

1,412,094.

Patented Apr. 11, 1922.

9 SHEETS—SHEET 1.

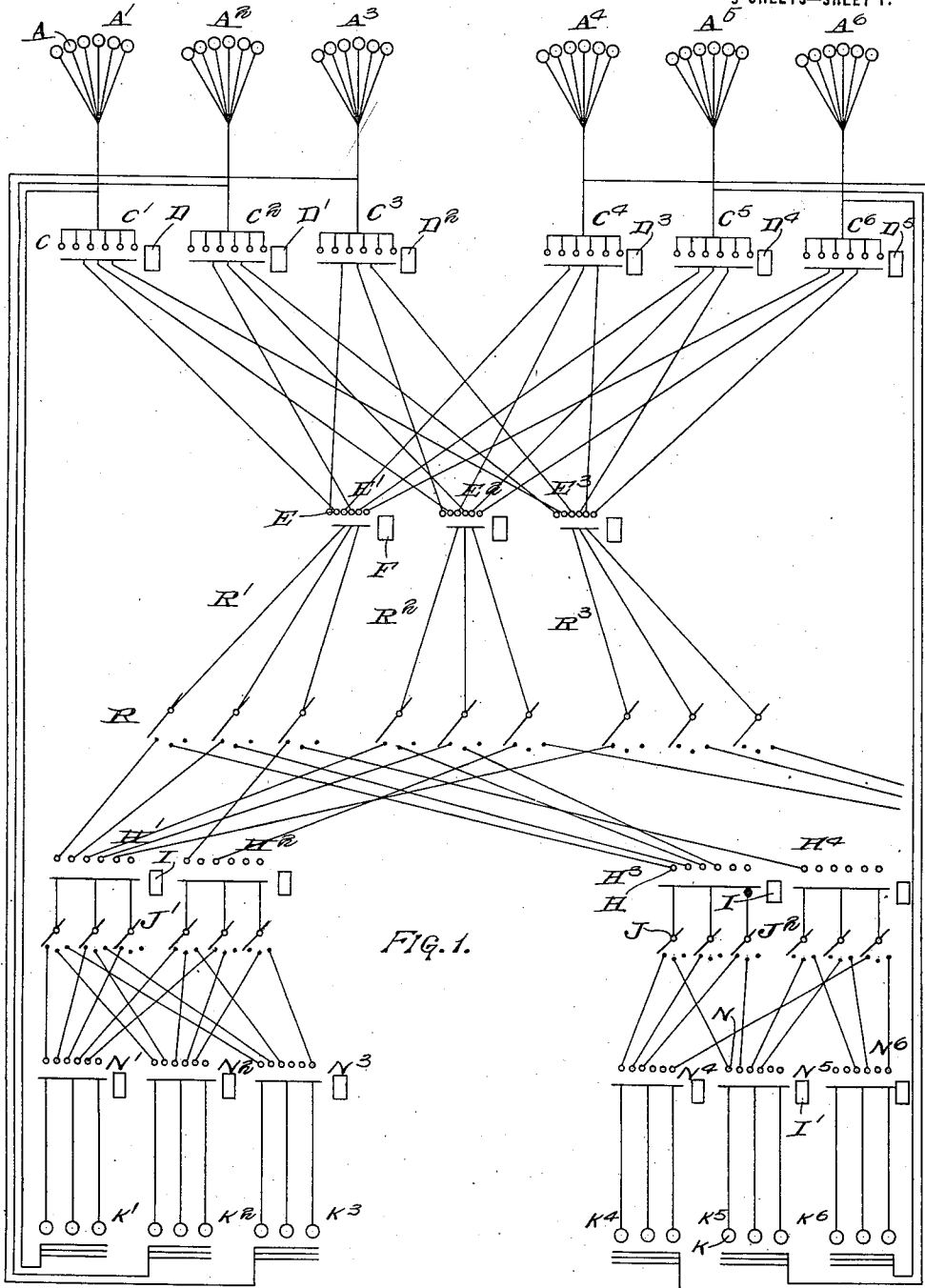


FIG. 1.

WITNESSES.

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1,412,094.

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9 SHEETS—SHEET 2.

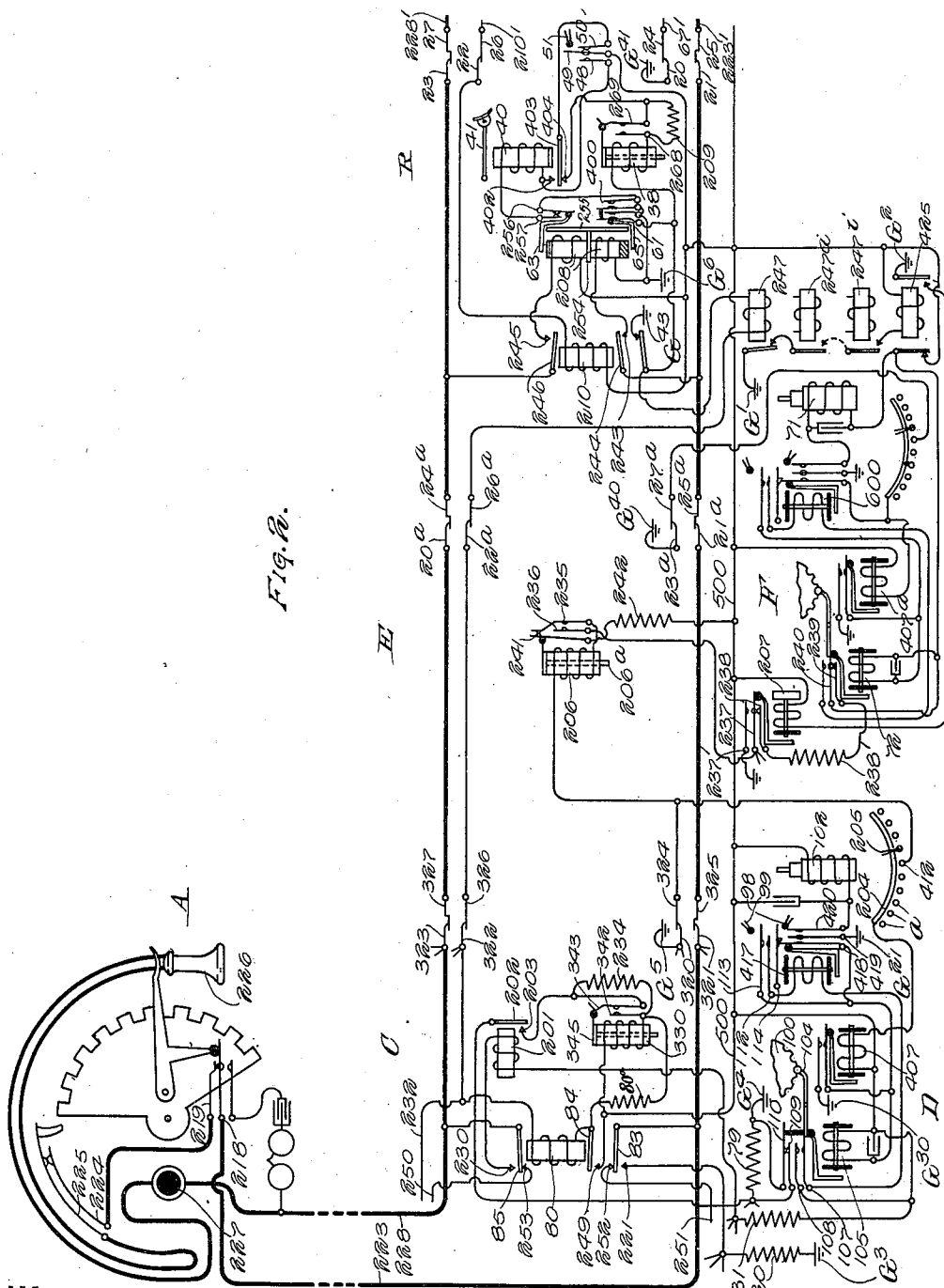


Fig. 2.

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A. B. SMITH.
AUTOMATIC TELEPHONE SYSTEM.

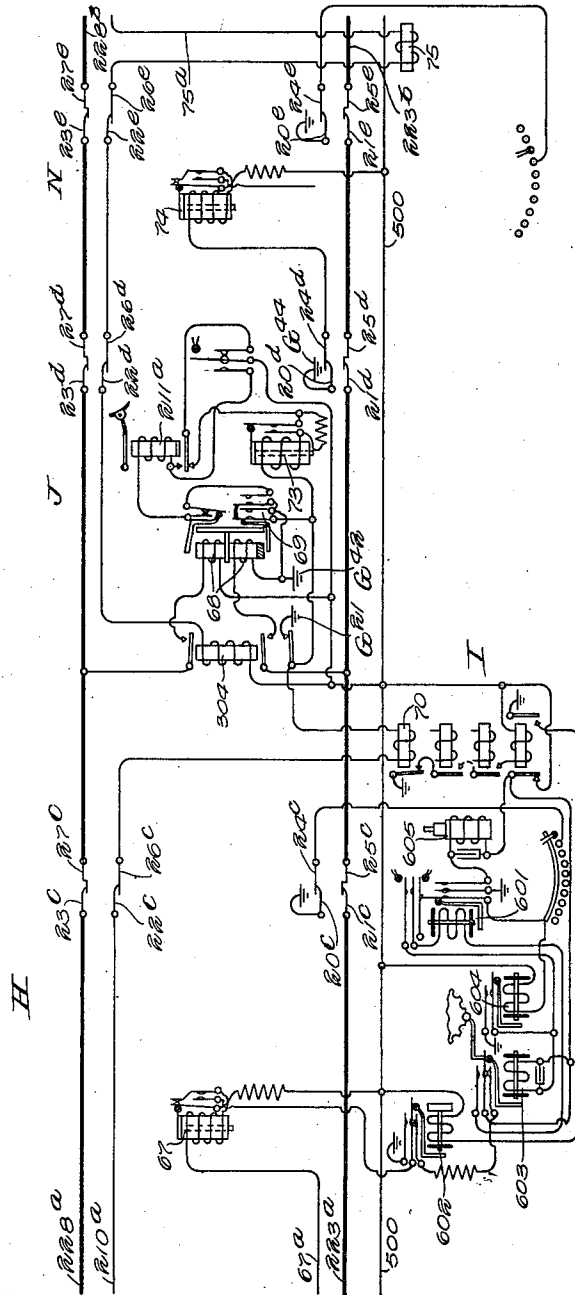
APPLICATION FILED OCT. 22, 1913. RENEWED OCT. 8, 1921.

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9 SHEETS—SHEET 3.

FIG. 3.



WITNESSES

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9 SHEETS—SHEET 4.

