G. A. YANOCHOWSKI.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED JULY 5, 1918.

1,423,899.

Patented July 25, 1922.

2 SHEETS—SHEET 1.

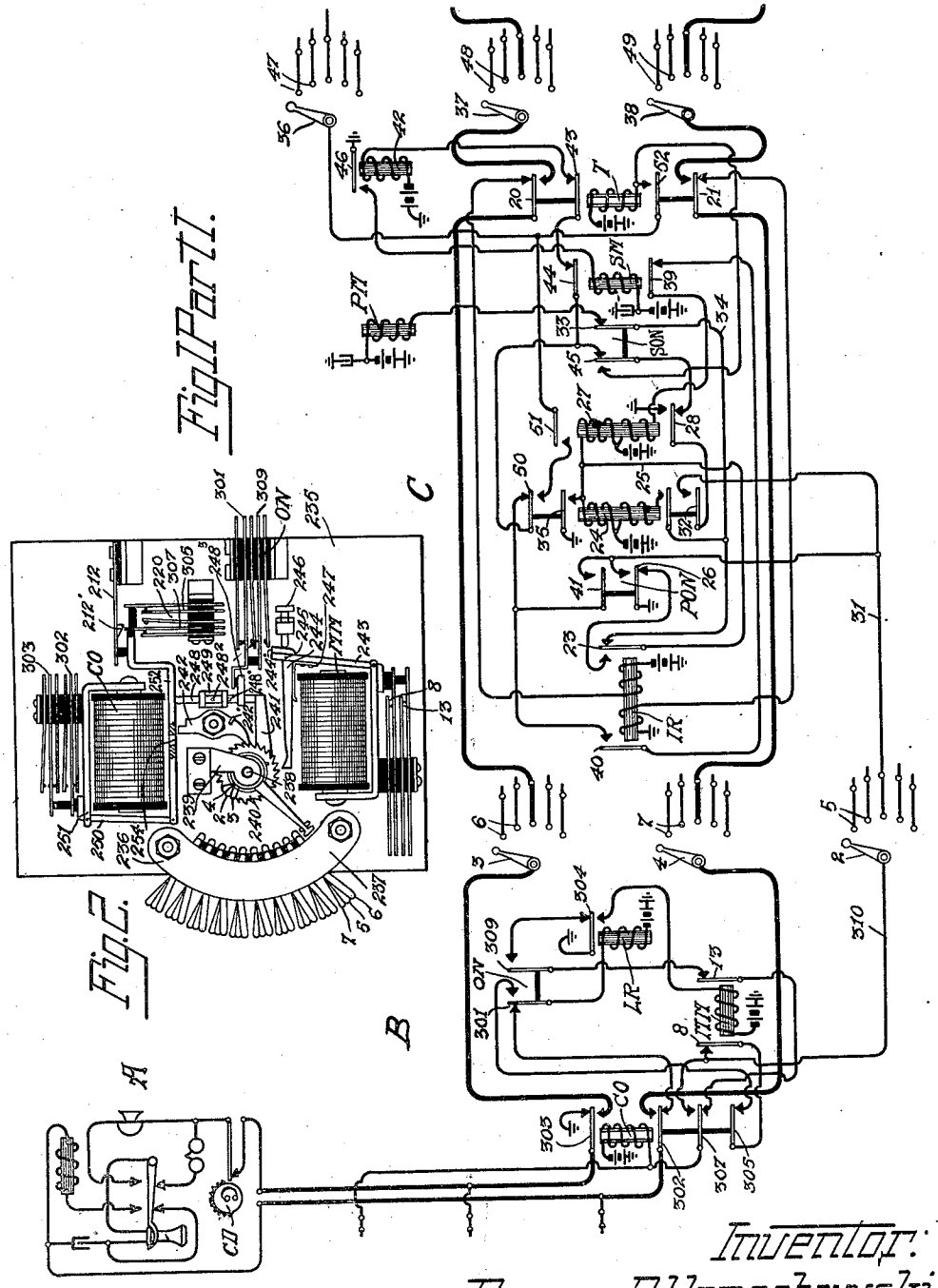

Fig. 1 Part I.

Fig. 2.

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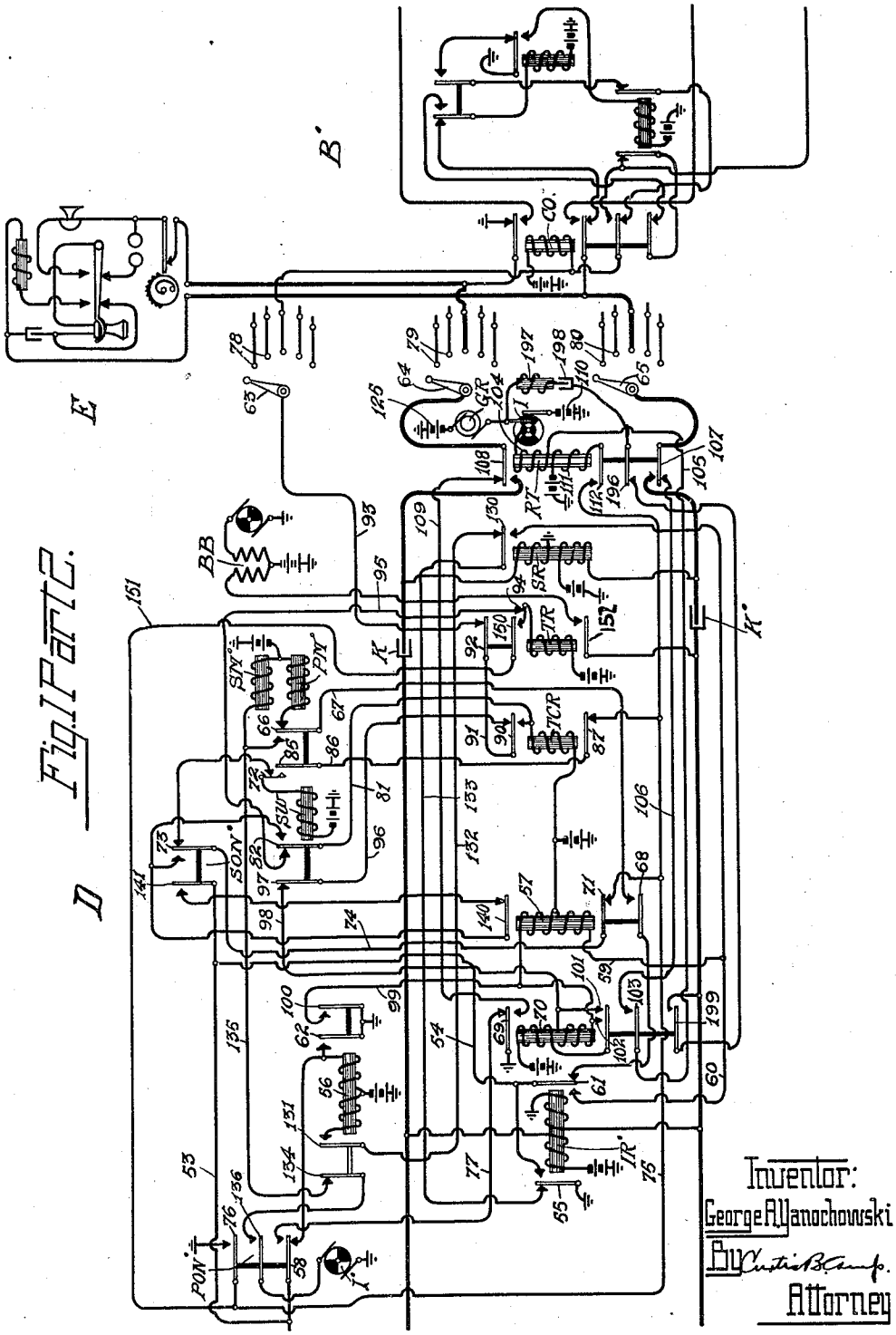

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UNITED STATES PATENT OFFICE.

