A. M. MALMBERG.

AUTOMATIC TELEPHONE SYSTEM.

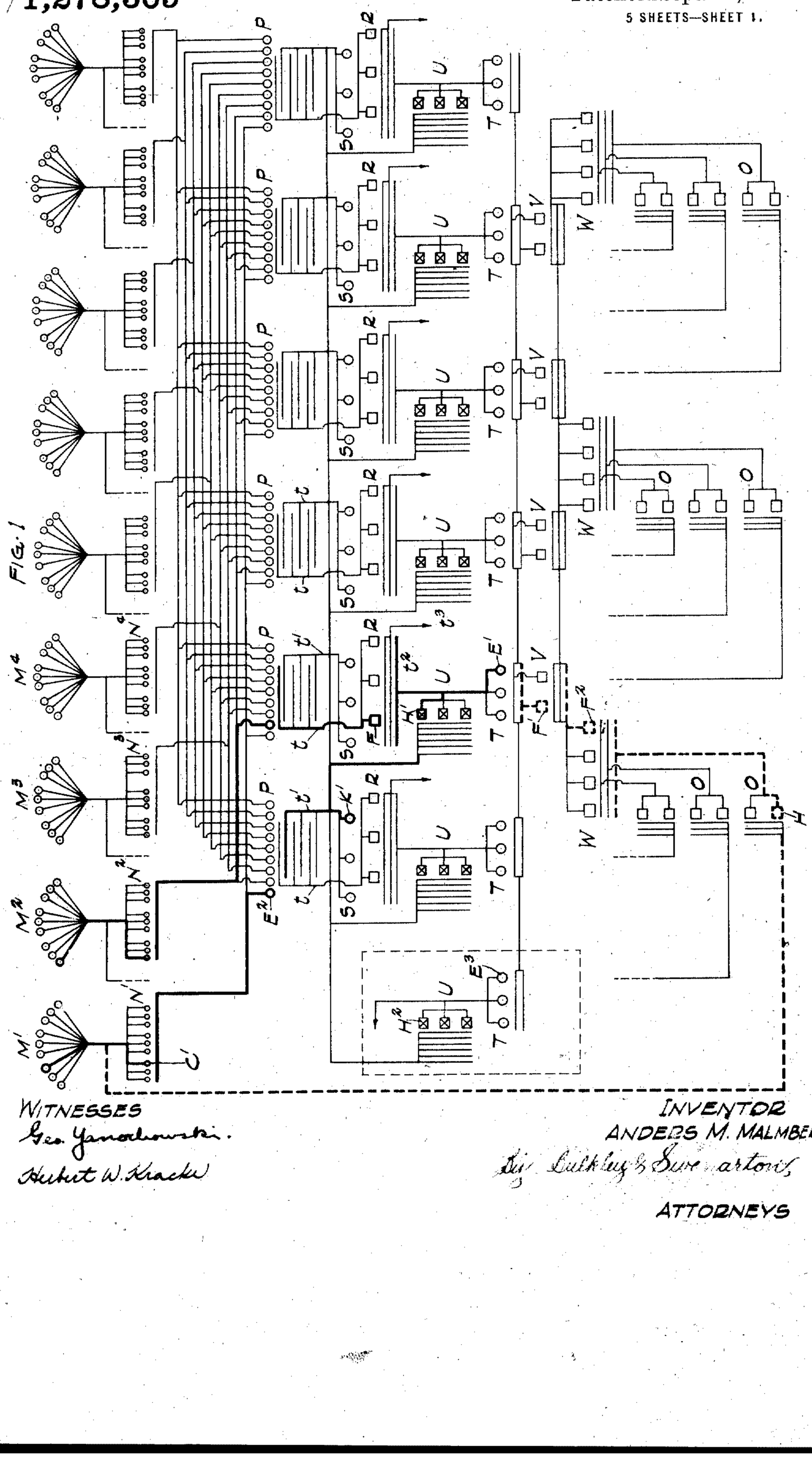
APPLICATION FILED APR. 27, 1914.

1,278,365

Patented Sept. 10, 1918.

5 SHEETS—SHEET 1.

FIG. 1



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5 SHEETS—SHEET 2.

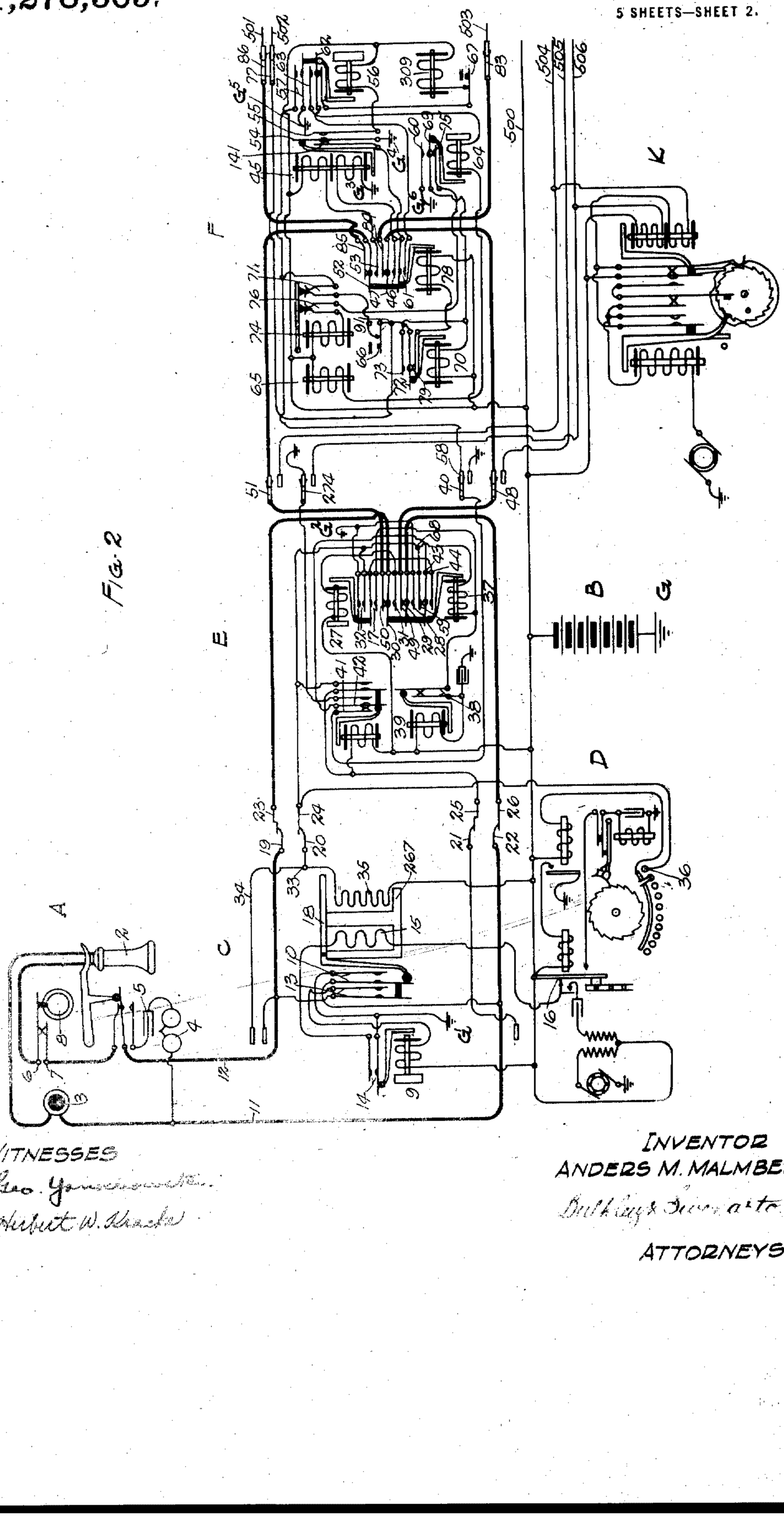

FIG. 2

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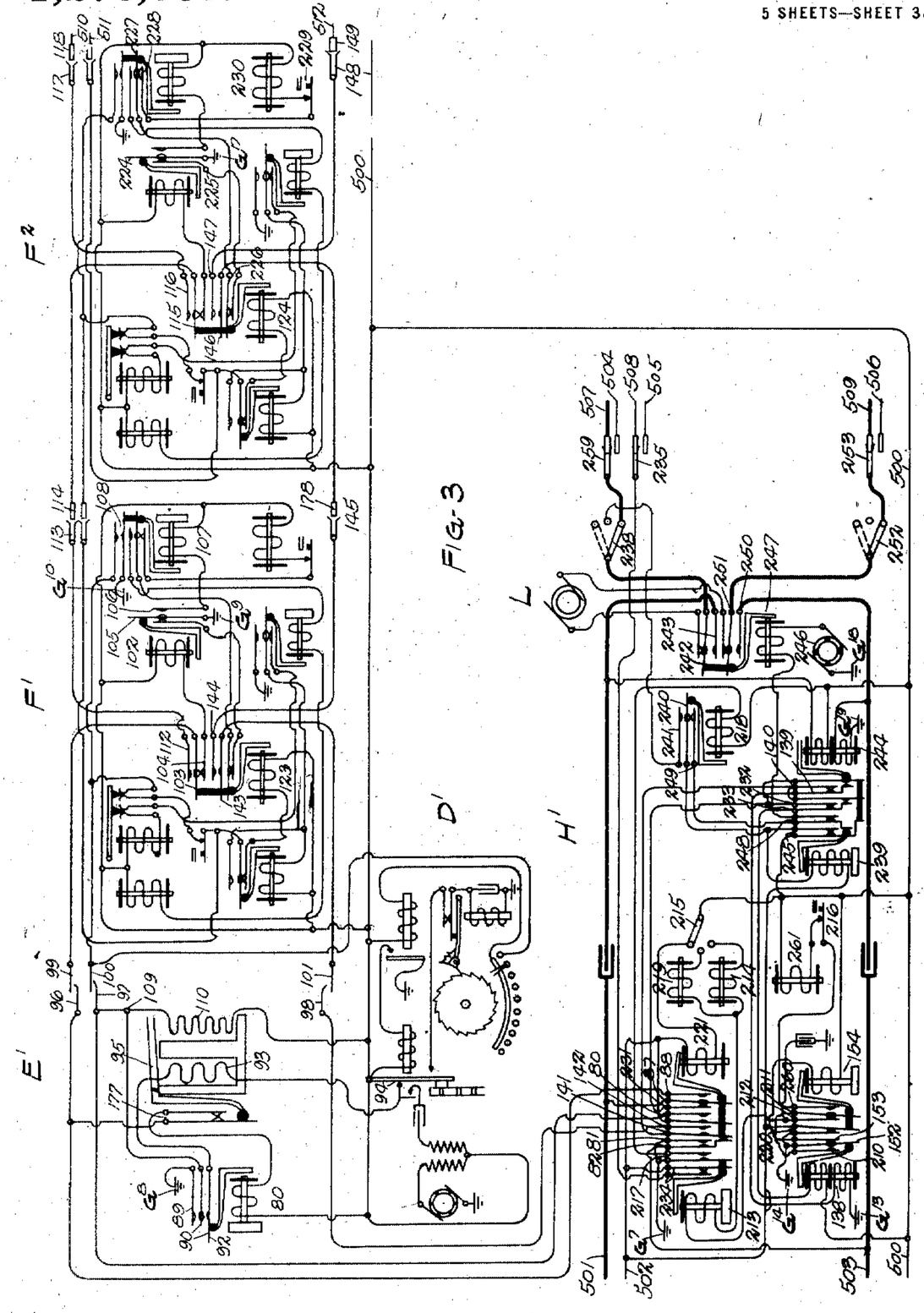
5 SHEETS—SHEET 3.