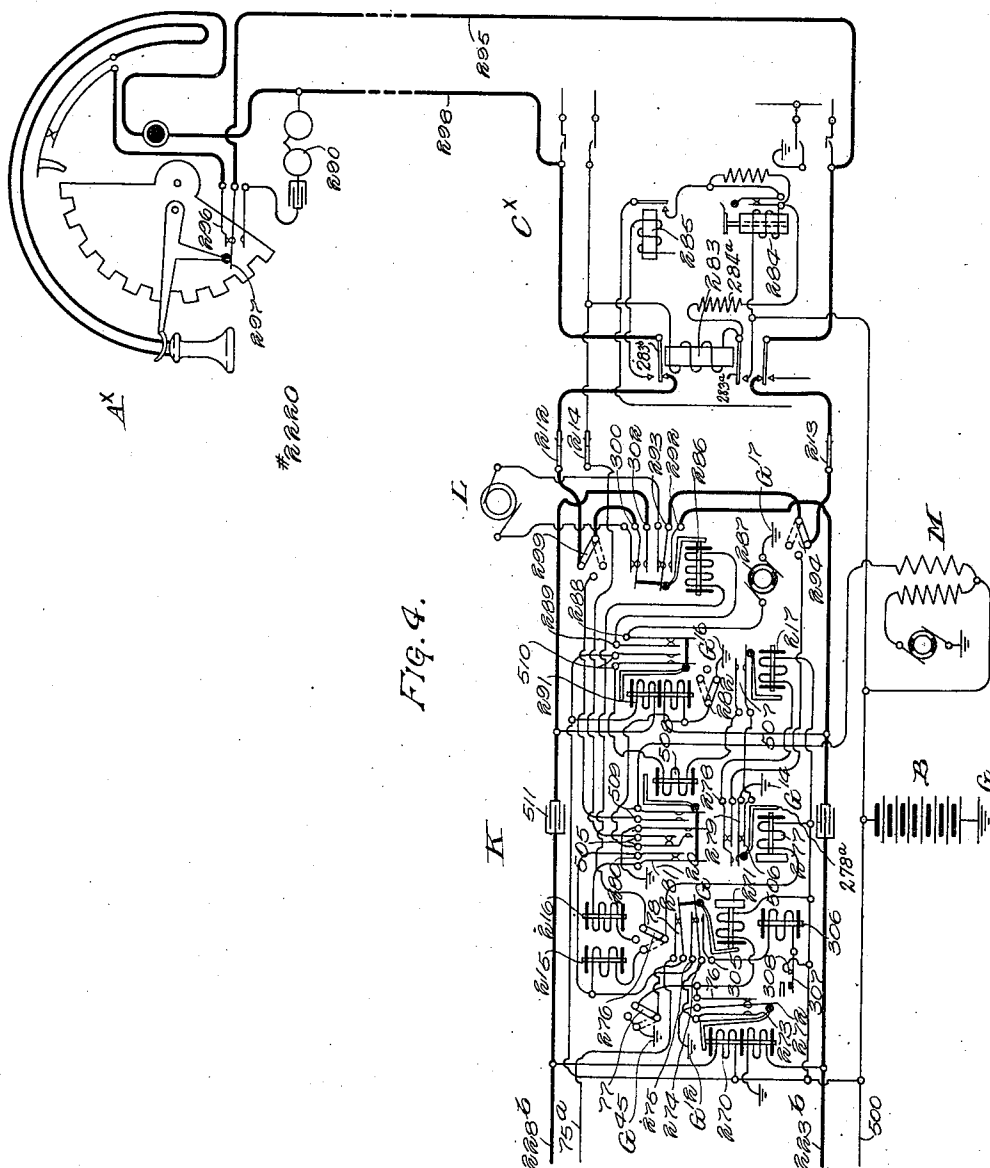


Fig. 4.

WITNESSES

Harry R. Murby.
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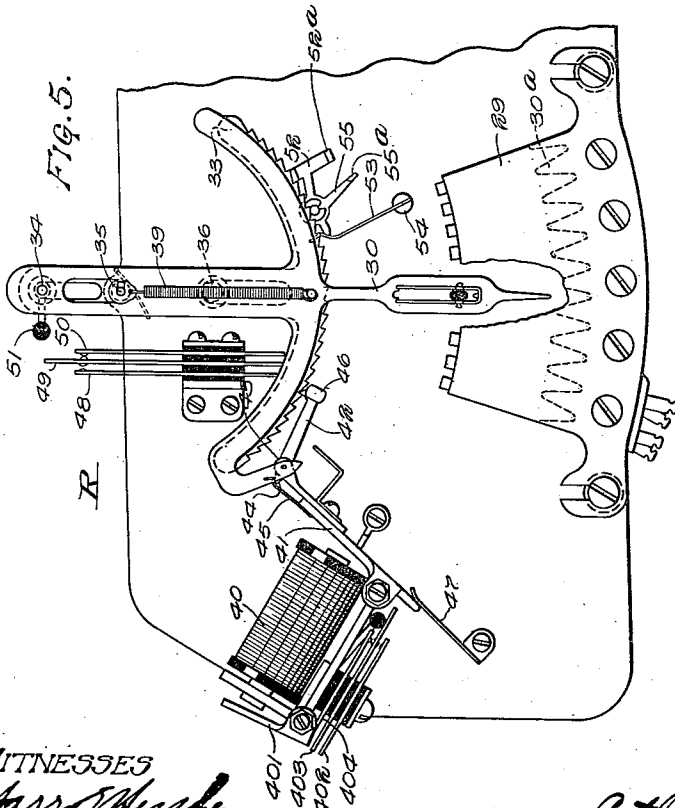
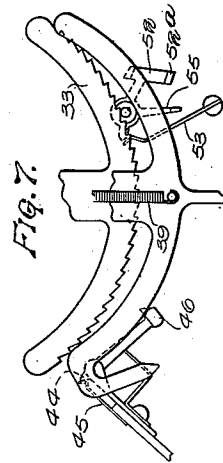
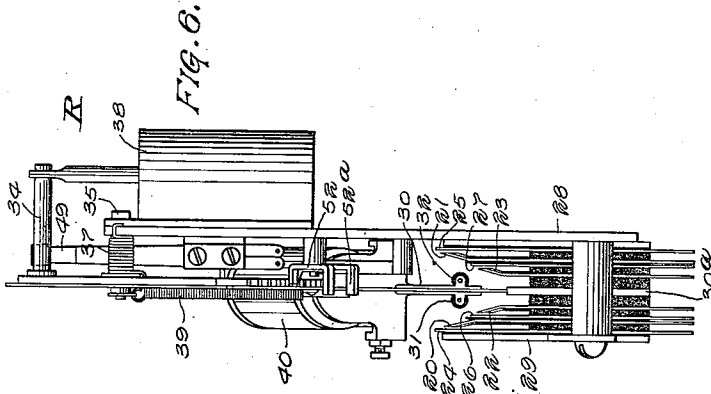
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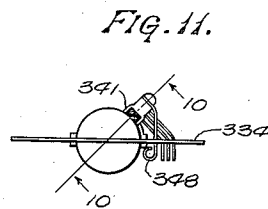
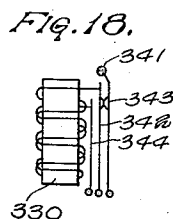
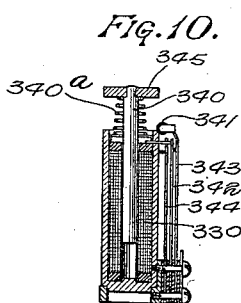
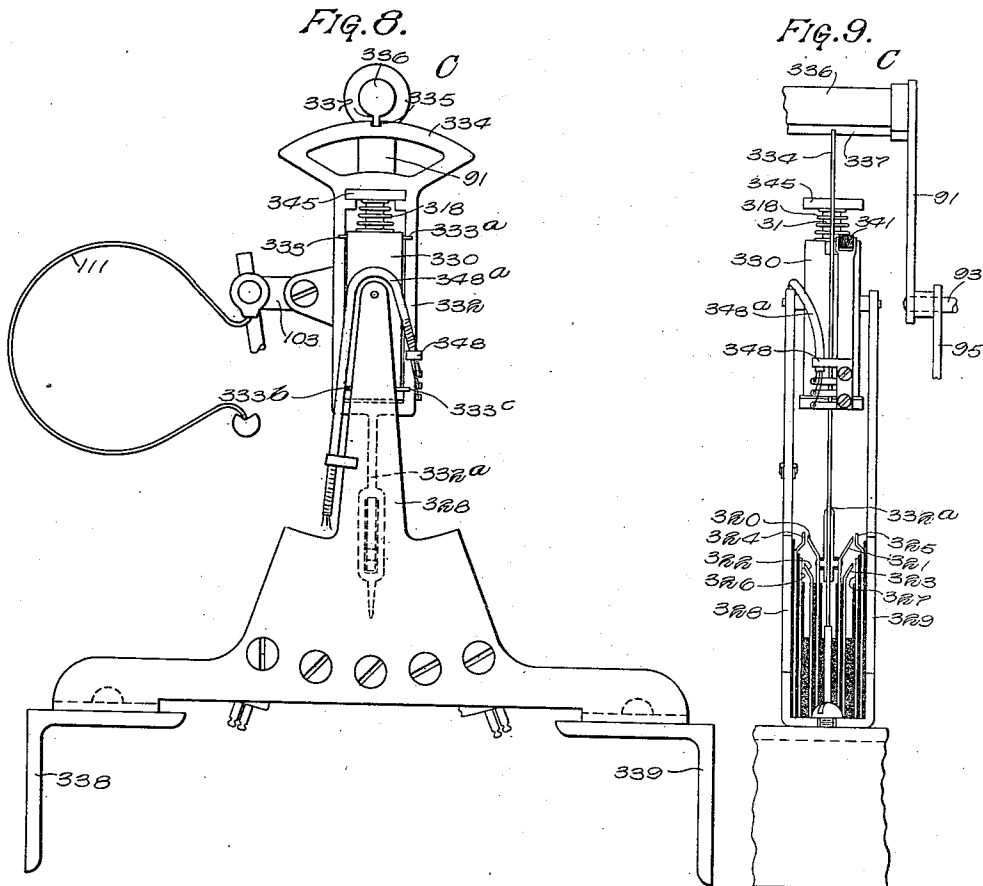
Patented Apr. 11, 1922.

9 SHEETS—SHEET 5.



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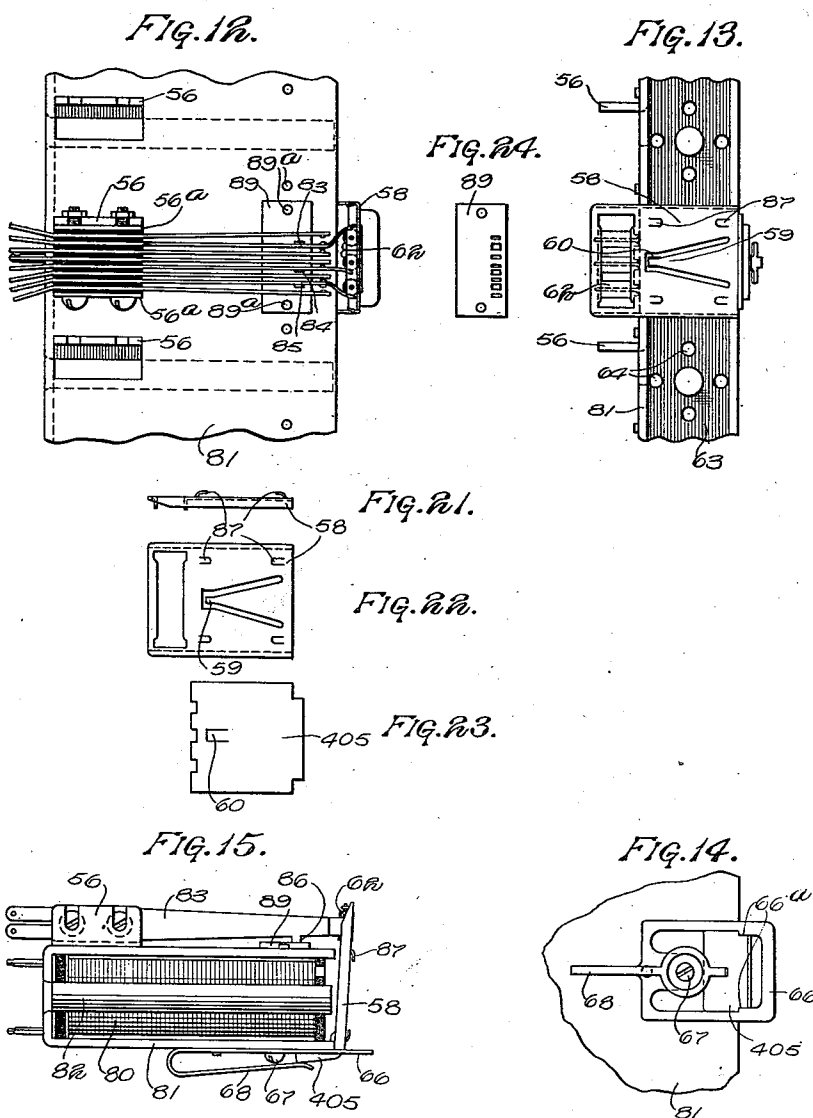
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1,412,094.

