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AUTOMATIC TRUNKING SYSTEM.

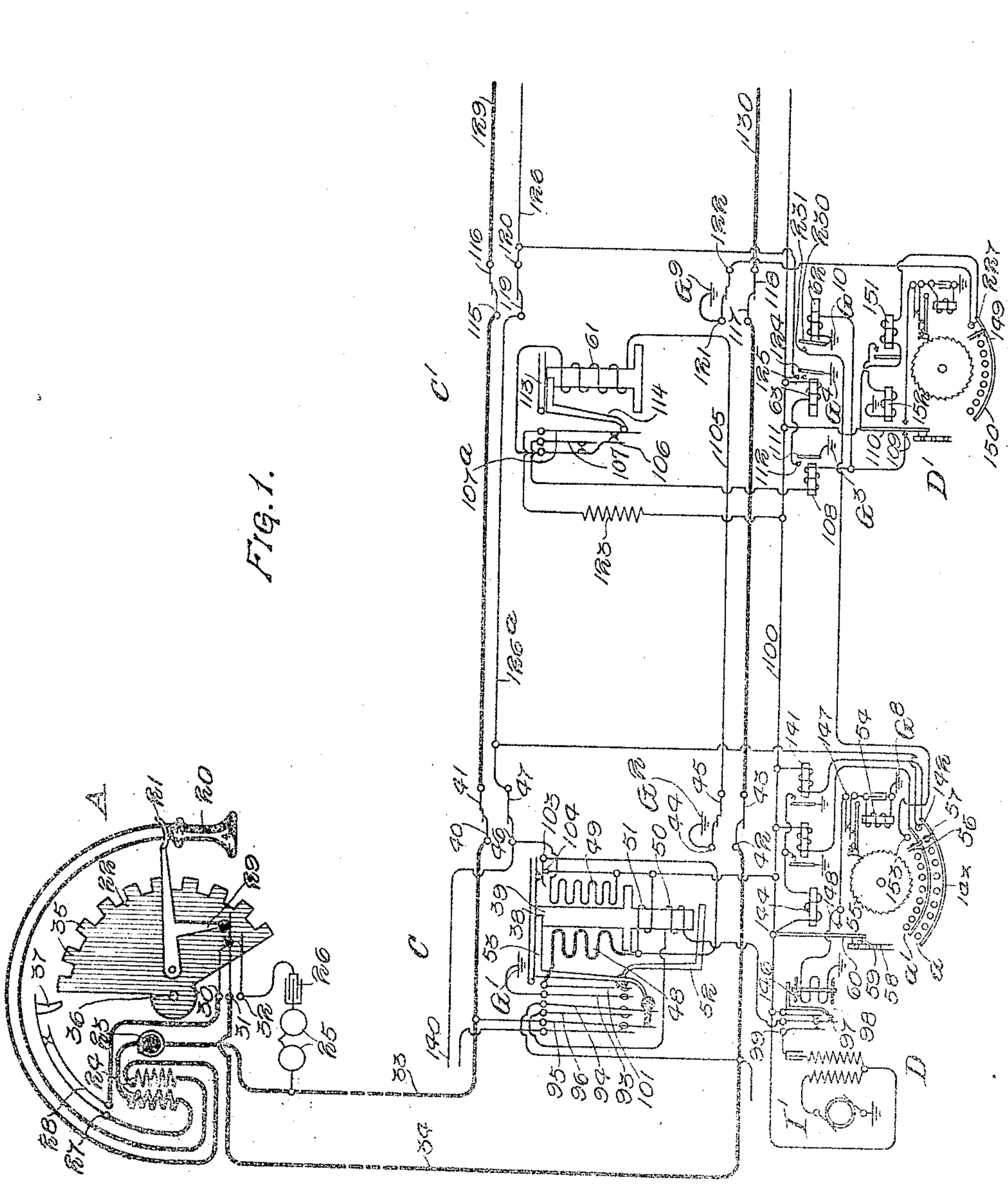
APPLICATION FILED MAR. 1, 1910.

1,101,854.

Patented June 30, 1914.

6 SHEETS—SHEET 1.

Fig. 1.



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6 SHEETS—SHEET 2.

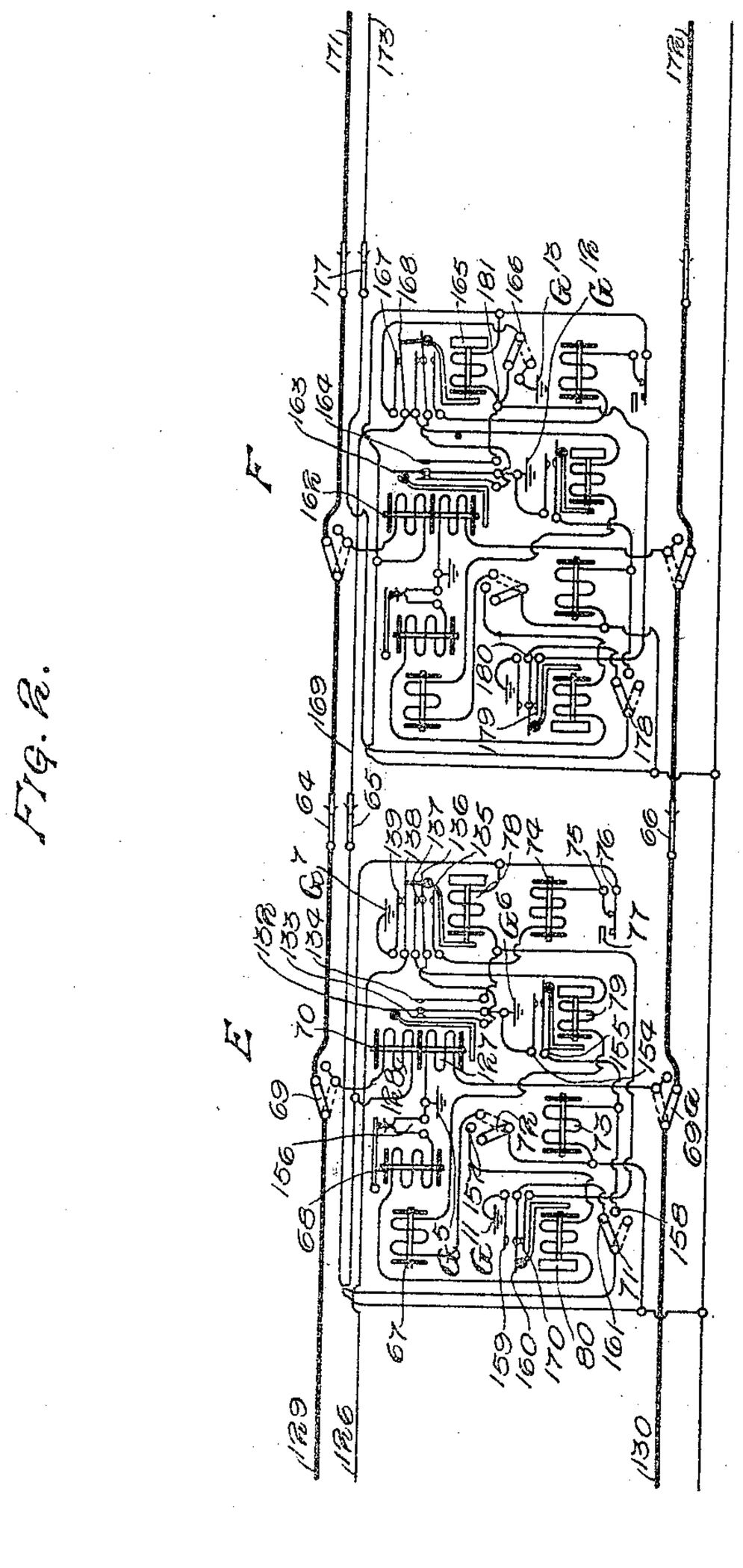

FIG. 2.

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6 SHEETS—SHEET 3.

