Oct. 20, 1925. 1,557,993

A. H. DYSON

AUTOMATIC TELEPHONE EXCHANGE SYSTEM

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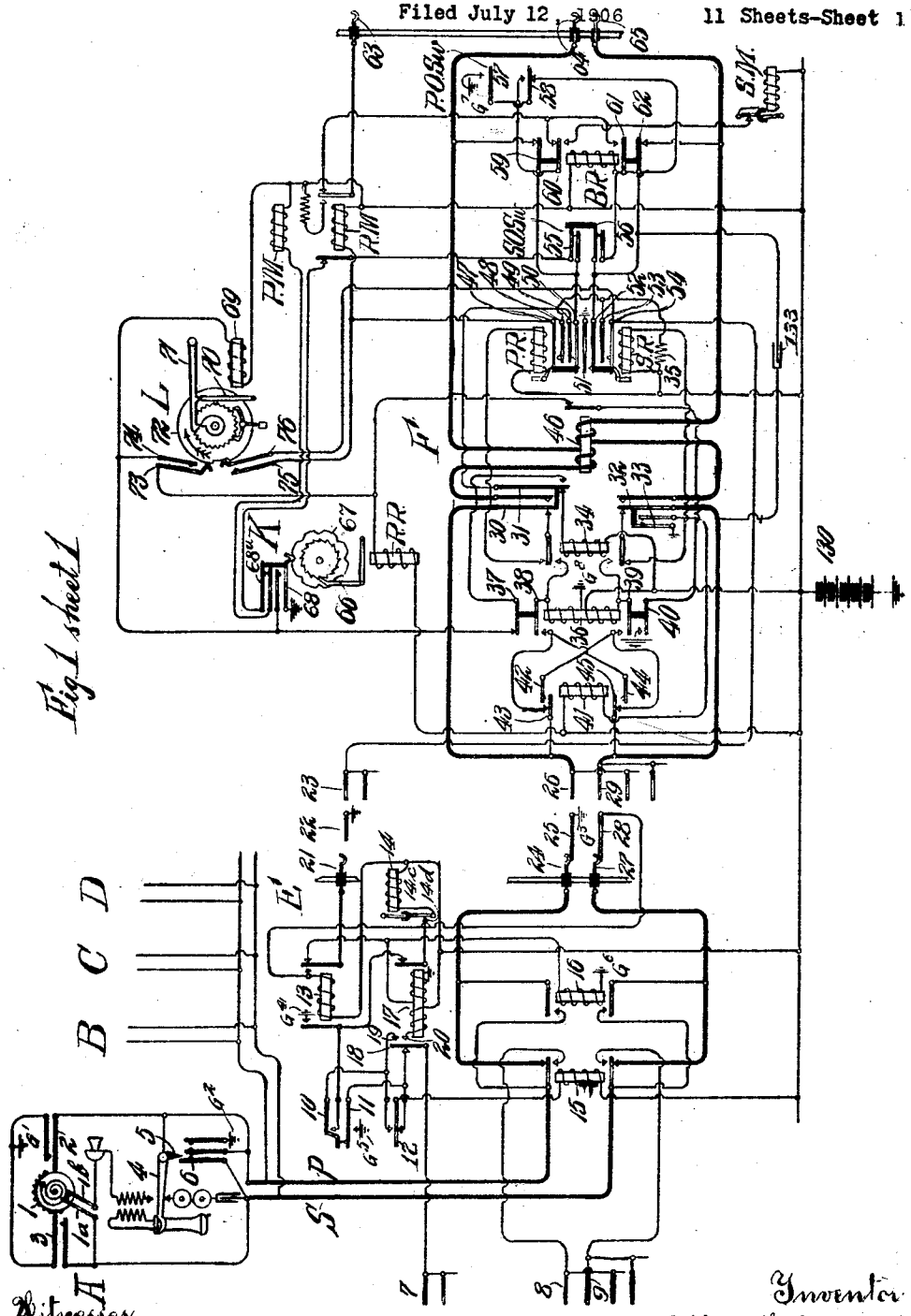

Fig 1 sheet 1

Witnesses
Geo. E. Mueller.
R. Webster

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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed July 12, 1906 11 Sheets-Sheet 2

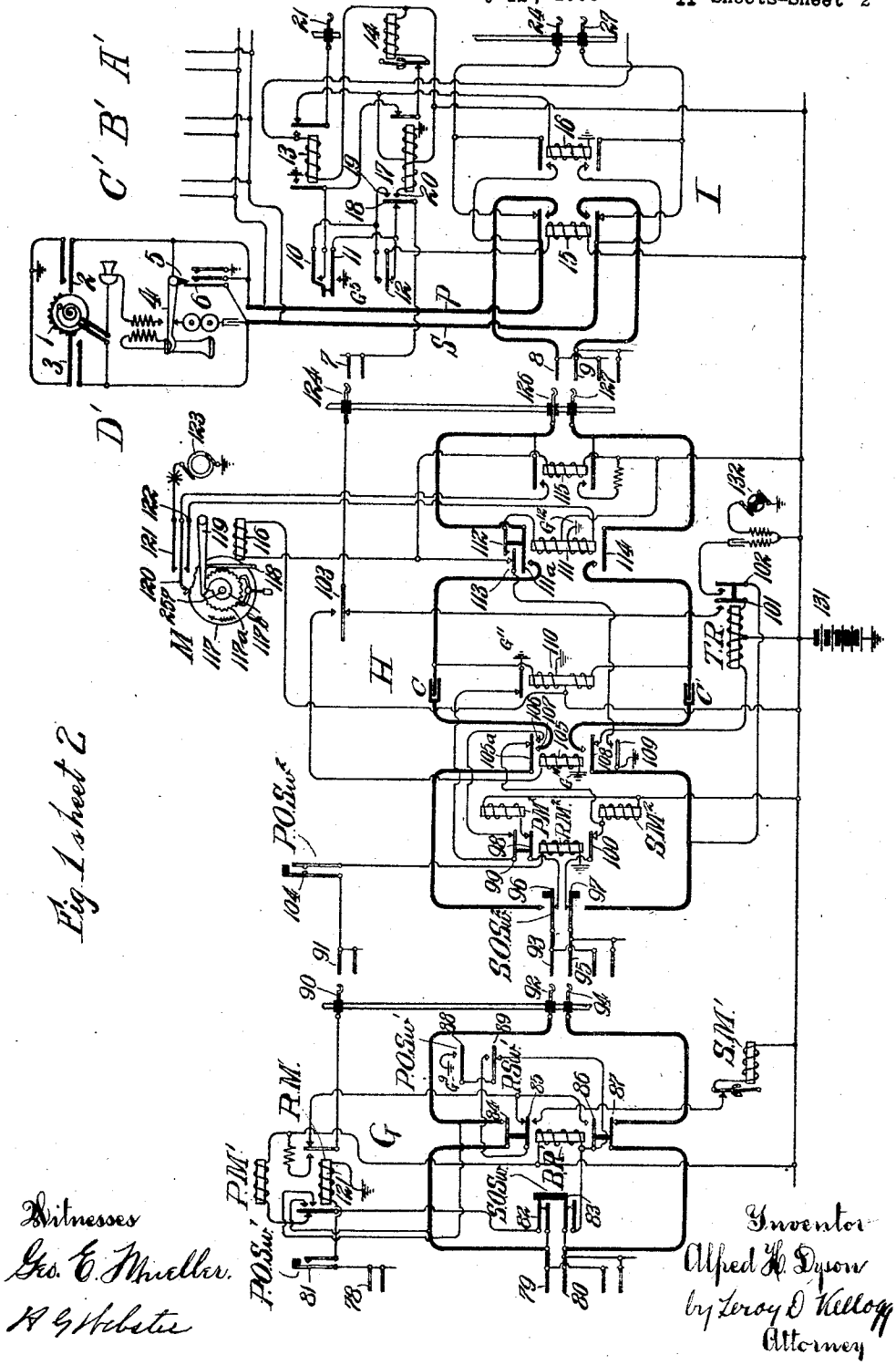

Fig. 1 sheet 2

Witnesses
Geo. E. Mueller.
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Oct. 20, 1925. 1,557,993

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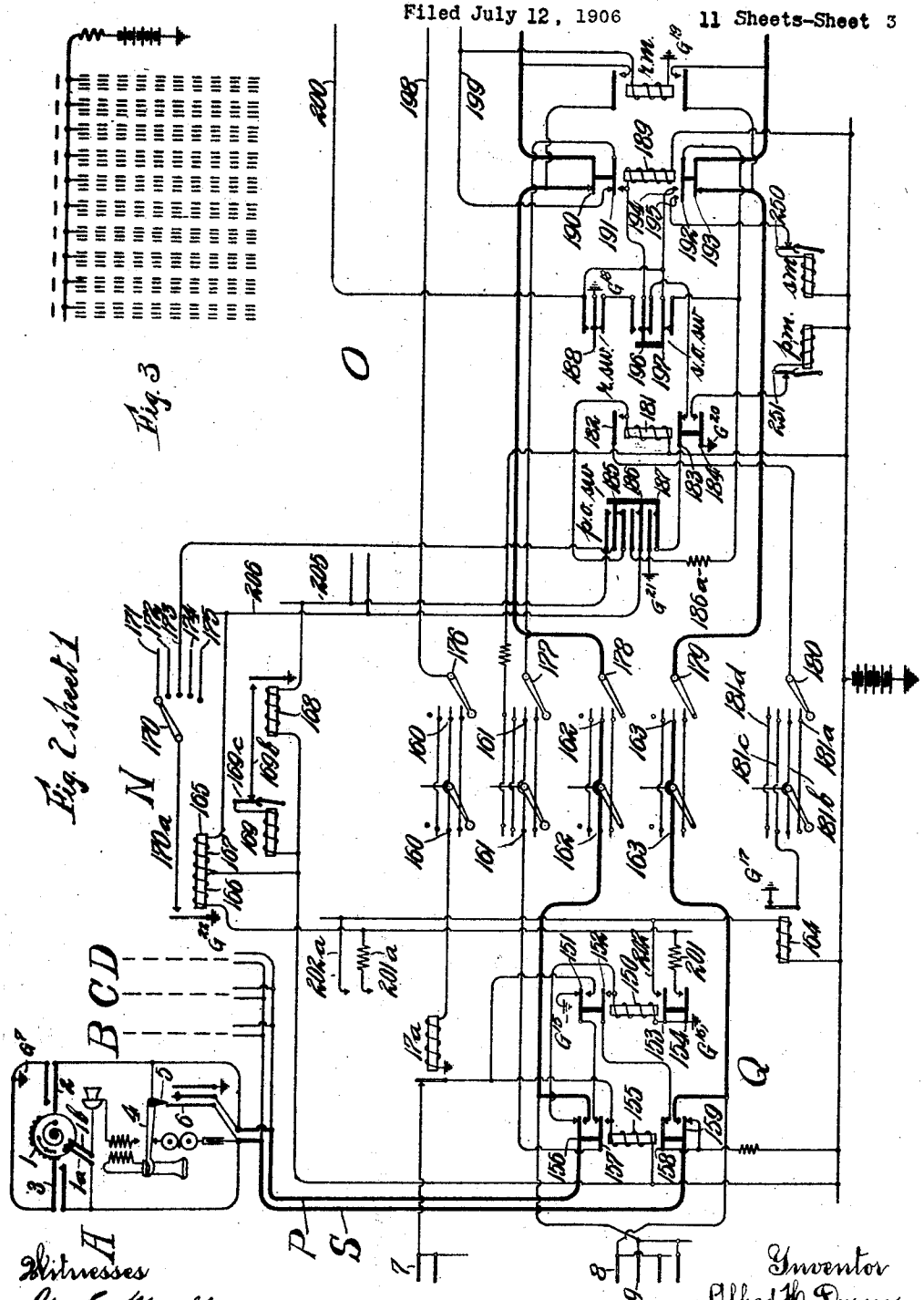
AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed July 12, 1906 11 Sheets-Sheet 3



Witnesses
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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed July 12, 1906 11 Sheets-Sheet 4

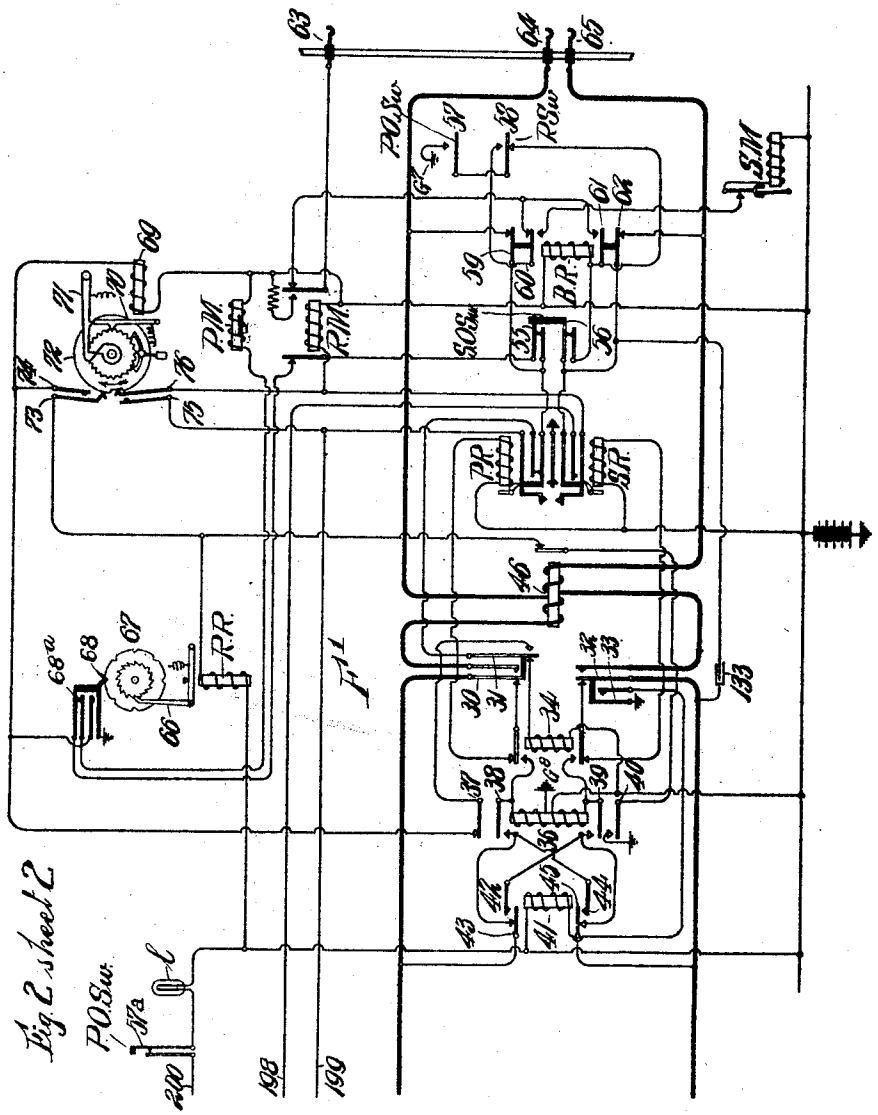

Fig 2 sheet 12

Witnesses
Geo. E. Mueller.
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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed July 12, 1906 11 Sheets-Sheet 5

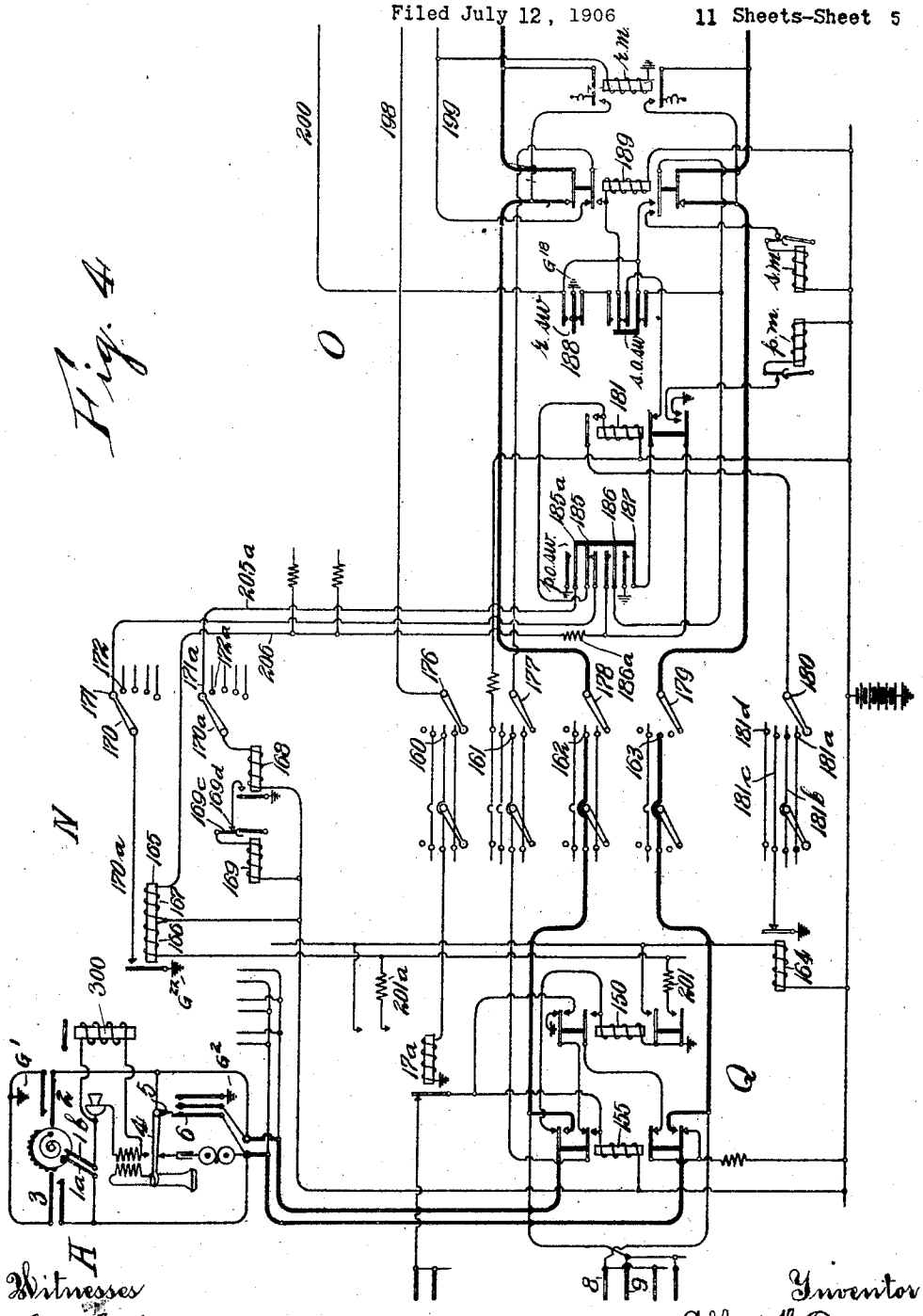

Fig. 4

Witnesses
Geo. E. Mueller.
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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

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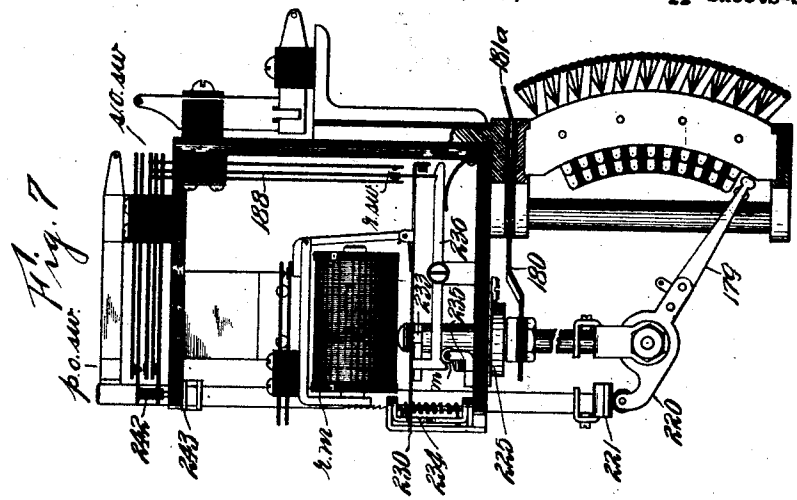

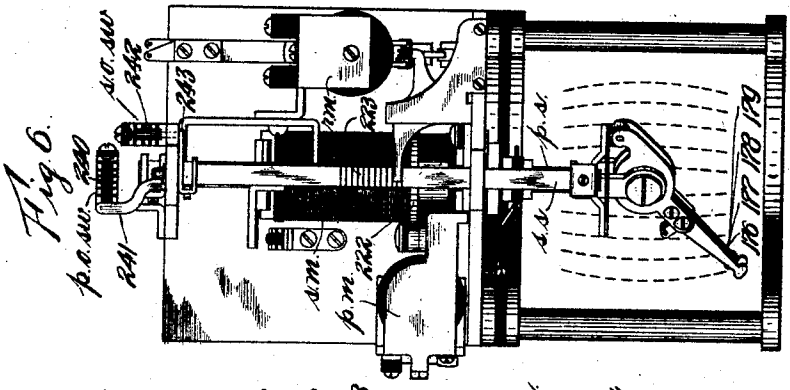

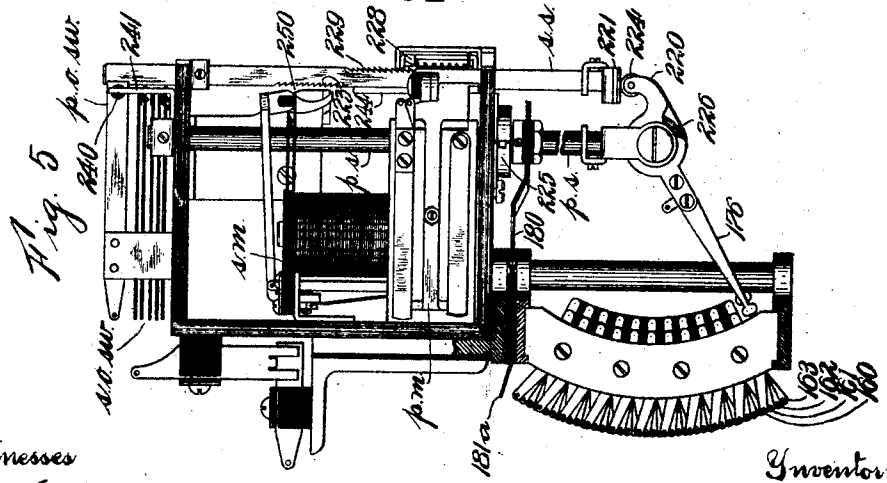

Witnesses
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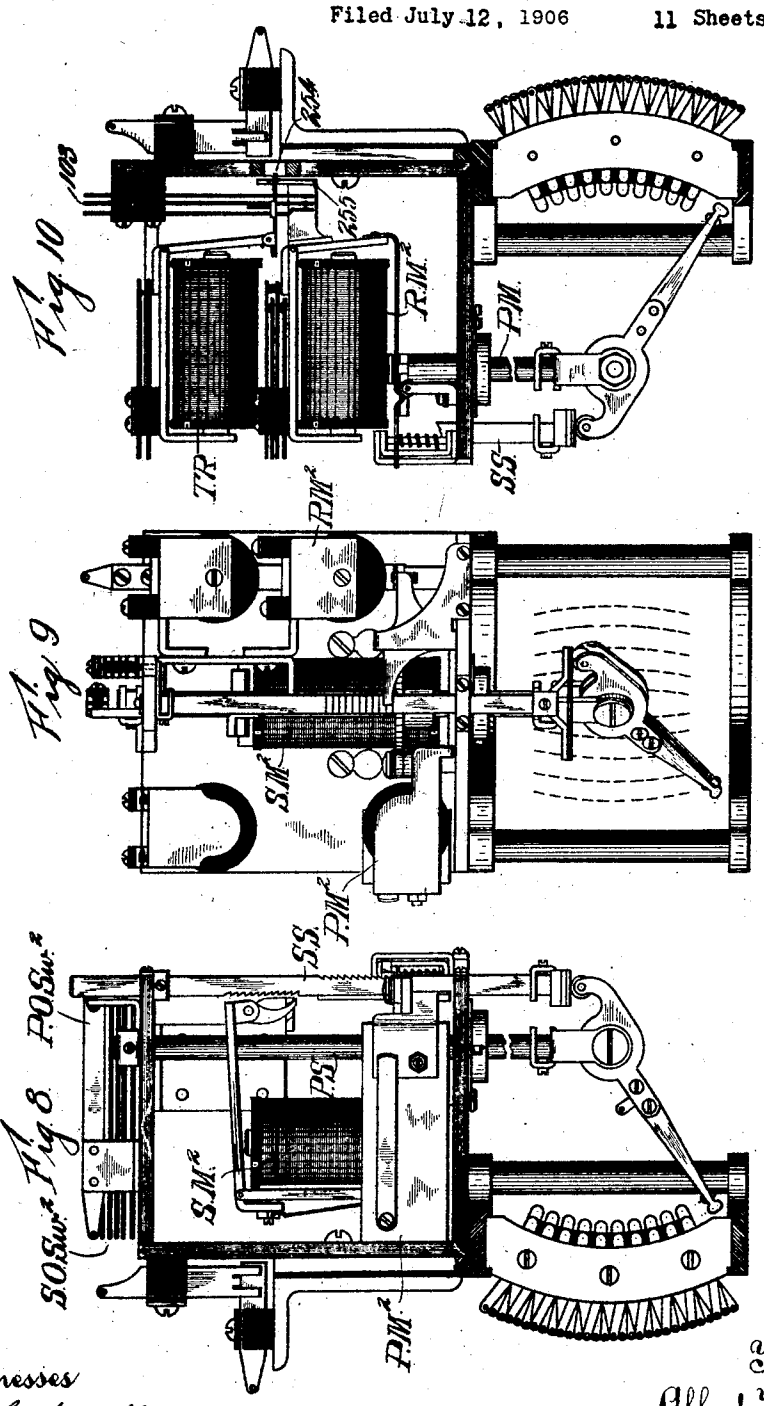
AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed July 12, 1906 11 Sheets-Sheet 7



