

No. 831,875.

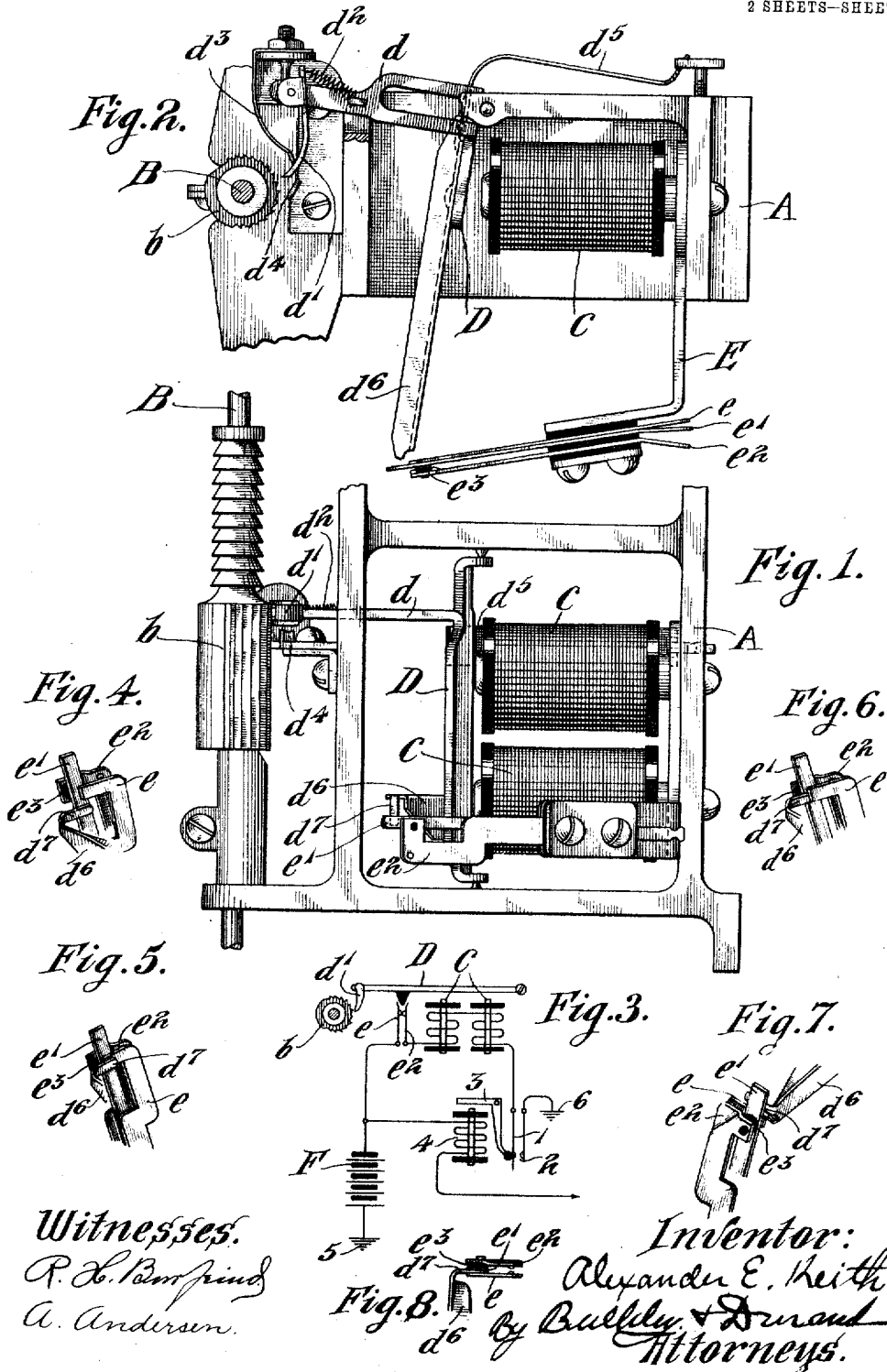
PATENTED SEPT. 25, 1906.

A. E. KEITH.

INTERRUPTER FOR AUTOMATIC TELEPHONE OR OTHER SWITCHES.

APPLICATION FILED FEB. 17, 1905.

