W. E. LAMB.

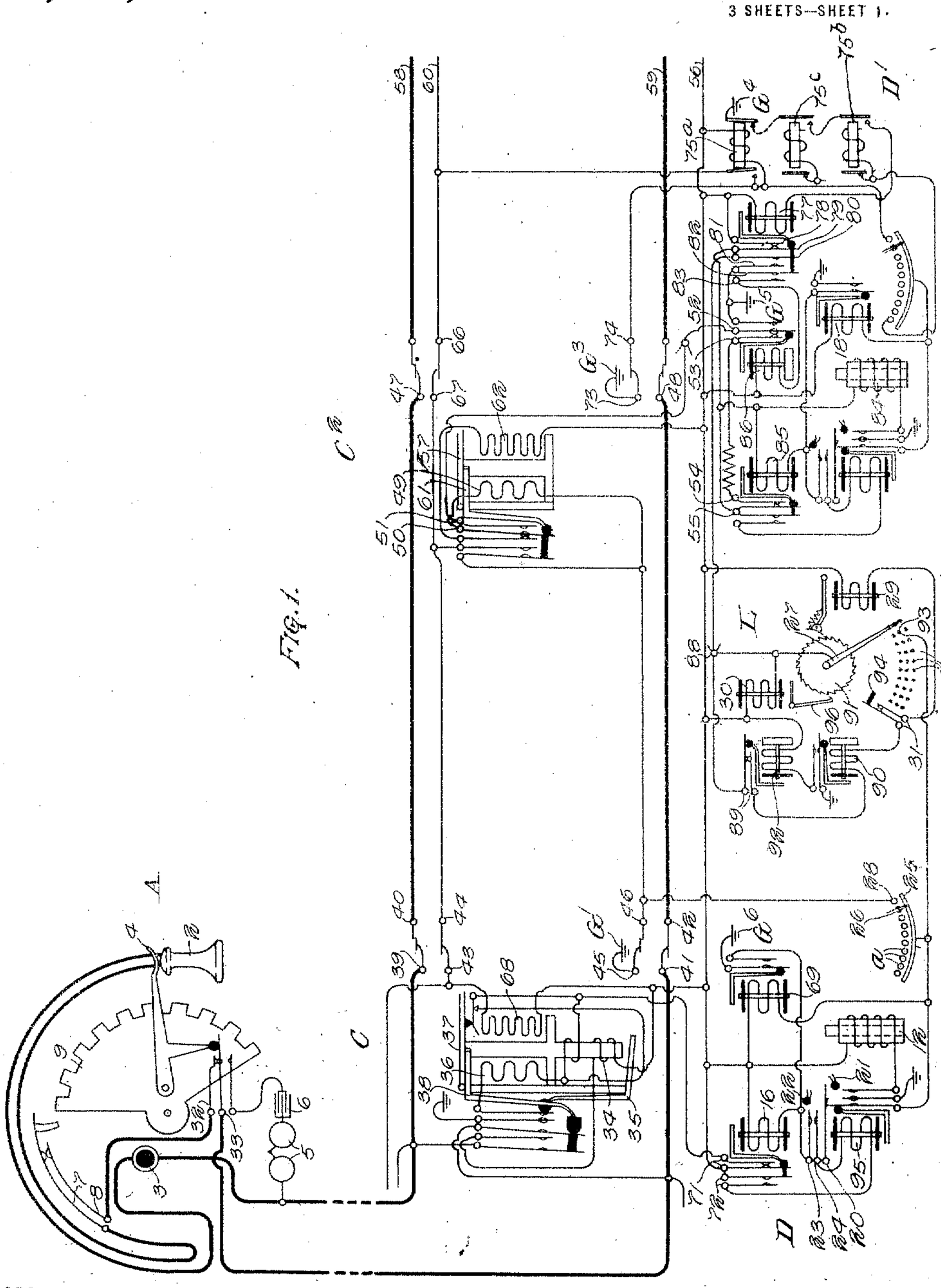
AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED JUNE 26, 1912. RENEWED DEC. 19, 1917.

1,275,186. Patented Aug. 6, 1918.

3 SHEETS—SHEET 1.

FIG. 1.



WITNESSES

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3 SHEETS—SHEET 2.

