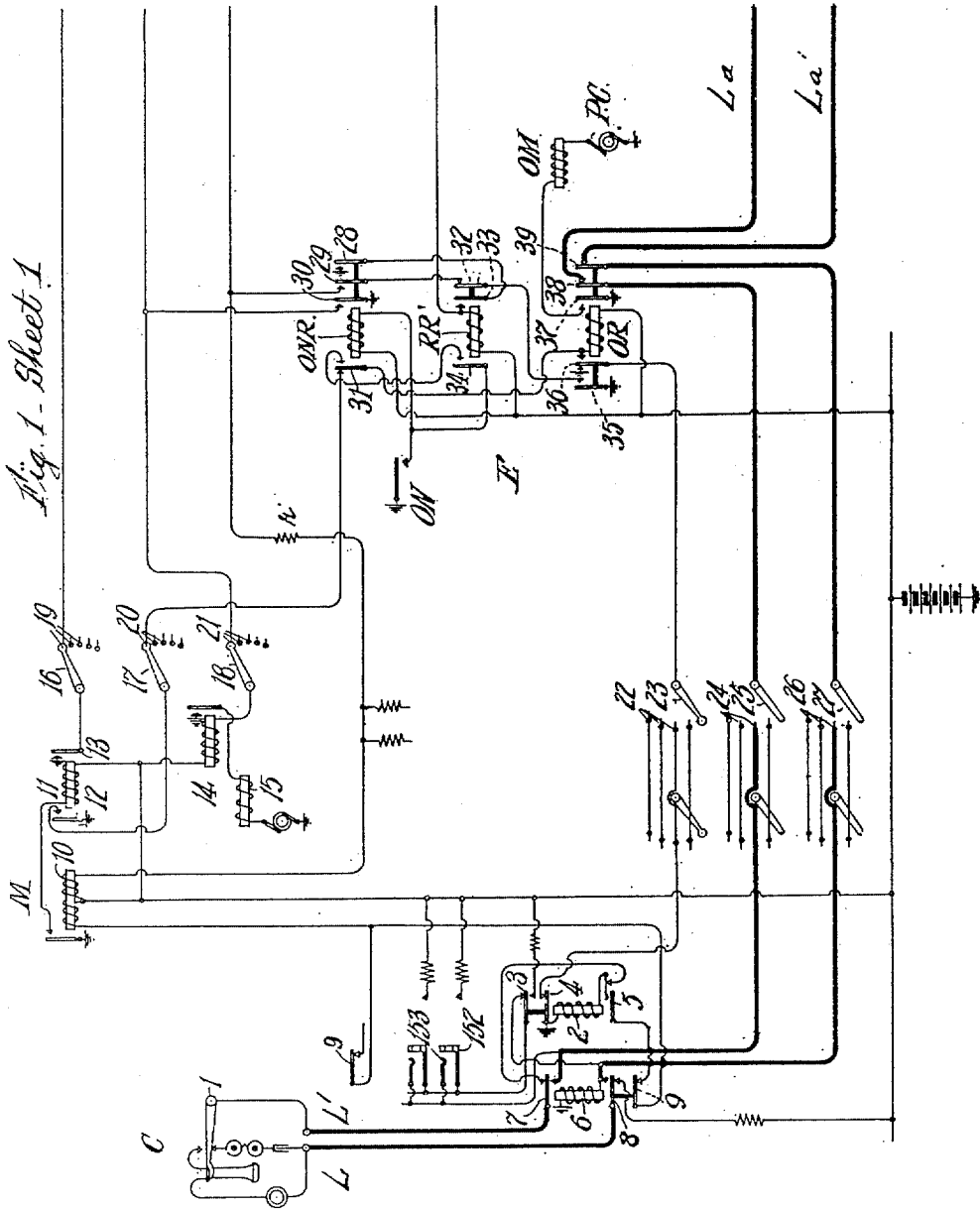


A. H. DYSON.
TELEPHONE TRUNKING SYSTEM.
APPLICATION FILED JAN. 22, 1907.

981,399.

Patented Jan. 10, 1911.

7 SHEETS—SHEET 1.

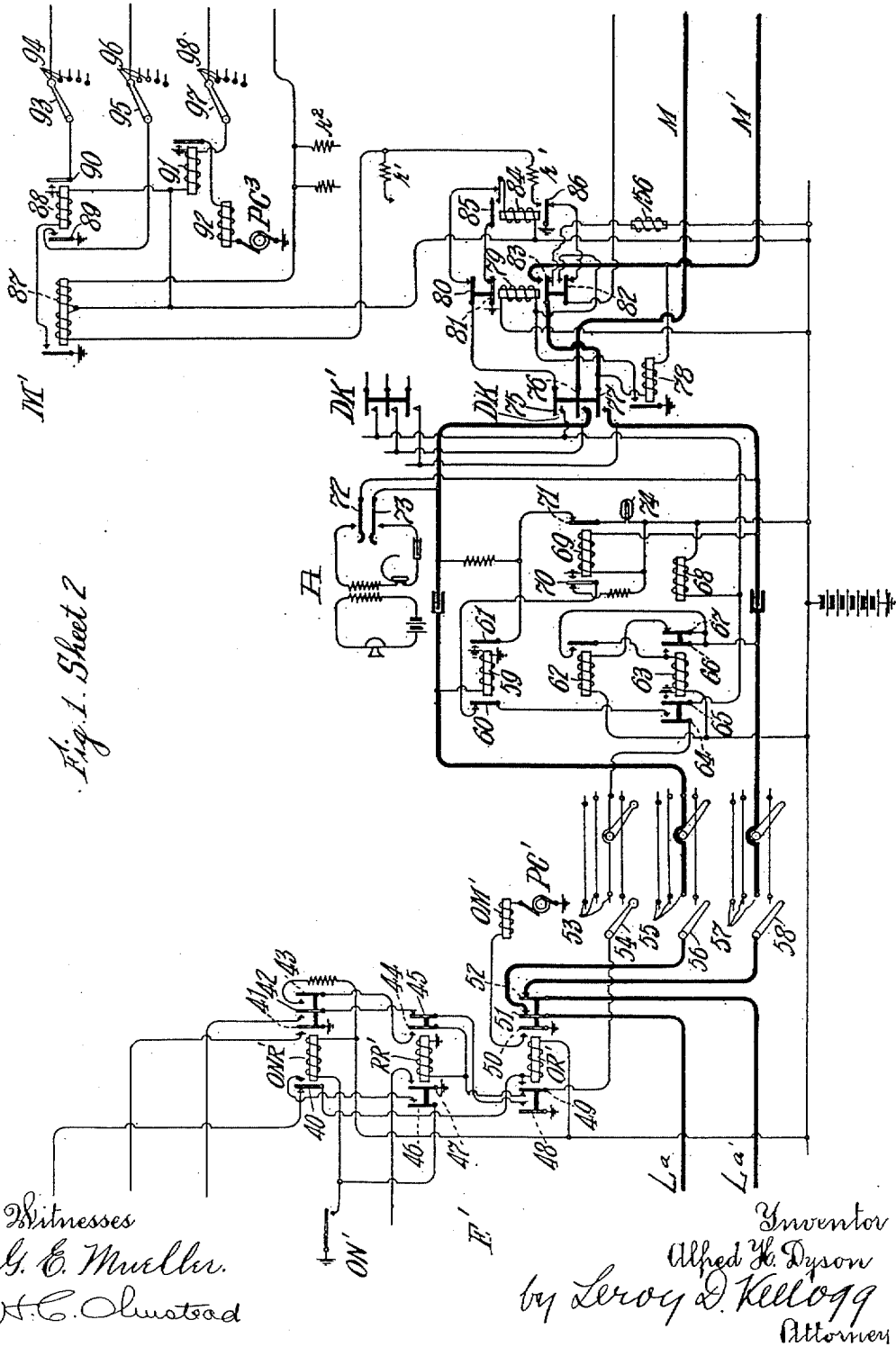


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7 SHEETS--SHEET 2.



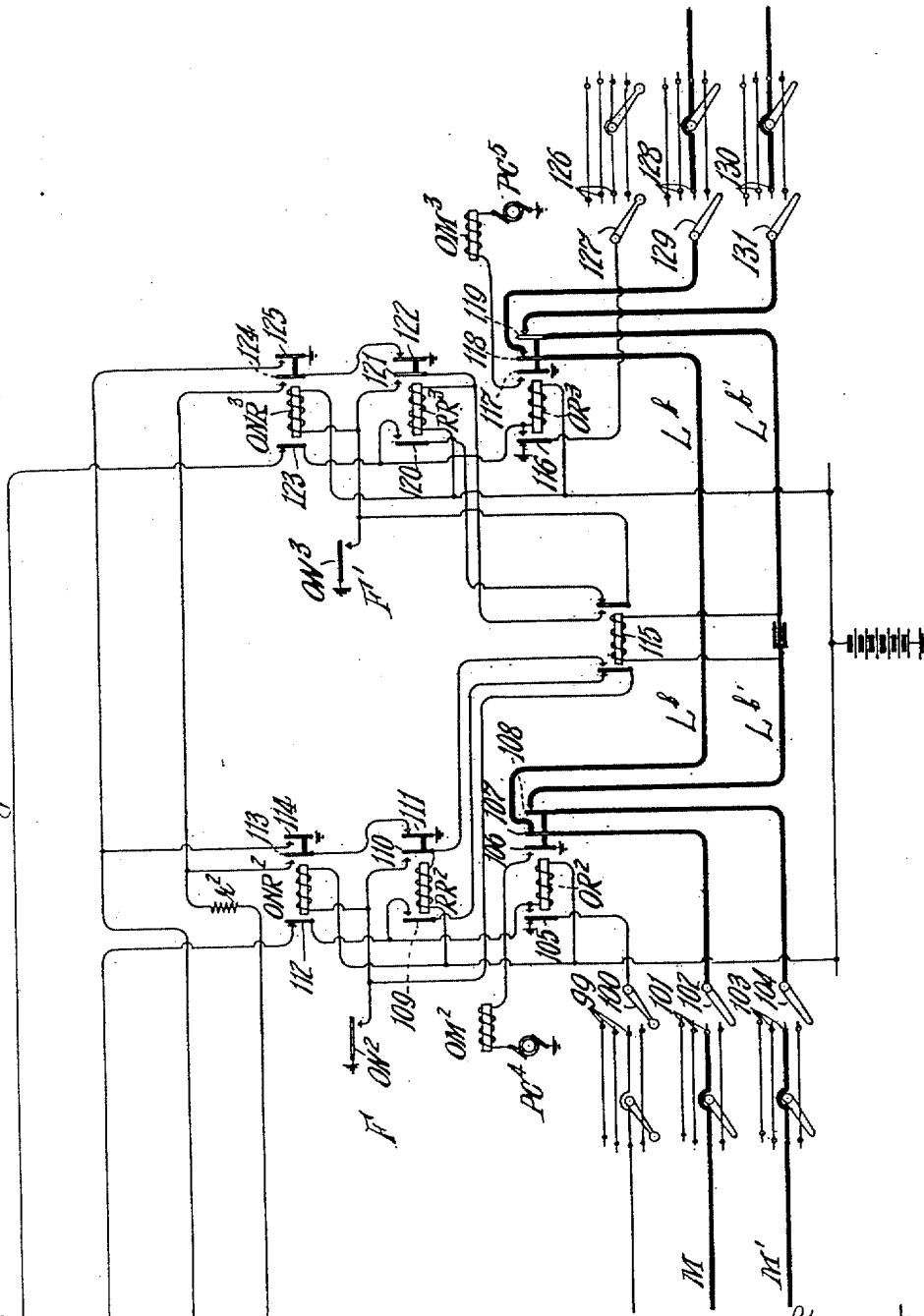
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7 SHEETS—SHEET 3.

Fig. 1—Sheet 3.



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7 SHEETS—SHEET 4.

