B. D. WILLIS.

AUTOMATIC TELEPHONE SYSTEM.

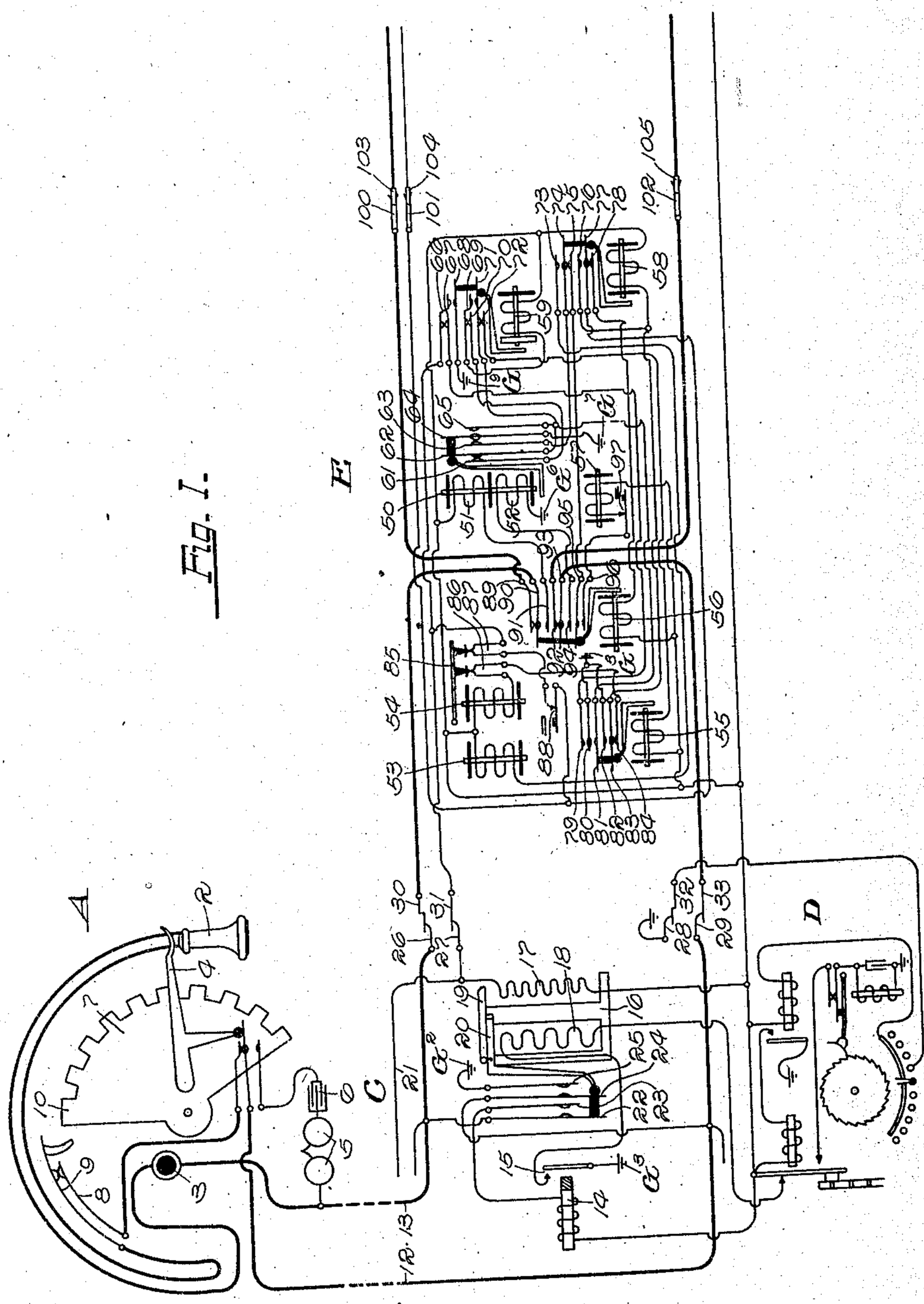
APPLICATION FILED NOV. 8, 1915.

Patented Nov. 6, 1917.

2 SHEETS—SHEET 1.

1,245,650.

FIG. 1.




