Oct. 9. 1923. 1,469,807

R. G. RICHARDSON

AUTOMATIC TELEPHONE SYSTEM

Filed Jan. 8, 1917 3 Sheets-Sheet 1

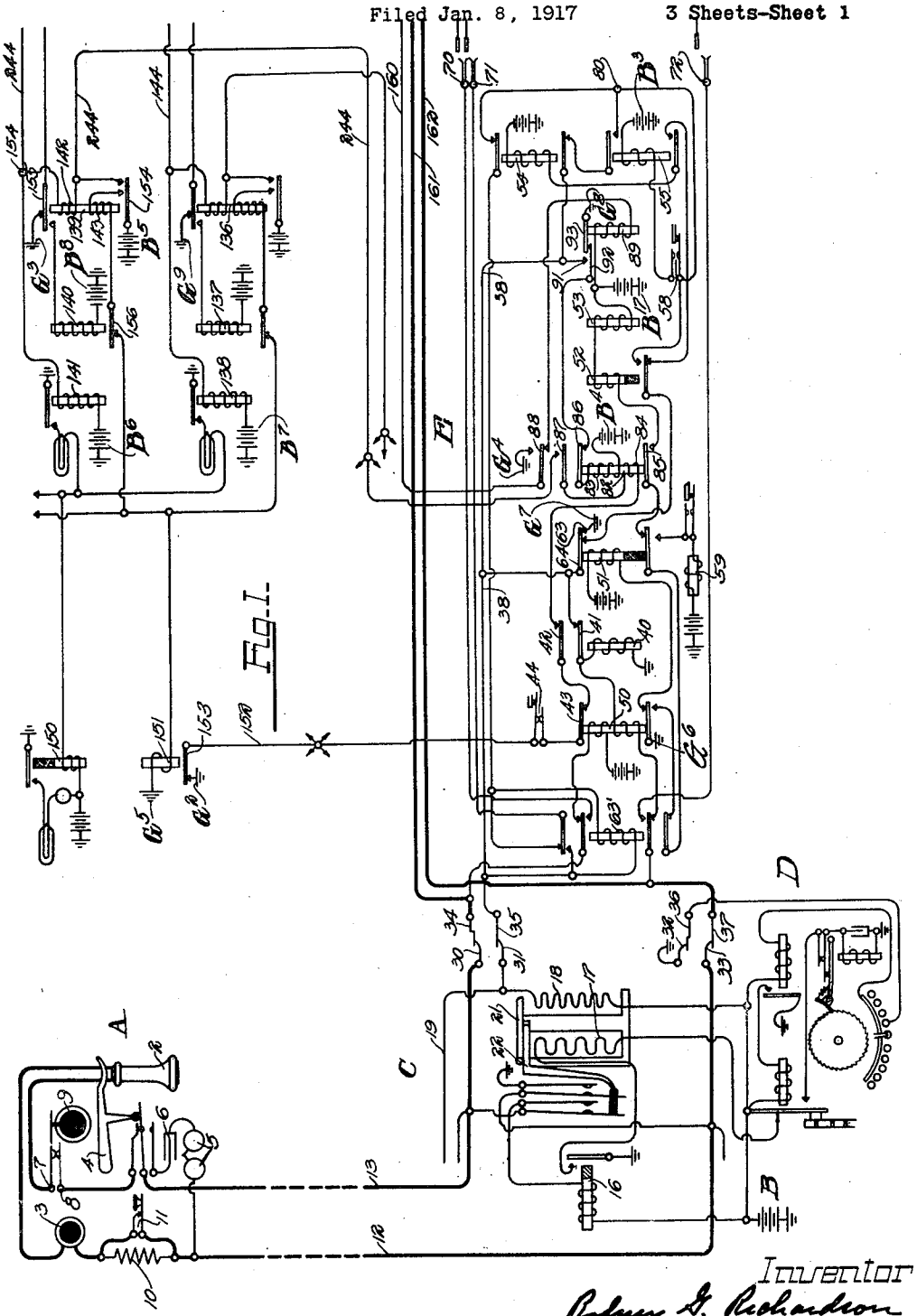

Fig. 1.

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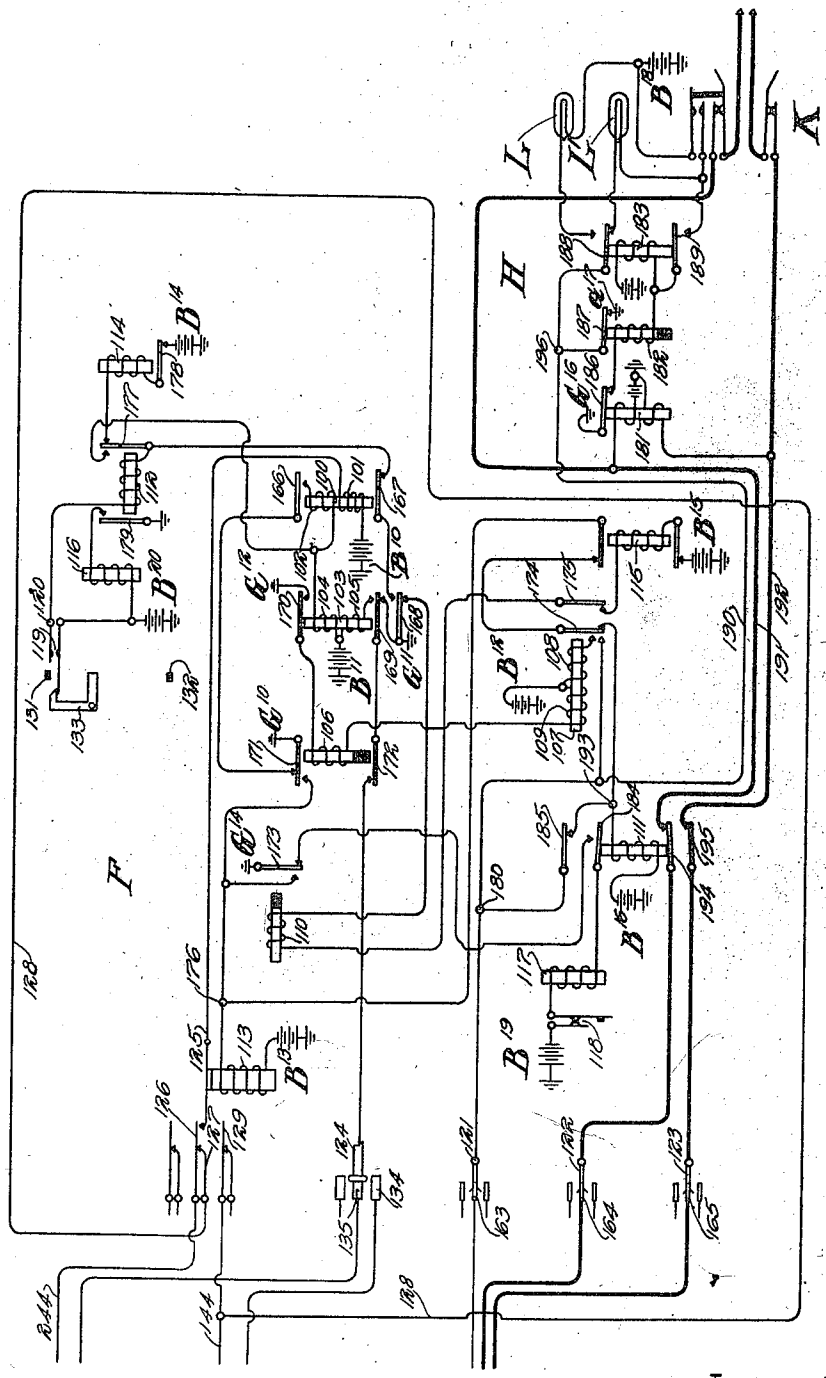

Fig. 2.

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Fig. 5.