Witnesses
Geo. E. Mueller.
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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

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Fig. 11

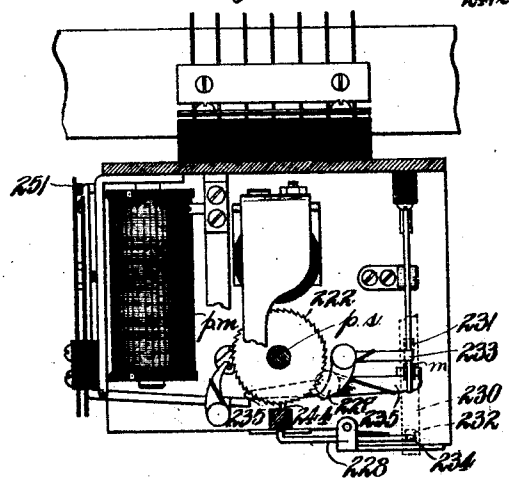
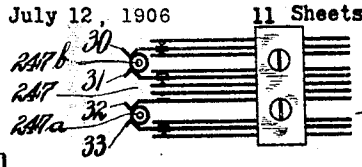


Fig. 12



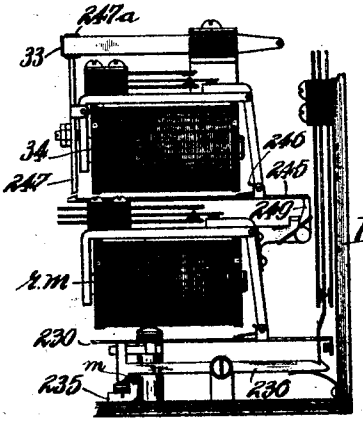


Fig. 18

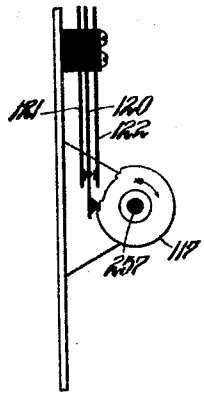


Fig. 17

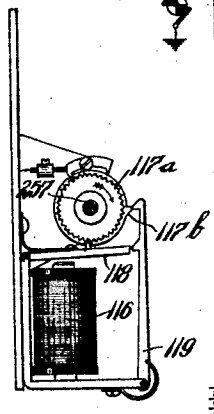


Fig. 16

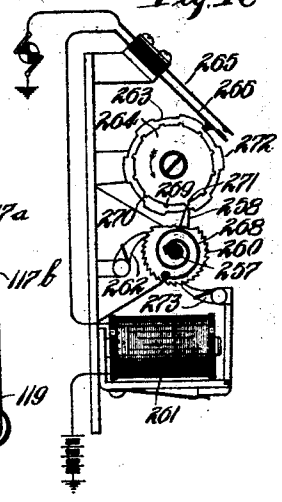


Fig. 15

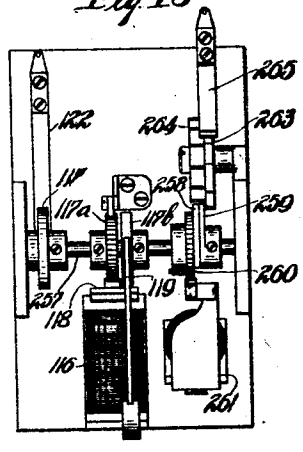


Fig. 19

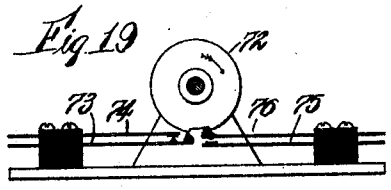
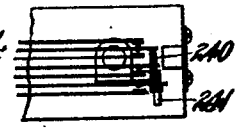


Fig. 14



Witnesses
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1,557,993

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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

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Fig. 22

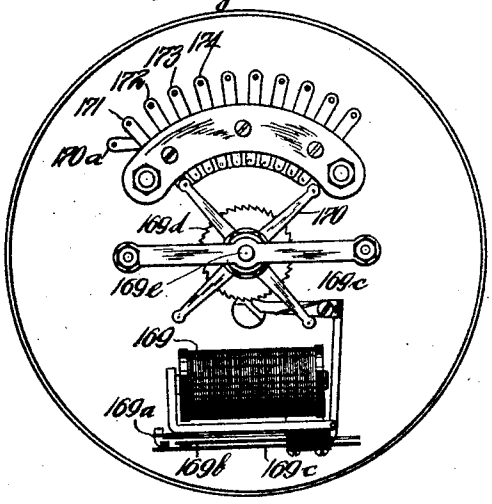


Fig. 23

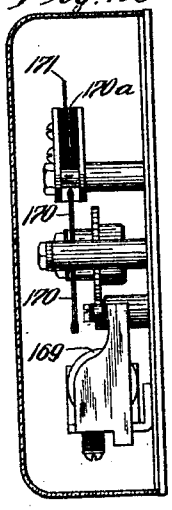


Fig. 20

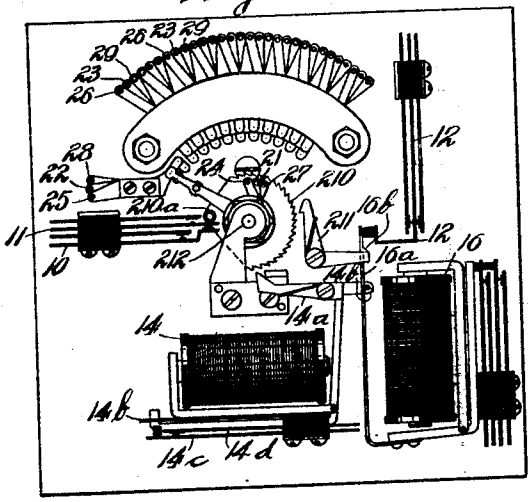
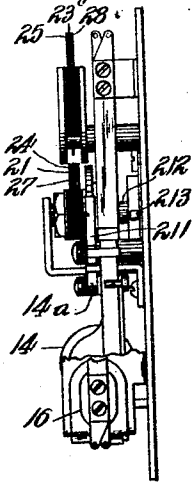


Fig. 21



Witnesses
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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed July 12, 1906 11 Sheets-Sheet 10

Fig. 24.

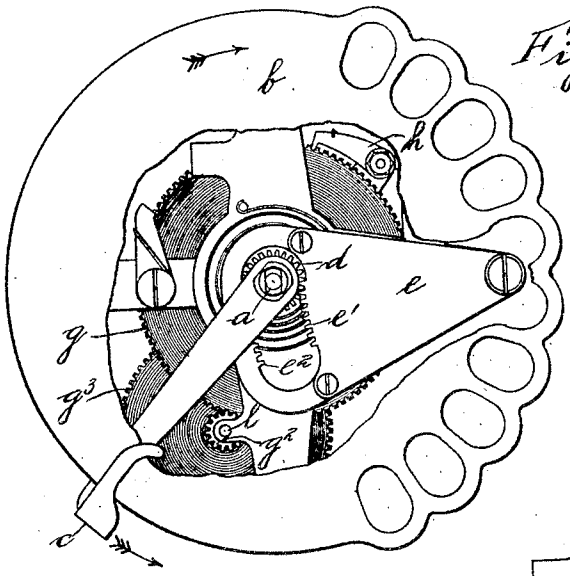


Fig. 26.

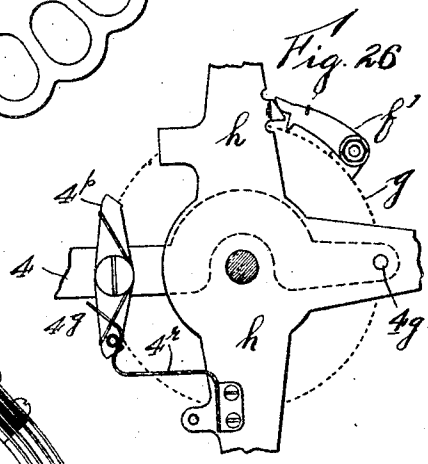
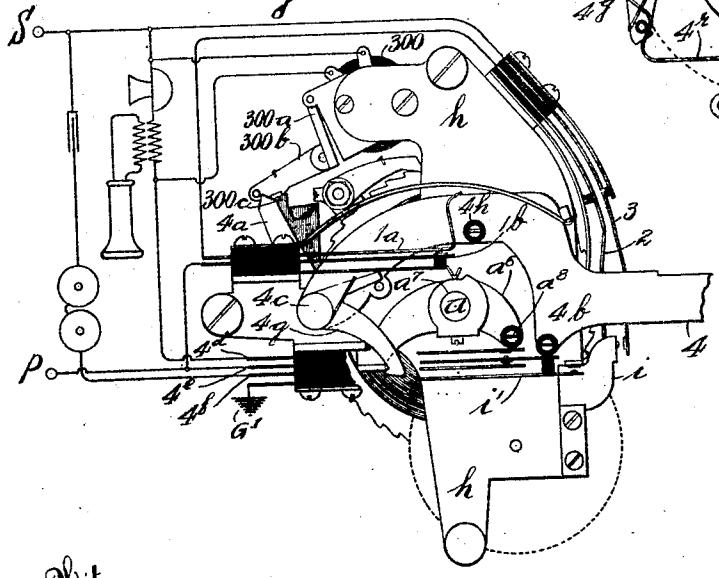


Fig. 25.



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AUTOMATIC TELEPHONE EXCHANGE SYSTEM

Filed July 12, 1906 11 Sheets-Sheet 11

Fig. 27

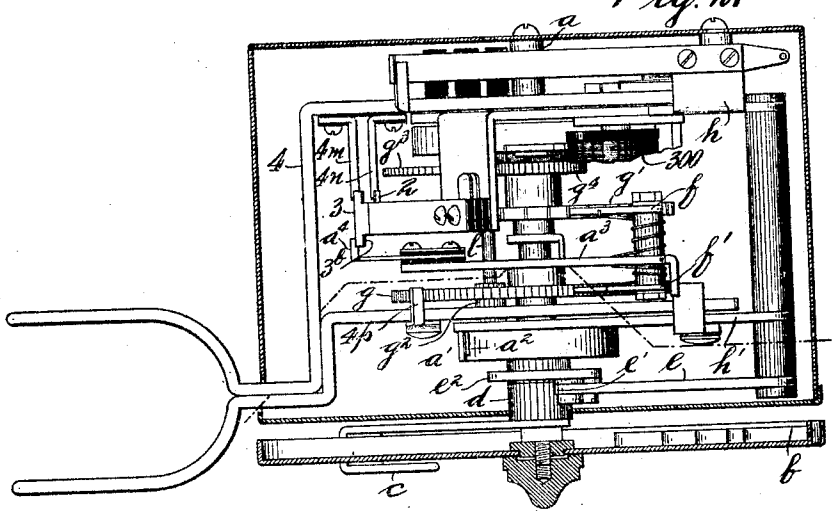


Fig. 28

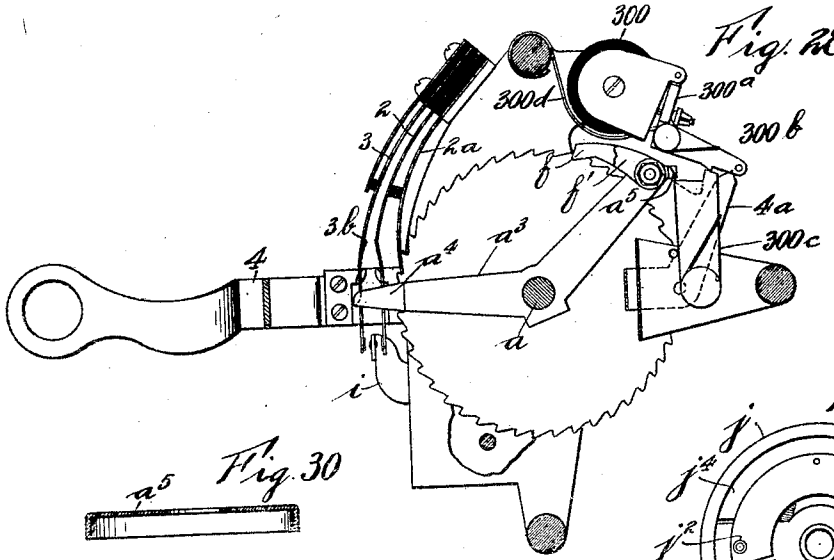


Fig. 29

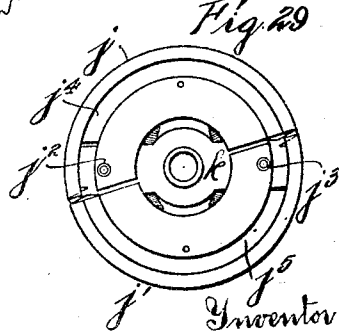
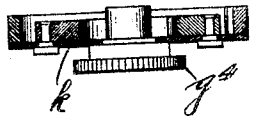


Fig. 30

Fig. 31



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Patented Oct. 20, 1925. 1,557,993

UNITED STATES PATENT OFFICE.

ALFRED H. DYSON, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLOGG SWITCHBOARD & SUPPLY CO., A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE-EXCHANGE SYSTEM.

Application filed July 12, 1906. Serial No. 325,830.

To all whom it may concern:

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

My invention relates more particularly to a structure including the provision of party line service in connection with automatic telephone systems, but is in no sense limited by any such party line features. I have illustrated my invention in such a system employing a plurality of switches successively operated for completing each connection between calling subscribers' lines and called subscribers' lines.

As is well known, in commercial automatic systems of this character, subscribers' lines are ordinarily divided into groups of one hundred, each group having their line terminals multipled to bank contacts of, say, ten connectors each of which is capable of connecting with any line of the hundred group. The calling subscriber, by appropriate mechanism controlled from his substation, selects the group of connectors wanted, and, after a connector of that group has been automatically individualized to his line, operates the same to complete the desired connection. Thus in an exchange of ten thousand subscribers' lines, there would be one hundred groups of one hundred lines, each group having its appropriate less numerous group of connectors. The proportion of ten connectors to one hundred lines is arbitrary.

For clearness of illustration, I shall assume my invention to be employed in an exchange of ten thousand subscribers, supplied with four party line service. There would thus be twenty-five hundred individual lines, each having four stations connected to it.

For commercially satisfactory party line service, non-interfering selective ringing is required, and one system of this character (that disclosed in patent to Wm. W. Dean, No. 779,533, dated January 10, 1905, title, Party line telephone system) I shall refer to as employed in connection with my invention, though other systems may readily be employed.

This system operates upon the well-known principle of tuned bells responding separately to ringing currents of different predetermined frequency.

In the system I have assumed, the ten thousand party line subscribers would be divided into groups of one hundred subscribers each and a particular group of connectors would be assigned to each group of subscribers. Each one hundred line group would include subscribers only whose substation bells respond to one particular frequency of ringing current.

Subscribers' lines would still be arranged in groups of one hundred each having their terminals multipled to connector banks. Instead, however, of having one group of connectors capable of making connection with them, there would be four such groups of ten connectors each, the line terminals being multipled to forty connector contact banks. Each of the four groups of connectors have their ringing apparatus connected to a ringing machine of a different frequency, and current is projected over a called line of the frequency appropriate for ringing the bell of the substation wanted, without ringing the other bells on the line

In general terms, for party line service, each group of one hundred subscribers is represented at the exchange by its own individual group of connectors, just as in single line systems. In making a call for subscriber 1050, whose number is in the group 1000—1100, for instance, the calling subscriber would select and employ a connector of the group appropriated to those numbers 1000—1100 and operate it to connect with line 50 of the line group. Ringing current of frequency #1, we will say, is now projected over the called line and rings bell 1050. After the conclusion of the conversation, the lines are disconnected and the calling subscriber makes a second call. Assume the wanted subscriber is number 1150 in the group 1100—1200. This may be considered a substation on the same line as 1050 just before called. The calling subscriber selects and employs a connector of the group assigned to subscribers 1100—1200. This connector will have access to terminals of the same lines as that employed for connecting to 1050, and will be brought to connect with line 50 of the same line group, i e., the same line. But this connector of group 1100—1200 causes ringing current of frequency #2 to

be projected over the called line and bell No. 1150 is now rung.

Having indicated in a general way the arrangement of apparatus employed in carrying out my invention, I will now mention some of the problems more particularly involved in the provision of such service.

As is well known, it is necessary, in order to prevent existing conversations from being interfered with, to arrange the structure of an automatic telephone system so that when lines are busy, other subscribers shall fail in endeavors to get into communication with them. Furthermore, a calling line is made to test busy soon after a call is indicated. This is moreover especially desirable in party line service, since, were it not so, while party A of a line is making his call, party B might be called up by some one else and the line taken away from A.

From these considerations arise the problem of enabling a calling subscriber to connect a selected connector to his own line and ring out over that line to call a substation on the same line, without sacrificing the preferred method of operation whereby a calling line is made busy soon after a call is initiated, and held so until the calling or called subscriber releases it. In accordance with my invention, I provide mechanism for rendering the calling line busy after a subscriber initiates a call, and mechanism including means operated whenever connection is made with a called line, whether the same or another, for momentarily (and only so) removing the test potential from the connector bank contacts of the calling line. Thus in calling one's own line, the line will test idle at the moment the connector is to complete its circuit, while a call from any other line will find the line busy unless it chances to make co-incident connection, a circumstance of necessarily rare occurence.

The ordinary practice has been in automatic telephone systems to release or destroy an existing connection by simultaneous grounding of the substation line limbs, accomplished whenever the substation receiver is replaced on the hook. This will not do for party line service inasmuch as during a conversation, a third party on either one of the connected lines, who might desire to make a call and so remove his receiver, would, on hearing conversation proceeding, replace his receiver, thereby grounding the two line limbs and disconnecting the lines. To prevent this, I have arranged the structure of my invention in such manner that release is accomplished, after connection has been made, only when one of the connected lines has its circuit conductively broken, the arrangement being such that when the circuit of either one of a connected line pair is opened, all switches employed in the connection are restored.

Until a connection is actually completed, however, the replacing of a receiver at any substation on a line will, by grounding the line limbs, release the switches. Thus no subscriber can, after partially making a call, leave his receiver off the hook and prevent other subscribers on his line from restoring the common apparatus to normal.

The general object of my invention is to provide an efficient and simple structure for supplying party line service in automatic telephone systems of the described character, embodying the advantages and combinations more particularly pointed out in the specific descriptions of the drawings and in the claims.

In the drawings, I have elected to illustrate my invention in combination with common battery automatic telephone systems, which systems, as well as the party line structures, are of my invention. I shall describe the party line system in connection with three such systems, differing principally in the manner whereby a first selector is brought into operative relation with the calling substations, it being understood that, in either system, are first selectors individual to telephone lines employed.

The first of these systems is one wherein each subscriber's line is provided with a simple switch individual to it, operated on the removal of a substation receiver to select an indifferent idle first selector and place it under control of the telephone line.

The second system differs from the first in that no switches individual to subscribers' lines are used. In this second system, first selectors are assigned, in groups of ten, to one hundred subscribers' lines, which selectors are in permanent association, each with its own auxiliary switch, which I shall call a "line selector." In accordance with this second system, when a subscriber at a calling substation removes his receiver, he operates a mechanism common to the group of one hundred lines among which his line is included, which starts an idle line selector in search of bank contacts of his line, which appear in association with the line selector wipers. The line selector seeks these contacts out and its wipers come to rest in engagement with them, thereby placing an idle first selector in operative relation with the calling substation line.

Salient features of my invention, common to both systems, are the employment of a single pair of relays adapted for operation by directive currents transmitted from the substation, which relays control the operating magnets of the first selector, second selector and connector successively, thus doing away with relays for each switch. Another feature common to the two systems is a structure employed for releasing the switches employed in the connection, its arrangement

being such that the release of all switches employed in a connection is accomplished when either subscriber of two connected lines replaces his receiver.

My invention includes also certain novel arrangements of substation calling apparatus arranged for employment in connection with the central office systems. As will be understood from the description of these, a time interval is required between the initial substation switching operation to cause the placing of a first selector in connection with a calling line and the time when the first set of directive switching impulses is to be sent and the calling device is especially arranged to secure such interval.

Referring to the drawings, Fig. 1 shows diagrammatically circuits embodying my invention; Fig. 2 shows a varying circuit structure; Fig. 3 shows a plan view of a line selector bank; Fig. 4 shows a modification of the structure of Fig. 2; Figs. 5, 6 and 7 show side and front views of line selector mechanism; Figs. 8, 9 and 10 show similar views of a connector mechanism; Fig. 11 is a sectional view of a line selector; Figs. 12 and 13 illustrate release and special switch mechanism of a first selector; Fig. 14 shows detail of a primary off-normal switch; Fig. 15 illustrates the special ringing mechanism of a connector; Fig. 16 winding mechanism thereof; Fig. 17 is starting mechanism; and Fig. 18 its circuit changing combination; Fig. 19 shows the circuit changing mechanism of special releasing mechanism for a first selector; Figs. 20 and 21 show front and side views of a private switch; Figs. 22 and 23 show similar views of a master switch; Fig 24 is a front view of the calling device; Fig. 25 is a rear view thereof; Fig. 26 shows special governor mechanism for the device; Fig. 27 is a top view of the calling device; Fig. 28 is a view thereof on the sectional line indicated in Fig. 27; Fig. 29 shows the governor of the calling device; Fig. 30 the friction member thereof; and Fig. 31 the receptacle of said member.