2 SHEETS—SHEET 1.



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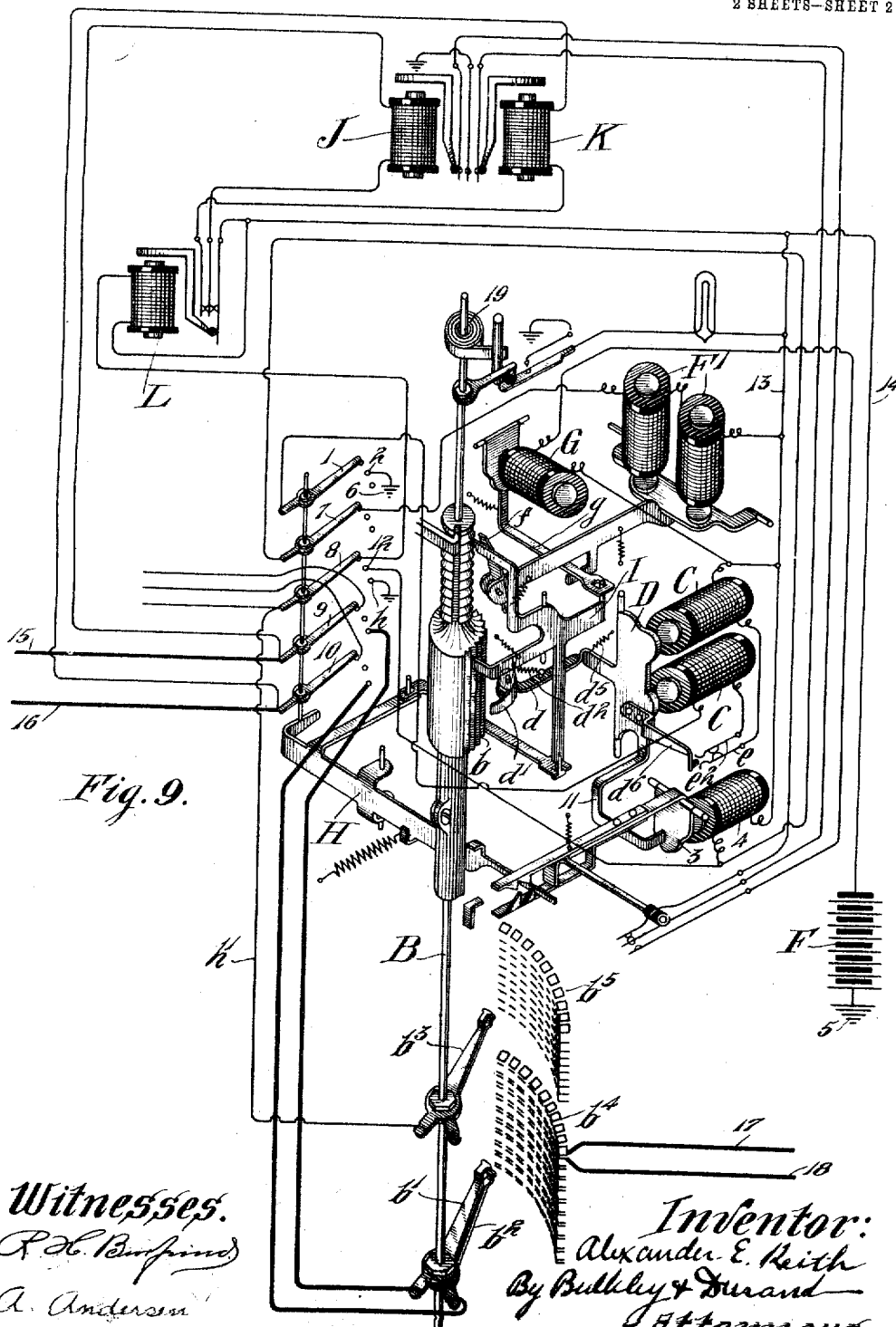


Fig. 9.

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UNITED STATES PATENT OFFICE.

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INTERRUPTER FOR AUTOMATIC TELEPHONE OR OTHER SWITCHES.

No. 831,875.

Specification of Letters Patent.

Patented Sept. 25, 1906.

Application filed February 17, 1905. Serial No. 248,126.

To all whom it may concern:

Be it known that I, ALEXANDER E. KEITH, a citizen of the United States of America, and a resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Interrupters for Automatic Telephone or other Switches, of which the following is a specification.

My invention relates to automatic telephone apparatus of that particular character in which automatic step-by-step switches are employed; and it relates more particularly to the so-called "selector-switches"—that is to say, the switches which respond to electrical impulses representing the first or second digits of the number called—and in an apparatus of this character it is desirable that the rotatable, and endwise-movable switch-shaft be combined with means whereby it will move endwise the desired distance and then rotate automatically until an idle trunk-line is found and connection made therewith.

Generally stated, the object of my invention is the provision of an improved and highly effective arrangement for insuring an automatic step-by-step rotary motion of the switch-shaft of an automatic switch until an idle trunk-line or other connection is found and the desired connection established there-with.

A special object is the provision of an improved construction and arrangement whereby the magnet or magnets employed for operating the switch-shaft in its step-by-step rotary movements also effect an intermittent opening and closing action of the circuit through which current is supplied for energizing the said magnet or magnets and whereby the said magnet or magnets are alternately energized and deenergized and the step-by-step mechanism thereby operated for the purpose of rotating the switch-shaft until an idle trunk-line is found and until the said energizing-circuit is automatically opened by the arrival of the switch-shaft at a position where connection is made with the bank-contacts corresponding to the idle trunk-line.

Another object is to provide an improved construction and arrangement whereby certain apparatus heretofore considered necessary and heretofore employed for producing a vibratory or intermittent current in the cir-

cuit in which the said magnets or magnet are included may be dispensed with.

A further object is to provide an improved trunk-selecting switch mechanism.

Another object is to provide an improved form of interrupter—that is to say, an arrangement whereby an electromagnet may automatically open and close its energizing-circuit, and thus maintain a rapid vibration of its armature as long as the continuity of the circuit is preserved at all of the points.