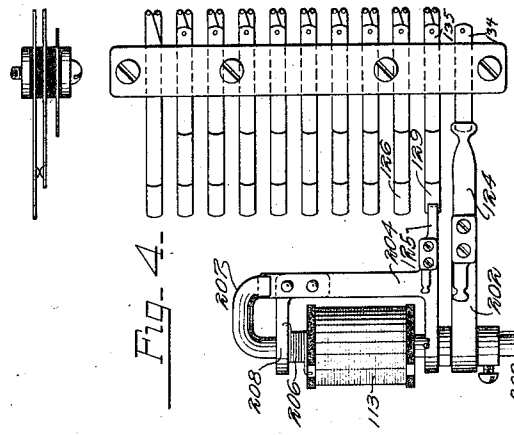
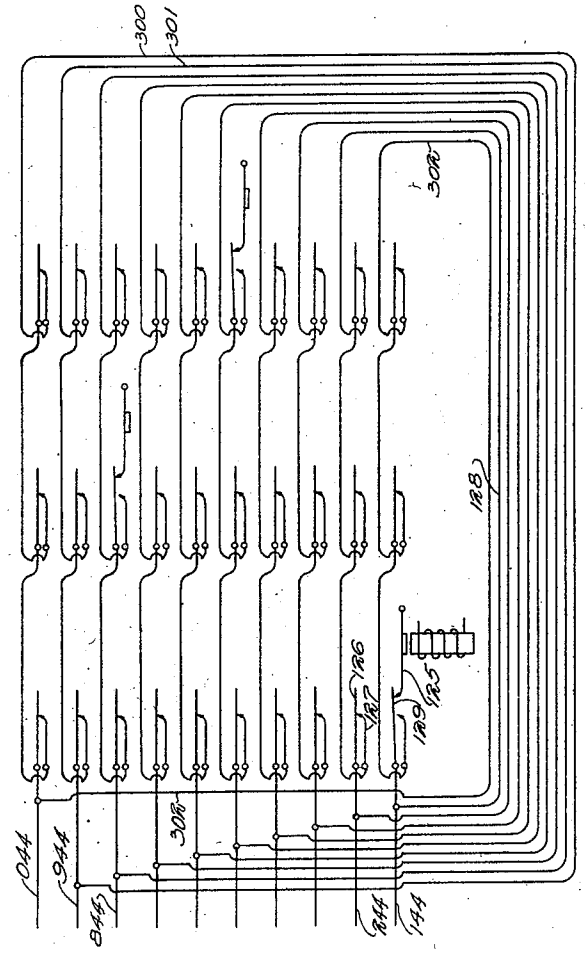


Fig. 4.

Fig. 3.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed January 8, 1917. Serial No. 141,120.

To all whom it may concern:

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

My invention relates in general to automatic telephone systems of the usual percentage type in which automatic switching apparatus is provided at the exchange, through the medium of which calling subscribers are enabled to obtain desired connections; and embodies a number of features which will be pointed out and described hereinafter.

One of the principal features of my invention relates to an improved trunking system whereby subscribers are enabled to call an operator for the purpose of placing a long distance call, or for other purposes.

In a well known type of automatic system employing individual line switches, first selector, second selector, and connector switches, it has been customary in the past to assign a certain level, for example, the tenth level, of the first selectors to the trunks extending to recording toll operators. With this arrangement when a subscriber desires to place a long distance call he will remove his receiver and then proceed to manipulate his calling device in accordance with the digit 0, thereby operating a first selector to extend connection to a recording operator. While this method of operation is fairly simple for the subscriber, it has the great disadvantage of reducing the capacity of the exchange by 1000 lines, which is often such a serious objection as to warrant extraordinary efforts to overcome it.

In my improved trunking system, the groups of trunk lines extending from the individual line switches to the first selectors are combined into main groups of 100 trunk lines each and the trunk lines of each main group are then multipled in the banks of a group of 100 point finder switches which latter are provided with movable terminals of trunk lines extending to recording operators' positions. With this trunking arrangement, when a calling subscriber removes his receiver his line is extended as usual by the operation of the individual line switch associated therewith to a trunk line terminating in an idle first selector. If a connection to another subscriber is desired, the calling subscriber then operates his calling device as usual to obtain the connection and it is to be noted here that all the levels of the first selector are assigned to main groups of subscribers' lines, none of them being reserved for the toll recording trunks. Suppose, however, that the calling subscriber desires to obtain connection with a toll recording operator. In this case he has simply to press a button with which his substation instrument is provided, as a result of which operation an idle finder switch is set in motion to find the trunk line to which the calling subscriber's line is connected and extend it to an operator's position.

Another important feature of my invention relates to the finder switches and has for its object the securing of extreme rapidity in extending connections. It has been mentioned before that each main group of trunk lines which is accessible to a given group of finders is made up of a number of smaller or sub-groups. The finder switches employed are preferably of the type which have primary movement to select groups (sub-groups in this case) and secondary movement to select the individual trunk line in the group. By my invention, however, the finder switches have no normal position as regards the groups and when disconnection is effected they release only in so far as their secondary movement is concerned. It follows that a finder may at various times be associated with any one of the groups which it serves. A peculiar starting circuit is provided whereby a calling subscriber will start the finder switch which at the time happens to be associated with the group of lines of which his line is one, thereby permitting the primary movement of the switch to be eliminated; or in case there is at that time no finder switch associated with his group, that finder will be started which is at the time associated with the next group in reverse order, etc. In other words when a calling subscriber presses his button to call an operator, he will start that finder switch which requires the least movement to locate the group; and if there is already a finder associated with that group, that finder will be used, and no primary or group selecting movement thereof is required.

The foregoing and other useful objects not now specifically mentioned are attained through means which will be fully described hereinafter, reference being had to the accompanying drawings.

In the drawings, Figs. 1 and 2, arranged in order with the lines at the adjacent ends thereof in alignment, represent diagrammatically a complete circuit connection between a calling substation A and a trunk line terminating in the operator's equipment H, in a system embodying the principles of my invention. The connection has been established through the medium of the individual line switch C (Fig. 1) and the finder switch (Fig. 2). In Fig. 3 I have shown the starting circuit extending through three finder switches of the same group; while Figs. 4 and 5 are views of a special bank with which each finder switch is provided.

The substation A (Fig. 1) may be of any approved automatic type, such, for example, as the substation shown in British patent to Martin, No. 1419 of 1910. As represented herein, it comprises essentially the receiver 2, transmitter 3, switch hook 4, ringer 5, and condenser 6. The resistance 10, in series with one of the line conductors, is normally short-circuited by the springs of the push button 11. Being an automatic substation, there is also provided a pair of impulse springs 7 and 8 controlled by an impulse wheel 9 through the medium of a finger hole dial (not shown).

The line conductors 12 and 13 of the substation A are connected at the exchange to the individual line switch C which is of the general type of line switch disclosed in the British patent to James, No. 26,301 of 1906; being, however, of the particular type shown in U. S. Letters Patent No. 1,078,690, granted Jan. 17, 1912, to Frank Newforth. Through the medium of line switch C the line of substation A when calling is given access to a plurality of trunk lines extending to selector switches.

The line switch C and a plurality of similar line switches are controlled in their trunk selecting operations by means of a master switch D. The master switch D is of the general type of master switch disclosed in the above mentioned British patent to James, No. 26,301 of 1906; being, however, more nearly of the particular type disclosed in the British patent to Martin, No. 1419 of 1910, also previously referred to. As is well known, the function of the master switch is to maintain the plungers of all idle line switches which it controls in position before the terminals of an idle trunk line.

One of the trunk lines to which the line switch C has access is shown in Fig. 1 extending to the selector switch E. The selector E may be of the general type of selector switch disclosed in U. S. Letters Patent No. 815,321, granted March 31, 1906, to Keith, Erickson, and Erickson; the side switch and private magnet being omitted, however, and the circuits being modified in accordance with the two-wire system of control. The circuits are further modified by the addition in accordance with my invention of several relays which are of utility when a call is to be extended to an operator's position, as will be explained fully hereinafter.