In Fig. 1, four substations A, B, C and D are indicated, station A being diagrammatically shown in full, B, C and D being indicated only by their branch conductors from limbs P and S. These are connected by the line limbs P and S with the private switch E at the exchange. Each substation includes the usual condenser and call-bell normally held in bridge of limbs P and S by hook lever 4, the latter being adapted, on removal of the receiver, to place the bell in open circuit and connect the transmitter in metallic circuit with the line. The calling device 1 is provided, diagrammatically shown as a disk with teeth of insulating material, capable of clockwise rotation by the hand of the subscriber and adapted, when thereafter released, to be returned by the associated spring, its insulated teeth then operating upon spring 2 to connect limb P of the line to ground G′ intermittently a number of times, corresponding to the extent of rotation and the number of teeth thereby brought beneath spring 2. After the last tooth of dial 1 has passed above 2, a tooth at the left of the dial closes momentarily limb S to ground G′ by operating spring 3, in its return to normal as shown. When the dial is in other than normal position, the pin thereon moving with it allows spring 1^a by its tension to disengage spring 1^b, whereby limbs P and S are temporarily disunited during the substation switching operations. An arm 5, fastened to hook lever 4, moves over the top of spring 6 when the receiver is removed; and upon the subsequent replacing thereof, presses spring 6 to a position where it is connected with the two associate springs; and ground G^2 is thereby temporarily applied to both line limbs P and S. As the hook lever descends to normal, arm 5 passes over the top of spring 6 which then disengages its associate springs. Substations B, C and D have each equipment identical with that of A, as have also substations A′, B′, C′ and D′ at the right of Fig. 1.

The exchange apparatus of Fig. 1 includes the private switch E, individual to the calling line and capable, when a call is initiated, of bringing an indifferent idle first selector under control of the calling line. The lines may conveniently be divided into groups of one hundred lines each, each line being provided with its private switch including the wipers 21, 24 and 27, adapted to engage multipled terminals of an appropriate number of first selectors, say ten. A first selector circuit is shown at F. Its passive terminals 23, 26 and 29 are shown as multipled a single time, but it will be understood that they would in fact be multipled one hundred times, once to each private switch of the one hundred lines the selector is to serve.

There would be associated with wipers 21, 24 and 27, nine additional sets of contacts 23, 26 and 29, each leading to a different first selector.

The principal function of a first selector in a ten thousand line system is to respond to the thousands digit impulses transmitted from the substation and move its wipers under their influence to a group of contacts associated with them and forming multiplied terminals of second selectors belonging to a limited group of subscribers, one thousand in number. As we have supposed an exchange of ten thousand subscribers, the wipers 63, 64 and 65 of first selector F would have accessible to them ten such groups of second selector terminals, one for each one thousand subscribers in the exchange. The number

of second selectors for each thousand group, appearing by their terminals at a first selector, is ordinarily ten, and a first selector contact bank may therefore comprise one hundred second selector terminals arranged in ten groups of ten each.

The group of second selectors of the appropriate one thousand having been selected, wipers 63, 64 and 65 are caused to move over the terminals of the group, passing by terminals of busy switches and stopping in engagement with terminals of the first idle second selector.

The terminal contacts 78, 79 and 80 of second selector G are shown multipled a single time, but it is to be understood that they would in practice be multipled to a large number of first selectors, say one hundred.

The function of the second selector G is to respond to the hundreds digit impulses transmitted from the substation and move its wipers under their influence to an associated group of contacts forming terminals of connectors belonging to a particular limited group of subscribers, one hundred in number. As a second selector is assigned to a particular one thousand subscribers, it has accessible to its wipers ten groups of connector terminals, one group for each one hundred subscribers of its thousand. A group of second selector bank contacts will ordinarily include terminals of ten connectors.

I have shown terminals 91, 93 and 95 of a connector H in Fig. 1 as multiplied a single time, but it will be understood that they will in fact be mutiplied to a large number of second selectors, ordinarily one hundred times.

The function of a connector H is to respond to the tens and units digit impulses transmitted from the substation and move its wipers under the influence of the tens digit impulses to a group of ten line terminals among which the line of the wanted subscriber is included, and thereafter under influence of the units digit impulses move the wipers into engagement with the terminals of the particular line with which the wanted subscriber's substation is connected.

The terminals 7, 8 and 9, shown at circuit I in Fig. 1, would in the four party line selective ringing system of my invention ordinarily be multipled to the contact banks of forty connectors, which, as indicated in the general statement of my invention, would be divided into four groups, the switches of each group connecting with the same one hundred sets of line terminals, but the connectors of each of the four groups being arranged to supply ringing current of a different frequency to whatever line one of them may be connected to, for the purpose of ringing selectively the bell of one of the four substations on the line.

As the circuit features are the principal part of my invention, the mechanical features being subordinate thereto, I shall first describe Fig. 1; and for purposes of illustration, I shall assume that subscriber A desires to enter into conversation with subscriber D' whose number is 2345 and whose bell is tuned to respond to current of frequency #4.

It is to be understood that all apparatus in Fig. 1 is shown at normal.

Subscriber A first removes his receiver, hook-lever 4 engaging its opposed contact and conductively uniting the line limbs P and S. This causes relay 13 to attract its armatures, circuit being traced from ground G^3, through normal wiper contact 25—24, upper armature of relay 15, over limb P, through hook-lever 4, returning over limb S, lower armature of relay 15, normal wiper contact 27—28, winding of relay 13 to battery 130.

The attracted left-hand armature of relay 13 is now connected to ground G^4 and has closed circuit from said ground via right armature of relay 17, through vibratory magnet 14 to battery 130. Magnet 14 is thereby actuated and effects a forward off-normal step of wipers 21, 24 and 27, the former, 21, engaging permanently grounded contact 22 and establishing a locking path for current through the now attracted right-armature of relay 13, the relay winding and to battery. Wipers 24 and 27 advance upon contacts 25 and 28 without disengaging them, ready to be moved to engage the first set of first selector contacts 23, 26, 29, on a second actuation of magnet 14.

The first movement of the wipers also caused off-normal switch springs 10 and 11 to disengage one another and to make contact with their respective opposed contacts. Spring 12 is also shifted to engage its alternate contact. The movement of spring 11 connects G^5 with the multiple contacts 7 at the connector banks, alternating their potential to render them busy, while the movements of springs 10 and 12 complete circuit from G^4 through relay 15 to battery, which relay, by attracting its armatures, disconnects wipers 24 and 27 from limbs P and S so that the said wipers are in open circuit while passing over contacts 26, 29, of busy first selectors, in order to prevent interference with existing conversations.

Relay 13 continuing energized, magnet 14 vibrates its armature a second time, which moves wipers 21, 24 and 27 to engage contacts 23, 26 and 29 of the first selector of the group. If this switch is idle, contact 23 is in the condition shown, insulated from ground. Wiper 21 having left contact 22 and engaged open contact 23, circuit is

broken through relay 13, whose retracted left armtaure opens the circuit of magnet 14, preventing further actuation thereof and hence further movement of the wipers. The retracted left armature of relay 13 also causes relay 15 to be de-energized, whose armatures thereupon connect wipers 24 and 27 with line limbs P and S.

The retracted right armature of relay 13 has now connected ground G^6 through release magnet 16 with wiper 21 and contact 23 and all its multiples, to render the first selector busy.

Thus if it is supposed that a second private switch such as E is started by the removal of the receiver at its substation, wiper 21 of such switch, upon leaving its contact 22 to engage a multiple of contact 23 of Fig. 1, will find said contact grounded through magnet 16 at G^6 of the private switch of A. Circuit will therefore be continued through relay 13 of this second private switch, its magnet 14 will again vibrate its armature, moving wipers 21, 24, 27 along to engage terminals 23, 26, 29 of the next first selector, when wiper 21 again tests the switch and the foregoing is repeated till an idle set of selector terminals is reached.

Release manget 16 is of relatively low efficiency and when placed in series with relay 13 of another private switch, as just described, does not attract its armatures, although said relay 13 continues energized.

Subscriber A now operates dial 1 to transmit two current impulses from G', through spring 2, over limb P, upper armature of relay 15, contact 24—26, spring 30, its normal contact, upper armature of relay 34, through primary relay PR to battery. The twice attracted armature of PR causes transmission of two current impulses from ground, through spring contact 51—50, switch spring 55, primary magnet PM to battery. PM is thereby twice actuated and moves wipers 63, 64, 65 two steps to proximity with a group of contacts such as 78, 79 and 80, terminals of second selectors belonging to the second thousand group of subscribers.

With the first primary step of wipers 63, 64, 65, primary off-normal switch spring 57 engages its opposed contact, while spring 58 is shifted to its alternate position.

Following the two impulses over limb P, a single impulse is transmitted from G', through spring 3, over limb S, traversing the lower armature of relay 15, contact 27—29, spring 32 and its normal contact, lower armature of relay 34, the winding of secondary relay SR to battery. The momentarily attracted armature of SR closes contacts 51—52 and 53—54. The closure of the latter completes a circuit from ground at switch E, through right winding of relay 17, right armature of relay 13, contacts 21—23, 53—54 and to battery through resistance 35. Release magnet 16 at E is in a branch extending to this circuit, but due to its sluggishness and the presence of resistance 35, does not attract its armatures at this time. The armatures of relay 17 are attracted momentarily, armature 18 temporarily removing the busy ground from contact 7. Each time secondary relay SR is actuated by an impulse transmitted from the substation, this process is repeated. Thus for four momentary periods during the establishment of a connection, once following the transmission of each set of digit impulses, a calling line has its guarding potential temporarily removed.

Returing now to the operation of switch F, the temporary closure of contact 51—52 causes a current impulse from ground through said contact, spring 56, busy relay BR to battery 130. BR attracts its armatures, whereof 60, engaging its opposed contact, completes a circuit from ground G^7, through spring 57, spring 58 and its opposed contact, armature 60 and its opposed contact, through secondary magnet SM to battery 130. SM being provided with a vibratory circuit attracts and releases its armature, moving wipers 63, 64 and 65 (now on open circuit at contacts 59 and 62) to engage contacts 78, 79 and 80, terminals of the first second selector of the previously selected group. If this switch is idle, then contact 78 is on open circuit, as shown at G, busy relay BR loses current, and armature 60 falls back to prevent a second actuation of secondary magnet SM and hence further movement of the wipers. The other armatures also fall back, whereof 60 places G^7 in connection with wiper 63 and contact 78 and its multiples, via spring 57 and spring 58 and the latter's opposed contact, to render the second selector busy.

With the first (and in this case, the only) actuation of SM, secondary off-normal switch springs 55 and 56 are moved to disengage their normal contacts, cutting the primary magnet PM and the busy relay BR out of operative relation with the primary and secondary relays PR and SR.

Supposing, now, that a second first selector F is brought to engage multiples of contacts 78, 79 and 80. Wiper 63 of this second switch will find ground from G^7 of the selector Fig. 1 thereon; its busy relay BR will be locked by current from ground G^7 of Fig. 1, to wiper 63 of the second switch, via the right armature of its release magnet RM and its normal contact; armature 61 and its opposed contact through BR to battery. All armatures of the busy relay of this second switch will therefore remain attracted, armature 60 continuing the vibratory circuit of secondary magnet SM of this other switch, which will advance

its wipers 63, 64, 65, to engage the next contacts of the group of second selector terminals. If this switch is idle, the busy relay will be demagnetized and the wipers arrested. If busy, however, another locking circuit will be established through the busy relay, its armatures will remain attracted, and successive vibrations of the armature of the secondary magnet will occur till wiper 63 reaches an idle terminal, when circuit through the busy relay of the second switch will be broken and its armatures retracted.

Returning now to the calling subscriber at A, he next operates his dial to transmit from G', over limb P, current impulses corresponding in number to the hundreds digit of the called subscriber. These three impulses traverse the winding of primary relay PR, following the before traced path. Three attractions and releases of the armature of PR transmit three impulses from ground through contact 51—50, armature 59 and its contact (contact 55 is now open), through 64—79, contact 82, the primary magnet PM' of the second selector G to battery 131. Magnet PM', responsive to these three impulses, causes three movements of wipers 90, 92, 94, to bring them to proximity to a group of ten sets of contacts 91, 93, 95, terminals of ten connectors, which connectors are provided with one hundred sets of bank contacts forming terminals of lines to which telephone substations of the two thousand three hundred group are connected. The ringing connections of these connectors are all alike and extend from a ringing generator of such frequency as to be capable of ringing the bells of the one hundred substations numbered as above, only, the bells of such substations being properly attuned to respond to generator currents of this frequency, while the bells of other substations that may be connected to the same lines, will be incapable of responding to the particular frequency of the generator connected to said connectors.

The first actuation of PM' at G also caused off-normal switch springs 81 and 88 to be shifted to engage their associate contacts, while spring 89 is also shifted.

An impulse over limb S from G', following the third impulse over P, energizes secondary relay SR, and an impulse flows from ground, through contact 51—52, contact 62, contact 65—80, contact 83, the busy relay BR' at G to battery 131.

The busy relay BR' is thereby energized and attracts its armatures, the attraction of 85 completing circuit from ground, through spring 88, spring 89 and its opposed contact, attracted armature 85, through secondary magnet SM' to battery. The resulting energization of SM' moves wipers 90, 92 and 94 to engage contacts 91, 93 and 95, forming terminals of the first connector of the selected group. If this connector is idle, as shown at H, contact 91 is on open circuit; and at the cessation of the impulse through BR', the relay is de-energized and its armatures retracted. The retraction of 85 opens circuit through secondary magnet SM', preventing further vibration of its armature, whereby wipers 90, 92 and 94 are left in engagement with contacts 91, 93 and 95 of H. The armature 85, in engaging its normal contact, connects ground G^9 through springs 88 and 89, the armature 85 and the right armature of release magnet RM' to contact 91 and its multiples, rendering the connector busy. The first actuation of SM' also actuates secondary off-normal switch springs 82 and 83 to disengage their associated contacts, thus cutting the primary magnet and the busy relay out of operative relation with contacts 79 and 80.

Supposing now that a second second-selector similar to G brings its wipers to engage multiples of contacts 91, 93 and 95. In such case, wiper 90 of this second switch will find ground G^9 connected to the multiple of contact 91 engaged by it; a locking path for the busy relay BR' of the second switch will therefore be established via its wiper 90, its armature 86, through the busy relay to battery. The busy relay of this second switch will therefore continue to hold its armature 85 attracted and its secondary magnet SM' will continue in circuit, vibrating its armature a second time to move the wipers 90, 92 and 94 of this second switch to engage a set of contacts forming terminals of a second connector of the group. If this is busy, a locking path similar to that just described will be produced for BR'; and the secondary magnet SM' of the second switch will continue vibrating its armature until its wipers 90, 92 and 94 reach terminals of an idle connector.

Subscriber A now transmits four impulses from ground G', over limb P, through primary relay PR, the four resulting actuations of said relay transmitting four current impulses from ground through contact 51—50, contact 59, contact 64—79, contact 84, contact 92—93, spring 96 at connector H, armature 98, primary magnet PM^2 to battery, causing four actuations of PM^2. These actuations are effective to move wipers 124, 126 and 127 of the connector to a position adjacent to a group of contact sets in the connector bank, forming terminals of lines 41, 42, 43, etc. to 49 followed by 40, of the one hundred line group to which the wipers have access. It will be remembered that forty substations are connected to these ten lines. With the first of the four primary movements of the wipers, off-normal switch spring 104 engages its associated contact.

The single impulse over limb S, following the four impulses over limb P, causes secondary relay SR to transmit an impulse of current from ground, through contact 51—52, contact 62, contact 65—80, contacts 87, 94—95, through spring 97 and its normal contact, contact 100, secondary magnet SM^2 to battery. The resulting actuation of SM^2 causes wipers 124, 126 and 127 to advance a step toward the group of connector bank contacts selected. The normal position of these wipers with respect to the edge of the contact bank is such that two steps are required to bring them to engage the first contact set of a selected group. This first actuation of SM^2 caused secondary off-normal switch spring 96 to be shifted into engagement with its opposed contact, while spring 97 is shifted to disengage its normal contact, but not to an extent to bring it into engagement with its opposed contact, this engagement occurring only with the second energization of SM^2. The purpose of this delay is to prevent a possible actuation of test relay TR, which might otherwise be momentarily actuated by the impulse now being transmitted from secondary relay SR if the operation of 97 were rapid enough to engage its opposed contact before the impulse ended. Such an unintended energization of TR would cause the attraction and release of its armature, effecting the shifting of spring 103, controlled by the said relay, which would cause the calling subscriber to be connected with the line he now proceeds to select, whether said line were busy or not, as will be apparent from the description of the testing operation hereinafter made.

Subscriber A now transmits five impulses from G′, over limb P, through relay PR, which in turn transmits five impulses over the previously traced path, through contact 92—93, the current now flowing through spring 96 and its opposed contact, through armature 105^a and its normal contact, secondary magnet SM^2 to battery. Five resulting actuations of the secondary magnet are effective to move wipers 124, 126 and 127 successively into engagement with the first, second, third, fourth and fifth contact sets of the selected group. The last of these is a set forming terminals of the line to which the telephone of the wanted subscriber #2345 is connected.

A single impulse, flowing over limb S at the conclusion of the last of the five impulses over limb P, by energizing the secondary relay SR, causes an impulse to be transmitted over the previously traced path to and through contact 94—95, thence by spring 97 and its opposed contact, through armature 108 and its normal contact, the left winding of test relay TR to battery. The test relay attracts its armatures.

Assuming first that the called line is idle, which is the condition illustrated at I of Fig. 1, contact 7 is connected to battery 131, through armature 18, spring 12 and the winding of relay 15. Armature 101 has connected the right winding of the test relay to the same pole of battery 131 and hence no locking path for the said relay TR exists; and on the cessation of the impulse transmitted through its left winding, the relay TR is de-energized, its armatures 101 and 102 falling back. The de-energization of the relay TR is also effective to throw spring 103 to engage its alternate contact, whereupon current flows from ground G^{10}, through relay 105, energizing the said relay, spring 103 and its opposed contact, contact 124—7, armature 18, spring 12, relay 15 to battery, energizing also relay 15, whose attracted armatures disconnect the called line from the private switch and connect it to the terminal contacts 8 and 9, now engaged by wipers 126 and 127.

The connection of ground G^{10} by the shifting of spring 103, through wiper 124 to contact 7 and its multiples, has placed the called line in such condition that if it be now supposed that wiper 124 of another connector is brought to engage contact 7, the ensuing energization of the test relay of this other connector, by an impulse transmitted over limb S of the other calling line, will cause the test relay to be locked by a current flowing over a path that may be traced as follows: from ground G^{10} of the connector, Fig. 1, through its relay 105, its shifted spring 103, its wiper 124, through contact 7, thence to a multiple of said contact engaged by the wiper 124 of the other connector now seeking connection with the called line, through the unshifted spring 103 of this other connector, through attracted armature 101′ of its test relay TR to battery. This flow prevents the de-energization of the test relay on the cessation of the impulse through its left winding, its armature 102 continues attracted, and the busy signal is transmitted from machine 132 through armature 102, through spring 97 of the other connector and thence through the talking-circuit of the second-selector and the first-selector, there traversing condenser 133, through the receiver at the calling substation and back over limb P to battery, notifying the subscriber that the line wanted is busy, whereupon he replaces his receiver and the apparatus he has used in attempting connection with the busy line is restored to normal, as hereinafter explained.

Returning now to the point where subscriber A brought the connector wipers to rest engaging contacts 7, 8, 9, of the line of D′, the current flowing through relay 105 caused its armatures to be attracted. A

first result of this is the closing, by armatures 105[a] and 108, of two normally open contacts in the talking circuit about to be established. Armature 105[a] also connects ground G[11] through contact 99, contact 106—105[a], spring 96 and to the left via the upper talking conductor, through contact 59 at F, contact 50—49, spring 31 and relay 34 to battery. Relay 34 is thereby actuated to bridge the battery 130 across the line of A via the windings of relay 36. The latter is therefore in turn actuated and its armatures are attracted, whereof 38 and 39 connect the relay's windings with the calling line via springs 45 and 43, while armature 40 completes circuit from ground, through the armature of relay 46, release relay RR to battery, actuating said relay. This relay, on its subsequent de-energization, effected at the proper time as hereafter explained, releases the switches.

Returning to relay 105 at H, a further effect of its actuation at this time, caused by the attraction of armature 109, is the closure of circuit from ground, through said armature 109, spring 113 and magnet 116 of ringing device M to battery, energizing 116, a branch path of said circuit being also established through relay 115 energizing it.

The apparatus at M includes the notched disk 117 pivoted at its center, having fastened to it the circular rack 117[a] and cam 117[b]. Toothed armature 118 of magnet 116 normally engages rack 117[a], holding the disk from rotation. Power is provided for the disk so that it continually has a tendency to rotate in the direction of the arrow.

Magnet 116 having become energized as above described, armature 118 is attracted, disk 117 is released and commences rotation, spring 120 immediately rising to ride upon the periphery of 117 and engaging spring 121, whereby ringing current of frequency #4, the same being adapted to ring the bell at station D′, is projected from the common generator 123, through contact 121—120, the attracted upper armature of relay 115, contact 126—8, the attracted upper armature of relay 15, over limb P, through the bells of the substations of the line in parallel, returning over limb S, the lower attracted armature of relay 15, contact 9—127, the lower attracted armature of relay 115 and through the circuits of battery 131. As disk 117 completes a revolution, spring 120 rides down into a first notch to disengage spring 121. An instant later, it rides down into a second and deeper notch in which position it closes contact 120—122.

Assuming that at this time subscriber D′, whose bell alone was rung, has answered the call by removing his receiver. Instantly circuit is completed from ground G[12], through the lower winding of relay 111, through contact 122—120, upper armature of relay 115, out over limb P, over the conductive path now established by the raised hook-lever at substation D′, returning over limb S, the lower armature of 115 to battery. This current causes relay 111 to attract its armatures, 111[a] and 114 closing normally open contacts in the connector talking conductors, while armature 112 contacts with spring 113 to lock its relay 111 by means of its upper winding and thereafter open the circuits of magnet 116 and relay 115, which become de-energized.

All this occurs instantly and while spring 120 continues in the deep notch of 117. The armature of magnet 116 would now be retracted, but is for a moment prevented by the detent of pivoted arm 119. This arm drops down off from the raised portion of cam 117[b] when disk 117 is first moved, and its pawl then engages armature 118, holding it against retraction.

When now, under the present circumstances, disk 117 reaches the point of complete rotation (which it immediately does), arm 119 is lifted by cam 117[b] to release armature 118, which flies back and, engaging rack 117[a], stops the disk in the position shown, wherein spring 120 is in an intermediate position.

As soon as armatures 111[a] and 114 engage their associate contacts, as before described, battery 131 was placed in bridge of the line limbs P and S of subscriber D′, through the windings of relay 110. The attracted armature of 110 opens the circuit before traced from ground G[11], through relay 34, which relay is de-energized, its armatures retracted, and springs 30, 31, and 32, 33, are shifted to engage their opposed contacts. The shifting of springs 30 and 32 disconnect the windings of relays PR and SR and complete the talking circuit of first selector F. The shifting of spring 33 completes circuit from ground, through relay 41 to battery, and the armatures of said relay first engage springs 43 and 45 and then cause said springs to disengage their normal contacts. By this actuation of relay 41, the direction of the flow of current from battery 130 in the line of calling subscriber A is reversed.

The subscribers A and D′ are now in conversation, the talking circuit being traced from station A to D′, through the exchange by way of the heavily marked conductors, battery being fed to the line of A through the windings of relay 36 from 130, and to the line of D′ through the windings of relay 110 from battery 131.

The condensers c and c' are in the two talking conductors at the connector and, owing to their presence, there is no flow of direct current through the windings of the relay 46. This relay is differentially wound, so as to offer no material impedance to the rapidly alternating voice currents. The left

winding of relay 46 is alone employed for switching purposes, the other winding being solely to render the relay non-inductive.

