first step of the wipers will open the busy off-normal contact BO so that the relay BR thereafter depends for current upon the encountered local contacts 72^a. In the present case, the contact set of the calling line C is indicated as being the first set in the a sub-group so that, after the completion of one step, the segment 62^a will be crossed to an ungrounded local contact 72^a, whereupon the relay BR will deenergize and circuit connections result as follows: The relay PR, which, during the energization of relay BR, was maintained energized in series with the relay SR by circuit traced through alternate contacts 82 and 84, has its circuit extended on the retraction of armature 85 as follows: over wire P', through contact 3^a, segment 58^a, contact 70^a of the line of C, over wire P, contact 9, cut-off relay CO to ground, whereby the relay CO energizes and, by ar-

mature 10, extends the circuit of relay PR over line limb *p* to substation C, through normal contact 6, transmitter 2, upper contacts 1, magnet 3, normal contact 3, thence
 5 through limb *x* and the now closed alternate contact 11, over wire S, contact 71^a of line C, wiper 59, segment 60^a, contact 2^a, wire S', normal contact 83, wire S², relay SR, to battery B. These shiftings of the
 10 circuit of relay PR are effected without the relay being deenergized to permit the retraction of its armature, whereby the relay RR remains operated. The energization of relay CO further deenergizes line relay LR^a
 15 by opening its circuit at contacts 10 and 11. By the closure of alternate contact 12, the relay CO is maintained energized and its initial operating circuit is opened at contact 9, circuit being traced from ground through
 20 relay CO, alternate contact 12, local wire L, contact 72^a, wiper 61, segment 62^a, contact 1^a, normal contact 81, and to battery A¹.

By virtue of the circuits then traced, it will be seen that the relays PR and SR are
 25 now connected over a clean circuit with the limbs of the substation C, and the operative conditions of said relays can be controlled by the subscriber operating the calling device 4 in a manner presently to be described.
 30 Before proceeding with this, however, the manner in which the master-switch D is caused to step along to select the contact set of an idle-line selector E will be described. As soon as relay CO energized on the selection
 35 of the calling line, the operating relay 27 of master-switch D was energized by current flowing from the active side of the associated battery A², through the wiper 45, segment 45', the contact 51' (each line selector E having a contact 51' associated
 40 with segment 45'), over wire 51, the off-normal contact 74—73, closed on the first step of line selector E, wire 88, alternate contact 93, to the left through normal contact 81, contact 1^a, segment 62^a, contact 72^a,
 45 over wire L, and alternate contact 12 to ground through relay CO. On the energization of relay 27, master-switch magnet M has its generator circuit closed and drives the wipers of switch D step by step. Merely
 50 to allow a better spacing of contacts 32, 34, 36, etc., the contacts 51' are interspaced with permanently grounded contact points. The first step of the wipers of switch D
 55 will therefore continue the circuit closed through the upper winding of relay 27, since segment 45' will be crossed to a grounded contact, and a second actuation of magnet M and a second step of the wipers
 60 will be produced, whereupon the respective wipers will cross their respective segments to the contacts of the next line selector E which will have circuits identical with that shown at Fig. 1. If this is an already busy
 65 line selector, its contact 51' will be grounded

over its respective wire 51, through the cut-off relay CO of the line with which said line selector is in engagement and circuit will be continued closed through the upper winding of relay 27, and a further stepping of
 70 master-switch D will ensue. When the segment 45' is crossed to a contact 51' pertaining to an idle line selector E, such contact will be ungrounded because the wire 51 will be open at segment 74; the relay 27 will be
 75 deenergized and its armatures retracted, armature 28 preventing further actuations of magnet M. As long as relay 27 is operated, relay 22 is also operated and its armatures thus hold wires *a*, *b*, *c*, *d* on open circuit
 80 while the master-switch is rotating. Armature 30 of relay 27 similarly holds wire *e* open during the time mentioned. As soon as another idle line selector E has been selected as described, any other line having
 85 its circuit closed by the removal of its receiver will operate the group relay 17 of its sub-group and cause an impulse to flow over the appropriate starting wire and to the circuit of the line selector waiting to be
 90 started.

From the time that relay RR energized, the operated relay R^a is energized over a locking circuit extending through its armature 4^a, to ground through contact 89—90,
 95 said relay R^a remaining energized until the time of disconnection. It will be seen that instantly upon the operation of a relay 17 and the corresponding relay R at E, the ground is taken from the wire 54 by the
 100 opening of normal contact at 90, the energizations of relays PR and RR following instantly upon that of the operated relay R. As normal contact at 90 remains open from this time until the time of disconnection,
 105 the energization of the relay R of any other sub-group of lines is effectively prevented so that two wiper segments at the same line selector cannot simultaneously be rendered
 110 "live" by the calling of lines in different sub-groups. It will also be seen that the relays 17, except the last relay 17^c, have their connections to the operating battery B³ led through series contacts controlled by
 115 one another, so that but one of said relays can be maintained energized at one time. Thus if, during the time a started selector is operating, or the time the master-switch D is traveling to pick out contacts of an
 120 idle line selector, subscribers from two different groups initiate calls, but one relay 17 will thereby be held energized and this will prevent effectively the cutting "live" of the wiper contacts for two sub-groups at the
 125 moment when the master-switch selects the idle line selector. In such cases it will be seen that the groups *e*, *d*, *c*, *b*, *a*, have preferential calls in the order named upon the line selector with which the master-switch D
 130 makes connection.

The line selecting scheme above outlined may be used to connect any sort of central office link-circuit with a calling line and the invention is in this respect not limited to purely automatic telephone systems.

In the case of the present automatic system, the substation at C may comprise the usual call-bell and talking circuit connections, the arrangement illustrated being of a well-known type and requiring no specific description. The impedance coil 3 in the present case is provided with an armature controlling a pawl normally locking the dial 4 of the calling device, said pawl being adapted, on energization of coil 3, to be withdrawn from the dial to so render the device rotatable by hand. At the time line relay LR* first operated, a momentary current impulse flowed through the coil 3, and the dial was momentarily unlocked. As soon as relay LR completed its energization, however, battery was taken from the line limbs of substation C by the shunt at armature 7 and remained absent therefrom until the completed operation of line selector E when the relays PR and SR were bridged across the line as before described. At this time, the magnet 3 became energized, and the calling device 4 was unlocked to remain so until the time of disconnection.

The dial 4 is for rotation by hand in a clockwise direction, whereby a number of insulating teeth, corresponding to the units of a digit of the called number, may be brought below the spring 6. The dial, being then released, is returned to zero by its associated spring. Each time a tooth of dial 4 passes over contact 6, contact 6' is closed and thereafter contact 6 is opened. As a passing tooth frees contact 6, contact 6' will be closed and thereafter contact 6' will be opened. Thus each time contact 6 is opened, whereby a deenergization of relay PR will be effected, the relay SR will be maintained energized, since the limb *s* is grounded before contact 6 is opened over a connection traced through contact 5, coil 3, upper contacts at 1, transmitter 2, and to ground through contact 6'; and since the metallic circuit of the line is, with each vibration of contact 6, reestablished before said contact is opened, the relay PR will be successively deenergized and energized as dial 4 returns to normal, while relay SR remains operated. After the last tooth of dial 4 passes above contact 6, the tooth at the extreme left of dial 4 will actuate spring 5 in such a manner that contact 5' will be closed, whereby a maintaining circuit for relay PR is continued, whereafter, contact 5 being opened, relay SR will be deenergized until the tooth passes over the end of spring 5 when the dial will be at normal and will stop. When the tooth passes over contact 5, said contact, by its tension, reestablishes its

normal connection and thereafter opens contact 5'. Thus, by successive actuations of dial 4, the subscriber is enabled to count out the number of the called telephone, each actuation of the dial effecting deenergizations of relay PR, corresponding in number to the units of a called number digit, relay SR remaining operated, whereafter each time a deenergization of relay SR will occur while relay PR remains operated.

Let it now be assumed that the called subscriber's number is 1113-3. The subscriber C in such case will first actuate dial 4 until one tooth passes below spring 6 and will release the dial. This causes first a single deenergization of relay PR and thereafter a deenergization of relay SR and thereby impulses are transmitted to adjust the first selector H to select the first group of terminals of second selectors, those assigned for connection to the first thousands, whereafter the first selector automatically selects a terminal set of an idle second selector from the group.