The finder switch F (Fig. 2) is in general similar in construction to the switch shown in U. S. Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson, and Erickson, except that the side switch and private magnet are omitted, and the circuits are changed radically in order to permit the switch to perform the functions of a finder switch. It is thought best to defer the description of the circuits until later, when the operation of the complete system will be considered in detail.

There are, however, a number of important differences in mechanical construction which it is considered advisable to explain briefly at this time. The Keith and Erickson switch above mentioned has a bank of 100 sets of contacts, each set comprising two line contacts and one private contact, arranged in ten groups or levels. The switch is provided also with a pair of line wipers and a private wiper which have a vertical movement to select groups and a rotary movement to select a particular set of contacts in the selected group. The finder switch F, likewise, is provided with a pair of line wipers, which are the wipers 122 and 123, and with a private or test wiper, which is the wiper 121. The finder switch bank also has 100 sets of contacts divided into ten levels (one set in each of the three lower levels being shown in the drawing) and the wipers 121, 122, and 123 have a vertical group selecting movement under control of the vertical magnet 114, and a rotary movement under control of the rotary magnet 115. So far the finder switch F is substantially like the switch shown in the Keith and Erickson patent. An essential difference appears, however, in the release mechanism.

I provide separate holding pawls for the switch shaft for controlling its restoration in a rotary direction and in a vertical direction. These pawls are normally in engagement with the ratchet teeth of the shaft and may be of any well known construction. When the rotary release magnet 117 is energized the rotary holding pawl is withdrawn to permit the release of the shaft as regards its rotary movement and when the vertical release magnet 116 is energized the vertical holding pawl is withdrawn to permit the release of the switch shaft verti-

cally. Another essential difference is in the position of the wipers on the shaft. When the shaft of the finder switch F is in its lowest position the wipers 121, 122, and 123 are standing opposite the first level of contacts, and are not one step below the first level. Minor details which should be noted are the rotary off-normal springs 118, which are permitted to close on the first rotary step, and the vertical off-normal springs 119 and 120, which are controlled by the shaft cams 131 and 132 and the dog 133. When the shaft is in its lowest position the spring 119 is disengaged from spring 120 by the cam 131. When the shaft is stepped up in the operation of the switch, the spring 119 is held in the position shown in Fig. 2 by the dog 133 until the shaft arrives opposite the tenth level, whereupon the cam 132 disengages the dog 133 and permits the springs to close.

In addition to the foregoing details, each finder switch is also provided with a vertical strip of ten group test contacts and a vertical strip of ten starting circuit contact sets. These test and starting circuit contacts are preferably combined in a single bank as shown in Figs. 4 and 5, and may be mounted in any suitable manner on the switch frame. The vertical test wiper 124 is always in engagement with some one of the vertical test contacts 134, 135, etc.; and is attached to the member 202 which in turn is rotatably mounted on an upward extension of the switch shaft 200, and is held in position by the adjustable collar 203. When the switch is idle the starting wiper or contact member 125 is likewise in engagement with some one of the contact springs 129, 126, etc., of the starting circuit contact sets. When the finder switch is engaged in a connection, however, the starting wiper 125 is disengaged by means of the magnet 113. The magnet 113 is rigidly mounted on the switch shaft which forms its core, and is provided with a U shaped armature 204 which is rotatable to a limited extent on the shaft. The upper leg 208 of the armature 204 is preferably of brass to avoid short-circuiting of the magnetic circuit. With no current flowing in the winding of magnet 113, the armature 204 is held by the spring 206 in such position that the wiper 125 engages the contact spring 129 (or corresponding spring in another level), and the spring 206 has sufficient tension to cause the spring 129 to be separated from its resting contact. When the magnet 113 is energized, the armature 204 is rotated several degrees and the starting wiper 125 is thereby disengaged from the contact spring of the starting circuit contact set opposite which it is standing and the springs of such set are permitted to close.

With each of the ten sub-groups of trunk lines to which the finder switch F has access there is associated a set of three group relays which among other things control the removal of the test potential from the finder switch group test contacts. Thus, referring to Fig. 1, the first group of trunk lines, not shown in the drawing but which are understood to be multipled in the first levels of the group of finder switches of which the finder switch F is one, are provided with the group relays 136, 137, and 138; while the second group of trunk lines, which is similarly multipled in the second level of the finder switches, and which includes the trunk line terminating in the selector E, is provided with the group relays 139, 140, and 141. It is understood that each of the other eight groups of trunk lines to which the group of finder switches has access is similarly provided with a set of group relays. The relay 136, when energized, removes ground potential from the group test contact 134 and its multiples in the banks of the other finder switches of the group, and the corresponding relays in the other sets of group relays perform like functions.

With each set of group relays there is associated a starting wire. Considering the second group of trunk lines and the associated set of group relays, the starting wire 244 is multipled at one end to all the first selectors in which the trunk lines terminate, including the selector E; it includes the winding 142 of the relay 139; and it terminates in spring 126 of the second set of starting circuit contacts of the finder switch F, which it should be mentioned is assumed to be the first finder switch of the group. In the same way each of the other groups of trunk lines has a starting wire which extends by way of the associated group relay corresponding to relay 139 to the starting circuit contact bank in the first finder switch; and since there are ten groups of trunk lines there will be ten of these starting wires. The starting wires are not multipled in the other finder switches of the group directly, as are the vertical and rotary test contacts and the line contacts, but are tapped on to a continuous series or loop circuit extending through all the finders and which can be best understood by reference to Fig. 3.

In Fig. 3 there is shown the wiring of the starting circuit contact banks of three finder switches, this number being thought sufficient for purposes of illustration. Beginning with the starting wire 044 which is associated with the tenth group of trunk lines, the circuit may be traced by way of the top or tenth sets of starting circuit contact springs of the three finder switches in series and conductor 300 to the starting wire 944 of the ninth group, thence by way of the ninth sets of starting circuit contact springs of the three finders in series and conductor 301 to

the starting wire 844 of the eighth group, etc., until the circuit finally returns via conductor 302 to the starting wire 044, thus forming a complete loop. It will be observed that the above described loop circuit is divided into as many sections as there are idle finder switches by the starting wipers of the finder switches, such as the wiper 125 of the finder switch F. Briefly stated, the starting wiper of each idle finder switch opens the starting loop and is in electrical connection with the upwardly extending portion thereof.

In addition to the ten sets of group relays, there is provided a pair of relays 150 and 151, which are common to these group relays, or in other words, which are individual to the group of finder switches which includes the finder switch F. The relay 150 is a general alarm relay, while relay 151 controls the ground connection to the common conductor 152. This latter conductor, it may be mentioned, is multipled to the first selectors of all the ten groups of trunk lines which are served by the finder switch F and associated finders.

The operator's equipment, which has been indicated in Fig. 2 by the reference character H, comprises a group of relays, the signal lamps L and L' and a key K. The utility and operation of this apparatus will be described later.

I have shown throughout the drawings a plurality of batteries, but it is to be understood that in accordance with the usual practice there may be and is preferably but one battery, the positive pole of which is grounded.

Having described more or less briefly the apparatus involved, I will now proceed to explain the operation of my improved telephone system. In order to afford an opportunity of describing the operation of the selector E, it will first be assumed that the subscriber at substation A desires to obtain connection with another subscriber, after which the assumption will be made that the same subscriber desires to communicate with the operator presiding over the operator's equipment H, this latter being the complete circuit connection shown in the drawings and previously referred to.