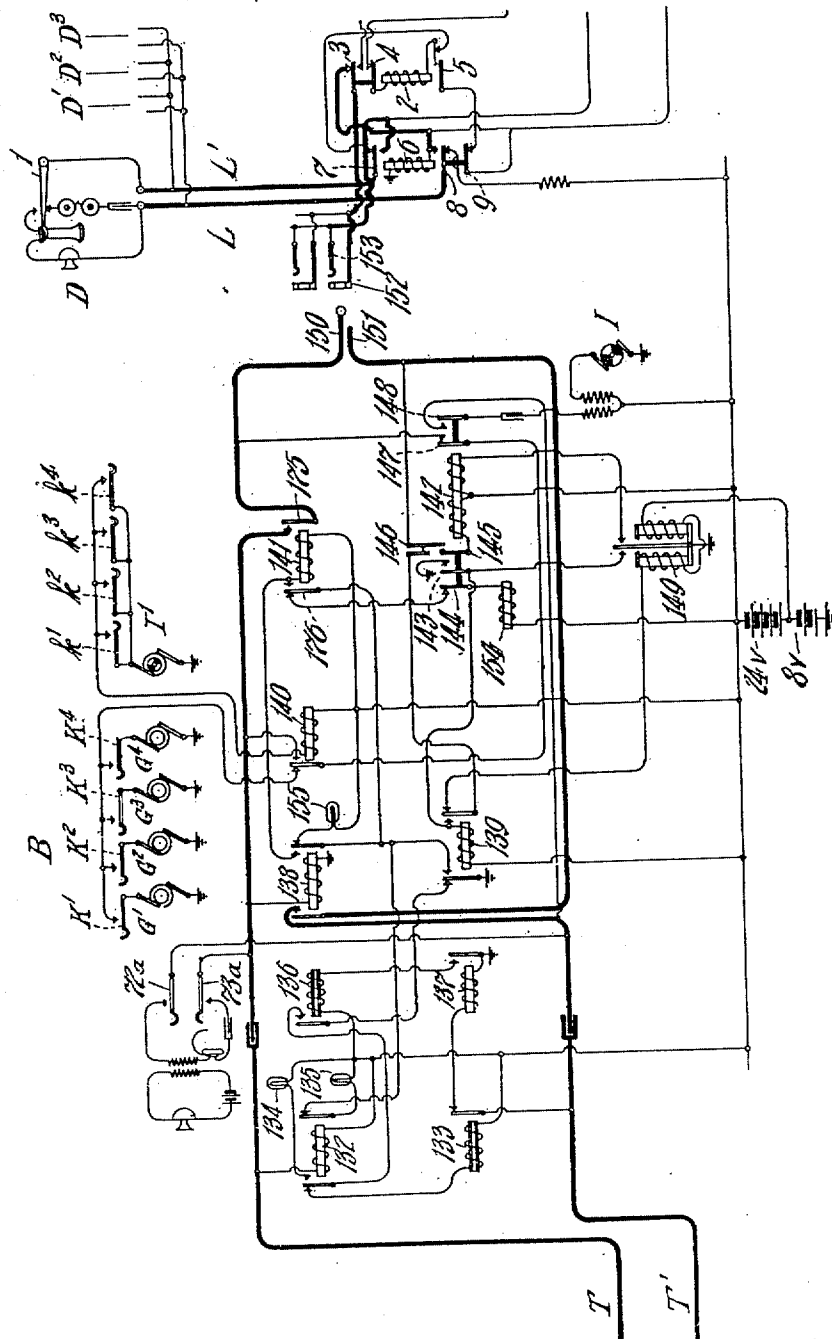


Fig. 1. Sheet 4

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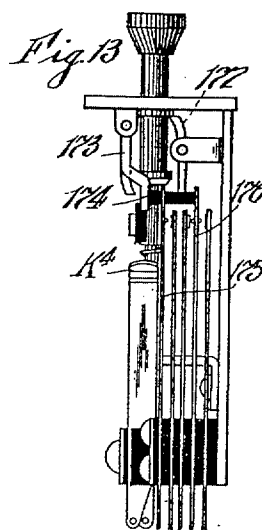
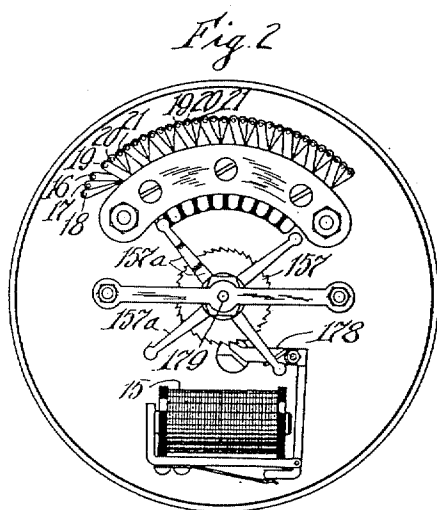
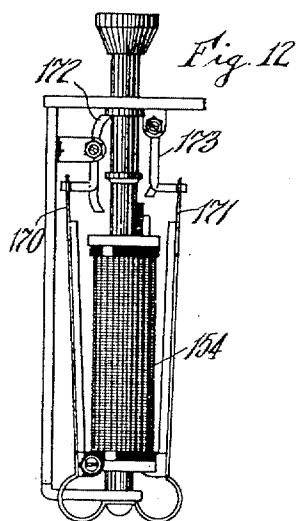
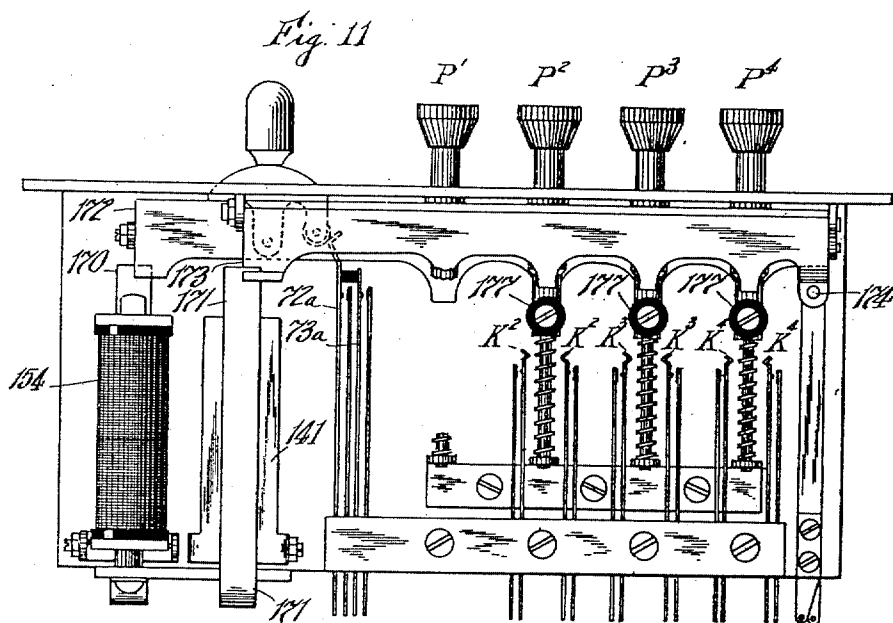
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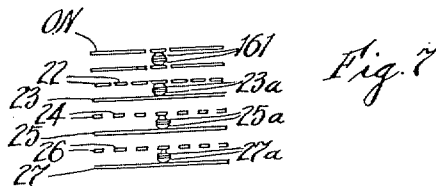
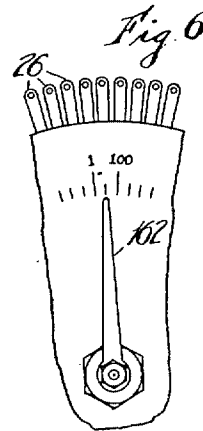
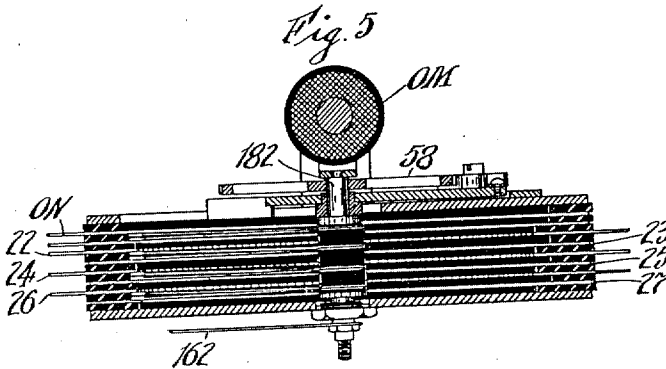
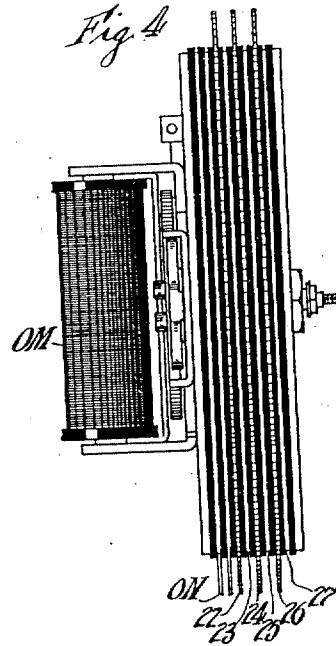
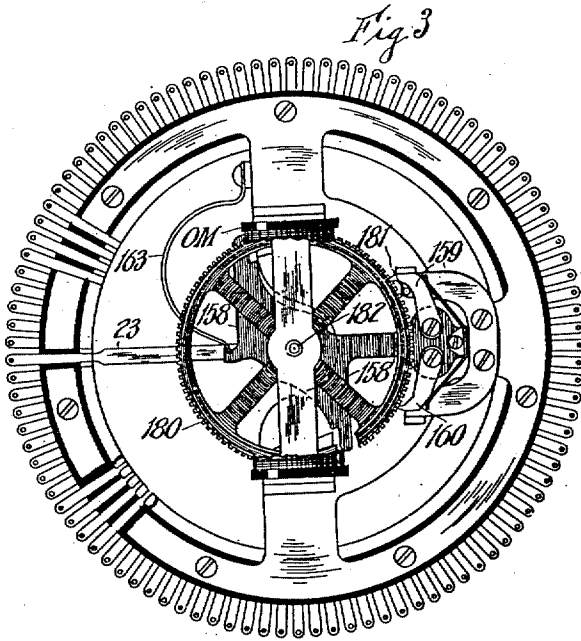
7 SHEETS—SHEET 5.



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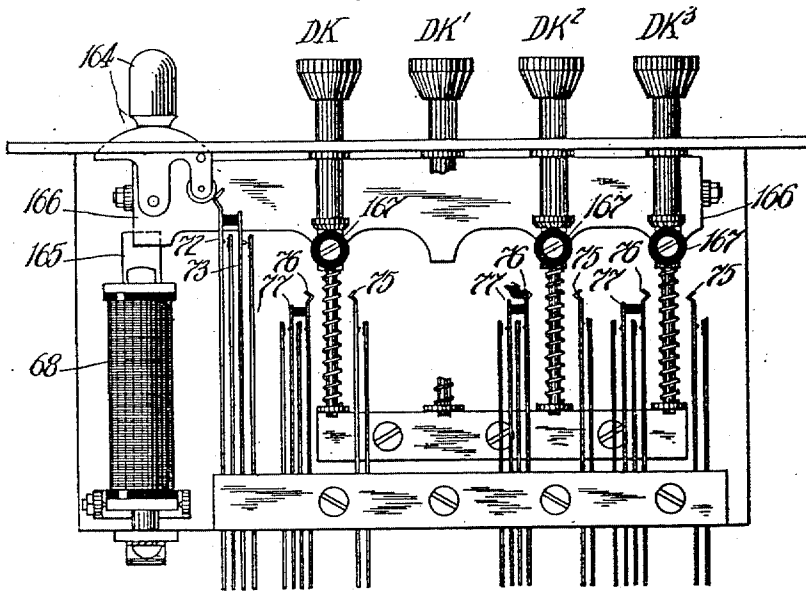
A. H. DYSON.
TELEPHONE TRUNKING SYSTEM.
APPLICATION FILED JAN. 22, 1907.

Patented Jan. 10, 1911.

7 SHEETS—SHEET 7.

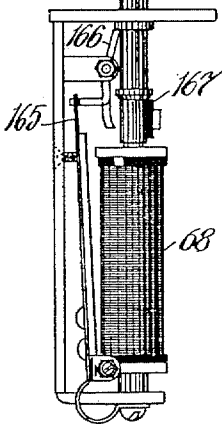
981,399.

Fig. 8



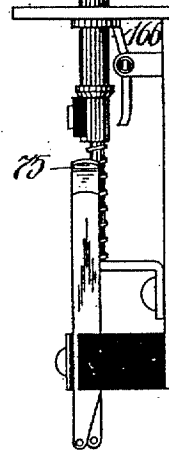
DK

Fig. 9



DK'''

Fig. 10



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UNITED STATES PATENT OFFICE.

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TELEPHONE TRUNKING SYSTEM.

981,399.

Specification of Letters Patent. Patented Jan. 10, 1911.

Application filed January 22, 1907. Serial No. 353,517.

To all whom it may concern:

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

As is well known, it is the usual practice in large cities where a very great number of subscribers are to be served, to divide the territory into sections, terminating the lines of the subscribers of each section in switchboards located conveniently to the end of having the subscribers' lines as short as may be. In addition to the above indicated advantage of saving in the length of the subscribers' lines, such an arrangement is necessary where manually operated switchboards are employed because the best practice requires that multiple switchboards be employed, and such switchboards have a limited capacity on account of the fact that each operator must have within her reach multiple springjacks for each subscriber's line.