It is also an object, of course, to provide certain details and features of improvement tending to increase the general efficiency and serviceability of the means for automatically interrupting the current employed for energizing the magnet or magnets which operate the step-by-step mechanism in an automatic switch for use preferably in an automatic telephone system of this particular character.

To the foregoing and other useful ends my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings, Figure 1 is a side elevation of that portion of an automatic switch—in this case a so-called "selector"—to which my invention relates. Fig. 2 is a plan of the mechanism shown in Fig. 1. Fig. 3 is a diagram of the circuits involved in my improved interrupter for automatic switches. Figs. 4, 5, 6, 7, and 8 are fragmentary detail views showing different positions of the switch-springs and the interrupter-arm for alternately opening and closing the circuit in which the magnets—in this case the so-called "rotary" magnets—of the automatic switch are included. Fig. 9 is a diagrammatic perspective view of a so-called bridging "first" selector provided with my improved means for automatically maintaining the step-by-step rotary motion of the shaft until an idle trunk-line is found.

As illustrated in Figs. 1 and 2 only a portion of the frame A is shown, together with only a portion of the rotary and endwise-movable switch-shaft B, the latter being supported in suitable bearings in any known or approved manner. The so-called "rotary" magnets C are mounted in the frame in any suitable manner and provided with a pivoted or swinging armature D. As shown, this armature has a forwardly-extending arm d,

upon which is pivotally mounted a pawl d' . This pawl is controlled by a spring d^2 , connected between the upper end of the pawl and a lug on the arm d . Stationary guides d^3 and d^4 cause the pawl when the said armature is vibrated to alternately engage and disengage the toothed ratchet-hub b on the said switch-shaft. Spring means d^5 of any suitable character are provided for holding the armature normally away from the magnets and in such position as to keep the pawl d' normally out of engagement with the said ratchet-hub. Said armature is also provided with a horizontally-projecting arm d^6 , which may be of insulation and which is adapted to vibrate in unison with the armature. A bracket-arm E is also secured to the frame of the switch and is provided with switch-springs e , e' , and e^2 . The springs e and e^2 are normally in engagement with each other, while the piece of insulation e^3 , secured to the spring e^2 , tends at all times to prevent contact between the springs e' and e^2 . The ends of said springs are formed as shown in Figs. 4 to 8, inclusive, while the adjacent end portion of the interrupter-arm d^6 is provided with a lateral projection d^7 . When the armature is attracted, the projection d^7 first engages the end portion of the spring e , as shown in Fig. 5, and then slips off said portion and engages the upper portion of the spring e' , as shown in Fig. 4, it being observed that the spring e' has a straight end portion lying between the laterally-projecting end portions of the other two springs. The movement of the armature continuing, the interrupter-arm bears upon the spring e' sufficiently to take the spring e^2 entirely out of contact with the spring e . When the armature is again released, the end of the interrupter-arm d^6 passes out from the end portions of the springs e and e' , as shown in Fig. 6, thereby keeping the springs e and e^2 out of engagement until the armature is completely restored to its normal position. It will be understood, of course, that each time the armature is attracted the pawl d' engages the ratchet-hub b , and thereby rotates the shaft B one step—that is to say, one step in the direction of its rotation.

Referring to Fig. 3, which shows a simple form of the apparatus, it will be seen that the main battery F is included in a grounded circuit and connected in series with the rotary magnets C , and in this same circuit, which is normally open, the springs e and e^2 are included. A pair of normally open relay-contacts 1 and 2 are also included in this circuit, said contacts being operated by the armature 3 of the relay-magnet 4. One terminal of this relay-magnet can be connected with the said battery, as shown, while the other terminal can be connected with other apparatus and arranged in circuit with means for closing the circuit of said relay. One pole of the

said battery is grounded at 5, and the other end of the circuit is grounded at 6, thus giving a normally open grounded circuit including a battery, two normally closed contacts, two normally separated contacts, and the two rotary magnets. Now, assuming that in the operation of the switch the relay-magnet 4 is energized, the circuit of the magnet C is thereby closed and the armature D attracted. This relay 4 can be any suitable relay or magnet; but in practice it has often been found desirable and practicable to employ the so-called "private" magnet of a selector for opening and closing the contacts 1 and 2 and for keeping the normally open switch-points in the circuit of the relay-magnet closed until an idle trunk-line is found. When the armature D is attracted, it breaks the contact normally existing between the springs e and e^2 , and thereby interrupts the flow of current in the circuit closed by the energizing of the relay 4. This of course causes the magnets C to release the armature immediately after the forward stroke of the latter has caused the pawl d' to rotate the switch-shaft one step. Upon its release the projection d^7 , carried by the interrupter-arm d^6 , passes between the end portions of the springs e and e' , and thereby, as previously stated, prevents a reengagement of the spring e^2 with spring e until after the armature has been allowed to regain its normal position, and it will be remembered that suitable spring means are employed for restoring said armature to its normal position. In this way the armature D is alternately attracted and released, the armature being equipped, so to speak, with means for alternately opening and closing the circuit of the magnet or magnets by which it is operated. In other words, the energizing of the so-called "rotary" magnets C sets in motion the part or means by which the continuity of the energizing-circuit is broken or interrupted and with the result, of course, that the armature is instantly released, and this alternate make-and-break action in the circuit of the magnet C will continue as long as the magnet 4 remains energized. As previously stated, this magnet 4 may be the so-called "private" magnet of a first or second selector, and in the operation of obtaining connection between two subscribers' lines remains energized until the switch-shaft B rotates to a position calculated to establish connection with an idle trunk-line. In other words, and through the medium of any suitable, known, or approved arrangement, the magnet 4 can be so connected that it will remain energized while the wipers or arms of the switch-shaft are passing over busy contacts and will only become de-energized when the said wipers or switch-arms find a set of bank-contacts corresponding to an idle trunk-line.