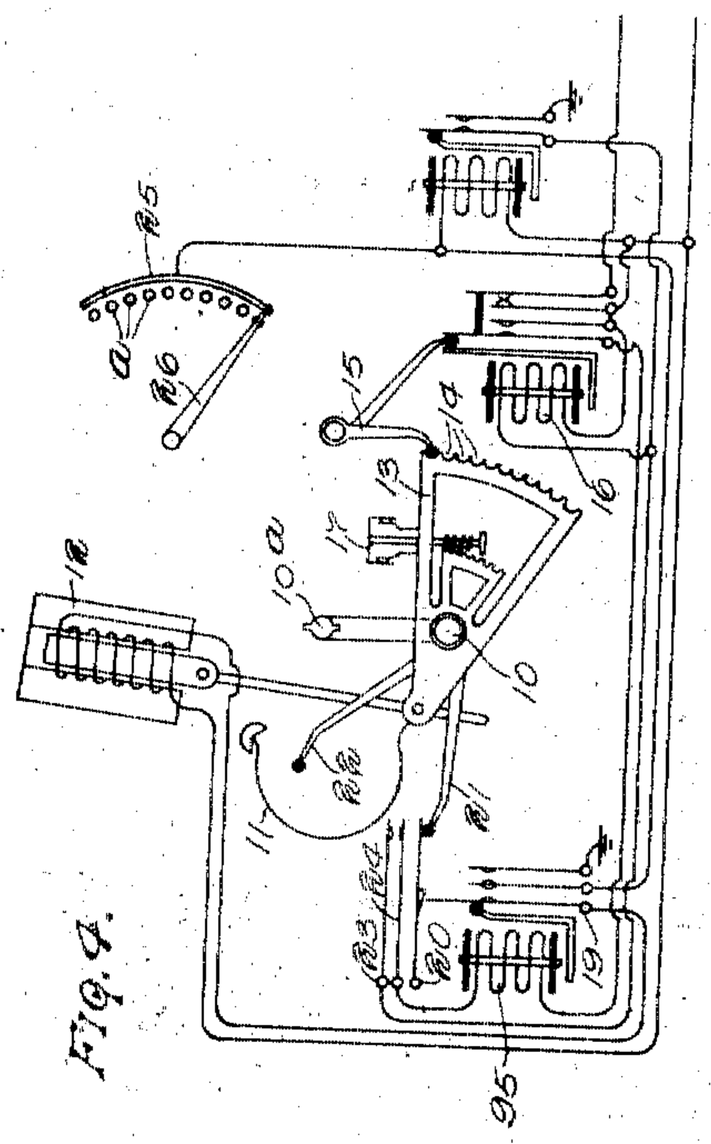

Fig. C.

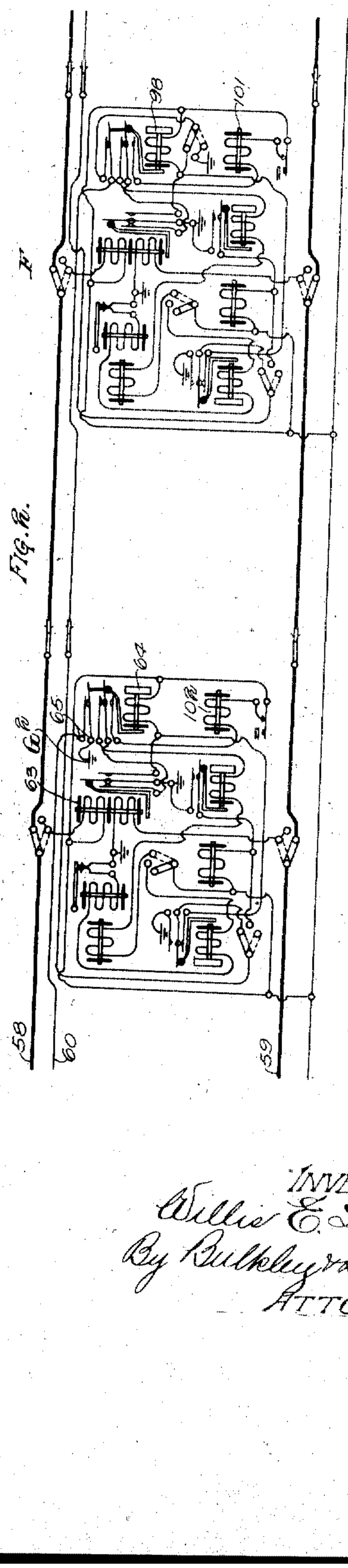

Fig. B.

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3 SHEETS—SHEET 3.