In a system such as that mentioned, the various exchanges are connected by trunk lines proportioned in number to the amount of traffic passing between the various exchanges.

It has been found where a number of exchanges are located in a single city that a very large proportion of the calls are for lines terminating in local exchanges other than the one in which the call originated, and in some cities the percentage of calls required to be trunked from one exchange to another amounts to as much as eighty or ninety per cent. of the total calls. In such systems, the operator who first handles the originating call at the local exchange is called an A operator, and the operator at the distant exchange who completes a connection to the called line is usually called a B operator. It has been the practice for an A operator receiving a call from a subscriber's line at the local exchange to complete the connection to a subscriber's line in the same exchange if such a subscriber's line was called for; or, if a subscriber in another exchange was wanted, to communicate by order wire with a B operator in the distant exchange, the B operator handling only trunking calls. It has been found difficult for an operator acting as an A operator to

handle both local and trunking calls, and inasmuch as such a very large percentage of calls are in any event trunked, it has been found desirable in very large systems to have all incoming calls handled by A operators who merely distribute them to B operators in their own exchange or in any other exchanges as required. By this arrangement, each operator handles one class of work exclusively, and service is found to be materially more rapid and accurate than when the operators are doing two classes of work.

It is to such a system as that above described that my invention relates, its object being in a general way to reduce as far as possible, the work required of an A operator, and, by means of electrically controlled switching mechanism to automatically distribute the calls passing through the system among the A operators and B operators, giving to each operator as much work as she can efficiently handle.

The present manner in which calls between A operators and B operators are ordinarily handled is as follows: The A operator on receiving a signal from a calling subscriber inserts an answering plug of a pair into a jack of the calling subscriber's line, ascertains the exchange and number of the subscriber wanted, communicates with the B operator of the exchange wanted, by order wire, telling such operator the number of the subscriber wanted. The B operator then advises the A operator of the designating number of the trunk which is to be used in completing the connection, the said trunk terminating before the A operator in multiple springjacks and before the B operator in a plug, whereon the A operator will insert the calling plug of the pair used in answering the call into a multiple jack of the trunk line designated, and the B operator inserts the trunk plug into the springjack of the called subscriber's line, provided the usual preliminary test has shown the called line to be idle. It has been found in practice that this method of operation, although it gives the subscribers very good telephone service, is quite expensive on account of the operators' time used in completing each connection. It has been found by careful study that it costs about twice as much for operators' hire, to put through a trunking call as it would cost were all lines terminated in a

single exchange and each call was completed by a single operator. The present trunking method not only causes two operators to take part in the connection, but as the number is repeated by the A operator to the B operator, the A operator in communicating with the B operator must as it were, get into step with other calls coming to the B operator from other A operators. This not only increases the item for operators' hire but renders the completion of the connection over the trunk slow, so that a relatively large number of trunks are necessary, and it is impossible to get the highest efficiency out of those provided.

In accordance with my invention, the A operator does not converse with the B operator at all, neither is she required to use any cord and plugs in putting through a connection, but the apparatus with which she is provided consists only of a number of signal lamps which may be located upon a desk together with a number of distributing devices which may assume the form of keys for each lamp signal equaling in number the number of exchanges to which connections must be made. The said signal lamps are not individual to any particular subscriber's line, but are preferably common to a plurality of lines, and selective switching mechanism is provided for interchangeably associating the signals with the lines over which calls are being originated. Thus, when a calling subscriber removes his receiver at the substation, he sets in train of motion automatically controlled selective switching mechanism which connects his line to an operator's signal associated with a set of keys before mentioned (which may be called distributing keys) not in use; the operator observing the signal will connect her telephone set with the called subscriber's line, learn the exchange wanted and throw over the key belonging to that exchange associated with the call lamp. A number of trunk lines are provided extending to each exchange, and the throwing over of a key by an operator will cause electrically controlled selective switching mechanism to be started to connect an indifferent idle trunk line leading to the wanted exchange to conductors connected with the particular key operated, the selective switch selecting the trunk line leading to the distant exchange automatically picking out a trunk of an idle B operator, who then ascertains from the calling subscriber the number of the line wanted and completes a connection in the usual manner by a cord circuit forming the terminal of the trunk. In connection with this cord circuit, I preferably employ mechanism such that the B operator on learning the wanted number inserts the plug of the cord in the multiple jack of the called line without making a preliminary test, the call

signal being extended to the called subscriber, or a busy signal extended to the calling subscriber automatically, according to the idle or busy condition of the called line. The supervision of a connection put up in this manner rests wholly with the B operator. The ordinary double supervision being provided, when the connected subscribers replace their receivers, the two signals will be displayed, and the B operator in withdrawing the plug from the springjack of the called line, will cause the trunk switches to be automatically disconnected from her cord and from the key at the A operator's position, restoring said key to normal, and the same act will also cause the switching mechanism by which a calling subscriber's line is connected to the signal circuit at the A operator's position to be restored to normal. It is thus seen that the A operator has no work to do except that of learning the exchange wanted after noticing the display of a call signal and operating a key corresponding to the exchange wanted associated with the call signal displayed. Further steps in the operation for completing a connection, and for restoring the apparatus therein employed to normal, being effected by the B operator, whose work is lightened to this extent that she does not have to designate a trunk or test a called subscriber's line.

As indicated, a telephone system organized in accordance with my invention may comprise a number of different exchanges in each of which a part of the telephone lines included in the system as a whole may terminate, the said lines being provided with multiple springjacks within reach of each B operator in their respective exchanges. In addition to the springjack terminals appearing before the B operators, each subscriber's line is provided at its exchange with multiple contacts appearing with those of other subscribers' lines in the contact banks of electrically controlled switches. The lines belonging to a particular exchange may for this purpose be conveniently divided into groups of say, one hundred, and the contacts of a one hundred line group may appear multiplied at the banks of a number of selective switches provided in number proportioned to the number of co-existing calls expected from the group, the selective switches being arranged to automatically select and connect with the calling line on the removal of the receivers at the substations. Associated with each such selective switch and individual thereto, is a second electrically controlled switch before whose movable contact members appear multiple contacts forming terminals of link-circuits extending to one or more A operators' positions, each link-circuit being there provided with a call signal and a plurality of keys, one for each

exchange included in the system as a whole. Thus, each group of subscribers' lines has associated with it a number of pairs of switches, any pair of which is capable of uniting a calling line of that group by means of a link-circuit connecting the switches of a pair with an idle link-circuit extending to an A operator's position and there displaying a signal.

The terminal of the link-circuits extending to the A operators' positions may appear in groups of one hundred at the switches with which they are associated, and may be multiplied say, one hundred times, in which case, if the usual ten per cent. trunking be employed, a group of one hundred A operators' link-circuits would serve a great group of one thousand subscribers' lines; in other words, the terminals of the A operator's link may be multiplied to the switch pairs of ten one hundred line groups of subscribers' lines. Each of the switches employed to select A operator links is preferably arranged so that when not in use, its movable contacts are at a particular zero or normal position, so that when a switch is operated by the initiation of a call at a substation, its wipers in their search for an idle A operator's link, may wipe over the terminal contacts of said links in consecutive numerical order. The said links are preferably assigned to the A operators in numerical order, that is, assuming that the A operators are placed at positions numbered 1, 2, 3 and 4, etc., the link or links whose contacts are first engaged by the wipers of a started selective switch may be assigned to the first A operator, the next contacts to the second A operator, and so on, in order that the first calls originating from a great group of lines may come to the first operator's position, and as the business increases and a greater number of calls co-exist from the great group, they may come to the succeeding operators. The division of the links, constituting any group, among the A operators may be arranged in any preferred manner; for instance, the first twenty or thirty links may be assigned to the first operator, the second twenty or thirty to the second operator, and so on, or, if a large exchange be supposed including the lines of several thousand subscribers, in which case, under the assumed ten per cent. trunking, a plurality of groups consisting each of one hundred A operators' links will be provided (one such group for each thousand lines), the first A operator may have assigned to her the first link-circuits of each one hundred line groups of circuits, the second operator the second link-circuits, and so on, the object being to automatically condense the incoming business at one end of the A operator's board until all link-circuits at one A operator's position are in use when addi-

tional calls coming in will be distributed to the second position, and so on along the switchboard. Any preferred arrangement of these groups of link-circuits may be employed, and I do not desire to be limited to those herein more specifically referred to.

Each group of switch pairs before described may be provided with a master-switch which is operatively associated with each and every line of the one hundred line group of lines which the particular switch pairs controlled by it, serve, the function of the said master-switch being, when a call is initiated at a substation to start into operation a switch pair, one of which selects the calling line and the other the first idle link-circuit leading to an A operator.

The outgoing ends of the link-circuits of the A operators are provided with terminal contacts which are multiplied at each of the keys pertaining to that link-circuit of which, as before indicated, one is provided for each of the exchanges in the system.

For extending connections from A operators' positions to B operators' positions, a number of switch pairs largely similar to those before mentioned may be provided, one switch of a pair being adapted to establish connection with the outgoing ends of the A operators' link-circuits. For each such group of a pair being adapted to select a trunk or link-circuit extending to a B operator's position at the wanted exchange, there being at least as many such groups of switch pairs as there are exchanges in the system, and the number included in each group being determined by the amount of business expected to exist at each exchange, and the number of A operator's link-circuits. For each such group of switch pairs may be provided a master-switch operatively associated with the A operators' link-circuit keys for the exchange to which the switch pair group controlled by the master-switch belongs. The keys of the A operators' link-circuits include contacts connected to circuits for controlling the master-switch, and contacts connected to multiple contacts appearing in the banks of one set of switches of a group of switch pairs. The other set of switches of a group of switch pairs have before their wipers, multiple contacts or trunks extending to the B operators' positions, their arrangements being preferably similar to that hereinbefore described with respect to the links leading to the A operators' positions, namely such that the business of B operators' positions will be condensed at one end of the switchboard, the switches employed to select trunks having a fixed normal or zero position as before mentioned.

When the A operator having learned from the calling subscriber what exchange is wanted, depresses the key appropriate to the exchange wanted belonging to the signal dis-

played before her, this act automatically causes the master-switch of the group of switch pairs for the wanted exchange to start an idle switch pair into operation.

5 The depressing of the key also alters the normal electrical condition of its multiple contacts appearing at the banks of the switches of the switch pairs adapted to select them and renders said contacts selectable by
10 one switch of the started pair; the other switch of the pair then selects a link at the first idle B operator's position and a signal is displayed, in response to which the B operator inquires the number of the subscriber
15 wanted, and on learning the same from the subscriber, completes the connection. The key operated by the A operator, which, it will be noted, is her only act after learning the exchange wanted, remains in its shifted
20 position until the B operator withdraws the plug from the jack of the called subscriber's line in response to the disconnect signal. When she does so, the said key at the A operator's position is automatically restored to
25 normal as well as the two switch pairs employed in completing the connection from the calling subscriber to the B operator. The A operator thus has absolutely nothing to do with taking down a connection, and in
30 fact, will not know when the conversation terminates or when her link-circuit employed therefor is freed and rendered available for use by other calling subscribers, and it is of
35 no interest or advantage that she should do so, her only work, as before indicated, being to distribute incoming calls among the various exchanges, a principal object of the invention being to reduce the work of the A operators in so far as may be to a minimum.

40 Referring to the drawings, Figure 1 consisting of four sheets illustrates a preferred organization of circuits embodying my invention, the four sheets when placed in numerical order with sheet 1 at the left and
45 sheet 4 at the right constituting a complete diagram. Fig. 2 illustrates a preferred form of master-switch mechanism adapted for use in connection with the circuits indicated at M and M' in Fig. 1. Fig. 3 shows a top
50 view of a circular selective switch mechanism adapted for use in connection with the circuits at E, E', F and F' in Fig. 1. Fig. 4 is a side view of said switch mechanism, Fig. 5 a sectional view thereof, Fig. 6 a rear view
55 of a portion of the switch mechanism. Fig. 7 is a diagrammatic illustration of the preferred arrangement of circuit contacts of the switch mechanism. Fig. 8 shows a preferred
60 A operator's key structure. Figs. 9 and 10 are respectively left and right end elevations thereof. Fig. 11 shows a preferred B operator's key structure, Figs. 12 and 13 being respectively left and right end elevations thereof.