GEORGE A. YANOCHOWSKI, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

1,423,899. Specification of Letters Patent. Patented July 25, 1922.

Application filed July 5, 1918. Serial No. 243,292.

To all whom it may concern:

Be it known that I, GEORGE A. YANOCHOWSKI, a citizen of the United States of America, residing at Chicago, in the 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 of the two-wire or metallic line type in which the directively controlled switches at the exchange are operated responsive to series of rapid interruptions of the subscribers' line circuits, and to such systems as above outlined in which non-numerical line switches are employed for automatically extending the circuit of a calling line to an idle directively controlled switch, or from a directively controlled switch to a repeater or to another directively controlled switch.

An object of my invention is to provide a system as above outlined having improved and simplified circuit arrangements, another object being to reduce the number of relays, magnets, switch contacts and mechanical parts on the line switch; and still another feature of my invention is the novel details of construction, of parts, and combination of parts, of the apparatus of the line switch.

Referring to the accompanying drawing in which like reference characters indicate like parts,

Fig. 1, which includes parts 1 and 2, illustrates diagrammatically an automatic telephone system embodying my invention; and

Fig. 2 illustrates a line switch adapted to be used in connection with the line switch circuit B, Fig. 1, part 2.

Referring now more particularly to the system as shown in Fig. 1, the substation A comprises the usual switch-hook and substation equipment, and includes a calling device. The said sub-station A is connected by means of the two line limbs as shown, to a line switch B at the exchange. The said line switch B is adapted, upon the initiation of a call from sub-station A, to automatically connect with an idle first selector C as shown in Fig. 1, part 1. The subscriber at A, by the use of the calling device in connection with his sub-station equipment, may by its actuation, operate the first selector C to extend the connection from the said sub-station A to an idle connector switch D. The subscriber at A then, may by further actuation of his calling device, operate the connector switch D to connect with the terminals of the called for line E. If the called line is idle, ringing current is automatically applied to the terminals thereof to signal the called for subscriber. Should the line of the called for subscriber be busy, a characteristic busy signal will be automatically transmitted back to the calling subscriber who may by replacing his receiver upon its switch hook release the switches which were used in extending his line to the line of the called for subscriber.

The line switch B is provided with a rotary shaft and carries a private test wiper 2 and a pair of line wipers 3 and 4. A line relay LR is provided which is energized over the subscriber's line conductors in series. A cut-off relay CO is also provided for disconnecting the subscriber's line circuit from the line relay LR and for connecting the switch wipers to the subscriber's line circuit. A motor magnet MM is provided for stepping the switch wipers 2, 3 and 4 step by step over the bank contacts 5, 6 and 7. An off-normal switch ON is provided which is actuated upon the first step of the wipers off normal. The switch wipers are spring restored and are adapted to be released to normal when the cut-off relay CO is de-energized.

The circuits shown for the selector C and connector D are adapted to work with a switch structure similar to that shown in application Serial No. 175,364, filed June 18, 1917. It is to be understood, however, that the circuits shown may be used in connection with various other switch structures of the art.

The first selector C comprises an impulse relay IR, which relay is energized and de-energized by impulses from the calling device CD at the calling substation A, and the energization and de-energization of the relay IR brings about the actuation of the primary magnet PM to step the first selector switch wipers 36, 37 and 38 in a primary direction to a certain group of contacts. A secondary magnet SM is provided for said selector which automatically steps the wipers 36, 37 and 38 in a secondary direction over the contacts 47, 48 and 49 in the selected group to seek an idle set of contacts leading to a connector, as D. A switching relay T is also provided which, when energized, ex-

tends the connection of the calling substation A to the idle connector D. Primary and secondary off-normal contacts PON and SON, respectively, are provided. The said primary off-normal contacts PON assume their alternate position on the first step of the wipers in a primary direction, and the secondary off-normal contacts SON assume their alternate position upon the first step of the wipers in a secondary direction.

The connector switch D is provided with an impulse relay IR′, responsive to the impulses of the calling device CD at the calling substation A, which relay IR′ brings about the actuation of the primary magnet PM′ to step the connector switch wipers 63, 64 and 65 in a primary direction to a certain group of contacts containing contacts of the called line E. A switching relay SW is provided which energizes upon the termination of the first set of impulses to connect the secondary magnet SM′ in circuit with the impulse relay IR′, to be actuated by the energization and the de-energization thereof to step the connector switch wipers 63, 64 and 65 over the contacts 78, 79 and 80 in the selected group to seek the contacts of the called line. A test control relay TCR is provided which assists in the test of the called line as to its idle or busy condition, and a test relay TR is provided which is actuated upon connection with a busy called line through the agency of the relay TCR. The said relay TR operates to connect busy-back apparatus BB to the calling subscriber to notify the said subscriber of the busy condition of the called line and disconnects the relay TCR from the test wiper 63. A ringing trip relay RT is also shown which is operated when a called subscriber removes his receiver in response to a call, the said relay opening the ringing circuit to disconnect the ringing current from generator GR which passes through the interrupter I. Should a called subscriber remove his receiver during either a ringing or a silent period, the ringing current is immediately disconnected, as will be more fully hereinafter described. The relay RT is provided with a locking winding to prevent a reapplication of ringing current to the called subscriber's line prior to a disconnection of the connector D from the line of the called subscriber. With this ringing arrangement, it is only necessary to provide one control relay for the ringing current. A back bridge or supervisory relay SR is also provided which operates upon the actuation of the ringing trip relay RT. Primary and secondary off-normal contacts PON′ and SON′ are provided and assume their alternate positions, respectively, upon the primary and secondary movements of the wipers 63, 64 and 65.

To the right of Sheet 2 of the drawings, I show a called substation E, similar to substation A, the said substation E being connected to a line switch B′ at the exchange, similar to line switch B.