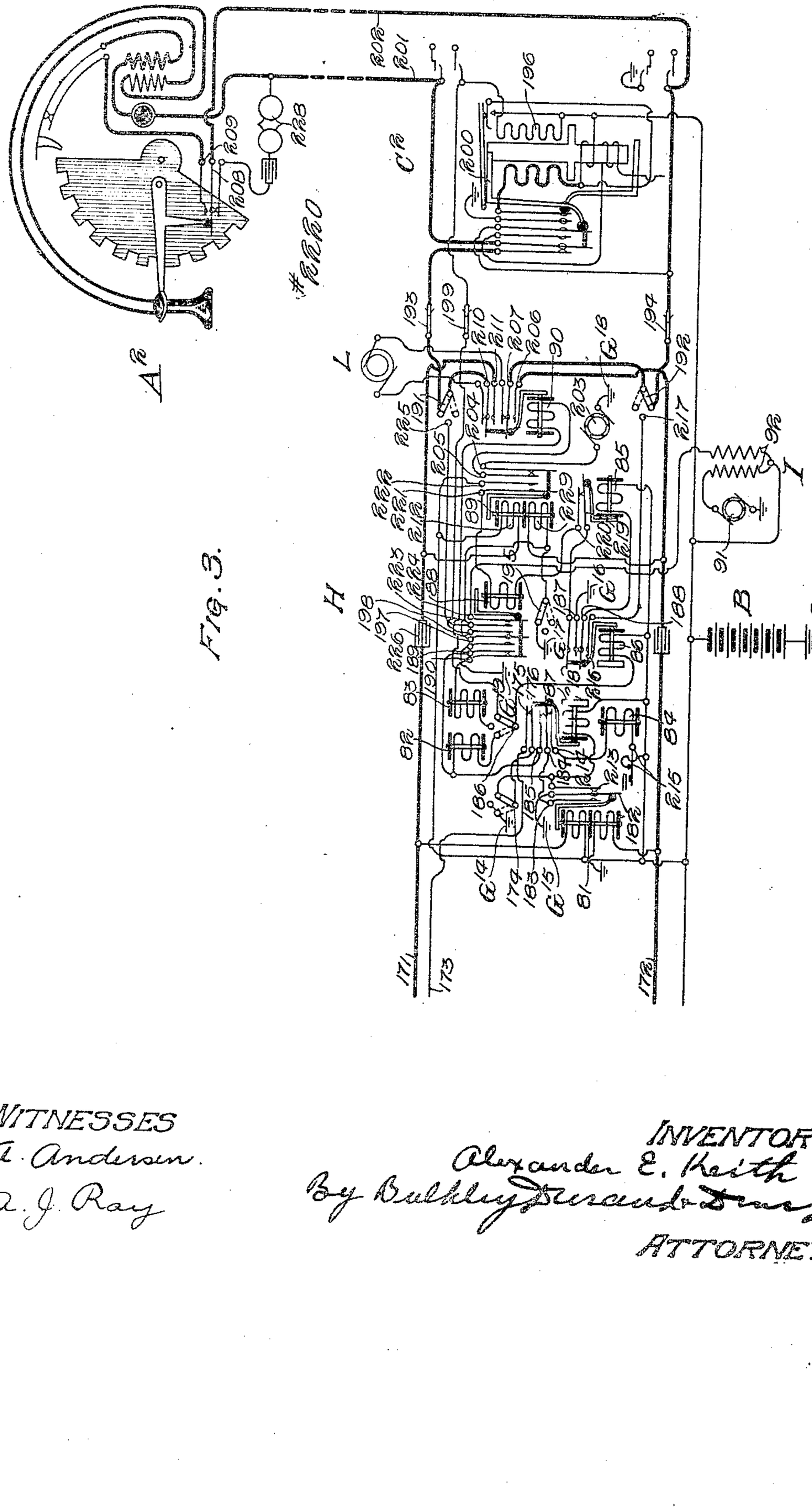

FIG. 3.

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APPLICATION FILED MAR. 1, 1910.

1,101,854.

Patented June 30, 1914.

6 SHEETS—SHEET 4.

FIG. 4.

PRIM. G.	1	2	3	4	5	6	7	8	9	10
	END GROUP TRUNKS									
1	1-1 1-1	1-2 2-1	1-3 3-1	1-4 4-1	1-5 5-1	1-6 6-1	1-7 7-1	1-8 8-1	1-9 9-1	1-10 10-1
2	2-2 1-2	2-4 2-2	2-6 3-2	2-8 4-2	2-10 5-2	2-1 6-2	2-3 7-2	2-5 8-2	2-7 9-2	2-9 10-2
3	3-3 1-3	3-6 2-3	3-9 3-3	3-1 4-3	3-4 5-3	3-7 6-3	3-10 7-3	3-2 8-3	3-5 9-3	3-8 10-3
4	4-4 1-4	4-8 2-4	4-1 3-4	4-5 4-4	4-9 5-4	4-2 6-4	4-6 7-4	4-10 8-4	4-3 9-4	4-7 10-4
5	5-5 1-5	5-10 2-5	5-4 3-5	5-9 4-5	5-3 5-5	5-8 6-5	5-2 7-5	5-7 8-5	5-1 9-5	5-6 10-5
6	6-6 1-6	6-1 2-6	6-7 3-6	6-2 4-6	6-8 5-6	6-3 6-6	6-9 7-6	6-4 8-6	6-10 9-6	6-5 10-6
7	7-7 1-7	7-3 2-7	7-10 3-7	7-6 4-7	7-2 5-7	7-9 6-7	7-5 7-7	7-1 8-7	7-8 9-7	7-4 10-7
8	8-8 1-8	8-5 2-8	8-2 3-8	8-10 4-8	8-7 5-8	8-4 6-8	8-1 7-8	8-9 8-8	8-6 9-8	8-3 10-8
9	9-9 1-9	9-7 2-9	9-5 3-9	9-3 4-9	9-1 5-9	9-10 6-9	9-8 7-9	9-6 8-9	9-4 9-9	9-2 10-9
10	10-10 1-10	10-9 2-10	10-8 3-10	10-7 4-10	10-6 5-10	10-5 6-10	10-4 7-10	10-3 8-10	10-2 9-10	10-1 10-10
11	11-1 1-11	11-2 2-11	11-3 3-11	11-4 4-11	11-5 5-11	11-6 6-11	11-7 7-11	11-8 8-11	11-9 9-11	11-10 10-11
12	12-2 1-12	12-4 2-12	12-6 3-12	12-8 4-12	12-10 5-12	12-1 6-12	12-3 7-12	12-5 8-12	12-7 9-12	12-9 10-12

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6 SHEETS—SHEET 5.

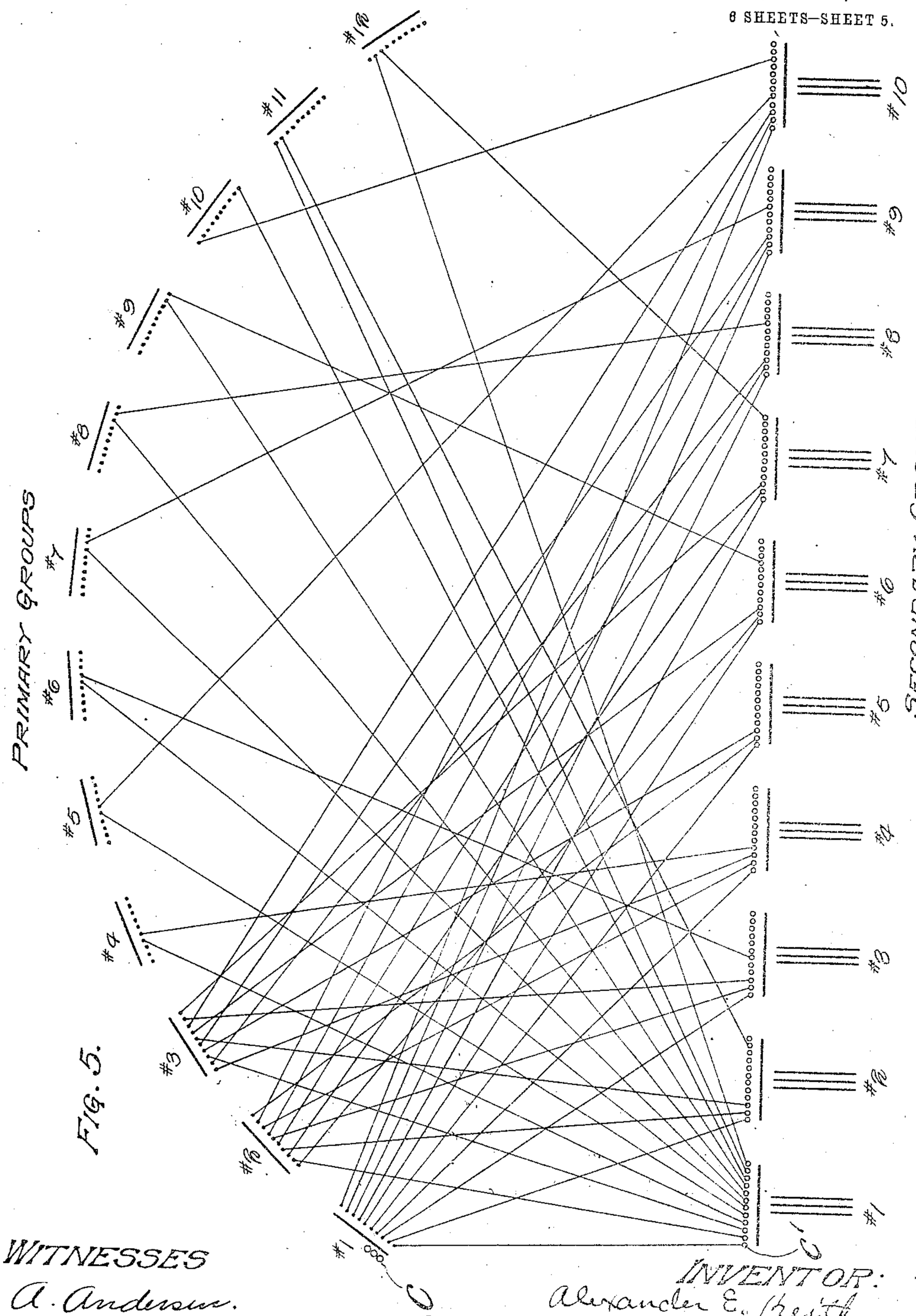

FIG. 5.

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6 SHEETS—SHEET 6.