Witnesses

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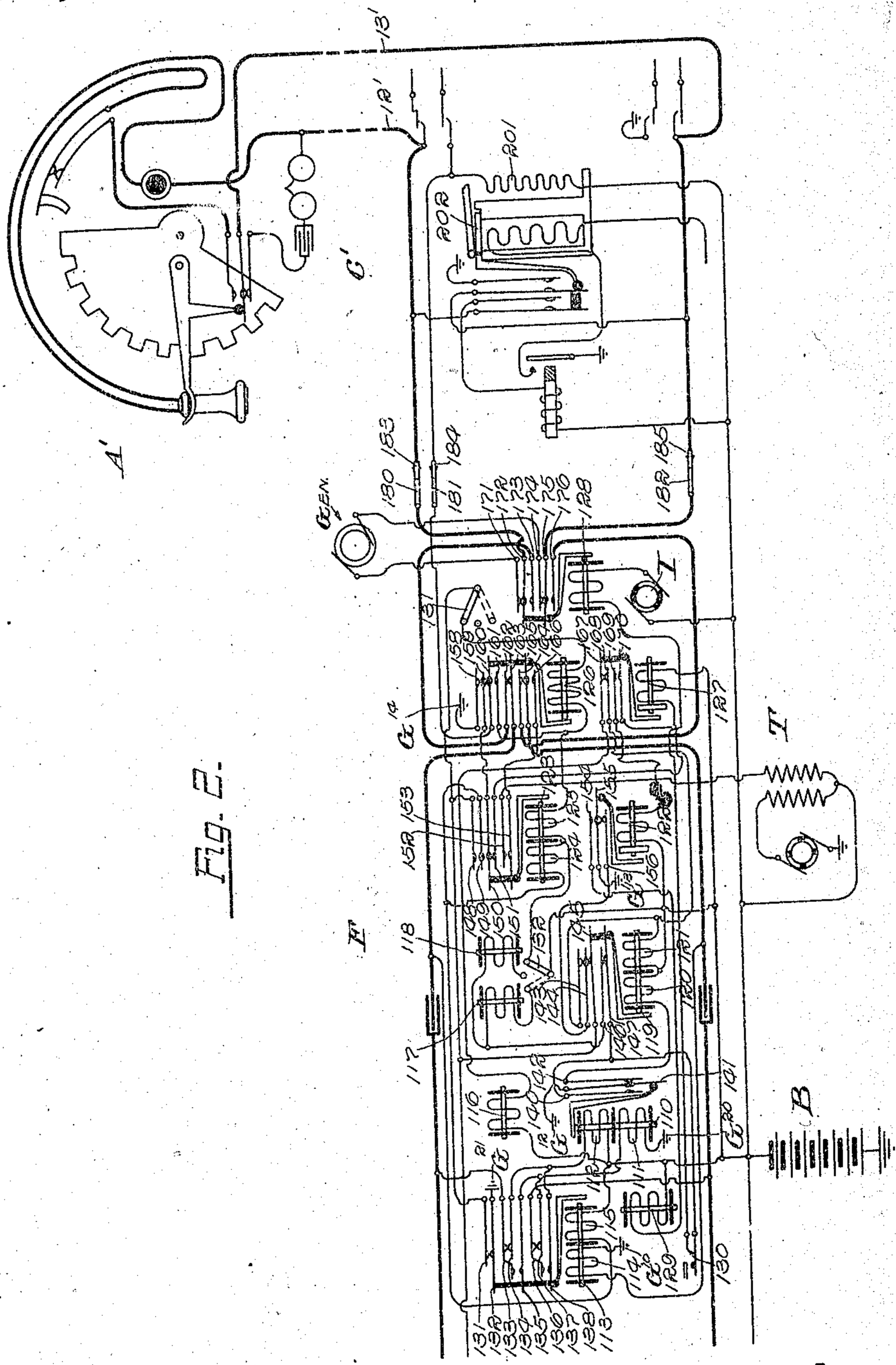


Fig. 2.

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# UNITED STATES PATENT OFFICE.

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## AUTOMATIC TELEPHONE SYSTEM.

1,245,650. Specification of Letters Patent. Patented Nov. 6, 1917.

Application filed November 8, 1915. Serial No. 60,265.

*To all whom it may concern:*

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

My invention relates to automatic telephone systems and more particularly to those systems in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series. In systems of the above general character it has been the common practice to control the selector and connector switches through the medium of so called fast and slow relays, these relays being responsive, respectively, to interruptions of the line circuit and to a series of such interruptions.

A well known type of selector switch, for example, has a controlling relay which sends an impulse to a vertical operating magnet at each interruption of the line circuit. At the same time impulses are sent to a slow relay which energizes at the first impulse and retains its armature in an operated position during a series of impulses. At the end of the series of impulses the slow relay retracts its armature thereby closing a circuit whereby the wipers are started rotating to automatically select an idle trunk line. In the common type of connector switch a slow relay similar to the one mentioned above is used to control a so-called side switch through the medium of a private magnet, the side switch being advanced after each series of impulses to change local circuits in preparation for the next series of impulses.

The object of my invention is to provide a new and more efficient method of shifting the local circuits of selector and connector switches, whereby I am able to avoid the use of a relay responsive to the time interval between two series of impulses.