A first selector H includes three sets of wipers 125, 132 and 139. A switching magnet SWM' drives these clockwise by virtue of an armature actuated pawl operating upon a ratchet wheel fastened to a rotary shaft supporting said wipers. Each actuation of magnet SWM' will cause a long step of the wipers so that each passes over an entire segment 124, 131, 138, respectively. Although but five segments are in Fig. 1 shown associated with each wiper, there will in practice be ten such segments, one for each group of second selector terminals. Although but three multiple terminals of second selectors are shown associated with each segment, there will, where ten per cent. trunking is provided, be ten terminals for each segment. The normal positions of the wiper contact are between the ninth and tenth groups of terminals. Contacts 126, 134, 140 are, respectively, the private and talking contact sets of second selectors for the first thousand; 127, 135, 141 are like contacts for the second thousand; 128, 136, 142 contacts for the third thousand, and so on for the other groups. It will be understood that each contact set is multiplied at other first selectors H and has connections to a second selector I, with circuits like that shown in Fig. 1. For the clearness in the circuit illustration, I have shown each wiper 125, 132 and 139 twice. It will be observed from the lower portion of the circuit H that each wiper is provided at each between-group position with a pair of contacts which are closed when the wiper is in any between-group position, and opened when the wiper first leaves such position. These are, of course group off-normal "break" contacts. In addition to the mechanism described, the first selector comprises merely a single off-

normal "make" contact ON' which, by a simple mechanical arrangement hereafter described, is closed when the wipers leave their position between the ninth and tenth groups, and is opened when they have completed a circle of revolution and again reach said position. It will be seen that to select the group of second selector terminals 126, 134, 140, the group for the first thousand, one long step for the wipers 125, 132 and 139 is required, whereafter short step travel will be initiated, each step causing the wipers to engage a different contact set 126, 134, 140 until an idle set is reached.

On the deenergization of relay PR before referred to, an impulse of current flows from ground through contacts 99, 98, 119, magnet SWM' to battery B^s. Said magnet momentarily energizes and effects a long step of the wipers up to, but not engaging, the first contact set of the first group. A portion of the current transmitted passed through release relay RR' which, by armature 111, locks over wire 107 and contacts 106, 92, to ground, the relay RR' now remaining operated until the time of disconnection. After relay PR energizes, relay SR is momentarily deenergized and a current impulse flows from ground, through contacts 97, normal contact 100, contacts 123, 113, contacts 146, via wiper 132, alternate contact 110, stop magnet STM', busy relay BR', to battery B^s. Magnet STM' and relay BR' simultaneously energize, the former throwing in a stop to limit the stroke of the armature of magnet SWM', while the latter, by armature 115, extends the circuit of itself and magnet STM' to the segments 124. Armature 116 completes a generator circuit for the short step winding of magnet SWM' which receives current alternations to energize and deenergize it, whereby it is effective to step the wipers 125, 132, 139 over the multiple contact sets of the first group in search of an idle set. Since busy contact sets will have their contacts 126 grounded, relay BR' will have its circuit continued closed by means of current flowing to ground through successive busy contacts encountered by wiper 125 until the idle set is reached. When wipers 125, 132, 139 engage the third contact set 126, 134, 140, that of second selector I, assumed to be that of the first idle second selector, the circuit of relay BR' and of the magnet STM' will be deprived of ground and they will deenergize, the opening of contact 116 preventing further actuations of magnet SWM'. It will be observed that the original energizing circuit of relay BR' is opened on the first step of the wipers, since wiper 132 will then disengage the contact pair 146 between the tenth and first groups. It is to be noted that the locking relay LOR' would be energized by a portion of the impulse operating

the relay BR', flowing through contacts 113, 112, and said relay LOR' in battery, were it not for the fact that the winding of said last-mentioned relay is at first short-circuited by a connection traced through a contact set 147 and wiper 139. When the first short step of the wipers begins, the wiper 139 opens contact at 147, removing the short-circuit from relay LOR', which instantly energizes, locking itself by armature 121 to ground over wire 107. By armature 123, said relay instantly opens the path of the current impulse transmitted by relay SR. Since relay LOR' is energized at the time relay BR' deenergizes on the selection of an idle contact set, a ground connection may be traced from armature 120, via normal contact 115, the segment 124, wiper 125 to the engaged contact 126 of second selector I, whereby said selector will be held busy.

In connection with the operation of selector H, it will be observed that the segments 131, 138, forming part of the talking circuit, are normally open at alternate contacts 119, 122, so that, while the selector is making its long step or steps, no interference, due to battery potential, will be caused upon already existing conversational circuits with which connection may be made. It will be further noted that upon the initiation of secondary travel to select contacts from a group, the relay BR' first energizes, placing segments 131, 138 on open circuit at contacts 114, 117, and that only after this occurs can the relay LOR' be operated to close the alternate contacts 119, 123. Thus the circuit of the selector of the present invention provides means for positively preventing interference with existing conversational circuits with which the conductors of the selector may be connected in its operation without depending in any way upon close time relations between the operation of relays or upon relative adjustments of relay armature mechanisms.

If the called number were in another thousand, say, the third, instead of the first, the operation of first selector H would be like that just described, except that a number of long steps of the wipers corresponding to the units of the thousands digit would be made before the short step travel was started.

To select the hundreds of the called number, the calling subscriber C again operates his dial 4 until one tooth is brought below spring 6 and releases it, whereby, as before, relay PR is momentarily deenergized and thereafter relay SR. In the present case, the deenergization of relay PR transmits a current impulse from ground, through contact 99, normal contact 98, alternate contact 119, contact 114, the segment 131 for the contacts 134, wiper 132, engaged contact 134, normal contact 219, winding of switch

magnet SWM^2 of second selector I, operating the magnet and causing a long step of the wipers, a part of the impulse flowing through relay RR^2 which, by armature 211, looks through contact 126, wiper 125, segment 124, normal contact 115 and closed contact 120 to ground. When thereafter relay SR is deenergized, the impulse transmitted will be from ground, through contact 97, normal contact 100, alternate contact 123, contact 117, a segment 138, wiper 139, engaged contact 140, normal contact 223, contact 213, the contact pair 246 engaged by wiper 232, alternate contact 210, stop magnet STM^2 , busy relay BR^2 to battery. The circuits of second selector I are like those of first selector H, with the exception that a contact 216^a is added for reasons hereafter explained. Like parts at I have reference numbers corresponding as to their tens and units values with those of like parts of first selector H and the corresponding electromagnets are designated by reference letters having the exponent 2 instead of the exponent 1, used with the electromagnets designated by reference letters in circuit H. The operation of the second selector proceeds upon the reception of the impulses transmitted by relays PR and SR in a manner entirely like the operation of first selector H already described, and need not be referred to in detail. It is assumed that the wipers of the second selector I will select the contact set 226, 234, 240, connected to wires 250, 251, 252, extending to the idle connector K, which of course is one of those assigned to lines of the first hundred of the first thousand, or lines numbered 1100 to 1199 inclusive. The relay LOR^2 serves to extend the talking conductors to the circuits of the connector K and to operatively connect the ground at contact 220 to the normal contact of armature 215, whereby the busy ground is placed on the private contacts 226 of the selected connector.

Mechanically considered, the construction of the connector K is like that of the first and second selectors. The contacts of a called line group of one hundred lines, which a connector serves, are multiplied at each of ten connectors such as K, in ten groups of ten contact sets each, although in the drawing but five groups of three contact sets each are shown. As in the case of the selectors, the normal position of the wipers is between the ninth and tenth contact groups. Long steps of said wipers are effected to select the tens value of the called number, each such step moving them over an entire group of contacts. The switching magnet of the connector is indicated at SWM^3 and the stop magnet at STM^3 . After sufficient steps of the wipers have been caused to select the group wanted, the stop magnet is energized to throw the stop and further

actuations of the switching magnet are then effected to move the wipers by short steps to select the individual multiple terminals of the called line out of the selected group.

The calling subscriber C now operates his calling device to again cause one deenergization of relay PR, followed by one of relay SR. A current impulse will flow on the deenergization of relay PR from ground, through contact 99, normal contact 98, alternate contact 119, contacts 114, 131—132—134, alternate contact 219, contacts 214, 231—232—234, wire 251, normal contact 272, magnet SWM^2 , actuating said magnet and moving the wipers 289, 291, 293 one long step in a clockwise direction to a position between the tenth and first contact groups, the wipers then being adjacent to the group of contact sets 13', 15', 14', containing contacts of lines numbered 1111 to 1119, followed by those of line 1110, zero being ten impulses. A portion of the impulse transmitted over wire 251 flows through locking relay LOR^2 to battery, energizing said relay, which by armature 254 locks itself over the wire 250 to ground at contact 220, which is the ground rendering the connector busy. Then the deenergization of relay SR transmits an impulse of current from ground through contact 97, normal contact 100, alternate contact 123, contacts 117, 138—139—140, alternate contact 223, contacts 217, 238—239—240, over wire 252, through the now closed contact 255, contact 261 and the relay 258 to battery, operating said relay. Its armature 259 energizes the locking relay LOR^3 , which by armature 262 locks to ground at off-normal contact ON^3 , shifted when the wipers left their normal positions. As soon as the impulse over wire 252 ceases, the relay 258 has the circuit of its locking armature 260 opened and becomes deenergized. It will be seen that said relay cannot be re-operated by a later flow of current over wire 252, since the direct connection of its winding with said wire has been opened at contact 261.