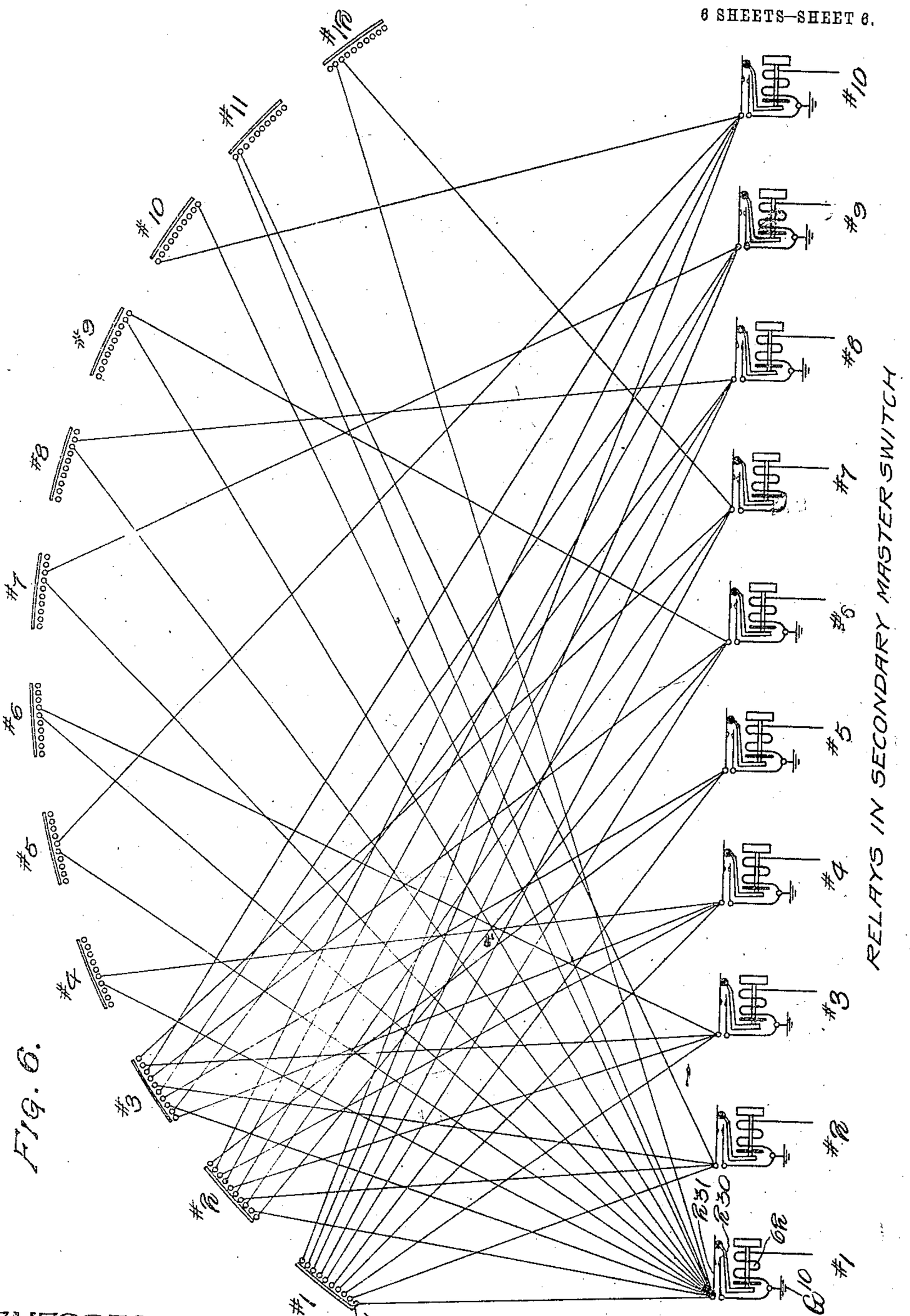

FIG. 6.

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TRUNKING SYSTEM.

1,101,854. Specification of Letters Patent. Patented June 30, 1914.

Application filed March 1, 1910. Serial No. 546,616.

To all whom it may concern:

Be it known that I, ALEXANDER E. KEITH, a citizen of the United States of America, and resident of Hinsdale, Dupage county, Illinois, have invented a certain new and useful Improvement in Automatic Trunking Systems, of which the following is a specification.

My invention relates to automatic or semi-automatic telephone exchange systems of that kind in which each subscriber's line is provided with a non-numerical trunking switch, and in which the trunks leading from these individual or line switches terminate in secondary line switches, whereby at least two non-numerical trunking operations occur before the call reaches the first selector or other switching apparatus. In a system of this kind the primary or subscribers' individual line switches are arranged in groups, and the said secondary line switches are also arranged in groups, the first comprising, say, ten groups and the second ten groups. As heretofore constructed, it was found that the secondary line switches of a group were liable to be put in use one at a time, until all trunks leading from that group were in use, before any of the calls coming through any of the groups of primary line switches would be directed to another group of secondary line switches. In other words, it was found that the calls from the different groups of subscribers would, in many cases, be taken care of by a certain group of secondary line switches, and that this group would fill up, so to speak, so that the trunks leading therefrom would all be put in use before subsequent calls would be taken care of by the other groups of secondary line switches. In this way the load was not evenly distributed between the groups of secondary line switches, as the first group was quite liable to be subjected to a heavier load than the others, and consequently the wear and tear on the apparatus was not evenly distributed between all parts thereof. It will be understood, of course, that successive calls coming from the same group of subscribers would be distributed between different groups of secondary line switches. The trouble, however, was that successive calls coming from different groups of subscribers would all be concentrated, so to speak, in a certain group of secondary line switches.

The object of my invention is, therefore, to provide a system in which primary and secondary line switches are used, and in which provision is made whereby the load or traffic is at all times evenly distributed between the different groups of secondary line switches, thus making it possible, and practically the rule, for example, for a subscriber of one group to call through and obtain connection with a secondary switch in the first group, and for a subscriber of another group to then call through and obtain connection with a secondary switch in the second group, even though the trunks leading from the first secondary group are not all busy. This means, of course, that the trunks leading from a certain group of primary line switches are distributed between the different groups of secondary line switches, and that the master switches for the different groups of primary line switches, or some of them, are so constructed and operated that each master switch is in selective relation to a different group of secondary line switches, even though the master switches, or some of them, are all in the same position. Consequently, as stated, a subscriber in the first group may call and obtain connection with a secondary line switch in one group; then a subscriber in the second group may call and automatically obtain connection with a secondary line switch in another group, even though the trunks leading from the group receiving the first call are not all busy; and subscribers successively calling from other groups are, in a similar manner, given connection with secondary line switches in as many different groups. With the old method there was much more likely to be a single preselected group of secondary switches in readiness for the groups of subscribers, and the first calling subscriber would get this group, regardless of which group of primary switches the call came from. Now, however, with my improved arrangement there is more likely to be a preselected group in readiness for each group of subscribers—that is to say, a different group of secondary switches for each group of subscribers, whereby a subscriber calling from one group will get a

preselected trunk leading to one group of secondary line switches, and the subscriber calling from another group will get another preselected trunk leading to another group of secondary line switches. Thus, the load is evenly distributed between the different groups of secondary line switches, and the liability of concentration of a number of calls in one group of such switches is reduced to a minimum.

In the accompanying drawings Figures 1, 2 and 3 taken together show the complete connections between a calling substation A (Fig. 1) and a called substation A^2 (Fig. 3) in a system embodying the principles of my invention. Fig. 4 is a table showing the distribution of the trunks between the primary and secondary line switches. Fig. 5 is a simplified diagram of the trunking between the primary and secondary switches, the trunks being distributed according to the table shown in Fig. 4. Fig. 6 shows diagrammatically the connections between the auxiliary banks of master switches of the primary line switches.

To the substation A (Fig. 1) there is allotted the individual or line switch C. This line switch C, together with a number of other similar switches, is controlled by a common mechanism D usually called a master switch. Accessible to the line switch C is a group of trunk lines leading to secondary line switches C'. Accessible to the secondary switch C' is the numerical switch E (Fig. 2), commonly called a first selector. The first selector E is one of a group of selectors common to a group of secondary switches C'. At F is shown a so-called second selector which is one of a number of selectors common and accessible to a number of first selectors E. At H (Fig. 3) is shown a connector switch by means of which connection may be completed to any one of a group of substations of which substation A^2 is a member. The substation A^2 is provided with a line switch C^2 similar to the line switch C of substation A. At I is shown a busy signaling machine, and at L a ringing current generator is shown.

The automatic substations may be of any suitable or approved type. As here shown, the substation A comprises a receiver 20, switch hook 21, impulse wheel 22, transmitter 23, induction coil 24, ringer 25, condenser 26 and impulse springs 27 and 28. The switch hook controls the substation circuits through the medium of the cam arm 29 and springs 30, 31 and 32. When the receiver is on the hook the arm 29 maintains the spring 31 in contact with the spring 32, thus bridging the ringer 25 and condenser 26 in series across the line conductors 33 and 34. When the receiver is removed the hook is forced upward by a spring (not shown), allowing the spring 31 to disengage from the spring 32 and come into engagement with the spring 30. By this action the circuit of the ringer 25 is opened and a bridge consisting of the transmitter 23, primary winding of the induction coil 24, and impulse springs 27 and 28 is closed across the line conductors 33 and 34. The impulse wheel 22 carries upon its periphery the impulse teeth 35 and is secured to a shaft 36, to which latter there is also secured a dial (not shown) provided with finger holes. When the dial is rotated forward, a certain number of teeth, corresponding to the digit called, are thereby advanced past the cam 37 upon the end of the spring 27, but with no effect upon said spring. When the dial is released it, together with the impulse wheel, is returned to normal position by a spring (not shown). As each tooth passes the cam 37 during this backward motion, the spring 27 is forced out of engagement with the spring 28 so as to open the bridge across the line.