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9 SHEETS—SHEET 7.



WITNESSES

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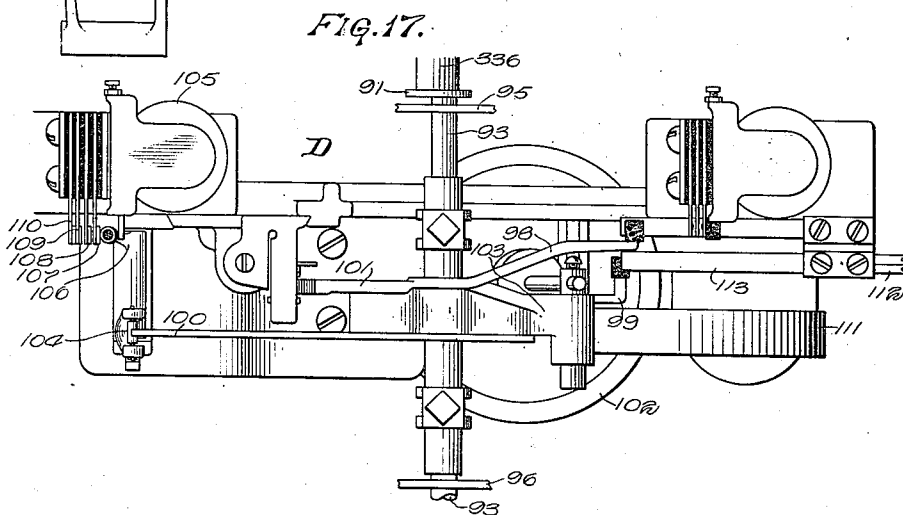
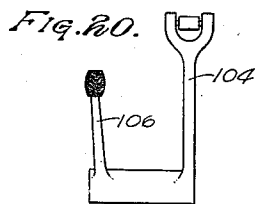
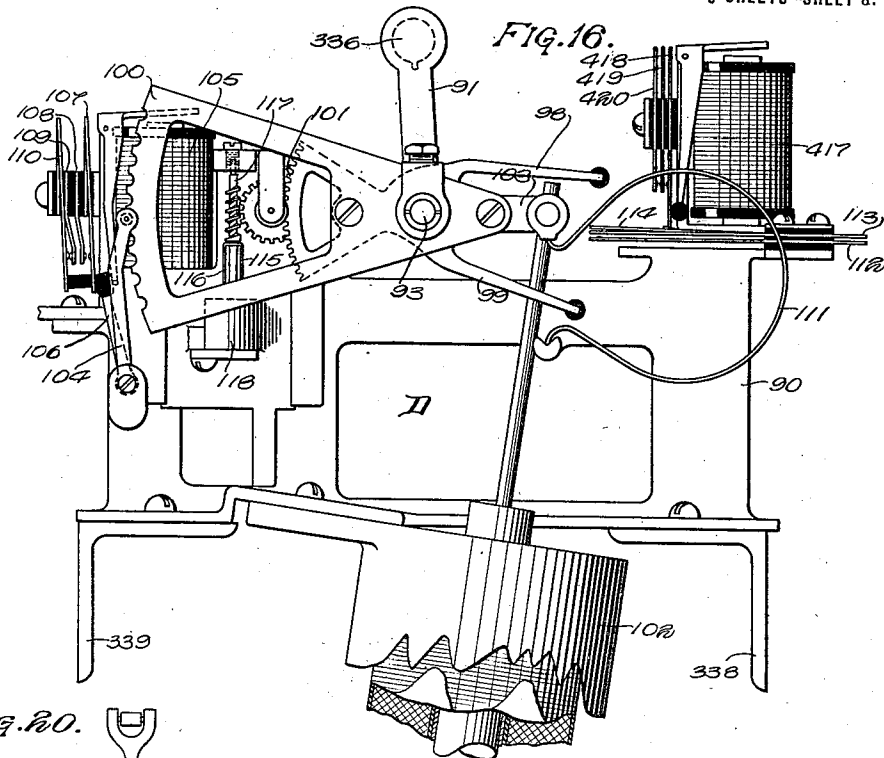
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A. B. SMITH.
 AUTOMATIC TELEPHONE SYSTEM.
 APPLICATION FILED OCT. 22, 1913. RENEWED OCT. 8, 1921.

1,412,094.

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9 SHEETS—SHEET 8.



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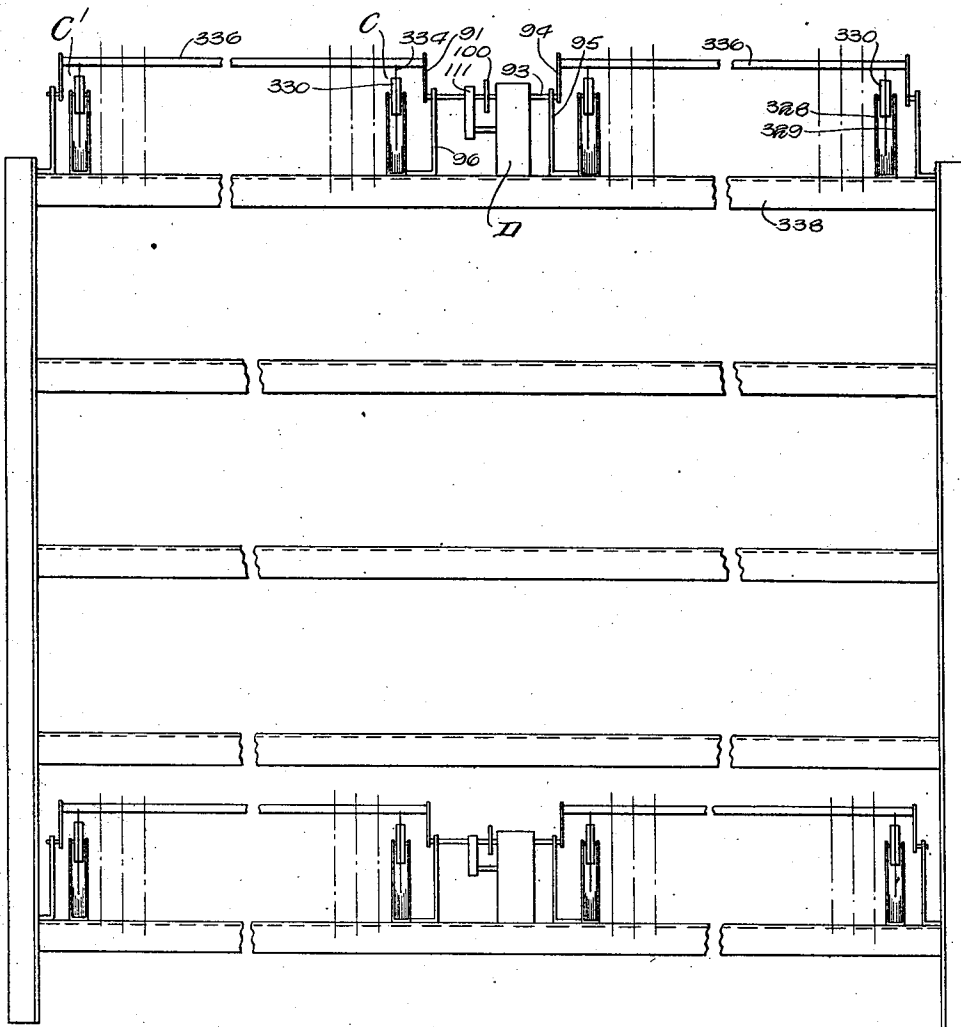
A. B. SMITH.
 AUTOMATIC TELEPHONE SYSTEM.
 APPLICATION FILED OCT. 22, 1913. RENEWED OCT. 8, 1921.

1,412,094.

Patented Apr. 11, 1922.

9 SHEETS—SHEET 9.

Fig. 19.



WITNESSES

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AUTOMATIC TELEPHONE SYSTEM.

1,412,094.

Specification of Letters Patent.

Patented Apr. 11, 1922.

Application filed October 22, 1913, Serial No. 796,593. Renewed October 8, 1921. Serial No. 506,491.

To all whom it may concern:

Be it known that I, ARTHUR BESSEY SMITH, a citizen of the United States of America, and resident of Evanston, Cook County, Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to improvements in automatic telephone systems, and has for its objects an improved method of trunking between a calling and a called line, and likewise an improved construction of certain of the automatic switches employed in establishing this connection. The trunking between a calling and a called subscriber in my improved system is accomplished by means of a series of non-numerical and numerical switches. The non-numerical switches are merely for the purpose of connecting with an idle trunk and are not controlled by the calling subscriber, while the numerical switches, or group selectors, have no automatic operation—that is, no trunk-selecting operation,—but are entirely under the control of the calling subscriber, so that they can be operated to connect with a predetermined trunk. Furthermore, the non-numerical switches are of the type in which a master switch is employed for controlling a group of such switches, so that the switches of any particular type, when not in use, are maintained in a position opposite an idle trunk line. Thus when any one of these switches is seized, it immediately establishes connection with an idle trunk, the master switch then operating to move the remaining switches of the group opposite the next idle trunk.

These and other objects and features of my invention will be more readily understood by reference to the accompanying drawings, in which I have illustrated one embodiment of my invention.

Figure 1 shows diagrammatically the trunking arrangement of the exchange system.

Figs. 2, 3 and 4 taken together represent a complete connection between a calling substation A, and a called substation A* in the above system.

Fig. 5 represents a side view, Fig. 6 a front view of the group-selecting switches

and Fig. 7 a section of the plunger portion of the group switch in operative position.

Figs. 8, 9, 10 and 11 show the construction of the idle trunk-selecting switch or trunk selector.

Figs. 12, 13, 14 and 15 show the construction of a form of relay employed in conjunction with the apparatus shown herein.

Figs. 16 and 17 show a so-called master switch for controlling a group of trunk selectors.

Fig. 18 is a detail view showing the circuit of the soil 330.

Fig. 19 is an elevation of a board containing five shelves of line switches. Each shelf represents one group of line switches, together with their controlling master switch. The top shelf is, for example, intended to represent the group of switches C'.

Figs. 20, 21, 22, 23 and 24 are detail views of parts of the apparatus.