At the conclusion of conversation, all switches are released when either subscriber, by replacing his receiver, opens the conductive circuit at his substation. It being supposed that subscriber D′ does this first, he thereby causes relay 110 to be de-energized, whose retracted armature connects ground G^{11} through contact 99, contact 106—105^a, spring 96 via the upper talking conductor to the left, the left-hand winding of relay 46, spring 30 and its opposed contact, contact 43—42, armature 39 and the lower winding of relay 36 to battery 130. Relay 46 attracts its armature, opening circuit through release relay RR (which has been energized during conversation). On its de-energization, RR by its retracted armature effects a thrust of pawl 66, and the said pawl having, on the energization of RR, been brought to engage a tooth of its associated rack adjacent to that shown engaged by it, disk 67 is rotated one step so that spring 68 rests on the periphery of 67, in which position it engages its associate contact, closing circuit from ground, through spring 68 and magnet 69 to battery. Magnet 69, armature 70 and arm 71 of apparatus L have the same mechanical functions with respect to disk 72, its rack and cam, that magnet 116 at H, armature 118 and arm 119 have to disk 117.

As magent 69 is now energized, disk 72 is allowed to rotate. Immediately after its start, spring 73 engages 74, closing circuit through relay RR from ground, via spring 68 and contact 73—74 to battery, again energizing RR. Spring 73 then rides upon the periphery, opening contact 73—74, and RR becomes de-energized, pawl 66 causing disk 67 to advance a second step when spring 68 engages a tooth of 67 and is therefore at normal. The movement of spring 68 de-energizes magnet 69, but disk 72 completes its rotation because of the interlock between 71 and 70, only broken at the completion of a revolution when its breaking will cause disk 72 to be arrested at its normal position.

As disk 72 starts on its rotation, spring 76 rides to the periphery, closing contact 75—76. Circuit is thereby closed from G^6 at switch E, through release magnet 16, retracted armature of relay 13, contact 21—23, terminal of spring 54, contact 76—75, release magnet RM to battery. As magnet 16 and magnet RM are both of low resistance, the branch circuit through the right winding of relay 17 is not effective, by its shunting effect, to prevent the attraction of the armatures of magnet 16, and release magnets 16 and RM are both fully actuated.

The attraction of the right armature of RM completes circuit through release magnet RM′ at switch G, the energization of RM′ in turn completing circuit through release magnet RM^2 at the connector H. The described energizations of the four release magnets prepare their respective switch mechanism for their returns to normal as soon as the magnet shall become de-energized.

In addition to the mechanical effects produced, described hereafter in connection with the mechanical drawings, circuit changes are produced by each release magnet to disconnect its switch's wipers and place them on open circuit while being restored, so that their necessary wiping over busy contacts may not interfere with other connections.

Magnet 16 at switch E, when energized, shifts spring 12 to engage its normal contact. Spring 11, being an off-normal switch spring, is not restored till switch E reaches normal. Hence spring 12 completes the circuit of relay 15, whose attracted armatures hold wipers 24 and 27 on open circuit during the release.

RM at switch F, when energized, shifts spring 58 to normal, and, off-normal spring 57 remaining temporarily connected to G^7, relay BR is energized and disconnects wipers 64 and 65, pending restoration.

Similarly, RM′ shifts spring 89 to energize BR′.

At connector H, magnet RM^2, when energized, shifts spring 103 to normal which opens the circuit of relay 105, whose retracted armature 109 causes relay 111 to be de-energized, whose armatures are retracted, 111^a and 114 disconnecting wipers 126 and 127.

Returning now to apparatus L at switch F, the above operations are all performed in a very brief space of time and before disk 72 completes a revolution. When a revolution is completed, contact 75—76 is opened as shown, and release magnets 16 and RM are de-energized, the former restoring switch E; the latter restoring switch F, its retracted armature also shifting springs 30, 31, and 32, 33, to normal. Moreover, the de-energization of RM opens circuit through RM′, restoring the second selector G. The de-energization of RM′ opens circuit through RM^2, which thereupon restores the connector H, and all apparatus is then at normal.

If subscriber A replaces his receiver in advance of subscriber D′, circuit is opened through relay 36 at first selector F, whose armature 40 opens the circuit of relay RR and the release operations proceed as before.

It will be remembered that springs 30 and 32 are shifted from their normal positions only on the response at the called substation. Relays PR and SR therefore remain in circuit with the calling line up to that time. Subscriber A, if he fails to secure a response or changes his mind after initiating

his call, can always restore whatever switches are in connection with his line by replacing his receiver. By this act, limbs P and S are momentarily simultaneously grounded, causing PR and SR to attract their armatures at the same time, whereby circuit is closed from G^6 at E, through magnet 16, via contact 21—23, springs 54—53, springs 48—47, release magnet RM to battery. The energization of the latter will cause the release magnets RM′ and RM^2 to be in turn energized if the connection has proceeded as far as G and H. In any event, whatever switches are connected have their release magnets energized; and when arm 5 at A passes over the end of spring 6, as the hook-lever 4 reaches normal, the resulting removal of ground from limbs P and S causes relays PR and SR to retract their armatures, which causes magnets 16 and RM to become de-energized and the relase operations proceed as before. Let it now be supposed that the line at the right of Fig. 1, belonging to substations A′ to D′, is the same line as that at the left of Fig. 1 belonging to substations A, B, etc.; in other words, that A and A′ are one substation, B and B′ one, etc., and that switches E and I are in reality one and the same, though twice illustrated.

Assuming that subscriber A, A′ desires to converse with subscriber D, D′ on his own line, the operations are in all respects the same as those before described up to the point where wipers 124, 126 and 127 engage contacts 7, 8 and 9, but certain differences arise in this case with the transmission of the last impulse over limb S, which energizes secondary relay SR. It has been hereinbefore explained that with each energization of SR, the resulting closing of contact 53—54 closes circuit through the right winding of relay 17 of the private switch to cause the temporary energization of said relay.

Thus when calling subscriber A has caused the connector H to connect with his own line and the impulse over limb S causes simultaneous energizations of test relay TR and relay 17 of switch E, i. e., switch I, contact 7 is, owing to the attracted condition of armature 18, engaging contact 20, connected to battery via the left winding of relay 17. No circuit, therefore, exists to render effective the locking armature 101 of TR and the test relay is de-energized, shifting spring 103. The relay 17 is so constructed as to release its armature 18 more slowly than relay TR releases its armatures. This may be accomplished in any one of several well known ways, e. g., by means of a copper shell about its core.

On account of this slowness, spring 103 is completely shifted before contact 18—20 is broken, and a locking circuit is established from ground G^{10} at the connector, via relay 105, spring 103, contact 124—7, contact 18—20, left winding of relay 17 to battery. Relays 105 and 17 are now energized and so remain until disconnection is effected. Relay 15 of the private switch is now also energized in a branch path extending from armature 18 of relay 17, contact 19, spring 12 and its opposed contact, through relay 15 to battery, the armatures of 15 being therefore attracted and line limbs P and S connected to contacts 8, 9, (see I) and cut off from wipers 24, 25 and the selector circuit (see E). The line of the subscribers is now busy, due to G^{10} at H being connected to contact 7 and its multiples, ground G^5 at the private switch having been disconnected by armature 18, which remains attracted.

The energization of relay 105 has been explained. Its attracted armature 105^a establishes circuit from G^{11}, via contact 99, contact 106—105^a and spring 96, over the talking circuit to the left, through contacts 59, 50—49, spring 31, relay 34 to battery. Relay 34 is actuated preparatory to shifting springs 30, 31, and 32, 33, on its de-energization. No energization of relay 36 occurs when a subscriber calls for another on his own line, because energized relay 15 has prevented the completion of a circuit therethrough.

Returning to relay 105, its attracted armature 109 has completed circuit from ground, through spring 113, magnet 116 to battery, a branch path through relay 115 being also established. Magnet 116 attracts armature 118, whose teeth disengage the ratchet of ringing disk 117, which now rotates in the direction of the arrow, spring 120 mounting to the periphery of 117 and engaging spring 121. Generator 123 delivers current of frequency #4 to cause the actuation of the tuned bell of substation D, D′, and ringing current is projected therefrom, through contact 121—120, the upper attracted armature of relay 115, contact 126—8, over limb P, in parallel through the four substations, ringing the bell of D, D′, returning through contact 9—127, the lower armature of 115 to battery.

This projection of ringing current continues during one revolution of disk 117 only. As said disk completes a revolution, spring 120 slips down from the periphery of the disk to engage the deep depression therein, whereby contact 120—122 is closed. Circuit is instantly closed from ground G^{12}, through the lower winding of relay 111, contact 122—120, attracted upper armature of relay 115, out over limb P of the line, through the hook lever and transmitter at substation A, A′, returning over limb S, contact 9—127, the lower attracted armature of relay 115 to battery. The armatures of relay 111 are attracted, 112 de-energizing magnet 116 to release its armature, which engages and arrests disk 17 in the position

shown, when arm 119 permits. Said armature 112 also de-energizes relay 115, and by engaging spring 113 completes a locking circuit through the upper winding for relay 111.

Armatures 111ª and 114, by their attraction, bring relay 110 in circuit with contacts 126—8 and 127—9 and limbs P and S of the called line. Through the windings of relay 10, talking current is supplied to the line limbs and in parallel through the two substation transmitters as soon as subscriber D, D′ answers the call and conversation can then proceed.

On the energization of relay 110 as described, its attracted armature opens circuit through relay 34 at switch F, and springs 30, 31, and 32, 33, are shifted to their alternate positions. Relay 41 is, of course, energized, but effects nothing; and as relay 36 remains inert, the release relay RR is not actuated and does not aid in the release operations now to be described.

When subscriber A, A′ and subscriber D, D′ finish talking and have both replaced their receivers, limbs P and S are conductively open and relay 110 is therefore de-energized. Circuit is thereupon closed from ground G^{11}, through armature of relay 110, contact 99, contact 106—105ª, through spring 96 and its opposed contact, contact 93—92, contact 84, contact 79—64, contact 59, contact 50—49, thence through spring 31 and its opposed contact, through contact 37, direct through magnet 69 to battery. Armature 70 is thereby attracted, releasing disk 72, and the returns to normal of the private switch, first selector, second selector and connector occur as before described.

There is a peculiarity of operation coming into play at this time. The current from ground G^{11} at the connector, through magnet 69, finds a branch path through relay RR as soon as disk 72 moves and contact 73—74 is closed, which relay becomes energized. When spring 73 immediately thereafter rises to the periphery of disk 72, RR is de-energized and spring 68 moved to engage its associated contact. Thus when disk 72 completes one revolution, magnet 69 continues energized by current from ground, through spring 68, and disk 72 proceeds to make another revolution. At its start, spring 73 engages 74 and relay RR is a second time energized and then becomes de-energized when 73 rides to the periphery of 72. On this de-energization, spring 68 is brought to one of its normal positions shown; and when disk 72 completes its second revolution, it comes to rest in the usual manner. The second revolution of disk 72 is without effect, as the switches were of course restored when the first revolution was completed.

The function of contact 68ª, which is always open when contact 68 is closed, is to hold the circuit of the primary magnet PM open to keep the said magnet at all times free from the influence of the ground at contact 68.

Referring now to Fig. 2, consisting of Sheets 1 and 2, these are to be viewed with Sheet 1 at the left. Sheet 1 shows a subscriber's line, its line circuit, a master switch circuit at N and a line selector circuit at O. The line selector O is in permanent association with the first selector circuit F′, shown on Sheet 2 of Fig. 2. The said first selector F′ has substantially the same circuit arrangement as that shown at F in Fig. 1, a few minor circuit changes being introduced on account of the difference in method whereby it is to be brought into operative relation with the calling line. In considering Fig. 2, Sheet 2 of Fig. 1 may be held at the right of Sheet 2 of Fig. 2, the second selector G and connector H of Fig. 1, Sheet 2, being for use in connection with Fig. 2. The line circuit at I would of course be replaced by a line circuit such as Q of Fig. 2.

The line circuit at Q includes the following apparatus individual to the line shown: the relays 150, 155 and 17ª; the set of bank contacts 7, 8 and 9 forming terminals of the line at the banks of connectors as H; and the set of multiple bank contacts consisting of contacts 160, 161, 162 and 163 forming terminals of the line at the banks of the line selectors O.

The subscribers' lines are divided into groups of 100, as calling lines, and to each group are assigned ten line selectors connected each with its own first selector. The contacts 160, 161, 162 and 163 of each of the one hundred lines of a group are multipled ten times, once to each of the ten line selectors assigned to the group. When a calling subscriber removes his receiver, he causes one of the ten line selectors assigned to his line group to operate and this switch, automatically controlled, seeks out the contacts 160, 161, 162 and 163 of the calling line and comes to rest in engagement with them, at which time the first selector F′, belonging to the particular line selector started, comes under the control of the calling subscriber.

The master switch N is provided, one for each one hundred group of calling lines and their ten line selectors. Its apparatus forms a link to which each of the one hundred lines has access and which each is capable of operating. When so operated by a line, it sets up an independent progressive movement of its wiper 170 which travels over the contacts 171, 172, etc., each a passive terminal of a different line selector; and as soon as wiper 170 reaches the terminal of

an idle one, such idle line selector is started on its travel, while the wiper 170 comes to rest.

The contacts 181, 181^b, 181^c, etc., of which there are ten as indicated in Fig. 3, showing a front view of a line selector contact bank, are not individual to a calling line but are common to ten calling lines. As is shown in Fig. 3, the terminals of a group of one hundred lines are divided into ten groups of ten, the contact sets of each such sub-group being arranged in a vertical row with a contact 181, 181^b or 181^c, etc., individual to the row.

The relay 164 is common to ten lines, whose contacts comprise a vertical row in Fig. 3, and has ten branch conductors 202, 202^a, etc., one leading to each relay 150 of the ten lines which the relay 164 serves.

The common contacts 181, 181^b, 181^c, etc., of the sub-groups are normally grounded, as shown, at back contacts of the relays 164. By means of his individual relay 150, a calling subscriber causes the actuation of the common relay 164 of his sub-group, which is then effective to take ground off the common contact 181 to render it selectable by the line selector.

The individual multiple contact sets 160, 161, etc., of a line are normally non-selectable by the line selectors, because their multiple contacts 161 are normally grounded via the back contact of armature 151 of relay 150. Relay 150 by its actuation under substation control removes this ground and so renders the contact sets, belonging to and individual to the line, selectable by the line selector.

It will be understood that the sub-group contact 181 and the individual line contact set 160, 161, 162, 163, are multipled to the banks of each of the ten line selectors having access to the one hundred group of calling lines, so that when a subscriber renders his common and individual contacts selectable as above mentioned, this condition occurs at each of the ten line selector banks, so that it is immaterial which one of said selectors is started in its travel by the master switch N when a call is initiated.

The branch conductors 201, 201^a, etc., are one hundred in number and extend one to each relay 150 of the one hundred lines whose ten line selectors the master switch N controls, so that each line is thereby operatively related to the winding 166 of master-switch relay 165.

Briefly stated then, the removal of the receiver at a substation, as A, effects the energization of relay 150, individual to the line. Three principal effects are produced in consequence. First: relay 165 of the master switch is influenced to cause wiper 170 to seek out and start an idle line selector. Second: common sub-group relay 164 is actuated to remove ground from the common contact 181 or 181^b, etc., at each line selector bank (see Fig. 3). Third: ground is removed from the individual line contact 161 at each line selector bank.

The started line selector begins its primary movements under control of wiper 180, which of course finds the successive contacts 181, 181^b, etc., grounded until the contact, belonging to the sub-group of the calling line, is reached. This contact, being ungrounded, opens circuit via wiper 180 and stops the primary movements of the switch.

Wipers 176, 177, 178 and 179 move along with wiper 180 as it seeks the row and stop with 180 when the row is found.

The four last-mentioned wipers then start traveling along the selected row, being fastened together, while wiper 180 remains stationary. These secondary movements are controlled by wiper 177 which of course finds the successive contacts 161 of lines not calling grounded, causing the four wipers to continue moving until the individual contact 161 of the calling line is reached. This contact, being ungrounded, opens circuit through wiper 177 and stops the four wipers in engagement with the line terminals 160, 161, 162 and 163 respectively.

The relay 17^a at line circuit Q is similar in function to relay 17 of switch E in Fig. 1, and is controlled in the present case by a special wiper 176.

Assuming that the subscriber at A in Fig. 2 desires connection with a subscriber assumed to be #2345 as before, he first removes his receiver, whereupon current flows from G^{16}, through relay 150, contact 156, over limb P, through hook-lever 4, and the substation transmitter, limb S, contact 159 to battery. Armature 153 closes circuit through relay 164 via conductor 202, causing 164 to disconnect G^{17} from common contact 181^c of the third sub-group, to which group, line A belongs, as is assumed. Armature 151 disconnects ground G^{15} from the individual line contact 161. Armature 152 establishes a locking circuit for relay 150 to insure a continuing ungrounded condition of contacts 181^c and 161 until the line shall have been selected.

Armature 154 completes circuit from G^{16} through resistance 201 and winding 166 of master-switch relay 165 to battery, which results in the attraction of the armature of relay 165, closing G^{22} to wiper 170.

Let it be assumed that contact 171 is the terminal of a line selector already in use and of course similar to O. In such case, the primary off-normal switch spring 185 of this line selector will have moved to engage its opposed contact, such movement always occurring with the first movement of the wipers of a line selector.

Current will hence flow from ground G^{22},

through 170—171, through spring 185, and its opposed contact of the line selector whose terminal is 171, then via common conductor 205 (from which branch conductors lead to the opposed contacts of springs 185 of the ten line selectors), through relay 168 to battery. The energized relay 168 now closes circuit through the operating magnet 169 of master switch N, which magnet vibrates its armature to move wiper 170 a step to engage contact 172. Assuming again that this belongs to a busy line selector, a second circuit through relay 168, via spring 185 and its opposed contact of this second line selector, will be completed, and relay 168 will hold its armature attracted while the vibratory magnet 169 makes a second stroke of its armature to move wiper 170 to engage contact 173, the terminal of idle line selector O. From the foregoing it is apparent that wiper 170, once started, will continue its movement until it reaches the terminal of an idle switch. It may be stated at this time that wiper 170 always moves in the one direction and is not restored to any initial starting point. The contacts engaged by wiper 170 will of course be arranged in a complete circle or may form the arc of a circle, in which case wiper 170 would be provided with a plurality of arms set at angles, determined by the degrees of the arc, so that one arm will move to engage the first contact of the arc as another moves off the last contact.

Having brought wiper 170 to engage an idle contact, the stopping of 170 and the starting of the idle line selector will be described. As shown at O, spring 185 of an idle switch is at normal so that circuit is opened through relay 168 as soon as contact 170—173 is closed, whereby relay 168 is de-energized, opening the circuit of magnet 169, whose resulting continuing de-energization allows wiper 170 to remain at rest. Relay 165 of course continues energized under the influence of relay 150 of the calling line, so that circuit is now completed from ground G^{22}, via contact 170—173, spring 185 at O, through relay 181 to battery. Relay 181 attracts its armature 184, completing circuit from G^{20}, through vibrating primary magnet *pm*, which thereupon effects a first primary movement of wiper 180 to engage the first sub-group contact 181^a, wipers 176, 177, 178 and 179, of course, also moving to a position opposite the first sub-group contact row.

With the first movement of the line selector wipers, off-normal springs 185, 186 and 187, and also release spring 188, are shifted to their abnormal positions. The movement of spring 186 causes current to flow from G^{18}, through spring 188, normal contact 197, resistance 186^a, spring 186, common conductor 206, winding 167 to battery. Resistances 201 and 186^a are equal, and as 201 is in circuit with winding 166 and 186^a in circuit with winding 167, relay 165 is de-energized, its windings being differential in character. Thus G^{22} is instantly disconnected from wiper 170. The movement of spring 185 at O to engage its opposed contact would cause relay 168 to again become energized, with the effect of again moving wiper 170, were it not for the de-energization of relay 165 which occurs in time to prevent this.

Let it be supposed that at the time contact 170—173 is closed, two subscribers on different lines had removed their receivers. In such case, two paths for current through winding 166 would exist, one through resistance 201 and another through resistance 201^a of the second line. In such case, the starting of switch O, cutting resistance 186^a in circuit with winding 167, would of course only partially neutralize the effect of winding 166 and relay 165 would retain its armature attracted. In such case, as soon as spring 185 at switch O engaged its opposed contact, a new circuit for relay 168 would be completed; wiper 170 would again begin to travel to seek out and start a second line selector in search of the second line. Thus, if two calls are simultaneously made via the same master switch, wiper 170 travels until it has started two line selectors, pausing momentarily only in its travel when it starts the first one until such switch makes a single first step. Similarly, if three calls or four calls come in simultaneously, a number of line selectors will be started quickly one after the other, corresponding in number to the calls sent in.

As has been stated, spring 185 is now shifted and this condition would cause de-energization of relay 181, except that attracted armature 182 has completed a locking circuit for 181 via wiper 180, the first sub-group contact 181^a to G^{17} of another sub-group relay 164. Relay 181 hence continues energized and primary magnet *pm* vibrates its armature a second time to bring wiper 180 upon contact 181^b. This will be grounded via the back contact of its sub-group relay; relay 181 continues energized; and *pm* advances wiper 180 a third step to engage contact 181^c. As relay 164 is energized, this contact 181^c is on open circuit and relay 181 becomes inert. Wipers 176, 177, 178 and 179 have now been moved to a position adjacent to the row of line contacts appropriate to contact 181^c, among which multiple contacts 160, 161, 162, 163 of the calling line are included.

To start the wipers along the selected row, armature 183 on its retraction closes circuit from G^{21} through spring 187 which is now shifted, armature 183 and its back contact, secondary off-normal switch spring 196 and

its normal contact, relay 189 to battery. The said relay attracts its armature, of which 190 and 193 disconnect the line wipers 178 and 179 of the line selector to hold them on open circuit while wiping over terminal contacts of lines that may be in use. Armature 192 closes circuit from ground G^{18}, through spring 188 and its opposed contact, through contact 194—192—195 and through secondary magnet *sm* of the line selector. This magnet, being in vibratory circuit, attracts and releases its armature, moving wipers 176, 177, 178 and 179 to engage the first set of line contacts of the selected row, wiper 180, as before stated, remaining stationary and in engagement with contact 181^c. With the first secondary movement of the wipers, secondary off-normal switch springs 196 and 197 are shifted, 197 opening the before traced circuit extending from ground G^{18}, through resistance 186^a and winding 167 of relay 165; a branch path, however, having been established by the closure of contact 194—192, from ground G^{18}, through resistance 186^a and winding 167. The neutralizing effect of windings 166 and 167 is not at this time altered, but such condition continues until the line selector has finally picked out the calling line. Until the contact set including contacts 160, 161, 162 and and 163 of the calling line is reached, wiper 177 will be passing successively over contacts, terminals of non-calling lines, which contacts will be grounded at G^{15} of their respective line circuits, through armatures 151 and 157 of such line circuits. Successive and continuous locking circuits will therefore be established from such grounds G^{15}, through wiper 177, relay 189 and its attracted armature 191 to battery, holding the said relay energized and permitting the secondary magnet *sm* to vibrate its armature successively, moving the wipers of the line selector successive steps until wiper 177 reaches contact 161 of the calling line which will be found ungrounded, because relay 150 of the calling line is energized and holds its armature 151 attracted. Owing to this, relay 189 has its circuit opened and its armatures will be retracted, 190 and 193 completing circuit from wipers 178 and 179 through to the circuits of first selector F′; and armature 191 falls back to complete circuit from ground G^{19} at the line selector O, through release magnet *rm*, by way of conductor 199, armature 191, contact 177—161, armature 157 and its normal contact, armature 151 and its opposed contact, through relay 155 to battery, causing the actuation of relay 155 but not the actuation of the release magnet *rm*, the windings of the two said electromagnets being properly proportioned to this end. Armature 157 of relay 155 completes a locking circuit for the relay from ground G^{19} at O, while armature 158 opens the locking circuit of the relay 150, causing the said relay to be de-energized. Armature 157, in addition to establishing the locking circuit, connects ground G^{19}, by way of the armature of relay 17^a and its back contacts, to contact 7 of the calling line and its multiples at the various connector banks, rendering the line busy to incoming calls. Armatures 156 and 159 complete the circuit of limbs P and S and the line of subscriber A, through contacts 162—178 and 163—179, armatures 190 and 193, through to the circuits of the first selector F′, which switch is now capable of being operated from substation A by impulses transmitted over limbs P and S in a manner similar to that described in connection with Fig. 1; and from this point, the operation of the system of Fig. 2 is the same as that already given in connection with Fig. 1 up to the time when the connector connects with the called line, except of course that the impulses transmitted through relays PR and SR from the calling substation traverse the talking conductors of the line selector instead of the talking conductors of a private switch, as in Fig. 1.