In the preferred form of my invention I provide at the subscriber's substation a type of impulse sending mechanism which is adapted to send a prolonged final impulse. The selector and connector switches at the exchange, in addition to the regular controlling relay, are provided with a relay which, is slow to energize and is, therefore, irresponsive to impulses of ordinary length, but is responsive to the prolonged final impulse. In the operation of the system, the last impulse of every series effectively energizes the special relay above mentioned, which relay controls certain circuits whereby, in the case of a selector switch, the rotary movement to select an idle trunk is initiated, and, in the case of a connector switch, the control of the side switch is effected.

A further object of my invention is the provision of a new and improved method of controlling the disconnection of the switches in a system of the above character. It has formerly been the practice to use for this purpose a slow acting release relay which deënergizes only when the line circuit is permanently opened, as by hanging up the receiver. I prefer to use a pair of locking relays which, in addition to other functions, serve to control the release of a selector and to provide a holding circuit for preceding switches during the time a selector switch is receiving impulses, after which the control is shifted in part to a slow acting relay while the selector is rotating, and finally, at the cessation of the rotation, the control is shifted to relays in the succeeding selector or connector, as the case may be.

In the application of the principles of my invention to selector and connector switches of standard type a variety of modifications and circuit changes are required, all of which have been provided and will be hereinafter fully explained, reference being had to the accompanying drawings.

I have shown in Figs. 1 and 2, taken in order with the lines at the ends thereof in alinement, a complete circuit connection between a calling substation A and a called substation A′ in a system embodying the principles of my invention. The said connection has been established through the medium of the individual line switch C, the selector switch E, and the connector switch F.

The substation A (Fig. 1) may be of the general type of substation disclosed in British patent to T. G. Martin, No. 1419 of 1910. As herein represented it consists of the receiver 2, transmitter 3, receiver hook 4, ringer 5 and condenser 6. Being an automatic substation it is also provided with a pair of impulse springs 8 and 9 controlled by the impulse wheel 7 through the medium of a finger hole dial (not shown). In ac-

cordance with my invention the last impulse tooth carried by the impulse wheel 7, indicated by reference character 10, is made somewhat longer than the rest of the impulse teeth for a purpose which will be explained hereafter.

The line conductors 12 and 13 of the substation A are connected at the exchange to the individual line switch C which may be of the general type disclosed in British patent to R. W. James, No. 26301 of 1906, being however, of the particular type shown in United States Letters Patent No. 1,078,690, granted January 17th, 1912, to Frank Newforth, Jr. The line switch comprises among other details a plunger (not shown) attached to the end of a so called plunger arm 19. The plunger arm 19 and the cut off armature 20 are controlled by the magnet 16 which has two windings; one of which, the pull in winding 18, operates both the plunger arm and the cut off armature, while the other, the holding winding 17, is only strong enough to operate the cut off armature and to hold the plunger arm in an operated position after it has been operated by the pull-in winding. When the plunger arm is operated, the plunger is forced into a bank of contact springs, forcing the springs 26, 27, 28 and 29 into engagement with contacts 30, 31, 32 and 33, respectively. Although only one set of springs and contacts (26 to 33, inclusive) is shown, it is understood that each line switch is provided with a plurality of such sets, each set forming the terminals of a trunk line leading to a first selector 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 line switch C is controlled by the subscriber through the medium of the line relay 14.

The master switch D is of the general type disclosed in British patent to R. W. James, No. 26301 of 1906, being, however, more nearly of the particular type disclosed in British patent to T. G. Martin, No. 1419 of 1910 above referred to. The function of the master switch, as is well known, is to maintain the plungers of all the idle line switches in position before the terminals of an idle trunk line.

Accessible to the line switch C is shown a selector switch E, which is of the general type of selector switch disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson, and Erickson, except that the so called side switch is omitted and the circuits are modified to enable 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. There are, furthermore, a number of other modifications necessary to carry out my invention and which will be explained hereafter. Among other details the selector E comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 100, 101, and 102 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 53, and a rotary movement controlled by the rotary magnet 54. The operation of the various parts of the switch are controlled through the medium of the double wound line relay 50. Means for permitting the switch to be restored to normal position are provided in the release magnet 57, which, upon energizing, withdraws the retaining pawls from the shaft. The contacts 88 and 97, are closed only when the shaft has been raised one or more steps from its lowest position. The relay 59 is constructed in a manner such that it is especially adapted to carry out the objects of my invention. The said relay is wound to a very high resistance and it is provided with a heavy slug of copper on the end of the core which is next to the armature. It may be well to point out also that in the adjustment of this relay the armature should have a long sweep and the springs a stiff tension. With this arrangement the said relay will not operate its armature upon receiving an impulse of current such as is ordinarily used to operate a relay similar to the line relay 50 of the selector E. The relay 59 will, however, operate in response to an impulse of current of somewhat longer duration than ordinarily used in such a system and the manner in which this is brought about will be more fully explained in connection with the detailed description of the operation of the system as hereinafter disclosed.