The line switch C and master switch D are of the general type disclosed in British Patent No. 26,301 of 1906, and in the *Western Electrician* of Chicago, Illinois, of January 25, 1908. As here shown, the line switch C consists essentially of a plunger (not shown) attached to a plunger arm 38, and a magnet 39. When the plunger arm 38 is attracted by the magnet 39 the plunger is forced into a bank of springs and forces the springs 40, 42, 44 and 46 into contact with the springs 41, 43, 45 and 47, respectively. The magnet 39 is composed of four windings, a pull-in winding 48, a cut-off winding 49, a line winding 50 and an auxiliary winding 51. The magnetic circuit of the windings 48 and 49 is separate from that of the windings 50 and 51. The pull-in winding 48 is for the purpose of attracting the plunger arm 38 to force the plunger into the bank. The circuit of the winding 48 is controlled by the calling subscriber through the medium of the line winding 50 and armature 52. The winding 51 prevents the armature 52 from falling back immediately upon the deënergization of the winding 50. The cut-off winding 49 is provided for the purpose of holding the plunger arm 38 in an operated position and for operating the cut-off armature 53. If the winding 49 is energized while the armature 53 and plunger arm 38 are in an operated position, both the armature and plunger arm will be held in this position after the winding 48 is deënergized; but if the winding 49 is energized while the armature 53 and plunger arm 38 are in normal position, only the armature 53 will be operated, as the winding 49 is not as strong as the winding 48. Although only one set of springs 40, 41, 42, 43, 44, 45, 46 and 47 is shown, each line switch C is provided with a bank com-

prising a number of such sets of springs, each set forming the terminal of a trunk line leading to a secondary switch C'. Each trunk is multiplied through the corresponding bank contacts of a group of switches C. The plungers normally rest in locking engagement with a plunger shaft (not shown), and through the medium thereof are always held opposite an idle trunk terminal by the master switch D.

The master switch D comprises a motor magnet 54 which operates the ratchet wheel 55, two banks of contacts *a* and *a'* and a number of circuit-controlling relays. The master switch banks *a* and *a'* are each provided with one individual segment for each trunk to which the switch C has access and a common segment. Each bank is provided with wipers 56 and 57 for keeping some one of the individual segments in electrical connection with the common segment. By means of a suitable mechanical connection the rotary motion of the ratchet wheel 55 is transmitted to the plunger shaft to give the said shaft an oscillatory motion and thus move the idle plungers back and forth in front of the bank terminals. To the plunger shaft there is also rigidly secured a cam 58 having on its surface a number of circular openings which are engaged by the pin 59 on the armature 60. The openings in the cam 58 are so spaced that the pin 59 can engage an opening only when the plungers that are in engagement with the plunger shaft are directly opposite the terminals of a trunk. The secondary switch C' is similar to the switch C except that its operating magnet has only one winding 61, which corresponds to the pull-in winding 48 of the switch C.

The master switch D' is similar to the master switch D but has only one bank of contacts. The relays 62 and 63 which are associated with the master switch D' are slow-acting relays—that is, relays which are slow to deënergize after their circuits have been broken.

The selector switch E is of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, but, as here shown, is adapted to operate in conjunction with a two-wire system, *i. e.*, a system in which there is no operating ground at the substation for controlling the automatic switches. Among other details the selector comprises a set of wipers 64, 65 and 66 carried upon a shaft (not shown) which has a vertical motion controlled by the vertical magnet 67, and a rotary motion controlled by the rotary magnet 68. The usual side switch, comprising the wipers 69, 69ª, 71 and 72, is controlled by the private magnet 73. The operation of the switch is controlled by the calling subscriber through the medium of the double-wound line relay 70. The release magnet 74 is normally disconnected from the battery by the separation of the springs 75 and 76, which springs are held out of engagement by the arm 77 as long as the switch shaft is in its lowest position. The relays 78, 79 and 80 deënergize slowly after their energizing circuits have been broken. The selector is provided with the so-called connector release, *i. e.*, the mechanism is restored immediately upon the energization of the release magnet, rather than by its deënergization, as shown in the said selector patent. The second selector F is similar to the first selector E.

The connector H is of the type disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but, like the selectors E and F, is adapted to operate in a two-wire system. Like the selectors the connector has a double-wound line relay 81, vertical magnet 82, rotary magnet 83, release magnet 84, private magnet 85 and a side switch. In addition, the connector is provided with a busy locking relay 88, back-bridge relay 89 through which the called substation is provided with talking current, and a ringer relay 90 by means of which the generator L may be connected with the called line. The busy signaling machine I consists of an interrupter 91 and an induction coil 92. The interrupted current through the interrupter and primary winding of the induction coil induces an alternating current in the secondary winding.

Having given a general description of the apparatus, I will now describe its mode of operation when the subscriber at substation A calls the substation A^2, the number of which latter will be assumed to be 2220. In order to call #2220 the subscriber at substation A first removes the receiver from the hook, then operates the dial once for each of the four digits. When the primary circuit of the substation is bridged across the line conductors by the removal of the receiver from the hook, it closes a circuit through the line winding 50 of the line switch C. This circuit extends from ground G' through the springs 93 and 94, line conductor 34, substation springs 31 and 30, impulse springs 28 and 27, primary winding of induction coil 24, transmitter 23, line 33 and springs 95 and 96, through the winding 50 and springs 97 and 98 to the battery lead 100, thence through battery B to ground G. The winding 50, upon energizing, attracts its armature 52, which forces the spring 101 into engagement with the spring 93. The engagement of springs 101 and 93 closes an energizing circuit through the pull-in winding 48. This circuit extends from ground G' through springs 93 and 101, windings 48 and 51 to battery lead 100, thence through the battery B to ground G.

The winding 48, upon energizing, attracts the plunger arm 38 and the cut-off armature 53. The armature 53, upon being attracted, forces springs 94 and 95 out of engagement with springs 93 and 96, respectively, thus opening the circuit of the winding 50. The armature 52 does not fall back immediately upon the deënergization of winding 50, but remains held up by the current flowing through the winding 51. When the plunger arm 38 is attracted it forces the plunger into the bank to press springs 40, 42, 44 and 46 into contact with the springs 41, 43, 45 and 47, respectively. The plunger arm 39, in its operated position, also forces spring 103 into engagement with spring 104, thereby short-circuiting the winding 51, which causes the armature 52 to fall back slowly to open the circuit of the pull-in winding 48. Before the armature 52 has time to fall back, however, the cut-off winding 49 is energized in the following manner: When the bank springs 44 and 45 are pressed into contact they close a circuit extending from ground G^2 through said springs, over trunk conductor 105, and through magnet 61 and springs 106 and 107 of the secondary switch C′ and through relay 108, contact point 109 and armature 110 to battery lead 100. The magnet 61, upon energizing, attracts the plunger arm 113 and armature 114. The plunger arm 113 operates to force the plunger into the bank to press the springs 115, 117, 119 and 121 into contact with the springs 116, 118, 120 and 122, respectively. The armature 114 operates to open the circuit of the relay 108 and close a locking circuit for the magnet 61 through the springs 106 and 107^a and resistance 123 to the battery lead 100. The relay 108, which is energized for an instant when the circuit is first closed through the magnet 61, closes a circuit extending from ground G^3 through the springs 111 and 112 and relay 63 to the battery lead 100. The relay 63, upon energizing, closes a circuit extending from ground G^4 through the armature 124, contact point 125 (there being one such contact point for each trunk to which the switch C′ has access), to the conductor 126, thence through the bank springs 120 and 119, conductor 126^a, bank springs 47 and 46 and winding 49 to the battery lead 100. This circuit through the winding 49 is closed before the winding 48 is deënergized, as before stated, and serves to hold the plunger arm 38 and armature 53 in an operated position. The relay 63 is slow to deënergize after its circuit is broken, and consequently maintains this circuit through the winding 49 until the selector E has time to close another circuit as follows: As soon as the bank springs 115 and 117 are forced into contact with the springs 116 and 118 by the plunger of the secondary switch C′ an energizing circuit is closed through the line relay 70 of the selector E. This circuit extends from ground G^5 through the winding 127 of the relay 70, side switch wiper 69^a, trunk conductor 130, bank springs 118, 117, 43 and 42, thence over the line conductor 34 to and through substation A and back over line conductor 33, bank springs 40, 41, 115 and 116, trunk conductor 129, side switch wiper 69 and winding 128 of relay 70 to battery lead 100. The relay 70, upon energizing, shifts spring 132 out of engagement with spring 133 and into contact with spring 134. The engagement of springs 132 and 134 closes an energizing circuit through the release relay 78. This circuit extends from ground G^6 through springs 132 and 134 and relay 78 to battery lead 100. The relay 78, upon energizing, shifts spring 136 out of engagement with spring 135 and into contact with spring 137, and presses spring 138 into engagement with spring 139. The engagement of springs 138 and 139 connects the ground G^7 with the conductor 126 before the relay 63 has time to disconnect the ground G^4. When the conductor 126^a is grounded by the operation of the secondary switch C′ a guarding potential is extended over the private normal conductor 140 to the connector bank contacts of the calling line, and a circuit is closed through the master switch relay 141. This circuit extends from the conductor 126^a, which is grounded, as previously described, through master switch bank contact 142, wiper 57, common segment 143, and relay 141 to battery lead 100. The relay 141, upon energizing, closes a circuit through the relay 144. The relay 144, upon attracting its armature 60, withdraws the pin 59 from the cam 58 and closes a circuit through the relay 146 and motor magnet 54. The circuit through the magnet 54 extends from ground G^8 through magnet 54, interrupter springs 147, contact point 148 and armature 60 to battery lead 100. Upon the closure of this circuit the motor magnet begins to operate in a manner similar to that of a buzzer to give the ratchet wheel 55 a step by step rotary motion. The motion of the wheel 55 is transmitted to the plunger shaft, which operates to move the idle plungers from their positions in front of the trunk seized by the line switch C. After the plungers have been moved a short distance the wipers 56 and 57, which are also attached to the plunger shaft, move off the bank contacts corresponding to the trunk occupied by the switch C. When the wiper 57 leaves contact 142 the relays 141 and 144 are deënergized, but the armature 60 cannot fall back because the opening in the cam 58, which was formerly engaged with pin 59, has passed out of register therewith. Thus, the master switch will continue to operate