65 Referring now more specifically to Fig. 1

as shown at C, a subscriber's station includes the usual transmitter, receiver, condenser and call-bell with the hook-switch 1 adapted on the removal of the receiver to disconnect
70 the condenser and bell operatively from the telephone line, and to connect the transmitter and receiver therewith. The said substation C is connected with the exchange by the two limbs L and L' of the telephone
75 line which is provided at the exchange with the usual multiple jack terminals comprising contacts 152—153, and also with the additional multiple terminals 22—24—26
80 which are multiplied in banks appearing before wipers 23—25—27 of a plurality of line selecting switches such as E. The line selecting switch E and the trunk selecting switch E' form a pair connected by the link conductor La—La'. In the organization of
85 the system there would be provided a number of pairs of switches E and E' for the one hundred line group of substation lines among which the line of C is included, the number of switch pairs being determined by
90 the amount of business expected from the group. Every one hundred line group of subscribers would be provided with its appropriate group of switch pairs E and E'. Ten such switch pairs for one hundred lines
95 would ordinarily be sufficient.

A master-switch mechanism M is provided, one for the group of one hundred lines with branch conductors leading to each line of the group which it serves to the end
100 that each line may control said mechanism. The said master-switch mechanism when operated from a substation is effective to start into operation from a normal position of rest an indifferent idle switch pair E—E' serving
105 the line group of the calling line. The switch E selects multiple contacts 22—24—26 of the calling line, while the other switch E' automatically selects multiple contacts
110 53—55—57 of the first idle link-circuit appearing before an A operator and being there provided with the call signal 74, and the multiple associated distributing keys DK and DK', etc., one for each exchange included in the system.

Each distributing key, DK for example, is
115 provided with link conductors terminating in multiple contacts 99—101—103, appearing before the wipers 100—102—104 of a plurality of trunk selecting switches such as F, each such switch being adapted auto-
120 matically to select the multiple terminals of the key DK after the same is operated by the A operator; the said multiple contacts 99—101—103 are associated with terminals of other distributing keys DK for the same
125 exchange pertaining to the same and other A operators' positions. Each such distributing key DK is also effective when operated to control the master-switch mechanism M' which is adapted to start into operation an
130

indifferent idle pair of a plurality of switch pairs such as F—F', the switches of a pair being united by the conductors Lb—Lb' of which the switch F as before indicated, selects the operated key DK and the other switch F' selects the terminals 126—128—130 of the first idle trunk circuit appearing before a B operator at the distant exchange.

The multiple key DK' may have connections similar to the key DK but its multiple terminals are to be considered associated with a different group of switches F, F', the switches F', paired with the switches F which are arranged to select contacts of keys DK' being adapted to select the first idle trunk circuits leading to an exchange of the system other than that in which the trunks selectable by the switches F' associated with the first key DK terminate. It will be understood that the key DK' in addition to its multiple terminals before referred to has access to a second master-switch mechanism M' controlling the switch pairs for the exchange to which the key DK' pertains and that this master-switch and the switch pairs controlled by it are common to other keys DK' of the operator to whom the link-circuit shown at A is assigned and to other keys DK' for the same distant exchange of other A operators.

The switch pairs E—E' and F—F' may all be located in the originating exchange, while the trunks T—T', each comprising but two conductors, extend from the originating exchange to the distant exchanges except of course, such trunks T—T' as lead to B operators in the same exchange as the A operator.

The apparatus at the exchange individual to a subscriber's line such as C, in addition to the multiple terminals before mentioned, includes a line relay 2 controllable from the substation, which relay has by its armature contacts control of the master-switch M and also of the electrical condition of the multiple contacts 22—24—26 to render them selectable by the line selectors E. In addition to the line relay, the individual cut-off relay 6 is provided for the line having the function of altering the normal connection of the line limbs L—L' when connection is made to terminals of the line to complete the talking circuit of the line to its multiple terminals. The master-switch mechanism M comprises a common differential relay 10 controlling the starting relay 11 which by its armatures 12 and 13, connected to wipers 17—16 is effective to start simultaneously any switch pair E—E', of which the said wipers may be engaging terminals 20—19. The wipers 16—17—18 of the master-switch normally rest in engagement with terminals of an idle switch pair E—E', and the wiper 18 has connections with the relay 14 of the master-switch, which relay is op-

erated when a switch pair is started to initiate movements of the master-switch wipers past contacts of busy switch pairs to come to rest engaging those of the first idle pair. The switches E—E' include their respective wipers 23—25—27 and 54—56—58, and for moving these wipers over their respective contact banks, the respective operating magnets OM and OM' are provided, controlled by their operating relays OR and OR'. These relays are originally controlled in the operation of the system by the master-switch mechanism but after their initial operation, they are controlled over circuits extending from the respective private wipers 23 and 54 in order that they by their control of the operating magnets OM and OM' may determine the selection of contacts engaged by the private wipers 23 and 54 when said contacts are in a particular selectable electrical condition. Each switch is provided with its off-normal spring ON or ON' shifted on the first movement of the switch to cause the operation of the respective off-normal relays ONR and ONR'. The armature mechanisms of these relays constitute the means by which the started switches are caused, as it were, to re-act upon the master-switch mechanism to restore the armature of common relay 10 to normal and to effect the movement of the wipers 16—17—18 in search of contacts of an idle switch pair as soon as a particular pair has been started. By employing the off-normal relays before mentioned controlled by off-normal switches having a single contact only, I am enabled to avoid the use of a large number of such off-normal switch springs effecting by an electromagnetic combination a result which it would otherwise be necessary to effect by a more complicated off-normal mechanism combination, and I consider that by the use of this relay, a materially more reliable method of operation is secured than by the mechanical off-normal combinations hitherto known. The switches E, E' are also provided with their respective release relays RR and RR', which, when the switches are released, are effective to cause the energization of the operating relays OR and OR' respectively, which relays are then locked causing continuous operation of the respective switches in the same direction as that in which they originally operated until they reach the zero or normal point when the off-normal switch is shifted to normal again, causing the switches to come to rest.

The switches F and F' constituting a pair, are provided with their respective operating relays OR² and OR³, their operating magnets OM² and OM³, their off-normal switches ON² and ON³, the off-normal relays ONR² and ONR³ and their release relays RR² and RR³. The arrangement of their parts is generally similar to those of

the switches E, E' and such differences as exist will be more particularly pointed out in the following narrative of operation. It being assumed that the subscriber at the substation illustrated at C desires his line to be connected with that of the subscriber whose substation is illustrated at D and whose line terminates in an exchange of the system other than that in which the line C terminates, the subscriber C removes his receiver from hook lever 1 which closes a path for current as follows: from battery to normal contact of armature 8 over limb L, hook lever 1, limb L', back contact of armature 7, through relay 2 to ground. Said relay in attracting its armature 5 completes a locking circuit for itself from ground through the attracted armature 5, normal contact of armature 9, left-hand winding of relay 10, to battery. The attraction of armature 4 removes ground from the private contacts 22 of the line at the line selectors E, while armature 3 connects the active side of the battery with sleeve contacts 152 of the line spring-jacks, through a suitable protective resistance, thus rendering the spring-jacks busy immediately upon the removal of the substation receiver. Armature 3 also disconnects the winding of cut-off relay 6 from sleeve contacts 152 of the spring-jacks.

The circuit before described as completed through the left-hand winding of relay 10 causes the attraction of the relay's armature which completes a circuit through starting relay 11 whose armatures 12 and 13 are attracted, respectively placing ground upon wipers 16 and 17, and through them upon contacts 19 and 20 pertaining respectively to the switches E, E' of an idle switch pair. Current then flows from ground through armature 13, contact 16—19, through back contact of armature 40, operating relay OR' to battery, and from ground through attracted armature 12, contact 17—20, back contact of armature 31, operating relay OR to battery, causing the energizations of the relays OR' and OR. Relay OR attracts its armatures of which 38 and 39 disconnect trunk conductors La and La' from the line wipers 25—27, while armature 37 completes a circuit from ground through pulsating current generator PC, operating magnet OM to ground, and the said magnet OM advances wipers 23—25—27 to engage the terminal contacts of the first line of the group. If this line is not that of the calling subscriber, its multiple contacts 22 will be grounded through the back contact of armature 4 of its line relay 2, and as relay OR, by the attraction of its armature 36 has had its winding operatively connected with wiper 23 now engaging a contact 22 of such line, the relay OR is locked and succeeding pulsations will be transmitted through operating magnet OM, moving wipers 23—25—27

over terminals of the non-calling lines until the operating relay OR becomes deenergized, which it does as soon as wiper 23 engages the contact 22 of the line of the calling subscriber whose relay 2 is energized and consequently the attracted armature 4 has removed ground from the multiple contacts 22. With the first step of the switch E, off-normal spring ON was shifted to engage its contact, completing circuit from ground through off-normal relay ONR to battery, armature 31 of this relay freeing operating relay OR from the influence of armature 12 of relay 11, while armature 29 completes a path from ground through attracted armature 35, back contact of armature 32, attracted armature 29, resistance r', the right winding of relay 10 to battery. The relay 10 being differentially wound and the resistance of r' corresponding substantially to that of relay 2, the core of relay 10 becomes substantially neutralized, its armature retracted and relay 11 then becomes deenergized. Off-normal relay ONR by its attracted armature 30 closes circuit from ground therethrough, over contact 21—18, relay 14 to battery, which relay is operated to close circuit from ground through the pulsating current generator and the magnet 14, the said magnet then becoming energized to advance wipers 16—17—18 along the contacts 19—20—21 of successive switch pairs, relay 14 continuing energized and keeping the circuit of magnet 15 closed until wiper 18 engages a contact 21 pertaining to an idle switch pair, in which case, of course, relays ONR and ONR' will both be deenergized and the circuit of relay 14 will be opened at contacts 30 and 41, the relay deenergized and further operation of magnet 15 prevented.

When switch E has selected a calling line, the retractions of armatures 38 and 39 of relay OR following the deenergization thereof, connect link-conductors La and La' through to the wipers; armature 36 places ground upon the private contacts 22 of the calling line via wiper 23 to prevent another switch E coming to rest with its wipers engaging contacts of said line which might result if switch E came to rest before switch E' came to rest, since as it will be hereinafter more fully explained, relay 2 is only deenergized when both switches of the pair have completed their selection.

Referring now to switch E', the flow of current through the operating relay OR' on the attraction of armature 13 at M energizes said relay OR' whose attracted armatures 51—52 disconnect the link-conductors La and La' from wipers 56—58, while armature 50 completes circuit from ground through pulsating current generator PC, operating magnet OM', returning by way of ground so that an impulse

flows through OM' and wipers 54—56—58 are advanced a step to engage multiple contacts 53—55—57 of the first link-circuit leading to an A operator's position. Attracted armature 49 has operatively connected the winding of relay OR' with private wiper 54, and if this first link-circuit is busy, contacts 53 will be grounded via wiper 54 of another switch E', back contact of armature 49 and release relay RR' of said other switch. The windings of the relays RR' and OR' are so relatively proportioned that an operated relay OR' placed in series with a relay RR' will receive enough current to retain its armature attracted while the relay RR' being inert will not receive sufficient current to cause the attraction of its armatures. Wiper 54 having engaged the private contact 53 of a busy link-circuit, the operating relay OR' will continue locked causing a second impulse to flow through operating magnet OM' and relay OR' will continue locked through successively established circuits similar to that before described, until wiper 54 engages contact 53 of an idle link-circuit such as that shown at A, in which case the private contact 53 will be in its normal condition, namely, on open circuit as shown. The locking circuit of relay OR' is therefore interrupted, its armatures 51—52 are retracted and also armature 50, preventing further operation of OM', while armature 49 in its retraction connects ground to wiper 54 and private contacts 53 of the selected link-circuit, through release relay RR' rendering the selected link-circuit busy with respect to other link-circuit selecting switches E'.