Referring now to Fig. 2, the switch structure there illustrated is adapted to operate in connection with the circuit of line switch B. The switch of Fig. 2 comprises a main mounting plate 235, to which is secured a contact bank 236. The said bank includes a pair of clamping plates 237 which firmly clamp ten sets of bank contacts 5, 6 and 7. The bank contacts are suitably insulated from each other and from the frame of the switch. Wipers 2, 3 and 4, which are adapted to co-operate with said bank contacts, are suitably secured to the shaft 238, the said shaft 238 being journalled in the plate 235 and bracket 239. Wipers 3 and 4 are adapted to co-operate with contacts 6 and 7, respectively, when shaft 238 is rotated, and wiper 2, which is the middle wiper, is adapted to co-operate with bank contacts 5. Wiper 2 has its end or contacting portion so formed that when being advanced along the row of contacts 5 it makes connection with one contact before breaking connection from the contact it is leaving. Ratchet wheel 240 is rigidly secured to shaft 238 as is also the arm 241. Detent 242, which is pivoted at an intermediate point, normally rests under tension spring 242′ against ratchet wheel 240, and is adapted to prevent the restoration of wipers 2, 3 and 4 until said detent is withdrawn from engagement with said ratchet wheel 240. Motor magnet MM, which is suitably mounted on the plate 235, has an armature 243 carrying a pawl 244 pivoted to said armature 243 by means of pin 245. Pawl 244 is shown in its normal position with its upwardly extending portion 244′ resting against the adjustable stop screw 246. Tension spring 247 is secured to armature 243 and is adapted to press pawl 244 into engagement with ratchet wheel 240 upon attraction of armature 243. As armature 243 is attracted, pawl 244 is moved toward the left and as it tends to move away from stop screw 246, spring 247 moves it upward into engagement with ratchet wheel 240 and the armature 243 continuing in its movement, pawl 244 rotates ratchet wheel 240 stepping the wipers into engagement with the first set of bank contacts. Upon each de-energization and energization of magnet MM, the wipers are advanced one step moving from one contact to the next along the row. A pair of interrupter contacts 8 and 13 are provided for the motor magnet MM. These contacts are insulatingly secured to the heel iron of the motor magnet. Rod 248 which is preferably square is carried in suitable openings in bracket 249, the said rod 248 being adapted to reciprocate in its bearings, but due to its square

shape is not rotatable. The pin 248′ in rod 248, due to its engagement with bracket 249, serves as a stop for wiper shaft 238 upon its restoration, due to the engagement of arm 241 with the said rod 248. Off normal springs ON rest under tension against member 248^3, the said member being rigidly secured to rod 248. Thus when the wiper shaft 238 is moved off normal, arm 241 moves away from rod 248, allowing off normal springs ON to move the rod 248 downward, the said springs thus assuming an alternate position. Excessive movement of rod 248 is prevented by stop pin 248^2 engaging the upper surface of the lower extension of bracket 249. Magnet CO which serves as a cut-off relay and release magnet, has an armature 250 pivoted to pole piece 251. Fastened to the said armature 250 is the release catch 252 normally resting under tension against the upper end of rod 248. The said release catch 252 has a hole therein which is adapted upon the energization of magnet CO to drop over the upper end of the detent 242. Sets of contact springs are secured to the heel iron 251 of the cut-off relay and are operated by armature 250 thereof. A second set of contact springs 220 is secured to the mounting plate 235. The springs 220 are adapted to be moved from their normal to their off-normal position by the release catch 252 when the cut-off relay CO is energized. When the springs 220 are moved to their off-normal position, a spring 212 provided with a catch 212′ retains these springs in their off-normal position until the wiper shaft 238 has returned to normal, and the bar 248 moves release catch 252 to its normal position thereby moving spring 212 and catch 212′ from engagement with the springs 220, permitting the springs 220 to return to normal.

Upon the energization of relay CO after wiper shaft 238 has moved off normal, the opening 254 of catch 252 drops downward over the end of detent 242 and also moves the springs 220 to their off-normal position, the catch 212′ then retaining the springs 220 in their off-normal position. Upon the de-energization of the magnet CO, the said release catch moves the upper end of detent 242 to the left, thereby moving detent 242 out of engagement with ratchet 240. When the switch shaft 238 returns to normal, arm 241 engages the rod 248, which releases the release catch 252 from detent 242 and at the same time moves catch 212′ out of engagement with the springs 220, thereby permitting them to return to normal.

The operation of the line switch of Fig. 2 is as follows: When the motor magnet MM is energized and de-energized, the pawl 244 engages the teeth of ratchet wheel 240, thus advancing wipers 2, 3 and 4 along the row of contacts 5, 6 and 7, each energization and de-energization of the said magnet advancing the wipers one step. Upon the first movement of the wiper shaft 238 off normal, arm 241, which is carried thereby, moves downward, thus allowing the off-normal springs ON to assume an alternate position and also move rod 248 downward, thereby allowing catch member 252 to rest on detent 242, and also permitting the spring 212 to move downward until the catch 212′ engages one of the contact springs of the springs 220. The magnet CO is now energized and upon the complete attraction of its armature 250 the springs 220 are moved to their off-normal position behind catch 212′ of spring 212 catch 212′ holding the springs in their off-normal position. The release catch 252 is now in a position to drop down over the end of detent 242. To release, the switch magnet CO is de-energized retracting the armature 250 thus moving the upper end of detent 242 towards the left. Detent 242 being pivoted at its central portion as its lower end moves out of engagement with ratchet 240 the wipers 2, 3 and 4 are restored to normal by means of the springs shown in connection with ratchet wheel 240. Upon the restoration of the wipers arm 241 engages rod 248 moving it upward until pin 248′ engages the lower surface of the bracket 249. The restoration of rod 248 restores off-normal springs ON and the upper end of the rod 248 engages catch 252 lifting it out of engagement with detent 242 and moving spring 212 to its normal position causing catch 212′ to release springs 220 to their normal position. Upon the restoration of the detent 242 into engagement with ratchet wheel 240 the switch of Fig. 2 is again at normal.

Having described in general the apparatus embodying my invention, I will now describe more in detail the operation of the system as illustrated. Assuming now, for instance, that a call is to be traced from the calling substation A to the called substation E, upon the removal of the receiver by the subscriber at the substation A, a circuit for the line relay of the individual switch B is established, this circuit being traced from battery through the line relay LR, normal contact 301 of off-normal springs ON, contact 302 of relay CO, and through the closed contacts of the switch hook at substation A, back to ground at normal contact 303 of relay CO. The line relay LR, upon energizing, establishes an energizing circuit for the motor magnet MM, which may be traced from battery through the winding of said magnet MM and through alternate contact 304 of relay LR to ground. The magnet MM, upon energizing, rotates the switch shaft and wipers one step, thereby permitting off-normal contacts ON to move to their alternate position. The