until the next opening in the cam passes under the pin 60, when the said pin drops into this opening, locking the shaft against further rotation, and the armature 60 disengages from the contact point 148, thus opening the circuit of the magnet 54 and relay 146. If the next trunk after the one seized by the line switch C has been busy the wiper 57 would have found the corresponding contact guarded, and would have maintained the circuit of the relays 141 and 144 while the next opening in the cam was passing under pin 59. Thus, the master switch would have continued to advance the plungers past the busy trunk. The relay 146, the circuit of which is closed during the time the master switch is rotating, operates to disconnect the battery from the line winding 50 of all switches that are controlled by the master switch D, and to connect the busy signaling machine I' with all idle lines through their line windings 50 and springs 96 and 95. When the bank springs 121 and 122 are pressed into engagement by the plunger of the secondary switch C' a circuit is closed extending from ground G^9 through the said springs, master switch bank contact 227, wiper 149, segment 150 and relay 151 to battery. The relay 151, upon energizing, closes a circuit through relay 152, which in turn unlocks the plunger shaft and causes the master switch D' to advance the idle plungers to an idle trunk in the same way in which the relay 144 caused the operation of the master switch D. While the master switch D' is operating, the armature 110 is separated from the contact 109, thus disconnecting the battery from the idle secondary switches to prevent their operation while their plungers are in motion. In its operated position, the armature 110 also opens the circuit of relay 62. The relay 62 is a slow-acting relay and does not have time to deënergize if the master switch D' does not have to pass over busy trunks. If, however, a number of busy trunks are to be passed over, the relay 62 deënergizes and connects the ground G^{10} with the contact 153 of the auxiliary bank of the master switch D. This ground on the contact 153 prevents the master switch D from stopping, with the plungers in position to engage this trunk, while the master switch D' is rotating.

The foregoing operations take place immediately upon the removal of the receiver at the calling substation and before the impulses are sent in for the first digit of the desired number. When the calling device is operated for the first digit (2) the impulse springs 27 and 28 are separated twice momentarily. The separation of springs 27 and 28 breaks the energizing circuit of the line relay 70 of the first selector E. The relay 70, upon deënergizing, permits spring 132 to disengage spring 134 and to engage spring 133. The relay 78 is slow-acting and does not have time to deënergize during the momentary separation of springs 132 and 134. The engagement of springs 132 and 133 closes a circuit through the private magnet relay 79 and vertical magnet 67. This circuit extends from ground G^6 through springs 132 and 133, 136 and 137, relay 79, vertical magnet 67, and side switch wiper 72 to battery lead 100. Since the digit called is 2, the vertical magnet receives two impulses over the circuit just traced, and operates to raise the shaft two steps, to carry the wipers to a position opposite the second row or level of bank contacts. As soon as the shaft leaves its lowest position the arm 77 permits springs 75 and 76 to come into engagement to provide the release magnet 74 with a battery connection. The relay 79, which is included in the energizing circuit of the vertical magnet 67, is energized by the first impulse, but being a slow-acting relay does not have time to deënergize between impulses. The relay 79, upon energizing, closes a circuit extending from ground G^6 through springs 154 and 155 and private magnet 73 to battery lead 100. After the last impulse is delivered to the vertical magnet the relay 79 deënergizes and opens the circuit of the private magnet 73, which in turn deënergizes and permits the side switch to pass into second position. When the side switch wiper 72 passes from first to second position it disconnects the battery from the vertical magnet 67 and closes a circuit through the rotary magnet 68. This circuit extends from ground G^5 through interrupter springs 156, rotary magnet 68, relay 80, contact point 157 and side switch wiper 72 to battery lead 100. The rotary magnet, upon energizing, operates to rotate the wipers one step to press down the private magnet armature and to open its own circuit at the interrupter springs 156. When the rotary magnet circuit is thus opened the rotary armature falls back. If the first trunk, upon the contacts of which the wipers have just been rotated, is not busy the private armature follows the rotary armature and permits the side switch to pass to third position. If the first trunk is already busy, however, the private wiper 65 finds the first bank contact grounded, and thus closes a circuit extending through the side switch wiper 71, contact point 158 and private magnet 73 to battery lead 100. The private magnet thereupon energizes and locks the side switch in second position. When the rotary armature permits the interrupter springs to again engage, the rotary magnet energizes a second time to advance the wipers a second step. The wipers will thus be advanced step-by-step until the private wiper 65 engages a non-grounded contact of an idle

trunk, whereupon the private magnet de-energizes and allows the side switch to pass to third position. When the side switch leaves second position the wiper 72 breaks the operating circuit of the rotary magnet. The relay 80 is energized in series with the rotary magnet 68 and, being a slow-acting relay, remains energized for a short time after the rotary magnet is energized for the last time. Thus, at the instant the side switch passes to third position, the seized trunk is provided with a guarding potential extending from ground G^{11} through springs 159 and 160 of relay 80, contact point 161, side switch wiper 71 and shaft wiper 65 to the selector private bank contacts. When the side switch wipers 69 and 70 pass from second to third position the relay 70 is disconnected from the line and the line connection is extended through the shaft wipers 64 and 66 to the selector F, energizing the relay 162 in the same manner that the relay 70 of the selector E was energized. The relay 162, upon energizing, closes a circuit from ground G^{12} through springs 163 and 164 and relay 165 to battery lead 100. The relay 165 thereupon energizes and supplies a new guarding ground to the private bank contacts of the first selectors. Also, as soon as the relay 80 of the selector E falls back a new circuit is closed through the release relay 78. This circuit extends from ground G^{13} through side switch wiper 166 of the second selector F, springs 167 and 168 of relay 165, conductor 169, private wiper 65, side switch wiper 71, contact point 161, springs 160 and 170 of relay 80 and through relay 78 to battery lead 100. This circuit is closed before the relay 78 has time to de-energize after its former circuit is opened by the deënergization of the relay 70. It is thus evident that the relay 78 must be slower than the relay 80, the function of which is to provide a guarding potential for the seized trunk between the time that the side switch of the selector E passes to third position and the time that the relay 165 of the selector F energizes. The second selector F is now in position to receive impulses for the second digit, and operates in response to these digits to extend the connection to the connector H over the conductors 171 and 172, in the same manner as the selector E. When the connection is extended to the connector the line relay 81 is energized in the same manner that the relays 162 and 70 of the switches F and E were energized when the connection was extended to their respective switches. The relay 81, upon energizing, closes a circuit through the release relay 87, which operates to close a new circuit through the relays 165 and 78 of the selector switches. This circuit extends from ground G^{14} through side switch wiper 174, springs 176 and 175, conductor 173, shaft wiper 177, side switch wiper 178 and springs 180 and 179 to point 181. From point 181 one branch of this circuit passes through the relay 165 to battery, and another branch passes through side switch wiper 166 and thence through the relay 78 of the selector E over a circuit already traced. The connector H now responds to the impulses for the last two digits to extend the connection to the substation A^2. When the substation calling device is operated for the third digit (2) the line relay 81 of the connector is deënergized twice momentarily. Each time the relay 81 deënergizes a circuit is closed extending from ground G^{15} through springs 182 and 183, 184 and 185, vertical magnet 82, side switch wiper 186 and private magnet relay 86 to battery lead 100. The vertical magnet receives two impulses over this circuit and operates to raise the shaft and wipers two steps. The private magnet relay 86 is energized by the first impulse to the vertical magnet, and remains in its operated position until after the last impulse is delivered. In its energized position the relay 86 closes a circuit extending from ground G^{16} through springs 187 and 188 and private magnet 85 to the battery lead 100. When the private magnet relay 86 deënergizes after the last impulse is delivered to the vertical magnet it breaks the circuit of the private magnet 85, which latter in turn deënergizes and allows the side switch to pass to second position. When the side switch wiper 186 reaches second position it connects the rotary magnet 83 with the battery lead 100 through the private magnet relay 86. When the calling device is operated for the last diget (O) the relay 81 deënergizes ten times, each time closing a circuit through the rotary magnet 83. This circuit extends from ground G^{15} through springs 182 and 183, 184 and 185, 189 and 190, rotary magnet 83, side switch wiper 186 and relay 86 to battery lead 100. Since the digit called is O, the rotary magnet receives ten impulses of this circuit and operates to rotate the wipers ten steps onto the terminals of the line #2220. The private magnet relay 86 is energized by the first one of this series of impulses and again closes the circuit of the private magnet 85. The relay 86 deënergizes after the last impulse is delivered to the rotary magnet, and opens the circuit of the private magnet 85, which thereupon allows its armature to fall back and trip the side switch from second to third position. The movement of the side switch wipers 191 and 192 to third position extends the connection through the wipers 193 and 194 to the line of the called substation. When the side switch wiper 195 engages its third-position contact point it establishes a guarding potential at the connector private bank contacts of the called line, and closes a circuit

through the cut-off winding 196 of the line switch C^2. This circuit extends from ground G^{17} through side switch wiper 195, springs 197 and 198, private wiper 199 and bank contact with which it is in contact, and winding 196 to the battery lead 100. The winding 196 upon energizing, attracts the armature 200, which operates to disconnect the switch C^2 from the called line and to connect the line conductor 201 with the connector bank contact which is engaged by wiper 193. When the side switch wiper 186 engages its third-position contact point a circuit is closed extending from ground G^{18} through interrupter 203, springs 204 and 205, ringer relay 90, side switch wiper 186 and relay 86 to battery lead 100. The relay 90, upon energizing, disconnects the calling and called lines and connects the ringer generator L with the called line to ring the bells 228. Since the circuit of the ringer relay includes the interrupter 203, the said relay is energized only intermittently so as not to ring the called subscriber continuously. When the called subscriber removes his receiver, or as soon thereafter as the ringer relay deenergizes, if it is energized at the time, the called substation is provided with talking current over a circuit extending from ground G^{17} through side switch wiper 195, winding 229 of the relay 89, ringer relay springs 206 and 207, side switch wiper 192, shaft wiper 194, line 202, hook switch springs 208 and 209, impulse springs, transmitter and primary winding of the substation A^2, line 201, shaft wiper 193, side switch wiper 191, ringer relay springs 210 and 211 and winding 212 of the relay 89 to battery lead 100. The relay 89 thereupon energizes and separates the springs 204 and 205, thereby opening the circuit of the relay 90 to prevent its further energization after the called subscriber has answered.