The selector switch E has access to a number of connector switches, one of which is shown at F. This connector switch may be of the general type of connector switch disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson, and Erickson, the circuits being modified, however, to adapt the switch to the hereinbefore mentioned two wire series method of control, and also to accomplish the several objects of my invention. Among other details the connector F comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 180, 181, and 182 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 117, and a rotary movement controlled by the rotary magnet 118. The usual side switch comprising the wipers 131 and 132 is controlled by the private magnet 116 in the well known manner, except that the private magnet is itself controlled in a man-

ner peculiar to my invention. The operations of the various parts of the switch are controlled through the medium of the double wound line relay 110 which also serves to supply talking battery to the calling line. The called line is provided with talking current by means of the double wound answering bridge relay 113. The ringing relay 128 affords means for projecting ringing current over the called line to signal the called subscriber. Means for permitting the switch to be restored to normal position are provided in the release magnet 129, which, upon energizing, withdraws the retaining pawls from the shaft. The contact 130 closes only when the shaft has been raised one or more steps from its lowest position. The relays 122 and 127 are similar to relay 59 of the first selector, that is, they will not attract their armatures when receiving the ordinary operating impulses. Relays 126 and 123 will be referred to hereafter as wiper cut off and busy test relays, respectively, and their functions will be explained more fully at the proper time.

The individual line switch C′ is similar to the line switch C and is controlled along with a number of other line switches by a master switch which may be the master switch D or a similar one. The substation shown at A′ is in all respects similar to the substation A.

For supplying operating and talking current I have shown at B a battery having its positive terminal grounded. I have also shown a generator Gen. for supplying ringing current and an interrupter I for intermittently operating the ringing relay. At T I have shown a busy signaling machine.

Having given a general description of the apparatus I will now proceed to a detailed explanation of the operation of the same. The various operations taking part in the establishing of the connection shown in the drawings, will be fully covered, particular attention being paid to the features of my invention.

Referring now to Fig. 1, the subscriber at substation A, upon removing his receiver to initiate a call, completes an energizing circuit for the line relay 14 of the line switch C over the following path: ground at $G^2$, contact springs 25 and 24, line conductor 12, to and through substation A, line conductor 13, contact springs 22 and 23, winding of line relay 14 to battery B. The line relay is energized over the above circuit and upon attracting its armature, completes a circuit from ground at $G^3$ to the pull in winding 18. The pull in winding, upon energizing, attracts the plunger arm 19 and the cut off armature 20; the former, by means of its plunger, forcing the springs 26—29 inclusive into engagement, respectively, with contacts 30—33 inclusive, and the latter disconnecting the line conductors 12 and 13 from ground and battery, respectively, by separating contact springs 24 and 25, and 22 and 23.

By the engagement of contact springs 26 and 29 with contacts 30 and 33, respectively, the line conductors 12 and 13 are extended to the double wound line relay 50 of the selector F, said relay being energized over the following path: ground at $G^6$, winding 52 of line relay 50, contact springs 94 and 93, contact 33, spring 29, line conductor 12, to and through substation A, line conductor 13, spring 26, contact 30, contact springs 90 and 91, and winding 51 of line relay 50 to battery B. Upon energizing the line relay completes a circuit for relay 55 as follows: ground at $G^7$, contact springs 64 and 65, contact springs 71 and 72, and winding of relay 55 to battery B. Relay 55, upon energizing, completes a holding circuit which extends back to the line switch C over the following path: ground at $G^8$, contact springs 80 and 79, contact springs 67 and 66, contact 31, spring 27 and holding winding 17 of line switch C to battery B. Although the circuit through the line relay 14 has already been broken, it retains its armature long enough for the above described holding circuit to be established and to take effect. A branch of the holding circuit extends from spring 27 over wire 21 to multiple test contacts in the banks of connectors having access to the line of substation A, where, by a ground potential on these test contacts, the said line is made busy.

Returning now to relay 55, of selector E, upon the energization of this relay, ground at $G^8$ is extended by way of contact springs 80 and 81 to contact spring 65 whereby relay 55 is provided with an energizing circuit independent of the contact springs 64 and 65. Also a circuit is completed for the relay 58 as follows: ground at $G^8$, contact springs 82 and 83, and winding of relay 58 to battery B. Relay 58, upon energizing, opens a contact in the circuit of the release magnet 57 by separating contact springs 74 and 75, and by closing contact springs 73 and 74, prepares a circuit for the vertical magnet 53. The closure of contact springs 76 and 77 has no effect other than to prepare circuits which will be explained later.