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5 SHEETS—SHEET 4.

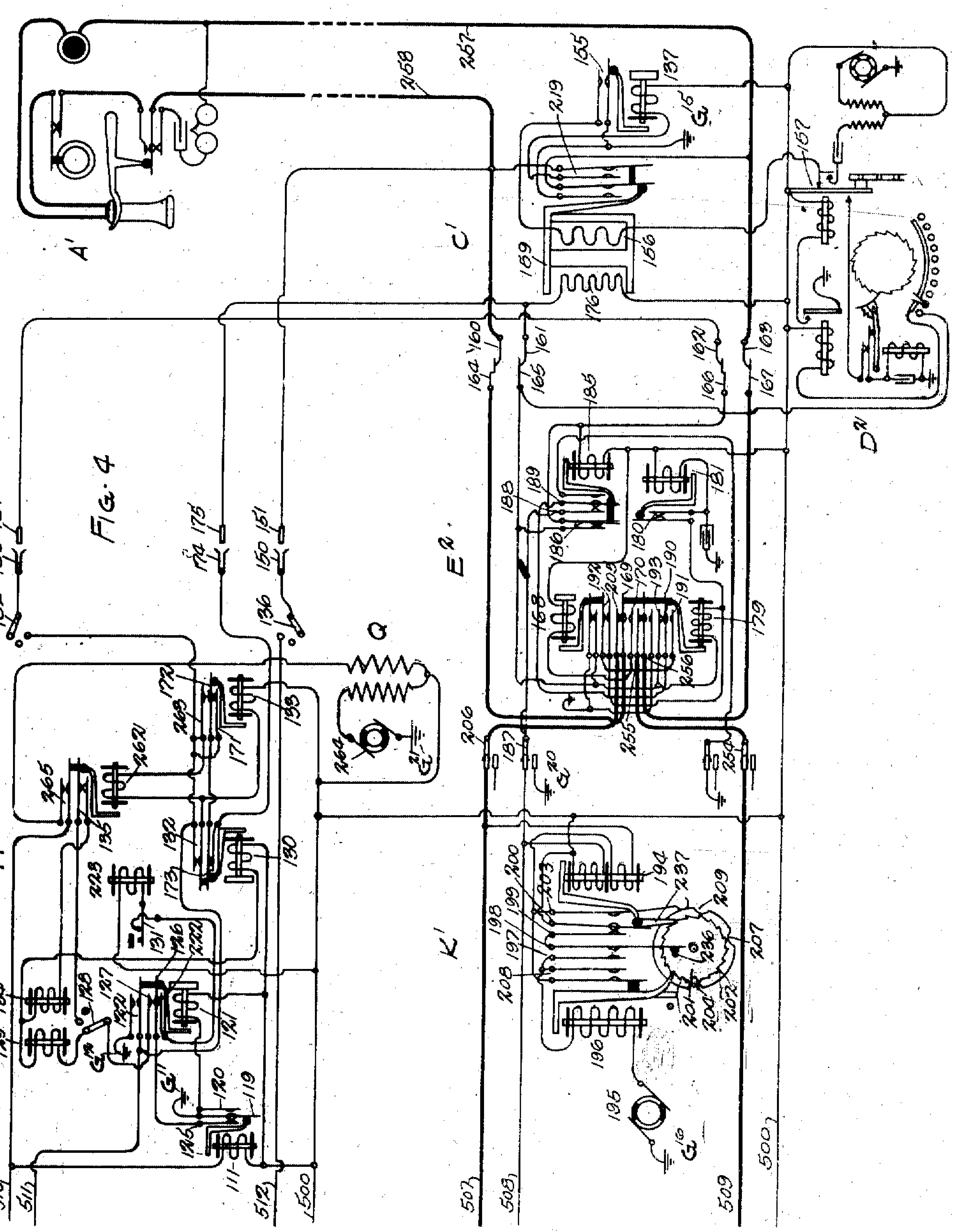

FIG. 4

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1,278,365.

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5 SHEETS—SHEET 5.

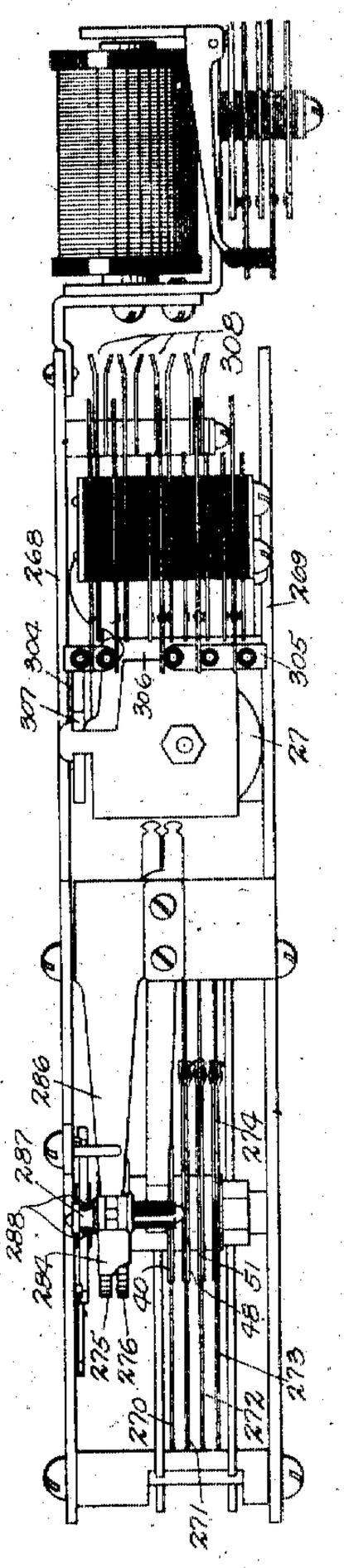

FIG. 5

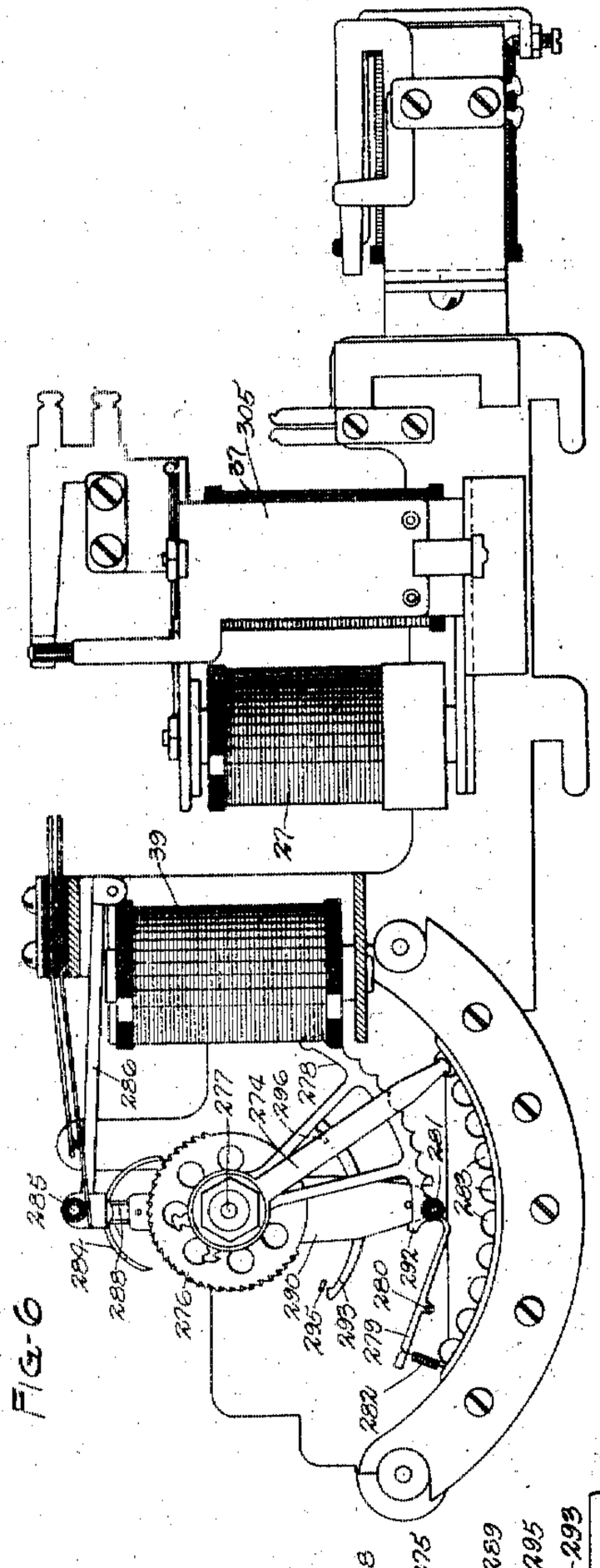

FIG. 6

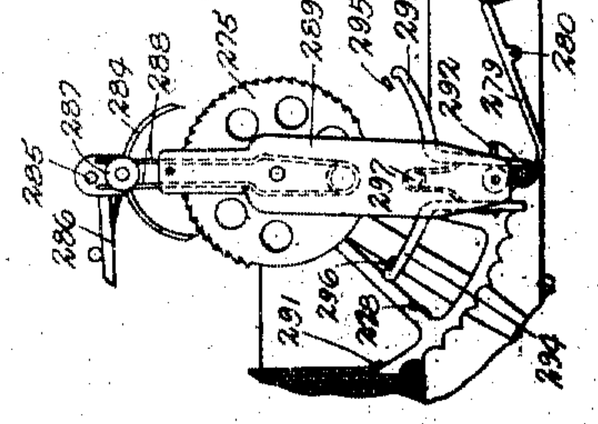

FIG. 7

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,278,365. Specification of Letters Patent. Patented Sept. 10, 1918.