As the switches I employ for line selectors are of the type adapted to select any one of the hundred sets of contacts in a maximum of twenty steps, this maximum indeed being only required for that set of contacts farthest distant from the normal position of the wipers; and as the maximum number of steps the master switch is required to make is ten, it will be seen that, under the most unfavorable conditions, thirty step-by-step movements only are required to select the calling line. Thirty steps per second is by no means an excessive speed at which to operate a switch of the character hereinafter shown, and under these circumstances the average time, after a subscriber removes his receiver to the time when a first selector is brought into circuit with his line, will be materially less than one second.

It may be observed at this time that no means are provided for releasing a line selector except by apparatus located at its associated first selector. Although an improbable occurrence, it might happen that a calling subscriber would remove and replace his receiver before a line selector had picked out his line. In such case, the line would nevertheless be selected because of the locking circuit provided for relay 150: and one of the ten line selectors with its associated first selector, assigned to the one hundred group in which the line of the calling subscriber is included, would be out of service and unavailable to the other subscribers until another call came in from that line. In view of these conditions, a lamp

l at first selector F′ is provided, its arrangement being such that on the first movement of the line selector O, the shifting of spring 188 provides a path for current from ground G^{18}, over conductor 200, contact 57^a, lamp *l* to battery, causing the lamp to light. It so continues until the first movement of first selector F′, when off-normal switch spring 57^a opens the lamp circuit, causing it to be extinguished. Ordinarily, the display of these lamps should be for a second or two only. If the lamp should continue to burn, the switchboard attendant would know that the first selector was in some trouble and would restore the apparatus by hand to its normal position.

With each secondary switch impulse transmitted from the substation over limb S, traversing the secondary relay SR, the said relay completes a circuit from ground, through relay 17^a at O, contact 160—176, over conductor 198, closed switch contact of relay SR, through release magnet RM to battery. Relay 17^a attracts its armature momentarily, while the impulse through SR continues, removing ground from contact 7 and its multiples, so as to enable a calling subscriber, desiring conversation with another subscriber on his own line, to complete a connection with his own line by means of a connector in a manner substantially similar to that described in connection with Fig. 1. The winding of release magnet *rm* is so proportioned that when current flows therethrough in series with the winding of relay 17^a, *rm* is not sufficiently magnetized to be operated.

As before stated, the first selector F′ is arranged similar to the first selector F shown in Fig. 1. It operates in connection with second selector G and connector H of Fig. 1, Sheet 2; and it being assumed that subscriber A desires to be connected to subscriber D′, whose substation is shown in Fig. 1, and whose number is 2345, the same series of impulses as that before described is transmitted from substation A, through primary relay PR and secondary relay SR, and the said relays operate successively the first selector F′, second selector G and connector H, just as before described in connection with Fig. 1. It is now assumed that the telephone line of substations A′, B′, C′ and D′ of Fig. 1, Sheet 2, is provided with a line circuit similar to that shown at Q, instead of that actually shown at I. It being assumed that the called line is idle, reference to Q in Fig. 2 will show that contact 7, now supposed to be engaged by wiper 124 of connector H, is connected through the winding of relay 155 to battery. Therefore, no locking circuit is completed for test relay TR when it is energized, responsive to a secondary impulse transmitted after the last set of impulses sent over limb P. Relay TR therefore becomes de-energized and spring 103 is shifted to its alternate position and a circuit is immediately closed from ground G^{10}, through relay 105, spring 103 and its opposed contact, contact 124—7, armature of relay 17^a (see Q), the winding of relay 155 to battery. The connection of ground G^{10} to contact 7 renders the called line busy, as described in connection with Fig. 1. Relay 105 is energized, as is also relay 155 of the called line, the latter attracting armatures 156 and 159 to close the circuit of the called-for line to the connector bank contacts 8—9, now engaged by wipers 126 and 127 of the connector. Armature 157 of relay 155, in engaging its opposed contact, connects ground G^{10} at the connector through to contact 161 at the line selector banks, causing the called line to continue in its normal unselectable condition. Relay 105 at the connector is of course energized at this time, and the remaining operation proceeds as described in connection with Fig. 1, including the ringing of the called subscriber and the shifting of springs 30, 31 and 32, 33 when the called subscriber answers the call.

When either subscriber replaces his receiver, release relay RR is operated as before described; and on the resulting rotation of disk 72, circuit is closed from ground G^{19}, through release magnet *rm* of the line selector O, over conductor 199, contact 75—76, release magnet RM to battery. Both are actuated, the actuation of RM causing RM′ at the second selector G to be energized, which in turn effects the energization of RM^2 at the connector; and when disk 72 completes its revolution, the release magnets become de-energized and the switches are restored to their normal positions.

If the called line had been found busy when wipers 124, 126 and 127 engaged its contacts 7, 8 and 9, contact 7 would have been grounded at G^{19} of a line selector if the called line was busy because a call has been initiated thereover; or at ground G^{10} if another connector has already made connection with the line. In either case, on the energization of the test relay TR, a locking circuit therefor would be established from the grounded contact 7, via wiper 124, spring 103 and its normal contact, armature 101, the right winding of TR to battery. The test relay would continue energized and would transmit the busy signal to the calling substation in a manner similar to that before described in connection with Fig. 1. The calling subscriber would thereupon replace his receiver, causing a momentary simultaneous energization of relays PR and SR, whose attracted armatures would throw release magnet *rm* at O in series with release magnet RM at F, causing the actuation of both release magnets and the resulting

actuations of RM′ and RM². On the ensuing de-energization of relays PR and SR, the release magnets would be de-energized and the switches restored, leaving all apparatus, including the line circuit of the calling subscriber, at normal.

If it be assumed that subscriber A desires to be connected with subscriber D on his own line, he accomplishes this by bringing wipers 124, 126 and 127 of the connector to engage contacts 7, 8 and 9 of his own line. Immediately following this engagement, the actuation of relay SR causes test relay TR to be energized, and simultaneously therewith relay 17ª to be energized. Since the armature of relay 17ª is attracted, contact 7 is temporarily disconnected from ground G¹⁹ at the line selector O, and no locking of the test relay results, the relay becoming de-energized and spring 103 being shifted to its alternate position as soon as the secondary impulse is ended. Relay 17ª is simultaneously de-energized, whereupon current flows from ground G¹⁰ at the connector H, through spring 103 and its opposed contact, contact 124—7, relay 155 to battery. Relay 105 is then energized and the ringing up of called subscriber proceeds in a manner similar to that described in connection with Fig. 1, continuing for one revolution of disk 117; on the completion of such revolution, relay 111 is energized, which results in the energization of 110, whose attracted armature takes current from magnet 34, resulting in the shifting of springs 30—31 and 32—33.

In this connection, it should be observed that as soon as spring 103 is shifted, the resulting closing of contact 105ª—106 completes circuit in the usual manner through magnet 34 at F′, causing the attraction of its armatures and the resulting energization of relay 36, which latter is immediately locked by a current from G⁸, through its attracted armature 38, spring 43, to the left over the heavily marked talking conductor, through the calling substation, returning over limb S, the heavily marked conductor, through spring 45, attracted armature of 39 and lower winding of relay 36 to battery. The relay therefore continues energized and when, with the before indicated de-energization of relay 34, spring 32 is shifted, and hence relay 41 becomes energized, the flow of current in the calling line is supplied to limb P from the active side of battery, through the lower winding of relay 36 and the lower winding of relay 110, returning over limb S via the upper winding of relay 36 and the upper winding of 110 to ground.

Referring now to Fig. 4, this drawing may be substituted for Fig. 2, Sheet 1, in a system similar to that just described. The operation of Fig. 4 is similar to that of Fig. 2, Sheet 1, except as regards the operation of master switch N in connection with the line selector.

In the said Fig. 4, an additional set of ten contacts and an additional wiper 170ª, which may be mounted upon the same shaft as wiper 170 and moved with it, are provided. The conductor 205ª and its terminal contact in the structure of Fig. 4 are individual to a line selector terminating at it in primary off-normal switch spring 185ª. These individual conductors 205ª take the place of the common conductor 205 of Fig. 2, Sheet 1.

This arrangement is provided for the purpose of securing the desirable method of operation whereby the wiper 170 of the master switch normally rests upon the terminal of and idle line selector. Thus, when a calling subscriber initiates a call, no movements of the master switch wiper ordinarily are required; the master switch starts the idle line selector upon whose terminal wiper 170 rests; and as soon as said switch is started, wipers 170 and 170ª start to travel and seek out terminals of an idle line selector, engaging which they come to rest waiting for another call to be initiated. The operations whereby this is accomplished are as follows:

Assuming that a calling subscriber, as A, removes his receiver, operations are as before described, whereby relay 165 is energized, closing circuit from ground G²², via conductor 170ª, contact 170—171, contact 185 and relay 181 to battery, initiating travel of the line selector which, in starting, closes circuit via resistance 186ª and winding 167 of relay 165 to neutralize its core and retract its armature, as described in connection with Fig. 2, Sheet 1. Primary off-normal switch spring 185ª, shifted on the first movement of the line selector to engage its opposed contact, closes circuit from ground connected thereto, over the individual conductor 205ª, contact 171ª—170ª, relay 168 to battery. The relay attracts its armature, closing circuit through operating magnet 169 which moves their shafts and wipers 170, 170ª to engage contact 172—172ª respectively. If contact 172² belongs to a busy line selector, the contact would be grounded by the shifted spring 185ª of such line selector; relay 168 will continue energized and magnet 169 will make another step. This process will be repeated until wiper 170ª engages a contact of an idle line selector, which contact being open at spring 185ª of such line selector, relay 168 is de-energized and its retracted armature prevents further operation of magnet 169. The wipers 170 and 170ª therefore rest, engaging terminals of such idle line selectors. Such a switch is, of course, not started to operate because relay 165 is de-energized and its armature retracted.

Of course, if two calls are to come in to a master switch simultaneously, or substan-

tially so, the first line selector would be started instantly and the just described operation would proceed, except that the idle switch selected would be started inasmuch as the armature of relay 165 would be attracted, owing to a preponderance of current in winding 166 of relay 165 over that in 167, as before described.

The selection of the calling line by line selector O is effected in exactly the same manner as that before described in connection with Fig. 2, Sheet 1, and the remainder of the operations are the same as those before described in connection with the complete circuit diagram including Fig. 2, Sheets 1 and 2, and Fig. 1, Sheet 2.

The private switch mechanism, of which the front view is shown in Fig. 20 and the side view in Fig. 21, is adapted for operation in connection with the circuits at E and I of Fig. 1. In the said circuits E and I, the only electromagnets having mechanical structures associated with them, other than ordinary relay combinations, are magnets 14 and 16 and these and their associated parts only are shown in Figs. 20 and 21.

In Fig. 20, ten sets of first selector terminals are shown arranged in the arc of a circle, each set including contacts 23, 26 and 29. The special contacts 22, 25 and 28 are shown at the left of the arc. The wipers 21, 24 and 27, of which 24 and 27 normally engage contacts 25 and 28, are mounted upon a rotatable shaft 212, to which is fastened rack 210 provided with a pin 210^a, normally holding switch springs 10—11 engaged as shown. Operating magnet 14 is provided with an armature-driven pawl 14^a arranged to engage the teeth of rack 210 when magnet 14 is energized, and with each energization thereof, rotates the rack 210, shaft 212 and the wipers one step from left to right. The first actuation of magnet 14 causes pin 210^a to disengage spring 11, whereupon off-normal springs 11 and 10, by their tension, disengage one another and engage their alternate contacts. The first actuation of magnet 14, by means of pin 14^f fastened to its armature and interlocking with release spring 16^a of release magnet 16, bends the said spring to the left, bringing it to such a position that its catch 16^b disengages the upper surface of retaining pawl 211 and allows the pawl to turn on its pivot to engage a tooth of rack 210, thus holding the rack and shaft temporarily against backward rotation under the influence of spring 213 shown in Fig. 21, against whose tension the shaft is returned. As pawl 211 turned on its pivot to engage the rack 210, its backwardly extending portion slips up to engage catch 16^b, now drawn to the left, whereby spring 16^a is held in its bent position until the switch is restored. This bending of spring 16^a draws its upper end away from the buffer upon spring 12, and the spring engages its alternate contact. Thus the first actuation of operating magnet 14 advances the wipers a step, shifts off-normal springs 10 and 11, releases the retaining pawl 211 and shifts spring 12.

Succeeding energizations of magnet 14 serve only to advance the wipers successive steps to engage successive sets of their contacts. Beneath magnet 14 is shown a spring 14^b fastened to its armature, serving, as the magnet becomes energized, to open contact 14^c—14^d, whereby the circuit of the magnet is interrupted and the magnet again de-energized when the springs again engage, thus rendering the magnet's circuit vibratory in character, as indicated at E and I in Fig. 1.

The restoration of the private switch is effected by magnet 16 which, in attracting its armature, in addition to closing the ordinary relay spring combination mounted thereon, draws spring 16^a upward to a point where catch 16^b is above the backwardly extending portion of retaining pawl 211, when the tension of the spring 16^a causes it to draw toward magnet 16, catch 16^b then engaging the upper surface of pawl 211 and also the buffer upon spring 12, the tension of 16^a acting upon the buffer and restoring spring 12 to normal. When release magnet 16 is thereafter de-energized, its armature draws spring 16^a downwardly, its catch 16^b rotating pawl 211 about its pivot to disengage rack 210. The rack, shaft and wipers are then free to rotate, under the influence of spring 213 shown in Fig. 21, to normal, which they do; pin 210, as the wipers reach normal, engaging spring 11 and causing it to again engage spring 10, the two said springs simultaneously disengaging their opposed contacts.

The master switch shown at N in Figs. 2 and 4 is mechanically illustrated in Figs. 22 and 23. It includes the ten line selector contacts 171, 172, 173 etc., arranged in an arc of ninety degrees with a common strip 170^a extending beneath them. The wiper 170 has four arms at angles of ninety degrees, as determined by the central arc, so that one arm and one only will always be engaging strip 170^a and a contact. The wiper itself has no circuit connections serving only to cross 170^a successively to contacts 171, 172, etc.

The wiper 170 is fastened to the rotatable shaft 169^e, to which in turn is rigidly attached the circular rack 169^d. The operating magnet 169, when energized, effects a thrust of armature-driven pawl 169^c which, engaging 169^d, rotates rack, shaft and wiper a step. Fastened to the armature of magnet 169 is spring 169^a, whose left end moves downward as the armature is attracted to engage and move spring 169^c out of engagement with 169^b, rendering the magnet's cir-

cuit vibratory in character, as indicated in Figs. 3 and 4.

Having described the mechanisms of the simpler switches which as described are directly operated by the preliminary closing of the line circuit at the substation, I shall now proceed to describe the mechanisms of the principal switches used in connection with the circuit diagrams and thereafter will take up mechanisms of the special ringing and release circuits.

The principal selective mechanisms or switches employed in connection with my invention comprise each essentially a contact bank including one hundred sets of circuit terminal-contacts arranged in ten groups or rows of ten contact sets each, with which bank is associated a single set of wipers forming circuit terminals capable of being moved in a first plane (primary movements) to select a particular group or row of contact sets of the ten groups provided, and then, in a second plane (secondary movements) along a selected row of contacts to engage a particular set, thus completing a desired circuit.

Auxiliary to the bank and wiper circuit control apparatus, a pair of switches are provided—namely *p.o.sw.*, including springs adapted to be shifted as the first primary movement of a wiper is made, and the secondary off-normal switch *s.o.sw.*, including springs adapted to be shifted when the first secondary movement of a wiper is made.

A third auxiliary switch is provided including a spring or springs, shifted as the first primary movement of a wiper is made.

A switch includes also apparatus for releasing or restoring its wipers and the auxiliary switches to normal when their use is no longer required, and the auxiliary switch last mentioned is restored just as the release apparatus is set to restore the wipers and before the wipers move toward their restoration. This switch may be called a release switch *rsw.*

When the wipers have returned, as to the secondary movements, the secondary off-normal switch is shifted to normal, and when the wipers have returned to normal, as to the primary movements, the primary off-normal switch is shifted to normal.

As stated, these are the principal parts of a switch and they are common to and included in a line selector, a first selector, a second selector or a connector.

The principal parts, magnets, off-normal switches, etc., I have indicated on the various switch-circuits of Figs. 1, 3 and 4 by corresponding letter combinations, *pm* for primary magnets, *sm* for secondary magnets, *p.o.sw* for primary off-normal switch, *s.o.sw* for secondary off-normal switch and *r.sw* for release switch, employing small letters to designate these parts in the line selector circuits, large letters in the first selector circuits, large letters primed in the second selector circuits and large letters squared in the connector circuits.

In the immediately following general description I shall refere more particularly to Figs. 6, 7, 11 and 13, these figures showing completely a line selector and shall thereafter indicate such changes as are necessary in the general structure to adapt it for use as a first selector and second selector.

For effecting the primary movements of a switch's wipers and for operating and restoring the primary off-normal switch, a first or primary shaft *ps* is provided, controlling which is a primary magnet *pm*, with its armature-driven pawl arranged to engage a circular rack upon the shaft.

Similarly, a second or secondary shaft *ss* is provided for effecting the secondary movements of the wipers and the operation and restoration of the secondary off-normal switch, controlling which is a secondary magnet *sm* with its armature-driven pawl arranged to engage a suitable rack upon the shaft.

Both shafts are provided with springs, tending to hold them at normal, against the tension of which springs the shafts are respectively moved. To prevent back motion, retaining pawls are provided, one for each shaft, engaging respectively racks upon the shaft when the switch is in use. When the switch is to be restored, these pawls are withdrawn and so held by the mechanism of a release magnet provided, whereby the two shafts are permitted to return to normal under the influences of their springs.

A preferred form of contact bank is indicated in Fig. 6, where a front view is shown, each set of contacts being represented by a single short line. As shown, the bank as a whole presents the appearance of a portion of a hollow sphere, the contacts projecting inwardly through the surface. Each curved row of contacts in the bank, Fig. 6 and Fig. 5, constitutes a group. The set of wipers shown is in its normal position, its primary movements to select a group of contacts being from left to right, Fig. 6, the ends of the wipers moving in the arc of a circle. The wipers are pivoted in a bearing which is firmly clamped to primary shaft *ps* and have an extension 220 extending to and engaging, by an associated roller, a broad lug 221 upon secondary shaft *ss*. The rack fastened to the primary shaft is circular as shown at 222 in Figs. 11 and 6 being adapted to rotate the primary shaft under influence of the armature pawl of *pm*, Fig. 11, their primary movements, rotary in character, being thereby imparted to the wipers.

In performing their secondary movements, the ends of the wipers also move in the arc of a circle toward the top of the bank and

in a plane at right angles to that of their primary movements.

The secondary shaft *ss* is provided with a rack 223 consisting of ten teeth cut in its edge, see Fig. 5, adapted to be engaged by the armature pawl of the secondary magnet *sm* to move the secondary shaft downwardly so as to cause it to impart their secondary movements to the wipers by means of the broad lug 221 clamped to the lower end of *ss* and engaging the roller 224 of the wipers. This lug is broad so that, when the wipers are making their primary movements, roller 224 moves freely across the lug without at any time passing off it, even when the full ten primary movements of the wipers have been made. Thus, whenever the secondary shaft is moved, no matter what number of primary movements have been made, the wipers are rotated in their pivoted support up along a selected group of contacts.

The spring, against whose tension the primary shaft is rotated, is indicated at 225, Figs. 5 and 7. The spring, against whose tension the secondary shaft is moved, is indicated at 226, Fig. 5, being disposed about the pivotal bearing of the wipers, its tension being transmitted via the wiper extension 220 and roller 224 to the lug 221 and the secondary shaft, tending always to press the shaft up.

The primary shaft retaining pawl 227 and that of the secondary shaft, 228, are shown, see Figs. 11 and 5, as out of engagement with the shaft ratchets, this being their normal position. The first 227 engages, when the switch is operated, the circular rack of the primary shaft. The latter 228 engages a separate rack, 229, of ten teeth provided on the secondary shaft.

As shown in Figs. 11 and 7, these pawls are held in these normal positions by a spring arm 230 upon the armature of release magnet *rm*, which arm is provided with two orifices 231 and 232, arranged to engage corresponding projections 233 and 234 upon the retaining pawls and hold them out of engagement with the shafts, the pawls being pivoted and provided with springs which would otherwise hold them against the shaft racks. It may be stated at this time that the release magnet when energized, attracts its armature to move the spring arm 230 to the left (Fig. 7) so that its orifices engage the said projections. When the said armature is retracted, the spring-arm 230 is moved in the opposite direction and, having previously engaged the retaining pawls, moves them about their pivots to disengage the shafts.

It being of course necessary to bring these retaining pawls into operation as soon as a switch is started to operate, pivoted arm 235 is provided, one end (as best shown in Fig. 11) being arranged to be engaged by the armature of primary magnet *pm* each time it is attracted. The other end of arm 235 (as best shown in Fig. 7) is provided with a small roller *m* engaging the pivoted arm 236. Thus, when the primary magnet *pm* is energized the first time, its armature turns arm 235 a short distance about its pivot, (Fig. 11) causing the roller *m* to engage the projection on arm 236 (Fig. 7) which is thereupon raised upward and lifts spring 230 so that its orifices are above the projections of the retaining pawls and the pawls move to engage their respective shaft racks, to hold the shafts (and hence the wipers) in whatever positions they may be moved to by the primary and secondary magnets.

The release switch *rsw* is shifted simultaneously with the last described operation and by the same mechanism. As shown in Fig. 7, its spring 188 is normally held engaging its normal contact by a catch upon the right end of pivoted arm 236. When roller, *m* on 235 lifts the left end of arm 236, the right end thereof is depressed and the catch disengages spring 188 which, by its tension, moves to engage its opposed contact. When the release magnet *rm* is energized, preparatory to the restoration of the switch, the hooked spring-arm 230, attached to the magnet's armature, engages the spring 188 and moves it so that it slips over and is held by the catch on arm 236.

The primary off-normal switch *p.o.sw.* is well illustrated in Figs. 5, 6 and 14. It includes any required combination of switch springs with their associated contacts and a stud of insulating material 240 engaging the switch springs, which stud is itself normally pressed upon by the arm 241, clamped to primary shaft *ps* and moving with it. Such pressure is of course effective to hold the switch springs in their normal positions, the tension of shaft spring 225, (Fig. 5) overcoming their own tension.

With the first movement of the primary shaft, the arm 241 is rotated away from stud 240, tension is thereby removed from the switch springs and they shift to their alternate positions. When, on the restoration of the switch, the primary shaft reaches normal, arm 241 again engages and moves stud 240, which restores the primary off-normal switch springs.