To transmit the fourth digit of the called number, the calling subscriber now moves three teeth of dial 4 below spring 6 and releases said dial, whereby three deenergizations of relay PR are caused, followed by one of relay SR. Each deenergization of relay PR transmits a current impulse from ground over a before traced path to wire 251. Each impulse will traverse the upper winding of switching magnet SWM^3 , causing the energization thereof. Each such energization will now, however, effect a short step only of the switch wipers, since, on the energization of relay LOR^3 , its armature 265 energized the stop magnet STM^3 by current flowing through normal contact at 267 and test relay TR to ground. Three short

steps of the wipers of connector K will accordingly be made and they will rest engaging the contacts 13', 15', 14', connected with called line C', or line number 1113.

5 Thereafter a deenergization of relay SR transmits a current impulse over the before traced path through wire 252, thence through contact 255, normal contact 260, contact 263, locking relay LOR¹ to battery, energizing said relay which, by armature 10 273, locks to ground through alternate contact 254 and contact ON³.

In conjunction with connector K, I have shown an automatic switch U for selecting 15 one of a plurality of call generators G arranged to deliver current of varying frequencies to selectively ring any known type of harmonic substation bells, thus rendering the system available for selective party line 20 service. The fifth digit of a called number designates the generator to be selected. But one substation C' is shown connected to the called line, but three other substations are indicated by their branch connections, which 25 other stations may be like C' in arrangement, except that they will have bells tuned to different frequencies. It will be assumed that the substation C' is provided with a bell tuned to respond to the frequency of 30 generator G³, so that three steps of the wiper 294 will be required to select the proper generator. The switch U may mechanically comprise the wiper 294 with the four associated contacts 295. The wiper 294 may be 35 mounted upon the customary rotary shaft having a ratchet adapted to be driven in the well known manner by an armature-actuated pawl of motor magnet MM³. The customary retaining pawl is provided to engage the 40 ratchet as it is driven and hold the same against back movement under the influence of the usual restoring spring. A release magnet RM³ is adapted to withdraw the retaining pawl when it is energized, whereby 45 shaft, ratchet and wiper will be automatically spring restored to normal. The off-normal contacts ON⁴ and ON⁵ of switch U are shifted to engage their opposed contacts whenever the switch wiper is moved from 50 normal and are restored to their open circuit relation shown when the wiper is thereafter restored to normal.

The calling subscriber C will now operate his dial 4 until three teeth are below 55 spring 6 and release said dial, whereby three deenergizations of relay PR are effected, followed by one of relay SR. Each deenergization of relay PR transmits a current impulse over a before traced path to 60 wire 251. The impulse thence flows through alternate contact 272, normal contact 270, motor magnet MM³ to battery B⁶, causing three actuations of said magnet and three steps of wiper 294 to engage the 65 contact of the generator G³. Thereafter a cur-

rent impulse is transmitted over a before traced path to wire 252, flowing thence through contact 255, normal contact 260, contacts 263, ON⁴, and test control relay TCR to battery, which relay, by armature 70 268, locks to ground through alternate contact 253 and contact ON³.

It will be seen that test relay TR has been maintained energized in series with stop magnet STM³ from the time relay LOR³ 75 first operated, so that alternate contact 276 of relay TR is now closed. The attraction of armature 267 closes alternate contact at that point and then opens the normal contact so that relay TR, while still energized, 80 is connected over a circuit traced through alternate contacts 267, 276, with ring 288 and via wiper 289 to the private contact 13' of the called line. If said line is idle, the contact 13' will, as shown, be connected to 85 ground only through cut-off relay CO. Thus when the called line is idle, both terminals of test relay TR are connected to points of like potential and said relay becomes deenergized, armature 276 then connecting battery A⁶ with the cut-off relay CO 90 of the called line so that said relay energizes and destroys the normal battery connections of said line. Furthermore, the retracted armature 277 closes a circuit as follows: from 95 ground through constantly operating interrupter I⁶, generator relay GR, alternate contact 269, normal contact 277, normal contact 285 to battery. Generator relay GR now alternately energizes and deenergizes, 100 including and excluding generator G³ with and from the called line C', periodically ringing the tuned bell at the called substation, the ringing circuit being traced from ground, through generator G³, contact 295— 105 294, alternate contact 287, contact 292—293—14', alternate contact 11, limb s, contact 5 at C', the substation condenser, the lower switch-hook contacts at 1, the call-bell, contact 6, limb p, the alternate contact 10, contact 110 15'—291—290, alternate contact 286 to ground.

When the subscriber at C' answers the call by removing his receiver and when relay 115 GR is deenergized, a circuit will be completed as follows to supply the substation transmitter with talking battery and for the other purposes hereafter mentioned: from battery A³, the upper winding of answering relay AR, contacts 271, 275, normal 120 contact 286, over the before traced circuit through limb s of the called line, contact 5, impedance 3, upper switch-hook contacts 1, transmitter 2, contact 6, limb p, thence 125 through normal contact 287, contact 279, contact 274, to the left over wire 252, through the circuits at I and H, alternate contact 100, reversing relay RV, to battery B⁴, whereby relay AR energizes and, by armature 130 282, connects its lower winding in cir-

cuit with the called line, so that battery is fed to said line through the two windings of said relay. Armature 280 operates ringing control relay RCR which locks by armature 284 to ground through alternate contact 253 and contact ON³. The opening at contact 285 interrupts the circuit for interrupter I⁸ so that relay GR remains inert and generator is excluded from the called line.

Relay RV at F was energized by the flow of current last traced through the called substation. On its operation, its armatures 101 and 102 reverse the connections of battery A and B of the calling line, such reversal being capable of being used in connection with any of the polarized auxiliary service devices of the art. Armature 103 operated the relay 94, which, by armature 105, locked to ground through off-normal contacts 75 and 76 at the line selector. Its armature 106 opened the connection extending from wire 107 to ground at contact 92, but said wire still remains grounded through alternate contact 104, closed before the opening of contact 106. By the opening of contact 106, the control of the ground upon wire 107 is rendered possible by relay RV for release purposes hereafter explained.

The two subscribers C and C' are now in conversation, the talking circuit thus established being traced over the heavily marked conductors from substation C to substation C', the condensers 95 and 96 being connected in the circuit at F.

When the subscribers finish their conversation, they replace their receivers. In case the called subscriber C' does so first, selectors H, I and K will all restore to normal, while line selector E will remain in connection with the calling line to be restored by the calling subscriber.

Thus when subscriber C' replaces his receiver, he opens the conductive circuit at his substation, and answering relay AR is deprived of current and also reversing relay RV at F. Upon the deenergization of the latter, ground is removed from the wire 107 at contact 104, since relay 94 remains energized; relays RR' and LOR' at H now have their locking circuits opened. Upon the deenergization of relay RR', normal contact 110 is closed and the circuit is completed from battery B⁵ in series through relay BR' and stop magnet STM', normal contact 110, contact ON' to ground. The stop is accordingly thrown in limiting position and armature 116 closes a generator circuit for the right winding of switch magnet SWM' and said magnet receives generator actuations, stepping the wipers 125, 132, 139 by short steps in the original direction of rotation until they complete a circle to the normal point, when contact ON' is opened, deenergizing relay BR' and magnet STM', and the wipers accordingly come to rest.

As soon as relay LOR' allows armature 120 to retract, ground is removed from the private contact 126 at I, deenergizing relays LOR² and RR². On the deenergization of the latter, a series circuit is established, energizing relay BR² and magnet STM², traced through off-normal contact ON² to ground. Second selector I accordingly restores in a manner similar to that of first selector H. During the restoration, the contact 216⁴ is closed, holding ground upon the multiple contacts 126 in order that second selector I may continue busy until it is finally freed for further use, when it reaches normal. Relay AR is of course now deenergized and, upon the retraction of armature 220 at I, the locking circuit of relay LOR⁵ is opened and said relay is deenergized. Thereupon a circuit may be traced from generator, through the lower winding of magnet SWM⁵, normal contact 257, alternate contact 277, normal contact 269 (test control relay TCR having had its locking circuit opened by the retraction of armature 253), through contact 264 to ground. Since test control relay TCR is deenergized, the series circuit including test relay TR and stop magnet STM⁵ has been reestablished so that the stop is thrown in its stroke-limiting position and magnet SWM⁵ causes short steps of wipers 289, 291, 293, until they complete a circle of rotation when contact ON⁵ is open, deenergizing relay LOR⁵, whereby the circuits of magnets STM⁵, SWM⁵ and of relay TR are opened. At this time the connector will be at normal, since upon the deenergization of relay LOR⁵, relay RCR had its circuit opened. During restoration, the multiple contacts 226 are grounded at ON⁵ since normal contact 253 is closed.

Upon the deenergization of locking relay LOR⁵ before described, the closure of contact 256 to ground operated release magnet RM⁵ of generator switch U, circuit being traced through contact ON⁵. Said magnet withdraws the retaining pawl of switch U and the wipers restore to normal, at which time off-normal contacts ON⁴ and ON⁵ are opened.