Referring to Fig. 1, when the subscriber at substation A removes his receiver to initiate the call, an energizing circuit is completed over the line conductors 12 and 13 for the line relay 16 of the line switch C. Upon attracting its armature, the line relay 16 closes a circuit for the pull-in winding 17. Upon energizing, the pull-in winding operates both the plunger arm 21 and the cut-off armature 22; the former through the medium of its plunger (not shown) forcing the bank springs 30–33, inclusive, into engagement, respectively, with contacts 34–37, inclusive; and the latter disconnecting the line conductors 12 and 13, respectively, from ground and from the line relay 16. By the engagement of bank springs 30 and 33, respectively, with contacts 34 and 37, the line conductors 12 and 13 are extended, respectively, to the low resistance relay 40 and the line relay 50 of the selector E, it being noted that the conductor 12 passes also through the lower winding of the line relay 50.

The relays 50 and 40 are accordingly energized over the loop circuit including substation A and the line relay 50, upon attracting its armature, closes a circuit for the slow-acting release relay 51. Upon energizing in turn, the relay 51 completes a holding circuit for the line switch C which may be traced as follows: ground at G^7, contact 63', armature 64, conductor 38, contact 35, bank spring 31, and holding winding 18 to battery B. Since the line relay 16 is slow acting, it retains its armature to maintain the pull-in winding 17 energized until after the above holding circuit has been established. A branch of the holding circuit extends by way of conductor 19 to multiple test contacts in the banks of connector switches having access to the line of substation A, where by a ground potential on these test contacts the said line is made busy. By the engagement of bank spring 32 with contact 36 the master switch D is operated in well known manner to advance the plungers of all the remaining idle line switches into position before the terminal of the next idle trunk line.

The foregoing operations have occurred in response to the removal of the receiver at substation A. It has been assumed that the calling subscriber desires to connect with another subscriber in the exchange and he will therefore proceed to operate his calling device in accordance with the first digit in the desired number. By the operation of the calling device, a series of interruptions is produced in the line circuit which as just explained now includes the line relay 50 and the relay 40 of the selector E in series. At each interruption of its circuit, the line relay 50 deenergizes momentarily and sends an impulse from ground G^6 through the slow acting relay 52 and the vertical magnet 53 in series. Responsive to these impulses the vertical magnet operates to raise the switch shaft step by step until the wipers 70, 71, and 72 arrive at that horizontal level of bank contacts in which are located trunk lines extending to the desired main group of subscribers' lines. At the first interruption of the line circuit the relay 40 deenergizes also and by closing the back contact of armature 41 short circuits its winding so that it is excluded from the line circuit during subsequent impulses. Since the

relay 40 does not again energize after the first interruption of the line circuit, the off-normal contact springs 44 are provided to prevent the closure of the finder switch starting circuit. The off-normal springs 44 are permitted to separate on the first upward movement of the switch shaft.

The slow acting relay 52, which as previously mentioned is included in the vertical magnet circuit, is energized at the first impulse and retains its armature attracted during the vertical movement of the switch. Upon the first upward movement of the switch shaft the off-normal springs 58 are closed, thereby completing an initial energizing circuit for relay 55 which may be traced as follows: ground at G^7, the working contacts of armature 64, the armature of relay 52 and its working contact, the said off-normal springs 58, and the winding of relay 55 to battery B^3. Upon energizing, relay 55 prepares at its lower armature a circuit for the rotary magnet 54, which is held open during the vertical movement of the switch by the relay 52, and at its upper armature locks itself independent of the relay 52 by closing the following circuit: grounded conductor 38, lower armature of the rotary magnet 54 and its resting contact, upper armature of relay 55 and its working contact, junction point 80, off-normal springs 58, and the winding of relay 55 to battery B^3. At this point it should be mentioned that by the closure of the off-normal springs 58, the line switching relay 63 was connected in series with relay 55. But since the junction point 80 has already been connected to ground as just described, it will be seen that the switching relay 63 is short circuited for the present and remains temporarily inoperative.

When the slow acting relay 52 deenergizes at the end of the series of impulses it completes at its back contact the previously mentioned circuit of the rotary magnet 54, extending from ground G^7 over an obvious path. Upon energizing, the rotary magnet operates to rotate the wipers 70, 71, and 72 into engagement with the first set of bank contacts of the horizontal level opposite which they were raised. Near the end of its stroke the rotary magnet also breaks, at its lower armature, the locking circuit of relay 55; and at its upper armature the circuit connecting the line switching relay 63 with the junction point 80. Upon deenergizing, the relay 55 breaks the energizing circuit of the rotary magnet which accordingly retracts its armatures to again close the contacts controlled thereby. The operation now depends on whether the first trunk line, the terminals of which are now engaged by the selector wipers, is busy or not. Assuming that this trunk line is busy, the test contact upon which the test or private wiper 71 is resting will have ground potential upon it, which ground potential will serve to maintain the switching relay 63 short-circuited and also to again energize the relay 55. The rotary magnet circuit is therefore again closed and the same operation is repeated. It will be seen then that the relay 55 will operate as an impulse sender to step the switch wipers around through the medium of the rotary magnet as long as the test wiper 71 continues to engage busy or grounded test contacts. When a non-busy or ungrounded contact is reached and the rotary magnet retracts its armature, the junction point 80 will no longer be grounded via the private wiper, whereupon the switching relay 63 will immediately energize in series with the relay 55. Relay 63 is of such high resistance that relay 55 does not energize. By the attraction of its armature, the switching relay 63 opens the circuit of the release magnet 59 to provide against the deenergization of relays 50 and 51; shifts the private wiper to the grounded terminal of switching relay 63; and disconnects the line conductors from the line relay 50 and extends them by way of the line wipers 70 and 72, and the line conductors of the selected trunk to the line relay of the second numerical switch of the series, which may be a second selector switch similar to the selector E. The line relay of the second selector is accordingly energized over the line circuit and through the medium of the usual slow acting release relay connects ground to the third conductor of the selected trunk, thereby establishing a new holding circuit for the line switch C and the switching relay 63 which includes the private wiper 71 and the upper armature of relay 63 and its working contact. It is understood, of course, this new holding circuit is completed before the slow acting release relay 51 has had time to deenergize.

Having operated the first selector E in the manner above explained, the calling subscriber may now manipulate the dial of his calling device in accordance with the remaining digits in the number, whereby the second selector and the final connector switch are controlled in the usual and well known manner to extend the connection to the desired subscriber's line. The foregoing operations, together with the signalling of the called subscriber and the final disconnection of the switches after conversation are the usual ones incident to the establishment of a connection in an automatic telephone system, and will not be further considered.

Attention will now be directed to the method pursued by the subscriber at substation A in extending a connection to an operator. Since the preliminary operations responsive to the removal of the receiver are the same, it will be assumed that the subscriber has removed his receiver, that the