The secondary off-normal switch is well illustrated in Figs. 6 and 7. It includes a suitable combination of switch springs and their associated contacts. A stud 242 of insulating material engages the switch springs, which stud is pressed upon by the arm 243 fastened to secondary shaft *ss*. The tension of the secondary shaft restoring spring 226, (Fig. 5), is sufficient to overcome that of the switch springs and they are held at normal. When the switch is being operated,

the first movement of the secondary shaft brings arms 243 to disengage a stud 242 and the switch-springs are, by their tension, shifted to their alternate positions. When the retaining pawl is withdrawn from *ss*, the shaft is restored; and as it reaches normal, arm 243 engages stud 242 to press the springs to normal.

To effect the sequence of restoration of the shafts in reverse order to that in which they were operated, a long detent 244 is provided, as shown in Figs. 5 and 11, upon the secondary shaft. This detent extends lengthwise of the shaft, its lower end being normally just above the circular rack of the primary shaft. When the first movement of *ss* occurs, detent 244 engages whatever tooth of the circular rack may be adjacent to it and moves down in the tooth as further movements of *ss* are made. Because of this interlock of the secondary shaft with the primary shaft, when the retaining pawls are withdrawn from the shafts to release the switch, the secondary shaft, until it reaches normal, nullifies any influence of the primary shaft restoring spring. When it does reach normal, the interlock is of course broken and the primary shaft spring rotates the shaft at the left of the arc.

Recapitulating, the first actuation of the primary magnet is effective (1) to move the wipers a first primary step; (2) to shift the primary off-normal switch and the release switch; and (3) to release the retaining pawls of primary and secondary shafts.

Succeeding actuations of the primary magnet are effective only to move the wipers additional primary steps.

The first actuation of the secondary magnet effects (1) a secondary movement of the wipers; (2) shifts the secondary off-normal switch; and (3) causes the secondary shaft to interlock with the primary shaft. Succeeding actuations of the secondary magnet simply move the wipers additional secondary steps.

The energization of the release magnet causes (1) its associated armature spring to engage the retaining pawls of the two shafts; and (2) the release switch to be shifted to normal.

The de-energization of the release magnet causes its armature spring to withdraw the retaining pawls, the secondary shaft is restored, allowing the wipers to free the bank and restoring the secondary off-normal switch. The primary shaft is restored, bringing the wipers and the primary off-normal switch to normal.

Referring now to circuit O of Fig. 2, Sheet 1, and comparing it with Figs. 5, 6, 7, 11 and 13, the operating magnets, wipers, contacts and auxiliary switches are indicated by corresponding characters on circuit and mechanical drawing, and it is necessary only to call attention to the fact that magnets *pm* and *sm* are each provided with its own circuit-breaker, that of *pm* (Fig. 11) including spring 251, adapted to be moved to disengage its contact by a stud fastened to the armature of the magnet, that of secondary magnet *sm* (see Fig. 5) including spring 250 also operated by a stud upon the magnet's armature.

Referring now to the first selector circuits F and F′, the mechanism of a line selector is applicable to these circuits with changes as follows: The auxiliary wiper 180 of the line selector with its contacts is not employed. Also, but three main switch-wipers are employed and, for each set of bank contacts, but three contacts are used instead of four. It will be remembered that the primary magnet is operated responsive to successive current impulses transmitted from primary relay *pr*. Hence no circuit-breaker is required for the primary magnet, and the mechanism of spring 251 (Fig. 11) would not be employed.

The magnet 34 of Fig. 13 is of course not used in connection with the line selector circuit. It is employed only in connection with the first selector, its function being to shift springs 30, 31 and 32, 33 of circuits F and F′. To this end, the armature of magnet 34 is provided with arm 245 hooked at its left extremity, the arm being held in the normal position shown by pivoted detent 249, supported by the armature of the release magnet. When the armature of magnet 34 is attracted, arm 245 is moved to the left, freeing itself from detent 249, when spring 246 lifts its hooked end to engage arm 247 pivoted at about its center. When magnet 34 is thereafter de-energized and its armature retracted, arm 245 rotates arm 247 about its pivot, the upper end of 247 being drawn to the left. Upon said upper end are fastened the two studs 247^a and 247^b (Figs. 12 and 13), the former engaging springs 32 and 33, the latter springs 30 and 31. These studs are drawn to the left by the described movement of 247 and press their associated springs outward to engage their alternate contacts. When the first selector release magnet is energized, pawl 249, which had been pressed back by arm 245, is tilted down by the magnet's armature and slips under the end of 245. When the release magnet is de-energized, its retracted armature causes detent 249 to lift the right end of arm 245. Its left end is thereby depressed, and arm 247 released, when the tension of springs 30, 31 upen stud 247^b, and 32, 33 upon 247^a restores arm 247 to normal, the switch springs then engaging their normal contacts.

The primary off-normal, secondary off-

normal and release switch spring combinations will, of course, be provided, as indicated at F and F'.

Referring now to the second selector G, the mechanism for this switch is the same as that for the first selector, except that magnet 34 (Fig. 13) is not employed, the proper off-normal and release switch spring combinations being, of course, provided.

The connector mechanism for circuit H is shown in Figs. 8, 9 and 10. It is generally similar to the line selector, but has no circuit-breaker for either primary magnet or secondary magnet. The release switch is omitted.

The test relay TR has fastened to its armature the arm 254 with an upraised portion at about its middle. When the armature of TR is attracted, the upraise is brought to the left of the insulating strip shown fastened to spring 103, arm 254 rises slightly and its upraise engages the spring 103. When magnet TR is again de-energized, its retracted armature carries arm 254 to the right again, which moves spring 103 to engage its alternate contact.

The restoration of spring 103 is effected when release magnet RM^2 becomes energized, the pawl 255 fastened to its armature being drawn down, which, interlocking with arm 254, brings the upraise of the latter downward to disengage the buffer on spring 103, whose tension then causes it to engage its normal contact.

As indicated in Figs. 8 to 10, the connector wipers are normally so placed as to require two secondary steps to bring them into engagement with the first contact set of a group. As before explained in connection with Fig. 1, the first secondary step of a connector is employed only to shift the secondary off-normal switch.

In Figs. 15, 16, 17 and 18, I have shown the mechanism of the structure diagrammatically shown at M in Fig. 1. The said mechanism comprises essentially a revolvable shaft 257 to which are rigidly attached, as shown in Fig. 15, the disk 117, the rack 117^a, the cam 117^b and also the pawl 259, not shown in Fig. 1. In Figs. 17 and 18 is shown the detail of the disk 117, the rack 117^a adapted to be disengaged by armature 118 of magnet 116 when the magnet is energized to allow rotation of the shaft, and cam 117^b normally holding arm 119 out of interlocking relation with armature 118, all as previously described in connection with Fig. 1.

In addition to the apparatus shown in Fig. 1, I have included in Figs 15 and 16 mechanism for providing a continual store of power for rotating the shaft, the detail thereof being best shown in Fig. 16. The spiral spring 268 has one end attached to shaft 257, the other end being attached to the rack 260 which moves freely upon the shaft. Briefly stated, the storage of power is secured by automatically bringing into play at the conclusion of each revolution of the shaft the winding magnet 261 which, with its armature-driven pawl 273, automatically steps rack 260 around until it has completed one entire revolution, thus restoring in spring 268 the exact amount of power expended by it in rotating the shaft one revolution.

To start the operation of magnet 261, the pawl 259 is fastened to the shaft 257, turning with it, the normal position of said pawl with relation to the teeth of rack 264 being parallel with pawl 258 as indicated in Fig. 16. Just before the shaft, after being released by magnet 116, has completed a revolution, pawl 259, turning with it, will engage tooth 269 of rack 264 shown in Fig. 16; and as the shaft continues to rotate, pawl 269 turns rack 264 until tooth 269 is brought to the position which tooth 271 is shown as occupying, when pawl 259 slips off the end of the tooth and rack 264 comes to rest. Rack 263 is fastened to rack 264 and, by the described movement of the latter, has been turned to such a position that spring 266 is brought to rest upon tooth 272, in which position it engages spring 265, whereby the circuit is closed from ground, through the interrupter shown connected to spring 265, contact 266—265, magnet 261 to battery. Under the influence of the interrupter, magnet 261 now continues to vibrate its armature, effecting successive thrusts of pawl 273, turning rack 260 from left to right, retaining pawl 262 holding the rack against back movement after each step. Thus spring 268 is wound up again.

The apparatus for stopping the operation of magnet 261, when it has operated long enough to complete one revolution of rack 260, includes the pawl 258 which moves with rack 260 freely on the shaft from left to right. Thus as rack 260 approaches a complete revolution, pawl 258 will engage tooth 270 of rack 264 which has been moved, by the previous described operation of pawl 259, to the position in which tooth 269 is shown in Fig. 16; and rack 260 continuing to turn, pawl 258 moves rack 264, carrying with it rack 263, from right to left until tooth 270 reaches the position which tooth 271 is shown as occupying, when pawl 258 disengages it and racks 263 and 264 come to rest. By the described movement of 263, tooth 272 has been brought to a position where spring 266 rides down off of it, disengaging spring 265, whereby the circuit of magnet 261 is interrupted and no further actuations of its armature are possible until shaft 257 is again rotated to again effect the closure of contact 265—266 by the operation, as described, of pawl 259.

Referring now to Figs. 24 to 31 inclusive, I there show the substation calling device of my invention arranged for use in connection with the circuit drawings.

A distinguishing feature of said device is the provision of means for preventing operation thereof by the calling subscriber until an idle first selector has been finally brought to connection with his line. This I accomplish positively by a magnet at the substation actuated responsive to the exchange switching mechanism, as more particularly pointed out hereafter. By this means a subscriber is absolutely prevented from prematurely operating the device.

The said device includes a journaled shaft provided with an actuating member to be operated by hand and then released, a spring for returning the shaft, an impulse transmitter actuated on the return, and governor mechanism to regulate the speed of such return.

The shaft a, Fig. 24, is journaled to the front and back plates h and h', and is rigidly attached to the movable finger member b provided with adjacent finger holds.

The actuating mechanism includes said member b adapted for rotation, as indicated by the arrow in Fig. 24, and the lever c adapted when b is turned to move in an opposed direction to meet the finger in the selected hold, when b and c will both be stopped. This arrangement reduces the extent of movement required of member b rendering the device very rapid of operation.

The described cooperation of parts b and c is secured by rack a', (see Fig. 27) rigidly secured to shaft a, meshing with rack e^2 of rocker arm e, the latter being pivoted at its right end. Thus on clockwise rotation of shaft a by means of finger member b, arm e, (Fig. 24) is raised upward and its rack e' meshing with rack d, arranged to turn freely on shaft a and fastened to lever c, imparts to the said lever a movement in the direction of the lower arrow in Fig. 24. The spring for returning the shaft after being turned by b and then released is indicated at a^2 in Fig. 27.

The impulse transmitter includes lever a^3, best shown in Fig. 28, firmly fastened to shaft a and moving with it. Supported upon lever a^3 are pawls f and f' adapted when the shaft is rotated by hand to ride freely over the teeth of their respective ratchet wheels g^1 and g without moving them, and arranged when the shaft is returned by spring a^2 to engage teeth of said wheels, which turn freely on the shaft, and rotate them a distance determined by the extent of movement of member b.

The primary impulse spring 2, Fig. 28, is mechanically attached to spring 2^a, engaging wheel g^1, so that when said wheel is turned from right to left by pawl f, spring 2^a rides over successive teeth, each time causing spring 2 to make and break contact with ground plate i.

As lever a^3 approaches normal on the return its attached arm a^4, which rides up under spring 3 on the first movement of shaft a, engages projection 3^b and riding down on its outer surface, causes spring 3 to make and break contact with plate i a single time.

The governor mechanism includes the gear wheel g, already described, which meshes with the small gear wheel g^2, the latter with wheel g^3 being fastened to an auxiliary shaft l. Wheel g^3 meshes with wheel g^4 loosely turning on main shaft a, and having fastened to it (see Figs. 27, 29, 31) the cross bar k to which are pivoted at j^2 and j^3 segments j and j^1 each provided with its respective slot j^4 or j^5, in which the circular friction member a^5, securely fastened to frame h is received.

Thus when gear wheel g is rotated under the influence of pawl f', when shaft a returns, gears g, g^2, g^3, g^4 are effective to rapidly rotate cross bar k, whose segments j and j' are thrown outward to clutch friction member a^5, whereby the speed of gear g is regulated and hence that of lever a^3 and shaft a.

The magnet 300 best shown in Figs. 28 (front view) and 25, (rear view) is provided with armature 300^a normally held retracted by spring 300^d. To said armature is pivoted the pawl 300^b tending to move downward under the influence of its associated spring. The pivoted arm 300^c is normally held by its spring in semi-position as to be just below lug a^5 of lever a^3, (Fig. 28) whereby movement of shaft a to which a^3 is rigidly attached is impossible until the position of arm 300^c is changed to free the said lug a^5.

When magnet 300 is energized armature 300^a is attracted carrying pawl 300^b to the left (Fig. 28) so that its tooth steps down to engage the cut away upper portion of arm 300^c. When magnet 300 is thereafter de-energized, spring 300^d retracts arm 300^c, which carries pawl 300^b and arm 300^c to the right (Fig. 28) so that the latter frees lug a^5, rendering arm a^3 and shaft a rotatable under the influence of finger member b.

In Fig. 25 is shown a rear view of the device including telephone substation circuits connected at P and S to the line limbs. The hook lever 4 is shown in its normal position as if supporting the receiver. On removal of the latter lever 4 pivoted at 4^e moves upward, stud 4^b removing tension from spring 4^e, which disengages spring 4^f and engages 4^d, whereby the normal circuit through the substation bell and condenser is opened, and

limbs P and S connected in metallic circuit through the transmitter a branch path also existing through magnet 300. A reference to any of the circuit drawings say, Fig. 2, will show that the central battery is at this time in series with limbs P and S and continues so until a first selector has been brought to connection with the calling line, at which time its relation to the limbs is changed, the active side of battery being then connected to both limbs through relays PR and SR.

Magnet 300 will be energized so long as the battery remains in series and so long only. Thus when the first selector is brought into connection with the line magnet 300 will allow its armature to be retracted to release the shaft as before described.

The before mentioned movement of stud 4^b also allows contact i' to be closed connecting ground G′ to contact plate i. As hook lever 4 rises pawl 4^g is lifted to release lever a^6 fastened to the shaft, and just before the upward movement is arrested stud 4^h opens contact 1^a—1^b.

As soon as shaft a is released by magnet 300 the subscriber having inserted his finger in the proper finger hold rotates member b from left to right until b and c cooperate to prevent further movement as before described. As lever b and shaft a begin this movement stud a^8 on arm a^6 fastened to shaft a moves up to allow contact 4^d—4^e to be broken while cam a^7 also fastened to shaft a effects closure of contact 1^a—1^b.

When the subscriber releases member b, the said member and shaft return in the opposite direction spring 2 making and breaking contact with plate i a number of times corresponding to the selected hold and consequent extent of rotation of shaft a, the current impulses flowing from G′ via contacts i'—i; 2; 1^a—1^b; out over limb P.

Before the shaft a reaches normal cam a^7 reaches a position such that its upraised portion no longer holds contact 1^b—1^a closed, the said contact opens and thereafter contact 3—i is closed to send an impulse over limb S, immediately following which stud a^8 closes contact 4^d—4^e.

It will be remembered that as soon as connection is made with the called line, battery is supplied over the calling line. This of course will pass in parallel through the transmitter and magnet 300, the latter being energized to attract armature 300^a which moves pawl 300^b so that arm 4^a again locks lever a^3 and shaft a which condition continues during conversation.

On the removal of the receiver arm 4^a, an integral part of hook lever 4, was tilted slightly to the left of the pin at the end pawl 300^b. When now at the conclusion of conversation the subscriber replaces his receiver, the hook lever 4 is depressed, arm 4^a is tilted toward the pin of pawl 300^b, armature 300^a being now attracted. Just as the hook lever completes its downward stroke stud 4^b opens contact 4^d—4^e, whereby the metallic circuit of the line will be broken, the central office apparatus restored, and magnet 300 deenergized. Armature 300^a is now a second time retracted but this time pawl 300^b does not move arm 300^c to release lever a^3 since arm 4^a is in such position that the pin on pawl 300^b rides up over the pointed end of said arm, the tooth of the pawl freeing arm 4^a and allowing it to hold the shaft a locked.

Referring to Fig. 27, 4^m and 4^n are two arms fastened to lever 4 arranged to move springs 2 and 3 to simultaneously make and then break contact with plate i on the downward stroke of the hook lever, whereby the two line limbs P and S will be simultaneously grounded for a moment for the purposes hereinbefore indicated.

In said Fig. 27 the pawl 4^p is provided upon hook-lever 4 arranged to ride over the teeth of gear wheel g on upward movement of the hook lever, while on downward movement thereof it engages and moves wheel g, whereby the governor regulates the speed of descent of lever 4 to the end that the simultaneous grounding of limbs P and S above mentioned may not be too brief.

In Fig. 26 I show another arrangement for securing a somewhat extended time interval between the removal of the receiver and the unlocking of the shaft.

In the structure of Fig. 26 the magnet 300 and its mechanism are not employed. In Fig. 25 the pawl 4^s unlocks the shaft by disengaging arm a^6 only as the upward stroke of hook lever 4 is nearly completed. Fig. 26 shows a structure to be employed in connection with the device illustrated in Figs. 24—25—27—28 for the purpose of bringing the governor mechanism into play on the removal of the hook lever so that the upward stroke of said lever may be delayed and consequently the unlocking of the calling device.

To this end in Fig. 26, the pawl upon hook lever 4 is made double having two parts, 4^n and 4^s. As shown the latter is normally held disengaged from gear wheel g by spring 4^r fastened to frame h. When lever 4 moves upward the stud on pawl 4^s rides into the bend of spring 4^r, the pawl engages gear g and as the lever moves upward continues in engagement therewith until the upward stroke is nearly completed when owing to the shape of spring 4^r it is brought to free the gear g.

In Fig. 26 I also show an extension upon plate h normally engaged by pawl f^1 and

holding the pawl out of engagement with gear g, so that the said gear is movable from left to right under the influence of pawl 4^g.

I claim as my invention:—

1. An automatic telephone system including a plurality of lines connecting stations with the exchange, passive contacts for said lines at the exchange, a less plurality of link-circuits, selective switches at the ends of said circuits adapted to automatically connect a link-circuit with a passive contact of a calling line, passive terminals for said switches, a master switch common to said switches and lines, a movable contact member therefor adapted to move over said passive terminals and normally resting in engagement with a terminal of an idle one of said plurality of switches, a circuit adapted to influence said master switch operated responsive to currents over a calling line to cause it to initiate travel of said idle one of said plurality of switches, means automatically effective thereon to initiate and continue travel of said master switch past terminals of busy switches to come to rest engaging a terminal of an idle one of said switches, and means for arresting travel of said idle switch when it engages terminals of a calling line.

2. An automatic telephone system including a plurality of lines connecting stations with the exchange, passive contacts for said lines at the exchange, a less plurality of link-circuits, selective switches at the ends of said circuits adapted to automatically connect a link-circuit with a passive contact of a calling line, passive terminals for said switches, a master switch common to said switches and lines, a movable contact member therefor adapted to move over said passive terminals and normally resting in engagement with a terminal of an idle one of said plurality of switches, a circuit adapted to influence said master switch operated responsive to currents over a calling line to cause it to initiate travel of said idle one of said plurality of switches, means automatically effective thereon to initiate and continue travel of said master switch past terminals of busy switches to come to rest engaging a terminal of an idle one of said switches, means for arresting travel of said idle switch when it engages terminals of a calling line, and selective switches at the other ends of said link-circuits adapted to be operated responsive to currents over a calling line.

3. An automatic telephone system including a plurality of lines connecting stations with the exchange, passive contacts for said lines at the exchange, a less plurality of link-circuits, selective switches at the ends of said circuits adapted to automatically connect a link-circuit with a passive contact of a calling line, passive terminals for said switches, a master switch common to said switches and lines, a movable contact member therefor adapted to move over said passive terminals and normally resting in engagement with a terminal of an idle one of said plurality of switches, a circuit adapted to influence said master switch operated responsive to currents over a calling line to cause it to initiate travel of said idle one of said plurality of switches, means automatically effective thereon to initiate and continue travel of said master switch past terminals of busy switches to come to rest engaging a terminal of an idle one of said switches, means for arresting travel of said idle switch when it engages terminals of a calling line, selective switches at the other ends of said link-circuits adapted to be operated responsive to currents over a calling line, other selective switches, with associated link-circuits, arranged for successive operation in completing a connection, and an impulse controller at a station for sending directive switching currents over a calling line to a selective switch in connecting with a called line.

4. An automatic telephone system including a plurality of lines connecting stations with the exchange, passive contacts for said lines at the exchange, a less plurality of link-circuits, selective switches at the ends of said circuits adapted to automatically connect a link circuit with a passive contact of a calling line, passive terminals for said switches, a master switch common to said switches and lines, a movable contact member therefor adapted to move over said passive terminals and normally resting in engagement with a terminal of an idle one of said plurality of switches, a circuit adapted to influence said master switch operated responsive to currents over a calling line to cause it to initiate travel of said idle one of said plurality of switches, means automatically effective thereon to initiate and continue travel of said master switch past terminals of busy switches to come to rest engaging a terminal of an idle one of said switches, means for arresting travel of said idle switch when it engages terminals of a calling line, selective switches at the other ends of said link-circuits adapted to be operated responsive to currents over a calling line, other selective switches, with associated link-circuits, arranged for successive operation in completing a connection, an impulse controller at a station for sending directive switching currents over a calling line to a selective switch in connecting with a called line, and release means at the exchange operable at will from either substation included in a completed connection to restore all switches used for the connection to normal.

5. In an automatic telephone exchange system, a calling and a called line extending

from their respective stations to the exchange, a non-numerical switch operating responsive to the closure of the line circuit at the calling substation to extend a connection from said calling line in the direction of the called line, a plurality of selective switches, operated responsive to successive sets of current impulses controlled at the calling station, connecting said lines, switching mechanisms at the stations adapted to be operated to open the metallic circuits of their lines, release magnets at the exchange, one for each of said switches, and apparatus adapted to be actuated responsive to the opening of either line circuit to operate each magnet to restore its respective switch to normal.

6. An automatic telephone exchange system including a poly-station telephone line having its metallic circuit temporarily closed, multiple calling terminals therefor at the exchange, passive in character, multiple called terminals therefor passive in character, an automatic switch temporarily applied to said calling terminals, a selective switch temporarily applied to said called terminals, apparatus at the stations of said line adapted to open the metallic circuit thereof, and mechanism at the exchange operative responsive to the opening of said circuit to restore both said switches to normal.

7. In an automatic telephone exchange system including polystation lines, a calling line and a called line extending from their respective stations to the exchange, a station of each line being switched to conversational relation with its line, a plurality of selective switches, operated responsive to successive sets of selecting impulses controlled at the calling station connecting said lines, and hence said stations for conversation, release apparatus at the exchange responsive to a definite change in electrical character of either of said lines to restore all switches connecting said lines to normal, mechanism at the substations of each line for producing such change, and means to prevent the production of such change by mechanisms at other stations of said lines independently of the stations in conversation.

8. An automatic telephone exchange system including a polystation telephone line, passive calling terminals therefor at the exchange, passive called terminals therefor, means for changing the electrical character of said last-mentioned terminals to render them busy when said line is in use, an automatic switch adapted to be temporarily applied to said calling terminals, a selective switch adapted to be thereafter applied to said called terminals, a link-circuit for uniting said switches, and means for temporarily changing said called terminals to a non-busy character when said selective switch is applied.