When now the calling subscriber replaces his receiver, relays PR and SR deenergize and circuit is opened through release relay RR. Circuit will then be traced as follows: from battery, through busy relay BR of line selector E, normal contact 91, contacts 77-78, and an off-normal wiper to ground. Relay BR energizes and remains operated until the wipers of line selector E are stepped to their normal positions adjacent to that from which they moved when the switch was first operated, since armature 80 remains attracted until a wiper ON passes free of contact 77-78, when the deenergization of said relay allows the wipers to come to rest.

During the restoring process, relays PR

and SR are energized, being re-operated on closure of contacts 82 and 84, but release relay RR is not reenergized because contacts 73^a, 74^a, are opened and so remain until the line selector reaches normal. It will be seen that on the deenergization of relay RR, the relay R^a at E is deenergized by the opening of contact 89—90. Said relay remains deenergized and if, when line selector E reaches normal, relay RR should momentarily reenergize upon the closure of contact 73^a—74^a, no harm will be done, as relay BR cannot be again energized, since contact 1^a at relay R^a is open.

15 If subscriber C were to replace his receiver in advance of subscriber C', line selector E would restore as just described. On the deenergization of release relay RR, ground is removed from the wire 107, and in consequence of this, first selector H and second selector I restore to normal in the manner before described. Connector K, however, is not restored until subscriber C' replaces his receiver, for the reason that the relay AR remains operated until the called subscriber replaces his receiver, and its armature 281 maintains the ground upon wire 250, whereby locking relay LOR^s remains locked. The circuits of connector K thereafter remain in their previous condition until the called subscriber C' replaces his receiver, when the deenergization of relay AR is effective to produce circuit changes, resulting in the restoration to normal, as before described.

Let it now be assumed that at the time test control relay TCR was energized as before described to connect relay TR with the test terminal 13' of the called line, said line was busy. In such case, the contact 13' will have battery connected to it either through a normal contact 276 of some other connector already engaging another set of multiple terminals of said called line, or in case said line has been selected as a calling line by a line selector E, battery will be connected to the engaged multiple contact 13' over a circuit traceable (referring to Fig. 1, parts 1 and 2) via alternate contact 12 of the called line, local wire L, engaged contact 72—62 of the sub-group to which the called line may belong, a closed contact of the relay R of the called line sub-group, the wire L', normal contact 81 to battery A¹. In either of these cases, the relay TR of the testing connector K will have its terminals connected via alternate contact 267 to points of different potential and said relay will remain energized, whereby the busy signaling circuit of interrupter I^a will be connected via alternate contact 266 and alternate contact 278 with wire 252 and the lower talking conductor, the busy signal being transmitted over said lower talking conductor to limb s of the calling line and will be heard in the receiver of

the called subscriber, the return circuit being traceable over limb p, over the upper talking conductor and through relay PR to ground. In this case, generator relay GR remains inert, since alternate contact 277 remains closed, and both terminals of said relay are therefore connected to ground. The calling subscriber, hearing the busy signal, replaces his receiver and line selector E, first selector H and second selector I restore in the manner before described. In the present case, connector K also restores to normal, since no circuit has been established for answering relay AR and wire 250 depends for its ground entirely upon second selector I. When in the release of second selector I, said wire 250 is ungrounded, locking relay LOR^s deenergizes and the opening of alternate contact 253 deprives relays LOR^r and TCR of current, whereupon they become inert, the opening of alternate contact 267 establishing a series circuit for test relay TR and stop magnet STM^s. The generator circuit for the lower winding of switching magnet SVM^s is now completed as before, whereby the wipers of connector K are restored to normal in the manner before described. On the deenergization of relay LOR^s, the before described circuit for release magnet RM^s of generator switch U is completed and the said switch is restored. In connection with first selector H and second selector I, I have provided means whereby, if all the ten contact sets of a selected group are busy, the wipers of said selectors will automatically pass over the entire group and a circuit connection will be established whereby a busy signal will be transmitted to the calling subscriber. Thus, in connection with first selector H, assume that all the contact sets 126, 134, 140 are busy. Obviously, relay BR' would, with the stepping of wiper 125, have its circuit continued closed until the wipers pass over the entire group of contact sets. As soon as they make their eleventh step, however, to the between-group position, wiper 125 will be on open circuit and relay BR' will be deenergized, allowing the wipers to stop. At this time the wiper 125 will be crossing the contacts 145 between the first and second groups and the busy signal will be transmitted to the calling telephone from interrupter I', via alternate contact 122, contact 125—145, normal contact 117, and alternate contact 123, and over the lower talking conductor to limb s, returning over limb p, through relay PR to ground. The calling subscriber, hearing the busy signal, will thereupon replace his receiver and the operated selectors will be restored to normal in a before described manner.

It is to be noted from the consideration of the description of operation of the directly operated switches H, I and K, that but three sets of wiper contacts are required

and a single off-normal contact. In operating switches of this character, the work required of the switch-adjusting magnet is of a rather exacting character, as in making the long steps the magnet's armature is required to move through a considerable arc. For this reason, I have given special attention to producing a circuit in which a minimum number of wiping contacts is required. At the same time I have directed my attention to keeping the number of off-normal contacts at a minimum so as to reduce as far as possible the chances for trouble in that connection.

It will be noted that in the selectors H and I, the busy relay BR and the stop magnet STM are always energized and deenergized at the same times. If desired, the stop mechanism may be actuated by the busy relay BR in each case and the separate magnet for that purpose may be dispensed with. I have, however, illustrated separate magnets for these purposes for the reason that I deem it preferable not to have relay contacts mounted directly upon the selectors.

The contacts 53' for the respective line selectors and their paired first selectors at master-switch D, and the associated wiper contact 45' connected to the lower winding of relay 27, cooperate to hold an operated switch pair EH unselectable at the master-switch until the first selector H is fully restored to normal. Thus each contact 53' is connected by a wire 53 with the contact ON' of its respective first selector, which contact is grounded as long as the first selector is off-normal. The ground upon contact 51' of a switch pair at the master-switch of course holds the switch pair unselectable till the line selector reaches normal. It will thus be seen that until the wiper 45 has its two ends engaging respectively contacts 51', 53' of a switch pair, both of whose switches are at normal, the relay 27 will be maintained operated by current through one or the other winding and the travel of the master-switch D continued.

It will be noted that after the operation of a line relay as LR* when a line starts a call, there is an unguarded interval during which a connector may make connection with the line as a called line. In such case, a talking circuit is established with the line in question and no improper operation is introduced by such an occurrence; a line selector which may have started merely having its travel continued to a normal point. The method in question enables me to reduce complexity that would otherwise exist in the circuits individual to the respective lines.

Preferred forms of mechanisms for use in connection with the circuits will now be referred to. In Figs. 2 and 3, illustrating apparatus for line selector E, the former figure shows a plan view wherein it will be

noted that five groups of twenty contacts each are provided, designated 70^a, 70^b, 70^c, 70^d and 70^e, between the groups of which are the primary off-normal contacts PO^a, PO^b, PO^c, PO^d and PO^e, respectively, the common segments 58^a, 58^b, etc. being mounted in the circular switch bank directly above their respective contacts. The common segment 60 and contacts 71 extend circularly beneath the contacts 70, as indicated in Fig. 3, and the segment 62 and associated contacts 72 extend circularly beneath the contacts 71. The off-normal contact segments 75, 76, are indicated in Fig. 3 directly beneath the contact 72 and it will be understood that the off-normal segments associated with the wipers ON at E occupy the indicated arcs in the contact bank horizontal with the contacts 75, 76, of Fig. 3. The arrangements of the local off-normal contacts LO^a to LO^e, indicated in Fig. 1, will be associated with contacts 62, 72, in a manner corresponding to that in which the contacts PO^a to PO^e are associated with contacts 70^a and 58^a in Fig. 2.

The contact bank as a whole is built up of a circular base plate 307 and a ring 308 between which the contacts are insulatingly mounted, as shown in the sectional view comprising the left part of Fig. 3, the contacts and their insulation being securely clamped between the elements 307 and 308. A bridge 304 is bolted to the bank and to said bridge, and to the base plate 307, the rotary wiper carrying shaft 305 is journaled. To said shaft, is attached a hub, carrying the arm 306 upon which the adjustable wiper contacts 57, 59, 61 and on are insulatingly mounted. A second hub, carrying the ratchet wheel 302, is also fastened to shaft 305, and upon one side of the bank the motor magnet MM is mounted; whose armature 301 actuates pawl 300 to drive the ratchet 302, shaft 305, and wiper support 306 rotarily step by step when the magnet MM is actuated.

Referring to the long and short step switch mechanism shown in Figs. 4, 5 and 6, the circular bank is in this case built up in a manner quite similar to that of the previously described mechanisms, the contacts being mounted between a base plate 361 and a ring 360. Fig. 4, showing the top view, shows ten groups of contact groups 126, 127, 128, etc., and the between-group contacts 145. These various contacts have the circuit connections shown at H. As indicated in Fig. 5, the segments 124, 131 and 138 are mounted in different levels in the bank, and the individual contacts associated with each of the segments will be placed immediately below them respectively, while the various between-group contacts 145, 146, 147 will be placed in the same levels with the common strips adapt-

ed to be engaged by the respective wipers 125, 132, 139.