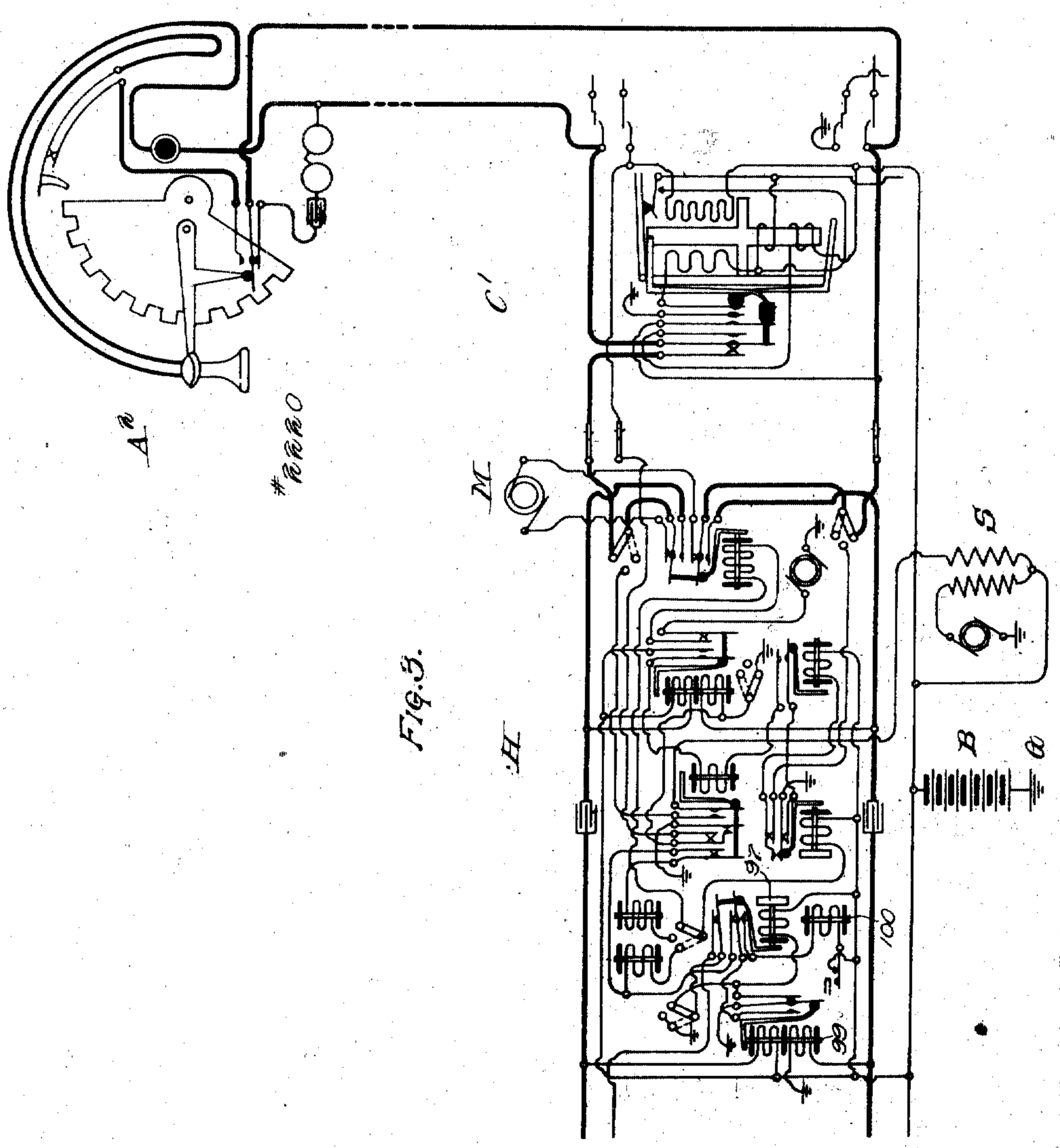

FIG. 3.

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AUTOMATIC TELEPHONE SYSTEM.

1,275,186. Specification of Letters Patent. Patented Aug. 6, 1918.

Application filed June 26, 1912, Serial No. 705,908. Renewed December 19, 1917. Serial No. 207,979.

To all whom it may concern:

Be it known that I, WILLIS E. LAMB, a citizen of the United States of America, and resident of Los Angeles, in the county of Los Angeles and State of California, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems, and particularly to systems which employ primary and secondary line switches.

In such systems these primary and secondary line switches are divided into groups or boards, and trunk lines leading out from each group of primary line switches are distributed equally among a plurality of groups of secondary line switches. There are usually ten groups of secondary line switches, so that one trunk line leads from each primary group to each secondary group. The number of secondary line switches in each group, and therefore the number of trunk lines leading into each group, is generally greater than the number of trunk lines leading out from the group. It will, therefore, be seen that if all the trunk lines leading out of any particular secondary group are in use, there will still be some idle trunk lines leading into that board, and it therefore becomes necessary to provide some means for preventing the primary line switches from selecting these idle trunk lines. Heretofore this has been accomplished by causing a guarding potential to be placed upon the primary master switch contacts of all the trunk lines leading into a secondary group when all the trunk lines leading out of that secondary group are in use. This guarding potential prevents any primary line switch from obtaining connection with a trunk line leading into a busy secondary board, provided all of the idle primary line switches are in locking engagement with the plunger shafts so as to be under the control of the master switches. In certain types of line switches, however, these switches are so arranged that, after one has been operated to select a trunk and then released, its plunger or contact arm remains standing in front of the trunk line with which it was last engaged until the plunger shaft, by subsequent operations, returns to the position in which it was when the line switch was operated. In such switches it will be seen that there may be as many as nine out of a group of ten line switches on each primary board which are not under the control of their master switch, and any one of these may be standing opposite a trunk leading into a busy secondary board, and the simple operation of putting a guarding potential upon the master switch bank contact will not move this line switch away from the trunk leading into the busy secondary board.

An object of my invention is the provision of means to absolutely insure that no primary line switches shall make connection with a trunk line leading into a busy secondary board. In order to accomplish this it is necessary to provide, in addition to placing a guarding potential upon the primary master switch bank contacts of the trunks leading into a busy secondary board, means whereby the primary master switches are caused to pick up all the idle plungers belonging to the respective line switches and bring them into locking engagement with their plunger shafts. This is accomplished by causing all the primary master switches to go through a complete operation each time all of the trunk lines leading out of a secondary board are in use.

A further and special object of my invention is the provision of means whereby all of the primary master switches which have trunk lines leading into a secondary board are not operated simultaneously. Such simultaneous operation would be objectionable, as it would cause a large momentary consumption of current. I therefore provide special means in which a small number of primary master switches are brought successively into operation, whereby the maximum current consumed in operating all of these master switches is greatly reduced.

These and other objects of my invention will be more readily and clearly understood by reference to the accompanying drawings, in which:

Figures 1, 2 and 3 taken together represent a complete circuit connection between a calling substation A (Fig. 1) and a called substation A^2 (Fig. 3).

Fig. 4 is a diagrammatic representation of the mechanism of the master switch D (Fig. 1).