movable contact 301 of the springs ON opens the circuit of the line relay LR and permits the same to de-energize. The relay LR, upon de-energizing, opens the circuit of the motor magnet MM, permitting the motor magnet MM to de-energize. The motor magnet MM, upon de-energizing, closes a circuit for line relay LR provided the private wiper 2 of the individual switch B has been moved into connection with a grounded or busy contact. If this is the case, a circuit for the line relay LR extends from battery through the winding of said relay LR, alternate contact 301 of springs ON, normal contact 305 of relay CO, normal contact 8 of magnet MM to the private wiper 2, which we have assumed is in connection with a grounded contact. The relay LR, upon energizing, again closes a circuit for the motor magnet MM, which magnet upon energizing opens the circuit of relay LR at its contact 8, permitting the relay LR to de-energize and open the circuit for the motor magnet MM. The motor magnet steps the switch shaft and wipers one step ahead, and upon de-energizing again closes a circuit for the line relay LR provided the wiper 2 is in engagement with a busy or grounded contact. This see-saw operation of the relay LR and motor magnet MM is continued as long as the private wiper 2 is moved into engagement with busy or grounded contacts. When the private wiper 2 is finally moved to an idle contact, the line relays LR and motor magnet MM remain at normal and a circuit is closed for the cut-off relay CO, extending from battery through the winding of said cut-off relay CO, through its normal contact 307, normal contact 13 of magnet MM, alternate contact 309 of springs ON, and normal contact 304 of relay LR to ground. The relay CO did not energize over this circuit before because its circuit was maintained open at either contact 13 of motor magnet MM or at contact 304 of relay LR during the selecting operation of the line switch B. The relay CO, upon energizing, connects the subscriber's line through its alternate contacts 302 and 303 to line wipers 4 and 3, respectively, of the individual switch B, thereby closing a circuit through impulse relay IR of the selected idle first selector switch, which circuit may be traced from battery through the winding of said relay IR, contact 20 of relay T, bank contact 6 and wiper 3 in engagement therewith, contact 303 of relay CO, through the calling subscriber's substation, back through contact 302 of relay CO, wiper 4 and bank contact 7 engaged thereby, contact 21 of relay T and through the other winding of relay IR to ground. The relay IR, upon energizing, closes its alternate contact 23, thereby establishing an energizing circuit for the relay 24, traced from battery through the upper winding of said relay 24, over conductor 25 and through alternate contact 23 of relay IR to ground at normal contact 26 of the primary off-normal contacts PON. An energizing circuit for the relay 27 is also established when relay IR is energized, over a circuit traced from battery through the upper winding of said relay 27, over conductor 25 and through alternate contact 23 of relay IR to ground at normal contact 26. The closing of alternate contact 28 of relay 27 establishes a substitute circuit for the cut-off relay CO of the line switch B before it has had time to de-energize, said circuit extending from battery through the winding of the said cut-off relay CO, alternate contact 307 of said relay CO, conductor 310, wiper 2, contact 5, conductor 31 and alternate contact 32 of relay 24 to ground at alternate contact 28 of relay 27, thus maintaining the relay CO of the switch B continuously energized until the conversation has terminated. The relay CO, upon energizing, locks its contacts 305 and 307 in their alternate positions by means of the spring 212 and catch 212′, as hereinbefore explained.

The idle first selector C having been selected by the line switch B, the subscriber at the calling substation A now actuates his calling device CD to call the first digit of the called number. Assuming that the number of the subscriber of the called substation E is 345, the subscriber at substation A actuates the calling device CD to send three impulses of current over the line, which impulses bring about three successive energizations and de-energizations of the impulse relay IR. Upon the first de-energization of the impulse relay IR, the circuit for the primary magnet PM is established, traced from battery through the winding of the magnet PM, normal contact 33 of the secondary off-normal contacts SON, conductor 34, normal contact 23, and conductor 25 to ground at alternate contact 35 of relay 24. The primary magnet PM is energized and de-energized three times, due to the opening and closing of contact 23 of relay IR, which magnet operates to step the wipers 36, 37 and 38 of the first selector C in a primary direction to the third group of contacts corresponding with the desired second selector or connector. After the last impulse, the relay 27 de-energizes, due to a circuit being closed through the lower winding of the relay 27, traced from battery through the lower winding of the said relay, normal contact 39 of relay SM, alternate contact 40 of relay IR, and alternate contacts 41 and 26 of primary off-normal contacts PON to ground. The said primary off-normal contacts PON moved to their alternate positions upon the first step of the wipers of the first selector C. The energizing circuit for

relay 27 just mentioned is closed upon the first step of the wipers off normal, but the relay 27 does not de-energize during the sending of impulses, due to the construction and adjustment of the said relay 27. The differential relay 27 only receives short impulses of current during the operation of relay IR which do not affect the relay sufficiently to cause it to de-energize. As soon as the above-mentioned circuit through the lower winding of relay 27 is closed and it receives a steady flow of current, the said differential relay 27 de-energizes. The opening of contact 28 of relay 27 disconnects ground from conductor 31 at this point but a substitute ground through alternate contact 26 of the primary off-normal contacts PON is substituted before said relay 27 de-energizes. The ground over conductor 31 also places a busy potential upon private contact 5, preventing any other individual line switch from engaging multiples of said contact. Owing to the construction and adjustment of differential relay 24, it is not de-energized during the rapid operation of relay IR. Upon the de-energization of the relay 27, an energizing circuit for the relay 42 is established, traced from battery through the winding of the said relay 42, normal contact 43 of relay T, normal contact 44 of secondary magnet SM, normal contact 45 of the secondary off-normal contact SON, normal contact 28 of relay 27, and alternate contact 32 of relay 24 to ground at alternate contact 26 of primary off-normal contacts PON.

The energization of the relay 42 establishes an energizing circuit for the secondary magnet SM, traced from battery through the winding of the said magnet to ground at alternate contact 46 of relay 42. Secondary magnet SM energizes and steps the wipers 36, 37 and 38 one step in a rotary secondary direction to engage the first set of contacts 47, 48 and 49. The energization of the secondary magnet SM brings about the restoration of the relay 42 due to the opening of normal contact 44 of said magnet SM. The opening of contact 39 of magnet SM again permits the energization of relay 27 by opening the circuit of its lower winding. The restoration of the relay 42 opens its alternate contact 46, bringing about the restoration of the secondary magnet SM. Upon the first step of the wipers 36, 37 and 38, the secondary off-normal contacts SON assume their alternate position, and the opening of the normal contact 45 of secondary off-normal contacts SON removes the initial ground from the relay 42; and should the private wiper 36 of the first selector C engage a contact leading to a busy connector D, an energizing circuit for the relay 42 is again established over a circuit traced from battery through the winding of the relay 42, normal contact 43 of relay T, normal contact 44 of magnet SM, alternate contact 50 of relay 24, alternate contact 51 of relay 27 and wiper 36 to the grounded busy contact 47. The closing of the alternate contact 46 of relay 42 brings about the energization of secondary magnet SM, as before described. The relay 42 and magnet SM are thus alternately energized and de-energized to step the wipers 36, 37 and 38 in a secondary direction to seek the contacts of an idle connector switch D. When a contact 47 leading to an idle connector as D is encountered by the wiper 36, the energizing circuit of the test relay 42 is maintained opened, thereby preventing further energizations of the secondary magnet SM. It will thus be seen that by this see-saw action of relay 42 and magnet SM a positive driving operation of the secondary magnet is secured, and that it is impossible to stop the selector C on a busy contact or to drive the said selector past an idle contact because unless relay 42 is energized, magnet SM cannot be energized, and relay 42 can only be energized when magnet SM is at normal and private wiper 36 is resting on a busy contact.