Before describing the construction and operation of the central office apparatus shown herein, a general description of the trunking arrangement will be given. Referring to Fig. 1, there is represented the trunking arrangement of two one-thousand groups, said groups representing two thousand subscribers' lines, said lines terminating in a telephone exchange arranged to accommodate ten thousand such lines, subdivided on the decimal plan. In this figure there are represented three groups of substations A in each thousand, so that assuming there are one hundred lines in a group, each thousand is completely represented on a scale of three to ten. In the system shown herein, each subscriber's line terminates at the central office in an individual trunk-selecting or line switch C. The line switches C are arranged in groups C¹, C², etc., of preferably one hundred switches each, thereby throwing the subscribers' stations into corresponding groups A¹, A², etc. A master switch D is provided for controlling each group of line switches. All the line switches in each of the groups C¹, C², etc., have common access to a plurality of trunk lines, each of which leads to a so-called secondary trunk-selecting switch E. The switches E are in turn arranged in groups E¹, E², etc., and preferably from each of the groups C¹, C², etc., of subscribers' switches one trunk line leads

into each group of secondary switches E. Each group of these secondary switches is controlled by a master switch R'. As shown herein, the groups E¹, E² and E³ of secondary switches contain switches which are accessible to two thousand subscribers. In turn, each of said groups has access to a plurality of trunk lines, each of which leads to a group selector R. Each of the group-selecting switches R has access to a plurality of trunk lines, ten in number if the system is arranged on the decimal plan, and is adapted to be operated to complete connection with any desired one of these trunk lines. Each trunk line to which the switches R have access leads in turn to a trunk-selecting switch H, which latter is similar to the subscriber's individual switch C. The first trunk line leading from each of the switches R in the system leads to a switch H, which is allotted to the first thousand. The second trunk line leading from each of the switches R leads to switches H allotted to the second thousand, etc. In each thousand the switches H are arranged in groups, and I have shown herein two such groups H¹ and H² in the first thousand and two groups H³ and H⁴ in the second thousand. The trunk lines leading from the switches R into any particular thousand may be distributed among the groups of switches H in that thousand in any desired manner. A ten-thousand exchange, with the arrangement above indicated, would be represented in five sheets similar to Fig. 1. On a basis of five per cent trunking, the nine trunks shown in Fig. 1 connecting the groups E¹, E² and E³ with the switches R represent one hundred trunks, which take care of two thousand subscribers. From each of the other four groups of two thousand subscribers similar to the one shown in Fig. 1, there would likewise be one hundred trunks connecting the switches E with the R switches, making, all-told, five hundred R switches to take care of ten thousand subscribers. The first contact of each of the R switches, with the particular distribution shown, is connected by a trunk with an H switch in the one thousand section. All-told, this means five hundred H switches in the one thousand group. It is found convenient to divide these H switches into groups of one hundred, each group being controlled by a master switch I. This would make, all-told, five groups of one hundred H switches each, which five groups are indicated in Fig. 1 by the groups H¹ and H². It is sometimes found advantageous to so distribute these trunks that the group R¹ of R switches shall have trunks terminating in H switches in each of these five H switch groups. Since from each of the groups of R switches extend ten trunks, this distribution may be accomplished, as indicated in Fig. 1, by having the trunks representing the first

contacts of the first two R switches of the group R¹ terminate, respectively, in one of the switch groups, such as the group H¹, and the first contact of the first two R switches in the group R² likewise terminates in the same group H¹ of the H switches, and so on. The first contacts of the third and fourth R switches in the group R¹ would in turn be connected respectively to trunks with H switches in the second switch group H², and so on. Each of the groups of switches H has access to a plurality of trunk lines, each of which leads to a group-selecting switch J similar to the group-selecting switch R. For example, the trunks from the switches in the groups H¹ and H² run to the J switches in the group J¹ and the trunks from the groups H³ and H⁴ run to the J switches in the group J². Each of the switches J has access to a plurality of trunk lines (ten in a decimal system), each of which leads to a trunk-selecting switch N. These switches N are likewise arranged in groups N¹, N², N³, N⁴, N⁵, N⁶, etc. The first contact of all the switches J in the first thousand leads to switches N in the group N¹, the second contact of all the switches J in the first thousand leads to switches in the group N², etc. The switches in the group N¹ have common access to a plurality of trunk lines, each of which leads to a connector K in a group K¹, each of which can complete connection with any subscriber in the first hundred group A¹. Likewise, the switches in the group N² have access to connectors K in a group K², which connectors have access to the subscribers in the group A², etc. In the second thousand the switches J in the group J² have access to switches N in groups N⁴, N⁵ and N⁶, and through the medium of the connectors in the groups K⁴, K⁵ and K⁶ access is had to the subscribers in the groups A⁴, A⁵ and A⁶ in the second thousand. A similar arrangement is carried out in each of the remaining thousands. For the sake of simplicity I have shown only a portion of the trunk lines in Fig. 1, but have shown sufficient to indicate how the remaining ones would be connected.

Having given a general description of the system, I shall now describe the construction of the various central office apparatus. The construction of the group selectors R is shown in Figs. 5, 6 and 7. The switch as a whole is mounted on a back plate of sheet metal and is provided with a plurality of sets of contacts, each set comprising springs 20, 21, 22, 23, 24, 25, 26 and 27. These sets of springs are arranged in the arc of a circle and are clamped together between the plates 28 and 29 and are separated from each other by suitable insulated bushings. Above said contacts there is a plunger 30, somewhat anchor-shaped, which is fitted to a guide mechanism 33 (Fig. 7), similar in shape,

possessing ratchet teeth for the engagement of a pawl. Said plunger is arranged so as to have a free up and down movement with relation to the guide by means of pins 34, 35 and 36 and slots therefor. The pins 34 and 36 are parts of the plunger proper and slide up and down in slots provided for them in the guide. The pin 35 is part of the guide and fits into a slot in the plunger. Both the plunger and its guide have an oscillatory motion, with the pivot 35 as an axis, and oscillate in synchronism. The lower end of the plunger, which is pointed, projects downward between the contact springs of the switch and is furnished with two small insulating bushings 31 and 32. This lower pointed end of the plunger is adapted to engage with the serrated member 30^a mounted between the plates 28 and 29. This member 30^a has one tooth or serration corresponding to each group of contact springs. When the plunger is retracted, as shown, these bushings are high enough to pass between the contact springs as the plunger is moved on its pivot without touching them, and the point of the plunger moves over the serrated member 30^a. Around the pivot 35 is a spiral spring 37, the tension of which keeps the plunger to the right (Fig. 5) when in normal position. A solenoid 38 is supported by and behind the plate 28, the plunger of which solenoid is attached to the plunger, as shown, so that when the solenoid is energized, the plunger is moved downward against the spring 39, forcing the bushings 31 and 32 against the springs 22 and 23 of whichever group of springs the plunger is then opposite, and as the plunger continues to move downward, the springs 20, 21, 22 and 23 make contact with the springs 24, 25, 26 and 27, respectively. There is also attached to the front of the plate 28 an electromagnet 40, which operates in response to the impulses sent over the line from the calling device of the subscriber. Attached to its armature 41 is a pawl 42 which has a hinge joint at 43 and also a projection 44. The fore portion of said pawl is held in active engagement with the teeth of the plunger guide by means of the spring 45 attached to the armature 41, the V-shaped end of which is shown pressing down on the projection 44 while the plunger is in normal position. This pawl acts in opposition to the tension of the spring 37 to advance the plunger step by step to the left as the magnet 40 is energized and deenergized. In Fig. 5 the plunger is represented as having been thus moved six steps from its normal position. When the plunger is pulled down by the solenoid 38, as shown in Fig. 7, it comes into contact with a knob 46 on the end of the pawl 42 and disengages the said pawl from the teeth on the plunger guide, and it is held in this inactive position by the same spring 45 until restored later by the hook on the left end of the plunger arc. There is also associated with the plunger guide a holding pawl 52 for the guide, which is held in active position by means of a spring 53 fastened securely to a post 54. This spring acts in the same manner as does the spring 45. The end 52^a of an arm projecting from the pawl 52 is bent up at right-angles, so as to form a finger which comes in the way of the plunger as it is thrust down into any set of bank springs, whereby said pawl 52 may be moved out of engagement with the plunger guide 33. The pawl 52 is held in a disengaged position by the same spring 53 acting in an opposite direction than when the pawl was engaging the teeth of the plunger guide. The pawl 52 likewise has a small arm 55 the end 55^a of which is also bent at right-angles and is so arranged as to be struck by the plunger when it swings back to its normal position by the action of the spring 37, when the solenoid deenergizes. The pawls 52 and 42, being disengaged from the plunger guide when the plunger is in its operated position, leaves nothing but the engagement of the plunger point with the teeth of the serrated member 30^a to keep the former from being returned to its normal position. Upon the deenergization of the solenoid 38 the plunger is first withdrawn from the bank by the spring 39 and then swung back to the right by the spring 37, and upon doing so the plunger hits against the small arm 55 of the pawl 52, restoring said pawl to active engagement with the guide, where it is held by means of the springs 53. The function of the hook on the left end of the anchor portion of the plunger is to engage with the knob 46 as the plunger returns to normal, and thus restore the pawl on said knob to active engagement with the teeth of the plunger guide.

The armature 41 of the electromagnet 40, to which the pawl 42 is attached, is, it will be seen, controlled by the spring 47. There is also attached to the magnet 40 a second armature 401, which is made slow acting—that is, slow to fall back—by the usual residual cap on the core being omitted, or in any other suitable known way. After being once attached to its core, said armature therefore remains so all the while the calling impulses are being sent over the line. In connection with the armature 401 there are three contact springs 402, 403 and 404, assembled in the usual manner, the spring 404 normally making contact with the spring 403. On the plate 28 (Fig. 5) there are mounted three contact springs 48, 49 and 50, separated by suitable insulating bushings. The spring 49 is normally held in contact with the spring 48 by means of the bushing 51 carried by the guide 33. When the plunger moves to the left, however, the bushing 51 moves away from the

spring 49, permitting the same to break contact with the spring 48 and make contact with the spring 50. A number of these group selectors are mounted side by side on shelves.

The trunk selectors, as represented in Figs. 8, 9, 10 and 11, are of the same general type of switches as the subscribers' individual or line switches disclosed in British patent to R. W. James No. 26,301 of 1906, and in the Western Electrician of Chicago of January 25, 1908. Each switch, like that of the group switch, is provided with a number of sets of contact springs, each set comprising the springs 320, 321, 322, 323, 324, 325, 326 and 327, which are similar to the contact springs in the group switch and are arranged in the same manner in the arc of a circle and clamped between the plates 328 and 329, and are separated from each other by suitable insulating bushings. Pivoted between the plates 328 and 329 there is a solenoid 330. Attached to the movable core thereof is a frame 332 arranged to slide up and down in slots 333, 333^a, 333^b and 333^c. To the lower end of the frame is attached a plunger 332^a the point of which projects downward between the contact springs of the switch. The lower end of the plunger is precisely the same as in Fig. 5 and acts in the same manner with regard to the sets of contact springs 320 to 327, inclusive. At the top of the movable frame and plunger is a curved flange 334, in the center of which is a notch 335.