By the foregoing arrangement I have made it possible to dispense with certain

more or less objectionable apparatus heretofore employed for furnishing a vibratory or intermittent current to the rotary magnets for the purpose described and to materially
 5 amplify and improve the operation of a selective switching apparatus of this particular character.

With the arrangement shown it is obvious that the stop d^4 is something more than a
 10 mere guide—that is to say, it not only guides the pawl d' into engagement with the ratchet-teeth on the shaft, but it also coöperates with said pawl in locking the shaft against any movement beyond the point necessary for
 15 completing each step of the step-by-step rotary motion. In other words, the pawl d' engages the face or short surface of a tooth each time the magnet is energized and in so doing gives the shaft one rotary step. Each step is, however,
 20 limited by the engagement of the pawl with the stop or guide d^4 , inasmuch as such engagement crowds the pawl firmly against the back or beveled surface of the next tooth. Consequently even the momentum of the
 25 shaft when thus propelled in a rotary manner is not sufficient to carry it by the point which marks the completion of each rotary step—that is, the point where the pawl becomes operative to positively interrupt each
 30 step of the mechanical step-by-step motion produced by the alternate energizing and de-energizing of the magnet C. Furthermore, it will be seen that the magnet-operated circuit-breaking means, comprising the arm d^6
 35 and the springs e , e' , and e^2 , is adapted and timed in its operation to each time maintain the continuity of the circuit until after the armature reaches the limit of its propulsive stroke, or, more broadly speaking, until
 40 after each step of the motion is completed. In this way the shaft is positively propelled for the full extent of each step of its motion, no part of such movement being dependent upon the momentum of the shaft, and consequently the shaft is, always certain of being
 45 given the desired or necessary extent of movement before the circuit is opened or before the magnetic force of the magnet ceases. This action is of course "assisted," so to
 50 speak, by the residual magnetism of the magnet, so that the positive interruption of the mechanical motion has a slight lead over the cessation of the magnetic force, thus insuring the positive and powerful propelling action
 55 throughout the entire range of movement necessary for completing each step of the step-by-step rotary motion of the shaft. This is due, it will be seen, to the fact that the end of the arm d^6 slips off from the end of
 60 the spring e at the instant that the armature reaches the limit of its forward or propulsive stroke and to the further fact that the circuit is even then not broken until the springs fly back toward their normal positions and not
 65 until the spring e' strikes the end of the arm

d^6 , thus interrupting the movement of the three springs and permitting the spring e to continue its movement, and thus move out of contact with the spring e^2 . In other words, the end of the arm d^6 is separated
 70 from the spring e' by the thickness of the end portion of the spring e during the propulsive stroke of the armature, thus permitting the mechanical motion to cease just prior to the opening of the circuit, for the disengagement
 75 of the arm d^6 from the spring e takes place practically at the instant the armature reaches the limit of its propulsive stroke, thus leaving the springs e and e^2 in contact for the fraction of a second after the motion
 80 of the shaft is positively interrupted. In a similar manner the end of the arm d^6 in regaining its normal position does not become disengaged from the end of the spring e until the armature practically reaches the limit of
 85 its stroke away from the magnet, thus insuring a separation of the springs e and e^2 for the fraction of a second after the armature and the pawl d' reach their normal positions. In other words, the circuit-breaker is of such
 90 character and is so timed in its operation that the necessary condition of the circuit is maintained until after each step of the rotary step-by-step motion is completed, and it is also adapted and timed in its operation to pre-
 95 serve the necessary condition of the circuit until after the armature is restored to its normal position.

In Fig. 9 the selector thus diagrammatically illustrated is of a well-known type. In
 100 this diagram the switch-shaft B is shown provided with the usual vertical and rotary line-wipers b' and b^2 and with the well-known private wiper b^3 . The said line-wipers coöperate with the bank of line-terminals b^4 in est-
 105 tablishing any one of a number of possible connections, it being understood that each terminal consists of two contacts and is connected with a trunk-line running to some other point. These terminals are multiplied
 110 with corresponding terminals of all other selectors having terminals corresponding to the trunk-lines running to the selector shown in Fig. 9. Also the "private-bank" contacts b^5
 115 are multiplied with the corresponding private-bank contacts of all selectors having line-terminals corresponding to or connected with the trunk-lines running to the terminals b^4 . The selector thus illustrated is further identified by the usual and well-known vertical
 120 magnet F', the release-magnet G, the side switch H, and the double locking-dog I, together with the ratchet-pawls f and d' , the release-link g , and the side-switch arms or wipers 1, 7, 8, 9, and 10. These parts, as
 125 well as the other parts and devices indicated in the drawings, are all familiar elements of a selector of this type and will require no further description.