The telephone system shown herein is of

the same type as that shown and described in British patent to Alexander E. Keith, No. 1421 of 1910—that is, it is a system in which the connections between the calling and called subscribers are established through the medium of primary and secondary preliminary trunk-selecting switches C and C², first selectors E, second selectors F and connectors H. The first selector E is the switch which operates in response to the operation of the substation calling device for the first digit of the called number. The first selector E is not permanently connected with the calling line, but the calling subscriber obtains connection therewith through the medium of two preliminary trunking switches C and C² which are operated immediately upon the removal of his receiver. The switch C is individual to the subscriber's line. The individual switches C of all the lines in the system are arranged in groups, usually one hundred in a group, each group having common access to a small number of trunk lines which lead to secondary switches C². These secondary switches are arranged in groups, like the primary switches, each group having access to a plurality of trunk lines leading to first selectors E. The trunk lines which lead from any particular group of primary switches C do not lead to secondary switches which are all included in the same group, but are distributed among secondary switches located in a plurality of groups of secondary switches. In this manner a number of first selectors considerably larger than the number of trunk lines leading from each group of primary line switches are made accessible in common to a plurality of groups of subscribers.

The automatic substation shown herein may be of any suitable or approved type of automatic substation. Referring to substation A, the substations shown herein comprise the usual receiver 2, transmitter 3, switch hook 4, ringer 5 and condenser 6. Being an automatic substation, it is also provided with an automatic calling device. This calling device may be of the type shown and described in British patent to S. G. S. Dicker, No. 29,654 of 1910. As shown herein, however, the calling device is represented diagrammatically by a pair of impulse springs 7 and 8 and a toothed impulse wheel 9, which latter may be controlled by the subscriber through the medium of a dial (not shown) provided with finger holes, in a well-known manner.

The primary and secondary preselecting or line switches are essentially the same as those shown in British Patent No. 1421 of 1910, referred to above, there being only slight changes in the circuit, as will be readily understood from the description which is to follow. These line switches, as is well known, are each provided with a plunger which, when idle, is always maintained opposite the bank terminal of an idle trunk line by a so-called master switch. The master switch D in this case is somewhat different from that shown in said British Patent No. 1421 of 1910. As shown in Fig. 4, the usual plunger shaft 10ª, through the medium of which the master switch controls the plungers, is connected with a rotary shaft 10 in such a manner that as the shaft 10 is rotated back and forth, the plunger shaft is caused to oscillate about said shaft 10 as an axis. The shaft 10 is adapted to be rotated in one direction by a spring 11 and in the other direction against the opposition of said spring by a solenoid 12. Secured to the shaft 10 there is a cam member 13 provided along its outer edge with a series of notches 14, one for each trunk line to which the line switches have access. The shaft 10 is normally locked against rotation in either direction by the engagement of the lever 15 with one of the notches 14. The lever 15 is controlled by the armature of the relay 16 in such a manner that when said relay is energized the lever is withdrawn from the cam so as to unlock the shaft 10. The speed of rotation of the shaft 10, and therefore the speed of the plunger shaft, is controlled through the medium of a suitable governor 17. Associated with the master switch there is a relay 95 the springs of which, upon being operated, are locked in their operated positions by the engagement of the spring 19 with the detent on the under side of the spring 20. The springs are unlocked by the arm 21 when the shaft 10 reaches the limit of its travel in one direction. When the shaft 10 reaches the limit of its travel in the other direction, the arm 22 forces the spring 23 into engagement with the spring 24. The master switch is also provided with a bank of contacts comprising the common segment 25 and an individual contact *a* for each trunk line. A wiper 26 keeps the common segment 25 in electrical connection with the individual contact *a* corresponding to the trunk line before which the plungers of the idle line switches are resting. In general, the operation of the master switch is as follows: Whenever a trunk line is seized by a line switch, the relay 16 is energized to unlock the shaft 10, the spring 11 thereupon rotating the shaft 10 to cause the plunger shaft to move the idle plungers away from the trunk just seized and to an idle trunk line. When the idle trunk line is reached, the relay 16 deenergizes and again locks the shaft. When the plungers pass beyond the last trunk line, the arm 22 forces the springs 23 and 24 into contact and thereby closes the circuit of the relay 95. The relay 95 thereupon energizes and the springs operated thereby be

come locked in their operated positions. This closes the circuit of the solenoid 12, which rotates the shaft 10 back in the opposite direction to bring all the plungers which are in engagement with the plunger shaft back to a position opposite the first trunk line and to restore tension to the spring 11. When the plungers reach their starting positions, the arm 21 unlocks the springs of the relay 95, which permits the solenoid to deënergize and the plunger shaft to come to rest. The master switch D' (Fig. 1) of the secondary switches is similar to that shown in Fig. 4, with the addition of a number of circuit-controlling relays, the function of which will be explained hereinafter.

The device shown at L is common to all the groups of primary and secondary switches which are associated together. This device comprises a rotary wiper 27 which is adapted to rotate in a step-by-step manner over a bank of contacts *b*. There are as many contacts in the bank *b* as there are groups of primary line switches C. There may be a plurality of contacts to be engaged by the wiper 27 in each step-by-step position. Each contact in the bank is connected to the starting relay 69 of a different master switch D. The wiper 27 is rotated through the medium of a motor magnet 29. The magnet 30 is a holding magnet which, when energized, prevents the wiper 27 from rotating backward. The springs 31 are adapted to be separated by the wiper 27 when it is rotated beyond the last set of contacts.