Application filed April 27, 1914. Serial No. 834,789.

To all whom it may concern:

Be it known that I, ANDERS M. MALMBERG, a citizen of the United States of America, and resident of Chicago, 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 object the provision of a system in which an improved trunking arrangement is employed, whereby the amount of apparatus in the exchange can be greatly reduced.

Heretofore, in automatic systems, attempts have been made to connect a calling and a called line by a more or less direct path after a connection has been established between said lines, thus enabling the apparatus employed for establishing the connection to be released. So far as I am aware, however, such attempts have been unsuccessful and the object of my invention is to provide such a system in which certain apparatus is employed for establishing a connection between a calling and a called subscriber's line, and then after this connection has been established a more direct path is established between the two lines, and part of the apparatus employed for originally establishing the connection is released and made accessible for other calls.

Further objects of my invention relate to improvements in certain of the switches employed for establishing these connections.

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 my invention in connection with automatic switches of well-known types.

In the drawings Figure 1 represents diagrammatically the layout of a telephone system embodying the principles of my invention.

Figs. 2, 3 and 4 taken together represent a complete circuit connection between a calling substation A (Fig. 2) and a called substation A′ (Fig. 4) in the system shown.

Figs. 5, 6 and 7 show in detail the mechanical construction of the secondary switch E.

Referring to Fig. 1, the method of carrying out my invention is in general as follows: The apparatus shown, exclusive of that within the dotted square to the left of the figure, represents the apparatus used in making local calls in a ten thousand line office of a one hundred thousand line system. The apparatus within the dotted square represents the apparatus by means of which calls may be made from another office of the system into this particular office, and there will be as many duplications of these last as there are other exchanges. There are shown in this figure several groups of subscribers' substations M', M^2, etc., the line conductors of each of which terminate in individual trunk-selecting or line switches N', N^2, etc. For the purpose of being called these lines have terminals in the banks of a plurality of call connector switches O. These connector switches are represented herein by small squares, three parallel lines underneath the same representing the multiple bank contacts, which are assumed to be arranged in horizontal rows or levels. The individual switches N of each of the groups of subscribers' stations M have access to groups of trunk lines which lead to so-called secondary line switches P. The switches P have access to trunk lines t which lead to first selectors R and also have access to trunk lines t' which lead to special auxiliary calling devices S. When a switch P is operated, due to being seized by the line switch of a calling line, connection will be made with an idle first selector R. It will presently be shown that when a connector O finds a called line the subscriber is not yet signaled, but the line switch of the called line first operates to trunk to a secondary line switch P, and the said secondary switch, when it operates, instead of trunking to a first selector, operates to trunk to one of the auxiliary calling devices S. It will be understood that the switches can be provided with as many trunks as it is found necessary. Each line switch may be given access to twenty trunks, and then if there are provided twenty groups of secondaries there would be a secondary line switch representing each primary group in each secondary. It will be understood also that the secondary line switches may be provided with as many trunks as is necessary, said trunks terminating in first selectors and in calling devices. The first selectors R have

access to trunks t^2 leading to tertiary line switches T. Associated with each of the switches T is a special connector U. The banks of these connectors comprise trunks leading to the normals of each of the calling devices S in the office. The selectors R also have access to trunk lines t^3, which are outgoing trunks, to other offices of the system. The tertiary line switches T have access to trunks leading to second selectors V, which in turn have access to trunks leading to third selectors W in the various thousands of this office. These tertiary switches also have access to as many trunks as are necessary. The third selectors W have access to trunks leading to the various groups of connectors O in their particular thousand. Although the bank contacts of all the second selectors V shown in Fig. 1 are represented as being multiplied together, it is to be understood that any other known or desired multipling arrangement of the selectors may be employed.

In general the operation of the system shown in Fig. 2 is as follows: Upon the removal of the receiver by the calling subscriber, his line switch C operates to select a trunk line leading to a secondary line switch E, which in turn operates to select an idle first selector F. The subscriber operates his calling device to cause the selected first selector to extend connection to an idle tertiary line switch E′ in the section or division of the exchange to which the called subscriber belongs. Assuming that the tertiary switch E′ has been seized, the same then operates to select an idle second selector F′, the special connector H′ which is associated with the tertiary switch E′ not being operated at this time. The selected second selector is then operated to extend the connection to an idle third selector switch F^2 in the section or division of the office to which the called subscriber belongs. Assuming that the third selector switch F^2 has been seized, the same is then operated to extend the connection to the idle call connector H in the section or division of the particular thousand to which the called subscriber belongs. Assuming that the call connector H has been seized, the same is then operated to extend the connection to the normals of the called line. As a result the line switch C′ of the called line operates as if the called subscriber had removed his receiver to make a call and selects a trunk line leading to a secondary line switch E^2, which in turn operates to select an idle calling device K′, as has previously been explained. The calling device K′ then operates to call its own number by transmitting a series of impulses back through the secondary switch E^2, the line switch C′, the call connector H, third selector F^2, second selector F′ and the tertiary line switch E′ to the special connector H′. The connector H′ thereupon operates in response to the number called by the calling device K′ and makes connection with the particular trunk in its bank which leads to the calling device K′. The calling and called subscribers' lines are now connected by way of the line switch C, secondary line switch E, first selector F, special connector H′, secondary line switch E^2 and the line switch C′. The second selector F′, third selector F^2 and the call connector H are released as soon as the connector H′ finds the instrument K′ and the said switches are made available for use in setting up other connections.

Should a subscriber in another office similar to the office shown in Fig. 1 desire to call the subscriber at substation A′, he would cause the selected first selector in his office to make connection with an outgoing trunk which terminates in the tertiary line switch E^3, together with the special connector H^2, for example, in the group U in the office shown in Fig. 1. The tertiary line switch E^3 thereupon extends the connection to an incoming second selector F^3. for example, in the group V and the remainder of the connection is completed in the same manner as in the local call already explained—that is, the special connector H^2 will connect with the trunk.

The automatic substation A (Fig. 2) comprises the usual receiver 2, transmitter 3, ringer 4 and condenser 5. Being an automatic substation it is also provided with a suitable call-sending mechanism for controlling the automatic switches, which mechanism is represented diagrammatically by a pair of impulse springs 6 and 7 and an impulse wheel 8, which latter may be controlled by a dial provided with finger holes in such a way that the impulse springs may be momentarily separated a number of times corresponding to the respective digits of the number of the called subscriber.

The subscriber's individual switch C (Fig. 1) is of the general type of subscriber's switch shown in British patent to R. W. James No. 26,301 of 1906, which is well known in the art. The line switch comprises among other details a plunger (not shown) attached to the end of a so-called plunger arm 18 which is controlled by the magnet 267. The magnet 267 comprises two windings, namely, a pull-in winding 15 and a holding winding 35. The pull-in winding 15 operates the plunger arm 18, while the holding winding 35 is only strong enough to hold the plunger arm 18 in its operated position. When the plunger arm 18 is operated, the plunger is forced into a bank of contact springs, forcing the springs 19, 20, 21 and 22 into engagement with the springs 23, 24, 25 and 26, respectively. Although only one set of springs (19 to 26, inclusive) is shown,

each line switch is provided with a plurality of such sets, each set forming the terminal of a trunk line leading to a secondary line switch. Each trunk line is connected in multiple with the corresponding springs of all the line switches of the group which is controlled by the master switch D. The switch C is controlled by the subscriber through the medium of the line relay 9, as will hereinafter be more fully explained. The tertiary line switch E′ is similar to the line switch C.

The master switch D (Fig. 2) is of the same general type as that disclosed in British patent to R. W. James No. 26,301 of 1906, above referred to, being, however, more nearly of the particular type disclosed in British patent to T. G. Martin No. 1410 of 1910. The function of the master switch, as is well known, is to maintain the plungers of all the idle line switches in position to engage the terminal of an idle trunk line. The master switches D′ and D² are the same as the master switch D.