After the conversation is completed the release of the central office switching apparatus is initiated by the restoration of the receiver at the calling substation. When the springs 30 and 31 are separated by the replacing of the receiver on the hook at the calling substation they break the energizing circuit of the line relay 81 of the connector H. The relay 81, upon deënergizing, permits the spring 182 to disengage the spring 213, thus breaking the circuit of the release relays 87, 165 and 78 of the switches H, F and E, respectively. It is evident that after the side switch wiper 174 passes to third position the holding ground of the selector release relays 165 and 78 is shifted from ground G^{14} to ground G^{15} through the springs 213 and 182, so that the deënergization of the relay 81 opens the circuit of the selector release relays, as well as that of the connector. The release relays, upon deënergizing, close the circuits of the release magnets of their respective switches. The circuit of the release magnet 84 of the connector H extends from ground G^{15} through the springs 182 and 183, 184 and 214, magnet 84 and off normal springs 215 to battery. The release circuit of the first selector E extends from ground G^6 through springs 132 and 133, 136 and 135, magnet 74 and off normal springs 75 and 76 to battery lead 100. The release circuit of the selector F is similar to that of the selector E. The various release magnets, upon energizing, cause the mechanisms of their respective switches to be restored to normal position. When the shaft of each switch reaches its lowest position it opens the circuit of its release magnet by operating the off normal springs. When the release relay 75 of the selector E deënergizes, besides closing the circuit of the release magnet 74 it opens the circuit of the winding 49 of the line switch C by allowing the springs 138 and 139 to disengage. The deënergization of the winding 49 allows the plunger of the line switch C to restore to normal position, thereby disconnecting the calling line from the secondary switch C′ and breaking the circuit of the magnet 61. The magnet 61, upon deënergizing, allows the secondary switch to be restored, and all the apparatus used in the connection is ready for another call.

Returning now to that stage of the operation when the connector wipers have been advanced to the contacts of the desired line, and before the private magnet relay has had time to deënergize, it will be explained how the calling subscriber is given the busy signal in case the called line is already in use.

From the foregoing description it is evident that whenever a line is in use there is a ground potential upon its contacts in the private bank of the connectors which have access to it. When the private magnet relay deënergizes and allows spring 188 to engage spring 216 with the private wiper 199 resting on the grounded contact of a busy line, a circuit is closed extending from said grounded contact through wiper 199, springs 198 and 197, winding 229 of relay 89, ringer relay springs 206 and 207, side switch wiper 192, contact point 217, springs 216 and 188 and private magnet 85 to battery lead 100. The spring 188 engages the spring 216 before breaking contact with the spring 187. The private magnet thus remains energized, locking the side switch in second position, and at the same time the relay 89 is energized by the current in the coil 229. The relay 89, upon energizing, closes a circuit through the locking relay 88. This circuit extends from ground G^{16} through springs 187 and 218 of relay 86, springs 219 and 220, relay 88 and springs 221 and 222 to battery lead 100. The relay 88, upon energizing, disconnects the rotary magnet 83 from the

impulse spring 183, shifts the holding circuit of the private magnet 85 and relay 89 from the private bank contact to ground G^{19} and connects the busy signaling machine I with the calling line. The spring 197 makes contact with the spring connected to ground G^{19} before breaking contact with the spring 198. The circuit over which the busy signal flows extends from the battery lead 100 through the secondary winding of induction coil 92, springs 224 and 223, contact point 225, side switch wiper 191, relay springs 210 and 211, condenser 226 and thence over the heavy conductors shown in Figs. 2 and 1 to and through substation A and back over the other side of the line, through one winding of the relay 81 to ground, and thence through the battery B to the starting point. The calling substation will continue to receive the busy signal until the receiver is restored to the switch hook, when the release of the switches will take place in the same manner as when a complete connection is established.

Having given a description of the operation of the system I will now explain the distribution of the trunks between the primary and secondary switches.

Each group of primary switches is usually provided with ten trunks and the secondary switches are divided into ten groups. Each of the ten trunks leading from a primary group leads to a switch in a different secondary group. In Fig. 5 are shown diagrammatically the trunk terminals of twelve groups of primary switches C, and ten secondary groups each consisting of twelve secondary switches C'. The connections of all ten trunks of the first three primary groups are shown, while only two trunks in each of the other groups are represented. As herein represented, the first trunk from the first primary group leads to the first switch of secondary group #1, the second trunk leads to the first switch of secondary group #2, etc. The first trunk of the primary group #2 leads to the second switch of secondary group #6, the second trunk leads to the second switch in the first secondary group, etc. By means of the table shown in Fig. 4, the connection of any trunk may be determined. The number above each vertical row of squares indicates the number of a secondary group, and the number at the left of each horizontal row indicates the number of a primary group. In each small square the upper left hand figure represents the number of a primary group, the upper right hand figure represents a trunk in that group, the lower left hand figure represents the secondary group, and the lower right hand figure the switch in that group to which the trunk is connected. To give an example of the use of the table, the first square in the first row would be read as follows: From the first primary group the first trunk leads to the first switch of the first secondary group. The second square signifies that the second trunk from the first primary group leads to the first switch in the second secondary group. From an inspection of the table it is evident that the upper left hand figure and the lower right hand figure in each small square is the same as the figure at the left of the horizontal row in which the square is situated. The lower left hand figure in the square is the same as the number at the top of the vertical row. The numbers in the upper right hand corners of the squares are arranged so that no number appears twice in this position in the first ten squares of each vertical row, and these numbers are arranged in a different order in each row. With the trunks distributed according to this table, if the plungers of all of the first ten primary groups are placed in front of the trunk leading to the same secondary group, and then each primary master switch is rotated one step, the plungers of no two primary groups will then be in position to engage trunks leading to the same secondary group. As shown, the table applies to only twelve primary groups, but may be easily extended to apply to any number. To extend the table all that is necessary is to add one horizontal row of ten squares for each primary group and number the rows consecutively, placing the number outside at the left of the row. The number at the left of the row is then placed in the lower right and upper left hand corners of each square. The number which appears above the vertical row in which each square lies is placed in the lower left hand corner. The numbers in the upper right hand corners of the squares in row No. 13 should be the same as those in row No. 3; the upper right hand numbers in row No. 14 are the same as the corresponding numbers in row No. 4, etc. In other words, the upper right hand numbers in the corresponding squares of every tenth horizontal row are the same. With the table as here shown, the number of the individual secondary switch to which a primary trunk is connected is the same as the number of the primary group from which the trunk leads. It is not essential to the principles of my invention, however, that the trunk lead to this particular switch, as the same result will be obtained if the trunk leads to any switch in the group designated by the lower left hand figure in the square. The object in connecting the trunk to a particular switch in the secondary group is that a more systematic arrangement is thereby obtained than heretofore.

The contacts of the auxiliary bank a' of the primary master switch are distributed in the same manner as the trunk lines. Each

bank contact of the bank a' is connected to the contact of the relay 62 belonging to the secondary group to which the trunk corresponding to the bank contact is connected. The table shown in Fig. 4 may be used in determining the connection of the master switch bank contacts. Since there is only one relay 62 for each secondary group, the lower right hand figure in each square is not used for determining the connection of the master switch bank contacts. As an example of the use of the table in connection with the master switch bank, the figure "3" in the upper right hand corner of the third square in the top row signifies that the third contact in the bank a' of the first primary group, designated by the upper left hand figure, is connected to the contact of the relay 62 of the third secondary group, designated by the lower left hand figure 3. Fig. 6 shows diagrammatically the connection of a part of the master switch bank contacts.