line switch C has operated to extend connection to the selector E, and that the relays 50, 40, and 51 of the selector are in energized position. The subscriber is of course acquainted with the fact that the push button 11 at his telephone is provided for the purpose of calling an operator and he will therefore, immediately after removing the receiver, press the button, thereby inserting the resistance 10 in the line circuit. The line relay 50 is not affected by the decreased current flow in the line circuit and maintains its armatures attracted. Relay 40, however, is marginal and at once retracts its armature, thereby short-circuiting itself at the back contact of armature 41 so that it will not again be energized when the push button at the calling substation is released. As a further result of the deenergization of relay 40 a starting circuit for initiating the operation of an idle finder switch is closed over the following path: ground at G^2, resting contact of armature 153 and the said armature, common conductor 152, off-normal springs 44 of the selector E (now closed), armature 43 and its working contact, armature 42 and its resting contact, winding 84 of relay 82, armature 87 and its resting contact, starting wire 244 including the winding 142 of relay 139, the second set of starting circuit contact springs 126 and 127 of finder switch F, conductor 128 including in series the second set of starting circuit contact springs in each of the other finders of the group (it being assumed that no finder has its wipers standing opposite the second level, see Fig. 3), starting circuit contact spring 129 of the first set, starting wiper 125 of finder switch F now in engagement therewith (it being assumed that the wipers of finder switch F are standing opposite the first level), and the winding 101 of the starting relay 100 to battery B^{10}. It will be noticed that there are two branches connected to the above circuit at points between the spring 129 and the starting relay of the finder switch. One branch extends from the starting wire 244 through the winding of relay 141 to battery B^6, while the other branch extends from starting wire 144 through the winding of relay 138 to battery B^7. In order to secure the proper operation of the various relays associated with the starting circuit, they are wound to approximately the following resistances: winding 84 of relay 82, 100 ohms; winding 142 of relay 139, 400 ohms; winding 101 of relay 100, 400 ohms; and relays 138 and 141, 10,000 ohms each. To proceed with the operation, upon the closure of the starting circuit, the relays 82, 138, and 141 are not sufficiently energized to enable them to attract their armatures; the former relay being in series with the higher resistance relay 139 and the added resistance of the multiple branches beyond, and the two latter relays being shunted by the comparatively low wound relay 100 of the finder switch, whereby they receive less than half the full potential of the battery. Relays 139 and 100, however, are operatively energized. Relay 139 is preferably given a stiff adjustment to insure that it will not pull up faster than relay 100. Considering first the functions of relay 139, this relay, upon attracting its armature 155, disconnects ground G^3 from the group test contact 135 and its multiples in the finder switch banks and substitutes therefor the winding of relay 140. Upon attracting its lower armature 154, relay 139 closes a locking circuit for itself over the following path: ground at G^5, common relay 151; resting contact of armature 156 and the said armature, winding 143 of relay 139, and the working contact of armature 154 and the said armature to battery B^5. By the energization of the common relay 151, ground G^2 is disconnected from the conductor 152 to prevent for the moment the starting of any other finder switch. Simultaneous with the closure of the above locking circuit for relay 139, and before relay 151 has had time to attract its armature, the battery B^5 is connected direct to the starting wire 244, thereby causing a momentary increased current impulse to flow through winding 84 of relay 82. Upon energizing relay 82 first closes a locking circuit for itself as follows: grounded conductor 38, contact 91, spring 92, working contact of armature 86 and the said armature, and the winding 83 of relay 82 to battery B^4. Further results of the energization of relay 82 are the opening of the circuit of vertical magnet 53 at armature 85, the opening of the starting circuit at armature 87, and the removal of ground G^4 from the test contact 163 and its multiples in the finder switch banks.

Returning now to the starting relay 100 of the finder switch F, this relay is sufficiently energized before its winding 101 is short-circuited by the application of battery B^5 to the starting wire at relay 139, to close a locking circuit including its other winding which may be traced as follows: ground at G^{10}, armature 171 and its resting contact, armature 166 and its working contact, winding 102 of relay 100, and the winding 104 of the vertical test relay 103 to battery B^{11}. Relay 100 is thus maintained energized temporarily independent of the starting circuit and at the same time relay 103 is operated. Upon energizing, relay 103 closes the following circuit: ground at G^{12}, working contact of armature 170 and the said armature, winding of slow acting relay 106, and the winding 109 of the rotary test relay 107 to battery B^{12}. Upon energizing, relay 106 closes a locking circuit for the

vertical test relay 103 as follows: ground at G^9 (Fig. 1), upper armature of relay 136, group test contact 134, test wiper 124, working contact of armature 172 and the said armature, armature 169 and its working contact, and the winding 105 of relay 103 to battery B^{11}. Another circuit closed by relay 106 extends as follows: ground at G^{10}, armature 171 and its working contact, and the winding of magnet 113 to battery B^{13}. Upon energizing, the magnet 113 disengages the starting wiper 125 from spring 129 and thereby permits the starting loop to be closed past the finder switch F. A branch of the circuit of magnet 113 may be traced from junction point 176 by way of the upper armature of the rotary magnet 115, armature 174 and its upper working contact, and the winding 108 of the rotary test relay 107. This branch circuit may be termed a locking circuit for the relay 107.

When the slow acting relay 106 was energized it also disconnected ground G^{10} from the armature 166 of relay 100. Relay 100 is therefore permitted to deenergize, but relay 103 remains energized by reason of the circuit through its lower winding 105. A circuit for the vertical magnet 114 may now be traced as follows: ground at G^{11}, armature 168 and its working contact, armature 167 and its resting contact, armature 177 and its resting contact, winding of vertical magnet 114, and the armature 178 and its resting contact to battery B^{14}. Responsive to the closure of the above circuit the vertical magnet 114 is operated to step up the finder switch shaft one step, thereby raising the wipers 121–125, inclusive, to the second level. The vertical magnet interrupts its own circuit near the end of its stroke and therefore immediately retracts its armature, but before its circuit can again be closed, the vertical test relay has deenergized due to the test wiper 124 leaving the grounded test contact 134 and engaging the non-grounded test contact 135. It will be understood of course that if the trunk line which the finder switch is in search of were located in one of its upper levels the vertical magnet would be energized intermittently to raise the switch shaft step by step until the test wiper 124 arrived at the right level.

Proceeding with the explanation, the first result of the deenergization of the test relay 103 which should be considered is the closure of a circuit for group relay 140 (Fig. 1) as follows: ground at G^{11}, resting contact of armature 169 and the said armature, armature 172 and its working contact, test wiper 124, test contact 135, armature 155 and its working contact, and the winding of relay 140 to battery B^8. Upon attracting its armature 156, relay 140 breaks the locking circuit of relay 139 which includes also the common relay 151. Upon deenergizing, relay 139 again connects ground G^3 to the second level of group test contacts in the finder banks; while the relay 151, upon deenergizing, again connects ground G^2 to the common conductor 152. A second calling line is now able to start another finder switch, even though the finder switch F has not yet located the trunk line to which the first calling line is connected.

Returning to the relay 103 (Fig. 2), additional results of its deenergization are the breaking of the circuit of slow acting relay 106, relay 107 remaining energized by reason of its previously described locking circuit; and the closure of a circuit for the rotary magnet 115 which may be traced as follows: ground at G^{11}, armature 168 and its resting contact, winding of slow acting relay 110, armature 175 and its working contact, winding of the rotary magnet 115, and the lower armature thereof to battery B^{15}. Upon the closure of the above circuit the slow acting relay 110 and the rotary magnet 115 are energized in series; the former connecting ground G^{14} to the circuit of magnet 113 to provide against the deenergization of relay 106, which occurs an instant later; and the latter rotating the switch shaft to bring the wipers 121, 122, and 123 into engagement with the first set of contacts of the second level. Near the end of its stroke the rotary magnet interrupts its own circuit and also, at its upper armature, the previously described locking circuit of test relay 107. By the latter operation the continued energization of the test relay 107 is made contingent on the presence of ground potential upon the test contact with which the test wiper 121 is now in engagement. Assuming that the set of contacts which the finder is in search of is not the first set in the second level, current will flow from ground on the test contact by way of test wiper 121, the lower working contact of armature 174, the said armature and its upper working contact, and the winding 108 of relay 107 to battery B^{12}. Since the rotary magnet opened its own circuit at the same time that it opened the initial locking circuit of the test relay it will deenergize immediately and again close both circuits, when the same operation will be repeated and the wipers will be advanced to the second set of contacts of the second level. Thus it will be seen that the test relay 107 will continue to be energized and the rotary magnet 115 will continue to step the shaft around as long as the test wiper 121 engages grounded test contacts. As soon however as the wipers arrive at the contact set associated with the trunk being hunted for, which is the contact set 163—164—165, the test wiper 121 will find no ground potential on the engaged test contact, which is the test contact 163, and the

test relay 107 will therefore deenergize as soon as its locking circuit is opened by the rotary magnet, and will break the circuit of the latter to prevent its reenergization. Thus the wipers of the finder are brought to rest in engagement with the contacts of the trunk line to which the line of substation A is connected.