The relay 27 does not de-energize during the secondary movement of the wipers, due to its adjustment and the rapidity of the interruptions of normal contact 39 of secondary magnet SM. The closure of normal contact 39 of secondary magnet SM, after its last de-energization, closes a circuit for the lower winding of the relay 27 over a circuit previously described, and due to its differential action it de-energizes. Upon the restoration of the relay 27, an energizing circuit for the relay T is established, traced from battery through the winding of the said relay T, alternate contact 45 of the secondary off-normal contacts SON, normal contact 28 of relay 27, alternate contact 32 of relay 24, to ground at alternate contact 26 of primary off-normal contacts PON. The opening of normal contacts 20 and 21 of relay T opens the energizing circuit of the impulse relay IR. The relay IR, upon de-energizing, closes a circuit through the lower winding of the relay 24 traced from battery through the said lower winding, normal contact 23 of said relay IR, to ground at alternate contact 35 of said relay 24. The relay 24, due to its differential windings, neutralizes and restores to normal. The relay 24 restoring, opens the circuit of relay 27, permitting the said relay 27 to restore. The closing of alternate contacts 20 and 21 of relay T extends the connection of the calling subscriber A to the idle connector D, engaged by wipers 36, 37 and 38 of selector C. The closing of alternate contacts 20 and 21 of relay T brings about the energization of the impulse relay IR′ of connector D, over a circuit

traced from ground through the right-hand winding of said relay IR′, bank contact 49, wiper 38, alternate contact 21 of relay T, bank contact 7, wiper 4, alternate contact 11 of relay CO, through the substation A, the alternate contact 12 of relay CO, wiper 3, bank contact 6, alternate contact 20 of relay T, wiper 37, bank contact 48, and through the left-hand winding of the interrupter IR′ to battery and ground. The restoration of the relay 24 of the first selector C opens the initial energizing circuit of relay T of the first selector C, but the relay T being slow to release has a substitute circuit established for it, traced from battery through the winding of said relay, its alternate contact 52, wiper 36, bank contact 47, conductor 53, and conductor 54 to ground at alternate contact 55 of the impulse relay IR′ before it has had time to de-energize. The said relay T remains energized until the termination of the conversation.

The energization of the relay IR′ of connector D brings about the energization of the relays 56 and 57, the circuit of relay 56 extending from battery through the right-hand winding of said relay, normal contact 58 of the primary off-normal contacts PON′, conductor 53 and conductor 54 to ground at alternate contact 55 of relay IR′. The circuit for relay 57 extends from battery through the lower winding of the relay 57, conductor 59, conductor 60, and alternate contact 61 of relay IR′ to ground at alternate contact 55 of impulse relay IR′. Upon the energization of relay 56, a locking circuit is closed for the said relay 56 extending from battery through its alternate contact 62 to ground.

The subscriber now operates his calling device CD to send the second series of impulses, which are four in number, over the line. These four impulses bring about four de-energizations and energizations of the relay IR′, causing the primary magnet PM′ to energize and de-energize four times to step the wipers 63, 64, and 65 in a primary direction to the fourth group of contacts containing the contacts of the called line. The circuit of the primary magnet PM′ may be traced from battery through the winding of the said magnet, normal contact 66 of switching relay SW, conductor 67, alternate contact 68 of relay 57, normal contact 61 of relay IR′, conductor 54, conductor 53, and normal contact 58 of the primary off-normal contacts PON′ to ground at alternate contact 62 of relay 56. The primary off-normal contacts PON′ assume their alternate positions upon the first step of the wipers off normal. The opening of the primary off-normal contact 58 substitutes the ground fed from contact 69 of relay 70 for the ground fed through contact 62 of relay 56. After the last impulse of the series has been sent, the steady flow of current through both windings of relay 57 causes the said relay 57, due to its differential action, to neutralize and restore its contacts to normal. Relay 57 does not restore during the sending of impulses due to its adjustment, construction, and the rapidity of the interruptions of contact 61. The closing of normal contact 71 of relay 57 brings about the energization of the switching relay SW traced from battery through the winding of said relay SW, the make-before-break contact 72 of said relay SW, normal contact 73 of secondary off-normal contacts SON′, conductor 74, normal contact 71 of relay 57, and conductor 75 to ground at alternate contact 76 of primary off-normal contacts PON′, the said primary off-normal contacts PON′ having been moved to their alternate position on the first step of the wipers 63, 64 and 65 of the connector switch D. The closing of alternate contact 85 of relay SW closes a locking circuit for itself traced from battery through the winding of relay SW, alternate contact 85, conductor 86, normal contact 87 of relay TCR, conductor 75 to ground at alternate contact 76 of primary off-normal contacts PON′. The said relay SW remains energized until the relay TCR is actuated, as will be presently described. The closing of alternate contact 66 of the switching relay SW now renders the secondary magnet SM′ operative so that when the calling subscriber at the substation A actuates his call device again to send the last set of impulses, which we have assumed are five in number, the said magnet SM′ will be energized and de-energized by the impulse relay IR′ five times over a circuit traced from battery through the winding of the said magnet SM′, alternate contact 66 of relay SW, conductor 67, alternate contact 68 of relay 57, normal contact 61 of relay IR′, conductor 54, conductor 53, alternate contact 58 of primary off-normal contacts PON′, and conductor 77 to ground at normal contact 69 of relay 70. The secondary magnet SM′ now steps the wipers 63, 64 and 65 in a secondary direction to engage contacts 78, 79 and 80 of the called line. Upon the first impulse of the last set, that is, upon the opening of contact 61 of relay IR′, the relay 57 again energizes to permit the secondary magnet SM′ to be operated, and after the last impulse the relay 57 is again de-energized by having a circuit closed through its lower winding, as previously described. The restoration of the relay 57 closes a circuit for the relay TCR traced from battery through the winding of the said relay, conductor 81, alternate contact 82 of relay SW, alternate contact 73 of the secondary off-normal contacts SON′, (said contacts having been moved to their alternate position upon the first step of the wipers in their secondary direction) con-

ductor 74, normal contact 71 of relay 57, conductor 75, to ground at alternate contact 76 of the primary off-normal contacts PON', thus causing the said relay TCR to energize. The relay TCR, upon energizing, opens the locking circuit of relay SW at its contact 87, permitting the said relay to de-energize. The relay SW de-energizing, opens the circuit of the relay TCR at its contact 82, leaving the relay TCR dependent upon the potential found on the private contact 78 of the called line.

The closing of alternate contact 90 of relay TCR connects the test relay TR in multiple circuit with the said relay TCR to the test wiper 63, the circuit of the test relay TR being traced from battery through the winding of said relay, its make-before-break contact 94, conductor 95, normal contact 82 of relay SW, conductor 81, alternate contact 90 of relay TCR, conductor 91, normal contact 92 of relay TR, conductor 93 to the test wiper 63. The circuit of the relay TCR may be traced from battery through the winding of the said relay, its alternate contact 90, conductor 91, normal contact 92 of relay TR and conductor 93 to the wiper 63.

Called line idle.