On the first step of the wipers of the switch E', off-normal spring ON' was shifted, causing the energization of off-normal relay ONR' whose attracted armature 40 freed relay OR' from connection with contact 19, while armature 41 placed ground on contact 21. We have thus seen that ground was placed on contact 21 at the two armatures 30 and 41. By this means, contact 21 pertaining to the switch pair shown in Fig. 1 remains grounded until both switches E and E' have finally been restored to normal. As these switches may reach normal at different times, it is necessary to have these two independent grounds placed upon contact 21 in order to prevent a possible coming to rest of the wiper 18 upon contact 21 of the switch pair before both switches have been fully restored. The attraction of armature 42 of off-normal relay ONR' completed a circuit from ground through attracted armature 48, back contact of armature 45, attracted armature 42, resistance r' , the right winding of differential relay 10 to battery. This being a branch path of that before traced through said relay winding to ground at armature 35, and both branch paths being of negli-

gible resistance, the provision of these two paths insures continuation of a neutralizing flow of current through the right winding of relay 10 until both switches E and E' have selected their contacts and come to rest, at which time circuit will be opened through the right winding of relay 10 so far as the particular switch pair is concerned. Simultaneously with the occurrence of this however, a circuit is completed from ground through cut-off relay 6 whose attracted armature 9 opens the circuit of relay 2 and the left-hand winding of relay 10 (current being thus practically simultaneously taken from the two differential windings of relay 10 and the operation of its armature prevented), through contact 26—27, contact 39, limb La', through contact 52, contact 58—57, through contact 67, relay 62 to battery. Relay 62 is thereby operated (as well as relay 6), and by the attraction of its armature, completes a circuit from battery through relay 63, attracted armature of 62, contact 57—58 to ground through the relay 6. Relay 63 attracts its armature 66 to lock the relay by current flowing to the before mentioned ground, while armature 67 opens the circuit of relay 62 causing its deenergization. Immediately upon the operation of relay 6, relay 59 was energized to attract armature 61 to close circuit through the call lamp 74 at the A operator's position displaying it, and to attract armature 60 to open a contact in the circuit of release relay RR' to prevent its premature operation. The circuit through relay 59 may be traced from ground through said relay over contact 55—56, contacts 51—38—25—24, attracted armature 7, limb L', hook lever 1, returning over limb L, attracted armature 8, contacts 26—27—39—52—58—57, attracted armature 66, relay 63 to battery.

It will be seen that if the circuit of relay 59 is opened at the substation by the subscriber C replacing his receiver, the retraction of armature 60 will cause current to flow from battery through contact 70, contact 60, attracted armature 64, contact 53—54, normal contact 49, release relay RR' to ground operating relay RR' and causing the release of the switch pair E—E' as will be hereinafter more fully explained. The A operator observing the display of the call signal 74, now throws over the levers 72—73 of the listening key associated with the call signal, thus placing her talking set in connection with the calling line to learn the exchange wanted by the calling subscriber. Having ascertained this to be the exchange in which the line of D is included, she throws over the distributing key DK belonging to the particular call signal displayed and her work is at an end.

It will be noted that when relay 63 was operated, as hereinbefore described, its arma-

ture 65 closed a circuit from ground through the key magnet 68 to battery, the mechanical connection of this magnet to be hereinafter described being such that any distributing key of the link-circuit which may be depressed while the magnet is operated, will be held in its depressed position until a subsequent deenergization of the magnet 68 which will allow the depressed key to return to normal. As soon as spring 75 of operated distributing key DK engages its contact, a circuit is completed from grounded armature 65 of relay 63 through contact 75, armature contact 80, winding of relay 84 to battery, the relay 84 thereon attracting its armature 85 to complete a locking circuit for itself through armature 81 to ground, while armature 86 is attracted to remove ground from the multiple private contacts 99 at the banks of the selectors F to render the contacts 99—101—103 selectable in character. The armature 86 in engaging its alternate contact completes a circuit from ground through resistance r'' , the left winding of relay 87 of the master-switch mechanism M' to battery, and the attracted armature of relay 87 completes a circuit for starting relay 88 whose armatures 89 and 90 are attracted, 89 to complete a circuit through contact 95—96, armature 112, operating relay OR² to battery, and 90 to complete a circuit from ground through contact 93—94, armature contact 123, and operating relay OR³ to battery. The two operating relays are now energized, closing circuit of their respective operating magnets OM² of switch F, and OM³ of trunk selecting switch F' and the two operating magnets advance the wipers of their respective switches to engage the first multiple contacts of their banks. Operating relay OR² will remain locked, causing successive current impulses to flow from pulsating current generator PC⁴ through operating magnet OM², advancing the wipers 102—104 step-by-step until wiper 100 reaches the contact 99 of distributing key DK whose relay 84 is operated and whose armature 86 has hence been attracted to remove the ground from the contacts 99. When this occurs, the operating relay OR², which, during the operation of the switch up to this time, remained locked by current flowing over successive paths extending through attracted armature 105, and contacts 99 to ground at armatures 86 of all unoperated keys, becomes deenergized, opening circuit through operating magnet OM², armature 105 then placing ground on the multiple contacts 99 of the selected key, while armatures 107—108 which were held attracted by relay OR² during the operation of the switch, fall back to again connect wipers 102—104 with limbs Lb—Lb'.

With the first step of switch F, off-nor-

mal spring ON² was shifted to complete circuit through off-normal relay ONR², whereby contact 96 was, by the operation of armature 112, disconnected from operating relay OR², while armature 114 completed a circuit for relay 91 of the master-switch upon whose operation magnet 92 initiated travel of wipers 93—95—97, past contacts 94—96—98 of busy trunk switch pairs F—F'. Armature 113 of the off-normal relay ONR² completed a circuit from ground through contact 111, resistance r^2 and the right winding of relay 87 to battery, and as resistance r^2 is substantially equal to resistance r'' in circuit with the left-hand winding of relay 87, the relay becomes substantially neutralized, the relay's armature is retracted causing the deenergization of starting relay 88, thus preventing other switch pairs from before starting as wipers 93—95—97 move in search of idle contacts.

The circuit before described as completed through operating relay OR³ of switch F', operates the relay, whose armature 117 is attracted to close circuit through operating magnet OM³ and pulsating current machine PC⁵, magnet OM³, then stepping wipers 127—129—131 a step to engage the contacts forming multiple terminals of the first trunk circuit T—T' terminating in a B operator's cord at the distant exchange. If this trunk circuit is busy, its contacts 126 will be grounded through the normal contact of armature 116 of the operating relay OR³ of another trunk selecting switch F' via the wiper 127 of said trunk selecting switch and the multiple 126 of the trunk line engaged by the wiper 127 of the other switch, and a locking circuit will therefore be completed via its attracted armature 116 for relay OR³ of the seeking switch F' of Fig. 1, armature 117 continuing attracted and a second impulse will flow through magnet OM³ advancing the wipers a second step to engage the multiple contacts of the next trunk circuit T—T'. If this trunk is also busy, another locking circuit for relay OR³ will be completed via wiper 127, and successive impulses will flow through magnet OM³ advancing the wipers step-by-step until the contacts of an idle trunk line are reached, at which time, owing to the normal insulated condition of its multiple contacts 126 as shown in Fig. 1, relay OR³ is deenergized, opening circuit through magnet OM³ by the retraction of armature 117, while armature 116 places ground upon the multiples of the contact 126 engaged by wiper 127, holding them busy and armatures 118 and 119 complete the circuit over the limbs T—T' of the selected trunk through contacts 128—129 and 130—131 to limbs Lb—Lb' of the switch pair.

With the first step of the wipers of the switch F', off-normal spring ON³ was

shifted to close its contact operating off-normal relay ONR³ whose armature 123 disconnected terminal 94 from relay OR³; armature 125, placed a busy ground upon
 5 contact 98 of the switch pair and armature 124 completed a branch to ground for neutralizing resistance r^2 in order that the windings of relay 87 may continue to neutralize one another until such time as both
 10 switches F—F' of the pair have completed their selections, at which time current is taken practically simultaneous from the two windings of relay 87 to prevent a second operation of its armature in the following manner. As soon as circuit is completed
 15 from wipers 102—104 to wipers 129—131 by the closing of contacts 107—108 and 118—119, a circuit is completed as follows: from ground at the cord of the B operator selected by switch F' through relay 137 associated with said cord, back contact of relay
 20 133, over limb T' of the trunk through contact 130—131, contact 119, relay 115, contact 108, contact 104—103, over limb M' through relay 78 of distributing key DK, contact 77, relay 69 to battery. Said relay 69 attracts its armature 71 to open the circuit of call signal lamp 74 whose going out indicates that the subscriber's line has been
 30 extended through to the B operator at the distant exchange. The operation of relay 78 resulting from the establishing of the circuit just described, causing the attraction of its armature, energizes relay 79 whose armature 81 opens the circuit of relay 84 whose thereupon retracted armature 86 interrupts the flow of current through resistance r' and the left winding of relay 87, while armature 80 of relay 79 opens a contact
 40 in the original energizing circuit of relay 84, preventing it from being again operated. Armature 83 of relay 79 short-circuits the winding of relay 78 to cause its deenergization.
 45 It will be remembered that the flow of current operating relay 78 also travels over the winding of relay 115 whose attracted armatures cause the energizations of the release relays RR² and RR³ of switches F—F', respectively. The attracted armatures 111 and 122 of these relays open the circuits through the right winding of relay 87 at a time practically simultaneous with the opening of the circuit through the left winding
 55 of the said relay 87, as before described, thus preventing the attraction of the armature of said relay. Attracted armature 82 of relay 79 completes a locking circuit for relay 79 extending from battery through said
 60 attracted armature 82, contact 99—100, retracted armature 105 to ground.

The attracted armature of relay 137 associated with the cord at the B operator's position completes a circuit causing the energization of relay 136, whose attracted armature

closes a normally open contact in the circuit of call signal lamp 134, while relay 132 now energized by current from battery over trunk limb T, thence following the talking circuit as indicated by the heavy conductor
 70 to the left, through closed contact 76 at the A operator's position and to ground through armature 61, by the attraction of its armature closes another normally open contact in the circuit of lamp 134 so that the lamp is
 75 now displayed, current flowing therethrough from battery through said lamp and to ground at the retracted left armature of relay 139. It will be observed that if the calling subscriber at this time has his receiver
 80 replaced, this act has opened the circuit of relay 59 at the A operator's position and caused its deenergization, the retraction of armature 60 resulting in the restoration of the switch pair E—E', while the retraction
 85 of armature 61 opens the circuit of relay 132 and the retraction of the left armature of relay 132 then causes the restoration of the switch pair F—F', the detail of which operations will be hereafter fully described.
 90

The B operator in response to the display of signal 134, will throw over levers 72^a and 73^a, and ascertain from the calling subscriber the number of the line wanted, the talking circuit being traced to the left over
 95 the heavily marked conductors and through substation C, current for conversational purposes being supplied to the calling line from battery at the A operator's board through the impedances of relays 59 and 63. The B
 100 operator having learned the number wanted, that of the called subscriber assumed to be D, inserts the plug of the cord associated with the displayed signal 134 into a multiple jack of the called line closing contacts
 105 150—153 and 151—152. Assuming that this line is an idle line, the sleeve contact 152 will be of the same potential as ground, being connected thereto through the winding of cut-off relay 6, and current will flow
 110 from the intermediate or eight volt tap of battery through the windings of polarized test relay 149, retracted armature of relay 139, contact 146, contact 151—152, normal contact of armature 3 of the line circuit of
 115 the called line D, cut-off relay 6 to ground, energizing relay 6 whose attracted armatures 8 and 7 connect limbs L—L' to jack contacts 153—152, while armatures 7 and 9 open the circuits of line relay 2. The direction of this current flow is such as to tilt the
 120 grounded armature of test relay 149 to the left, completing a circuit from the said grounded armature, through the winding of sleeve supervisory relay 139 whose attracted
 125 right armature locks the said relay over a circuit extending therethrough over contact 146, contact 151—152 to ground, through cut-off relay 6, and opens the circuit of test relay 149 whose armature returns to normal.
 130

The left armature of relay 139 opens the circuit of the call signal 134, causing its restoration, and by engaging its alternate contact, effects the display of the calling supervisory signal 155. The actuating means for springs $K'-k'$ and K^2-k^2 , etc., of the four party line ringing keys are normally locked by mechanism controlled by the armature of magnet 154, the energization of this magnet being required to unlock them to render the selected key capable of being actuated by the operator, as will more fully appear from the hereinafter contained descriptions of the mechanical drawings.

The ringing generators $G'-G^2-G^3-G^4$ are each provided with its appropriate ringing key springs $K'-k'$, K^2-k^2 , etc. one such key for each generator being provided in association with each B operator's cord circuit. The said generators are so arranged as to deliver ringing current of varying frequencies, to the end of enabling the B operator to selectively signal the desired one of the stations on a party line such as that of subscriber D, the multiple taps only to the other stations $D'-D^2-D^3$ being shown. Such a system is described and shown in patent to William W. Dean #779,533, issued January 10, 1905, for party line telephone system.

The attraction of the left-hand armature of relay 139 in addition to displaying lamp 155, establishes a branch path from ground through said left armature of relay 139, armature 176 of relay 141, contact 144, key magnet 154 to battery, causing the actuation of magnet 154, which, by its mechanical connections, now unlocks the four ringing keys of the cord circuit. The operator now actuates the ringing key appropriate to throw over springs $K'-k'$, and the mechanical connections of magnet 154 are effective to hold the actuated key in the ringing position, springs $K'-k'$ thus being placed in engagement with and held in engagement with their associated contacts, it being assumed that generator G' associated with lever K' delivers current of the proper frequency to ring the tuned bell of substation D. Ringing current then flows from generator G' through contact K' , normal contact of armature of relay 140, contact 147, contact 150-153, attracted armature 7 of cut-off relay 6, through hook lever 1 and the bell at substation D, causing it to ring, returning over attracted armature 8 of relay 6, contact 3, contact 152-151, contact 146, attracted right armature of relay 139, through said relay, and to ground through the central battery. Constantly operating interrupter I' alternately connects and disconnects shifted spring k' from ground, energizing and deenergizing the relay 140 whose armature when attracted, disconnects generator

G' from tip contact 150 of the plug, thereupon operatively connecting relay 138 with said tip contact, and when retracted, connects generator G' with contact 150 periodically ringing the called substation bell in the well known manner.