The secondary line switch E (Figs. 5, 6 and 7) comprises a bank of contacts secured between the plates 268 and 269 (Fig. 5). This bank comprises four sets or groups of contacts 270, 271, 272 and 273 and the wipers 40, 48, 51 and 274 are provided for wiping over and making contact with these contacts. These wipers, together with the two ratchet wheels 275 and 276, are secured to the shaft 277. There is also secured to the shaft 277 a notched segment 278 for the purpose of engaging with a retaining arm 279. This retaining arm is pivoted at 280 and at its end is provided with a bushing 281 which is pressed into the notches of the segment 278 by pressure exerted by the spring 282. The pressure on the segment 278 is sufficient to prevent the wipers 40, 48, 51 and 274 from prematurely moving off the contacts 283 by a possible jar. The pressure is not, however, enough to retard the ordinary operation of the wipers. Associated with the ratchet wheels 275 and 276 is a double pawl 284 which is pivoted at 285 on the armature 286. One end of the pawl 284 engages one ratchet wheel to rotate the wipers in one direction, while the other engages the other ratchet wheel to rotate the wipers in the opposite direction. The respective teeth of the ratchet wheels are necessarily facing in opposite directions, as shown in Figs. 5 and 6. Secured to the center of the pawl 284 is a grooved projection 287 for the purpose of sliding between the guide springs 288, the function of which projection is to tilt the pawl one way or the other into engagement with one or the other of the ratchet wheels. The springs 288 are securely fastened between the plates 289 and 290, which are loosely mounted on one end of the shaft 277. The manner in which the pawl 284 is tilted is as follows: When the wipers reach the end of the row of contacts in one direction, one or the other of the lugs 291 or 292 (depending on the way the wipers are traveling) on the segment 278 strikes the lower end of the arm composed of the plates 289 and 290 and moves said arm slightly in the same direction in which the wipers are traveling. This causes the upper end of the arm and the springs 288 to swing in the opposite direction to turn the pawl 284 on its pivot and reverse the position of the pawl 284, so that it now becomes operative to drive the shaft in the opposite direction. In order to hold the arm composed of the plates 289 and 290 in either of its positions, there are provided at its lower end two locking dogs 293 and 294 which are adapted to engage the lugs 295 and 296, respectively, which project from the side plate. These locking dogs are in the shape of bell crank levers and are pivoted between the plates 289 and 290 at their elbows. One arm of each of the levers extends down into the path of the lugs 292 and 291 on the segment 278, so that before either of these lugs strikes the arm composed of the plates 289 and 290 it first engages the locking dog and disengages it from its lug 295 or 296, as the case may be. A small spring 297 between the dogs 293 and 294 serves to bring them into engagement with their respective lugs when its arm is in the proper position. During the time when the wipers are rotating, the end of the pawl 284 which is not doing the driving engages its ratchet wheel when the armature 286 is in its fully attracted position, which prevents the wipers from being carried forward by their inertia after the armature 286 completes its stroke. Thus it will be seen that by continuously energizing and deënergizing the magnet 39, the wipers of the switch are caused to oscillate over the bank contacts. The switch is also provided with two relays 27 and 37, which control two groups of contact springs through the medium of their respective armatures 304 and 305. Pivotally mounted on a plate above the coils of the relays 27 and 37 there is a bell crank lever 306, one end of which engages a lug 307 on the armature 304, while the other end is provided with a notch which lies in the path of the upwardly-extending arm of the armature 305 of the relay 37. This end of the lever 306 normally forms an obstruction for the armature 305, so that it can not be operatively attracted. When the relay 27 is energized, its armature 304 rocks the lever 306 far enough to carry its end out of the path of the armature 305, so that if the relay 37 is energized at this time it may operatively attract its armature. The springs 308 are the usual jack springs, through the medium of which connections are made with the switch. The even contacts in each of the

groups 271, 272 and 273, for example, the contacts 2, 4, 6, etc., serve as terminals for trunks leading to calling devices such as the device K′, while the even contacts in the group 270 are permanently grounded. The odd contacts in the groups 270, 271 and 272, for example, the contacts 1, 3, 5, etc., serve as terminals for trunks leading to first selector such as the selector E, while the odd contacts in the group 273 are permanently grounded.

The selector switch F (Fig. 1) is of the general type of selector switch disclosed in United States Letters Patent No. 815,321, granted March 31, 1906, to Keith, Erickson and Erickson, except that the so-called side switch is omitted, and the circuits are modified to adapt the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series, as shown in British patent to T. G. Martin No. 10,376 of 1912. Among other details the selector F comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 77, 83 and 86 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 65 and a rotary movement controlled by the rotary magnet 74. The operations of the various parts of the switch are controlled through the medium of the double-wound line relay 45. Means for permitting the switch to be restored to normal position are provided in the release magnet 309, which, upon energizing, withdraws the retaining pawls from the shaft. The springs 66 and 67 close only when the switch shaft has been raised one or more steps from its lowest position. The relays 56 and 64 are slow acting—that is, slow to release their armatures upon deënergizing. The selectors F′ and F² are similar to the selector F.

The connector switch H′ (Fig. 3) is of the same general type of connector switch as disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits, however, being modified to adapt the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series. Among other details the connector H′ comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 235, 253 and 259 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 214 and a rotary movement controlled by the rotary magnet 219. The usual side switch comprising the wipers 215, 238 and 252 is controlled by the private magnet 218 in the usual and well-known manner. The operations of the various parts of the switch are controlled through the medium of the double-wound line relay 138, said relay being connected with the line through the reversing springs of a so-called back-ridge relay 244, through the windings of which latter relay the called line is provided with talking current. The ringer relay 247 affords the means by which ringing current is applied to the called line. Means for permitting the switch to be restored to normal position are provided in the release magnet 261, which, upon energizing, withdraws the retaining pawls from the shaft. The springs 216 close only when the switch shaft has been raised one or more steps from its lowest position. The relays 154 and 213 are slow acting—that is, slow to release their armatures upon deënergizing. The connector H is similar to the connector H′ except that it is capable of twenty vertical steps.

The called substation A′ (Fig. 4) and its individual line switch C′ are similar in all respects to the calling substation A and its individual line switch C.

For the purpose of supplying battery current for operating the apparatus and for talking purposes, there is shown the battery B having one terminal grounded at G. For the purpose of supplying ringing current there is shown the ringing current generator L, and for the purpose of supplying busy current there is shown the busy machine Q.

A general description of the apparatus having been given, it will now be explained how connection can be established between the line of substation A and the line of a called substation A′. The number of the called substation will be assumed to be 22222. Since the automatic switching apparatus disclosed herein is in general well known in the art, and is described in the publications herein referred to, its operation will be explained in a more or less general manner.

When the subscriber at substation A removes the receiver 2 preliminary to making a call, an energizing circuit is closed through the line relay 9 of the line switch C. This circuit extends from ground G′ through the springs 10, conductor 11, substation A, conductor 12, springs 13 and the line relay 9 to battery B. The line relay 9, upon energizing, closes a circuit from ground G′ through the springs 14, pull-in winding 15 and the springs 16 to battery B. The pull-in winding 15, upon energizing, attracts the plunger arm 18. The plunger arm 18, upon being attracted, forces the plunger which is attached to the end thereof into a bank of trunk terminals to which it has access, forcing the springs 19, 20, 21 and 22 into engagement with the springs 23, 24, 25 and 26, respectively. The engagement of the springs

19 and 22 with the springs 23 and 26, respectively, closes a circuit through the line relay 27 of the secondary line switch E. This circuit extends from ground G^2 through the springs 28 and 29, springs 26 and 22, conductor 11, substation A, conductor 12, springs 19 and 23, springs 30 and 31 and the line relay 27 to battery B. The energization of the line relay 27 closes a circuit extending from ground G^2 through the springs 32 and springs 24 and 20 to the point 33, thence one branch extends over the conductor 34 to the connector private bank contact associated with the calling line and the multiples of the same. This guarding potential prevents any party from connecting with the substation A while said substation is calling. Another branch extends from the point 33 through the holding winding 35 of the line switch C to battery B. This circuit through the holding winding 35 is closed before the line relay 9 deënergizes as a result of having its circuit opened at the springs 10 and 13. The relay 9 does not deënergize immediately upon the opening of its circuit, for the reason that it is slow acting, and thus the armature of the line relay 9 is held in an operated position until enough time has elapsed for the circuit through the winding 35 to be closed, whereby the plunger arm 18 is held in an operated position. A third branch of the above-traced circuit extends from the spring 24 to the contact 36 in the bank of the master switch D, said contact being associated with the trunk leading to the secondary line switch E. The placing of ground G^2 upon the contact 36 causes the master switch D to move all the idle line switches away from the trunk leading to the secondary line switch E in the usual and well-known manner. As shown, the master switch does not operate until a ground is returned from the secondary line switch. However, it will be readily seen by one versed in the art that the plunger arm 18 may be made to control an additional pair of springs, which would cause ground to be placed upon the contact 36 as soon as the plunger arm is operated.

A further result of the energization of the line relay 27 is the closing of a circuit from ground G^2 through the springs 32, relay 37, springs 38 and the rotary magnet 39 to battery B. Assuming that the wiper 40 is standing upon a busy contact, the relay 37 will be shunted by a circuit which may be traced from ground on the busy bank contact through the wiper 40, springs 41 and 42, springs 43 and 44, springs 17, springs 38 and the rotary magnet 39 to battery B. The rotary magnet 39 will energize over the last traced circuit and will operate to advance the switch wipers one step, at the same time breaking its own circuit at the springs 38. Thus it will be seen that the rotary magnet 39 will act in a manner similar to that of a buzzer to advance the switch wipers one step at a time as long as the wiper 40 engages grounded contacts. As has previously been explained, alternate contacts in the bank to which the wiper 40 has access are permanently grounded, the trunks corresponding thereto leading to calling devices such as the device K. The remaining contacts are associated with trunks leading to first selectors such as the selector F. Upon the wiper 40 reaching the first ungrounded contact, which will be assumed as leading to the selector F, the shunt will be removed from the relay 37, which will immediately energize over the circuit previously traced. The resistance of the relay 37 is such that the rotary magnet 39 will not be operatively energized when in series with it. The relay 37, upon energizing, extends the line connection to the line relay 45 of the first selector F. The circuit may be traced from ground G^3 through the lower winding of the line relay 45, springs 46 and 47, wiper 48, springs 49 and 29 to and through the substation A, springs 30 and 50, wiper 51, springs 52 and 53 and the upper winding of the relay 45 to battery B. The line relay 45, upon energizing, closes a circuit from ground G^4 through the springs 54 and 55 and the relay 56 to battery B. The energization of the relay 56 closes a circuit extending from ground G^5 through the springs 57, bank contact 58, wiper 40, springs 41 and 42 and the springs 43 and 59 to the point 68, where the circuit divides and one branch affords a holding ground for the winding 35 over a previously traced circuit. The second branch extends through the relay 37, springs 38 and the rotary magnet 39 to battery B. This circuit is closed before the line relay 27 deënergizes as a result of having its circuit opened by the relay 37. The line relay 27 does not deënergize immediately upon the energization of the relay 37 for the reason that it is slow acting, and thus the holding ground from ground G^2 is maintained until enough time has elapsed for the completion of the circuit from ground G^5.