The foregoing operations have all occurred in response to the removal of the receiver from the hook. The subscriber at substation A may now operate his dial in accordance with the first digit of the desired number, thereby breaking the continuity of his loop a number of times and resulting in a corresponding number of deënergizations of the line relay 50. At each deënergization the line relay sends an impulse to the vertical magnet 53 over the following path: ground at $G^7$, contact springs 64 and

63, contact springs 74 and 73, and winding of vertical magnet 53 to battery B. The vertical magnet, in response to these impulses, steps up the shaft until the wipers 100, 101 and 102 stand opposite the horizontal level in which are located contacts which are terminals of trunk lines leading to the desired connector group. At the first vertical step the off normal contact 88 is closed thereby completing a locking circuit for relay 58 which may be traced from contact spring 66 as a branch of the holding circuit as follows: contact spring 66, contact 87, off normal contact 88, contact springs 77 and 76, and winding of relay 58 to battery. A branch of the above circuit extends to the test wiper 101 from the lower off normal contact spring. Each time the line relay sends an impulse to the vertical magnet it also sends an impulse to the relay 59 over the following path: ground at $G^8$, contact springs 80 and 81, contact springs 62 and 61, contact springs 70 and 69, and winding of relay 59 to battery B. As previously explained however, relay 59 is not effectively energized by any of these impulses except the last one which is of longer duration than the rest. When the final impulse comes in, therefore, relay 59 attracts its armature with the following results: by closing contact springs 66 and 68 and separating contact springs 66 and 67 the holding circuit is shifted from ground at $G^8$ to ground at $G^9$. By separating contact springs 71 and 72 the circuit of relay 55 is broken and an instant later by closing contact springs 69 and 71 a new energizing circuit for relay 59 is completed from ground at $G^8$. This latter circuit is immediately broken again by the deënergization of relay 55 but exists long enough to fully attract the armature of relay 59 which is retained in operated position by the well known sluggish action until the relay 50 pulls up again after the final impulse and completes the following circuit: ground at $G^7$, contact springs 64 and 65, contact springs 71 and 69, and winding of relay 59 to battery B. It will be remembered that a branch of the holding circuit has been traced to contact spring 76 of relay 58. Upon the deënergization of relay 55, current flows over this branch circuit from ground at $G^9$ to contact spring 76 where it divides, one branch extending through winding of relay 58 to battery B, and the other branch extending by way of contact springs 83 and 84, contact 86, and the winding of rotary magnet 54 to battery B. As a result relay 58 remains energized, although its previous energizing circuit from ground at $G^8$ has been broken, and the rotary magnet 54 attracts its armature 85, thereby rotating the wipers 100, 101, and 102 until they stand on contacts which are terminals of the first trunk line of the desired group. Just before armature 85 reaches its extreme forward position it opens contacts 86 and 87, thereby breaking the rotary magnet circuit and the locking circuit of relay 58. The rotary magnet thereupon deënergizes but the relay 58 may deënergize or may not, depending on the condition of the test-contact upon which wiper 101 is now resting. If the first trunk line is busy, its test contact will have ground potential upon it and a circuit will exist for the relay 58 which may be traced as follows: ground on test contact, test wiper 101, contact springs 77 and 76, and winding of relay 58 to battery B. Assuming, then, that the first trunk line is busy, the relay 58 remains energized, and, as the rotary magnet retracts its armature, the contacts 86 and 87 will again close and complete the former energizing circuit of relay 58 and the rotary magnet. In this way the wipers are advanced step by step until they reach the terminals of an idle trunk line, when, the test wiper no longer finding ground on the test contact, the relay 58 deënergizes as contact 87 opens. Upon retracting its armature, relay 58 breaks the rotary magnet circuit and its own former locking circuit by separating contact springs 76 and 77, whereupon the wipers 100, 101, and 102 will be brought to rest upon contacts 103, 104, and 105, respectively, these contacts being the terminals of the first idle trunk line. Also, by separating contact springs 73 and 74 the vertical magnet circuit is broken, and by closing contact springs 74 and 75 a circuit is prepared for the release magnet. Finally, by closing contact springs 77 and 78, an energizing circuit is established for the line switching relay 56 as follows: ground at $G^9$, contact springs 68 and 66, contact 87, off normal contact 88, contact springs 77 and 78, and winding of relay 56 to battery B. Upon energizing, the line switching relay 56 separates a pair of contact springs, 95 and 96 in the circuit of the release magnet, and also shifts the two line conductors from line relay 50 to line relay 110 of connector F. Line relay 110 thereupon energizes over the following circuit: ground at $G^{20}$, winding 111 of line relay 110, contact springs 137 and 136, bank contact 105, wiper 102, contact springs 92 and 93, previously traced circuit through subscriber's loop, contact springs 90 and 89, wiper 100, bank contact 103, contact springs 133 and 134, and winding 112 of relay 110 to battery B. Upon attracting its armature line relay 110 completes a circuit for relay 119 as follows: ground at $G^{12}$, contact springs 141 and 142, and winding 120 of relay 119 to battery B. Relay 119, upon energizing, prepares a circuit for the vertical magnet by closing contact springs 146 and 147, and, by closing contact springs