A number of these trunk or line switches are mounted side by side upon a frame comprising a pair of angle irons 338 and 339 (Fig. 8). Above these switches, and parallel with the angle iron, there extends an oscillatory shaft 336 on which there is a flange member 337 which engages in the notch 335 above mentioned in the curved flange 334. Thus all the plungers of the line switches are normally locked with the shaft 336 and through the medium thereof may be moved back and forth in front of their respective banks of contact springs. When a line switch is operated, however, its plunger passes out of control of the shaft 336. If, when a line switch returns from its operated to its normal position, the shaft 336 is not in the same position in which it was when the line switch was operated, the notch 335 on the top of the plunger of the line switch will not engage with the projection 337, but said projection will strike somewhere on the smooth surface of the cam 334. During the subsequent movements of the shaft 336 the line switch will remain stationary, with its plunger in front of the group of contacts from which it was just disengaged, until the shaft returns to the position in which it was when that par-

ticular switch was operated. When the shaft reaches this position the notch 335 engages with the projection 337 and the plunger will again become locked with the shaft. The movement of the shaft 336 is controlled by a master switch, which is shown in Figs. 16 and 17, in a manner which will be described later. In Fig. 10 there is shown a sectional view of the solenoid 330, taken on the line 10—10 in Fig. 11. In the center of the solenoid 330 there is a movable plunger 340. This plunger is restored to normal position by means of the spring 340^a which surrounds the upper end of this plunger and bears against the cap or circular disk 345, to which the frame 332 of the line switch plunger is fitted. When the solenoid energizes, the disk is moved in a downward direction. In so doing it presses out the bushing 341, breaking contact between the springs 343 and 342. The spring 344 merely serves as a terminal for the winding of the solenoid 330. The spring 342 forms the other terminal of this winding, as clearly shown in Fig. 18. These springs are separated by insulating bushings and fastened to the shell of the solenoid by two screws. The loop 348 (Fig. 11) acts as a support for the flexible wires and wire conduit 348^a. In each group of line switches there is provided a group of cut-off relays, one for each switch (see Figs. 12, 13, 14 and 15). These relays are assembled in a common U-shaped frame or trough 81 which extends the whole length of the shelf, and within which are secured the magnet cores 82. The coils 80 for these relays are slipped over these cores 82 and are readily removable from the same after any connections to the two terminals are disconnected therefrom, which terminals pass through the holes 64 (Fig. 13). The cores 82 are, however, permanently secured to the frame 81. The armature 405 is L-shaped and is provided with an extension in the shape of a covering or metal cap 58, shown in detail in Figs. 21 and 22, which is made so as to be easily slipped on or off the end of the armature. This cap is retained in place by a tongue 59 which latches into a little hollow 60 in the armature, especially made for that purpose. Four lugs 87 are provided on said cap for inserting a number plate if desired. The end of the covering 58 is provided with a plurality of insulated rollers 62, which are adapted to engage the springs 83, 84 and 85, which make and break contact with the remaining springs, which are stationary. Said springs are insulated in the usual manner and are clamped between two washers 56^a by means of screws, which screws engage the threaded holes in the rear washer 56^a, whereby the group of springs may be assembled as a unit, independent of the relay proper. The group of springs is at-

tached to the relay by inserting the ends of the screws into slots in the bracket 56 and threading nuts over the ends of said screws. The stationary members of the group of springs are provided with lugs 86 (Fig. 15) to keep them rigid. Said lugs fit snugly into openings in a small block of fibre 89 which is secured to the frame or common U-piece 81 by little metal pins 89^a. The armature 405 is held in position by a special combined latch and retracting spring 66, which is shown in Figs. 14 and 15. The armature 405 protrudes through an opening in the spring 66. At the points 66^a a heel in the armature is engaged by a corresponding heel in the spring and in this way the armature is latched in position. By springing the latch 66 away from the frame 81, the armature is released and may be lifted out. It will be observed that the finger 68, which is a continuation of the spring 66, acts to hold the armature up normally. This spring is secured to the frame 81 by the screw 67.

The master switch shown in Figs. 16 and 17 is assembled on a base or frame 90 which, in this particular case, is mounted upon the angle irons 338 and 339 midway of their length, with line switches on either side of it (Fig. 19). These line switches extend along the guide shaft 336. About the middle of the shaft 336, and opposite where the master switch is located (Figs. 9, 17 and 19), there is a crank comprising the link 93, supported in bearings 95 and 96, and the arms 91 and 94, which are secured to the opposite ends of said shaft. Firmly secured to the link 93 there are two arms 98 and 99, a notched cam 100 and a gear segment 101. The link 93 is also connected with the plunger of a solenoid 102 by means of an arm 103. Adapted to register with the notches in the cam 100 there is a locking dog 104 which is controlled by the armature of the relay 105 through the medium of the arm 106. The relay 105 also controls the contact springs 107, 108, 109 and 110. When the relay 105 is energized, the dog 104 is disengaged from the cam 100 and the shaft 336 and link 93 is then free to rotate. If the solenoid is not energized, the shaft 336 and link 93 will be rotated in a counter-clockwise direction (Fig. 16) by the spring 111. When the solenoid is energized it rotates the shaft 336 and link 93 in a clockwise direction against the tension of the spring 111. In its normal operation the link 93 is rotated in either direction only far enough to carry the last notch in the cam 100 to the dog 104. This limiting action is controlled by the arms 98 and 99 in conjunction with the springs 112, 113 and 114 (Fig. 16), as will be shown. The motion of the link 93 is transmitted to the plunger shaft 336 to give it a corresponding oscillating motion about a line through the link 93 as an axis. This oscillatory motion of the plunger shaft moves the plungers of the line switches back and forth in front of their bank springs. There is a notch in the cam 100 for each set of springs in the banks of the line or trunk switches, and the notches are so spaced that when the dog 104 is in engagement with any one of them, the plungers of these switches that are in engagement with the plunger shaft will be in line with the corresponding sets of springs in their banks. The arm 99 of the master switch is so designed as to force, if properly adjusted, the spring 112 into contact with the spring 113 when the upper notch in the cam 100 reaches a position to register with the dog 104. Similarly, the arm 98 is so designed as to press, if properly adjusted, the spring 114 (Fig. 16) into contact with the spring 113 when the link 93 is rotated far enough to bring the lowest notch of the cam 100 in position to register with the dog 104. In order to operate the springs at the proper time, the arms 98 and 99 may be adjusted by bending, or they may be provided with adjusting screws or other well-known means of adjustment. The speed of operation of the master switch is controlled through the medium of the gear segment 101 by a governor comprising a pair of weighted springs 115 and 116 secured to a shaft 117, which is geared to said segment. As the master switch operates, the shaft 117 rotates and causes the ends of the springs 115 and 116 to fly outward and rub on the inside of a stationary cup 118 to produce a retarding action.

In Fig. 2 there is diagrammatically shown a substation A to the line conductors of which there is allotted at the central office one of the subscribers' individual switches C of the type shown in Figs. 8 and 9. As has been explained, each line switch is provided with a number of sets of springs. Each of these sets forms the terminal of a trunk line leading to a secondary switch E. This trunking arrangement is the same in principle as that described in British Patent No. 1421 of 1910, issued to T. G. Martin. Each trunk line is connected in multiple with the corresponding set of springs in the banks of all the line switches which are controlled by the same master switch. The said line conductors are connected in multiple with the springs 321 and 323 of all the sets in its own line switch bank. To each subscriber's line there is also allotted a cut-off relay 80, together with a line relay 201, both of which are preferably of the type of relays shown in Figs. 12, 13, 14 and 15, but in Fig. 2 are shown in conventional form. At D there is shown the master switch of the type shown in Figs. 16 and 17 for controlling the line switch plungers

of the group of line switches to which the switch C belongs. In addition to the parts already described, the master switch is provided with a suitable bank of contacts comprising a common segment 204 and an individual contact *a* for each trunk line to which the switches C have access. The wiper 205 is secured to the master switch shaft and is adapted to keep the common segment 204 in electrical contact with the individual contact corresponding to the trunk line before which the plungers are being held by the master switch. This master switch is also provided with a resistance winding 79, which, when the springs 109 and 110 are separated, is inserted between ground G^4 and the lead that supplies ground connection to the line switches in the group C^1 for holding their solenoids, such as the solenoid 330, energized. The object in inserting this resistance is to prevent a complete break between this ground lead and the ground terminal G^4 , which might some time cause the release of such solenoids prematurely.

The switch E, which is known as a secondary line or trunk switch, is equipped with a solenoid and plunger 206 and 206^a, respectively, of the same type as that of the switch C but for its contact springs, there being three in the former forming a make and break contact. The master switch F, which controls the group of secondary line switches to which the switch E belongs, is similar to the master switch D but for an extra relay 207 which is connected to the front contact of the relay 425. Associated with the secondary switches E there are a number of so-called chain relays 247, 247^a, etc. There is a chain of these relays for each group of switches E, and in each chain there is a relay for each trunk line which leads from the corresponding group of secondary switches E to R switches. When all the trunks leading from the group E^1 (Fig. 1) of secondary switches E become busy, all the relays 247, 247^a, etc., through 247ⁱ, are energized and complete a circuit from ground G^7 through the armatures of said relays and thence through the relay 425 to battery. When the relay 425 energizes, a circuit is completed from ground G^2 through the relay 207 to the battery lead 500. The relay 207, upon energizing, puts a guarding potential on all the primary master switches D, D', etc., (Fig. 1) having access to the secondary group E^1 in question, thereby preventing the selection of any further trunks until one or more trunks from that group become idle. The relay 425, upon energizing, also disconnects battery from the solenoid 71 and locking relay 72 to prevent the master switch from operating continuously while all its bank contacts are grounded.

The group selector R, which has been partly described in connection with Figs. 5,

6 and 7, is in addition provided with a line relay 208 and a cut-off relay 210, as shown in Fig. 2. The switches H, I and J are similar to the switches E, F and R, respectively. The switch N is similar to the switch H and is controlled by a master switch I', not shown in Fig. 3 but indicated in Fig. 1—that is, operated in the same manner as the master switch I and has precisely the same function.

The connector K (Fig. 4) is of the general type disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but is modified to operate in a two-wire system, as shown, for example, in said British Patent No. 1421 of 1910. This connector comprises the usual wipers 212, 213 and 214 carried upon a vertically and rotatably movable shaft which is controlled by a vertical magnet 215 and a rotary magnet 216 and the usual side switch, which latter is controlled by the private magnet 217 in the usual manner. At L there is shown a ringing current generator and at M is represented a busy signaling machine. A battery B having one terminal grounded at G is shown for supplying current for operating the switches and for talking purposes. The connector K is represented as having obtained connection with the line of substation A^x, which is provided with the line switch C^x in all respects similar to the line switch C (Fig. 2).

In order to give a clearer understanding of my invention, I will explain in detail how the subscriber at substation A may obtain connection with the subscriber at substation A^x, the number of which will be assumed to be 2220. Upon removing his receiver from the switch hook, the subscriber at substation A permits the spring 218 to engage the spring 219, whereby a circuit is completed extending from ground G^3 through the resistance coil 220, springs 221 and 83 of the cut-off relay 80, line 223, springs 218 and 219, 224 and 225, receiver 226, transmitter 227, line 228, spring 85, contact 230, through the winding of the line relay 201 and the resistance coil 231 to the battery lead 500. The relay 201, upon energizing, completes a circuit from ground G^4 through the springs 110 and 109, armature spring and contact 202 and 203, respectively, springs 343 and 342 (which are normally closed) and through the winding of the solenoid 330 to the battery lead 500. The solenoid 330, upon energizing, first breaks the connection between the springs 343 and 342, thereby removing the short-circuit shunt from the resistance 234, cutting the same in series with the solenoid 330 and draws the plunger of said solenoid down into the set of bank springs, making connection in pairs, as has been already explained. The engagement of the springs 320