Assuming that the called line is idle, private contact 78 of the called line will have a battery potential upon it, and the relay TR will not be energized but will remain at normal and the relay TCR failing to find a ground upon wiper 63 returns to normal, having its initial energizing circuit opened at alternate contact 82 of relay SW, as before described.

The relay TCR de-energizing, brings about the energization of the relay 70 over a circuit traced from battery through the cut-off relay CO' of the individual line switch B', bank contact 78, through wipers 63, conductor 93, normal contact 92 of relay TR, conductor 91, normal contact 90 of relay TCR, conductor 96, normal contact 97 of relay SW, conductor 98, through the lower winding of the relay 70, conductor 99, to ground at alternate contact 100 of the relay 56. Relays 70 and CO' energize over this circuit. Relay CO', upon energizing, removes the called subscriber's control of the line switch B'.

The closing of alternate contact 101 of relay 70 short-circuits the lower winding of the said relay and feeds ground to the cut-off relay CO' of the line switch B', and at the same time supplies the busy potential to the multiple private contacts of the called line. The closing of alternate contact 102 of relay 70 closes a circuit through the upper winding of said relay 70 traced from battery through its winding, the alternate contact 102 of said relay 70, and conductor 99 to ground at alternate contact 100 of relay 56. The closing of alternate contact 103 of the relay 70 closes a circuit for ringing current from generator GR to signal the called subscriber's substation, the path of said ringing current being traced from battery through the ringing generator GR, through the live segment of the interrupter I, through the winding 104 of ringing trip relay RT, conductor 105, alternate contact 103 of relay 70, conductor 106, normal contact 107 of relay RT, wiper 65, contact 80, through the call bell and condenser of the called substation E, back through contact 79, wiper 64, normal contact 108 of relay RT and conductor 109 to ground at alternate contact 69 of relay 70. The ringing current is intermittently connected to the called line due to the constantly rotating interrupter I, thus bringing about an intermittent actuation of the call signal at the called subscriber's substation E. The interrupter I is so arranged that ringing current from the generator GR and battery 110 are alternately connected to the called line so that should the subscriber answer in either a silent or a ringing period, ringing current is instantly disconnected, thus eliminating the undesirable feature of ringing the answering subscriber at the called substation in the ear should the subscriber remove his receiver during a ringing period. The closing of contacts 199 of relay 70 connects an audible ringing tone to the calling subscriber's line to apprise him of the fact that the called subscriber is being signaled. This circuit extends from the ungrounded pole of generator GR through an impedance coil 197, condenser 198, normal contact 196 of relay RT, contact 199 of relay 70 and over the subscriber's line to the calling substation, through the calling subscriber's receiver back to the exchange. The current is only sufficient to give the subscriber an audible tone. During the ringing and silent periods, and before the subscriber at the called substation E answers, the condenser at the said substation prevents a flow of battery through the winding 104 of the relay RT. The subscriber in response to the call signal removes his receiver, and should he remove it during a live period the combined generator and battery current of the generator GR and battery 125 bring about the energization of the relay RT over a circuit traced from battery 125 through the said generator GR, through the interrupter I, the upper winding 104 of relay RT, conductor 105, alternate contact 103, conductor 106, normal contact 107, wiper 65 and contact 80, through the now closed contacts at the substation switch hook, back through contact 79, wiper 64, normal contact 108, conductor 109, to ground at alternate contact 69. The relay RT energizes over the circuit just traced and closes a locking circuit for itself, traced from battery through the lower winding 111

of relay RT, its alternate contact 112, and conductor 75 to ground at alternate contact 76 of the primary off-normal contacts PON'. Should the subscriber remove his receiver from the switch hook during a silent period, the relay RT will energize over a circuit from battery 110 through the live segments of the interrupter I, the upper winding 104 or relay RT, and over the previously described path to ground at alternate contact 69, which causes the relay RT to energize and close the locking circuit for itself through its winding 111, as before described. Thus it may be seen that ringing current is instantly disconnected from the called line either during live or silent periods by the opening of contacts 107 and 108 of relay RT. Relay RT, upon energizing, disconnects the audible tone from the calling subscriber's line by opening its contacts 196. Upon the energization of the relay RT, an energizing circuit for the supervisory relay SR is established traced from battery through the lower winding of said relay SR, alternate contact 107 of relay RT, wiper 65, contact 80, through the substation back to the contacts 79, wiper 64, alternate contact 108 of relay RT and through the upper winding of the relay SR to ground. The subscribers are now in conversational circuit and the talking circuit may be traced over the heavily marked conductors, the said conductors having the condensers K and K' interposed.

The subscribers having finished conversation, and assuming that the subscriber at the substation A is the first to replace his receiver upon its switch hook, the opening of the switch hook contacts brings about the deenergization of the impulse relay IR' of the connector D. The restoration of the relay IR' brings about the opening of the holding circuit of the relay T of the first selector C, and the closing of normal contact 43 of the restored relay T of the first selector C closes an energizing circuit for the relay 42 which may be traced from battery through the winding of the relay 42, normal contact 43, normal contact 44 of magnet SM, normal contact 50 of relay 24, and alternate contacts 41 and 26 of primary off-normal contacts PON to ground. The closing of alternate contact 46 of the relay 42 brings about the energization of the secondary magnet SM. The relay 42 and the secondary magnet SM are alternately energized and deenergized, as previously described, the secondary magnet SM thus stepping the wipers 36, 37 and 38 beyond the last contacts of the row of bank contacts, from which point the wipers are restored to normal. The secondary off-normal contacts SON and primary off-normal contacts PON restore to normal, and the opening of alternate contact 26 of the primary off-normal contacts PON opens the energizing circuit of the cut-off relay CO of the individual line switch B. The restoration of the cut-off relay CO of the line switch B brings about the restoration to normal of the wipers 2, 3 and 4 of said individual switch B. The cut-off relay CO falling back also causes the springs 220 to return to normal, as hereinbefore described. The subscriber E placing his receiver upon the switch hook interrupts the circuit of the relay SR of the connector D at the switch hook contacts, causing the said relay to de-energize. The closing of normal contact 130 of relay SR closes a circuit through the left-hand winding of the relay 56, which may be traced from battery through the said left-hand winding of relay 56, through its alternate contact 131, conductor 132, normal contact 130, and conductor 133 to ground at normal contact 55 of the relay IR'. Due to the differential construction of the relay 56, the said relay neutralizes and restores to normal. The closing of normal contact 134 of relay 56 closes the circuit of secondary magnet SM', which may be traced from battery through the winding of said secondary magnet SM, conductor 135, normal contact 134 of relay 56, alternate contact 136 of primary off-normal contacts PON', through the interrupter I' to ground. The secondary magnet SM' thus steps the wipers 63, 64 and 65 beyond the last set of contacts in the group, and the wipers then restore to normal from this position. The restoration of the relay 56 also brings about the opening of the circuit of the relay 70 at alternate contact 100, bringing about the restoration of the said relay 70. The primary off-normal contacts PON' having restored upon the restoration of the switch, the opening of alternate contact 76 of the contacts PON' brings about the restoration of the relay RT. The relay 56 also causes the de-energization of cut-off relay CO' of the line circuit B', which is associated with the called subscriber's substation E. All of the apparatus used in establishing the connection between the calling subscriber at the substation A and the called subscriber at the called substation E is now at normal and available for use in establishing other connections.