9. An automatic telephone exchange system including a polystation telephone line, passive calling terminals therefor at the exchange, passive called terminals therefor, means for changing the electrical character of said last-mentioned terminals to render them busy when said line is in use, an automatic switch adapted to be temporarily applied to said calling terminals, a selective switch adapted to be thereafter applied to said called terminals, a link-circuit for uniting said switches, means for temporarily changing said called terminals to a non-busy character when said selective switch is applied, apparatus at the stations of said line adapted to open the metallic circuit thereof, and mechanism at the exchange operative responsive to the opening of said circuit to restore both said switches to normal.

10. An automatic telephone exchange system including a polystation telephone line, passive calling terminals therefor at the exchange, passive called terminals therefor, means for changing the electrical character of said last-mentioned terminals to render them busy when said line is in use, an automatic switch adapted to be temporarily applied to said calling terminals, a selective switch adapted to be thereafter applied to said called terminals, a link-circuit for uniting said switches, means for temporarily changing said called terminals to a non-busy character when said selective switch is applied, and means for signaling one station of said line to the exclusion of the others.

11. An automatic telephone exchange system including a polystation telephone line, passive calling terminals therefor at the exchange, passive called terminals therefor, means for changing the electrical character of said last-mentioned terminals to render them busy when said line is in use, an automatic switch adapted to be temporarily applied to said calling terminals, a selective switch adapted to be thereafter applied to said called terminals, a link-circuit for uniting said switches, means for temporarily changing said called terminals to a non-busy character when said selective switch is applied, means for signaling one station of said line to the exclusion of the others, apparatus at the stations of said line adapted to open the metallic circuit thereof, and mechanism at the exchange operative responsive to the opening of said circuit to restore both said switches to normal.

12. An automatic telephone exchange system including a polystation telephone line, passive calling terminals therefor at the exchange, passive called terminals therefor.

an automatic switch having wipers adapted to be temporarily applied to said calling terminals, a selective switch having wipers adapted to be thereafter applied to said called terminals, a link-circuit for uniting said switches, and means for signaling one station of said line to the exclusion of the others.

13. An automatic telephone exchange system including a polystation telephone line, passive calling terminals therefor at the exchange, passive called terminals therefor, an automatic switch having wipers adapted to be temporarily applied to said calling terminals, a selective switch having wipers adapted to be thereafter applied to said called terminals, a link-circuit for uniting said switches, means for signaling one station of said line to the exclusion of the others, apparatus at the stations of said line adapted to open the metallic circuit thereof, and mechanism at the exchange operative responsive to the opening of said circuit to restore both said switches to normal.

14. An automatic telephone exchange system including telephone lines, selective switches of a plurality of classes at the exchange adapted to be successively operated responsive to successive sets of current impulses transmitted from a substation for connecting lines for conversation, operating magnets for each of said switches, relays normally in operative relation with the switches of a first class only and arranged to be operated by all of said successive sets of impulses, means for placing said relays in operative relation with the magnets of switches of other classes as successive sets of impulses are transmitted, passive calling terminals of said lines, automatic switches having wipers adapted to engage said calling terminals, link-circuits connecting said automatic switches and said selective switches of a first class, passive called terminals of said lines adapted to be engaged by switches of one of said classes, means for changing the electrical character of said called terminals of a line when in use to render them busy, and mechanism for temporarily rendering the called terminals of a calling line idle when a selective switch connected with said line connects with called terminals of a line.

15. In an automatic telephone exchange system, a calling line and a called line extending from their respective stations to the exchange, a non-numerical switch operating responsive to the closure of the line circuit at the calling substation to extend a connection from said calling line in the direction of the called line, a plurality of selective switches, operated responsive to successive sets of current impulses controlled at the calling station, connecting said lines, a central source of current supplying current for conversational purposes to the transmitters of the stations of said lines, apparatus at the stations for interrupting the flow of said current, and apparatus at the exchange operative responsive to the interruption of said flow of current to restore all of said switches to normal.

16. An automatic telephone exchange system including a polystation telephone line having its metallic circuit temporarily closed, multiple calling terminals therefor at the exchange, passive in character, multiple called terminals therefor passive in character, an automatic switch temporarily applied to said calling terminals, a selective switch temporarily applied to said called terminals, a central source supplying current over said line for conversational purposes, switching mechanism at the stations of said line for interrupting the flow of said current, an electromagnet at the exchange energized during conversation, adapted to be de-energized on interruption of said current flow, and release mechanism operative responsive to the de-energization of said electromagnet to restore both said switches to normal.

17. In an automatic telephone exchange system including polystation lines, a calling line and a called line extending from their respective stations to the exchange, a station of each line being switched to conversational relation with its line, a plurality of selective switches operated responsive to successive sets of selecting impulses controlled at the calling station connecting said lines, and hence said stations for conversation, a central source supplying current to the transmitters of said lines for talking, switching means at stations of said lines adapted under substation operation to interrupt the flow of said current over their respective lines, and mechanism at the exchange responsive to the interruption of current in either line to restore all switches connecting said lines.

18. An automatic telephone exchange system including a polystation telephone line, passive calling terminals therefor at the exchange, passive called terminals therefor, means for changing the electrical character of said last-mentioned terminals to render them busy when said line is in use, an automatic switch adapted to be temporarily applied to said calling terminals, a selective switch adapted to be thereafter applied to said called terminals, a link-circuit for uniting said switches, means for temporarily changing said called terminals to a non-busy character when said selective switch is applied, a central source for supplying current in metallic circuit of said line for talking purposes, apparatus at the stations of said line adapted to open the

metallic circuit thereof, and mechanism at the exchange operative responsive to the opening of said circuit to restore both said switches to normal.

19. An automatic telpehone exchange system including a polystation telephone line, passive calling terminals therefor at the exchange, passive called terminals therefor, an automatic switch having wipers adapted to be temporarily applied to said calling terminals, a selective switch having wipers adapted to be thereafter applied to said called terminals, a link-circuit for uniting said switches, a central source for supplying current in metallic circuit of said line for talking purposes, apparatus at the stations of said line adapted to open the metallic circuit thereof, and mechanism at the exchange operative responsive to the opening of said circuit to restore both said switches to normal.

20. A telephone system including telephone lines divided into groups, selective switches to select said lines as calling lines by testing said lines by groups and by lines in a group, an auxiliary selective switch for starting said first-mentioned switches, a traveling contact therefor, means for electrically adjusting said auxiliary switch to provide except when traveling a normal path through said contact to an idle selective switch, and means for causing a current flow over said contact on initiation of a call to start said idle switch.

21. A telephone system including telephone lines, selective switches to select said lines, a traveling switch, a contact for each said selective switch associated therewith, electrically controlled adjusting mechanism for causing said traveling switch to normally rest engaging the contact of an idle selective switch, and connections whereby any line may influence said traveling switch to start said idle switch.

22. A telephone system including telephonic circuits having multiple contacts, a plurality of selectors for selecting said contacts, a distributor switch for starting said selectors, automatically controlled mechanism for adjusting said switch so that it normally rests maintaining established a normal connection therefrom to an idle selector, and means controllable over any of said telephonic circuits for causing said distributor switch to change the electrical condition of said connection to start the idle selector to select the circuit.

23. A telephone system including telephonic circuits having multiple contacts divided into groups, a plurality of selectors for selecting said contacts by testing said contacts by groups and by contacts in a group, a distributor switch for starting said selectors, automatically controlled mechanism for adjusting said switch to normally rest maintaining established a connection therefrom to an idle selector, means controllable over any of said telephonic circuits for changing the electrical condition of said connection to start the idle selector to select the circuit, and mechanism controlled by the process of selection to actuate said automatically controlled mechanism.

24. A telephone system including telephone lines divided into groups, a master-switch common thereto having mechanism operable responsive to currents over any of said lines, selectors for selecting said lines by testing said lines by groups and by lines in a group, a starting circuit normally extending from said master-switch to an idle selector and effective responsive to said mechanism to start said selector, and means controlled in the operation of said selector to cause alteration in the connections of said master-switch to establish another starting circuit extending to another selector.

25. A telephone exchange system comprising lines divided into groups, a plurality of electrically controlled devices for connecting with said lines, a swtich for said devices, means for actuating said switch so as to provide a path except when traveling through its contacts to an idle one of said devices, and means controlled by said switch for causing a current flow over said path to operate said device to cause it to test said lines by groups and by lines in a group.

26. A telephone exchange system comprising a plurality of electrically controlled devices, a switch for controlling said devices, operating means for said switch at rest only when a path for current extends through the switch contacts to an idle one of said devices, and means controlled by said switch for causing a current flow over said path.

27. A telephone exchange system comprising a plurality of electrically controlled devices, a switch for controlling said devices, normally occupying a position such as to provide a path for current through its contacts to an idle one of said devices, means controlled by said switch for subsequently changing the electrical condition of said contacts to initiate travel of the idle one of said devices and means operated in response to the operation of the device to actuate said switch to again establish a path for current through its contacts to another, then idle, device.

28. A telephone exchange system comprising a plurality of telephone lines divided into groups, a plurality of selecting switches each adapted to connect to said lines by moving in one driection to test said lines by groups and by moving in a second direction to test lines in a group, a master-switch for selecting and starting idle select-

ing switches to establish connection with calling lines, means actuated by a selected selecting switch prior to its final selecting movement to free said master-switch for further use, and means for actuating said master-switch once and once only per call.

29. An automatic telephone system including a telephone line, passive calling terminals therefor at the exchange, passive called terminals therefor at the exchange, means for imparting a changed electrical character to said called terminals when said line is in use to render them busy, a link-circuit at the exchange, automatic switching apparatus for connecting said link-circuit with said line at two points, namely at one of said calling terminals and one of said called terminals, and means for temporarily rendering said called terminals nonbusy at the time said link-circuit is brought to connection with one of them to render such connection effective.

30. A telephone system, including telephone lines, link-circuits at the exchange, passive calling and called terminals of said lines, subscriber controlled means for applying said link-circuits to said passive calling and called terminals to complete connections, apparatus for placing a busy potential upon the called terminals of a calling line, and means for temporarily removing said potential at the time a link-circuit in connection with the calling terminals of said line is brought to connection with called terminals of one of said lines.

31. A telephone system, including telephone lines, passive calling and called terminals therefor at the exchange, means for imparting a changed electrical character to said called terminals when said line is in use to render them busy, a link-circuit at the exchange, subscriber controlled automatic apparatus for connecting said link-circuit with said line at two points, means for extending a connection thereover from passive calling terminals of said line to passive called terminals thereof, means for temporarily removing the busy condition of said called terminals at the time said link-circuit is brought to connection with one of said terminals to render such connection effective, means for rendering said telephone line conductively discontinuous when disconnection is desired, and apparatus responsive thereto for disconnecting said link-circuit from the called terminals of said line.

32. In a telephone system, the combination with a telephone line, of called terminals therefor at the exchange, means for imparting a changed electrical character to said terminals when said line is in use to render them busy, a link-circuit at the exchange, apparatus for connecting said link-circuit with said line at two points, one being a called terminal of said line, means for temporarily removing the busy potential from said terminals at the time said link-circuit is brought to connection with one of said terminals to render such connection effective, means for rendering said telephone line conductively discontinuous when disconnection is desired, and apparatus responsive thereto for freeing said line for immediate use.

33. In a telephone system, the combination with telephone lines, of link-circuits at the exchange, calling and called terminals of said lines, means for applying said link-circuits to calling and called terminals to complete connections, apparatus for placing a busy potential upon the called terminals of a calling line, means for temporarily removing said potential at the time a link-circuit in connection with the calling terminals of said line is brought to connection with the called terminals of one of said lines, means for rendering said telephone lines conductively discontinuous when disconnection is desired, and apparatus responsive thereto for restoring said lines to their normal electrical connections.

34. A telephone system including telephone lines, multiple terminals for said lines at the exchange, selectors for selecting terminals of said lines responsive to calls initiated thereover, line relays one for each line, a distributor switch for starting said selectors, branch connections from said distributor switch to said line relays, whereby any line relay when operated may influence said distributor, a pair of contacts for each selector at said switch, a pair of movable contact-makers for said switch adapted to engage said pairs of contacts, relays for said selectors for energization to initiate travel of their respective selectors, a circuit of said distibutor switch controlled by the line relays of said lines for energizing the relay of an idle selector, said circuit including one of said contact makers, the contact of an idle selector engaged thereby and the relay of such selector, an electromagnet of said distributor switch controlling travel thereof, and a circuit for said magnet sensitive to the idle or busy conditions of said selectors, said circuit including the other contact-maker of said switch and the contact of the selector engaged thereby.

35. A telephone system including telephone lines, multiple terminals for said lines at the exchange, selectors for selecting terminals of said lines responsive to calls initiated thereover, line relays one for each line, a distributor switch for starting said selectors, branch connections from said distributor switch to said line relays, whereby any line relay when operated may influence said distributor, a pair of contacts for each selector at said switch, a pair of movable contact-makers for said switch adapted to

engage said pairs of contacts, relays for said selectors for energization to initiate travel of their respective selectors, a circuit of said distributor switch controlled by the line relays of said lines for energizing the relay of an idle selector, said circuit including one of said contact-makers, the contact of an idle selector engaged thereby and the relay of such selector, an electromagnet of said distributor switch controlling travel thereof, a circuit for said magnet sensitive to the idle or busy conditions of said selectors, said circuit including the other contact-maker of said switch and the contact of the selector engaged thereby, means controlled by the line relays for rendering the terminals of their respective lines at the selectors selectable in character by the started selectors, cut-off relays one for each line, a circuit for operating the cut-off relay of the selected line on selection made, and means providing for a continuing unselectable condition of the multiple terminals of any line as long as its cut-off relay is operated.

36. A telephone system including telephone lines, multiple terminals for said lines at the exchange, selectors for selecting terminals of said lines responsive to calls initiated thereover, line relays one for each line, a distributor switch for starting said selectors, branch connections from said distributor switch to said line relays, whereby any line relay when operated may influence said distributor, a pair of contacts for each selector at said switch, a pair of movable contact-makers for said switch adapted to engage said pairs of contacts, relays for said selectors for energization to initiate travel of their respective selectors, a circuit of said distributor switch controlled by the line relays of said lines for energizing the relay of an idle selector, said circuit including one of said contact-makers, the contact of an idle selector engaged thereby and the relay of such selector, an off-normal contact of the idle selector included in said circuit, an electromagnet of said distributor switch controlling travel thereof, and a circuit for said magnet sensitive to the idle or busy conditions of said selectors, said circuit including the other contact-maker of said switch and the contact of the selector engaged thereby.

37. A telephone system including telephone lines, multiple terminals for said lines at the exchange, selectors for selecting terminals of said lines responsive to calls initiated thereover, line relays one for each line, a distributor switch for starting said selectors, branch connections from said distributor switch to said line relays, whereby any line relay when operated may influence said distributor, a pair of contacts for each selector at said switch, a pair of movable contact-makers for said switch adapted to engage said pairs of contacts, relays for said selectors for energization to initiate travel of their respective selectors, a circuit of said distributor switch controlling travel thereof, a circuit for said magnet sensitive to the idle or busy conditions of said selectors, said circuit including one of the contact-makers of said switch and the contact of the selector engaged thereby, means controlled by the line relays for rendering the terminals of their respective lines at the selectors selectable in character by the started selectors, cut-off relays one for each line, a circuit for operating the cut-off relay of the selected line on selection made, means providing for a continuing unselectable condition of the multiple terminals of any line as long as its cut-off relay is operated, and switching means associated with said selectors for use in continuing circuits from selected calling lines to desired called line.

38. A telephone system including telephone lines, multiple terminals for said lines at the exchange, selectors for selecting terminals of said lines responsive to calls initiated thereover, line relays one for each line, a distributor switch for starting said selectors, branch connections from said distributor switch to said line relays, whereby any line relay when operated may influence said distributor, a pair of contacts for each selector at said switch, a pair of movable contact-makers for said switch adapted to engage said pairs of contacts, relays for said selectors for energization to initiate travel of their respective selectors, a circuit of said distributor switch controlled by the line relays of said lines for energizing the relay of an idle selector, said circuit including one of said contact-makers, the contact of an idle selector engaged thereby and the relay of such selector, an electromagnet of said distributor switch controlling travel thereof, a circuit for said magnet sensitive to the idle or busy conditions of said selectors, said circuit including the other contact-maker of said switch and the contact of the selector engaged thereby, and an off-normal contact of the selector also included in said circuit.

39. A telephone system including telephone lines, multiple terminals for said lines at the exchange, selectors for selecting terminals of said lines responsive to calls initiated thereover, line relays one for each line, a distributor switch for starting said selectors, branch connections from said distributor switch to said line relays, whereby any line relay when operated may influence said distributor, a pair of contacts for each selector at said switch, a pair of movable contact-makers for said switch adapted to engage said pairs of contacts, relays for said selectors for energization to initiate

travel of their respective selectors, a circuit of said distributor switch controlled by the line relays of said lines for energizing the relay of an idle selector, said circuit including one of said contact-makers, the contact of an idle selector engaged thereby and the relay of such selector, an off-normal contact of the idle selector included in said circuit, an electromagnet of said distributor switch controlling travel thereof, a circuit for said magnet sensitive to the idle or busy conditions of said selectors, said circuit including the other contact-maker of said switch and the contact of the selector engaged thereby, and an off-normal contact of the selector also included in said circuit.

40. A telephone system including telephone lines, multiple terminals for said lines at the exchange, selectors for selecting terminals of said lines responsive to calls initiated thereover, line relays one for each line, a distributor switch for starting said selectors, branch connections from said distributor switch to said line relays whereby any line relay when operated may influence said distributor, a pair of contacts for each selector at said switch, a pair of movable contact-makers for said switch adapted to engage said pairs of contacts, relays for said selectors for energization to initiate travel of their respective selectors, a circuit of said distributor switch controlled by the line relays of said lines for energizing the relay of an idle selector, said circuit including one of said contact-makers, the contact of an idle selector engaged thereby and the relay of such selector, an off-normal contact of the idle selector included in said circuit, an electromagnet of said distributor switch controlling travel thereof, a circuit for said magnet sensitive to the idle or busy conditions of said selectors, said circuit including the other contact-maker of said switch and the contact of the selector engaged thereby, an off-normal contact of the selector also included in said circuit, means controlled by the line relays for rendering the terminals of their respective lines at the selectors selectable in character by the started selectors, cut-off relays one for each line, a circuit for operating the cut-off relay of the selected line on selection made, means providing for a continuing unselectable condition of the multiple terminals of any line as long as its cut-off relay is operated, and switching means associated with said selectors for use in continuing circuits from selected calling lines to desired called line.

41. In a telephone system, a telephone line, a source of calling current adapted for connection with said line, an electromagnet for operation by current over said line to disconnect said source, selective switch mechanism actuated responsive to currents over said line to operatively associate said source and magnet therewith, a circuit changer associated with said magnet and source having a definite normal position, means for actuating said circuit changer, said circuit changer serving, when actuated, to connect said source with said line before said electromagnet can be connected therewith, and thereafter said electromagnet therewith.

42. In a telephone system, a party telephone line, a link-circuit, selective switch mechanism for connecting said circuit and line, a source of signalling current for connection with said circuit and so with said line, an electromagnet for operation responsive to circuit changes at the substation of said line to disconnect said source therefrom, and means for preventing premature operation of said electromagnet when signalling back over said line, said means including a circuit changer serving upon connection of said link-circuit with said line to insure connection of said source with said line before said magnet is connected therewith.

43. In a telephone system, a telephone line, a link-circuit, a selective switch serving to connect said link-circuit and line, a ringing generator adapted to be applied to said link-circuit and so to said telephone line, an electromagnet adapted to be operated by current over said line to disconnect said generator, means for connecting said electromagnet with said line only after said generator has been connected in circuit a predetermined time, and means to prevent a further application of the ringing generator to said line irrespective of whether a response has or has not been secured.

44. An automatic telephone system including a telephone line, a link-circuit, selective switches, means for transmitting directive currents thereto to connect said link-circuit and line, a ringing generator adapted to be applied to said link-circuit and so to said telephone line, an electromagnet adapted to be operated by current over said line to disconnect said generator, and a circuit changer individual to the link-circuit serving to first connect said generator and afterwards said relay to said circuit.

45. A telephone system including telephone lines having calling and called contacts at the exchange, a link-circuit, automatic selectors for connecting its opposite ends to calling and called contacts respectively, an automatic test relay for said circuit serving to effect transmission of a busy signal when said circuit is connected to called contacts of a line already in use, means for rendering ineffective said transmission when the connected called contacts are those of a line to which the answering end of the circuit is already connected, a source of calling current, means for connect-

ing said source in circuit to signal a connected substation when the opposite ends of said circuit are connected to calling and called contacts of the same line, an electromagnet controllable over the line adapted to have its condition altered to disconnect said source, and circuit changing mechanism adapted to connect said source and said magnet to the line, said source being always connected thereto in advance of said magnet.

46. In a telephone system, a telephone line, a ringing generator adapted to be connected therewith, an electromagnet responsive to circuit changes controlled at the substation to maintain said generator excluded from the line circuit, a circuit changer for actuation to connect said generator and said magnet with said line, said circuit changer having connections serving on its actuation to always connect said generator before said magnet, a connector for operatively associating said circuit changer with said line, and directive impulse mechanism for adjusting said connector.

47. In a telephone system, a telephone line, a source of calling current adapted for connection with said line, an electromagnet for operation by current over said line to disconnect said source, a circuit changer associated with said magnet and source having a definite normal position, means for actuating said circuit changer, said circuit changer serving, when actuated, to connect said source with said line before said electromagnet can be connected therewith, and thereafter said electromagnet therewith.

48. In a telephone system, a party telephone line, a link-circuit adapted to be connected with said line, a source of signalling current for connection with said circuit and so with said line, an electromagnet for operation responsive to circuit changes at the substation of said line to disconnect said source therefrom, and means for preventing premature operation of said electromagnet when signalling back over a calling line, said means including a circuit changer serving upon connection of said link-circuit with said line to insure connection of said source with said line before said magnet is connected therewith.

49. In a telephone system, a telephone line, a link-circuit connected therewith, a ringing generator adapted to be applied to said link-circuit and so to said telephone line, an electromagnet adapted to be operated by current over said line to disconnect said generator, and means for connecting said relay with said line effective only after said generator has first been connected in circuit a predetermined time.

50. In a telephone system, a telephone line, a link-circuit connected therewith, a ringing generator adapted to be applied to said link-circuit and so to said telephone line, an electromagnet adapted to be operated by current over said line to disconnect said generator, and a circuit changer individual to the link-circuit serving, when actuated, to always first connect said generator and afterwards said electromagnet to said circuit.

51. A telephone system including telephone lines having calling and called contacts at the exchange, a link-circuit adapted to have its opposite ends connected to calling and called contacts respectively, an automatic test relay for said circuit serving to effect transmission of a busy signal when said circuit is connected to called contacts of a line already in use, means for rendering ineffective said transmission when the connected called contacts are those of a line to which the answering end of the circuit is already connected, a source of calling current, means for connecting said source in circuit to signal a connected substation when the opposite ends of said circuit are connected to calling and called contacts of the same line, an electromagnet controllable over the line adapted to have its condition altered to disconnect said source, and circuit changing mechanism adapted to connect said source and said magnet to the line, said source being always connected thereto in advance of said magnet.

52. In a telephone system, a telephone line, a ringing generator adapted to be connected therewith, an electromagnet responsive to circuit changes controlled at the substation to maintain said generator excluded from the line circuit, and a circuit changer for actuation to connect said generator and said magnet with said line, said circuit changer having connections serving on its actuation to always connect said generator before said magnet is connected.

53. A telephone exchange system including telephone lines, a plurality of selectors each having access to said lines, a master-switch for starting idle selectors to establish connection with calling lines, a starting circuit normally extending from said master-switch to an idle selector, a relay for said master switch for closing said starting circuit, and means actuated by a started selector prior to the final selecting movement to free said master-switch for further use.