As soon as the called subscriber D in response to the signal, has removed his receiver and relay 140 has its armature attracted, a circuit will be completed from ground through the relay 138, attracted armature of relay 140, contact 147, contact 150-153, the current then flowing over the before traced path for ringing current over the line of subscriber D except that it now passes through the hook lever and its alternate contact returning over limb L and the before traced path, through relay 139 to battery. This causes the energization of tip supervisory relay 138 whose attracted armature opens the circuit of supervisory lamp 155, and by engaging its alternate contact, energizes relay 141. Armature 176 of relay 141 causes the deenergization of magnet 154, and said armature 176 by engaging its alternate contact, locks the relay 141 by current traversing the attracted left armature of relay 139 to ground. The armature 175 of said relay 141 closes a normally open contact in the tip strand of the cord, while a corresponding normally open contact in the sleeve strand has previously been closed on the operation of relay 138. The mechanical connections of relay 141 are such that when the actuated ringing key on the deenergization of magnet 154 leaves its ringing position, its full return to normal is prevented, and the key held in an intermediate or so-called indicating position in order that the B operator may know which key she has actuated should it become necessary to ring the called subscriber a second time. The subscribers C and D are now in conversation, the talking circuit being traced from substation C to substation D over the heavily marked conductor, talking current being supplied to the line C through relays 59 and 63 and to the line of D through relays 138 and 139.

If the line of D be in use at the time the B operator inserts the plug of her cord circuit in the multiple jack of said line, the sleeve contact 152 will be connected to the twenty-four volt tap of the exchange battery, if the subscriber is a calling subscriber and his line has not yet been selected by a line selector as will be understood from the preceding description of the selection of line C. If he be a calling subscriber and his line has been selected, sleeve contact 152 will be connected to battery at the A operator's position, through winding of relay 63, and owing to the relative resistances of relay 63, cut-off relay 6 of the calling line and the other instrumentalities in the circuit, there

will be a potential at the sleeve contact 152 of the spring-jack of from thirteen to fifteen volts. If the line called for be busy as a called line, the sleeve contacts 152 of its 5 jacks will be connected with the twenty-four volt tap of the exchange battery through a relay 139, and this relay 139 and cut-off relay 6 and the other instrumentalities in the circuit are so proportioned that 10 the sleeve contacts 152 of the line spring-jacks will be at a potential of approximately thirteen to fifteen volts. In any of these cases it will be observed that the potential at the sleeve contacts of the spring-jacks of 15 the busy line is greater than the potential at the intermediate tap at the exchange battery indicated as eight volts, and upon the insertion of a connecting plug, into a multiple jack of a busy line, current will flow 20 through the polarized test relay 149 in a direction opposite to that in which it flowed when its associated plug was connected with the multiple jack of the idle line. On connection made with the busy line, therefore 25 the grounded armature of polarized test relay 149 will be tilted in the opposite direction, that is, to the right, completing a circuit through the right winding of relay 142 whose attracted armature 145 will close 30 a locking circuit for the relay, extending through the contact 145-146, plug contact 151, to sleeve 152 of a jack of the busy line to ground through its cut-off relay 6. Said armature 145 immediately thereafter causes 35 spring 146 to disengage its normal contact, opening the circuit of test relay 149. Armature 147 disconnects the ringing conductor from the tip 150 of the plug, armature 40 operatively connects the busy signal and interrupter I with trunk conductor T' whereby the busy signal is automatically transmitted to the calling subscriber notifying him that the line wanted is busy. Armature 143 engages its alternate contact to 45 close circuit through relay 139 whereby calling supervisory signal 155 is displayed, while armature 144 opens the circuit of key magnet 154 to prevent its operation on the energization of relay 139 so that the ringing 50 keys remain locked and the operator knows the line is busy even before the calling subscriber in response to the busy signal by replacing his receiver, causes deenergization of relay 59 whose retracted armature 61 will 55 open the circuit of relay 132 to display supervisory signal 135, both supervisory signals being then displayed. The operator thus has an indication enabling her, if her cords are all in use, to take down the connection without waiting for the calling subscriber to transmit the disconnect signal. 60

It will be observed that whether connection is made with an idle or busy line, as soon as the B operator has inserted the plug 65 of one of her cords into the spring-jack of

a wanted line, the sleeve supervisory relay 139 is energized either over a circuit extending to ground through cut-off relay 6 if the called line is idle, or by a circuit extending to ground through armature 143 of relay 70 142 if the called line is a busy line. The left-hand armature of this relay 139 in addition to the functions previously mentioned, has that of opening a normally closed contact in the circuit of relay 133, which is the 75 relay employed for restoring to normal the two switch pairs used in the connection as well as the distributing key at the A operator's position. As soon therefore, as the B operator inserts the plug into the jack of 80 the wanted line, the previously existing control of the calling subscriber over the releasing circuits is destroyed, and the release is then controlled by the B operator.

Let it be assumed that the called line is 85 found idle, that conversation is finished and the two subscribers C and D have replaced their receivers. When subscriber D does so, the movement of hook lever 1 opens the circuit through supervisory relay 138 and its 90 right armature again closes the circuit of calling supervisory signal 155. When subscriber C replaces his receiver, the movement of hook lever 1 opens the circuit of relay 59, and its armatures 60-61 are retracted, armature 61 opening the circuit extending 95 through contact 76 of distributing key DK, over conductors M, Lb, trunk conductor T, relay 132 to battery; the armatures of relay 132 then return to normal, the right-hand 100 armature closing a circuit from ground at the attracted left armature of relay 139, through the retracted right armature of relay 132, answering supervisory signal 135 to battery causing the display of said signal. 105 The two supervisory signals 135 and 155 being now displayed, the B operator withdraws the plug of the cord from the jack of the called line. This deenergizes relay 139 and its retracted right armature 110 again connects test relay 149 operatively to the sleeve 151 of the plug, while its retracted left armature opens the circuit of supervisory signal 155, and said armature by engaging its back contact, completes a circuit 115 from ground through said armature, attracted armature of relay 136, retracted armature of relay 132, relay 133 to battery. The attracted armature of relay 133 opens the circuit previously extending from 120 ground through relay 137 over conductors T', Lb', and relay 115, conductor M' and relay 69 to battery, causing the deenergization of relays 115 and 69. The deenergization of relay 115 results in the restoration 125 of the switch pair F-F', while the deenergization of relay 69 results in the restoration of the distributing key DK and of the switch pair E-E'.

Tracing first in detail the result of the de- 130

energization of relay 115, it will be remembered that the armatures of said relay closed the circuits of release relays RR^2 and RR^3 which relays remained operated from the time relay 115 was first energized, their armatures 110 and 121 respectively having locked their relays through off-normal springs ON^2 and ON^3 respectively. Hence these relays will remain energized until the respective switches are restored to zero and off-normal springs ON^2 and ON^3 then restored. The restoration of the left armature of relay 115 completes a circuit from ground at off-normal spring ON^2 through said retracted armature, attracted armature 109 of release relay RR^2 , operating relay OR^2 to battery. Operating relay OR^2 therefore becomes energized and will continue energized, its armature 106 causing successive actuations of operating magnet OM^2 to move the wipers of switch F continuously in the same direction as that in which they were originally moving until they have completed one revolution and the switch being restored to normal, off-normal spring ON^2 is shifted, opening the circuit of off-normal relay ONR^2 , release relay RR^2 and operating relay OR^2 . Similarly, the retraction of the right armature of relay 115 closes a circuit from ground at off-normal spring ON^3 through retracted right armature of relay 115, attracted armature 120 of release relay RR^3 , through operating relay OR^3 to battery, and the attracted armature 117 of the operating relay OR^3 causes successive actuations of operating magnet OM^3 until the wipers of the switch F' reach normal when the shifting of spring ON^3 to normal deenergizes relays ONR^3 , RR^3 and OR^3 . As soon as in the restoration of switch F, wiper 100 disengages contact 99 of the distributing key DK, circuit was opened through relay 79 and its armatures retracted. The deenergization of relay 69 before described, caused the retraction of its armatures of which armature 70 completed a circuit as follows: from ground through the winding of release relay RR' at switch E', normal contact of armature 49, contact 54—53, attracted armature 64, retracted armature 60, retracted armature 70 and to battery, operating release relay RR' whose armature 46 closes circuit from ground at off-normal spring ON' through attracted armature 46, attracted armature 40, operating relay OR' to battery. Armature 44 of relay RR' on its attraction was effective to lock the relay RR' by a circuit extending from ground through the relay winding, attracted armature 44, attracted armature 43 and to battery, and as off-normal relay ONR' remains operated until off-normal spring ON' is shifted back, the three relays ONR' , RR' and OR' remain energized. Operating relay OR' by its attracted armature 50 closes

a circuit for current impulses through operating magnet OM' and the said magnet advances the wipers of switch E' step-by-step until the switch completes a revolution, and on its return to zero, off-normal spring ON' opens circuit through relays ONR' and OR' . The deenergization of the former opening the circuit of the release relay RR' . On the operation of the release relay RR' , its armature 47 completed a circuit from ground through said attracted armature through release relay RR of switch E to battery. Attracted armature 33 of relay RR , locked the said relay over a circuit extending to ground through attracted armature 28 of off-normal relay ONR , while armature 34 completed a circuit from grounded off-normal spring ON through said attracted armature 34, through attracted armature 31, operating relay OR to battery. The relays ONR , RR and OR now remain locked, while operating magnet OM steps the wipers of switch E around to zero when the shifting of off-normal spring ON results in the deenergization of the three relays ONR , RR and OR .

As soon as operating relay OR' of switch E' was energized, the attracted armature 52 opened the circuit of relay 63, the retraction of whose armature 65 opened the circuit of key magnet 68 allowing the restoration of the distributing key DK. The attraction of armature 52 also causes the deenergization of cut-off relay 6 of the calling line, placing the line circuit of the calling line in its normal condition.

Referring again to the cord circuit at the B operator's position, it will be observed that the deenergization of relay 139 was effective to open the circuit of relay 141 allowing the actuated ringing key to return from its indicating position to its normal position. The release operation, when the B operator has inserted the plug of her cord into the spring-jack of a busy called line, follows upon the withdrawal of the plug and the consequent deenergization of relay 139 in the same manner as that previously described. If the calling subscriber replaces his receiver before the B operator has inserted the connecting plug into the spring-jack, the act causes deenergization of relay 59 and consequentially the deenergization of relay 132, and since relay 139 is at this time deenergized and its left-hand armature has remained retracted, the release operations proceed as before described. If the calling subscriber replaces his receiver before connection has been established between the distributing key of the A operator's position and the B operator's cord circuit, his act deenergizes relay 59 causing the retraction of armature 60 and this is effective to cause the release of the switch pair E—E' as before described, because owing

to the fact that relay 69 had not been operated, such operation only occurring when connection is established through to a B operator's position, the armature 70 of relay 69 has remained retracted, permitting the release circuit for switch E' to be established. If the calling subscriber restores the switch pair E—E' during the time the switch F is seeking the contacts of operated distributing key DK, the deenergization of key magnet 68 occurring before selection is made, restores the distributing key DK.

The ground having been previously taken off contacts 99 by the operation of armature 86 of relay 84, which relay locked itself by a circuit extending through armature 81 of relay 79 to ground, the trunk selecting switch F will now proceed to select contacts 99—101—103 of the distributing key as if the same had remained operated. When this selection has occurred and switch F' has also completed its selection, a circuit is closed from ground at the cord circuit through relay 137 over T', Lb', 115, M', relay 78, back contact of armature 83 to battery through impedance 156. The resulting current flow operates relay 115 causing the energization of relays RR² and RR³ and also operates relay 78 whose attracted armature energizes for a moment, relay 79. The attraction of armature 83 of the latter relay 79 opens the battery connection extending through impedance 156 which permitted the energizing of relays 115 and 78 as described, and the deenergizations of these relays follow; that of 115 causing the restoration of switches F—F' in the manner before described. It is thus seen that under all circumstances until the operator inserts the plug of the selected trunk into a jack of a called line, the calling subscriber by replacing his receiver, accomplishes circuit changes resulting in the complete restoration of whatever switches have been operated.