As previously stated, the private magnet 130

4 controls the switch-contacts 1 and 2 through the medium of the usual side switch H, these contacts being closed together when the side switch is moved to second position. When the rotary magnet C is thus energized by the closing of a local circuit, its armature-finger 11 operates the private-magnet armature 3, thus putting the side switch in condition to move to third position as soon as the armature 3 is released. Suppose, however, that the first terminal engaged by the line-wipers is connected with a trunk-line already in use, whereby the corresponding private-bank contact engaged by the private wiper b^3 has a guarding potential by reason of its connection to ground through some other switch. In such case the circuit immediately established from the grounded pole of the battery F through ground and through the private-bank contact, through the private wiper b^3 , through the switch-arm 8 and the contact 12, through the private magnet 4 and the conductors 13 and 14 to the non-grounded pole of the battery energizes the said private magnet. In this way the guarding potential at a busy private-bank contact is utilized in energizing the private magnet, thus causing the latter to retain its armature 3 in its attracted position. This of course prevents the restoration of the armature 3 when the rotary magnet C is deenergized, and thereby prevents the shifting of the side switch from second to third position, and this energization of the private magnet, and the consequent retention of the side switch in its second position, is maintained as long as the private wiper b^3 continues to encounter the private-bank contacts supplied with guarding potential and until the wipers arrive at a position corresponding to a trunk-line which is not busy. As soon as this happens the circuit through the private magnet is broken and the armature 3 is released and allowed to effect a shifting of the side switch from second to third position. As soon as the side switch shifts to third position the incoming line conductors 15 and 16 are connected with the outgoing trunk-line conductors 17 and 18 through the medium of the side-switch arms or wipers 9 and 10 and through the medium of the shaft-wipers b^1 and b^2 .

In Fig. 9 the circuit-breaker is shown in a simplified form and in a manner similar to that in which it is shown in Fig. 3. It will be understood, however, that in actual practice the construction is preferably of the form shown in the other figures of the drawings, inasmuch as it is desirable to insure a full stroke of the armature in both directions, and, as stated, this is accomplished by so timing the operation of the circuit-breaker that either condition of the circuit is not changed or reversed until after the armature has reached the limit of its stroke in either direction, and this is particularly desirable

with respect to the forward or propulsive stroke of the armature, inasmuch as the switch-shaft B is always subject to the retracting influence of the coil-spring 19. Consequently the construction is preferably such that the tension of this retracting-spring is positively opposed by the magnetic force of the rotary magnet until after the shaft has completed each rotary step, thus making it impossible for the double-locking dog I to fail to catch the shaft and hold it exactly in the right position. In other words, should the magnetic force of the rotary magnet cease or fail just before the shaft reaches the desired position there would be nothing to prevent the spring from immediately giving the shaft a slight back rotation, and there would even be more or less danger of this uncertainty of action with the parts adjusted to break the circuit at the very instant that the rotary motion is positively interrupted. Consequently and as explained the continuity of the circuit is preferably maintained for the fraction of a second, at least, after the rotary motion of the shaft is positively interrupted or stopped, and with such provision I preclude or greatly reduce all danger of uncertainty of action on the part of the automatic step-by-step rotary motion of the shaft. This adjustment of the interrupter-springs may be modified in each individual switch in order that the best and most efficient operation of the switch may result. In some switches it may be found that an adjustment which breaks the circuit of the rotary magnet at an appreciable time before the rotary armature strikes the pole-pieces produces best results; but some switches require a more close adjustment, and my improved interrupting-machine affords opportunity for such adjustment.

As previously stated, the private magnet will remain energized while the shaft-wipers are passing over busy contacts and until an idle or non-busy trunk-line is found. This is due to the fact, it will be seen, that the private contacts in the private bank and the trunk-line terminals in the line-bank are arranged so close together in each and every level of the said banks that both the line and the private wipers engage one contact or terminal before breaking contact with another. In other words, the private wiper slides readily from one contact to another without ever being completely out of engagement with the same, whereby if the first five contacts in any level are busy the private magnet will remain constantly energized until the private wiper is completely disengaged from the fifth contact. The energizing of said private magnet, as well as the energizing of the vertical and rotary magnets and also the release-magnet, is controlled by the usual so-called "vertical" and "rotary" line-relays J and K, which latter are bridged across the

line conductors 15 and 16 with the middle point of the bridge between the two relays connected to the non-grounded pole of the battery through the medium of the normally closed contacts of the bridge-cut-off relay L. When the selector is in use, the guarding potential is furnished from the grounded pole of the battery through the contacts *h* and 8, through the conductor *h'*, and through the private wiper *b'* to the private-bank contact which is engaged by the said private wiper and thence to all multiples of such contact in other selectors or switches.