The selectors E and F and the connector H are of the general type of selector and connector switches disclosed in United States Letters Patents Nos. 815,321 and 815,176, respectively, granted March 13, 1906, to Keith, Erickson and Erickson. The circuits are modified, however, as shown in said British Patent No. 1421 hereinabove referred to.

The line switch C' and the substation A^2 are in all respects the same as the substation A and line switch C.

At M (Fig. 3) there is shown a ringing current generator and at S a busy signaling device is represented. At B there is shown a battery having one terminal grounded at G for the purpose of supplying current for operating the central office apparatus and for talking purposes.

Having given a general description of the apparatus, it will be explained how the subscriber at the calling substation A may obtain connection with the subscriber at the called substation A^2, the number of which latter will be assumed to be 2220. As is well known, the plunger of the line switch C of the calling line is normally held opposite the terminal of an idle trunk line. When the calling subscriber removes his receiver preparatory to making a call, the closure of the hook switch springs 32 and 33 completes a bridge across the calling line through the transmitter and receiver, whereupon the line winding 34 of the switch C becomes energized. The winding 34, upon energizing, attracts the armature 35, whereby the circuit of the operating winding 36 is closed. The winding 36, upon energizing, attracts the plunger arm 37 and the cut-off armature 38. The armature 38 operates to disconnect the line winding 34 from the line, while the plunger arm 37 causes the plunger to be thrust into the group of contact springs forming the terminal of the trunk line before which it is being held and forces the springs 39, 40, 41, 42, 43, 44, 45 and 46 into contact in pairs, as shown. The engagement of the springs 39 and 41 with the springs 40 and 42, respectively, extends the line circuit through to the springs 47 and 48 of the switch C^2. The engagement of the springs 45 and 46 of the switch C completes a circuit extending from ground G' through the springs 45 and 46, winding 49 of the switch C^2, springs 50, 51, 52, 53, 54, 55, 79 and 78 to the battery lead 56, thence through battery B to ground G. The winding 49, upon energizing, attracts its plunger arm 57, which operates in the same manner as the plunger arm of the switch C to extend the line connection over the trunk conductors 58 and 59 to a first selector E (Fig. 2). When the winding of the switch C^2 is energized it also attracts the armature 61, which operates to insert the high resistance winding 62 in series with the winding 49 to reduce the current consumption while the switch is being held in its operated position. When connection is extended to the first selector E its line relay 63 becomes energized and closes the circuit of the relay 64. The relay 64, upon energizing, completes a circuit extending from ground G^2 through the springs 65, conductor 60, springs 66, 67, 44 and 43 and the holding winding 68 of the switch C to the battery lead 56, thence to the battery B. This, of course, takes place before the line winding 34 deënergizes and breaks the circuit of the winding 36.

When the back springs 45 and 46 of the switch C are forced into contact by the operation of said switch, a circuit is closed extending from ground G^2 through the springs 45 and 46, contact point 28 (which is assumed to correspond to the trunk line leading to the switch C^2), wiper 26 (which is assumed to be standing on the contact 28 at the time), common segment 25 and the relay 69 to the battery lead 56. The relay 69, upon energizing, completes an energizing circuit for the relay 16. The relay 16 thereupon operates to open the springs 71 and to close the springs 72. The

opening of the springs 71 disconnects the operating windings of all the switches C from the battery lead 56. The closure of the springs 72 is without any particular function at this time. The relay 16, upon energizing, also operates to withdraw the locking arm 15 from the cam 13 (Fig. 4), thereby releasing the shaft 10 and permitting it to be rotated by the spring 11 to cause the plungers of the idle line switches to be moved away from the trunk line seized by the switch C. When the plungers have been moved away from this trunk line, the wiper 26 passes off the contact 28, and if the next trunk line is not busy, the relay 16 deënergizes and permits the arm 15 to drop into the next notch in the cam 13, thereby bringing the shaft to rest with the plungers standing opposite the next trunk line. If the next trunk line after the one seized by the switch C has been busy, the wiper 26 would have found the next contact grounded and the relay 16 would have remained energized and caused the plunger to be rotated past all the busy trunks to an idle one.

When the bank springs 73 and 74 are forced into contact by the operation of the switch C^2, the master switch D′ is caused to advance the plungers of all the idle secondary switches C^2 which it controls to an idle trunk line. The relay 18 of the switch D′ corresponds to the relay 69 of the switch D.

In systems such as shown herein there are generally a smaller number of trunk lines leading out of each group of secondary switches than there are switches in the group of trunk lines leading thereto. It is thus evident that when all the trunk lines leading out of a secondary group become busy, there will still be trunk lines leading into said group which are idle and means should be provided to keep any of the primary switches from seizing one of these idle incoming trunks while the outgoing trunks are all busy. This, of course, can be done by preventing the master switches of the primary groups from stopping with their plungers resting in front of a trunk line leading into the busy secondary group, providing the plungers of all the idle primary switches are under the control of their master switches. The line switches represented herein, however, are so arranged that when they are released from their operated positions, their plungers do not again become locked with the plunger shaft and said switches do not come under the control of the master switch again until the master switch, by subsequent operations, returns the plunger shaft to the position in which it was when each of the disengaged plungers was first operated. It is thus evident that in order to insure that the plungers of none of the primary switches shall remain in position to seize a trunk line leading into a secondary group when all the trunk lines leading out of it are in use, it is necessary to cause all the primary master switches to be operated so as to cause all the idle plungers of the primary line switches to become locked with their plunger shafts. It is the function of the device L (Fig. 1) to cause the primary master switches to pick up their idle plungers. Its operation is as follows:

Associated with each of the trunk lines to which the secondary switches C^2 have access there is a relay 75. Only three relays 75^a, 75^b and 75^c belonging to trunk lines which are accessible to the switches controlled by the master switch D′ are shown. The relay 75^a belongs to the first trunk line of this group, the relay 75^b to the last trunk and the relay 75^c to some intermediate trunk. It will be seen that when the switch C^2 operates to engage the trunk conductors 58 and 59, the relay 75^a is energized over a circuit extending from ground G^3 through the springs 73 and 74 and the relay 75^a to the battery lead 56. In like manner, the relay 75 of each of the other trunks is energized when its trunk is seized. The contact springs of all the relays 75^a to 75^b are connected in series, so that when all these relays are energized a circuit is closed from ground G^4 through the contacts of each of the relays 75 in succession, and thence through the relay 77 to the battery lead 56. The relay 77, upon energizing, separates the springs 78 and 79 and closes the contacts between the springs 80 and 81 and 82 and 83. The separation of the springs 78 and 79 disconnects the battery from the solenoid 84 and from the spring 55 of the relay 85, so as to prevent the master switch D′ from operating. The closing of the springs 82 and 83 closes a circuit through the relay 86 which, upon energizing, disconnects the battery from all the idle switches C^2 which are controlled by the master switch D′ and extends a connection from ground G^5 back through the windings 49 of said idle switches to their corresponding contacts in the banks of the primary master switches D to prevent the primary switches from stopping opposite a trunk line leading to a secondary switch on a board whose outgoing trunk lines are all in use. The closing of the springs 81 and 80 by the relay 77 completes a circuit extending from ground G^5 through said springs 81 and 80, and thence to the point 88 in the device L, from whence one branch of the circuit passes through the holding magnet 30 to the battery lead 56, while another branch passes through the springs 89, relay 90, interrupter springs 31 and the motor magnet 29 to the battery lead 56. The magnet 30, upon energizing, draws the pawl 96 down into the teeth of the ratchet

wheel 91. The magnet 29, upon energizing, rotates the ratchet wheel 91 and the wiper 27 one step, whereupon a circuit is closed from ground G^5 to the point 88, as just traced, thence through the wiper 27, contact point 93 and the relay 69 of the master switch D to the battery lead 56. The relay 69, upon energizing, closes the circuit of the relay 16, which in turn unlocks the plunger shaft and permits it to operate in the manner hereinbefore described. The relay 16 remains energized and the plunger shaft of the master switch D continues to operate until the motor magnet 29 of the device L is energized again to advance the wiper 27 a second step. The magnet 29 is energized a second time by the coöperation of the relays 90 and 92 in the following manner: The relay 90 is energized in series with the magnet 29 and, upon energizing, operates to close the circuit of the relay 92. The relay 92, upon energizing, separates the springs 89, thereby interrupting the circuit of the relay 90 and the magnet 29. The magnet 29 deënergizes immediately, but the relay 90 being a slow acting relay remains in its operated position for a short time. When the relay 90 finally deënergizes it interrupts the circuit of the relay 92, which also, being a slow acting relay, remains in its operated position for an instant and then deënergizes to again close the circuit of the relay 90 and the magnet 29. It will thus be seen that through the medium of the relays 90 and 92 the circuit of the magnet 29 will be automatically interrupted to advance the wiper 27 step by step until said wiper strikes the bushing 94, whereupon the operating circuit will be opened and the wiper 27 allowed to come to rest. The wiper 27 remains in each of its stop positions for a short interval of time owing to the slow action of the relays 90 and 92. This interval is long enough to allow the master switch D to carry the plungers which it controls completely across their sets of bank contacts. When the plungers reach the last trunk line, the arm 22 presses the springs 23 and 24 into contact, thereby closing the circuit of the relay 95. This circuit extends from ground G^6 through the springs of the relay 69, springs 23 and 24, relay 95 and the springs 72 to the battery lead 56. The relay 95, upon energizing, closes the circuit of the solenoid 12 which, upon energizing, operates to restore the plunger shaft and plungers back to their starting positions. When the relay 95 is energized its springs become locked in their operated positions by the spring 20. When the plunger shaft reaches its starting position, the arm 21 unlocks the springs of the relay 95, thereby permitting the solenoid 12 to deënergize. It will thus be seen that the plunger shaft is caused to complete its entire movement at least once, thereby causing all the idle plungers which it controls to become locked in engagement therewith, so as to be sure that none of them will be left standing opposite a trunk line leading into the group of secondary switches to which the switch C^2 belongs, all the trunk lines leading out from which are assumed to be busy. As shown in the device L, there is more than one contact engaged by the wiper 27 in each of its stop positions. Thus at each step said wiper causes a plurality of the master switches D to operate to pick up their idle plungers. By thus having a number of contact points in each position of the wiper 27, the number of steps required to be made by said wiper is less than the total number of master switches, and yet a large number of switches are not operated at once, thereby reducing the current consumption. When any one of the busy secondary switches C^2 controlled by the master switch D' is released, the relay 75 of the trunk which was engaged by it becomes deënergized and breaks the circuit of the relay 77. The relay 77, upon deënergizing, breaks the circuit of the holding magnet 30 of the device L, which allows the pawl 96 to be withdrawn from the ratchet wheel 91 to permit the wiper 27 to be restored to its normal position.