143, 144 and 145, completes a locking circuit for itself as follows: ground at $G^{13}$, contact springs 155 and 156, contact springs 144 and 143, and winding 121 of relay 119 to battery. A branch of the above circuit provides a holding ground for the selector E and line switch C and may be traced as follows: contact springs 145, bank contact 104, wiper 101, where it divides, one branch extending by way of contact springs 77 and 78 and winding of relay 56 to battery B, and the other branch extending by way of off normal contact 88 and contact 87 to where it joins the previously described holding circuit extending to line switch C. Although the circuits of relays 50 and 59 have already been broken, relay 59 retains its armature for an instant in order to allow sufficient time for establishing the above holding circuit.

Returning now to the connector F, we may trace a circuit for the private magnet 116 which extends from the junction of contact spring 143 and winding 121, by way of contact springs 168 and 167 and winding of private magnet 116 to battery B. We now have relays 110 and 119 of connector F energized, and current flowing from ground at $G^{13}$ through private magnet 116, winding 121 of relay 119, and over the holding circuit all in parallel.

The subscriber at substation A may now operate his dial in accordance with the second digit of the desired number resulting, in this case, in a corresponding number of deënergizations of the line relay 110. At each retraction of its armature the line relay sends an impulse to the vertical magnet 117 over the following path: ground at $G^{12}$, contact springs 141 and 140, contact springs 147 and 146, winding of vertical magnet 117, and side switch wiper 132 in its first position to battery B. The vertical magnet, in response to these impulses, raises the shaft step by step until the wipers stand opposite the horizontal row of contacts in which are located the terminals of the desired line. At the first vertical step off normal contact 130 is closed and thereafter the relay 127 receives impulses in parallel with the vertical magnet over the following path: ground at $G^{12}$, contact springs 141 and 140, off normal contact 130, and winding of relay 127 to battery B. As has been explained, however, relay 127 is slow to energize and does not respond to any of these impulses except the last one, which is longer than the others. Upon receiving the final impulse, therefore, relay 127 energizes for an instant and breaks the circuit of the private magnet 116 momentarily, thereby allowing the side switch levers 131 and 132 to advance to their second positions in the well known manner. Upon energizing, relay 127 also sends an impulse to relay 122 by way of contact springs 169 and 170, but relay 122 is slow to energize and does not respond thereto.

The subscriber at substation A may now operate his dial in accordance with the third and final digit of the desired number, resulting as before in a corresponding number of deënergizations of the line relay 110 which now, side switch wiper 132 being in its second position, sends impulses to the rotary magnet 118 and also to the relay 127. Responding to these impulses the rotary magnet rotates the wipers 180, 181 and 182 until they rest upon contacts which are terminals of the desired line and which are indicated by reference characters 183, 184 and 185. At the final impulse relay 127 energizes momentarily as before whereupon the private magnet deënergizes for an instant and allows the side switch wipers 131 and 132 to advance to their third position. Assuming now that the called line was idle, a circuit is completed for the energization of relay 126 which may be traced as follows: ground at $G^{13}$, contact springs 155 and 156, contact springs 144 and 145, side switch wiper 131 in its third position, winding of relay 126, winding 125 of relay 123, and side switch wiper 132 to battery B. Relay 126 is energized over the above circuit but winding 125 is so designed as to be inoperative when in series with relay 126. Upon attracting its armature, relay 126 connects the two line conductors through to the wipers 180 and 182, thereby completing the connection between the calling and the called subscribers' lines. At the same time circuits are established for the test wiper 181 and the ringing relay 128. The former of these circuits extends from ground at $G^{14}$, by way of contact springs 158, 159 and 160, test wiper 181, and bank contact 184 to the holding winding 201 of the individual line switch C' where, by attracting cut off armature 202, the called line is disconnected from ground and battery. Ground from the test wiper 181 also serves to make the called line busy to other connector switches through the multiple connection of test contact 184 with the test contacts of other connectors. The circuit for the ringing relay 128 is as follows: ground at $G^{14}$, contact springs 158 and 159, contact springs 150 and 151, winding of ringing relay 128, and interrupter I to battery B. Upon the completion of the above circuit the ringing relay operates intermittently to project ringing current from the generator Gen. out over the line of the called subscriber to the substation A'. When the subscriber at substation A' removes his receiver in response to the ringing of his bell he completes, at the first deënergization of the ringing relay, a circuit for the double wound answering bridge relay 113 as follows: ground at $G^{10}$, winding 114 of relay 113, contact springs 165 and 164, contact