and 324 completes a circuit from ground G⁵ through said springs, through the solenoid 206 of the secondary line switch E, springs 235 and 236, 237 and 238, through the resistance coil 238' and the springs 239 and 240 to the battery lead 500. The coil 238' prevents the negative and positive sides of the battery from short-circuiting if the springs 237', 237 and 238 should happen to come into contact at the same time. When the solenoid 206 becomes energized, the main battery lead 500 is connected through the resistance coil 242 in series with the solenoid to ground G⁵ by way of the springs 235 and 241. It will be noticed that the springs 236, 241 and 235 are so devised that when the solenoid 206 energizes, the spring 235 engages the spring 241 before it breaks from the spring 236. Also when the solenoid 206 becomes energized, the plunger is inserted into a set of bank springs similar to those in the line switch C which make contact in pairs as follows: 20^a with 24^a; 22^a with 26^a; 23^a with 27^a and 21^a with 25^a. The engagement of the springs 20^a and 21^a with the springs 24^a and 25^a, respectively, extends the line connection to the group switch R, whereupon its line relay 208 becomes energized, providing a holding circuit for the solenoid of the switch C. The circuit of the relay 208 of the switch R extends from ground G⁵ through the lower winding of said relay, springs 243 and 244, springs 25^a and 21^a, 325 and 321, line 223, substation A, back by way of the line conductor 228, springs 323 and 327, 20^a, 24^a, relay springs 246 and 245 and through the top winding of the relay 208 to the battery lead 500. The relay 208, upon energizing, completes the aforesaid holding circuit for the switch C, said circuit extending from ground G⁵ through the contact 61, chain relay 247, springs 26^a, 22^a, 326 and 322, through the winding of the coil 80 and through its own contact springs 84 and 249 to the battery lead. This ground G⁵ also furnishes a guarding potential over the private normal conductor 232 to the connector private bank contacts of the calling subscriber, placing thereon a guarding potential to keep other subscribers from calling the subscriber A while he is calling. Upon the relay 80 becoming energized, contact is broken at the springs 84 and 249, cutting the winding of said relay 80 and resistance 80^a in series with the winding of the solenoid 330. The flow of current is thus cut down in the solenoid 330, since it takes less to hold the plunger of the solenoid and the armature of the relay when once they are energized. Contact is also broken at the springs 85 and 230, and 83 and 221, deenergizing the line relay 201, which, up to this time, has been the means of supplying battery current from ground G⁴ to the solenoid 330, which means is now no longer required. In addition, upon the energizing of the relay 80, the normal line wires 250 and 251 are connected to the line conductors of the calling subscriber, but at this time this operation has no particular function. When the springs 324 and 320 were forced into contact by the plunger of the line switch, a circuit in multiple with that already described through the solenoid 206 was closed from ground G⁵ through said springs, master switch bank contact 412 (which is assumed to be the contact belonging to the trunk line leading to the secondary switch E), wiper 205, common segment 204 and the relay 407 to the battery lead. The relay 407, upon energizing as explained, completes a circuit through the relay 105, thereby energizing the relay 105, which latter separates the springs 109 and 110, closes the contact between the springs 107 and 108 and withdraws the locking dog 104 from the cam 100. As soon as the cam is unlocked, the spring 111 (Fig. 16) begins to move the plunger shaft 336 to move the plungers of all the idle line switches which are in engagement therewith away from the trunk line just seized by the switch C. Of course, the switch C, when it operates as described, becomes disengaged from the plunger shaft and is therefore not affected by the movement of said shaft. After the plungers have been moved a short distance, the master switch wiper 205 passes off the contact 412, which allows the relay 407 to deenergize and in turn break the circuit of the relay 105. The relay 105 thereupon allows the dog 104 to drop back and engage the next notch in the cam 100, which stops the master switch and the plunger shaft with the plungers resting in front of the next trunk line—that is, provided this trunk line is idle. If this trunk line is busy, however, the wiper 205 will find the next contact grounded, which will cause the relays 407 and 105 to remain energized, while the next opening in the cam 100 is passing the dog 104, and the plungers will be carried past the busy trunk to an idle one. When the plungers reach a position opposite the last trunk, the springs 112 and 113 are forced into contact by the arm 99, as has been hereinbefore explained. Therefore, if the plungers of the line switches are being held in front of the last trunk and this trunk becomes seized by some line switch, or if this trunk is busy when the plungers arrive opposite it, a circuit will be closed from ground G⁵ through the springs of the relay 407 (said relay being energized because the wiper 205 is in engagement with the guarded contact of the last trunk, which is assumed to be busy), springs 113 and 112 (which are now held in contact by the arm 99), relay 417 and the springs 107 and 108 to battery. The relay

417 thereupon energizes, forcing the springs 418, 419 and 420 into contact, in which position said springs become locked by the co-operation of the lug on spring 114 with the spring 418. The engagement of the springs 419 and 418 completes a circuit from ground G²¹ through the said springs and through the relay 105 to maintain the said relay 105 energized independent of the relay 407. The engagement of the springs 419 and 420 completes a circuit through the solenoid 102 of the master switch. The solenoid, upon energizing, rotates the shaft 336 (Fig. 16) in a clockwise direction, thereby causing the said shaft 336 to carry the plungers of the idle line switches back to the position opposite the first trunk. When the plungers reach this position, the arm 98 depresses the spring 114, which allows the springs of the relay 417 to restore to normal position, thereby breaking the circuit of the solenoid 102 and the relay 105. The relay 105, upon deenergizing, allows the dog 104 to drop into the cam 100 and lock the master switch with the plungers standing opposite the first trunk. When connections are made through to the secondary trunk switch E in the manner hereinbefore described, the engagement of the springs 23^a and 27^a completes a circuit from ground G⁴⁰ through the relay 407^a to battery to operate the master switch F in the same manner as described in connection with the master switch D. As each trunk line is engaged, the chain relay in connection therewith operates in the manner already described to close one contact in the circuit of the relay 425. When all the trunk lines leading out of the group of switches to which the switch E belongs become busy, the circuit of the relay 425 will be completed. The relay 425, upon energizing, operates to close the circuit of the relay 207, which in turn operates not only to provide a guarding potential at the primary master switches D, as has already been explained, but also to cut off the operating current from the remaining idle switches E in this group.

The operations so far described, resulting in the extension of the connection from the telephone to the switch R, are brought about by the removal of the receiver from the switch hook. The subscriber now operates his dial for the first digit 2, momentarily separating the substation impulse springs 224 and 225. Each time the impulse springs are separated, the energizing circuit for the line relay 208 of the group selector R is momentarily broken. Said relay 208, as has already been explained, has two windings and each winding has a separate magnetic circuit, this being brought about by the core of the relay having near its center a lateral projection 254, to which latter the mounting 255 for the armatures is attached.

Therefore the armature on one end of the relay is not affected by the winding on the other end. Of the two said armatures, the upper one (armature 63) operates the quicker and in response to impulses sent over the line by the subscriber at the substation A. The lower armature 65 remains held against the core of the magnet by the residual magnetism in said core. This may be accomplished by omitting the usual brass residual cap from the lower end of the core, thereby allowing the armature 65 to strike the bare core and retaining said residual cap for the upper part of the core, or inserting a brass residual screw through the center of the armature. Since the lower armature is slow acting it does not have time to drop back during the momentary separation of the substation impulse springs 224 and 225, and does not permit the holding circuit of the switch C to be broken while impulses are being transmitted. This relay is similar to that described in Australian patent specification No. 4772 of 1912.

The engagement of the springs 256 and 257 upon each momentary deenergization of the relay 208 completes an energizing circuit through the rotary magnet 40. The circuit extends from ground G⁶ through the contact 400, springs 256 and 257, rotary magnet 40, springs 48 and 49 to the battery lead 500. At the first step of the switch the rotary off-normal bushing 51 allows the springs 48 and 49 to separate and springs 49 and 50 to make contact, and conducts battery current to the rotary magnet by way of the last-mentioned springs and through the springs 403 and 402, said circuit being maintained by the armature which controls the spring 403, said armature being slow acting and not responding to the impulses as does the driving armature 41. The digit called being 2, the magnet 40 receives two impulses and operates in response thereto to rotate the plunger of the switch two steps in the manner described in connection with Figs. 5 and 6, whereby said plunger is brought in front of a group of springs representing the terminal of a trunk line leading to a trunking switch H in the second thousand. When the two impulses have been transmitted and the subscriber is removing his finger from the hole in the dial preparatory to calling the second digit, the line circuit is temporarily closed through the springs 224 and 225 and the two armatures of the relay 208 are for the time being attracted, cutting off the operating current from the rotary magnet 40. After a short time the slow acting armature of said magnet 40 drops back, whereupon the springs 403 and 404 make contact, completing a circuit from ground G⁶ through the winding of the solenoid 38 and the springs 268 and 269, 404, 403, 50 and 49 to

the battery lead 500. Upon the energization of the solenoid 38, the plunger is drawn down into the set of bank springs in a manner similar to that of the line switch C. Also, the springs 269 and 268 break contact, removing the short-circuit from the resistance 209, whereby the current flowing through the solenoid 38 is reduced. The engagement of the springs 23 and 21 with the springs 27 and 25, respectively, extends the line connection to a given trunk switch H, and the engagement of the spring 20 with the spring 24 closes the circuit of the solenoid 67 of said switch H from ground G⁴¹. The switch H thereupon operates in the same manner as the switch E to extend the line connection through the springs 23^c and 27^c on one side and the springs 21^c and 25^c on the other side to the second group selector J. When this connection is extended to the switch J, an energizing circuit is established through the line relay 68, which operates to close an energizing circuit for the cut-off relay 210 of the switch R in the same manner in which the line relay 208 of the switch R operates to close the energizing circuit from ground G⁶ through the contact 61 and the chain relay 247 for the cut-off relay 80 of the line switch C. This new holding circuit extends from ground G⁴² at the switch J through the contact 69, chain relay 70, springs 26^c and 22^c, springs 26 and 22 and through the cut-off relay 210 to battery. The relay 210, upon energizing, disconnects the line relay 208 from the line and provides a new holding ground G⁴³ for the solenoid 38 and cut-off relay 80 of the switch C to take the place of ground G⁶ when the relay 208 deenergizes.

The subscriber now operates his dial for the second digit 2, whereupon the line relay 68 receives two impulses, operating in turn the rotary magnet 211^a two steps to bring the plunger opposite a group of springs representing the terminal of the trunk line leading to a trunk switch N in the second hundred, whereupon the solenoid 73, operating in a manner similar to that of the solenoid 38 of the switch R (Fig. 2), thrusts the plunger into position, pressing the springs 23^a, 22^a, 20^a and 21^a into contact with the springs 27^a, 26^a, 24^a and 25^a, respectively, thereby extending the line connection to the switch N and energizing the solenoid 74 over a circuit extending from ground G⁴⁴ and through the springs 20^a and 24^a. The switch N operates just like the switch H and in so doing extends the connection to the connector K by pressing the bank springs 23^e, 22^e, 20^e and 21^e into contact with the springs 27^e, 26^e, 24^e and 25^e, respectively. As soon as connection is extended to the connector the line relay 270 is energized, whereby the springs 272 and 76 are brought into contact, thereby closing an energizing circuit for the slow acting release relay 271 from ground G¹². The relay 271, upon energizing, closes an energizing circuit for the relay 304 in the switch J as follows: from ground G⁴⁵ through the side switch wiper 77, spring contact 78 to the trunk wire 75^a, thence through the chain relay 75 and the springs 26^e and 22^e, 26^d and 22^d and the coil 304 to battery. The relay 271 also prepares the energizing circuits for the vertical and rotary magnets 215 and 216, respectively, by closing the springs 275 and 274 in contact.