As has been explained, the operation of the switches C and C^2, which is initiated by the removal of the receiver from the switch hook, extends the line connection through to a first selector E. The calling subscriber now operates his calling device in a well known manner for the successive digits of the number of the called line. The switch E responds to the impulses for the first digit, the selector F responds to the impulses for the second digit and the connector H operates in response to the impulses for the last two digits to extend the connection to the called line. The operation of these switches is, in general, well understood in the art and is fully described in British Patent No. 1421 of 1910 previously referred to and it is not thought necessary to describe the same in detail herein.

After a conversation is completed, the entire connection is automatically released by the hanging up of the receiver at the calling substation. This is brought about in the following manner: During the time the conversation is being carried on the release relays 97, 98 and 64 of the switches H, F and E are maintained energized by a circuit which is closed through the springs of the connector line relay 99. When the calling subscriber hangs up his receiver, the relay 99 deënergizes and breaks the circuit of the relays 97, 98 and 64. The relays 97, 98 and 64, upon deënergizing, operate to close the circuit of the release magnets 100, 101 and 102 of their respective switches. The re-

lease magnets, upon energizing, immediately restore the switches to normal position. The relay 64 of the selector E, upon deënergizing, also destroys the holding circuits of the windings 62 and 68 of the switches C^2 and C, respectively, whereupon the plungers of said switches are permitted to be restored to normal position and all the apparatus employed in the connection is left in readiness for another call.

It will thus be seen that I have devised a very efficient system in which it is impossible for a primary line switch to seize an idle trunk which extends into a group of secondary line switches when all the trunks leading out of said secondary group are in use.

While I have illustrated and described my invention in connection with a particular type of telephone system and a particular type of line switch, it will be readily understood that my invention is not so limited, as it is obvious that my invention is of broader scope, and I do not wish to be limited to the exact construction shown and described.

What I claim as my invention is:—

1. In a telephone system, primary line switches divided into groups, a master switch for controlling each group of line switches, secondary line switches divided into groups, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said groups of secondary line switches, and means operable when all the secondary trunk lines leading out of a particular group are in use for causing any one of said master switches to sweep over all of the trunk lines of a particular group of primary switches while some of said last trunk lines are idle.

2. In a telephone system, a plurality of groups of primary line switches, a master switch for controlling each group, a plurality of groups of secondary line switches, a secondary master switch for controlling each group of secondary line switches, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said secondary line switches, and means operable when all the secondary trunks leading out of a particular group of secondary line switches are in use for causing any one of said primary master switches to sweep over all of the trunk lines of a particular group of primary switches while some of said last trunk lines are idle.

3. In a telephone system, a plurality of groups of primary line switches, a master switch for controlling each group, a plurality of groups of secondary line switches, trunk lines leading out from each group of primary line switches and distributed among a plurality of groups of secondary line switches, secondary trunk lines leading out of said secondary line switches, and means operable when all of the secondary trunks leading out of a particular group are in use for causing any one of said master switches to sweep over all of the trunk lines of a particular group of primary switches while some of said last trunk lines are idle.

4. In a telephone system, a plurality of groups of primary line switches, a master switch for controlling each group, a plurality of groups of secondary line switches, a secondary master switch for controlling each group of secondary line switches, trunk lines leading out from each group of primary line switches and distributed among a plurality of groups of secondary line switches, secondary trunk lines leading out of each group of secondary line switches, and means operable when all of the secondary trunks leading out of a particular group of secondary line switches are in use for causing any one of said primary master switches to sweep over all of the trunk lines of a particular group of primary switches while some of said last trunk lines are idle.

5. In a telephone system, primary line switches divided into groups, a master switch for controlling each group of line switches, secondary line switches divided into groups, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said groups of secondary line switches, and means for successively operating groups of said primary master switches when all the secondary trunk lines leading out of a group of secondary line switches are in use.

6. In a telephone system, a plurality of groups of primary line switches, a master switch for controlling each group, a plurality of groups of secondary line switches, a secondary master switch for controlling each group of secondary line switches, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said secondary line switches, and means for successively operating groups of said primary master switches when all the secondary trunk lines leading out of a group of secondary line switches are in use.

7. In a telephone system, a plurality of groups of primary line switches, a master switch for controlling each group, a plurality of groups of secondary line switches, trunk lines leading out from each board of primary line switches and distributed among a plurality of boards of secondary line switches, secondary trunk lines leading out of said secondary line switches, and means for successively operating groups of said primary master switches when all the secondary trunk lines leading out of a group of secondary line switches are in use.

8. In a telephone system, a plurality of groups of primary line switches, a master switch for controlling each group, a plural-

ity of groups of secondary line switches, a secondary master switch for controlling each group of secondary line switches, trunk lines leading out from each group of primary line switches and distributed among a plurality of groups of secondary line switches, secondary trunk lines leading out of each group of secondary line switches, and means for successively operating groups of said primary master switches when all the secondary trunk lines leading out of a group of secondary line switches are in use.