The calling subscriber now operates his calling device for the first digit 2 of the called number, whereby the substation impulse springs 6 and 7 are separated twice momentarily, each time breaking the circuit of the line relay 45 of the selector F. The relay 56 of the selector F being slow acting does not deënergize during the momentary interruptions of its circuit by the relay 45, and consequently each time the latter relay deënergizes an impulse is transmitted over the circuit extending from ground G^4 through the springs 54 and 141, springs 61, springs 62 and 63, relay 64 and the vertical magnet 65 to battery B. The vertical magnet receives two impulses over this circuit and

operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts, and at the same time the shaft-controlled contacts 66 and 67 are closed. The slow acting relay 64 is maintained in its energized position continuously while impulses are being transmitted to the vertical magnet through it, and in its energized position closes a circuit extending from ground G^6 through the springs 60 and 69 and the relay 70 to battery B. The relay 70, upon energizing, forms a locking circuit for itself extending from ground G^5 at the relay 56 through the springs 57, springs 71, off-normal springs 66, springs 72 and 73 and the relay 70 to battery B. Thus, upon the deënergization of the relay 64 after the last impulse is delivered to the vertical magnet, the relay 70 remains energized and the circuit of the rotary magnet 74 is closed, which circuit extends from ground G^5 at the relay 56 through the springs 57, springs 71, off-normal springs 66, springs 72 and 73, springs 69 and 75, springs 76 and the rotary magnet 74 to battery B. The rotary magnet 74, upon energizing, rotates the shaft wipers one step, and by opening the springs 71 and 76 disconnects ground G^5 from itself and from the relay 70. If the first trunk line of the second level is idle, the relay 70 deenergizes as soon as the springs 71 are opened. If this trunk line is busy, however, the private wiper 77 finds the contact which it engages provided with a guarding ground potential which is transmitted to the relay 70 through the springs 72 and 73, thereby preventing it from deënergizing. The rotary magnet 74, however, deënergizes when the springs 76 are opened, regardless of whether the relay 70 remains energized or not. If the relay 70 remains energized, the circuit of the rotary magnet will be again closed as soon as its armature drops back far enough to close the springs 71 and 76. The rotary magnet will, therefore, operate in a manner similar to that of a buzzer to advance the wipers step by step over the contacts until the non-grounded contact of an idle trunk line is reached by the wiper 77, whereupon the relay 70 deënergizes. The relay 70, upon deënergizing, whether after one or several operations of the rotary magnet, permanently breaks the circuit of said rotary magnet and closes the circuit of the switching relay 78, which circuit extends from ground G^5 at the relay 56, through the springs 57, springs 71, off-normal springs 66, springs 72 and 79 and the relay 78 to battery B. The relay 78, upon energizing, disconnects the line relay 45 from the line and extends the line connection to the line relay 80 of the tertiary line switch E'. A circuit may now be traced from ground G^7 at the talking connector H' through the springs 81 and 82, wiper 83, springs 84 and 47 to and through the substation A, springs 52 and 85, wiper 86, springs 87 and 88, springs 177 and the line relay 80 to battery B. The relay 80, upon energizing, closes a circuit which may be traced from ground G^8 through the springs 89 and 90, springs 80 and the wiper 77 to the point 91, where the circuit divides and one branch extends over a circuit previously traced to the winding 35 of the line switch C and to the relay 37 of the secondary switch E. A second branch extends from the point 91 through the springs 72 and 79 and the relay 78 to battery B. This circuit is closed before the relay 56 deënergizes as a result of having its circuit opened by the line relay 45. The relay 56 does not deënergize immediately upon the deënergization of the line relay 45 for the reason that it is slow acting, and thus the holding ground from ground G^5 is maintained until enough time has elapsed for the completion of the circuit from ground G^8.

A further result of the energization of the line relay 80 is the closure of a circuit from ground G^8 through the springs 89, 90 and 92, pull-in winding 93 and the springs 94 to battery B. The pull-in winding 93, upon energizing attracts the plunger arm 95, which operates to force the springs 96, 97 and 98 into engagement with the springs 99, 100 and 101, respectively. The engagement of the springs 96 and 99 extends the connection to the line relay 102 of the selector F'. The circuit may be traced from ground G^7 through the springs 81 and 82 to and through the substation A, springs 87 and 88, springs 96 and 99, springs 103 and 104 and the line relay 102 to battery B. The energization of the line relay 102 closes a circuit extending from ground G^9 through the springs 105 and 106 and the relay 107 to battery B. The energization of the relay 107 closes a circuit extending from ground G^{10} through the springs 108 and springs 100 and 97 to the point 109, where the circuit divides, one branch extending over a previously traced circuit to the winding 35 of the line switch C, relay 37 of the line switch E and the relay 78 of the selector F. A second branch of this circuit extends from the point 109 through the holding winding 110 to battery B. This circuit is closed before the line relay 80 deënergizes as a result of having its circuit opened at the contact springs 177. The relay 80 does not deënergize immediately upon the pulling up of the plunger arm for the reason that it is slow acting, and thus the holding ground from ground G^8 is maintained until enough time has elapsed for the completion of the circuit from ground G^{10}.

The calling subscriber now operates his calling device for the second digit 2 of the

called number. The selector F′ thereupon operates to extend the connection to the first idle trunk in the second level in the same manner as explained for the selector F. Assuming that the connection is extended to the selector F², a holding ground is returned to the preceding switches, as before explained.

The calling subscriber now operates his calling device for the third digit 2 of the called number. The selector F² thereupon operates to extend the connection to the first idle trunk in the second level in the same manner as did the selectors F and F′. Assuming that the connection is extended to the line relay 111 of the call connector H, a circuit may be traced from ground G⁷ through the springs 81 and 82, to and through the substation A, springs 96 and 99, springs 103 and 112, wiper 113, bank contact 114, springs 115 and 116, wiper 117, bank contact 118 and the line relay 111 to battery B. The line relay 111, upon energizing, closes a circuit from ground G¹¹ through the springs 119 and 120 and the relay 121 to battery B. The relay 121, upon energizing, returns a holding circuit from ground G¹² through the springs 122 to the winding 35 of the line switch C, relay 37 of the switch E, relay 78 of the selector F, winding 110 of the line switch E′, relay 123 of the selector F′ and the relay 124 of the selector F².

The calling subscriber now operates his calling device for the fourth digit 2 of the called number, whereby the substation impulse springs 6 and 7 are separated twice momentarily, each time breaking the circuit of the line relay 111 of the call connector H. The relay 121 being slow acting does not deenergize during the momentary interruptions of its circuit by the line relay 111, and consequently each time the latter relay deenergizes an impulse of current is transmitted over the circuit extending from ground G¹¹ through the springs 119 and 125, springs 126 and 127, side switch wiper 128 (in first position), vertical magnet 129 and the relay 130 to battery B. The vertical magnet receives two impulses over this circuit and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts, and at the same time the shaft-controlled springs 131 are closed. The slow acting relay 130 is maintained in its energized position continuously while impulses are being transmitted to the vertical magnet through it, and in its energized position closes a circuit from ground G¹² through the springs 122, springs 132 and the private magnet 133 to battery B. This circuit is broken when the relay 130 deënergizes after the last impulse has been delivered to the vertical magnet. The breaking of said circuit causes the private magnet 133 to deënergize, thus permitting the side switch to pass to second position.

The calling subscriber now operates his calling device for the last digit 2 of the called number, in response to which the connector line relay operates to transmit two impulses through the rotary magnet 134, whereby the shaft wipers are rotated onto the contacts of the desired line. The circuit of the rotary magnet extends from ground G¹¹ through the springs 119 and 125, springs 126 and 127, side switch wiper 128 (in second position), springs 135, rotary magnet 134 and the relay 130 to battery B. The relay 130 operates in response to the impulses for this digit in the same manner as for the previous digits to cause the private magnet 133 to advance the side switch to third position.

Upon the side switch wiper 136 passing to third position, a circuit is closed through the line relay 137 of the line switch C′. This circuit may be traced from ground G¹³ at the talking connector H′ through the lower winding of the relay 138, springs 139 and 140, springs 141 and 142, springs 98 and 101, springs 143 and 144, wiper 145, bank contact 178, springs 146 and 147, wiper 148, bank contact 149, side switch wiper 136 (in third position), wiper 150, bank contact 151, springs 219 and the relay 137 to battery B. The relay 138 is so adjusted that the current flow in this circuit is not sufficient to operatively energize the said relay at this time. The line relay 137 however energizes in series with the lower winding of the relay 138 and closes a circuit from ground G¹⁵ through the springs 155, pull-in winding 156 and the springs 157 to battery B. The pull-in winding 156, upon energizing, attracts the plunger arm 159. The plunger arm 159, upon being attracted, forces the plunger which is attached to the end thereof into the bank of trunk terminals to which it has access, forcing the springs 160, 161, 162 and 163 into engagement with the springs 164, 165, 166 and 167, respectively. The engagement of the springs 160 and 164 closes a circuit through the line relay 168 of the secondary line switch E². This circuit extends from ground G¹³ through the lower winding of the relay 138, springs 139 and 140, springs 141 and 142, springs 98 and 101, springs 143 and 144, wiper 145, bank contact 178, springs 146 and 147, wiper 148, bank contact 149, side switch wiper 136 (in third position), wiper 150, bank contact 151, springs 160 and 164, springs 169 and 170, line relay 168 to battery B. The deënergizing of the private magnet 133 of the call connector H closes a circuit from ground G¹² through the springs 122, springs 171 and 172, springs 173, private wiper 174, bank contact 175 and the holding winding 176 to battery B. The holding

winding 176, upon energizing, will hold the plunger arm 159 in an operated position after the circuit of the pull-in winding 156 is opened by the deënergization of the line relay 137, which follows shortly after the plunger arm 159 has broken the contact of springs 219. A second branch of the circuit from ground G^{12} extends over the previously traced circuit to the bank contact 175 and from thence through the springs 161 and 165, relay 179, springs 180 and the rotary magnet 181 to battery B. As this circuit is completed before that through the line relay 168, and therefore before a shunt is placed around the relay 179, it is evident that the relay 179 would become operatively energized were it not for the mechanical locking device previously explained, which prevents the operation of the relay 179 unless the line relay 168 is in an operated position. Upon the side switch wiper 182 passing to third position, a circuit may be traced from ground G^{12} through the springs 122, side switch wiper 182 (in third position), wiper 183, bank contact 184, springs 162 and 166 and the relay 185 to battery B. The relay 185, upon energizing, prepares a new circuit for itself by means of the springs 186.

Assuming that the wiper 187 of the secondary line switch E^2 is standing upon a busy contact, then, upon the energization of the line relay 168, a shunt is placed around the relay 179, which shunt may be traced from ground on the busy bank contact, wiper 187, springs 188 and 189, springs 190 and 191, springs 192, springs 180, rotary magnet 181 to battery B. The rotary magnet 181 will energize over this circuit and operate to advance the switch wipers one step, at the same time breaking its own circuit at the springs 180. Thus it will be seen that the rotary magnet 181 will act in a manner similar to that of a buzzer to advance the switch wipers one step at a time as long as the wiper 187 engages grounded contacts. As has previously been explained, alternate contacts in the bank to which the wiper 187 has access are permanently grounded, the trunks corresponding thereto leading to first selectors such as the selector F. The remaining contacts are associated with trunks leading to calling devices such as the device K'. Upon the wiper 187 reaching the first ungrounded contact, which will be assumed as leading to the calling device K', the shunt will be removed from the relay 179, which will immediately energize over the circuit previously traced. The resistance of the relay 179 is such that the rotary magnet 181 will not be operatively energized when in series with it. The relay 179, upon energizing, extends the connection to the calling device K'.