It will be seen, therefore, that my invention broadly contemplates an interrupter adapted and timed in its operation to maintain the necessary condition of the magnet-circuit until after the armature reaches the limit of its propulsive stroke—that is, until after the armature has been moved the desired distance in one direction. Also it broadly contemplates an interrupter which will maintain the necessary condition of the circuit until after the armature reaches the limit of its movement in the opposite direction. More specifically considered, it contemplates an interrupter which will maintain the continuity of the circuit until after the mechanical motion is positively interrupted. Also, more specifically considered, it contemplates an interrupter adapted and timed in its operation to keep the magnet-circuit open until after the armature reaches its position of rest. Again, as herein shown and described, my invention broadly contemplates the use of a "selector-actuating" magnet for opening and closing its own circuit, so as to automatically maintain the step-by-step actuation of the machine until an idle trunk-line is found. Also, and more specifically considered, my invention contemplates the combination of a telephone selector-actuating magnet with means for positively interrupting the mechanical motion and with an interrupter operated by said magnet in such manner as to keep the circuit closed until after the mechanical motion is positively interrupted. In other words, my improved interrupter and means for automatically selecting an idle trunk-line is broadly new, so far as I am aware, and the specific character of interrupter by itself is also of course broadly new. It is also broadly new, so far as I am aware, to operatively combine a selector-actuating magnet or other telephone-switch-operating magnet with means of any suitable character whereby it may automatically open and close its own circuit while the machine is passing in front of busy contacts and until an idle trunk-line is found. Furthermore, my invention contemplates a trunk-selecting switch mechanism having provisions for automatically and intermittently interrupting its operating current for the purpose of maintaining a

step-by-step actuation of the selecting mechanism until an idle trunk-line is found.

By my invention each trunk-selecting switch mechanism is complete in itself and is self-contained in this respect—namely, that it contains the means for producing the vibratory current essential to an automatic step-by-step operation of the switch until it finds an idle trunk-line. Prior to my invention it was customary to use for this purpose an arrangement involving an interrupter which was common to all of the trunk-selecting switches in the exchange. With such arrangement a great deal of difficulty was experienced—as, for example, should the mechanism of such interrupter get out of order it is obvious that the whole exchange would then be temporarily rendered inoperative. With my improved arrangement, however, each selector or trunk-selecting switch has its own interrupter, and in this way the exchange apparatus is no longer subject to a single and more or less complicated interrupting-machine. In other words, I provide selectors or trunk-selecting switch mechanisms having individual interrupters, whereby each interrupter when it becomes injured or rendered unfit for use does not thereby render the entire exchange inoperative. If a first selector is allotted to each subscriber's line, there is then with my improved arrangement an individual automatic interrupter for each line. In any event, however, I prefer the arrangement by which the switches which perform trunking operations corresponding to the digits of any called number have individual interrupters, and, as stated, one of the most important features of my invention consists in the use of interrupters for different switches or for different parts of the exchange apparatus whereby the failure of one interrupter will at least not render the entire exchange inoperative.

As I am the first to successfully propose and employ a current-interrupter which is operated directly by a telephone trunk-selecting switch mechanism so as to produce an intermittent or interrupted current as long as busy trunks are encountered, it is obvious that more or less change or variation can be made in the construction without departing from the spirit of my invention, and for this reason I do not, as far as the broader aspect of my invention is concerned, limit myself to the exact construction shown and described.

I claim as my invention—

1. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising step-by-step switching mechanism, an energizing-circuit for effecting the operation of said step-by-step mechanism, switch-contacts in said circuit, and a magnet also in said circuit, and with means whereby said contacts

are alternately opened and closed by the alternate energizing and deenergizing of said magnet together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and means for supplying all necessary energizing-current.

2. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising an electromagnet, an energizing-circuit for said magnet, normally closed contacts in said circuit, means operated by said magnet for alternately opening and closing said contacts, and step-by-step mechanism operated by the alternate make-and-break action produced by said magnet in its own circuit together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and means for supplying all necessary energizing-current.

3. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising an electromagnet, an energizing-circuit for said magnet, means for closing said circuit, means operated by said magnet for alternately opening and closing its own circuit, and step-by-step mechanism dependent for its operation upon the make-and-break action produced by said magnet in its own circuit together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and means for supplying all necessary energizing-current.

4. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising a rotatable switch-shaft, an electromagnet, an energizing-circuit for said magnet, switching means operated by said magnet for alternately opening and closing its own circuit, and a pawl-and-ratchet device for rotating said shaft and dependent for its continued operation upon the make-and-break action produced by said magnet in its own circuit together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and means for supplying all necessary energizing-current.

5. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising an electromagnet, a rotatable switch-shaft, a pawl-and-ratchet device for rotating said shaft in a step-by-step manner, means actuated by said magnet for operating said pawl-and-ratchet device, an energizing-circuit for said magnet, and means also actuated by said magnet for alternately opening and closing its own circuit together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and

means for supplying all necessary energizing-current.

6. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising a step-by-step switching mechanism, an electromagnet for actuating said mechanism, a normally open energizing-circuit for said magnet, electromagnetic means for closing said circuit, and means operated by and adapted to open said circuit when the said electromagnet is energized together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and means for supplying all necessary energizing-current.

7. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising a "selector" for automatic telephone systems, comprising a step-by-step switching mechanism, and means for automatically continuing the operation of said step-by-step mechanism until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and means for supplying all necessary energizing-current.

8. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising an automatic selective step-by-step switching device comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and means for supplying all necessary energizing-current.

9. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising an automatic selective step-by-step switching mechanism comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, a normally open energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and means for supplying all necessary energizing-current.