The instant the test relay 107 deenergizes the following circuit is completed for the switching relay 111: ground at G^{14}, armature 173 and its working contact, junction point 176, upper armature of the rotary magnet 115 and its resting contact, armature 174 and its resting contact, and the winding of switching relay 111 to battery B^{16}. Upon energizing, the switching relay at its armatures 194 and 195 connects the line wipers 122 and 123, respectively, with the trunk conductors 191 and 192; breaks at its armature 184 a contact in the circuit of the release magnet 117 in order to guard against the deenergization of the slow-acting relay 110; and finally at its armature 185, completes a circuit for relay 89 of the selector E which may be traced as a branch of the circuit of relay 111 as follows: junction point 193, working contact of armature 185 and the said armature, junction point 180, test wiper 121, test contact 163, conductor 160, armature 88 and its working contact, and the winding of relay 89 to battery B^{17}. Upon attracting its armature, relay 89 substitutes ground G^{8} for ground G^{7} in the locking circuit of relay 82. The above circuit of relay 89 also serves to supply ground to multiples of test contact 163 to prevent the stopping of a subsequently started finder switch on the same trunk.

The switching relay 111 having energized, it will be seen that the line conductors 12 and 13 are now extended by way of conductors 161 and 162, bank contacts 164 and 165, line wipers 122 and 123, and armatures 194 and 195, to the trunk conductors 191 and 192 extending to the operator's position. The instant the calling line is extended as above pointed out the double wound line relay 181 is energized in multiple with the line relay 50 of the selector E, and upon attracting its armature completes a circuit for the slow acting relay 182 as follows: ground at G^{16}, armature 186 and its working contact, winding of relay 182, armature 189 and its resting contact, and the upper contacts of key K to battery B^{18}. Upon energizing, relay 182 completes the following holding circuit as a substitute for ground G^{14}: ground at G^{17}, working contact of armature 187 and the said armature, and the conductor 190 to junction point 180, where the circuit divides, one branch extending over a previously described path to relay 89 of the selector E, and the other branch extending by way of armature 185 and its working contact to junction point 193, where the circuit again divides into branches extending to relay 111 and to magnet 113, respectively. It is to be understood that the above holding circuit is completed before the slow acting relay 110 has had time to deenergize after the last rotary impulse.

The connection having been extended to the operator's position, I will now explain how the call signal lamp L is illuminated. As soon as the relays 106 and 107 are energized following the closure of the starting circuit, a circuit through lamp L may be traced as follows: ground at G^{10}, armature 171 and its working contact, junction point 176, upper armature of the rotary magnet 115 and its resting contact, armature 174 and its lower working contact, conductor 190, armature 188 and its resting contact, and the lamp L to battery B^{18}. It will be seen then that the call signal lamp is lighted immediately upon the starting of the finder switch, thus giving the operator warning in advance of the completion of the connection that such connection is to be established. After the finder has operated, current is of course supplied to lamp L from ground G^{17}.

The operator will respond to the signal thus received by operating the key K to the position shown in the drawing, thereby bridging her head set (not shown) across the trunk conductors 191 and 192, and at the same time removing the short circuit from relay 183. Relay 183 is accordingly energized in series with relay 182, and upon attracting its armatures 188 and 189, shifts the conductor 190 from lamp L to lamp L′, and also opens a contact in its shunt circuit so that if the key K is restored it will not again be short-circuited. The operator may now converse with the calling subscriber and ascertain his wants as is usual in such cases. If it should become necessary for the operator to have the subscriber wait while certain facts, his credit for example, are being investigated, she may restore her key to normal position. When this is done the lamp L′ (a red lamp, preferably) is lighted to insure that the operator will not forget the call.

Whatever course the conversation may pursue, it will finally be terminated and the calling subscriber will replace his receiver. When the receiver is hung up the line relay 50 of the selector E and the relay 181 at the operator's position will be deenergized simultaneously, and these relays, upon retracting their respective armatures, will break the circuits of slow-acting relays 51 and 182. When the relay 51 deenergizes, the holding circuit including the winding

18 of line switch C will be broken and the line switch will be released in the usual manner. Upon the deenergization of relay 182, the relay 89 of selector E, the relay 111 of the finder switch, and the magnet 113 of the finder switch will be deenergized. Relay 89, upon retracting its armature, breaks the locking circuit of relay 82 thus permitting that relay to restore and again connect ground G^4 to conductor 160. When the relay 111 retracts its armatures, a circuit is closed for the rotary release magnet 117 as follows: ground at G^{14}, armature 173 and its resting contact, resting contact of armature 184 and the said armature, winding of release magnet 117, and the rotary off-normal springs 118 to battery B^{19}. Upon energizing, the release magnet 117 withdraws the rotary holding pawl from the shaft, thereby permitting the restoration of the shaft and wipers in so far as their rotary movement is concerned, and as soon as the return is effected the circuit of the release magnet is again opened at the off-normal springs 118. The magnet 113 being now deenergized, as soon as the shaft is released the starting wiper 125 will engage the starting circuit contact spring 126 and will separate it from spring 127, thereby cutting the finder switch in on the starting loop again. After disconnection, therefore, the finder switch wipers are left standing opposite the bank level last served; or in other words, the wipers ordinarily are not released as regards their group selecting movement.

Under certain circumstances, however, for example as when the wipers are standing opposite the tenth level and it is necessary to cause them to hunt over a lower level, the finder switch shaft is restored vertically by energizing the vertical release magnet 116, but such release is always effected during the establishment of the connection and not upon disconnection. In order to explain the vertical release it will be assumed that when the calling subscriber at substation A pressed his button to call the operator the finder switch F was standing opposite the ninth level instead of the first level. Now when the starting wire 244 is grounded the finder switch F will be started as before (there being no other finders cut in on the starting loop between the second and ninth levels) and the vertical magnet 114 will be operated to raise the wipers to the tenth level. Since the group test contact for the tenth level is grounded the test relay 103 will not deenergize. As the armature of the vertical magnet reaches nearly the end of its stroke and just as the magnet circuit is interrupted, the cam 132 on the shaft engages the dog 133 and releases the off-normal spring 119, which thereupon makes contact with spring 120 and closes the following circuit: ground at G^{11}, armature 168 and its working contact, armature 167 and its resting contact, winding of relay 112, and the off-normal springs 120 and 119 to battery B^{20}. Upon energizing, relay 112 breaks the vertical magnet circuit at the back contact of its armature 177, closes a locking circuit for relay 103 at the front contact of the same armature, and at its armature 179 closes a circuit for the release magnet 116. By the operation of release magnet 116 the vertical holding pawl is withdrawn and the shaft is permitted to drop vertically until the wipers stand opposite the first level. During the restoration of the shaft the operation of the vertical magnet 114 is of course suspended, and also the test relay 103 is locked as previously mentioned to prevent its deenergization when the test wiper 124 passes the test contact 135 on the way down. With the complete return of the shaft, the cam 131 has separated the off-normal springs again, whereupon the release magnet circuit is broken and the circuit of the vertical magnet 114 is again closed. Thereupon the finder switch resumes its operation and the calling line is found as before.

The purpose of the relays 138 and 141 and similar relays (not shown) associated with the other eight sub-groups will now be briefly explained. These relays are provided for the purpose of giving an alarm in case the finder switches are all busy when a call is attempted to be made, or in case there is an open circuit somewhere in the starting loop. In the former case all ten of these relays will be connected to whichever starting wire is grounded and since they are not shunted by the starting relay of a finder switch, will be energized in multiple to light their associated lamps in series with the alarm relay 150. Relay 139 is so adjusted that it will not operatively energize in series with 1000 ohms. In the case of an open circuit in the starting loop those relays which are connected to the starting wires beyond the break will not be energized, and the last lamp lighted therefore will indicate the approximate location of the trouble. In case the latter supervision is not desired, however, all but one of the relays may be omitted.