Upon the connection being extended to the calling device K' a circuit may be traced from ground G^{14} at the talking connector H' through the lower winding of the relay 138, springs 139 and 140, springs 141 and 142, springs 98 and 101, springs 143 and 144, wiper 145, bank contact 178, springs 146 and 147, wiper 148, bank contact 149, side switch wiper 136 (in third position) wiper 150, bank contact 151, springs 160 and 164, springs 169 and 205, wiper 206, lower winding of the relay 194, normally closed springs 203 and 200 to battery B. The lower winding of relay 194 is of comparatively low resistance allowing sufficient current to flow in the above described circuit to energized relay 138 of the connector H' which, attracting its armature, closes the following circuit: ground at G^{14}, springs 152 and 153, and relay winding 154 to battery B. Relay 154 in turn is energized and prepares the circuits for the vertical and rotary magnets 214 and 219, which however, remain open at the relay 138 for the time being. A holding circuit for the relay 194 may also be traced at this time from ground G^{12} through the springs 122, springs 171 and 172, springs 173, wiper 174, bank contact 175, springs 161 and 165, springs 193 and 190, springs 189 and 188, wiper 187 and the upper winding of the relay 194 to battery B. The relay 194, upon energizing, closes a circuit from ground G^{16} through the interrupter 195, relay 196, springs 197 and 198 and the springs 199 and 200 to battery B. The end of the spring 203 is resting at this time in the depression 204 of cam 202 allowing the spring 203 to follow and remain in contact with the spring 200. The relay 196 is energized intermittently due to the interrupter 195 and operates to advance the ratchet wheel 201 and with it the cam 202. Upon the first energization of the relay 196, the cam 202 is advanced so that the spring 203 has just risen out of contact with the depression 204, thus breaking contact with the spring 200. At this time a circuit may be traced from ground G^{13} at the talking connector H' through the lower winding of the relay 138, springs 139 and 140, springs 141 and 142, springs 98 and 101, springs 143 and 144, wiper 145, bank contact 178, springs 146 and 147, wiper 148, bank contact 149, side switch wiper 136 (in third position), wiper 150, bank contact 151, springs 160 and 164, springs 169 and 205, wiper 206, lower winding of the relay 194, springs 208, springs 197 and 198 and the springs 199 and 200 to battery B. This circuit is similar to the one already described for relay 138 except that the springs 208 are included as a shunt around the springs 200 and 203 and it is evident that the springs 208 and the cam 202 must be so adjusted relatively to each other that the springs 208 will close before the springs 200 and 203 break contact to insure that the circuit of relay 138 will not

be broken at this time. Each time the relay 196 deënergizes due to the interrupter 195, this circuit will be broken at the springs 208. Upon the sixth energization of the relay 196, the spring 203 will have extended into the depression 207 so that the opening of the springs 208 upon the following deënergization will not open the circuit of the relay 138, for the springs 208 are now shunted by the springs 200 and 203. Upon the seventh energization of the relay 196, the spring 203 leaves the depression 207. As a result the following deënergization of the relay 196 causes the circuit of the relay 138 to be opened at the springs 208. Upon the eleventh energization of the relay 196, the spring 203 enters the depression 209, so that the opening of the springs 208 upon the following deënergization will not open the circuit of the relay 138, for the springs 208 are now shunted by the springs 200 and 203. From the foregoing it will be seen that the circuit of the relay 138 was first closed and then broken five times momentarily, a pause followed and again the circuit was broken four times momentarily, followed by a pause.

The operation of the talking connector H′ due to the first group of impulses delivered by the calling device K′ will now be explained. The relay 154 of the talking connector H′ being slow acting does not deenergize during the momentary interruptions of its circuit by the relay 138, and consequently each time the latter relay deenergizes an impulse is transmitted over the circuit extending from ground G^{14} through the springs 152 and 210, springs 211 and 212, relay 213, vertical magnet 214 and the side switch wiper 215 (in first position) to the battery B. The vertical magnet receives five impulses over this circuit and operates to raise the switch shaft and wipers five steps to a position opposite the fifth row or level of bank contacts, and at the same time the shaft-controlled springs 216 are closed. The slow acting relay 213 is maintained in its energized position continuously while impulses are being transmitted to the vertical magnet through it, and in its energized position closes a circuit from ground G^{7} through the springs 217 and the private magnet 218 to battery B. This circuit is broken when the relay 213 deënergizes after the last impulse has been delivered to the vertical magnet. The breaking of said circuit causes the private magnet 218 to deënergize, thus permitting the side switch to pass to second position. In passing from first to second position the side switch wiper 215 transfers the battery connection from the vertical magnet 214 to the rotary magnet 219.

The apparatus is now in position to respond to the impulses of the second group of impulses delivered by the calling device K′, in response to which the line relay 138 operates to transmit four impulses through the rotary magnet 219, whereby the shaft wipers are rotated onto the contacts of the trunk leading to the calling device K′. The circuit through the rotary magnet extends from ground G^{14} through the springs 152 and 210, springs 211 and 212, relay 213, rotary magnet 219 and the side switch wiper 215 (in second position) to battery B. The relay 213 operates in response to these impulses in the same manner as for the previous digit to cause the private magnet 218 to advance the side switch to third position. The side switch wipers 238 and 252, upon passing to third position, complete a connection between the connector H′ and the calling device K′, which has already been connected to the called substation A′. Upon the deënergization of the relay 213 just previous to the passing of the side switch to third position, a circuit may be traced from ground G^{14} through the springs 220, springs 234, wiper 235, upper winding of the relay 194 to battery B. A branch of the above circuit extends from the wiper 235, wiper 187, springs 188 and 189, springs 190 and 193, relay 179, springs 180 and the rotary magnet 181 to battery B. A third branch of the same circuit extends from the spring 193 through the springs 165 and 161 and the holding winding 176 to battery B. Upon the engagement of the side switch wiper 215 with its third position contact point, a circuit may be traced from ground G^{14} through the springs 220, relay 221 and the side switch wiper 215 (in third position) to Battery B. The relay 221, upon energizing, opens the holding circuits of the switches E′, F′, F^{2} and H, thus allowing them to return to normal. The disengagement of the springs 87 and 88 of the relay 221 opens the circuit of the line relay 111 of the call connector H, which, upon deënergizing, opens the circuit of the relay 121. The relay 121, upon deenergizing, removes ground G^{12} from the circuit of the winding 110, relay 123 of the selector F′ and the relay 124 of the selector F^{2}, and in addition closes a circuit from ground G^{11} through the springs 119 and 125, springs 126 and 222, off-normal springs 131 and the release magnet 223 to battery B. The release magnet 223, upon energizing, operates to remove the retaining pawls from the shaft and its own circuit is opened at the springs 131 when the said shaft reaches its lowest position. The relay 124 of the selector F^{2}, upon deënergizing, closes a circuit from ground G^{17} through the springs 224 and 225, springs 226, springs 227 and 228, off-normal springs 229 and the release magnet 230 to battery B. The release magnet 230, upon energizing operates to remove the retaining pawls from the shaft and its own circuit is opened at the springs 229 when the

said shaft reaches its lowest position. Upon the deënergization of the relay 123, the release of the selector F′ takes place in the same manner as explained for the selector F^2. The winding 110, upon deënergizing, allows the plunger arm 95 to return to normal position.

The line circuit of the calling subscriber may now be traced from ground G^{13} through the lower winding of the relay 138, springs 139 and 140, springs 141 and 82, wiper 83 to and through the substation A, wiper 86, springs 87 and 231, springs 232 and 233 and the upper winding of the relay 138 to battery B. Ground from G^{14} is now supplied through the springs 220 and thence over the previously traced circuit to the winding 35 and the relay 37 and relay 78.

Returning to a consideration of the calling device K′, it should be stated that upon the twelfth energization of the relay 196, the pin 236 causes the spring 198 to break contact with the spring 197, thus permanently breaking the circuit of the relay 196. Furthermore, upon the twelfth energization of the relay 196, the spring 203 leaves the depression 209, thus breaking contact with the spring 200 and removing battery from the negative side of the trunk which was completed by the secondary line switch E^2 and the primary line switch C′ which, until the disconnection of the connector H and the preceding switches, had formed part of the impulse circuit for the relay 138 of the connector H′. The relay 194 will remain energized throughout the conversation, and by means of the dog 237 will prevent the wheel 201 from returning to normal.

When the side switch wiper 238 at the talking connector H′ was in second position, a circuit extended from ground G^{14} through the springs 220, relay 239, springs 240 and 241, side switch wiper 238 (in second position), springs 242 and 243 and the upper winding of the relay 244 to battery B. The relay 239 operatively energizes over this circuit, but being of a high resistance the relay 244 will not receive sufficient current to operatively energize. The relay 239, furthermore, upon energizing, forms a locking circuit for itself, which extends from ground G^{14} through the springs 220, relay 239 and the springs 245 to battery B. When the private magnet 218 deënergizes after the last group of impulses from the calling device K′, a circuit is completed which extends from ground G^{18} through the interrupter 246, ringer relay 247, springs 248, springs 249 and 240 and the springs 245 to battery B. The ringer relay is energized intermittently due to the interrupter 246 and operates to disconnect the calling line from the called line, and to bridge the ringing current generator L across the called line to signal the called subscriber. Upon the response of the called subscriber his line is provided with talking current over a circuit extending from ground G^{19} through the lower winding of the relay 244, springs 250 and 251, side switch wiper 252 (in second position), wiper 253, wiper 254, springs 255 and 256, springs 167 and 168 and the conductor 257 to and through the substation A′, conductor 258, springs 160 and 164, springs 169 and 205, wiper 206, wiper 259, side switch wiper 238 (in third position), springs 242 and 243 and the upper winding of the relay 244 to battery B. The relay 244, upon energizing, reverses the current in the calling line and in addition opens the circuit of the ringer relay 247 and of the relay 239 at the springs 245.