54. A telephone exchange system including telephone lines, a plurality of selectors each having access to said lines, a master-switch for starting idle selectors to establish connection with calling lines, a starting circuit normally extending from said master-switch to an idle selector, a relay for said master-switch for closing said starting circuit, and means actuated by a started selector prior to its final selection

to free said master-switch for further use by initiating travel thereof to establish a different starting circuit.

55. A telephone exchange system including telephone lines, a plurality of selectors each having access to said lines, a master-switch provided with a relay for starting idle selectors to establish connection with calling lines, a starting circuit normally extending from said master-switch to an idle selector, and means for adjusting said master-switch and connections altered by a started selector prior to its final selection to free said master-switch for further use, said means then serving to adjust said master-switch to establish a starting circuit extending to another idle selector.

56. In a telephone system, a telephone line connecting a substation with the exchange, a normally locked directive impulse device, selective devices responsive to impulses from said impulse device, a selector to select said line, and electromagnetic means operated first on selection of said line by said selector to unlock said device to render it manually movable.

57. In a telephone system, a telephone line having a substation, a directive impulse device at the substation normally locked against actuation, selective devices responsive to impulses from said impulse device, an automatic switch at the exchange adapted to extend said telephone line and electromagnetic means for unlocking said device to render it manually movable first effective when said switch establishes a definite connection.

58. In a telephone system, the combination with a normally locked directive impulse device, selective devices responsive to impulses from said impulse device, a selective switch at the exchange, and electromagnetic means to unlock said device to render it manually movable first effective when said switch reaches a definite position.

59. Telephone lines; two or more telephones connected to one of said lines; a line selector whereby any one of said lines may be selected and connected to another selector; means whereby any telephone in the system may be selected by any other telephone; and means whereby the telephone called may be signalled.

60. Party lines; two or more telephone stations connected to each of said lines; a line selector whereby any one of said lines calling may be selected and connected to another selector; means whereby the selector may be connected to any one of all the party lines; means whereby any telephone station on any one of said party lines may be selected by any other telephone station calling on any one of said party lines.

61. A telephone system comprising telephone lines, several substations connected to one of said lines, connector switches, line selectors for connecting to said line when calling, means for extending the circuit of said line and selector to an idle connector, means for operating said connector to connect with said line and means for signalling a substation on the line.

62. A telephone system including party telephone lines, line selectors for connecting to one of said lines when calling, connector switches, means for extending the circuit of a calling line and connected line selector to an idle one of said connectors, and means for operating said connector to connect with and signal a called substation on said line.

63. A telephone system including party telephone lines, line selectors for connecting to a calling one of said lines, and apparatus for extending the circuit of the calling substation to any other substation in the exchange and ringing its bell-call selectively.

64. A telephone system including party telephone lines, line selectors for connecting to a calling line, and means for extending the circuit of the calling substation to, and signalling any other substation in the exchange selectively.

65. A telephone system including party telephone lines, and instrumentalities at the exchange including calling line selectors for signalling selectively a called substation on a calling line.

66. A telephone system including party telephone lines, line selectors for connecting to calling lines, and other selectors and connectors for extending the circuit of the calling substation to, and selectively signalling, any other substation in the exchange.

67. The combination of a manually operated transmitting device, a locking device normally engaging the same, an electromagnet for operating said locking device to unlock the transmitter, a receiving device normally disconnected from said transmitting device and co-operating therewith, means for connecting said receiving device into circuit and for automatically operating said electromagnet to unlock said transmitter when said receiving device is brought into circuit, substantially as specified.

68. A telephone system including a subscriber's telephone line, calling and called terminals at the exchange for said line, means for placing a busy potential upon said terminals when said line is in use to render them busy, a link circuit at the exchange, subscriber controlled automatic apparatus for connecting the calling terminals to the said link circuit, subscriber controlled means for connecting said link circuit with the said called terminals, means for temporarily removing the said busy potential at the time said link circuit is brought into connection with said called terminals, and means for rendering said telephone line con-

ductively discontinuous whereby said link circuit is disconnected from said subscriber's line.

69. In a telephone system the combination with a telephone line, of calling and called terminals therefor, means for changing the electrical character of said terminals when the said line is in use to render them busy, a link circuit at the exchange, automatic switching apparatus for connecting the said calling terminals with the link circuit, subscriber controlled means for connecting the link circuit with the said called terminals, means for temporarily removing the said busy potential at the time said link circuit is brought to connection with said called terminals to render such connection effective, and means for rendering said telephone line conductively discontinuous whereby said link circuit is freed from the said calling terminals.

70. A telephone system including subscribers' telephone lines divided into groups, two-motion selective switches to select said lines as calling lines, a master switch for said first mentioned switches, a traveling contact therefor, means for electrically adjusting said master switch to provide, except when traveling, a normal path from said contact to an idle one of said selective switches, and means for causing a current flow over said contact upon initiation of a call to start said idle switch to test said lines by groups and by lines in a group.

71. A telephone system comprising a plurality of subscribers' lines, electrically controlled selective devices for connecting to said lines as calling lines, a master switch for said switches, operating means for said switch at rest only when a path of current extends through said switch to an idle one of said selective devices, and means responsive to the initiation of a call over one of said lines for operating said switch to cause a current flow over said path.

72. A telephone system including a subscriber's telephone line, multiple line terminals for said line, a calling and a called test terminal for said line, means for placing a busy potential upon said test terminals, a link circuit, automatic means for connecting said link circuit to said line terminals, subscriber controlled means for connecting said link circuit to other of said line terminals, means for removing said busy potential to render said last connection effective, and means for rendering said telephone line discontinuous whereby said link circuit is disconnected from said line.

73. A telephone system including a subscriber's line provided with calling and called terminals, means for placing a busy potential upon said called terminals when said line is used as a calling line, a link circuit, automatic means for connecting said line to said link circuit, electromagnetic means for connecting said link circuit to a called terminal of said line, relay means for removing said busy potential to render said last connection effective, and subscriber controlled means for rendering said telephone line discontinuous whereby said link circuit is disconnected from said line.

74. In a telephone system, a line, a plurality of substations on said line, a non-numerical automatic switch for extending a connection from said line, a connector switch, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a test circuit for said line, means for applying a guarding potential to said test circuit, and for rendering said guarding potential ineffective thereby permitting said connector to connect with the line.

75. In a telephone system, a party line, means including automatic switches whereby one subscriber may call another on the same line, means for supplying signaling current to said line when one party calls another on the same line, an interrupter at the central office for automatically applying the signaling current, while the conductors of the party line are connected in series, and means controlled over two sides of a line in series for controlling said automatic switches.

76. In a telephone exchange system, the combination with a telephone line extending from a substation to a central office, of a connecting circuit at the central office, a non-numerical switch for uniting said connecting circuit with said line, a party telephone line, an automatic switch having step by step motor magnets for uniting said connecting circuit with said party line, and a second automatic switch mechanically independent of said first mentioned automatic switch for impressing ringing current on said party line.

77. In a telephone exchange system, the combination with a telephone line extending from a substation to a central office, of a connecting circuit at the central office, a non-numerical progressively movable switch for uniting said connecting circuit with said line, a party telephone line, an automatic switch having step by step driving magnets for uniting said connecting circuit with said party line, and a second automatic switch mechanically independent of said first mentioned automatic switch for impressing ringing current on said party line.

78. In a telephone system, subscribers' lines, a non-numerical switch controlled over two sides of a subscriber's line in series for extending a connection therefrom, means including said switch and a connector switch controllable by separately grounding the two sides of a calling line at the sub-

station for extending connection to a called line, means for supplying current to the talking bridges at the calling and called substations and releasing means in said connector under the control of either the calling or called subscriber and operative responsive to the opening of the talking bridge at either calling substation or called station to release the connection.

79. In a telephone exchange system, the combination of a calling telephone line, a called telephone line, automatic switching machinery for connecting the two lines, means for grounding a calling telephone line to release the switching machinery before the called subscriber answers, and means for opening said calling telephone line circuit to release the switching machinery after the called subscriber answers.

80. In a telephone exchange system, the combination of a calling telephone line, a called telephone line, automatic switching machinery for connecting the two lines together, means for grounding the calling line to release the switching machinery before the called subscriber answers, and means for opening the circuit of either telephone line to release the switching machinery after the called subscriber answers.

81. In a telephone exchange system, the combination of a calling telephone line, a called telephone line, automatic switching machinery for connecting the two lines together, means for grounding a telephone line to release the switching machinery before the called subscriber answers, and means for opening up the circuit of either telephone line to release the switching machinery after the called subscriber answers.

82. In a telephone exchange system, the combination of a calling telephone line, a called telephone line, automatic switching machinery for connecting the two lines together, said machinery comprising banks of line terminals, line wipers adapted to co-operate with said terminals in making connections, said terminals arranged in rows, means for moving the wipers in one direction while out of contact with said terminals, means for moving the said wipers in another direction while in contact with the terminals of a selected row, and means for opening the circuit of either telephone line to release the switching machinery.

83. In an automatic party-line telephone system having a series of party lines, two separate stations on each party-line, telephone receiving and transmitting devices in each station, means by which a station may be telephonically connected with any other station in the system, and means by which the telephonic connection can be broken only by the receivers of both stations being hung on their respective hooks if the connected stations are on the same line.

84. An automatic telephone exchange system comprising a subscriber's telephone line, a private normal for said line, an individual switch for said line, said individual switch provided with a private normal controlling relay having two windings, parallel energizing circuits each including one of said windings, one of said energizing circuits controlled by the relay itself, and means having motion to select groups and then rotary motion to connect with the called line in any group selected by the non-rotary motion of the same means both motions controlled over said telephone line from the substation thereof.

85. A two-wire telephone exchange system including a calling line, a non-numerical switch, responsive to the closure of a bridge on said line to extend a connection therefrom, release mechanism, and switches controlled over the two sides of said line in series, having one motion to select groups and rotary motion to connect with a line in the selected group, and means for determining the busy condition of the called line and for locking thereon to maintain the connection uncompleted.

86. A two-wire telephone exchange system including a calling line, a non-numerical switch responsive to the closure of a bridge on said line to extend a connection therefrom, said system having release mechanism and comprising switches controlled over the two sides of the said line in series, having one motion to select groups and rotary motion to connect with a line in the selected group, and provided with locking relays for preventing connection with the called line when it is busy and for transmitting busy signals to the calling line.

87. A two-wire telephone exchange system including a line, a non-numerical switch responsive to the closure of a bridge on said line to extend a connection therefrom, said system having release mechanism, and in combination with centralized means for supplying talking current over the lines in series for both talking and operating purposes, and provided with locking relays for preventing connection with the called line when it is busy and for transmitting a busy signal to the calling line, said switching mechanism remaining in its operated position.

88. A two-wire automatic telephone exchange system including switches controllable over the two sides of a calling line in series, said switches including a switch operated responsive to the closure of a bridge across a line, and release mechanism and locking relays for maintaining the connection uncompleted while the switches remain in their operated position when the called line is busy.

89. In a two-wire automatic telephone exchange system, a calling and a called line,

an automatic progressively movable switch operated responsive to the closure of a bridge across said calling line, a centralized source of current for talking purposes, progressively movable switching mechanism controlled over the two sides of a calling line in series for establishing a connection to a called line, means for making the called line busy, and means in said switching mechanism for determining the busy condition of the called line and for locking thereon to maintain the connection uncompleted.

90. In a telephone system, a calling line, a switch responsive to the closure of a bridge across the calling line to extend a connection therefrom, a called line, a central source of current for talking purposes, means for making the called line busy, means including a progressively movable switch controlled over the two sides of said calling line in series for finding the called line, and means in said switch associated with said first means to retain said switch in its operated position for preventing the called line from being signaled.

91. In a telephone system, a calling line, a non-numerical switch responsive to the closure of a bridge across said calling line to extend connection therefrom, a called line, a central source of current for talking purposes, means for making the called line busy, means including a progressively movable switch controlled over the two sides of said calling line in series for finding the called line, and means controlled by said first means to retain said switch in its operated position and to prevent a connection from being extended to said called line.

92. In a telephone system, a calling line, a non-numerical switch responsive to the closure of a bridge across said line for extending connection therefrom, a called line, a central source of current for talking purposes, means for making the called line busy, means including a progressively movable switch controlled over the two sides of said calling line in series for finding the called line, and means associated with said first means to retain said switch in its operated position for preventing a circuit from being extended from the switch to a station on the called line.

93. In a telephone system, a calling line, a switch responsive to the closure of a bridge across said calling line for extending a connection therefrom, a called line, a central source of current for talking purposes, progressively movable switching mechanism controlled over the two sides of said calling line in series for finding said line, means to retain said switching mechanism in its operated position upon finding said line busy.

94. In a telephone system, a calling line, a progressively movable switch responsive to the closure of a bridge across said calling line for extending a connection therefrom, a called line, a central source of current for talking purposes, progressively movable switching mechanism controlled over the two sides of said calling line in series for finding said line, and means in said switching mechanism to retain the same in its operated position upon finding said line busy.

95. In a telephone system, a calling line, a non-numerical switch responsive to the closure of a bridge across said calling line to extend a connection therefrom, a called line, a central source of current for talking purposes, progressively movable switching mechanism controlled over the two sides of said calling line in series for finding said line, means to retain said switching mechanism in its operated position upon finding said line busy, and means for preventing a connection being completed with said called line.

96. In a telephone system, a non-numerical progressively movable switch having a line relay responsive to the closure of a bridge across the calling line to cause said switch to operate to extend a connection from said calling line in the direction of a called line, a central source of current for talking purposes, progressively movable switching mechanism controlled over the two sides of said calling line in series for finding said called line, and means to retain said switching mechanism in its operated position upon finding said line busy and for preventing the called line being signaled.

97. In a telephone system, a non-numerical progressively movable switch having a line relay responsive to the closure of a bridge across the calling line to cause said switch to operate to extend a connection from said calling line in the direction of a called line, means including a test conductor for making the called line busy, means including a progressively movable switch controlled over the two sides of said calling line in series for finding the called line, means associated with said first means to retain said switch in its operated position for preventing the called line being signaled, said last means including a magnet, a circuit over said test conductor for energizing said magnet, and a second circuit for said magnet after it energizes, said second circuit excluding said test conductor.

98. In a telephone system, a non-numerical progressively movable switch having a line relay responsive to the closure of a bridge across the calling line to cause said switch to operate to extend a connection from said calling line in the direction of a called line, means including a test conductor for making the called line busy, means including a progressively movable switch controlled over the two sides of said calling line in series for finding the called line, means controlled

by said first means to retain said switch in its operated position and to prevent a connection from being extended to said called line, said last means including a magnet, a circuit over said test conductor for energizing said magnet, and a second circuit for said magnet after it energizes, said second circuit excluding said test conductor.

99. In a telephone system, a line, a plurality of substations on said line, a connector switch controllable over the two sides of the line in series, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a guarding potential for said line, and means separate from the talking circuit for removing said guarding potential to permit said connector to connect with the line.

100. In a telephone system, a line, a plurality of substations on said line, a connector switch controllable over the two sides of the line in series, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a guarding potential for said line, and means separate from the talking circuit for lowering said guarding potential to permit said connector to connect with the line.

101. In a telephone system, a line, a plurality of substations on said line, a connector switch controllable over the two sides of the line in series, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a guarding potential for said line, and means for rendering said guarding potential ineffective to prevent said connector from connecting with the said line.

102. In a telephone system, a line, a plurality of substations on said line, a connector switch controllable over the two sides of the line in series, said switch being provided with a terminal of said line, means for engaging said terminal when one subscriber calls another on the same line, a guarding potential for said line, and automatic means controlling said guarding potential in such manner that said connector switch when it engages a contact of said line operatively connects with said line to signal a called substation thereon.

103. A telephone system including a subscriber's line, a plurality of substations on said line, automatic switching means including a connector switch, controlled over the two sides of the line in series, for establishing connection between said line and another subscriber's line, said switch being provided with a terminal of said first line, means for operating said connector switch to cause it to engage said terminal when one subscriber calls another subscriber on said first line, a guarding potential for said line for preventing other subscribers from connecting to said first line when it is in use, and means for rendering ineffective said guarding potential when one subscriber calls another subscriber on the same line, thereby permitting said connector to operatively connect with the line.

104. A telephone system including a subscriber's line, a plurality of substations on said line, automatic switching means including a connector switch, controlled over the two sides of the line in series, for establishing connection between said line and another subscriber's line, said switch being provided with a terminal of said first line, means for operating said connector switch to cause it to engage said terminal when one subscriber calls another subscriber on said first line, a guarding potential for said line for preventing other subscribers from connecting to said first line when it is in use, busy means for said connector switch operable when a subscriber calls a substation on said first line for preventing a connection with said line if said line is busy, and means for rendering ineffective the operation of said busy means when one subscriber calls another subscriber on the same line, thereby permitting said connector switch to effectively connect with the line.

105. In a telephone system, a plurality of lines each having a plurality of connected substations, automatic switching mechanisms at the exchange, controllable over the two sides of a calling line in series, for extending a connection to a called line, a test circuit for rendering the calling line busy closed upon the initiation of the call, and automatic means for momentarily opening said test circuit to permit one of said switching mechanisms to connect with the calling line as a called line.

106. In a telephone system, a party line, means controlled by a calling subscriber on said line and including an automatic switch for completing two bridges of said line at the exchange, a source of ringing current in one bridge, a battery and a relay in the other bridge, said relay energized over the line circuit to maintain said switch in operated position, means for opening the ringing current bridge and for inserting a second relay in said battery bridge, and means controlled by said second relay for preventing another completion of the ringing current bridge.

107. In a telephone system, a party line, means whereby one party may call another on the same line, means for supplying signaling current to said line when one party calls another on the same line, means for interrupting the signaling current, mechanism for disconnecting the signaling current when

the called subscriber answers, dependent for its operation upon momentary interruption of the said current, and automatic means for extending connection from said party line, said automatic means being controllable over the two sides of a line in series.

108. In a telephone system, a party line, means controlled over the two sides of the line in series for selectively signaling on said line when one party calls another on the same line, and automatic means for extending connection from said party line.

109. In a telephone system, a party line, means whereby one subscriber may call another on the same line, means for supplying signaling current to said line when one party calls another on the same line, and an interrupter at the central office for automatically applying the signaling current while the conductors of the party line are connected in series, and a non-numerical switch for extending a connection from said line.

110. In a telephone system, a line, means for signaling on said line, from a station on said line, means for interrupting the signaling current, mechanism for disconnecting the signaling current when the called subscriber answers, said mechanism operative only during interruption of the ringing current, and a non-numerical switch operable in response to the closing of a bridge across a line for extending a connection therefrom.

111. In a telephone system, a party line, and means controlled over the two sides of the line in series for selectively signaling on said line when one party calls another on the same line, said selective signaling means being common to a plurality of such party lines.

112. In a party line telephone system, trunks for connection with calling lines, means for enabling a subscriber to call back on his own line, comprising a slow-acting relay individual to the party line, centralized means for supplying battery current over the lines for both talking and operating purposes, and a slow-acting relay and another relay for each trunk to which the party line can be directly connected, as set forth.

113. In a telephone system, the combination of means for extending connection to the called line by the use of means controllable over the two sides of the calling line in series, substation controlled means for ringing another substation on the same line of the calling subscriber, centralized means for supplying battery current over the lines for both talking and operating purposes, and automatic means for ringing a substation on a line other than the calling line.

114. In a telephone system, the combination of substation controlled means for ringing another substation on the same line of the calling subscriber, centralized means for supplying battery current over the lines for both talking and operating purposes, automatic means for ringing a substation on a line other than the calling line, and a non-numerical switch forming a part of said substation controlled means.

115. In a telephone system, the combination of means including a non-numerical switch and switches having a primary motion and a secondary motion for extending connection to the called line, substation controlled means for ringing another substation on the same line of the calling subscriber, and automatic means for ringing a substation on a line other than the calling line.

116. In a telephone system, the combination of substation controlled means for ringing another substation on the same line of the calling subscriber, automatic means having one motion and then another motion to find the calling line, and automatic means for ringing a substation on a line other than the calling line.

117. In a telephone system, subscribers' stations including calling mechanism, a plurality of trunk lines, two switches, one switch for selecting an idle trunk line independently of any operation of said calling mechanism, and thus extend a connection over said selected trunk to the second switch, means for maintaining said first switch in contact with said trunk, means including a circuit extending from said second switch for controlling said first means, and means for controlling said switches over two sides of the calling line circuit in series.

118. A telephone exchange system comprising telephone lines, automatic connectors less in number than said telephone lines, selectors less in number than the telephone lines, provided with means having step-by-step motion to select different operative groups, depending on the number called, and rotary step-by-step motion to connect with a line in the selected group, subscribers' individual switches corresponding in number to the telephone lines, subscribers' devices for closing the lines to control said individual switches and selectors and connectors, line circuits by which the said individual switches and selectors and connectors are controlled, each line circuit including the two sides of a calling telephone line in series, and means for releasing said individual switches and selectors and connectors by the opening of the calling line.

119. A telephone exchange system comprising a calling telephone line, a called telephone line, means including a plurality of selectors and a connector for extending connection from the calling line to the called line, calling mechanism requiring a separate manual operation thereof for each digit of the called number, operative to transmit

suitable controlling current for one digit before the said mechanism is manually operated for the next digit, line circuits for controlling the selectors, and a line circuit for controlling the connector, each line circuit including said mechanism and the two sides of the calling line in series.

120. A telephone exchange system comprising telephone lines, automatic connectors less in number than said telephone lines, selectors less in number than the telephone lines, subscribers' individual switches corresponding in number to the telephone lines, subscribers' apparatus for closing the lines to control said individual switches and selectors and connectors, comprising a calling mechanism requiring a separate manual operation thereof for each digit of the called number, operative to transmit suitable controlling current for one digit before the said mechanism is manually operated for the next digit, line circuits by which the said individual switches and selectors and connectors are controlled, each line circuit including said mechanism and the two sides of a calling telephone line in series, and means for releasing said individual switches and selectors and connectors by the opening of the calling line.

121. In an automatic telephone exchange trunking system, a calling line and a called line, a plurality of switches for connecting the calling line with the called line, including a switch individual to the calling line, line bank springs for the said individual line switch included in the connecting line circuit, and automatic means whereby if said springs are separated all of the switches are released.

122. A telephone exchange system comprising telephone lines, automatic connectors less in number than said telephone lines, selectors less in number than the telephone lines, subscribers' individual switches corresponding in number to the telephone lines, subscribers' devices for closing the lines to control said individual switches, and selectors and connectors by a varying number of impulses, line circuits by which the said individual switches and selectors and connectors are controlled, each line circuit including the two sides of a calling telephone line in series, said devices having provisions for determining the number of impulses necessary for each digit of the called number, and means for releasing said individual switches and selectors and connectors by the opening of the calling line.

123. A two wire automatic telephone exchange system involving polystation telephone lines, non-numerical switches responsive to the closure of bridges across said lines for extending connections therefrom, release mechanism, switches controlled over the two sides of a line in series having one motion to select groups and another motion to connect with a line in a select group to establish connections between any of the substations on the lines, and means for determining the busy condition of a called line and for locking thereon and maintaining connection uncompleted unless the called subscriber is on the line of the calling subscriber.

124. A two wire telephone exchange system including polystation telephone lines, individual switches responsive to the closure of bridges across said lines for extending connections therefrom, automatic switch controllable over the two sides of the line in series having one motion to select groups and rotary motion to connect with a line in the selected group to extend the connection to a called line, and means for determining the busy condition of the called line and for locking thereon and maintaining the connection uncompleted.

125. A telephone exchange system including polystation telephone lines, progressively movable non-numerical switches for extending connections from said lines, automatic switches controlled over the two sides of lines in series having motion to select groups and then lines in the groups to complete connections with called subscribers either on the calling lines or on other lines, and means for determining the busy condition of the called lines.

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

ALFRED H. DYSON.