Assuming now that the subscriber at the called substation E is the first to replace his receiver upon the switch hook, the opening of the switch hook contacts at the substation E brings about the de-energization of the relay SR. Nothing else happens at this time as the relay IR' is still maintained energized over the line of the calling substation A. The calling subscriber at the substation A replacing his receiver interrupts the circuit of the impulse relay IR' at the switch hook contacts. The relay IR' de-energizing, closes a circuit through the left-hand winding of relay 56, causing the said relay to de-energize as hereinbefore de-

scribed. The restoration of the individual switch B, first selector C and connector D is the same as previously described from this point on.

Should the called subscriber E fail to replace his receiver upon the switch hook after the conversation is terminated, the replacing of the receiver at the substation A brings about the de-energization of the impulse relay IR′ of connector D, the same as before, and the opening of alternate contact 55 of the impulse relay IR′ opens the circuit of the relay T of the first selector C, as before described, and causes the release of the selector C and individual switch B. The subscriber at the called substation failing to replace his receiver upon the switch hook permits the continued energization of the relay SR, thus holding contact 130 of said relay in its alternate position, preventing the differentially wound relay 56 from restoring to normal and closing the energizing circuit for the secondary magnet SM′. The relay 57 energizes when the impulse relay IR′ drops back but is immediately restored to normal due to the closure of an energizing circuit through the lower winding of the said relay 57, which may be traced from battery through the lower winding of the relay 57, conductor 59, conductor 60, alternate contact 130, conductor 133, to ground at normal contact 55 of the now restored impulse relay IR′. The relay 57 being differentially wound restores to normal, and the closing of normal contact 140 of said relay 57 places a ground upon the private contact of the connector D over a circuit which may be traced from ground to alternate contact 76 of primary off-normal contacts PON′, through conductor 75, normal contact 71 of relay 57, conductor 74, alternate contacts 73, normal contacts 140 of relay 57, alternate contact 141 of secondary off-normal contacts SON′ and conductor 53 to the private contact 47. The placing of the busy potential upon the private contact prevents any first selector switch C from engaging the contacts of this busy connector.

Called line busy.

Assuming now that the called line is busy, the operation of the circuit is the same up to and including the time when the relay TCR energizes, as previously described. The line being busy, private contact 78 has a busy potential placed upon it, thus closing the multiple circuit for the relay TCR and the test relay TR, the circuit of the relay TCR being traced from battery through the winding of the said relay TCR, its alternate contact 90, conductor 91, normal contact 92 of relay TR, conductor 93, to the busy grounded private contact 78. The circuit of the test relay TR is traced from battery through the winding of the said relay TR, the make-before-break contact 94 of said relay, conductor 95, normal contact 82 of relay SW, conductor 81, alternate contact 90 of relay TCR, conductor 91, normal contact 92 of relay TR, conductor 93 and wiper 63 to ground at busy private contact 78. The contacts 94 and 92 of the relay TR are so adjusted that the alternate contact 150 makes before the contact 92 breaks, thus closing a locking circuit for relay TR through its alternate contact 150 before the normal contact 92 of the said relay breaks. The locking circuit of the said relay TR extends from battery through the alternate contact 150 of the relay TR, conductor 151, to ground at alternate contact 76 of primary off-normal contacts PON′. The locking circuit for the said test relay TR is independent of the grounded private contact and the opening of the normal contact 92 of the relay TR opens the circuit for the relay TCR which restores to normal. The falling back of relay TCR does not affect relay 70 due to the fact that the test conductor 93 is held open at contact 92 of relay TR. The locking circuit for the test relay TR is thus independent of the busy grounded contact 78. This arrangement does away with the method usually employed of locking the busy relay up to the busy private contact of the called busy line. The closing of alternate contact 152 of relay TR connects the busy back signal BB to the calling line to transmit a busy signal to the said calling subscriber at the substation A, thus notifying him of the busy condition of the said called substation E.

The calling subscriber now replaces his receiver upon the switch hook, bringing about the de-energization of IR′. The relay IR′ restoring opens the circuit for the relay T of first selector C, which closes the circuit of the secondary magnet SM, as previously described, thus bringing about the release of the first selector C and individual switch B. The relay IR′ de-energizing brings about the restoration of the relay 56, due to the fact that the relay SR is not energized. The closing of normal contact 134 of the said relay 56 closes the circuit for the secondary magnet SM′, which magnet steps the wipers 63, 64 and 65 beyond the last set of contacts. The wipers then restore to normal. Primary off-normal contacts PON′ and secondary off-normal contacts SON′ are also restored. The apparatus used in this busy connection is now at normal and available for use in establishing other connections. Should the called line become idle during the time of the transmission of the busy signal and the time the calling subscriber replaces his receiver, nothing happens as the contact 92 of relay TR is in its alternate position, preventing the energization of relay 70, and thus preventing ringing cur-

rent from being sent out to the now idle called line.

From the foregoing, it is at once apparent that I have provided a very simple, yet highly efficient, non-numerical switch. The circuit arrangement provides for a positive drive, and the mechanical parts of the switch are very simple and not liable to get out of adjustment or order.

While I have shown a system of 1,000 line capacity, it is to be understood that by inserting second selectors this system may be increased to 10,000 lines, etc.

While I have described my invention operating in connection with a well known system, I do not wish to be limited to this exact disclosure as my invention may be applied to other systems without departing from the spirit of the invention, and I, therefore, do not wish to be limited to this exact disclosure but aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

What I claim as new and desire to secure by United States Letters Patent is:

1. A telephone system including a trunking switch, a motor magnet for said trunking switch, a line relay for controlling said motor magnet, off-normal contacts for controlling the circuit of said line relay, a cut-off relay for said trunking switch, and a circuit for said cut-off relay including contacts of said line relay and contacts of said motor magnet.

2. A telephone system including a trunking switch, a motor magnet for said trunking switch, a line relay for controlling said motor magnet, a cut-off relay for said trunking switch, a circuit for said cut-off relay including contacts of said line relay and said motor magnet, and means for keeping said circuit open while said switch is being operated to select a trunk by alternate actuations of said line relay and said motor magnet.

3. A telephone system including a trunking switch, a motor magnet for said trunking switch, a line relay for controlling said motor magnet, off-normal contacts, a cut-off relay for said trunking switch, and a circuit for said cut-off relay including contacts of said line relay, contacts of said motor magnet and said cut-off relay and said off-normal contacts.

4. A telephone system including a trunking switch, a motor magnet for said trunking switch, a line relay for controlling said motor magnet, a cut-off relay for said trunking switch, a circuit for said cut-off relay including contacts of said line relay, said motor magnet and said cut-off relay, and means for keeping said circuit open while said switch is being operated to select a trunk by alternate actuations of said line relay and said motor magnet.