The relays 136 and 133 are preferably rendered slow to release their armatures after current has once been closed through their windings in order that when relay 133 attracts its armature to start the release operation, as before described, which also results in the falling back of the armature of relay 136—a relatively long time may elapse before relay 136 allows the retraction of its attracted armature, and of course relay 133 remains energized thereafter a relatively long time to the end that a sufficient time may elapse before relay 133 releases its armature for the release operations at switch pair F—F' to proceed far enough to cause the energization of operating relay OR³ of switch F' so that on the retraction of the armature of relay 133, contact 119 may be open, and the ground through relay 137 again placed on limb T' of the trunk line

may have no effect upon relay 115. To render their armatures slow to retract, copper shells may as indicated, be placed about the cores of relays 133 and 136.

Referring now to Fig. 2, showing the master-switch mechanism which may be considered as that shown at M in Fig. 1, corresponding reference characters have been supplied to Fig. 2. The operating magnet 15 is provided with an armature driven pawl 178 arranged to engage the teeth of the ratchet 157 fastened to a suitable supported rotary shaft 179 to which is fastened the angularly disposed contact wipers 157^a of which there are three sets fastened to shaft 179, one above the other. One of the angular wipers of each of the upper and middle sets being shown as broken, discloses one arm of each of the middle and lower wiper sets. Ten sets of contacts, 19—20—21 are shown in Fig. 2 corresponding to the similarly designated terminals in Fig. 1, the wipers 16—17—18 shown in said Fig. 1 being represented by the common strips 16—17—18 in Fig. 2, strip 16 extending around underneath contacts 19, strip 17, underneath contacts 20 and strip 18 underneath contacts 21, wipers 157^a having in themselves no circuit connections but being arranged to cross the successive contacts of the three levels with their common strips successively in the operation of the switch. The structure shown in Fig. 2 is also adapted for use in connection with the circuits shown at M' in Fig. 1.

Figs. 3, 4, 5, 6 and 7 illustrate a mechanical structure that may be employed in connection with the circuits of switches E—E' and F—F' in Fig. 1. As these switches preferably have a continuous movement in one direction in their operation and a further movement in the same direction in their restoration to normal, I preferably arrange the switching contacts in a circle and place beneath each set a common strip extending around the circle, the switch wipers in themselves having no circuit connection, but serving when the switch is operated to cross successive contacts of the three sets provided, to their respective common strips. In the said Figs. 3 to 7, reference characters corresponding to those of switch E' in Fig. 1 are supplied for convenience of reference. A suitably supported rotary shaft 182 is provided to which is fastened the circular ratchet 180 together with the wipers 161 and 23^a, 25^a and 27^a, shown in Figs. 5 and 7. The operating magnet OM is provided with the armature 158 extending the length of the magnet and engaged by the stiff spring 163 for restoring it after being attracted by the magnet on the deenergization thereof. Carried by the armature 158 are the two pawls 159—160 held against the ratchet by their associated springs.

Referring to Fig. 3; when the magnet OM attracts armature 158, said armature turns about the shaft 182 being free to move thereon, pawl 160 carried by the armature 5 being thereby brought downward to advance ratchet 180 a step, pawl 159 moving downward also and being brought by its movement, just as the stroke of the armature 158 is completed to such a position that the pin 10 181 lifts it out of engagement with the tooth of the ratchet 180 engaged by it, so that on the deenergization of the magnet OM and the retraction of armature 158 by the spring 163, pawl 159 slips over the top of an adjacent tooth of the ratchet 180 and into engagement with an adjacent space of said ratchet, while pawl 160 is by the retraction of the armature 158 brought to engage the next tooth of ratchet 180. Successive actua- 20 tions of operating magnet OM advance ratchet 180 step-by-step which carries with it rotary shaft 182 to move wipers 161, 23^a, 25^a and 27^a step-by-step in a rotary direction. The pawl 159 is provided for the purpose of insuring against the possibility of a half step of the ratchet and hence of the wipers, it being noted that until a complete step of the ratchet is effected by pawl 160, pawl 159 remains engaging the tooth engaged by it at the beginning of the stroke of pawl 160 so that if under these circumstances, armature 158 is retracted, pawl 159 still engaging the tooth originally engaged by it, is effective to step the ratchet, shaft 35 and wipers back to the position occupied by them before the half step began. In Figs. 4, 5 and 7 the off-normal switch contact ON of Fig. 1 is shown as a strip ON extending in a circle above the contact banks of the 40 switch, its contact being shown beneath it as a similar strip and the wiper 161 being provided to cross the off-normal strip with its contact strip on the first step of the switch wipers. The wipers 161 normally rest engaging the short blank pieces shown in Fig. 7 being then on open circuit. A pointer 162 is provided on the back of the switch in order that the switch-board attendant may readily know upon what contacts an operated switch is resting. The mechanical elements of the Figs. 3 to 7 may be employed in connection with the circuits of switches E', F and F' as well as in connection with the circuit of switch E. 55 Referring to Figs. 8, 9 and 10, an A operator's listening and distributing key mechanism for a link-circuit is illustrated. The listening key comprises the cam 164 arranged when its handle is turned to the right by the operator to cause springs 72 and 73 to engage their alternate contacts and cut the operator's telephone into circuit. Four distributing key plungers DK—DK'—DK²—DK³ are shown, providing facilities 65 as will be understood for reaching B opera-

tors in four different exchanges. Each plunger is provided with a stud of insulating material 167, adapted when the plunger is depressed by the operator, to cause the springs 75—76—77 to engage their respective associated contacts. The magnet 68 is provided, its armature having fastened to it the spring member 165 which interlocks with a pivoted pawl member 166, the said member being provided with four pawls, adapted 75 when the member is at normal, to engage the upper shoulders of the plungers as shown, to hold them locked against depression by the operator. The said member 166 is also provided with four pawls adapted to en- 80 gage the lower shoulders of the key plungers when they are depressed and hold them in operated position, the spring 165 holding the pawls normally engaging the upper shoulders, but being adapted when magnet 85 68 is energized, to tilt the pawl member to free the upper shoulders, whereon the lower pawl members are brought to press against the stud so that when the A operator depresses one of them, the lower shoulder of 90 the depressed stud is brought beneath its respective pawl of member 166 to be held in the depressed position as long as magnet 68 remains energized. When the magnet is thereafter deenergized, spring 165 is re- 95 tracted by the magnet's armature, the lower pawl of member 166 disengages the shoulder of the depressed stud and the stud is raised by its associated spring to normal position and the upper pawl again engages its upper 100 shoulder and holds the stud against actuation.

In Figs. 11, 12 and 13, a B operator's cord circuit key structure is shown, adapted for use in connection with the circuits shown at 105 B in Fig. 1. It comprises the usual listening key adapted to cause springs 72^a—73^a of the operator's telephone circuit to engage their alternate contacts to cut in the B operator's talking set, and the four ring- 110 ing key plungers or buttons P¹—P²—P³—P⁴. Two key magnets 154 and 141 are provided, spring 170 fastened to the armature of 154 interlocking with pawl member 172 suitably pivoted and having four pawls, one 115 for each of the ringing studs, normally engaging the upper shoulders of said studs indicated as shown in Figs. 12 and 13, and four pawls, one for each stud adapted to engage the lower shoulders of the studs, pro- 120 vided the magnet 154 is energized when the stud is depressed. The operation of this magnet and its associated parts corresponds to that of magnet 68 of the A operator's key structure. The additional magnet 141 is 125 provided with the spring 171 fastened to its armature interlocking with pawl member 173 suitably pivoted and provided with four pawls, one for each ringing stud, the arrangement being such that when the magnet 130

141 is energized, the pawl member 173 is, by the operation of spring 171, brought to press against these studs, being then in such position that if a depressed stud whose lower shoulder has been engaged by the appropriate lower pawl of member 172 is released, the pawl of member 173 will (on the de-energization of magnet 154 releasing the stud), permit the stud to be lifted by its associated spring only a portion of the distance required for its return to normal, the stud being then held in the so-called indicating position hereinbefore referred to. Each stud is provided with an insulating piece 177 adapted when the stud is depressed to press its respective key springs $K'-k'$, K^2-k^2 , etc., to engage their alternate contacts connecting the respective generator and interrupter I' as indicated in Fig. 1. Upon the pawl member 173 controlled by magnet 141 is also a stud of insulating material 174 adapted, when magnet 141 is operated and the pawl member shifted to its alternate position, to shift springs 175 and 176 to their alternate positions (see Figs. 1 and 13). It will be understood that upon the deenergization of magnet 141 whose pawl member is then shifted to normal as indicated at Fig. 12, the depressed stud will be free to be lifted by its associated spring to normal where it is again held locked by pawl member 172.

The multiplying of contacts 99—101—103 of the A operators' distributing keys may be arranged in any desired way. A preferred arrangement being one in which the outgoing trunks to each distant exchange are in a single group, that is, each switch F' for a particular distant exchange preferably is capable of selecting any trunk leading to such exchange. In carrying out the invention I also prefer to arrange the switch-pairs F, F' in such manner that each and every A operator's link-circuit may be adapted for connection to each outgoing trunk to a distant exchange. To give a concrete example of one method of multiplying by which this may be effected, let it be supposed that one hundred trunks $T-T'$ are provided leading from a first exchange in which the B operator's link-circuit of Fig. 1 is located, to a distant second exchange in which the B operators's link-circuit of Fig. 1 is located. Let it further be assumed that the A operators' link-circuits in the first exchange are five hundred in number. There will be in such case, of course, five hundred sets of contacts 99—101—103, forming terminals of the five hundred distributing keys, of these five hundred link-circuits for the second exchange. As I preferably employ one hundred point switches, although the invention is not limited to such, the five hundred contacts 99—101—103 would require five different groups of switches F to

accommodate them. As we have assumed one hundred outgoing trunks, we necessarily should have at least one hundred switches F' to make each trunk available for use, which fact means that an equal number, one hundred, of paired switches F would be provided. As we have seen, the switches F are to be divided into five groups. Hence under the conditions assumed, each set of contacts 99—101—103 would be multiplied twenty times at switches F and twenty-point master-switches would accordingly be employed, while the contacts 126—128—130 of the outgoing trunks $T-T'$ would be multiplied one hundred times at the switches F' . It is obvious however, that if actual operation should show that a particular group of one hundred A operators' link-circuits required more than twenty simultaneous connections to the distant exchange trunks, and that another group of one hundred A operators' circuits required less than twenty such connections, a portion of the F switches of the latter group could have their bank contacts disconnected from the distributing keys of that group, connections to the distributing keys of the former group being substituted, thus taking away a certain number of "chances" at the outgoing trunks from one group and transferring them to another group. Of course in such case additional master-switch contacts for the added E switches would be provided.

Variations in facilities in a general way similar to those above suggested may obviously be made as between the subscribers' lines and the A operators' link-circuits, the contacts of the E and E' switches being connected up as experience may indicate.

My invention is not to be limited to the particular mechanical and electrical structures embodying its preferred form as herein shown and described, as it may be variously and broadly employed in the art by those skilled therein, but

What I do claim as my invention is:

1. A telephone system including a calling line, a signal at the exchange displayed responsive to currents controlled at the substation of said line, a plurality of distributing devices individual to said signal, and automatically controlled mechanism operated responsive to the actuation of particular ones of said devices selected by the operator for extending the circuit of said line to predetermined points.

2. A telephone system including telephone lines, terminals for said lines, a plurality of switchboards at each of which terminals of a portion of said lines only are provided, a calling line, a signal at an exchange adapted to be displayed responsive to currents controlled at the substation of said line, a plurality of distributing devices individual to said signal and automatically controlled

mechanism operated responsive to the actuation of said devices by the operator for extending the calling line to switchboards corresponding to the actuated devices.

5 3. A telephone system including telephone lines, terminals for said lines, a plurality of switchboards at each of which terminals of a portion of said lines only are provided, a calling line, a signal at the exchange adapted
10 to be displayed responsive to currents controlled at the substation of said line, a plurality of distributing devices individual to said signal, selective switches divided into groups corresponding to said devices, means
15 for operating idle switches of a group corresponding to a distributing device responsive to the actuation of the device by the operator, and mechanism included in said operated switches for automatically extending
20 the calling line to a switchboard corresponding to the actuated device.

4. A telephone system including telephone lines, terminals for said lines, a plurality of switchboards each containing terminals of a
25 portion only of said lines, signals at a switchboard adapted to be displayed responsive to currents controlled at substations of certain ones of said lines, and a plurality of distributing devices for each of said signals
30 adapted for actuation by the operator to cause extensions of calling lines in association with said signals to particular ones of said plurality of switchboards.