From the foregoing it will be seen that I distribute the calls evenly, or more nearly so than heretofore, between the different groups of secondary non-numerical trunking switches. Furthermore, I provide a greater number of switches in each secondary group than there are trunks in each primary group. In this way the primary groups are greater in number than the secondary groups, the number of trunks leading to each secondary group being the same in number as the total number of primary groups. Thus the first selectors are all common to all the subscribers, any subscriber in the exchange having access to any particular first selector; and with my improved arrangement of the trunks between the primary and secondary switches, successive calls from as many different groups of subscribers are not concentrated in one and the same group of first selectors, but to the contrary are distributed in different groups of first selectors, thus equalizing the load and preventing excessive use of any particular switch or switches of the exchange. With my improved arrangement there are as many preselected trunk lines ready and waiting at all times as there are groups of subscribers—that is to say, as there are groups of primary switches—and each of these trunk lines, or some of them, leads to a different group of secondary switches, even though the master switches are all in the same position. With the old arrangement the condition of the trunks between the primary and secondary switches was such that a call from one group of primary switches would be directed to a certain group of secondary switches, and succeeding calls from other groups of subscribers would, if all the master switches were in the same position, all be directed to the same group of secondary switches, until this particular group of secondary switches was rendered entirely busy, or filled up, so to speak, thus concentrating the calls in one group of secondary switches. With my improved arrangement, and assuming that no subscribers have called, a subscriber calling from the first group (#1, Fig. 5) will get the first trunk leading to the first group of secondary switches; then a subscriber calling from group #2 will get the first trunk of that group, which trunk leads to group #6 of secondary switches; then a subscriber calling from group #3 of the primary switches will get the first trunk line leading from that group, which trunk line, however, leads to group #4 of the secondary switches. In this way, and even when the master switches of the different primary switches are all in the same position, successive calls are then distributed to different groups of secondary switches. Obviously, therefore, successive calls from the different groups of primary switches could only be concentrated in a certain group of secondary switches by reason of the simultaneous arrival of the different master switches of the primary groups at the terminals of the different trunks leading to the particular group of secondary switches, and this, of course, is not liable to occur. With my improved arrangement, and even assuming that the master switches of the primary groups are all in first position, successive calls from the different primary groups will be distributed to the different groups of secondary switches, so that no secondary group will receive more than one of said calls. In this way the traffic is evenly distributed and an overload on any particular group of first selectors is not likely to occur. Thus when a subscriber of one group calls, the master switch of that group is operated to pick out or preselect another trunk for the next calling subscriber in the same group, but the master switches for the other groups are not disturbed.

Referring to Fig. 5 it will be seen that the arrangement here shown constitutes what may be called a traffic distributer. The arrangement is such that the calls are automatically distributed in different secondary groups. There are as many trunks terminating in each secondary group as there are primary groups, and there are as many trunks leading from each primary group as there are secondary groups. The trunks of any secondary group, or at least some of them, are given unlike or dissimilar positions in as many different primary groups. For example, the first trunk of secondary group #1 leads to primary group #1 and to the first contact or position thereof. The second trunk, however, of the secondary group #1 leads to the second contact or position in the primary group #2, and the other trunks of this secondary group are

given various and different positions in the remaining primary groups. In this way the trunks which occupy like or similar positions in the different primary groups are arranged to terminate at as many different secondary groups. Thus, as stated, the arrangement tends to equalize the load and distribute the traffic more evenly between the different secondary groups.

What I claim as my invention is:—

1. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks extending from the primary groups to the secondary groups, the number of primary groups being greater than the number of secondary groups, and the number of trunks leading to each secondary group being the same as the number of primary groups, and means for controlling said primary non-numerical switches over two sides of a subscriber's line in series.

2. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks leading from the primary groups to the secondary groups, the number of trunks leading from each primary group being the same as the number of secondary groups, the number of trunks leading to each secondary group being the same as the number of primary groups, and the number of primary groups being greater than the number of secondary groups, and means for controlling said primary non-numerical switches over two sides of a subscriber's line in series.

3. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being different from the number of secondary groups, the number of trunks leading from each primary group being the same as the total number of secondary groups, and the number of trunks leading to each secondary group being the same as the total number of primary groups, and means for controlling said primary non-numerical switches over two sides of a subscriber's line in series.

4. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, and trunks connecting the primary groups with the secondary groups, the trunks terminating in any particular secondary group being given dissimilar positions in the different primary groups.

5. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, and trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, and the trunks which have similar positions in the primary groups, or some of them, being arranged to terminate at their other ends in different secondary groups.

6. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, and trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, the trunks terminating in any secondary group being the same in number as the total number of primary groups, a number of trunks in each secondary group equal to the total number of secondary groups being given dissimilar positions in as many different primary groups, and the remaining trunks of each secondary group being given positions in the remaining primary groups similar to the positions that certain other trunks of the same secondary group are given in other primary groups.

7. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks extending from the primary groups to the secondary groups, the number of primary groups being greater than the number of secondary groups, and the number of trunks leading to each secondary group being the same as the number of primary groups, means for controlling said primary non-numerical switches over two sides of a subscriber's line in series, and a master switch for each primary group, each master switch, when all are in the same position, being in selective relation to a secondary group different from those of other master switches.

8. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks leading from the primary groups to the secondary groups, the number of trunks leading from each primary group being the same as the number of secondary groups, the number of trunks leading to each secondary group being the same as the number of primary groups, and the number of primary groups being greater than the number of secondary groups, means for controlling said primary non-numerical switches over two sides of a

subscriber's line in series, and a master switch for each primary group, each master switch, when all are in the same position, being in selective relation to a secondary group different from those of other master switches.

9. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being different from the number of secondary groups, the number of trunks leading from each primary group being the same as the total number of secondary groups, and the number of trunks leading to each secondary group being the same as the total number of primary groups, means for controlling said primary non-numerical switches over two sides of a subscriber's line in series, and a master switch for each primary group, each master switch, when all are in the same position, being in selective relation to a secondary group different from those of other master switches.

10. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the trunks terminating in any particular secondary group being given dissimilar positions in the different primary groups, and a master switch for each primary group, each master switch, when all are in the same position, being normally in selective relation to a secondary group different from those of other master switches.

11. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, and the trunks which have similar positions in the primary groups, or some of them, being arranged to terminate at their other ends in different secondary groups, and a master switch for each primary group, each master switch, when all are in the same position, being in selective relation to a secondary group different from those of other master switches.

12. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, the trunks terminating in any secondary group being the same in number as the total number of primary groups, a number of trunks in each secondary group equal to the total number of secondary groups being given dissimilar positions in as many different primary groups, and the remaining trunks of each secondary group being given positions in the remaining primary groups similar to the positions that certain other trunks of the same secondary group are given in other primary groups, and a master switch for each primary group, each master switch, when all are in the same position, being in selective relation to a secondary group different from those of other master switches.

13. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks extending from the primary groups to the secondary groups, the number of primary groups being greater than the number of secondary groups, and the number of trunks leading to each secondary group being the same as the number of primary groups, means for controlling said primary non-numerical switches over two sides of a subscriber's line in series, trunk lines leading from said secondary groups, and a first selector for each trunk line, whereby each first selector is common to all of the primary groups.

14. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks leading from the primary groups to the secondary groups, the number of trunks leading from each primary group being the same as the number of secondary groups, the number of trunks leading to each secondary group being the same as the number of primary groups, and the number of primary groups being greater than the number of secondary groups, means for controlling said primary non-numerical switches over two sides of a subscriber's line in series, trunk lines leading from said secondary groups, and a first selector for each trunk line, whereby each first selector is common to all of the primary groups.

15. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being different from the number of secondary groups, the number of trunks leading from each primary group being the same as the total number of secondary groups, and the number of trunks leading to each secondary group being the same as the total number of primary groups, means for controlling said

primary non-numerical switches over two sides of a subscriber's line in series, trunk lines leading from said secondary groups, and a first selector for each trunk line, whereby each first selector is common to all of the primary groups.

16. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the trunks terminating at any particular secondary group being given dissimilar positions in the different primary groups, trunk lines leading from said secondary groups, and a first selector for each trunk line, whereby each first selector is common to all of the primary groups.

17. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, and the trunks which have similar positions in the primary groups, or some of them, being arranged to terminate at their other ends in different secondary groups, trunk lines leading from said secondary groups, and a first selector for each trunk line, whereby each first selector is common to all of the primary groups.

18. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, the trunks terminating in any secondary group being the same in number as the total number of primary groups, a number of trunks in each secondary group equal to the total number of secondary groups being given dissimilar positions in as many different primary groups, and the remaining trunks of each secondary group being given positions in the remaining primary groups similar to the positions that certain other trunks of the same secondary group are given in other primary groups, trunk lines leading from said secondary groups, and a first selector for each trunk line, whereby each first selector is common to all of the primary groups.

19. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks extending from the primary groups to the secondary groups, the number of primary groups being greater than the number of secondary groups, and the number of trunks leading to each secondary group being the same as the number of primary groups, means including selectors and connectors for extending connection from the secondary groups in the direction of the called subscribers, and means for controlling said selectors and connectors over the two sides of the line circuit in series.

20. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks leading from the primary groups to the secondary groups, the number of trunks leading from each primary group being the same as the number of secondary groups, the number of trunks leading to each secondary group being the same as the number of primary groups, and the number of primary groups being greater than the number of secondary groups, means including selectors and connectors for extending connection from the secondary groups in the direction of the called subscribers, and means for controlling said selectors and connectors over the two sides of the line circuit in series.

21. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being different from the number of secondary groups, the number of trunks leading from each primary group being the same as the total number of secondary groups, and the number of trunks leading to each secondary group being the same as the total number of primary groups, means including selectors and connectors for extending connection from the secondary groups in the direction of the called subscribers, and means for controlling said selectors and connectors over the two sides of the line circuit in series.

22. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the trunks terminating in any particular secondary group being given dissimilar positions in the different primary groups, means including selectors and connectors for extending connection from the secondary groups in the direction of the called subscribers, and means for controlling said selectors and connectors over the two sides of the line circuit in series.

23. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the sec-

ondary groups, the number of primary groups being greater than the number of secondary groups, and the trunks which have similar positions in the primary groups, or some of them, being arranged to terminate at their other ends in different secondary groups, means including selectors and connectors for extending connection from the secondary groups in the direction of the called subscribers, and means for controlling said selectors and connectors over the two sides of the line circuit in series.

24. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, the trunks terminating in any secondary group being the same in number as the total number of primary groups, a number of trunks in each secondary group equal to the total number of secondary groups being given dissimilar positions in as many different primary groups, and the remaining trunks of each secondary group being given positions in the remaining primary groups similar to the positions that certain other trunks of the same secondary group are given in other primary groups, means including selectors and connectors for extending connection from the secondary groups in the direction of the called subscribers, and means for controlling said selectors and connectors over the two sides of the line circuit in series.

25. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks extending from the primary groups to the secondary groups, the number of primary groups being greater than the number of secondary groups, and the number of trunks leading to each secondary group being the same as the number of primary groups, trunk lines leading from said secondary groups, and means for controlling the switches of the primary groups over metallic line circuits.

26. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks leading from the primary groups to the secondary groups, the number of trunks leading from each primary group being the same as the number of secondary groups, the number of trunks leading to each secondary group being the same as the number of primary groups, and the number of primary groups being greater than the number of secondary groups, trunk lines leading from said secondary groups, and means for controlling the switches of the primary groups over metallic line circuits.

27. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being different from the number of secondary groups, the number of trunks leading from each primary group being the same as the total number of secondary groups, and the number of trunks leading to each secondary group being the same as the total number of primary groups, trunk lines leading from said secondary groups, and means for controlling the switches of the primary groups over metallic line circuits.

28. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the trunks terminating in any particular secondary group being given dissimilar positions in the different primary groups, trunk lines leading from said secondary groups, and means for controlling the switches of the primary groups over metallic line circuits.

29. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, and the trunks which have similar positions in the primary groups, or some of them, being arranged to terminate at their other ends in different secondary groups, trunk lines leading from said secondary groups, and means for controlling the switches of the primary groups over metallic line circuits.

30. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, the trunks terminating in any secondary group being the same in number as the total number of primary groups, a number of trunks in each secondary group equal to the total number of secondary groups being given dissimilar positions in as many different primary groups, and the remaining trunks of each secondary group being given positions in the remaining primary groups similar to the positions that certain other trunks of the same secondary group are given in other primary groups, trunk lines

leading from said secondary groups, and means for controlling the switches of the primary groups over metallic line circuits.

31. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks extending from the primary groups to the secondary groups, the number of primary groups being greater than the number of secondary groups, and the number of trunks leading to each secondary group being the same as the number of primary groups, means for controlling said primary non-numerical switches over two sides of a subscriber's line in series, and a central source of current for operating said switches, with connections for supplying talking current to the subscribers' stations.

32. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks leading from the primary groups to the secondary groups, the number of trunks leading from each primary group being the same as the number of secondary groups, the number of trunks leading to each secondary group being the same as the number of primary groups, and the number of primary groups being greater than the number of secondary groups, means for controlling said primary non-numerical switches over two sides of a subscriber's line in series, and a central source of current for operating said switches, with connections for supplying talking current to the subscribers' stations.

33. In a telephone system, a plurality of subscribers' lines, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being different from the number of secondary groups, the number of trunks leading from each primary group being the same as the total number of secondary groups, and the number of trunks leading to each secondary group being the same as the total number of primary groups, means for controlling said primary non-numerical switches over two sides of a subscriber's line in series, and a central source of current for operating said switches, with connections for supplying talking current to the subscribers' stations.

34. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the trunks terminating in any particular secondary group being given dissimilar positions in the different primary groups, and a central source of current for operating said switches, with connections for supplying talking current to the subscribers' stations.

35. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, and the trunks which have similar positions in the primary groups, or some of them, being arranged to terminate at their other ends in different secondary groups, and a central source of current for operating said switches, with connections for supplying talking current to the subscribers' stations.

36. In a telephone system, a plurality of groups of primary non-numerical trunking switches, a plurality of groups of secondary non-numerical trunking switches, trunks connecting the primary groups with the secondary groups, the number of primary groups being greater than the number of secondary groups, the trunks terminating in any secondary group being the same in number as the total number of primary groups, a number of trunks in each secondary group equal to the total number of secondary groups being given dissimilar positions in as many different primary groups, and the remaining trunks of each secondary group being given positions in the remaining primary groups similar to the positions that certain other trunks of the same secondary group are given in other primary groups, and a central source of current for operating said switches, with connections for supplying talking current to the subscribers' stations.

37. In a telephone system, a traffic distributer comprising groups of primary automatic switches, groups of secondary automatic switches, and trunks connecting the primary groups with the secondary groups, the trunks terminating at each secondary group, or at least some of them, being given unlike or dissimilar positions in as many different primary groups, whereby successive calls from different primary groups are distributed in different secondary groups.

38. In a telephone system, a calling line, trunks, mechanism associated with said line for automatically selecting an idle trunk, mechanism on said selected trunk for then automatically selecting another idle trunk, and means controllable over two sides of the selected trunk lines in series for afterward switching in accordance with the first digit of the called number.

39. In a telephone system, the combination of trunks, automatic switches for extending connection through a plurality of said

trunks when a subscriber calls, and means controllable over two sides of the trunk connection in series for then switching in accordance with the first digit of the called number.

40. In a telephone system, the combination of subscribers' lines, trunk lines, switches individual to the subscribers' lines for automatically selecting idle trunk lines, other trunk lines, automatic switches individual to the first-mentioned trunk lines for automatically selecting idle ones of the said other trunk lines, and means including mechanism responsive to the calling subscriber, and operated over two sides of the subscriber's line in series, for switching in accordance with the first digit of the called number.

41. In a telephone system, the combination of trunks, mechanism for automatically selecting idle trunks ahead of the calls, means whereby the calling subscriber seizes the preselected trunk, suitable lines, mechanism for selecting idle lines ahead of the calls, means for connecting the preselected trunk with a preselected line when the subscriber calls, and suitable means operable over two sides of the subscriber's line in series for then completing the connection to the line of the called subscriber.

42. In a telephone system including subscribers' lines, the combination of first selectors, means for controlling said selectors in accordance with the first digit of any called number, switches for automatically selecting idle selectors, means for automatically selecting idle switches, and means for controlling said first selectors over two sides of the subscriber's line in series.

43. A telephone exchange system comprising subscribers' lines divided into a plurality of groups, a first selector and a second selector and a connector, said first selector being common to all of the subscribers' lines in all of said groups, means for establishing a connection from a calling subscriber's line to an idle first selector, and means for then controlling said first selector over two sides of the subscriber's line in series.

44. A telephone exchange system comprising subscribers' lines divided into a plurality of groups, a plurality of first selectors less in number than the subscribers' lines, means for establishing a connection from a calling subscriber's line to an idle first selector, suitable means for then extending connection from the first selectors to the called subscribers' lines, each of said first selectors being common to all of the subscribers' lines in all of said groups, and means for controlling said first selectors over two sides of the subscriber's line in series.

45. A telephone exchange system comprising subscribers' lines, automatic numerical switches less in number than the subscribers' lines, individual non-numerical switches for the subscribers' lines, automatic non-numerical switches for extending connection directly from the subscribers' individual switches to the said numerical switches, said last-mentioned non-numerical switches being less in number than the subscribers' lines, and means for controlling said numerical switches over two sides of the subscriber's line in series.

46. In a telephone system, a plurality of subscribers' lines, means for extending a connection from a calling to a called subscriber's line, said means including a plurality of trunk lines, a plurality of successively-operated non-numerical switches for selecting idle trunk lines, and a plurality of numerical switches controlled by the calling subscriber over two sides of a line circuit in series.

47. In a telephone system, a plurality of trunk lines, a non-numerical switch for selecting an idle trunk line, an operating magnet therefor, a resistance normally disconnected from said operating magnet, and means for connecting said resistance in series with said operating magnet when said operating magnet is energized and for maintaining said magnet energized while said switch is operated.

48. In a telephone system, a subscriber's line, a trunking switch provided with a bank of trunk terminals, a plunger adapted to cooperate with said bank in connecting the subscriber's line with any trunk, a magnet for operating said plunger, a resistance normally disconnected from said magnet, and means for connecting said resistance in series with said magnet when said magnet is energized and for maintaining said magnet energized while said switch is operated.

49. In a telephone system, a plurality of subscribers' lines, a plurality of non-numerical switches for selecting trunks extending from said lines, and means for automatically reducing the operating current passing through the operating magnet of the second of these non-numerical switches when said switch is operated.

50. In a telephone system, trunk lines, a line switch for automatically selecting idle trunks, an operating magnet for said switch, and a resistance for cutting down the amount of current through said magnet while the line switch is energized and for maintaining said magnet energized while said switch is operated.

51. In a telephone system, first-selectors, and means by which a plurality of successive non-numerical automatic trunking operations controlled over two sides of a line circuit in series are necessary to enable any calling subscriber to reach any first-selector.

52. In a telephone system, a plurality of automatic trunking switches controlled over two sides of a line circuit in series, each

having only a single level of trunk terminals, a first selector, and means for successively operating said switches to reach said first selector.

53. In a telephone system, the combination of trunks, mechanism for automatically selecting an idle trunk, mechanism for then automatically selecting another idle trunk, said mechanism being controlled over two sides of a line circuit in series, and means for afterward switching in accordance with the first digit of the called number.

54. In a telephone system, the combination of trunks, automatic switches controlled over two sides of a line circuit in series for extending connection through a plurality of said trunks when a subscriber calls, and means for then switching in accordance with the first digit of the called number.

Signed by me at Chicago, Cook county, Illinois, this 9 day of Feb. 1910.

ALEXANDER E. KEITH

Witnesses:
EDWARD D. FALES,
ARTHUR J. RAY.