The subscriber now again operates the dial for the third digit 2. The energizing circuit for the connector line relay 270 is broken twice momentarily by the making and breaking of the impulse springs 225 and 224 of the calling device at the substation A. Since the relay 271 of the connector is slow acting, it does not have time to deenergize during the momentary deenergization of the relay 270. Consequently, the engagement of the springs 272 and 273 closes an energizing circuit through the vertical magnet 215. This circuit extends from ground G¹² through the springs 272 and 273, springs 274 and 275, vertical magnet 215, side switch wiper 276 and the private magnet relay 277 to the battery lead 500. The vertical magnet receives two impulses over this circuit and operates to raise the shaft wipers 212, 213 and 214 two steps. The private magnet relay 277 operates to close the circuit of the private magnet 217 while the vertical magnet is operating. The circuit through the private magnet extends from ground G¹⁴ through the springs 279 and 278 and the private magnet 217 to the battery lead 500. This circuit is broken shortly after the last impulse is delivered to the vertical magnet, whereupon the private magnet deenergizes and permits the side switch to pass to second position. The movement of the side switch wiper 276 from first to second position transfers the battery connection from the vertical magnet 215 to the rotary magnet 216. The connector is then in position to receive impulses for the last digit 0. The operation of the substation calling device for this digit breaks the energizing circuit of the relay 270 ten times. Each time the relay 270 deenergizes it closes a circuit extending from ground G¹² through the springs 272, 273, 274 and 275, springs 280 and 281, rotary magnet 216, side switch wiper 276 (in second position) and the relay 277 to the battery lead 500. The rotary magnet 216 receives ten impulses over this circuit and operates to rotate the wipers ten steps onto the contacts of the line No. 2220. The private magnet relay 277 is energized by the first impulse to the rotary magnet and again closes the circuit of the private magnet 217. The circuit of the relay 277

is not opened long enough to permit it to deenergize until after the last impulse has been delivered to the rotary magnet. The relay 277 then deenergizes and breaks the circuit of the private magnet 217, which, if the called line is not already busy, in turn deenergizes and permits the side switch to pass to third position, whereby connection is completed between the calling and called lines. The side switch wiper 77, upon passing to third position, shifts the holding ground for the switch R from ground G^{45} to ground G^{12} by way of the springs 76 and 272 of the line relay 270. The side switch wiper 282 (in third position) extends a guarding potential from ground G^{16} through the private wiper 214 to the connector private bank contacts of the called line, and also provides an energizing circuit for the cut-off relay 283 of the line switch C^x , which extends to the connector private bank contact as traced, thence through the cut-off relay 283 and its normally engaged contact springs 283^a and 283^b to battery. When the said relay 283 attracts its armature the direct battery connection is removed from the springs 283^b and a new circuit will be formed which extends from ground as traced to the connector private bank contact, through cut-off relay 283, resistance 284^a , and solenoid 284 to the battery B, but the combined resistances in this circuit are high enough to prevent sufficient current from flowing to operate the solenoid. Although this current is not strong enough to operate the line switch, it is sufficient to hold it in its operated position, as explained in connection with the line switch C of the calling line. The relay 283, upon energizing, cuts off the line relay 285 and connects the called line with its connector bank contacts. When the side switch wiper 276 of the connector reaches third position, the energizing circuit is established for the ringer relay 286. This circuit extends from ground G^{17} through the interrupter 287, springs 288 and 289, relay 286, side switch wiper 276 and the relay 277 to the battery lead 500. The relay 277 is not operatively energized over this circuit owing to the comparatively high resistance of the relay 286. Since this circuit includes the interrupter 287, the relay 286 is energized only intermittently. Each time the relay 286 is energized it operates to disconnect the calling line from the called line and to bridge the generator L across the called line to ring the bell 290. When the called subscriber removes his receiver, or as soon thereafter as the relay 286 deenergizes, if it happens to be energized at the time, the called substation is provided with talking battery current from the central office. The circuit over which this talking current flows extends from ground G^{16} through the side switch wiper 282, lower

winding of the relay 291, ringer relay springs 292 and 293, side switch wiper 294, shaft wiper 213, line 295, hook switch springs 296 and 297, substation receiver and transmitter, line 298, shaft wiper 212, side switch wiper 299, ringer relay springs 300 and 302, and the upper winding of the back-bridge relay 291 to the battery lead 500. When the connector back-bridge relay 291 is energized, it breaks the circuit of the ringer relay 286 at the springs 288 and 289 to prevent further application of ringing current to the called line.

After the conversation is completed, the release of the central office apparatus is initiated by the hanging up of the receiver at the calling substation. When the receiver 226 is restored to the switch hook, the springs 218 and 219 are separated, thereby breaking the energizing circuit through the connector line relay 270. The relay 270, upon deenergizing, breaks the holding circuits of the relays 271 and 304 of the switches K and J, respectively. When the relay 271 of the connector deenergizes it completes a circuit from ground G^{12} through the springs 272 and 273, springs 274 and 305, release magnet 306 and the off-normal springs 307 and 308 to the battery lead 500. The energization of the magnet 306 immediately restores the connector to normal position, thereby breaking the connection with the called line and allowing the relay 283 of the called line to deenergize. The deenergization of the relay 304 of the switch J breaks the circuit of the solenoid 73, as well as that of the relay 210 of the switch R. The solenoid 73, upon deenergizing, permits its plunger to be withdrawn from its banks and returned to normal position, while the relay 210, upon deenergizing, breaks the circuits of the solenoid 38 of the switch R and the relay 80 and solenoid 330 of the switch C. Upon the deenergization of the solenoid 38, the plunger of the switch R is restored to its normal position, while at the same time the plunger of the switch C is permitted to be withdrawn from its bank by the deenergization of its solenoid 345. The switches J, R and C, upon releasing, destroy the holding circuits of the switches N, H and E, respectively, and all the apparatus is thus restored to normal position.

The foregoing is an explanation of how connection is completed with an idle line. It will now be explained how the calling subscriber is given the busy signal in case the called line is in use.

It has been explained how the connector private bank contacts of the called line are provided with a guarding potential. It will be evident that the calling line is also provided with a guarding potential extending from ground G^{43} at the selector R through the relay 247, springs 26^a and 22^a , 130

326 and 322 and the conductor 232, which latter leads to the connector private bank contacts of the substation A. Thus, whenever the private wiper 214 of the connector engages the contact of a busy line, a grounded potential is extended from the grounded private bank contact of said line through said wiper, springs 505, lower winding of the relay 291, springs 292 and 293 and the side switch wiper 294 (in second position) to the springs 278^a and 278 at the private magnet relay 277 and through relay 217 to the battery B. Thus, when the relay 277 deenergizes after the last digit is called, the circuit of the private magnet 217 is not opened; but is shifted from ground G¹⁴ to the ground at the private wiper by the engagement of the springs 278^a and 278. The relay 291 thereupon becomes energized, because its lower winding is included in the holding circuit of the private magnet, and a circuit is closed from ground G¹⁴ through the springs 279 and 506 of the relay 277, springs 507 of the relay 217, relay 508 and the springs 510 to battery. The relay 508, upon energizing, shifts the holding circuit of the private magnet 217 and the relay 291 from the private wiper to ground G²⁰. Since the private magnet does not deenergize, the side switch remains locked in second position without completing connection with the busy line and the busy signaling machine M is connected with the calling line through the springs 509, side switch 299 (in second position), springs 300 and 302 and the condenser 511, along the heavy conductor to and through the substation and back through the lower winding of the line relay 270 to ground. After the subscriber at the station A receives the busy signal, he will, of course, hang up his receiver, whereupon he will open the line circuit at the springs 218 and 219, as already explained, causing the line relay 270 at the connector K to deenergize. The deenergization of this line relay 270 will again cause the release of the instruments K and J. The instrument J, upon releasing, will in turn cause the release of the instruments N and R, and the instrument R will, upon releasing, cause the release of the instruments H and C. The release of the instrument C finally causes the release of the switch E, in the manner already explained.

It will thus be seen that I have devised a very efficient and improved automatic telephone system in which the trunking connection is established by means of a series of non-numerical and numerical switches. The numerical switches are entirely under the control of the called subscriber and are merely for the purpose of selecting groups, while the non-numerical switches are for the purpose of connecting with an idle trunk. It will further be noticed that the trunk-se-

lecting operation is not performed by the old method of having the contact arm step from one trunk to another until an idle trunk is reached, but on the contrary the non-numerical switches of a group are always maintained in a position opposite an idle trunk, whereby they can immediately establish connection with such idle trunk when the trip magnet is operated. It will furthermore be seen that the trunk-selecting element is not individual to any one group selector, or any one of the non-numerical switches, but on the contrary this trunk-selecting element, which is the master switch, is common to a group of such switches, and thus it is necessary to have but one trunk-selecting element for as many as one hundred non-numerical switches.

While I have illustrated and described one particular embodiment of my invention, it will, of course, be understood that various modifications and changes could be made, both in the construction of the various switches employed, and likewise in the specific trunking arrangement illustrated. Thus, for example, the R switches or group selectors could be made individual to the subscribers' lines, or they could be reached through a single line switch instead of through the primary and secondary switches, as shown. Other modifications and changes will readily suggest themselves to those skilled in the art and come within the contemplated scope of my invention.

What I claim as my invention is:—

1. In a telephone system, a line, a series of non-numerical switches, a second series of numerical switches to which said first series is adapted to extend a connection, and a third series of switches divided into groups to which said second series is adapted to extend a connection, each switch of said second series having an individual switch in each group of said third series of switches, and means for controlling said switches over a circuit including the two sides of said line in series to extend connections.

2. In a telephone system, a series of lines, a series of automatic switches, trunking means for making said switches common to said lines, a second series of switches, trunking means between said first and second series of switches whereby connections from the switches of the first series may be extended to the switches of the second series, a second series of lines, a third series of automatic switches, trunking means for making the switches of the third series common to the lines of the second series, a fourth series of automatic switches, trunking means between the third and fourth series of switches whereby trunking connections may be extended from the switches of the third series to the switches of the fourth series, a fifth series of switches, and trunking means be-

tween the fourth and fifth series for making the fifth series common to the second and fourth series.

3. In a telephone system, a line, a plurality of other lines associated with said first line, a terminal for each of said last lines, terminals for said first line, one for each of said other lines, an impulse sender and a progressively movable circuit closer associated with said first line, means for operating said circuit closer in response to a plurality of impulses from said line to place the circuit closer in readiness to connect the said first line with one of said other lines via the contact of the other line and the corresponding contact of the first line.

4. In a telephone system, a line, a plurality of other lines associated with said first line, a terminal for each of said last lines, terminals for said first line, one for each of said other lines, an impulse sender and a progressively movable circuit closer associated with said first line, means for operating said circuit closer in response to a plurality of impulses from said line to place the circuit closer in readiness to connect the said first line with one of said other lines via the contact of the other line and the corresponding contact of the first line, and means for closing the connection in response to the cessation of the impulses.

5. In a telephone system, a line, a plurality of other lines associated with said first line, a terminal for each of said last lines, terminals for said first line, one for each of said other lines, an impulse sender and a progressively movable circuit closer associated with said first line, means for operating said circuit closer in response to a plurality of impulses from said line to place the circuit closer in readiness to connect the said first line with one of said other lines via the contact of the other line and the corresponding contact of the first line, said means comprising a propelling magnet individual to the said first line.

6. In a telephone system, a line, a plurality of other lines associated with said first line, a terminal for each of said last lines, terminals for said first line, one for each of said other lines, an impulse sender and a progressively movable circuit closer associated with said first line, means for operating said circuit closer in response to a plurality of impulses from said line to place the circuit closer in readiness to connect the said first line with one of said other lines via the contact of the other line and the corresponding contact of the first line, said means comprising a propelling magnet individual to the said first line, and means for closing the connection in response to the cessation of the impulses.

7. In a telephone system, a line, a terminal for said line, another line, a terminal

for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the same impulse for operating said circuit closer to so connect said lines, and a circuit for said second magnet passing through contacts directly controlled by said first magnet.

8. In a telephone system, a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the same impulse for thereafter operating said circuit closer to so connect said lines, and a circuit for said second magnet passing through contacts directly controlled by said first magnet.

9. In a telephone system, a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the cessation of the impulse for operating said circuit closer to so connect said lines, and a circuit for said second magnet passing through contacts directly controlled by said first magnet.