A bridge 358 is bolted to the switch bank at 372, 373. Upon this bridge are secured 5 the two electromagnets comprising the switch magnet SWM', each magnet being provided with a core with a pole-piece of the shape indicated at 359 in Fig. 4 at its lower end. Between these pole-pieces, the 10 centrally pivoted armature 350 is adapted to rock, said armature having at its opposite ends forwardly extending finger members approaching the pole-pieces, but adapted to clear the same when attracted, whereby a 15 strong initial pull is secured while providing a large range of actuation. The armature, as shown in Fig. 5, is preferably laminated and is rigidly fastened to a shaft 364 which is journaled below to the bridge 358 20 and above to a stud 368 fitting into an orifice in the bridge 367 of magnetic material, screwed to the upper end of the cores of the magnet spools. The armature restoring spring 371 has one end attached to the armature and the other end to the stud 368. The 25 stirrup member 369 embraces the stud 368 above and below the bridge 367. A screw 370 is threaded to the stirrup 369 and, when tightened, clamps the stud 368 between the elements 367 and 369. By loosening the 30 screw 370, the slotted stud 368 may be turned to increase or decrease the tension of the spring 371, and when the proper tension is secured, the tightening of the screw 370 35 will maintain the selected tension of the armature restoring spring. The wiper shaft 362 is journaled below to the circular base plate 361 and above is provided with a bore to receive the reduced end of the armature shaft 364, the said shaft 362 being thus rota- 40 table in its bearings. A hub 363 is screwed to the shaft 362 and said hub supports insulatingly the wipers 125, 132, 139. The ratchet wheel 352 is attached to the wiper shaft 362, adapted to be engaged by the 45 pawl 351, best shown in Fig. 4, pivoted to the arm 380, rigidly attached to the armature shaft 364. A triangular piece 354 is bolted to the switch bank and supports the stop magnet STM', whose armature 357 50 abuts upon a vertically extending lug 355 of the piece 354. Said armature 357, as best shown in Fig. 5, is, when the magnet is inert, beneath the pawl 351 so that when the parts are in this position, each actuation of magnet 55 SWM' will cause the pawl 351 to advance a long step until it engages the adjustable stop screw 356, carried by the piece 354. Each such long thrust of pawl 351 will of course 60 drive ratchet, shaft and wipers a long step, moving the wipers over an entire group of contacts. After the proper group has been selected, the energization of stop magnet STM' attracts armature 357 so that its end 65 is horizontal with, and in the path of, the

pawl 351, whereafter each actuation of magnet SWM' can drive the ratchet, shaft and wipers a short step only so that the wipers move from one contact set to the next one 70 adjacent. The pawl 353, pivotally mounted upon piece 354, serves to prevent the ratchet from being jarred to retrogress when the arm 380 is retracted. Said pawl 353 has upon it a pin which projects to engaging 75 relation with the backward extending arm of piece 380. By this arrangement, pawl 353 also serves, in case a partial short step of the wipers is accidentally caused, to restore the wipers to the previous exact operating posi- 80 tion. Thus if a partial short step is produced, the pawl 353 will not be engaging the adjacent tooth of the ratchet 352 and, when the arm 380 is retracted, it will impact upon the pin of pawl 353 and jam said pawl to fill the engaged tooth of the ratchet, 85 whereby the shaft will be drawn slightly backward to one of its operative positions. The off-normal contact ON' is normally held open by a stud 366, mounted upon ratchet wheel 352. Obviously, on the first clockwise 90 step of said wheel, stud 366 frees spring ON' which then engages its alternate contact and, when a complete revolution of wheel 352 has been completed, said stud again engages the spring and the contact ON' is opened. In 95 Fig. 6, a sectional detail view shows the manner in which the pawl 351 is mounted pivotally upon the arm 380, a spiral spring being provided to press the pawl 351 constantly inward toward the ratchet wheel 352. 100

For convenience, the mechanisms illustrated in Figs. 3, 4 and 5 have been supplied, so far as like parts are present, with reference characters corresponding to those of 105 first selector H of Fig. 1. The same switch mechanism may be employed for the second selectors F and for the connectors K.

It will be seen that I have throughout the illustrations employed common strips, each with a group of associated adjacently dis- 110 posed individual contact terminals, with wipers having in themselves no circuit connections, but which serve, when they are operated, to cross common strips to suc- 115 cessive contacts. It is to be noted that a common strip and a wiper, in switches of this character, may be used for a wiper having a conductor permanently connected to it, or 120 connected to it by a brush bearing upon a conducting element in circuit with the wiper. Thus where a term such as "wiper contact" 125 is used in the claims, it is used in the sense of a contact at the end of a conductor, adapted to be interchangeably connected with different terminal contacts, and is used 130 without reference to whether the contact in question is a movable wiper member in itself, or is a brush or common strip contact adapted to be connected interchangeably with different contacts by means of a wiper.

I have followed the usual practice of showing battery symbols where convenient. Those symbols, which have like poles indicated as grounded, represent batteries of the indicated polarities having the same number of cells or of the same potential. They may be and preferably are a single source of current. Thus the various symbols A may be one source and the symbols B another source.

It will be obvious that the invention described in this specification and pointed out in the claims may be modified and applied in various systems without departing from my invention, which is accordingly not to be limited in these respects.

I claim as my invention:—

1. A selective mechanism for automatic exchanges including terminals arranged in groups, traveling contact means, one for each group common to its group, electromagnets, one for each group, said electromagnets being adapted to be selectively energized, and each controlling a switch contact connected to the contact means of its respective group.

2. A selector for automatic exchanges including terminal contacts arranged in groups, wiper contacts, one for each of said groups, electromagnets for said selector, one for each group, and circuit means for operating the magnet of a group to render the respective wiper contact "live" or operative.

3. A selector for automatic exchanges including terminal contacts arranged in groups, wiper contacts, one for each of said groups, electromagnets for said selector, one for each group, circuit means for operating the magnet of a group to render the respective wiper contact "live" or operative, and means for preventing more than one of said magnets being energized at one time.

4. A telephone system including a selector having terminal contacts arranged in groups, wiper contacts, one for each of said groups, electromagnets for said selector, one for each group, a telephone line, and means controllable by current thereover for operating the magnet of a group to alter the operative relation of the wiper contact of said group.

5. A telephone system including a selector having terminal contacts arranged in groups, wiper contacts, one for each of said groups, electromagnets for said selector, one for each group, a telephone line, means controllable by current thereover for operating the magnet of a group to alter the operative relation of the wiper contact of said magnet, and means for preventing another magnet being operated after one is operated.

6. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for se-

lecting said terminals having a wiper contact for each said group, magnets for said switch, one for each group of lines, and means responsive to current over a line to energize the magnet of a particular group whereby the wiper contact of that group has its circuit relation altered.

7. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having a wiper contact for each said group, magnets for said switch, one for each group of lines, means responsive to current over a line to energize the magnet of a particular group whereby the wiper contact of that group has its circuit relation altered, and means preventing energization of a second magnet after one is operated.

8. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having a wiper contact for each said group, magnets for said switch, one for each group of lines, means responsive to current over a line to energize the magnet of a particular group, and circuit connections controlled by said magnet for operatively extending the connections of the wiper contact of the respective group.

9. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having a wiper contact for each said group, magnets for said switch, one for each group of lines, means responsive to current over a line to energize the magnet of a particular group, circuit connections controlled by said magnet for operatively extending the connections of the wiper contact of the respective group, and means preventing energization of a second magnet after one is operated.

10. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having wiper contacts one for each said group, electromagnets for said switch, one for each said group, a group relay for each said group of lines adapted for operation responsive to current over any line of its group, and a connection normally extending from each said group relay to the electromagnet of the respective group, whereby operation of a group relay will energize the corresponding magnet to render operative the wiper contact of its group.

11. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in correspond-

ing groups, a selective switch for selecting said terminals having wiper contacts one for each said group, electromagnets for said switch, one for each said group, a group relay for each said group of lines adapted for operation responsive to current over any line of its group, a connection normally extending from each said group relay to the electromagnet of the respective group, whereby operation of a group relay will energize the corresponding magnet to render operative the wiper contact of its group, and means for continuing energized a magnet once operated independent of the electrical condition of the group relay initially operating it.

12. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having wiper contacts one for each said group, electromagnets for said switch, one for each said group, a group relay for each said group of lines adapted for operation responsive to current over any line of its group, a connection normally extending from each said group relay to the electromagnet of the respective group, whereby operation of a group relay will energize the corresponding magnet to render operative the wiper contact of its group, and master-switch mechanism connected in said connections and controlling their continuity.

13. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having wiper contacts, one for each said group, electromagnets for said switch, one for each said group, a group relay for each said group of lines adapted for operation responsive to current over any line of its group, a connection normally extending from each said group relay to the electromagnet of the respective group, whereby operation of a group relay will energize the corresponding magnet to render operative the wiper contact of its group, means for continuing energized a magnet once operated independent of the electrical condition of the group relay initially operating it, and master-switch mechanism connected in said connections and controlling their continuity.

14. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having wiper contacts, one for each said group, electromagnets for said switch, one for each said group, a group relay for each said group of lines adapted for operation responsive to current over any line of its group, a connection normally extending from each said group relay to the electromagnet of the respective group,

whereby operation of a group relay will energize the corresponding magnet to render operative the wiper contact of its group, and switching means effective on operation of any magnet to alter the circuit relations of said connections to render the operation of any group relay thereafter ineffective to energize its corresponding magnet.

15. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having wiper contacts, one for each said group, electromagnets for said switch, one for each said group, a group relay for each said group of lines adapted for operation responsive to current over any line of its group, a connection normally extending from each said group relay to the electromagnet of the respective group, a conductor common to said group relays and normally adapted on energization of any one of them to be connected to the respective connection to cause energization of the corresponding magnet, and switching means effective on operation of any magnet to alter the electrical condition of said conductor to prevent the energization of a second magnet when a second relay is energized.

16. A selective mechanism for automatic exchanges including terminals arranged in groups, contact means, one for each group common to its group, electromagnets, one for each group, said electromagnets being adapted to be selectively energized, and each controlling a switch contact connected to the contact means of its respective group, a switch adjusting magnet for said mechanism adapted for actuation to cause said mechanism to select a terminal upon energization of any magnet.

17. A selective mechanism for automatic exchanges including terminals arranged in groups, contact means, one for each group common to its group, electromagnets, one for each group, said electromagnets being adapted to be selectively energized, and each controlling a switch contact connected to the contact means of its respective group, a switch adjusting magnet for said mechanism adapted for actuations to cause said mechanism to select a terminal, a busy or test relay for controlling the actuations of said magnet, and a circuit for initially energizing said relay effective on energization of any electromagnet.

18. A selector for automatic exchanges including terminal contacts arranged in groups, wiper contacts, one for each of said groups, electromagnets for said selector, one for each group, circuit means for operating the magnet of a group to render the respective wiper contact "live" or operative, and a switch adjusting magnet for said selector adapted for actuation to cause said selector

to select a terminal upon energization of any of said electromagnets.

19. A selector for automatic exchanges including terminal contacts arranged in groups, wiper contacts, one for each of said groups, electromagnets for said selector, one for each group, circuit means for operating the magnet of a group to render the respective wiper contact "live" or operative, means for preventing more than one of said magnets being energized at one time, a switch adjusting magnet for said selector adapted for actuations to cause said selector to select a terminal, a busy or test relay for controlling the actuations of said magnet, a circuit for initially operating said relay effective on energization of any electromagnet, and circuit connections for maintaining said relay energized dependent on the electrical conditions of terminal contacts encountered by said selector in its adjustment.

20. A telephone system including a selector having terminal contacts arranged in groups, wiper contacts, one for each of said groups, electromagnets for said selector, one for each group, a telephone line, means controllable by current thereover for operating the magnet of a group to alter the operative relation of the wiper contact of said magnet, means for preventing another magnet being operated after one is operated, a switch adjusting magnet for said selector, a busy or test relay for controlling actuations of said magnet, means for initially operating said relay and connections for maintaining said relay energized until said magnet adjusts the selector to connection with said telephone line.

21. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having a wiper contact for each said group, relays for said switch, one for each group of lines, means responsive to current over a line to energize the relay of a particular group whereby the wiper contact of that group has its circuit relation altered, a switch controlling magnet adapted to control connection of said wiper contact to successive terminals, and means for stopping said switch when said wiper contact is connected with a terminal of a calling line.

22. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having wiper contacts one for each said group, electromagnets for said switch, one for each said group, a group relay for each said group of lines adapted for operation responsive to current over any line of its group, a connection normally extending from each said group relay

to the electromagnet of the respective group, whereby operation of a group relay will energize the corresponding magnet to render operative the wiper contact of its group, apparatus for causing travel of said selective switch to connect said wiper contact to successive multiple terminals, and means for stopping said switch when said contact is connected to the terminal of a calling line.

23. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having wiper contacts one for each said group, electromagnets for said switch, one for each said group, a group relay for each said group of lines adapted for operation responsive to current over any line of its group, a connection normally extending from each said group relay to the electromagnet of the respective group, whereby operation of a group relay will energize the corresponding magnet to render operative the wiper contact of its group, apparatus for causing travel of said selective switch to connect said wiper contact to successive multiple terminals, and means controlled by the electrical condition of multiple terminals connected with said wiper contact for stopping said switch.

24. A telephone system including telephone lines, multiple terminals therefor arranged in groups whereby said lines are in corresponding groups, a selective switch for selecting said terminals having wiper contacts, one for each said group, electromagnets for said switch, one for each said group, a group relay for each said group of lines adapted for operation responsive to current over any line of its group, a connection normally extending from each said group relay to the electromagnet of the respective group, a conductor common to said group relays and normally adapted on energization of any one of them to be connected to the respective connection to cause energization of the corresponding magnet, switching means effective on operation of any magnet to alter the electrical condition of said conductor to prevent the energization of a second magnet when a second relay is energized, apparatus for causing travel of said selective switch to connect said wiper contact to successive multiple terminals, and means controlled by the electrical condition of multiple terminals connected with said wiper contact for stopping said switch.

25. A telephone system including telephone lines, line selectors, multiple terminals of said lines at said selectors arranged in groups whereby said lines are divided into groups, a line relay for each line for controlling the electrical condition of its line's terminals, a wiper contact for each said group of terminals at said selectors, relays

at each said selectors, one for each wiper contact and its associated terminal group, and a common means controlled by the line relays of each line group for energizing the relay of the group at a line selector to render the associated wiper contact operative.

26. A telephone system including telephone lines, line selectors, multiple terminals for said lines at said selectors arranged in groups whereby said lines are divided into groups, a line relay for each line for controlling the electrical condition of its line's terminals, a wiper contact for each said group of terminals at said selectors, relays at each said selector, one for each wiper contact and its associated terminal group, a common means controlled by the line relays of each line group for energizing the relay of the group at a line selector to render the associated wiper contact operative, and master-switch mechanism for interchangeably operatively associating the different line selectors and their relays with the common means of the different line groups.

27. A telephone system including telephone lines, line selectors, multiple terminals for said lines at said selectors arranged in groups whereby said lines are divided into groups, a line relay for each line for controlling the electrical condition of its line's terminals, a wiper contact for each said group of terminals at said selectors, relays at each said selector, one for each wiper contact and its associated terminal group, a common means controlled by the line relays of each line group for energizing the relay of the group at a line selector to render the associated wiper contact operative, and means for causing travel of a line selector having one of its relays operated to select a calling line of the group whose relay is operated.

28. A telephone system including telephone lines, line selectors, multiple terminals for said lines at said selectors arranged in groups whereby said lines are divided into groups, a line relay for each line for controlling the electrical condition of its line's terminals, a wiper contact for each said group of terminals at said selectors, relays at each said selector, one for each wiper contact and its associated terminal group, a common means controlled by the line relays of each line group for energizing the relay of the group at a line selector to render the associated wiper contact operative, means for causing a line selector having a relay operated to seek out terminals of a line whose line relay is energized, and master-switch mechanism for interchangeably operatively associating the different line selectors and their relays with the common means of the different line groups.

29. A telephone system including telephone lines, line selectors, multiple terminals

for said lines at said selectors arranged in groups whereby said lines are divided into groups, a line relay for each line for controlling the electrical condition of its line's terminals, a wiper contact for each said group of terminals at said selectors, relays at each said selectors, one for each wiper contact and its associated terminal group, a common means controlled by the line relays of each line group for energizing the relay of the group at a line selector to render the associated wiper contact operative, apparatus for holding the operated relay energized independently of said common means, means for causing travel of a line selector having one of its relays operated to select a calling line of the group whose relay is operated, and master-switch mechanism for interchangeably operatively associating the different line selectors and their relays with the common means of the different line groups.

30. A telephone system including telephone lines, line selectors, multiple terminals for said lines at said selectors arranged in groups, whereby said lines are divided into groups, a line relay for each line for controlling the electrical condition of its line's terminals, a wiper contact for each said group of terminals at said selectors, relays at each said selector, one for each wiper contact and its associated terminal group, a common means controlled by the line relays of each line group for energizing the relay of the group at a line selector to render the associated wiper contact operative, means for causing travel of a line selector having one of its relays operated to select a calling line of the group whose relay is operated, and directly operable electrically controlled selectors adapted to be connected with said telephone lines responsive to the operations of the line selectors.