5. A telephone system including a trunking switch, a motor magnet for moving the wipers of said switch, a line relay for controlling said motor magnet, an off-normal switch operated upon the first step of said wipers from normal, a cut-off relay for said trunking switch, and a circuit for said cut-off relay including contacts of said line relay, said off-normal switch, said motor magnet and said cut-off relay.

6. A telephone system including a trunking switch, a motor magnet for moving the wipers of said switch, a line relay for controlling said motor magnet, an off-normal switch operated upon the first step of said wipers from normal, a cut-off relay for said trunking switch, a circuit for said cut-off relay including contacts of said line relay, said off-normal switch, said motor magnet and said cut-off relay, and means for keeping said circuit open while said switch is being operated to select a trunk by alternate actuations of said line relay and said motor magnet.

7. A telephone system including a subscriber's individual trunking switch, trunk lines, wipers for said individual switch adapted to be moved to select an idle trunk line, a motor magnet for moving said wipers, a line relay for controlling said motor magnet, off-normal contacts, a single wound cut-off relay for said switch, a circuit for said cut-off relay including contacts of said line relay, contacts of said motor magnet and said cut-off relay and said off-normal contacts, and a substitute circuit for said cut-off relay including only contacts of said cut-off relay.

8. A telephone system including a trunking switch provided with wipers, a line relay and a motor magnet adapted to be alternately actuated to rotate said wipers, a circuit for said line relay including a contact of said motor magnet, a holding pawl for preventing said wipers from releasing during the time that the said wipers are searching for an idle trunk, and a magnet adapted upon de-energization to cause said pawl to release said trunking switch.

9. A telephone system including a trunking switch provided with wipers, a line relay and a motor magnet adapted to be alternately actuated to rotate said wipers, a circuit for said line relay including a contact of the said motor magnet, a holding pawl for preventing said wipers from releasing during the time that the said wipers are searching for an idle trunk, a magnet adapted upon de-energization to cause said pawl to release said trunking switch, and switch springs actuated upon energization of said last magnet and restored by the return of said switch to normal.

10. A telephone system including a subscriber's line provided with an individual trunking switch, movable contacts for said

trunking switch, a cut-off relay for controlling the connection of said movable contacts to said subscriber's line, switch springs, a cut-off relay adapted upon energization to move said switch springs to their alternate position, a catch for retaining said switch springs in their alternate position, and means controlled by the return of said switch to normal for removing said catch from engagement with said switch springs thereby permitting said switch springs to return to normal.

11. A telephone system including a subscriber's telephone line, a switch for said line, wipers for said switch, a cut-off relay for controlling the connection of said wipers to said line, switch contacts adapted to be moved to their alternate position by the energization of said cut-off relay, a catch for holding said switch contacts in their alternate position, and means controlled by the return of said switch to normal for removing said catch from engagement with said switch springs, thereby permitting said switch springs to return to normal.

12. A telephone system including a trunking switch, wipers for said trunking switch, a pawl for retaining said wipers in their advanced positions during the time that said motor magnet is operating, a test relay for controlling said motor magnet, said test relay being adapted to be energized for each actuation of said motor magnet, a cut-off relay for said switch, and a mechanical link controlled by said cut-off relay for releasing said pawl when said cut-off relay de-energizes.

13. A telephone system including a subscriber's telephone line, an individual trunking switch for said line, movable contacts for said switch, a single-wound cut-off relay controlling the connection of said movable contacts to said line, switch contacts, means controlled by said cut-off relay for moving said switch contacts to their alternate position when said cut-off relay is energized, a catch for holding said contacts in operated position, and means controlled by the restoration of said wipers to normal for restoring said catch thereby permitting said contacts to return to normal.

14. An individual trunking switch provided with a movable switch shaft, a holding pawl for preventing the release of said switch shaft while said shaft is being rotated, a cut-off relay, switch contacts adapted to be actuated upon energization of said cut-off relay, a catch for holding said contacts in operated position, means controlled by the de-energization of said cut-off relay to release said holding pawl, thereby releasing said switch shaft to normal, and means controlled by the return of said switch shaft to normal to release said catch thereby permitting said switch contacts to return to normal.

15. A telephone system including a subscriber's telephone line, a trunking switch for said line, a switch shaft and wipers for said trunking switch, a pawl for preventing the release of said switch shaft while said switch shaft is being rotated, switch contacts, a cut-off relay for controlling the connection of said wipers to said line, means controlled by said cut-off relay for moving said switch contacts to their off-normal position, means for holding said switch contacts in their off-normal position independent of said cut-off relay, means controlled upon the de-energization of said cut-off relay to remove said pawl from engagement with said switch shaft to permit said shaft to return to normal, and means controlled by the return of said switch shaft to normal to operate said second means to release said switch springs.

16. A telephone system including an individual spring-restored automatic trunking switch provided with wipers, a motor magnet for advancing said wipers, a line relay for controlling said motor magnet, a set of off-normal contacts, a cut-off relay for said switch, a circuit for said cut-off relay including contacts of said line relay and of said motor magnet and a contact of said set of off-normal contacts, and means controlled by said cut-off relay for permitting the switch to restore to normal.

17. A telephone system including a non-numerical spring-restored trunking switch, a motor magnet for said switch, a line relay for controlling said motor magnet, a set of off-normal contacts, a cut-off relay for controlling said line relay, a circuit for said cut-off relay including contacts of said line relay and of said motor magnet and a contact for said set of off-normal contacts, and means controlled by the cut-off relay for releasing said switch.

18. A telephone system including a non-numerical spring-restored switch, a set of off-normal contacts, a motor magnet, a line relay and a cut-off relay for said switch, and a circuit for said cut-off relay controlled by contacts of said line relay and said motor magnet and said set of off-normal contacts.

19. A telephone system including a trunking switch, a motor magnet for moving the wipers of said switch, a line relay for controlling the circuit of said motor magnet, a circuit for said line relay controlled by said motor magnet upon the first step of the switch wipers off normal, a set of off-normal contacts, a cut-off relay, and a circuit for said cut-off relay passing through contacts of said motor magnet and said line relay and said set of off-normal contacts.

20. A telephone system including a subscriber's telephone line, a trunking switch for said line, a motor magnet for moving the wipers of said switch, a line relay initially

energized over said line, a circuit for said motor magnet controlled by said line relay, a circuit for said line relay controlled by said magnet upon the first step of the switch wipers off normal, a cut-off relay, and a circuit for said cut-off relay passing through normal contacts of said motor magnet and said line relay when said motor magnet and said line relay are de-energized.

21. A telephone system including a subscriber's telephone line, a trunking switch for said line, a motor magnet for moving the wipers of said switch, off-normal contacts for said switch, a line relay initially energized over the line, a circuit for said motor magnet controlled by said line relay, a circuit for said line relay controlled by said motor magnet and said off-normal contacts upon the first step of the wipers off normal, a cut-off relay, and a circuit for said cut-off relay passing through contacts of said motor magnet and said line relay and said off-normal contacts and said cut-off relay.

Signed by me at Chicago, in the county of Cook and State of Illinois this 2d day of July, 1918.

GEORGE A. YANOCHOWSKI.