springs 176 and 175, wiper 182, bank contact 185, line conductor 13′, to and through substation A′, line conductor 12′, bank contact 183, wiper 180, contact springs 172 and 173, contact springs 162 and 133, and winding 115 of relay 113 to battery B. Talking current for the called substation is supplied over the above circuit through the windings of relay 113 which, upon energizing, reverses the battery connections to the calling line and also completes a circuit for relay 123 as follows: ground at $G^{21}$, contact springs 132 and 131, winding 124 of relay 123, and side switch wiper 132 to battery B. Upon energizing, relay 123 breaks the circuit of the ringing relay 128 and also completes for its winding 124 a circuit which is independent of the relay 113. This circuit may be traced either from ground at $G^{13}$ or $G^{14}$. Beginning at $G^{13}$, the circuit extends by way of contact springs 155 and 156, contact springs 144 and 145, contact springs 148 and 149, and winding 124 of relay 123 to battery B. From $G^{14}$ the circuit extends via contact springs 158 and 159, contact springs 150 and 149, and winding 124 of relay 123 to battery B. Briefly stated, the effect of the above circuit arrangement is to connect ground $G^{14}$ to the holding circuit in parallel with ground $G^{13}$ and to connect the said holding circuit to winding 124 of relay 123.

The two subscribers may now carry on a conversation without further effort on the part of either of them. Should the called subscriber hang up his receiver the relay 113 deënergizes and separates the springs 131 and 132, without affecting relay 123, however, for this relay remains energized over an independent circuit. Should the calling subscriber hang up, the line relay 110 deenergizes and ground from $G^{12}$ is extended to relay 127 over a path previously traced. Relay 127, upon energizing, extends the same ground to relay 122 which relay, upon attracting its armature, disconnects ground $G^{13}$ from the holding circuit and connects it to the release magnet 129. Upon energizing, the release magnet operates to restore the shaft and the side switch wipers to their normal position. As the side switch wiper 131 leaves its third position the circuit of relay 126 is broken and relay 126 thereupon deënergizes, removing ground $G^{14}$ from the holding circuit. As a result the holding winding 17 of line switch C and the line switching relay 56 of selector E deënergize, the former allowing the plunger to be withdrawn from the bank of contacts, and the latter closing a circuit for the release magnet 57 which, upon energizing, restores the shaft and side switch wipers to their normal position.

I will now describe briefly the case where the called line is busy. It has been mentioned before that the test contact of a busy line will have ground potential upon it. Assuming that the wipers 180, 181 and 182 have been moved to the contacts of a busy line, when the side switch wipers come into their third position a circuit is completed for winding 125 of relay 123 as follows: ground on test contact, test wiper 181, contact springs 160 and 161, winding 125 of relay 123 and side switch wiper 132 in its third position to battery B. It will be seen from the above that a direct ground via the test wiper is connected to the junction of winding 125 and relay 126 thereby short circuiting relay 126 and causing sufficient current to flow in winding 125 to energize relay 123. Upon energizing, relay 123 closes a previously described circuit for its locking winding 124 and in addition connects a lead from the busy signaling machine T to one side of the calling line for the purpose of indicating to the calling subscriber that the desired line is busy. The circuit may be traced as follows: Battery B, secondary of busy machine transformer, contact springs 152 and 153, contact springs 166 and 165, and over the lower heavy talking conductor to and through substation A, whence it returns over the upper heavy talking conductor and reaches battery B again via contact springs 133 and 134 and winding 112 of relay 110. Upon receiving the signal the calling subscriber replaces his receiver whereupon the apparatus is restored to normal substantially as has been described.

It will be seen from the foregoing explanation that I have provided a new and efficient method of switching local selector and connector circuits, after a series of impulses without depending in any way upon the time interval between impulses of a series and between two series of impulses. In addition I have provided an improved method of controlling the release magnets of selector and connector switches and have also revised the circuits and general arrangement in order to enable the parts provided by my invention to coöperate with well known elements to form a complete and efficient mechanism.

While I have described one embodiment of my invention I do not wish to be held strictly to the exact form disclosed herein, for modifications will no doubt suggest themselves to persons skilled in the art. I desire, therefore, to include and have protected by Letters Patent all forms and modifications of my invention which may come within the scope of the appended claims.

What I claim as my invention is:

1. In a telephone system, an automatic switch having a plurality of operating magnets, a controlling relay for one of said magnets responsive to all the impulses of a

series; an auxiliary controlling relay for another of said magnets responsive only to the final impulse, a third relay coöperating with said second relay to control said last magnet, and circuit connections whereby said third relay is energized responsive to said first relay and deënergized responsive to said second relay.