31. A telephone system including telephone lines, line selectors, multiple terminals for said lines at said selectors arranged in groups, whereby said lines are divided into groups, a line relay for each line for controlling the electrical condition of its line's terminals, a wiper contact for each said group of terminals at said selectors, relays at each said selector, one for each wiper contact and its associated terminal group, a common means controlled by the line relays of each line group for energizing the relay of the group at a line selector to render the associated wiper contact operative, master-switch mechanism for interchangeably operatively associating the different line selectors and their relays with the common means of the different line groups, means for causing a line selector having a relay operated to seek out terminals of a line whose line relay is energized, and directly operable electrically controlled selector

adapted to be connected with said telephone lines responsive to the operations of the line selectors.

32. A telephone system including telephone lines divided into groups, line selectors and multiple terminals of said lines at said selectors arranged in corresponding groups, a wiper contact for each group of lines at each selector, an electromagnet for each group of lines at each selector, each magnet serving when energized to render "live" the wiper contact of its line group at its selector, a master-switch mechanism common to said selectors and lines having wiper contacts, one for each group of lines, common conductors, one for each group of lines and connected to the wiper contact for that group at said mechanism, a contact for each said electromagnet at said master-switch mechanism, and selective apparatus controlling said mechanism to cause it to normally rest connecting said common conductors, respectively, with the electromagnets of their groups at an idle line selector.

33. A telephone system including telephone lines divided into groups, line selectors and multiple terminals of said lines at said selectors arranged in corresponding groups, a wiper contact for each group of lines at each selector, an electromagnet for each group of lines at each selector, each magnet serving when energized to render "live" the wiper contact of its line group at its selector, a master-switch mechanism common to said selectors and lines having wiper contacts, one for each group of lines, common conductors, one for each group of lines and connected to the wiper contact for that group at said mechanism, a contact for each said electromagnet at said master-switch mechanism, selective apparatus controlling said mechanism to cause it to normally rest connecting said common conductors, respectively, with the electromagnets of their groups at an idle line selector, and means whereby the initiation of a call over any line of a group will change the electrical connection of the common conductor of that group, to cause energization of the electromagnet of that group at the idle line selector.

34. A telephone system including telephone lines divided into groups, line selectors and multiple terminals of said lines at said selectors arranged in corresponding groups, a wiper contact for each group of lines at each selector, an electromagnet for each group of lines at each selector, each magnet serving when energized to render "live" the wiper contact of its line group at its selector, a master-switch mechanism common to said selectors and lines having wiper contacts, one for each group of lines, common conductors, one for each group of lines and connected to the wiper contact for that group at said mechanism, a contact for

each said electromagnet at said master-switch mechanism, selective apparatus controlling said mechanism to cause it to normally rest connecting said common conductors, respectively, with the electromagnets of their groups at an idle line selector, means whereby the initiation of a call over any line of a group will change the electrical connection of the common conductor of that group, to cause energization of the electromagnet of that group at the idle line selector, means whereby the initiation of a call over a line renders its terminals at the line selectors selectable, and adjusting mechanism for each line selector operating upon the energization of one of its electromagnets to cause said selector to seek out selectable terminals.

35. A directly operable selector for electrical exchanges adapted for primary adjustment, and thereafter for secondary adjustment, a wiper contact for said selector and a talking conductor connected therewith, a normally closed contact in said conductor, a normally open contact in said conductor, means for primarily adjusting said selector while said conductor remains in its normal condition, and means for secondarily adjusting said selector while said normally open contact is closed and said normally closed contact is open.

36. A directly operable selector for electrical exchanges adapted for primary adjustment, and thereafter for secondary adjustment, a wiper contact for said selector and a talking conductor connected therewith, a normally closed contact in said conductor, a normally open contact in said conductor, means for primarily adjusting said selector while said conductor remains in its normal condition, means for secondarily adjusting said selector while said normally open contact is closed and said normally closed contact is open, and means for restoring said selector to normal while both said contacts are open.

37. A selector for automatic exchanges including a conductor adapted to be traversed by voice currents and provided with a terminal, an electromagnet controlling a normally open contact in said conductor, a second electromagnet controlling a normally closed contact in said conductor, electrically controlled primary adjusting mechanism adapted to alter the connections of the terminal of said conductor while said magnets are inert, and means for energizing said second electromagnet to open said normally closed contact and thereon initiate secondary travel of said selector.

38. A selector for automatic exchanges including a conductor adapted to be traversed by voice currents and provided with a terminal, an electromagnet controlling a normally open contact in said conductor, a second electromagnet controlling a normally

closed contact in said conductor, electrically controlled primary adjusting mechanism adapted to alter the connections of the terminal of said conductor while said magnets are inert, means for energizing said second electromagnet to open said normally closed contact and thereon initiate secondary travel of said selector, a source of current, connections from the opposite poles of said source to the ends of the winding of said first electromagnet existing when said secondary travel is initiated said winding having then a short-circuiting connection, and a contact in said connection opened after initiation of the secondary travel whereby said winding receives current to cause its energization.

39. A selector for automatic exchanges including a primary impulse wire and a secondary impulse wire, said wires being adapted to be traversed by the voice currents, rotary wiper members for said selector for altering the connections of said wires, contacts for engagement by said wipers arranged in groups, means for transmitting impulses over said primary wire to cause travel of said wipers by long steps to select a group, each such step moving them over an entire contact group to the next, means for transmitting an impulse over said secondary wire to thereafter cause short step travel of the wipers from contact to contact of the selected group, a normally open contact and a normally closed contact in each said wire, an electromagnet adapted to be operated by the impulse over said secondary wire to open said normally closed contacts and thereafter initiate the short step travel, a second electromagnet adapted to be operated to close said normally open contacts, and means controlled by a wiper member in making its first short step to cause energization of said second electromagnet.

40. A selector for automatic exchanges including a primary impulse wire and a secondary impulse wire, said wires being adapted to be traversed by the voice currents, rotary wiper members for said selector for altering the connections of said wires, contacts for engagement by said wipers arranged in groups, means for transmitting impulses over said primary wire to cause travel of said wipers by long steps to select a group, each such step moving them over an entire contact group to the next, means for transmitting an impulse over said secondary wire to thereafter cause short step travel of the wipers from contact to contact of the selected group, a normally open contact and a normally closed contact in each said wire, an electromagnet adapted to be operated by the impulse over said secondary wire to open said normally closed contacts and thereafter initiate the short step travel, a second electromagnet adapted to be operated to close said normally open contacts

and connected with said secondary impulse wire, a short-circuit about the winding of said second magnet, and a contact in said short-circuit opened by a wiper member in making the first short step, whereby said winding receives energizing current.

41. A connector for electrical exchanges including an adjustable wiper contact, an electromagnet having an armature controlling adjustment of said contact, a second electromagnet having a stop member adapted to limit the stroke of said armature, a test relay for said connector arranged for initial operation in series with said second magnet, a test wiper, a test control relay, and contact means controlled thereby for opening said series circuit and connecting said test relay to said wiper.

42. A connector for electrical exchanges including an adjustable wiper contact, an electromagnet having an armature controlling adjustment of said contact, a second electromagnet having a stop member adapted to limit the stroke of said armature, a test relay for said connector arranged for initial operation in series with said second magnet, a test wiper, a test control relay, contact means controlled thereby for opening said series circuit and connecting said test relay to said wiper, and a circuit for locking said test control relay.

43. A connector for electrical exchanges including an answering relay adapted to be energized when a subscriber responds, talking conductors for said connector, a pair of windings for said relay normally disconnected from said conductors, an auxiliary relay for operation to connect one of said windings with a conductor, and a switch contact of said answering relay for operation to connect the other winding with said other conductor.

44. A connector for electrical exchanges including an answering relay adapted to be energized when a subscriber responds, talking conductors for said connector, a pair of windings for said relay normally disconnected from said conductors, an auxiliary relay for operation to connect one of said windings with a conductor, a switch contact of said answering relay for operation to connect the other winding with said other conductor, a release circuit for said connector adapted to be controlled from one point, and switching means controlled by said answering relay for shifting the control of said release circuit.

45. A directly operable selector for electrical exchanges adapted for primary adjustment, and thereafter for secondary adjustment, a wiper contact for said selector and a talking conductor connected therewith, a normally closed contact in said conductor, a normally open contact in said conductor, means for primarily adjusting said

selector while said conductor remains in its normal condition, means for secondarily adjusting said selector while said normally open contact is closed and said normally closed contact is open, and means for restoring said selector to normal while said normally open contact is open.

46. A directly operable selector for electrical exchanges adapted for primary adjustment, and thereafter for secondary adjustment, a wiper contact for said selector and a talking conductor connected therewith, a normally closed contact in said conductor, a normally open contact in said conductor, means for primarily adjusting said selector while said conductor remains in its normal condition, means for secondarily adjusting said selector while said normally open contact is closed and said normally closed contact is open, and means for restoring said selector to normal while said normally closed contact is open.

47. A selective switch for electrical exchanges and a circuit therefor including private multiple contacts, an off-normal contact for said switch normally connected with said multiple contacts, said contact being grounded when travel of the switch is initiated, means for disconnecting said off-normal contact from said multiple contacts on initiation of travel, and a release controlling relay serving to reconnect said off-normal contact with said multiple contacts when release is begun.