It remains only to discuss one other situation, when the explanation it is thought, will be complete. Suppose that the subscriber at substation A should remove his receiver and press his button to call an operator, and then immediately hang up the receiver again before the finder switch which has been started has had time to find his line. Since the finder switch is turned loose, so to speak, after receiving its initial starting impulse,

it will be operated as usual to locate the group and unlock the group relay to restore ground to the group test contact; but when in the rotary movement the test wiper 121 arrives at test contact 163, it will find ground potential and the rotation will continue. Obviously then, were no special means adopted to prevent it, the switch would continue to buzz. Such contingency is obviated by providing the rotary shaft with an extra tooth so that on the eleventh rotary step the wipers will be rotated off the bank. The provision of such an extra tooth on the shaft is old in the art, switches of many types having been used in the past which have more than ten teeth to the rotary hub so that the wipers may be rotated off the contacts of the bank. A shaft having more than ten teeth is shown in United States Letters Patent #815,176, granted March 13, 1906, to Keith, Erickson and Erickson. When the test circuit through wiper 121 is interrupted the rotation will be stopped and the switching relay 111 will be energized as usual; but since the line wipers 122 and 123 are not in engagement with a calling line, or any other line, no holding circuit will be established, and the switch will be released following the deenergization of the slow-acting relay 110.

Having described my invention, what I consider to be new and desire to have protected by Letters Patent will be pointed out in the appended claims.

What I claim as my invention is:

1. In a telephone system, a subscriber's line, a trunk line having two branches, means for connecting said line and trunk line, a selector switch for one branch, a calling device at the station on said line for operating said switch to extend a connection over the associated branch, a finder switch, and another calling device at the station on the said line manually operable after the line and trunk are connected, and means responsive to said second calling device for causing said finder to extend a connection over the other of said branches.

2. In a telephone system, a subscriber's line, a trunk line having two branches, the first branch extending toward an operator's switchboard, and the second branch extending toward a called line, means for connecting said subscriber's line when calling with said trunk line, switch hook springs at the station on the calling line for controlling said connecting means, a variable impulse sender and a circuit changing switch at the said station, and automatic switching mechanism at the exchange for extending the calling line over said first branch to said switchboard responsive to the actuation of said switch, and for extending said calling line to a called line over said second branch responsive to the actuation of said calling device.

3. In a telephone system, a subscriber's line, a trunk line terminating in an automatic selector switch, a finder switch, a branch of said trunk line terminating in the bank of said finder switch, means for extending said line when calling to said trunk line, an impulse sender at the substation on the calling line for operating said selector switch, and an auxiliary device associated therewith for initiating the operation of said finder switch.

4. In a telephone system, a subscriber's line, a trunk line terminating in an automatic switch, a finder switch, a branch of said trunk line terminating in the bank of said finder switch, means for extending said line when calling to said trunk line, an impulse sender at the substation on the calling line for operating said selector switch, an auxiliary device associated therewith for initiating the operation of said finder switch, and means whereby if either the selector switch or the finder switch is operated the other switch is rendered inoperative until the connection is released.

5. In a telephone system, a subscriber's line, a trunk line having two branches, an automatic switch for extending one of said branches to an operator's position, a numerical automatic switch individual to said trunk line for extending the other of said branches toward another subscriber's line, means for connecting said first line when calling with said trunk line, and means for then immediately operating either of said switches separately at the option of the calling subscriber.

6. In a telephone system, a subscriber's line, a trunk line having two branches, an automatic switch for extending one of said branches to an operator's position, a numerical automatic switch individual to said trunk line for extending the other of said branches toward another subscriber's line, means for connecting said first line when calling with said trunk line, and separate controlling devices for the said switches, respectively, at the substation on the calling line, each controlling device being manually operable after the said first line and trunk line are connected to cause the operation of its associated switch for the purpose set forth.

7. In a telephone system, a subscriber's line, a trunk line having two branches extending to numerical and non-numerical switches, respectively, separate controlling relays and operating magnets for each switch, switching mechanism for connecting the said subscriber's line when calling with said trunk line, a device at the station on the calling line for controlling said mecha-

nism, and manually operable controlling means whereby the subscriber on the calling line is enabled to operate either of said switches as soon as his line is connected to the said trunk line.

8. In a telephone system, a subscriber's line, a trunk line having two branches extending to forward and backward selecting automatic switches, respectively, separate controlling relays and operating magnets in each switch, mechanism for connecting the said subscriber's line when calling with said trunk line, switch hook springs at the station on said line for controlling said mechanism, separate subscriber controlled devices in the line circuit at said station, and circuit connections whereby each of said switches is rendered responsive only to a particular one of said devices.

9. In a telephone system, a subscriber's line, a trunk line having two branches each terminating in an automatic switch, means for connecting the said line when calling with said trunk line, an impulse sender and a push button in the line circuit at the substation on the calling line, and circuit connections at the exchange whereby one of said switches is rendered responsive to said impulse sender and the other of said switches to said push button.

10. In a telephone system, a subscriber's line, a trunk line having two branches each terminating in an automatic switch, means for connecting the said line when calling with said trunk line, and separate controlling devices operated independently for operating the respective switches, said devices located at the substation on the calling line and controlling the two sides of the subscriber's line in series to operate said switches.

11. In a telephone system, lines divided into groups, an automatic switch having group and line selecting movements and having no normal position as regards the said groups, means for operating said switch to select a desired one of said lines, with means for preventing a group selecting movement thereof if the said switch is already associated with the proper group.

12. In a telephone system, lines divided into groups, a switch having automatic group and line selecting movements and having no normal position as regards the said groups, means for initiating the operation of said switch to select a desired one of said lines, with means permitting the omission of the group selecting movement if the said switch is already associated with the proper group.

13. In a telephone system, lines divided into groups, a plurality of switches having automatic group and line selecting movements, said switches being normally associated, respectively, with the groups last served, and means for initiating the operation of one of said switches to select a desired line, the switch operated being one which is already associated with the proper group.

14. In a telephone system, lines divided into groups, a plurality of switches having automatic group and line selecting movements, said switches being normally associated, respectively, with the groups last served, means for initiating the operation of one of said switches to select a desired line, the switch operated being one which is already associated with the proper group, and means whereby if the group in which the desired line is located has no switch associated therewith that switch will be operated which requires the shortest group selecting movement.

15. In a telephone system, a plurality of lines divided into groups, a plurality of finder switches associated indifferently with the various groups and having group and line selecting movements, and means responsive to a call received over one of said lines for starting that one of said switches which requires the shortest group selecting movement to locate the calling line.

16. In a telephone system, a plurality of lines divided into groups, a plurality of finder switches having group and line selecting movements for extending calls received over said lines, each switch when idle being associated with the group last served, and means responsive to a call for starting that one of said switches which requires the shortest group selecting movement to locate the calling line.

17. In a telephone system, a plurality of lines divided into groups, a plurality of finder switches associated indifferently with the various groups and having primary and secondary selective movements for selecting groups and lines, respectively, and means responsive to a call received over one of said lines for operating one of said finders in either one or both of its selective movements to locate the said line, the number of selective movements required being dependent upon the initial position of said finder switch.

18. In a telephone system, a plurality of lines divided into groups, a plurality of finder switches having primary and secondary selective movements for selecting groups and lines, respectively, said finders having no normal position as regards the said groups, and means responsive to a call received over one of said lines for starting the finder switch associated with the proper group to find the said line by a secondary selective movement only.

19. In a telephone system, a plurality of

lines divided into groups, a finder switch having group and line selecting movements for extending one of said lines when calling, and means for releasing said switch thereafter only in so far as its line selecting movement is concerned whereby a subsequently calling line in the same group may be extended by said switch without group selecting movement thereof.

20. In a telephone system, a plurality of lines divided into groups, a finder switch having group and line selecting movements and operable responsive to a call received over one of said lines to extend the call to another line, means for thereafter releasing said switch in so far as its line selecting movement is concerned, and means for retaining said switch in operated position in so far as its group selecting movement is concerned.

21. In a telephone system, a plurality of lines divided into groups, trunk lines, finder switches having primary and secondary selective movements for selecting groups and lines, respectively, to extend calls to idle trunk lines, releasing means in each finder switch, and means for retaining each switch after disconnection in association with the last selected group.