5. A telephone system including telephone
35 lines, terminals for said lines, a plurality of switchboards each containing terminals of a portion only of said lines, signals at a switchboard adapted to be displayed responsive to currents controlled at substations of
40 certain ones of said lines, a plurality of distributing devices for each of said signals adapted for actuation by the operator to cause extensions of calling lines in association with said signals to particular ones of
45 said plurality of switchboards, and mechanism for automatically restoring an actuated device independently of the operator actuating said device.

6. A telephone system including telephone
50 lines, a plurality of exchanges included in said system among which said lines are divided, B operators' positions at said exchanges, link-circuits at said exchanges adapted for use by B operators in completing
55 connections from calling to called line, link-circuits at said exchanges adapted for use by A operators in completing connections from calling lines to said first-mentioned link-circuits at B operators' positions,
60 and distributing devices for said last-mentioned link-circuits adapted to be placed in operated position by the A operators to automatically cause extensions of calling lines to B operators' positions in desired
65 changes.

7. A telephone system including telephone lines, a plurality of exchanges included in said system among which said lines are divided, B operators' positions at said exchanges, link-circuits at said exchanges
70 adapted for use by B operators in completing connections from calling to called lines, link-circuits at said exchange adapted for use by A operators in completing connections from calling lines to said first-mentioned
75 link-circuits at B operators' positions, distributing devices for said last-mentioned link-circuits adapted to be placed in operated position by the A operators to automatically cause extensions of calling lines to
80 B operators' positions in desired exchanges, and mechanism for automatically restoring said distributing devices to normal, actuated independently of said A operators.

8. A telephone system including telephone
85 lines extending from substations to an exchange, an operator's position at the exchange, signals at said position for display responsive to currents over said lines, a link-circuit for each said signal, and a plurality
90 of distributing devices for each said circuit adapted for actuation by the operator to cause automatic extension of a calling line in connection with the link-circuit of an actuated device to a predetermined point
95 depending upon which device is actuated.

9. A telephone system including telephone lines and switchboards, a distributing link-circuit, a plurality of connecting link-circuits divided among said switchboards, automatically operated selective switches for
100 interchangeably connecting calling lines with the incoming end of said distributing link-circuit, a plurality of groups of selective switches, one group for each switchboard, distributing devices for said link-circuit, one
105 for each of said groups adapted for actuation by an operator, means for causing the operation of a switch of a group corresponding to an actuated device to automatically
110 connect a connecting link-circuit of its particular switchboard to the outgoing end of said distributing link-circuit.

10. A telephone system including telephone
115 lines, terminals for said lines, a plurality of exchanges each containing terminals of a portion only of said lines, an A operator's link-circuit at an exchange, selective switches for interchangeably connecting said link-circuit with calling lines, B operators' link-circuits at said exchanges, selective switches
120 for automatically connecting said B operators' link-circuits with said A operators' link-circuit, distributing means for said link-circuit controlled by the A operator, and
125 mechanism responsive to the actuation thereof for causing operation of particular selective switches to connect said A operator's circuit with the first idle B operator's circuit at a predetermined exchange.

11. A telephone system including telephone exchanges and telephone lines having terminals distributed among said exchanges, the operators' positions at each of said exchanges, manually operated connection terminals for the B operators adapted to connect with the terminals at the respective exchanges, A operators' positions at each of said exchanges, mechanism for automatically distributing the originating calls of the lines of said exchanges to the first idle A operators' positions of the respective exchanges, distributing means operable by said A operators to distribute the originating calls of said exchanges to the B operators of any predetermined ones of said exchanges, and mechanism for automatically distributing the calls to the first idle B operators' positions of said exchanges.
12. A telephone system including telephone exchanges and telephone lines having their terminals distributed among said exchanges, B operators' positions at each of said exchanges, manually operated connection terminals for the B operators at each exchange adapted to connect with the terminals at the respective exchanges, A operators' positions at each of said exchanges, call signals at said A operators' positions adapted to be displayed responsive to currents controlled at the substations of the lines, distributing mechanism associated with said call signals operable by the A operators for distributing the originating calls among said exchanges as required, automatic selective switches controlled by said mechanism for extending each call handled by an A operator to the first idle B operator's position at the exchange to which it is distributed.
13. A telephone system including an operator's signal, a link-circuit for said signal, multiple terminals of said link-circuit, manually operated actuating mechanism for each said terminal, other link-circuits, and selective switches operating responsive to the actuating mechanisms of said terminals to connect the link-circuit of said signal to particular ones of said other link-circuits.
14. A telephone system including an operator's signal, a link-circuit for said signal, multiple terminals of said link-circuit, a manually operated actuating device for each said multiple terminal, other link-circuits divided into a number of groups equal to said multiple terminals and a selective switch for each group of link-circuits responsive to actuation of the multiple terminal corresponding to the group adapted to extend the link-circuit of said signal to connection with an idle link-circuit of a selected group.
15. A telephone system including a link-circuit, other link-circuits divided into groups, multiple terminals of said link-circuit, one for each said group, manually operated actuating means for said terminals, and a selective switch associated with a group adapted in response to the operation of the actuating means of a particular terminal to extend said link-circuit to an idle circuit of its group.
16. A telephone system including a link-circuit, other link-circuits divided into groups, multiple terminals of said link-circuit, one for each said group, manually operated actuating means for said terminals, a selective switch associated with a group adapted in response to the operation of the actuating means of a particular terminal to extend said link-circuit to an idle circuit of its group, and means for restoring the operated actuating means to normal controlled from said idle link-circuit.
17. A telephone system including a plurality of telephone exchanges, an A operator's link-circuit, manually operated distributing devices individual to said link-circuit, one for each exchange, means for temporarily holding an operated device in operated position, selective switches for operation responsive to said devices to extend said link-circuit to exchanges corresponding to the operated devices, and electromagnetically restoring operated devices to normal.
18. A telephone system including telephonic circuits, multiple terminals for said circuits, selective switches for selecting said terminals, other selective switches paired with said first-mentioned switches, relays at the exchange responsive to currents controlled over said circuits, and starting circuits for the pairs of selective switches directly controlled by said relays substantially as described.
19. A telephone system including a telephone circuit, multiple terminals as 99, 101, 103 pertaining to said circuit arranged in groups and normally unselectable in character, and means for changing the electrical character of a single predetermined group only of said terminals to render them selectable.
20. A telephone system including a telephone circuit, multiple terminals pertaining to said circuit arranged in groups and normally unselectable in character, selective switches arranged in groups corresponding to said groups of terminals, means for changing the electrical character of a single predetermined group of said terminals to render them selectable, and mechanism responsive to said means for starting an idle selective switch of the group corresponding to the group of terminals whose electrical character is changed.
21. A telephone system including a telephone circuit, a plurality of multiple terminals pertaining to said circuit arranged in

groups having definite normal electrical characters, and manually operated switching mechanism for said circuit adapted when operated to change the electrical character of a predetermined group of said terminals.

22. A telephone system including a telephone circuit, multiple terminals for said circuit arranged in groups and having a definite normal electrical character, selective switches arranged in groups corresponding to said groups of terminals, manually operated switching mechanism for said circuit adapted when operated to change the electrical character of the terminals of a single predetermined group, and means responsive to said switching mechanism for starting an idle selective switch of the group corresponding to the group of terminals whose electrical character is changed.

23. A telephone system including a telephone circuit, multiple terminals pertaining to said circuit arranged in groups and having definite normal electrical characters, manually operated switching mechanisms for said circuit, one for each of said groups, and means responsive to the actuations of said mechanisms for changing the normal electrical characters of the terminals of groups corresponding to the actuated devices.

24. A telephone system including a telephone circuit, multiple terminals pertaining to said circuit arranged in groups and normally unselectable in character, selective switches arranged in groups corresponding to said groups of terminals, manually operated switching mechanisms for said circuit, one for each of said groups, means responsive to the actuations of said mechanisms for rendering terminals of groups corresponding to the actuated devices selectable, and apparatus responsive to actuations of said devices for starting idle switches of groups corresponding to the actuated devices.

25. A telephone exchange system comprising a telephone line, selecting switches for selecting said line, an electrically actuated means for starting said selecting switches, a relay initially energized by current over said line, and means responsive to such energization to close an operating circuit for said electrically actuated means through the winding of said relay.

26. A telephone exchange system comprising a telephone line, selecting switches for selecting said line, an electrically actuated means for starting said selecting switches, a relay initially energized by current over said line, and an operating circuit for said electrically actuated means including contacts and a winding of said relay.

27. A telephone exchange system comprising a telephone line, selecting switches for selecting said line, a master switch for controlling said selecting switches, a relay for starting said switches, a line relay initially

energized by current over the line, and a circuit including windings of said relays and normally open contacts of said line relay.

28. A telephone exchange system comprising a telephone line, selecting switches for said line, a master switch having a movable contact and cooperating fixed contacts severally connected in circuit with said selecting switches, means for stopping said movable contact on the fixed contact of an idle selecting switch, a relay for completing the starting circuits of the selecting switches when their fixed contacts are thus engaged, a line relay initially energized over the line, and a circuit including windings of said relays and normally open contacts of said line relay.

29. A telephone exchange system comprising a telephone line, selecting switches for said line, a relay for starting said switches, a line relay initially energized by current over said line, and a circuit including windings of said relays and normally open contacts of said line relay.

30. The combination with a selective switch of a second selective switch paired therewith, a distributor switch having a starting circuit for starting simultaneously said selective switches, a relay for controlling said starting circuit, telephone conductors having terminals adapted for selection by one of said selective switches, a relay individual to said conductors, and means for establishing a path for current including said last-mentioned relay and the relay for controlling said starting circuit.

31. The combination with telephone conductors, of a plurality of selective switches adapted to select said conductors, a common starting relay for starting an idle selective switch, a relay individual to said conductors, and means for establishing a circuit including serially said relays to start an idle switch.

32. A telephone exchange system comprising telephone lines, selecting switches for selecting said lines individually, a common control means for starting said switches, a pair of relays associated with each of said lines, and an energizing circuit for said control means including contacts of both of said relays.

33. A telephone exchange system comprising telephone lines, selecting switches for selecting said lines, a distributor switch for selecting an idle selecting switch, a relay associated with said distributor switch, a pair of relays associated with each of said lines and an energizing circuit for said first-mentioned relay including contacts of each relay of a pair.

34. A telephone system including a selective switch, an operating relay for controlling the extent of travel of said switch, an initial energizing circuit for said relay, a

second relay for said switch having a contact included in said circuit, and means for energizing said second relay to open said contact effective when said switch moves from normal.

35. In a telephone system a selective switch, a relay therefor, means for energizing said relay when said switch leaves normal, and means for deenergizing said relay only on restoration to normal of said switch.

36. In a telephone system a selective switch having a definite normal position, a relay deenergized when said switch is at normal, and means whereby said relay is energized at every other position of said switch.

37. A telephone system including a link-circuit having passive contacts, a plurality of selective switches for selecting different contacts, and operator's means including apparatus for rendering pre-determined contacts selectable by a switch while leaving other contacts of said circuit unselectable.

38. A telephone system including a link-circuit having passive contacts, a plurality of selective switches for selecting the different contacts of said link-circuit, means enabling a plurality of said switches to simultaneously travel, and operator's means adapted to render pre-determined contacts of said circuit selectable by a switch when engaged thereby while leaving other contacts of said circuit unselectable when engaged by their respective switches.

39. A telephone system including a link-circuit having multiple terminals, a plurality of selective switches adapted to engage different terminals of said circuit, a plurality of operators' positions having mechanism for starting travel of said switches, means controllable at an operator's position for rendering terminals of said circuit capable of selection by certain ones of

said switches when engaged by them while leaving the remainder of said terminals at the others of said switches unselectable, and mechanism operating with said means to initiate travel of an idle switch at which a terminal of said circuit is rendered selectable.

40. A telephone system comprising a called line, an operator's position, a link-circuit to be included in connection between said operator's position and said called line, a selective switch individual to said link-circuit and located at the end of said link-circuit nearest said operator's position, operator's switching means for controlling the operation of said switch and other link-circuits for completing the connection from said position to said line.

41. A telephone system comprising calling and called lines, interconnecting link-circuits, an operator's position, normally passive selecting switches for uniting certain of said link-circuits, said switches being operative, some to select backward toward said calling line, and some forward toward said called line, and operator's switching means for controlling certain of said switches.

42. A telephone system comprising calling and called lines, interconnecting link circuits, an operator's position, selecting switches for uniting certain of said link circuits, said switches being operative, some to select backward toward said calling line, and some forward to said called line, and a plurality of multiply connected operator's switching means for controlling certain of said switches.

In witness whereof, I hereunto subscribe my name this 19th day of January, 1907.

ALFRED H. DYSON.

Witnesses:

G. E. MUELLER,

H. C. OLMSTEAD.