10. In combination with trunk-lines, a telephone trunk-selecting apparatus comprising a rotatable switch-shaft, a ratchet-wheel on said shaft, a pawl for engaging said ratchet to rotate the shaft in a step-by-step manner, an electromagnet, an armature for said magnet, said armature being connected to operate said pawl, an energizing-circuit for said magnet, normally closed switch-springs included in said circuit, and an interrupter-arm connected to said armature and adapted, upon the energizing of said magnet, to separate said springs and then, upon the consequent deenergizing of said magnet, keep said springs out of contact with each other until the armature is restored to its normal position together with automatic means adapted and operative to maintain the vibratory or intermittent energization of said magnet until an idle trunk-line is found, and means for supplying all necessary energizing-current.

11. The combination of step-by-step switching mechanism, an energizing-circuit for effecting the operation of said step-by-step mechanism, switch-contacts in said circuit, and a magnet also in said circuit, together with means whereby said contacts are alternately opened and closed by the alternate energizing and deenergizing of said magnet, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

12. The combination of an electromagnet, an energizing-circuit for said magnet, normally closed contacts in said circuit, means operated by said magnet for alternately opening and closing said contacts, and step-by-step mechanism operated by the alternate make-and-break action produced by said magnet in its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

13. The combination of an electromagnet,

an energizing-circuit for said magnet, means for closing said circuit, means operated by said magnet for alternately opening and closing its own circuit, and step-by-step mechanism dependent for its operation upon the make-and-break action produced by said magnet in its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

14. The combination of a rotatable switch-shaft, an electromagnet, an energizing-circuit for said magnet, switching means operated by said magnet for alternately opening and closing its own circuit, and a pawl-and-ratchet device for rotating said shaft and dependent for its continued operation upon the make-and-break action produced by said magnet in its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

15. The combination of an electromagnet, a rotatable switch-shaft, a pawl-and-ratchet device for rotating said shaft in a step-by-step manner, means actuated by said magnet for operating said pawl-and-ratchet device, an energizing-circuit for said magnet, and means also actuated by said magnet for alternately opening and closing its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

16. The combination of a step-by-step switching mechanism, an electromagnet for

actuating said mechanism, a normally open energizing-circuit for said magnet, electromagnetic means for closing said circuit, and means operated by and adapted to open said circuit when the said electromagnet is energized, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

17. A "selector" for automatic telephone systems, comprising a step-by-step switching mechanism, and means for automatically continuing the operation of said step-by-step mechanism until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

18. In an automatic telephone apparatus, an automatic selective step-by-step switching device comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

19. In an automatic telephone apparatus, an automatic selective step-by-step switch-

ing mechanism comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, a normally open energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

20. An automatic telephone-switch comprising a rotatable switch-shaft, a ratchet-wheel on said shaft, a pawl for engaging said ratchet to rotate the shaft in a step-by-step manner, an electromagnet, an armature for said magnet, said armature being connected to operate said pawl, an energizing-circuit for said magnet, normally closed switch-springs included in said circuit, and an interrupter-arm connected to said armature and adapted, upon the energizing of said magnet, to separate said springs and then, upon the consequent deenergizing of said magnet, to keep said springs out of contact with each other until the armature is restored to its normal position, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the continuity of the circuit until after the armature of said magnet reaches the limit of its propulsive stroke, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic opening of said circuit.

21. The combination of step-by-step switching mechanism, an energizing-circuit for effecting the operation of said step-by-step mechanism, switch-contacts in said circuit, and a magnet also in said circuit, together with means whereby said contacts are alternately opened and closed by the alternate energizing and deenergizing of said magnet, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary con-

dition of the circuit until after each step of the motion is completed, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic change of conditions in said circuit.

22. The combination of an electromagnet, an energizing-circuit for said magnet, normally closed contacts in said circuit, means operated by said magnet for alternately opening and closing said contacts, and step-by-step mechanism operated by the alternate make-and-break action produced by said magnet in its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary condition of the circuit until after each step of the motion is completed, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic change of conditions in said circuit.

23. The combination with an electromagnet, an energizing-circuit for said magnet, means for closing said circuit, means operated by said magnet for alternately opening and closing its own circuit, and step-by-step mechanism dependent for its operation upon the make-and-break action produced by said magnet in its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary condition of the circuit until after each step of the motion is completed, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic change of conditions in said circuit.

24. The combination of a rotatable switch-shaft, an electromagnet, an energizing-circuit for said magnet, switching means operated by said magnet for alternately opening and closing its own circuit, and a pawl-and-ratchet device for rotating said shaft and dependent for its continued operation upon the make-and-break action produced by said magnet in its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary condition of the circuit until after each step of the motion is completed, whereby the

positive interruption of the mechanical motion takes place each time just prior to the automatic change of conditions in said circuit.

25. The combination of an electromagnet, a rotatable switch-shaft, a pawl-and-ratchet device for rotating said shaft in a step-by-step manner, means actuated by said magnet for operating said pawl-and-ratchet device, an energizing-circuit for said magnet, and means also actuated by said magnet for alternately opening and closing its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary condition of the circuit until after each step of the motion is completed, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic change of conditions in said circuit.