10. In a telephone system, a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the cessation of the impulse for thereafter operating said circuit closer to so connect said lines, and a circuit for said second magnet passing through contacts directly controlled by said first magnet.

11. In a telephone system, a line, a terminal for said line, a plurality of other lines, a terminal for each one of said other lines, an impulse sender, a line relay and a circuit closer associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to impulses over said line to place the closer in

readiness to connect the said first line with one of said other lines via their terminals, a second magnet responsive to the cessation of the impulses for operating the closer to connect said lines, and a circuit for said second magnet passing through contacts directly controlled by said first magnet.

12. In a telephone system, a line, a plurality of other lines associated with said first line, a terminal for each of said other lines, terminals for said first line, one for each of said other lines, an impulse sender, a line relay and a progressively movable circuit closer all associated with said first line, means including a propelling magnet and a second magnet for operating said circuit closer controlled by said line relay in response to a plurality of impulses from said line to place the circuit closer in readiness to connect the said first line with one of said other lines and to then operate said circuit closer to connect said lines via the terminal of the other line and the corresponding terminal of the first line, and a circuit for said second magnet controlled by said first magnet.

13. In a telephone system, a line, a plurality of other lines associated with said first line, a terminal for each of said other lines, terminals for said first line, one for each of said other lines, an impulse sender and a progressively movable circuit closer and a line relay associated with said first line, means including a propelling magnet for operating said circuit closer controlled by said line relay in response to a plurality of impulses from said line to place the circuit closer in readiness to connect the said first line with one of said other lines via the terminal of the other line and the corresponding terminal of the first line, and means including a second magnet for closing the connection in response to the cessation of the impulses, and a circuit for said second magnet controlled by said first magnet.

14. In a telephone system, a line, a plurality of other lines associated with said first line, a terminal for each of said other lines, terminals for said first line, one for each of said other lines, an impulse sender, a line relay and a progressively movable circuit closer associated with said first line, means for operating said circuit closer controlled by said line relay in response to a plurality of impulses from said line to place the circuit closer in readiness to connect the said first line with one of said other lines via the terminal of the other line and the corresponding terminal of the first line, said means comprising a propelling magnet and a second magnet individual to the said first line, and a circuit for said second magnet controlled by said first magnet.

15. In a telephone system, a line, a plu-

65 rality of other lines associated with said first line, a terminal for each of said other lines, terminals for said first line, one for each of said other lines, an impulse sender, a line relay and a progressively movable circuit closer associated with said first line, means 70 for operating said circuit closer controlled by said line relay in response to a plurality of impulses from said line to place the circuit closer in readiness to connect the said first line with one of said other lines via the 75 terminal of the other line and the corresponding terminal of the first line, said means comprising a propelling magnet individual to the said first line, and means including a second magnet for closing the 80 connection in response to the cessation of the impulses, and a circuit for said second magnet controlled by said first magnet.

16. In a telephone system, a plurality of telephones, means for connecting any two 85 comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said 90 circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the same im- 95 pulse for operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, and a central battery for supplying current for operating and talking 100 purposes.

17. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, 105 an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to 110 place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the same impulse for thereafter operating said circuit closer to so connect said lines, a circuit for said 115 second magnet passing through contacts of said first magnet, and a central battery for supplying current for operating and talking purposes.

18. In a telephone system, a plurality of 120 telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with 125 said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to

place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the cessation of the impulses for operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, and a central battery for supplying current for operating and talking purposes.

19. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the cessation of the impulses for thereafter operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, and a central battery for supplying current for operating and talking purposes.

20. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, a plurality of other lines, a terminal for each one of said other lines, an impulse sender, a line relay and a circuit closer associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to impulses over said line to place the closer in readiness to connect the said first line with one of said other lines via their terminals, a second magnet responsive to the cessation of the impulses for operating the closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, and a central battery for supplying current for operating and talking purposes.

21. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the same impulse for operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means responsive to the breaking

of the battery circuit at one of the telephones for restoring said circuit closer to normal.

22. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, means for operating said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the same impulse for thereafter operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means responsive to the breaking of the battery circuit at one of the telephones for restoring said circuit closer to normal.

23. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the cessation of the impulse for operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means responsive to the breaking of the battery circuit at one of the telephones for restoring said circuit closer to normal.

24. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the cessation of the impulse for thereafter operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means responsive to the breaking of the battery circuit

cuit at one of the telephones for restoring said circuit closer to normal.

25. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, a plurality of other lines, a terminal for each one of said other lines, an impulse sender, a line relay and a circuit closer associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to impulses over said line to place the closer in readiness to connect the said first line with one of said other lines via their terminals, a second magnet responsive to the cessation of the impulses for operating the closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means responsive to the breaking of the battery circuit at one of the telephones, for restoring said circuit closer to normal.

26. In a telephone system, a plurality of telephones, means for connecting any two comprising a series of automatic switches, impulse sending means for said telephones for operating said switches, a second series of switches, lines between said first and second series of switches, means including a line relay and a propelling magnet in the switch of the first series responsive to impulses from said sending means for operating the switch of the first series to establish connection with a switch of the second series and for preventing the said operating switch from closing a connection with any one of said lines until the switch has advanced to a position corresponding to the switch in the second series, a second magnet for then operating said operating switch to close a connection with the said switch in the second series in response to the last impulse, a circuit for said second magnet controlled by said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means for breaking the connection and for restoring each of the switches, involved in holding the connection, to normal, said means responsive to the breaking of the battery circuit at one of the telephones.

27. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the same impulse for operating said circuit closer to so con-

nect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means for releasing the connection under the control of the first line at its telephone.

28. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the same impulse for thereafter operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means for releasing the connection under the control of the first line at its telephone.

29. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said lines via said terminals, a second magnet responsive to the cessation of the impulse for operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means for releasing the connection under the control of the first line at its telephone.

30. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, another line, a terminal for said other line, an impulse sender for said first line, a circuit closer and a line relay associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to an impulse over said line to place the circuit closer in readiness to connect the said line via said terminals, a second magnet responsive to the cessation of the impulse for thereafter operating said circuit closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means for

releasing the connection under the control of the first line at its telephone.

31. In a telephone system, a plurality of telephones, means for connecting any two comprising a line, a terminal for said line, a plurality of other lines, a terminal for each one of said other lines, an impulse sender, a line relay and a circuit closer associated with said first line, a magnet for propelling said circuit closer controlled by said line relay in response to impulses over said line to place the closer in readiness to connect the said first line with one of said other lines via their terminals, a second magnet responsive to the cessation of the impulses for operating the closer to so connect said lines, a circuit for said second magnet passing through contacts of said first magnet, a central battery for supplying current for operating and talking purposes, and automatic means for releasing the connection under the control of the first line at its telephone.

32. In a telephone system a subscriber's line, a plurality of trunk lines, a numerical switch for electing one of said trunk lines, a non-numerical preselecting switch associated with each of said lines, other lines, means for operating said non-numerical switch to connect with one of said other lines, said numerical and non-numerical switches having selective movement in a single plane, and a circuit including the two sides of said subscriber's line in series for controlling the operation of said switches.

33. In a telephone system, a subscriber's line, a plurality of trunk lines, a numerical switch for electing one of said trunk lines, a non-numerical preselecting switch associated with each of said lines, other lines, means for operating said non-numerical switch to connect with one of said other lines, said numerical switch having rotary motion in selecting one of said first lines, and a circuit including the two sides of said subscriber's line in series for controlling the operation of said switches.

34. In a telephone system, a subscriber's line, a plurality of trunk lines, a numerical switch for electing one of said trunk lines, a non-numerical preselecting switch associated with each of said trunk lines, other lines, means for operating said non-numerical switch to connect with one of said other lines, said non-numerical switch having a rotary motion controlled over a circuit including the two sides of said subscriber's line in series.

35. A telephone system comprising telephone lines, first selectors and connectors, automatic switching devices for connecting said lines and said first selectors, calling devices at the substations of said lines for sending impulses over the two sides of said

lines in series for operating said first selectors and connectors, and interposed non-directive automatic switching devices individual to each of said selectors for connecting said selectors to said connectors.

36. A telephone system comprising telephone lines, a selector switch and a plurality of connectors, means for connecting a calling one of said lines to said selector switch, a calling device at the substation of said calling line for sending impulses over the two sides of the calling line in series for directly controlling said selector, a plurality of non-directive automatic switching devices individual and accessible to said selector, and means for operating one of said non-directive switching devices for connecting with one of said connectors.

37. A telephone system comprising telephone lines, a first selector and a plurality of connectors, automatic means for connecting said first selector to a calling one of said lines, and an interposed non-directive progressively movable switching device for the exclusive use of said selector for connecting said selector to one of said connectors, and a circuit including the two sides of said calling line in series for controlling the operation of said connectors.

38. In a telephone trunking system, a main group of lines comprising a plurality of subgroups, a group of first selectors, serially related primary and secondary trunking switches whereby all the lines of said main group are given common access to said group of first selectors, a second main group of lines and associated first selectors, two groups of second selectors, one for each main group of lines, and automatic trunking switches inserted between said first selectors and second selectors whereby all the second selectors are rendered accessible from each group of first selectors.

39. In a telephone trunking system, a plurality of groups of first selectors, each group being common to a plurality of subscribers' lines, a plurality of groups of second selectors there being one such group for each of said pluralities of lines, and each group of second selectors being divided into subgroups, trunking switches intervening between the first and second selectors, and trunk lines so arranged that the second selectors of each subgroup are accessible from each group of first selectors.

40. In a telephone system including a plurality of switches each having a longitudinally movable plunger for closing any one of a plurality of sets of bank contacts, a series of such switches and circuits whereby they may be directly controlled by a calling subscriber in accordance with digits of a called number, and a second series of such switches arranged alternately with the switches of said first series and having cir-

cuits adapted exclusively for non-directive control.

41. In a telephone system including a plurality of switches each having a longitudinally movable plunger for closing any one of a plurality of sets of bank contacts, a series of such switches and circuits whereby they may be directly controlled by a calling subscriber in accordance with digits of a called number, a second series of such switches arranged alternately with the switches of said first series and having circuits adapted exclusively for non-directive control, and a directly controlled final connector accessible to the last switch of the said second series.

42. In a telephone system, automatic switches each having one movement to select a particular trunk and a second movement to connect with the selected trunk, there being a series of such switches for use by a calling subscriber in extending a connection to a called line, circuit arrangements whereby alternate switches in the series are directly controlled in their trunk selecting operations by the calling subscriber, a plurality of common automatic trunk selecting devices, and means whereby the remaining switches in the series are controlled by said devices.

43. In a telephone system, a calling subscriber's line, means for extending said line to desired called lines, said means comprising a trunk line terminating in a selector switch and a group of other trunk lines accessible to said switch, a plurality of sets of terminals in said switch each set comprising a terminal for a trunk line of said group and a multiple terminal of said first trunk line, a movable device adapted to be positioned by the calling subscriber before any desired set of terminals, and means for actuating said device to close together any set of terminals before which it is positioned.

44. In a telephone system, means for connecting a calling and called line including a plurality of trunk lines and a switch having a contact closer, means controlled by the calling subscriber for directly adjusting said contact closer in a single plane to definitely select one of said trunk lines, and means for further operating said contact closer in the same plane to complete the connection to the selected trunk line.

Signed by me at Chicago, Cook County, Illinois, this 11th day of October, 1913.

ARTHUR BESSEY SMITH.

Witnesses:

HARRY E. HERSHEY,

GEO. A. YANOSKOWSKI.