Upon the completion of the conversation, the restoring of the receiver to the switch hook at the calling substation destroys the holding circuit of the line relay 138. The line relay 138, upon deënergizing, opens the circuit of the relay 154, which in turn, upon deënergizing, removes the holding ground from the winding 35 of the line switch C, relay 37 of the switch E, relay 78 of the selector F and the upper winding of the relay 194 of the calling device K′, relay 179 of the switch E^2 and the winding 176 of the line switch C′, and in addition closes a circuit which extends from ground G^{14} through the springs 152 and 210, springs 211 and 260, off-normal springs 216 and the release magnet 261 to battery B. The release magnet 261, upon deënergizing, removes the retaining pawls from the shaft and its own circuit is opened at the springs 261 when said shaft reaches its lowest position. Upon the deënergization of the relay 78, the release of the selector F follows in the same manner as explained in connection with the selector F^2. The relay 37, upon deënergizing, restores the secondary line switch E to normal. The winding 35, upon deënergizing, releases the plunger arm 18, which, upon returning to normal, places the switch C in readiness for the next call. The relay 194, upon deënergizing, allows the calling device K′ to return to normal. The deënergizing of the relay 179 places the secondary switch E^2 in readiness to be used again, and the deënergizing of the holding winding 176 allows the line switch C′ to return to normal.

It having been explained how one subscriber establishes connection and releases the same, it will now be explained how a connection is prevented from being made with a busy line. If the called number is busy, there will be a guarding potential upon the call connector private bank contact associated with that line, just as explained in connection with the line switch C. The connector private wiper 174, upon engaging this guarded contact and before

the side switch has passed to third position, completes an energizing circuit through the relay 262. This circuit extends from ground at the private bank contact through the wiper 174, springs 173, springs 172 and 263 (which are still in engagement for the reason that the springs 132 are adjusted so as not to break upon the de-energization of the relay 130 until after the springs 173 make contact), relay 262 and the private magnet 133 to battery B. Thus it will be seen that the private magnet 133 locks the side switch in second position, and in addition the relay 262 energizes and connects the busy tone with the calling line over the following circuit: from ground G^{21} through the interrupter 264, secondary winding of the busy machine Q, springs 265 and the bank contact 118 to and through the substation A, over a previously traced circuit and to ground G^{7} at the talking connector H'. The calling subscriber upon hearing the busy tone, restores his receiver to the switch hook, thereby opening the circuit of the line relay 111 of the call connector H and the release of the apparatus follows in practically the same manner as previously explained.

It will thus be seen that I have devised a very efficient trunking system in which the amount of apparatus at the central station can be greatly reduced. This relates particularly to the second and third selectors, which in my system are greatly reduced in number, as they are only operated for a very short time while the call is being established and are then immediately released and made accessible for use in establishing a second call. It will furthermore be noticed that the special connector which is employed for completing the short cut to the called line is connected to the system at the point at which it is first determined into which exchange the call is to be made—that is, the operation of the first selector F determines whether the call is to be made in the exchange in which this selector is located, or whether it is to go to some other exchange, and the special connector H, when operated, completes a direct connection from the trunk extending from this first selector to the called line. In this way all the other apparatus local to the exchange for extending the connection thereto is enabled to be released as soon as the connection is established.

Furthermore, it will be seen that I have devised improved means for controlling certain of the automatic switches in that they are controlled over a local circuit including but one side of a line and ground return—that is, I am enabled not only to operate non-numerical switches in this manner, but can also operate switches which have two separate and distinct motions, one for selecting a desired group of trunks, and the second for selecting or connecting with a trunk in a selected group. It will also be noticed that in my system the second and third selectors are common to all the subscribers of the system—that is, I have a one hundred thousand subscriber system which consists of a plurality of exchanges, and the second selectors are not only common to all the lines of a certain exchange, but are also accessible from lines in any of the other exchanges.

It will be understood that if desired the principle of having a calling trunk connect directly with a called trunk after the called trunk has been identified indirectly, and having the apparatus which is contained in the indirect circuit release, is not limited to any particular form of trunking at any particular step. Any suitable trunking operation may be used between the subscribers' lines and the first selectors R and the calling devices S. Likewise, any suitable form of trunking may be used between the tertiary line switches T and the second selectors V. Not only may the trunking system shown in British Patent No. 1421 of 1910, issued to T. G. Martin, be used, but any modification of this trunking arrangement may be resorted to. For example, each group of subscribers need not have a secondary switch in each group. Furthermore, the number of subscribers in each group may be varied. Also, if necessary, the banks of the tertiary line switches T may be cut or separated into several sections so as to increase the trunking capacity. It will likewise be understood that the form of the switches may be varied, and other various changes and modifications may be made without departing from the spirit of my invention.

What I claim as my invention is:—

1. In a telephone system, a first line, a second line, a link circuit, means for connecting said lines over said link circuit, a circuit for controlling said means, a plurality of switches for closing said controlling circuit, means for controlling one of said switches comprising a magnet individual to said switch, and a circuit for said magnet including a portion of the said link circuit.

2. In a telephone system, a first line, a second line, a link circuit, means for connecting said lines over said link circuit, a circuit for controlling said means, a plurality of switches for closing said controlling circuit, means for controlling one of said switches comprising a magnet individual to said switch, and a circuit for said magnet including a portion of the said link circuit, said last circuit including also said first line.

3. In a telephone system, a first line, a

second line, a link circuit, means for connecting said lines over said link circuit, a circuit for controlling said means, a plurality of switches for closing said controlling circuit, means for controlling said switches comprising magnets individual thereto, and means for operating said magnets successively over a circuit including said first line and a portion of said link circuit in series.

4. In a telephone system, a first line, a second line, a link circuit, means for connecting said lines over said link circuit, a circuit for controlling said means, a plurality of switches for closing said controlling circuit, means for controlling one of said switches comprising a magnet individual to said switch, a circuit for said magnet including a portion of the said link circuit, and means for releasing said switches after said lines have been connected and before the connection is destroyed.

5. In a telephone system, a first line, a second line, a link circuit, means for connecting said lines over said link circuit, a circuit for controlling said means, a plurality of switches for closing said controlling circuit, means for controlling one of said switches comprising a magnet individual to said switch, a circuit for said magnet including a portion of the said link circuit, said last circuit including also said first line, and means for releasing said switches after said lines have been connected and before the connection is destroyed.

6. In a telephone system, a first line, a second line, a link circuit, means for connecting said lines over said link circuit, a circuit for controlling said means, a plurality of switches for closing said controlling circuit, means for controlling said switches comprising magnets individual thereto, means for operating said magnets successively over a circuit including said first line and a portion of said link circuit in series, and means for releasing said switches after said lines have been connected and before the connection is destroyed.

7. In a telephone trunking system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a connective circuit accessible to called lines and having a branch circuit, means for extending a calling line into connection with said connective circuit, and means for operating said trunking switches successively via said calling line and said branch circuit in series.

8. In a telephone trunking system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a connective circuit having a talking conductor accessible to called lines and having a branch circuit directly connected to said talking conductor, means for extending a calling line into connection with said connective circuit, and means for further extending said calling line by way of said branch circuit and for operating said trunking switches over said branch circuit.

9. In a telephone system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a plurality of connective circuits accessible to called lines and each having a branch circuit, means for extending a calling line into connection with an idle connective circuit, and means for operating said trunking switches successively over said calling line and the branch of said connective circuit in series.

10. In a telephone trunking system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a connective circuit accessible to called lines and having a branch circuit, means for extending a calling line into connection with said connective circuit, means for operating said trunking switches successively via said calling line and said branch circuit in series, and other switches operated automatically when a called line is located for connecting the called line with said connective circuit, whereby the said calling and called lines may be connected.

11. In a telephone trunking system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a connective circuit accessible to called lines having a talking conductor and having also a branch circuit directly connected to said talking conductor, means for extending a calling line into connection with said connective circuit, means for further extending said calling line by way of said branch circuit, for operating said trunking switches, and other switches operated automatically when a called line is located for connecting the called line with said connective circuit, whereby the said calling and called lines may be connected.

12. In a telephone system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a plurality of connective circuits accessible to called lines and each having a branch circuit, means for extending a calling line into connection with an idle connective circuit, means for operating said trunking switches successively over said calling line and the branch of said connective circuit in series, and other switches operated automatically

when a called line is located for connecting the called line with said connective circuit, whereby the said calling and called lines may be connected.

13. In a telephone trunking system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a connective circuit accessible to called lines and having a branch circuit, means for extending a calling line into connection with said connective circuit, means for operating said trunking switches successively via said calling line and said branch circuit in series, other switches operated automatically when a called line is located for connecting the called line with said connective circuit, whereby the said calling and called lines may be connected, and means for disconnecting said branch circuit to exclude said trunking switches from the connection.

14. In a telephone trunking system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a connective circuit accessible to called lines having a talking conductor and having a branch circuit directly connected to said conductor, means for extending a calling line into connection with said connective circuit, means for further extending said calling line by way of said branch circuit, for operating said trunking switches, other switches operated automatically when a called line is located for connecting the called line with said connective circuit, whereby the said calling and called lines may be connected, and means for disconnecting said branch circuit to exclude said trunking switches from the connection.

15. In a telephone system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a plurality of connective circuits accessible to called lines and each having a branch circuit, means for extending a calling line into connection with an idle connective circuit, means for operating said trunking switches successively over said calling line and the branch of said connective circuit in series, other switches operated automatically when a called line is located for connecting the called line with said connective circuit, whereby the said calling and called lines may be connected, and means for disconnecting said branch circuit to exclude said trunking switches from the connection.

16. In a telephone trunking system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a connective circuit accessible to called lines and having a branch circuit, means for extending a calling line into connection with said connective circuit, means for operating said trunking switches successively via said calling line and said branch circuit in series, other switches operated automatically when a called line is located for connecting the called line with said connective circuit, whereby the said calling and called lines may be connected, means for disconnecting said branch circuit to exclude said trunking switches from the connection, and means for releasing said trunking switches to make them accessible to other calling lines.

17. In a telephone trunking system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a connective circuit accessible to called lines having a talking conductor and having a branch circuit directly connected to said conductor, means for extending a calling line into connection with said connective circuit, means for further extending said calling line by way of said branch circuit, for operating said trunking switches, other switches operated automatically when a called line is located for connecting the called line with said connective circuit, whereby the said calling and called lines may be connected, means for disconnecting said branch circuit to exclude said trunking switches from the connection, and means for releasing said trunking switches to make them accessible to other calling lines.