22. In a telephone system, groups of lines an automatic switch having primary and secondary motor magnets for operating the same to connect with a desired one of said lines, independently operable primary and secondary release magnets for restoring said switch, and means for operating said secondary release magnet only to restore said switch in readiness for another call.

23. In a telephone system, groups of lines, an automatic switch having primary and secondary motor magnets for operating the same to connect with a desired one of said lines, independently operable primary and secondary release magnets for restoring said switch, and circuit connections for energizing in order the said primary release magnet, the said motor magnets, and the said secondary release magnet.

24. In a telephone system, a subscriber's line, a trunk line, means including an automatic switch for connecting said lines, an operating magnet and a release magnet in said switch, and automatic means for actuating said magnets alternately during the establishment of the connection.

25. In a telephone system, groups of lines, an automatic switch having group and line selecting movements for connecting with a desired one of said lines, means for restoring said switch as regards its line selecting movement independent of restoration as regards its group selecting movement, and means for again operating said switch to select a line without restoring it as regards its group selecting movement.

26. In a telephone system, finder switches each operative through a plurality of stages for extending a connection, circuit connections for starting said finders in succession, including spacing means for establishing a time interval between the starting of successive finders, and means actuated by said finders at the completion of preliminary stages of their operation for terminating said time intervals.

27. In a telephone system, groups of lines, finder switches having group and line selecting movements for connecting with said lines, means responsive to calls for starting said finders, and circuit connections preventing simultaneous group selection by two or more finders, while permitting group selection by one finder to occur contemporaneously with line selection by another finder.

28. In a telephone system, a plurality of lines, finder switches having primary and secondary movement for extending calls received over said lines, means responsive to a call for starting an idle finder, and means actuated during the primary movement of the started finder but not in the secondary movement thereof for preventing the starting of another finder switch.

29. In a telephone system, a plurality of lines, finder switches having a plurality of selective movements for extending calls received over said lines, a starting circuit for starting said finders successively responsive to successive calls, means for rendering said circuit ineffective each time a finder switch is started, and means for rendering said circuit again effective while each finder is performing its final selective operation.

30. In a telephone system, a subscriber's line, a trunk line terminating in an operator's position, a plurality of automatic switches successively operable to extend said line when calling to said trunk line, a signal operated at an intermediate stage in the connecting operation to warn the operator of the approach of the call, and means for momentarily flashing the said signal when the connection is complete.

31. In a telephone system, groups of lines, finder switches for extending calls received over said lines, and a starting circuit including a normally closed contact for each of said groups in each of said switches.

32. In a telephone system, groups of lines, finder switches for extending calls received over said lines, a starting circuit including a normally closed contact for each of said groups in each of said switches, and means in each of said switches for opening one of said contacts, whereby the said circuit may be divided into sections.

33. In a telephone system, groups of lines, finder switches for extending calls received over said lines, a starting circuit including

a normally closed contact for each of said groups in each of said switches, means in each of said switches for opening one of said contacts whereby the said circuit may be divided into sections, a controlling relay for each of said finder switches, and means for connecting each relay to one of said sections.

34. In a telephone system, groups of lines, finder switches for extending calls received over said lines, a starting circuit including a normally closed contact for each of said groups in each of said switches, and means in each of said switches effective when the switch is idle for opening one of said contacts, whereby the said circuit may be divided into as many sections as there are idle switches.

35. In a telephone system, groups of lines, finder switches for extending calls received over said lines, a starting circuit including a normally closed contact for each of said groups in each of said switches, means in each of said switches effective when the switch is idle for opening one of said contacts, whereby the said circuit may be divided into as many sections as there are idle switches, and a starting relay in each idle finder switch connected to one of said sections.

36. In a telephone system, groups of lines, finder switches for extending calls received over said lines, a starting circuit including all of said switches in series, and a plurality of branches of said circuit equal in number to the number of said groups, said branches being all connected to said circuit at the same switch.

37. In a telephone system, groups of lines, finder switches for extending calls received over said lines, a loop circuit passing through each switch as many times as there are groups, and a starting wire for each group of lines joined to said circuit.

38. In a telephone system, groups of lines, a finder switch for extending a call received over one of said lines, relays individual to groups and lines, respectively, a starting relay for said finder, and a starting circuit including one of said group relays, one of said line relays and the said starting relay.

39. In a telephone system, a finder switch, a starting circuit including a low resistance controlling relay in said switch, and a high resistance alarm relay connected in parallel with said controlling relay.

40. In a telephone system, a finder switch, a starting circuit including a low resistance controlling relay in said switch, means for closing said circuit, a plurality of normally closed contacts in the circuit between the point of closure and the said relay, and an alarm relay in parallel with said first relay and connected to the circuit between the point of closure and the said contacts, said relay being of high resistance whereby when the circuit is closed it will be rendered inoperative by the shunting effect of said first relay.

41. In a telephone system, a trunk line having two branches, means for connecting a calling subscriber's line with said trunk line at the undivided end thereof, means for completing a talking connection over one of said branches, and means for supplying talking current to the calling line over both of said branches in parallel.

42. In a telephone system, a plurality of lines divided into groups, an automatic switch having primary and secondary movements to select groups and lines, respectively, said switch when idle being associated with different groups at different times, means controlled by a calling subscriber in setting up a connection for causing both primary and secondary movement of said switch for selecting one of said lines, and means controlled by another calling subscriber for causing a secondary movement of said switch without primary movement thereof for selecting another of said lines.

43. In a telephone system, a calling subscriber's line, a trunk line, a vertical and rotary switch, and a device at the station on the calling line manually operable after the receiver is removed for causing said switch to rotate without first moving vertically to connect the said calling line with said trunk line.

44. In a telephone system, a calling subscriber's line, a trunk line, an automatic switch having primary and secondary selective movements, and a device at the station on the calling line manually operable after the receiver is removed for causing said switch to connect the said line and trunk line by means of a secondary selective movement only.

45. In a telephone system, an automatic switch for use in connecting a calling and called line, a wiper shaft for said switch, a magnet coil wound on said shaft as a core and movable with the shaft, and a circuit changing armature adapted to be attracted when the said coil is energized.

46. In a telephone system, a finder switch for use in extending a calling line to a trunk line, a starter wire extending to said switch, a magnet for extending said starter wire to another finder switch, and a wiper shaft for said first finder constituting a core for said magnet.

47. In a telephone system, a finder switch for use in extending a calling line to a trunk line, a test wiper for said finder, a magnet for rendering said test wiper inoperative with respect to its associated test contacts, and a wiper shaft for said finder constituting a core for said magnet.

48. In a selector switch having hunting movements in two different co-ordinate di-

rections, means for starting the contact arms from a variable initial position in the first co-ordinate direction upon a call being initiated, means for setting the contact arms in the first co-ordinate direction for the selection of a contact row, and means for setting the contact arms in the second co-ordinate direction for the selection of a particular contact.

49. In a selector switch having hunting movements in two different co-ordinate directions, means for setting the contact arms in the first co-ordinate direction for the selection of a contact row, means for setting the contact arms in the second co-ordinate direction for the selection of a particular contact, means for restoring the contact arms, means for automatically stopping the return movement of the contact arms upon the latter reaching a position opposite to the contact row just left, and means for starting the contact arms from said position in the first co-ordinate direction upon a call being initiated.

50. In a selector switch having hunting movements in two co-ordinate directions, fixed line contacts arranged in rows, means for starting the contact arms from a variable initial position in the first co-ordinate direction for the selection of a contact row, means for setting the contact arms in the second co-ordinate direction for the selection of a particular contact, and means for marking a contact row as engaged as soon as the switch has found the contact row to which the calling line is connected.

Signed by me at Chicago, Cook County, State of Illinois, this 29th day of December, 1916.

RODNEY G. RICHARDSON.