2. In a telephone system, a line, an automatic switch accessible to said line having a plurality of operating magnets, a controlling relay for one of said magnets responsive to all the impulses of a series, an auxiliary controlling relay for another of said magnets responsive only to the final impulse, said impulses being transmitted over the two sides of said line in series and a locking circuit for said second relay under control of said first relay, whereby the said second relay may be maintained energized during the operation of said last magnet.

3. In a telephone system, an automatic trunk selecting switch having a plurality of selective movements, actuating magnets for said switch, a controlling relay for one of said magnets responsive to all the impulses of a series for selecting a group of trunks, a second relay for initially controlling another of said actuating magnets to select an idle trunk in said group, said second relay irresponsive to all impulses of a series except the last one and a locking circuit for said second relay under control of said first relay, whereby said second relay is maintained energized during the selection of an idle trunk.

4. In a telephone system, a line, an automatic switch accessible to said line, and means for controlling said switch by impulses delivered over the two sides of said line in series, said means comprising a relay responsive to all the impulses of a series, a second relay responsive only to the final impulse of the series, and a third relay controlled jointly by said first and second relays.

5. In a telephone system, an automatic switch having a plurality of operating magnets, a controlling relay for one of said magnets responsive to all the impulses of a series, an auxiliary controlling relay for another of said magnets responsive only to the final impulse, and means comprising a third relay and a magnet for restoring said switch to normal position, said third relay controlled jointly by said controlling relays.

6. In a telephone system, an automatic trunk selecting switch having a plurality of selective movements, actuating magnets for said switch, a controlling relay for one of said magnets responsive to all the impulses of a series for selecting a group of trunks, a second relay for initially controlling another of said actuating magnets to select an idle trunk in said group, said second relay irresponsive to all impulses of said series except the last one, and means for restoring said switch to normal position, said means controlled jointly by said controlling relays.

7. In a telephone system, a subscriber's station, an impulse sending device at said station, means included in said device for prolonging the final impulse of a series, a line for said station, an automatic switch accessible to said line and having a plurality of selecting movements, actuating magnets for said switch, a controlling relay for one of said magnets responsive to all the impulses of a series for selecting a group of trunks, a second relay responsive to the final impulse of said series for initially controlling another of said actuating magnets to select an idle trunk in said group, and means for restoring said switch to normal position, said means controlled jointly by said controlling relays.

8. In a telephone system, an automatic switch having primary and secondary operating magnets, a controlling relay for said primary magnet responsive to all the impulses of a series, a second control relay responsive only to the final impulses of a series, means for closing the circuit of the secondary magnet at one point prior to the cessation of the primary movement of said switch, a locking relay initially energized by said first relay for holding said circuit open at another point, and means responsive to the energization of said second relay for opening the locking circuit of said third relay, whereby the circuit of said secondary magnet may be closed.

9. In a telephone system, an automatic switch having directive primary movement to select a group of trunks and automatic secondary movement to select an idle trunk line in the selected group, a trunk release conductor extending to said switch, a relay for grounding said conductor during the said primary movement, a second relay for grounding said conductor during the secondary movement, means for initially energizing said relays, and locking circuits for said relays, respectively, for maintaining them energized during the said primary and secondary movements.

10. In a telephone system, an automatic switch having primary and secondary operating magnets and a release magnet, a relay for directively controlling said operating magnets, a second relay under control of said first relay for controlling the "change over" from one operating magnet to the other, and a third relay under control of said second relay for controlling said release magnet.

11. In a telephone system, an automatic switch having primary and secondary operating magnets and a release magnet, a relay for directively controlling said operating

magnets, a second relay under control of said first relay for controlling the "change over" from one operating magnet to the other, and a third relay under the joint control of said first and second relays and operative to close an energizing circuit for said release magnet.

12. In a telephone system, a line terminating in an automatic switch having primary and secondary operating magnets and a release magnet, three relays for controlling, respectively, the actuation of said operating magnets, the "change over", from one operating magnet to the other, and the said release magnet, said relays being responsive, respectively, to short, long, and prolonged interruptions of the line circuit, and means for producing suitable interruptions in the line circuit to operate said relays.

13. In a telephone system, a subscriber's line, an automatic switch having primary and secondary operating movement and releasing means, means for extending said line to said switch, three relays in said switch for controlling, respectively, the operating movement of said switch, the "change over", from one operating movement to the other, and the said releasing means, said relays being responsive, respectively, to short, long, and prolonged interruptions in the extended line circuit, and means at the substation on said line for producing suitable interruptions to operate said relays, whereby connection to another line may be established and disconnection effected.

Signed by me at Chicago, Cook county, Illinois, this third day of November, 1915.

BERNARD D. WILLIS.

Witnesses:

CHAS. M. CANDY,

LOUIS M. LANDA.