48. A selective switch for electrical exchanges and a circuit therefor including private multiple contacts, an off-normal contact for said switch normally connected with said multiple contacts, said contact being grounded when travel of the switch is initiated, means for disconnecting said off-normal contact from said multiple contacts on initiation of travel, a circuit connection maintaining ground upon said multiple contacts while said off-normal contact is disconnected therefrom, and means for opening said connection, said opening serving to initiate release and cause connection of said off-normal contact with said multiple contacts.

49. A telephone system including a called telephone line, a connector for connection therewith having a talking conductor, an electromagnet through which current may be fed to said talking conductor and so to the connected line for talking purposes, said magnet being normally disconnected from said conductor throughout its length, and automatic means actuated in the operation of said connector to connect said magnet with said conductor.

50. A telephone system including a called telephone line, a connector for connection therewith having a talking conductor, an electromagnet through which current may be fed to said talking conductor and so to

the connected line for talking purposes, said magnet being normally disconnected from said conductor throughout its length, automatic means actuated in the operation of said connector to connect said magnet with said conductor, a second talking conductor for said connector, and a circuit changer for operation subsequent to the connection of said magnet with said first mentioned conductor to connect said magnet also with said second conductor.

51. A selective switch for electrical exchanges having wiper contacts and a pair of talking conductors connected therewith, one normally open contact only for each conductor between its ends, electromagnetic means for closing one of said contacts, and means subsequently operated for closing the other contact.

52. A selective switch for electrical exchanges having wiper contacts and a pair of talking conductors connected therewith, one normally open contact only for each conductor between its ends, means controlled by a calling subscriber for closing one of said contacts, and means adapted to be subsequently operated by a called subscriber for closing the other contact.

53. A selective telephone system having subscribers' lines, selectors and connectors, a circuit composed of talking conductors extending between said lines through a plurality of selectors and a connector, release controlling magnets, one for each of said plurality of selectors and one for said connector, said magnets being energized when their respective selectors and connector are in operated positions, and means under the control of both calling and called subscribers for consecutively deenergizing said magnets to restore their respective selectors and connector.

54. A selective telephone system having subscribers' lines, selectors and connectors, a circuit composed of talking conductors extending between said lines through a plurality of selectors and a connector, release controlling magnets, one for each of said plurality of selectors and one for said connector, said magnets being energized while said circuit continues as described, and means under the control of both calling and called subscribers for deenergizing one of said magnets, its deenergization deenergizing the magnet of an adjacent selector, and the deenergization of the latter deenergizing another magnet and so on.

55. A telephone system including a telephone line extending from a substation to the exchange, a line relay therefor at the exchange adapted for initial energization by current over said line, means for locking said relay on initial operation over a circuit including a portion of said telephone line local to the exchange and for short-circuit-

ing the portion of said line extending to the substation, a calling device, and a locking magnet for said device adapted to be connected in circuit with said line.

5 56. A telephone system including a telephone line extending from a substation to the exchange, a line relay therefor at the exchange adapted for initial energization by current over said line, and a locking armature switch for said relay having a pair of contacts connected to opposite limbs of said line at the exchange over paths of inappreciable resistance, whereby on initial energization said relay connects said contacts to lock itself over portions of said line limbs and to short-circuit those portions of the line limbs external to the exchange, a calling device, and a locking magnet for said device adapted to be connected in circuit with said line.

10 57. A telephone system including a telephone line extending from a substation to the exchange, a line relay therefor at the exchange adapted for initial energization by current over said line, a locking armature switch for said relay having a pair of contacts connected to opposite limbs of said line at the exchange over paths of inappreciable resistance, whereby on initial energization said relay connects said contacts to lock itself over portions of said line limbs and to short-circuit those portions of the line limbs external to the exchange, a cut-off relay for said line having a pair of lever contacts included in said locking circuit and adapted when shifted to extend the limbs of said line, and a third lever contact only for said cut-off relay adapted when shifted to lock said relay.

15 58. A telephone system including telephone lines, selective switches for connecting a calling line with a called line, a control relay, means controlled thereby to reverse the direction of current in the calling line on response made over the called line and when disconnection is desired, to restore a switch to normal.

20 59. A telephone system including telephone lines, selective switches for connecting a calling line with a called line, a relay at the exchange for operation on response over the called line to reverse the direction of current in the calling line, means for deenergizing said relay when disconnection is desired, and a release circuit for a selective switch adapted to be operated responsive to deenergization of said relay.

25 60. A telephone system including telephone lines, line selectors to select said lines, a master-switch for controlling distributive starting of said line selectors, auxiliary selectors paired with said line selectors, a master-switch relay controlling travel thereof, and a pair of windings for said relay, one of said windings being arranged for inclusion in circuits controlled by the line selectors, and the other winding for inclusion in circuits local to said auxiliary selectors.

61. A telephone system including telephone lines, selective switches, a circuit including a plurality of said switches and extending from a calling line to a called line, an answering relay adapted for operation by current over the called line on response thereover, a relay adapted to reverse the direction of current flow in the calling line on response over the called line, and an energizing circuit having branch connections extending through said relays during conversation.

70 62. A telephone system including telephone lines, selective switches, a circuit including a plurality of said switches and extending from a calling line to a called line, an answering relay adapted for operation by current over the called line on response thereover, a relay adapted to reverse the direction of current flow in the calling line on response over the called line, said relays being connected in multiple with a limb of said called line during conversation.

75 63. A selector for electrical exchanges including multiple terminals, an adjustable wiper for said selector, a magnet controlling travel of said wiper to select a particular terminal, a circuit and means for transmitting current thereover to initially energize said magnet to initiate travel of said wiper, an electromagnet having a switch contact in said circuit, said last-mentioned magnet being short-circuited when said current is transmitted, and a wiper controlled contact included in said short-circuit, opened when said travel is initiated whereby said electromagnet energizes to open said switch contact.

80 64. A selector for electrical exchanges including a controlling circuit, means for transmitting current over said circuit to initiate travel of said selector, an electromagnet having a normally closed switch contact in said circuit, a short-circuit extending about said magnet when said current is transmitted, and a wiper contact of said selector in said short-circuit adapted to be opened when said travel is initiated.

85 65. A selector for electrical exchanges including a controlling circuit, means for transmitting current over said circuit to initiate travel of said selector, an electromagnet having a normally closed switch contact in said circuit, a short-circuit extending about said magnet when said current is transmitted, and means including a wiper contact of said selector opened when said travel is initiated to destroy said short-circuit, whereby said magnet energizes and opens said controlling circuit.

90 66. A selector for electrical exchanges including a controlling circuit, means for

transmitting current over said circuit to initiate travel of said selector, an electromagnet having a normally closed switch contact in said circuit, said magnet being connected
 5 to said controlling circuit, a short-circuit extending about said magnet when said current is transmitted, a wiper contact of said selector opened when said travel is initiated to destroy said short-circuit, whereby said magnet energizes by current over said controlling circuit to open said normally closed contact, and a locking circuit for said magnet.

67. A selective switch for electrical exchanges including multiple contact terminals, an adjusting magnet for said switch
 15 to cause the same to contact with different terminals, a controlling circuit for determining the operations of said magnet, a stop for limiting the strokes of said magnet, and
 20 a stop-controlling magnet connected in said controlling circuit and sensitive to the electrical conditions of the said terminals with which said switch contacts.

68. A selector for electrical exchanges including multiple terminals arranged in groups, an adjustable wiper adapted to be connected with said terminals, an adjusting magnet, an armature therefor adapted to drive said wiper by long steps to select the
 30 group, a stop adapted to limit the strokes of said armature whereby said wiper is adjusted by short steps to select a terminal of a selected group, a second magnet adapted to control said stop, and controlling circuit
 35 means for said selector to determine its short step travel, said means including said last-mentioned magnet, said wiper, successively

engaged terminals and a suitable source of current.

69. A selective telephone system having subscribers' lines, selectors and connectors, a circuit composed of talking conductors extending between said lines through a plurality of selectors and a connector, release controlling magnets, one for each of said plurality of selectors and one for said connectors, said magnets being energized when their respective selectors and connector are in operated positions, and means under the control of the called subscriber for consecutively deenergizing said magnets to restore their respective selectors and connectors.

70. A selective telephone system having subscribers' lines, selectors and connectors, a circuit composed of talking conductors extending between said lines through a plurality of selectors and a connector, release controlling magnets, one for each of said plurality of selectors and one for said connector, said magnets being energized while said circuit continues as described, and means under the control of the called subscriber for deenergizing one of said magnets, its deenergization deenergizing a magnet of an adjacent selector, and the deenergization of the latter deenergizing another magnet and so on.

In witness whereof, I hereunto subscribe my name this 3rd day of March, 1909.

HARRY G. WEBSTER.

Witnesses:

THOMAS H. FERGUSON,
 CAROLYN WEBER.