18. In a telephone system, a plurality of lines terminating in a central exchange, a plurality of serially related trunking switches for locating a called line, a plurality of connective circuits accessible to called lines and each having a branch circuit, means for extending a calling line into connection with an idle connective circuit, means for operating said trunking switches successively over said calling line and the branch of said connective circuit in series, other switches operated automatically when a called line is located for connecting the called line with said connective circuit, whereby the said calling and called lines may be connected, means for disconnecting said branch circuit to exclude said trunking switches from the connection, and means for releasing said trunking switches to make them accessible to other calling lines.

19. In a telephone trunking system, a plurality of lines terminating in a central exchange, a divided connecting circuit having two branches, two series of automatic switches for extending said branches toward called lines, means for connecting a calling line with said connecting circuit, means for operating the switches of one series over said calling line and one of said branches in series to select a called line, and means for automatically operating the other series of switches to connect the said called line with

said connecting circuit by way of the other branch.

20. In a telephone trunking system, a plurality of lines terminating in a central exchange, a trunk circuit for interconnecting calling and called lines, a branch of said trunk circuit, means for extending a calling line into connection with said trunk circuit, a plurality of trunking switches accessible to said branch circuit for selecting a called line, and means for operating said switches over said calling line and said branch circuit in series.

21. In a telephone trunking system, a plurality of lines terminating in a central exchange, a divided connecting circuit having two branches, two series of automatic switches for extending said branches to called lines, means for connecting a calling line with said connecting circuit, means for operating the switches of one series over said calling line and one of said branches in series to select a called line, means for automatically operating the other series of switches to connect the said called line with said connecting circuit by way of the other branch, and means for then disconnecting the series of switches first operated.

22. In a telephone trunking system, a plurality of lines terminating in a central exchange, a divided connecting circuit having two branches, two series of automatic switches for extending said branches to called lines, means for connecting a calling line with said connecting circuit, means for operating the switches of one series over said calling line and one of said branches in series to select a called line, means for automatically operating the other series of switches to connect the said called line with said connecting circuit by way of the other branch, and means for disconnecting the branch circuit over which the selecting series of switches were operated before interfering with the connection over the other branch.

23. In a telephone trunking system, a plurality of lines terminating in a central exchange, a divided connecting circuit having two branches, two series of automatic switches for extending said branches to called lines, means for connecting a calling line with said connecting circuit, means for operating the switches of one series over said calling line and one of said branches in series to select a called line, means for automatically operating the other series of switches upon the selection of a called line to extend the same into connection with said connecting circuit by way of the other branch whereby the said calling and called lines may be connected, and means for then disconnecting the series of switches first operated.

24. In a telephone trunking system, a plurality of lines terminating in a central exchange, a divided connecting circuit having two branches, two series of automatic switches for extending said branches to called lines, means for connecting a calling line with said connecting circuit, means for operating the switches of one series over said calling line and one of said branches in series to select a called line, means for automatically operating the other series of switches upon the selection of a called line to extend the same into connection with said connecting circuit by way of the other branch whereby the said calling and called lines may be connected, and means for then releasing said first series of switches before destroying said connection.

25. In a telephone trunking system, a plurality of lines terminating in a central exchange, a trunk line terminating in a connector switch and having a branch, a plurality of automatic switches for selecting a called line operating circuits for each of said switches including the two sides of said trunk line in series, means for extending a calling line into connection with said trunk line and for further extending it via said branch to operate said automatic switches over said operating circuits, means including said connector switch for connecting said trunk line with the called line, and means for then disconnecting said branch.

26. In a telephone trunking system, a plurality of lines terminating in a central exchange, a trunk line terminating in a connector switch and having a branch, a plurality of automatic switches for selecting a called line, means for extending a calling line into connection with said trunk line and for further extending it via said branch to operate said automatic switches, means including said connector switch for connecting said trunk line with the called line, means for then disconnecting said branch, and a battery and a pair of bridged relays in said connector for supplying talking current from said battery to the calling and called lines.

27. In a telephone trunking system, a plurality of lines terminating in a central exchange, a trunk line terminating in a connector switch and having a branch normally connected thereto, a plurality of automatic switches for selecting a called line, a second plurality of automatic switches for extending a calling line into connection with said trunk line and means for further extending it via said branch to operate said first switches, and a third plurality of switches operated to effect in conjunction with said connector switch a connection between the said calling and called lines.

28. In a telephone trunking system, a plurality of lines terminating in a central exchange, a trunk line terminating in a con-

nector switch and having a branch normally connected thereto, a plurality of automatic switches for selecting a called line, a second plurality of automatic switches for extending a calling line into connection with said trunk line and means for further extending it via said branch to operate said first switches, a third plurality of switches operated to effect in conjunction with said connector switch a connection between the said calling and called lines, and means for disconnecting said branch.

29. In a telephone trunking system, a plurality of lines terminating in a central exchange, a trunk line terminating in a connector switch and having a branch normally connected thereto, a plurality of automatic switches for selecting a called line, a second plurality of automatic switches for extending a calling line into connection with said trunk line and means for further extending it via said branch to operate said first switches, a third plurality of switches operated to effect in conjunction with said connector switch a connection between the said calling and called lines, means for disconnecting said branch, and a release control circuit common to the switches of said second and third pluralities.

30. In a telephone trunking system, a plurality of lines terminating in a central exchange, a trunk line terminating in a connector switch and having a branch normally connected thereto, a plurality of automatic switches for selecting a called line, a second plurality of automatic switches for extending a calling line into connection with said trunk line and means for further extending it via said branch to operate said first switches, a third plurality of switches operated to effect in conjunction with said connector switch a connection between the said calling and called lines, means for disconnecting said branch, a release control circuit common to the switches of said second and third pluralities, and a relay in said connector for controlling said circuit.

31. In a telephone trunking system, a plurality of lines terminating in a central exchange, a trunk line terminating in a connector switch and having a branch normally connected thereto, a plurality of automatic switches for selecting a called line, a second plurality of automatic switches for extending a calling line into connection with said trunk line and means for further extending it via said branch to operate said first switches, a third plurality of switches operated to effect in conjunction with said connector switch a connection between the said calling and called lines, means for disconnecting said branch, a release control circuit common to the switches of said second and third pluralities, and a relay in said connector for controlling said circuit, said relay controlled from one of said connected lines, whereby the disconnection of the switches of said second and third pluralities may be effected simultaneously.

32. In a telephone trunking system, a plurality of subscribers' lines, means including a plurality of automatic switches controlled by a calling line for selecting a called line, a second plurality of switches operated automatically to connect the selected called line with the calling line to the exclusion of said first mentioned switches, and means for releasing said second plurality of switches controlled over the said calling line.

33. In a telephone trunking system, a plurality of subscribers' lines, means including a plurality of automatic switches controlled by a calling line for selecting a called line, a second plurality of switches operated automatically to connect the selected called line with the calling line to the exclusion of said first mentioned switches, and a pair of bridged relays in one of said second plurality of switches for supplying talking current to the connected calling and called lines.

34. In a telephone system, a plurality of subscribers' lines, means including a plurality automatic switches for establishing a connection between a calling and a called line, means including other automatic switches for then completing a second connection from the called line around certain of said first-mentioned switches, and means for releasing said second connection controlled by the calling line.

35. In a telephone system, a plurality of subscribers' lines, means including a plurality of automatic switches for establishing a connection between a calling and a called line, means including other automatic switches for then completing a second connection from the called line around certain of said first-mentioned switches, means for then releasing said first-mentioned switches about which the second connection is established, and means for releasing said second connection controlled by the calling line.

36. In a telephone system, a plurality of subscribers' lines, means including a plurality of switches for extending a connection to a called one of said lines, a connector switch, means for automatically operating said connector switch upon the called line being seized to establish a connection from the called line around certain of said first-mentioned switches, whereby a more direct connection is established between the calling and the called lines, a source of current, and a pair of bridged relays in said connector switch for supplying talking current from said source to the said calling and called lines.

37. In a telephone system, a plurality of subscribers' lines, calling trunks accessible

to the calling lines, called trunks accessible to the called lines, means including automatic switches for establishing a connection from a calling trunk to a called line, means controlled by the seizure of a called line for automatically connecting a called trunk directly with a calling trunk, said connection excluding said automatic switches, and means for controlling the release of all connecting means over a circuit including the connected calling trunk.

38. In a trunking system, a plurality of subscribers' lines, a trunk-selecting switch, two groups of trunk lines extending from said switch, means for operating said switch to select an idle trunk in one of said groups when a line is calling, means for operating said switch to select a trunk in the other of said groups when a line is being called, said means comprising a series of test contacts for the trunk lines of each group equal in number to the whole number of trunk lines, a test wiper in said switch coöperating with each series, and permanent ground connections for the test contacts in each series which correspond to the trunk lines of the other group.

39. In a telephone system, a pair of subscribers' lines, a plurality of automatic switches, a controlling relay in each switch, means for controlling said switches successively over circuits each including two sides of one of said lines and one of said relays in series to extend a connection to the other of said lines, and means controlled over said extended connection for thereafter establishing a connection between said lines excluding said first mentioned switches.

40. In a telephone system, a plurality of subscribers' lines, means including a plurality of automatic switches for establishing a connection to a called one of said lines, and means including other automatic switches for then completing a second connection from the called line around certain of said first mentioned switches to a calling one of said lines, said first mentioned switches being controlled over circuits each including one of said relays in series with a calling one of said lines.

41. In a telephone system, a plurality of subscribers' lines, means including a plurality of automatic switches for establishing a connection to a called one of said lines, means including other automatic switches for then completing a second connection from the called line around certain of said first mentioned switches to a calling one of said lines, said first mentioned switches being controlled over circuits each including one of said relays in series with a calling one of said lines, and means for then releasing said first mentioned switches about which the second connection is established.

42. In a telephone system, two connector switches, means for extending a calling line to a first one of said connectors, means for then extending the calling line over a branch circuit to the second of said connectors, means for operating the said second connector over the two sides of the calling line and a conductor of said branch in series to locate a called line, means including a plurality of automatic switches for rendering the selective called line accessible to said first connector, and automatic means for operating said first connector to complete a talking connection between the said calling and called lines.

Signed by me at Chicago, Cook county, Illinois, this 16 day of April, 1914.

ANDERS M. MALMBERG.

Witnesses:
CHARLES M. CANDY,
EDWARD D. FALES.