9. In a telephone system, a plurality of groups of primary line switches, each of said line switches including a plunger, a master switch for each group of primary line switches having a shaft with which said plungers are normally in engagement and adapted to be disengaged therefrom upon the operation of said line switches, a group of secondary line switches divided into groups, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said groups of secondary line switches, and means operable when all the secondary trunks leading out of a group are in use for causing any one of said master switches to sweep over all of the trunk lines of a particular group of primary line switches to connect all the plungers with the corresponding shaft while some of said last trunk lines are idle.

10. In a telephone system, a plurality of groups of primary line switches, each of said line switches including a plunger, a master switch for each group of primary line switches having a shaft with which said plungers are normally in engagement and adapted to be disengaged therefrom upon the operation of said line switches, a group of secondary line switches divided into groups, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said groups of secondary line switches, means for operating said primary master switches to connect all the plungers of the line switches with the corresponding shaft when all the secondary trunks leading out of a group are in use, and a rotary switch for succesively bringing groups of said master switches into operation.

11. In a telephone system, a plurality of groups of primary line switches, each of said line switches including a plunger, a master switch for each group of primary line switches having a shaft with which said plungers are normally in engagement and adapted to be disengaged therefrom upon the operation of said line switches, a group of secondary line switches divided into groups, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said groups of secondary line switches, means for operating said primary master switches to connect all the plungers of the line switches with the corresponding shaft when all the secondary trunks leading out of a group are in use, a rotary switch for successively bringing groups of said master switches into operation, and means for delaying the operation of said rotary switch.

12. In a telephone system, primary line switches divided into groups, a master switch for controlling each group of line switches, secondary line switches divided into groups, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said groups of secondary line switches, means for successively operating groups of said primary master switches when all the secondary trunk lines leading out of a group of secondary line switches are in use, bank contacts on said primary master switches corresponding to the trunks leading to said secondary switches, and means for placing a guarding potential on said bank contacts of trunk lines extending to a group of secondary line switches when all of the trunks leading out of said group are in use.

13. In a telephone system, a plurality of groups of primary line switches, a master switch for controlling each group, a plurality of groups of secondary line switches, a secondary master switch for controlling each group of secondary line switches, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said secondary line switches, means for successively operating groups of said primary master switches when all the secondary trunk lines leading out of a group of secondary line switches are in use, bank contacts on said primary master switches corresponding to the trunks leading to said secondary switches, and means for placing a guarding potential on said bank contacts of trunk lines extending to a group of secondary line switches when all of the trunks leading out of said group are in use.

14. In a telephone system, a plurality of groups of primary line switches, a master switch for controlling each group, a plurality of groups of secondary line switches, trunk lines leading out from each group of primary line switches and distributed among a plurality of groups of secondary line switches, secondary trunk lines leading out of said secondary line switches, means for successively operating groups of said primary master switches when all the secondary trunk lines leading out of a group of secondary line switches are in use, bank contacts on said primary master switches corresponding to the trunks leading to said secondary switches, and means for placing a guarding potential on said bank contacts of trunk lines extending to a group of sec-

ondary line switches when all of the trunks leading out of said group are in use.

15. In a telephone system, a plurality of groups of primary line switches, a master switch for controlling each group, a plurality of groups of secondary line switches, a secondary master switch for controlling each group of secondary line switches, trunk lines leading out from each group of primary line switches and distributed among a plurality of groups of secondary line switches, secondary trunk lines leading out of each group of secondary line switches, means for successively operating groups of said primary master switches when all the secondary trunk lines leading out of a group of secondary line switches are in use, bank contacts on said primary master switches corresponding to the trunks leading to said secondary switches, and means for placing a guarding potential on said bank contacts of trunk lines extending to a group of secondary line switches when all of the trunks leading out of said group are in use.

16. In a telephone system, a plurality of groups of primary line switches, each of said line switches including a plunger, a master switch for each group of primary line switches having a shaft with which said plungers are normally in engagement and adapted to be disengaged therefrom upon the operation of said line switches, a group of secondary line switches divided into groups, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said groups of secondary line switches, means for operating said primary master switches to connect all the plungers of the line switches with the corresponding shaft when all the secondary trunks leading out of a group are in use, a rotary switch for successively bringing groups of said master switches into operation, bank contacts on said primary master switches corresponding to the trunks leading to said secondary switches, and means for placing a guarding potential on said bank contacts of trunk lines extending to a group of secondary line switches when all the trunks leading out of said group are in use.

17. In a telephone system, a plurality of groups of primary line switches, each of said line switches including a plunger, a master switch for each group of primary line switches having a shaft with which said plungers are normally in engagement and adapted to be disengaged therefrom upon the operation of said line switches, a group of secondary line switches divided into groups, trunk lines leading from said primary to said secondary line switches, secondary trunk lines leading out of said groups of secondary line switches, means for operating said primary master switches to connect all the plungers of the line switches with the corresponding shaft when all the secondary trunks leading out of a group are in use, a rotary switch for successively bringing groups of said master switches into operation, means for delaying the operation of said rotary switch, bank contacts on said primary master switches corresponding to the trunks leading to said secondary switches, and means for placing a guarding potential on said bank contacts of trunk lines extending to a group of secondary line switches when all of the trunks leading out of said group are in use.

Signed by me at Los Angeles, Los Angeles county, California, this tenth day of June, 1912.

WILLIS E. LAMB.

Witnesses:
MARIE H. LAMB,
E. DE MEULLE.