26. The combination of a step-by-step switching mechanism, an electromagnet for actuating said mechanism, a normally open energizing-circuit for said magnet, electromagnetic means for closing said circuit, and means operated by and adapted to open said circuit when the said electromagnet is energized, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary condition of the circuit until after each step of the motion is completed, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic change of conditions in said circuit.

27. A "selector" for automatic telephone systems, comprising a step-by-step switching mechanism, and means for automatically continuing the operation of said step-by-step mechanism until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary condition of the circuit until after each step of the motion is completed, whereby the positive interruption of the me-

chanical motion takes place each time just prior to the automatic change of conditions in said circuit.

28. In an automatic telephone apparatus, an automatic selective step-by-step switching device comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary condition of the circuit until after each step of the motion is completed, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic change of conditions in said circuit.

29. In an automatic telephone apparatus, an automatic selective step-by-step switching mechanism comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, a normally open energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, there being a suitable structural provision for effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary condition of the circuit until after each step of the motion is completed, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic change of conditions in said circuit.

30. An automatic telephone-switch comprising a rotatable switch-shaft, a ratchet-wheel on said shaft, a pawl for engaging said ratchet to rotate the shaft in a step-by-step manner, an electromagnet, an armature for said magnet, said armature being connected to operate said pawl, an energizing-circuit for said magnet, normally closed switch-springs included in said circuit, and an interrupter-arm connected to said armature and adapted, upon the energizing of said magnet, to separate said springs and then, upon the consequent deenergizing of said magnet, keep said springs out of contact with each other until the armature is restored to its normal position, there being a suitable structural provision for

effecting a positive interruption of each step of the mechanical step-by-step motion produced by the alternate energizing and deenergizing of said magnet, and the said magnet-operated circuit-controlling means being adapted and timed in its operation to maintain the necessary condition of the circuit until after each step of the motion is completed, whereby the positive interruption of the mechanical motion takes place each time just prior to the automatic change of conditions in said circuit.

31. The combination of step-by-step switching mechanism, an energizing-circuit for effecting the operation of said step-by-step mechanism, switch-contacts in said circuit, and a magnet also in said circuit, together with means whereby said contacts are alternately opened and closed by the alternate energizing and deenergizing of said magnet, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the necessary condition of the circuit until after the armature of said magnet regains its normal position, whereby the said armature always reaches its position of rest just prior to the automatic change of conditions in the said circuit.

32. The combination of an electromagnet, an energizing-circuit for said magnet, normally closed contacts in said circuit, means operated by said magnet for alternately opening and closing said contacts, and step-by-step mechanism operated by the alternate make-and-break action produced by said magnet in its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the necessary condition of the circuit until after the armature of said magnet regains its normal position, whereby the said armature always reaches its position of rest just prior to the automatic change of conditions in the said circuit.

33. The combination of an electromagnet, an energizing-circuit for said magnet, means for closing said circuit, means operated by said magnet for alternately opening and closing its own circuit, and step-by-step mechanism dependent for its operation upon the make-and-break action produced by said magnet in its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the necessary condition of the circuit until after the armature of said magnet regains its normal position, whereby the said armature always reaches its position of rest just prior to the automatic change of conditions in the said circuit.

34. The combination of a rotatable switch-shaft, an electromagnet, an energizing-circuit for said magnet, switching means operated by said magnet for alternately opening and closing its own circuit, and a pawl-and-

ratchet device for rotating said shaft and dependent for its continued operation upon the make-and-break action produced by said magnet in its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the necessary condition of the circuit until after the armature of said magnet regains its normal position, whereby the said armature always reaches its position of rest just prior to the automatic change of conditions in the said circuit.

35. The combination of an electromagnet, a rotatable switch-shaft, a pawl-and-ratchet device for rotating said shaft in a step-by-step manner, means actuated by said magnet for operating said pawl-and-ratchet device, an energizing-circuit for said magnet, and means also actuated by said magnet for alternately opening and closing its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the necessary condition of the circuit until after the armature of said magnet regains its normal position, whereby the said armature always reaches its position of rest just prior to the automatic change of conditions in the said circuit.

36. The combination of a step-by-step switching mechanism, an electromagnet for actuating said mechanism, a normally open energizing-circuit for said magnet, electromagnetic means for closing said circuit, and means operated by and adapted to open said circuit when the said electromagnet is energized, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the necessary condition of the circuit until after the armature of said magnet regains its normal position, whereby the said armature always reaches its position of rest just prior to the automatic change of conditions in the said circuit.

37. A "selector" for automatic telephone systems, comprising a step-by-step switching mechanism, and means for automatically continuing the operation of said step-by-step mechanism until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the necessary condition of the circuit until after the armature of said magnet regains its normal position, whereby the said armature always reaches its position of rest just prior to the automatic change of conditions in the said circuit.

38. In an automatic telephone apparatus, an automatic selective step-by-step switching device comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the necessary condition of the circuit until after the armature of said magnet regains its normal position, whereby the said armature always reaches its position of rest just prior to the automatic change of conditions in the said circuit.

39. In an automatic telephone apparatus, an automatic selective step-by-step switching mechanism comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, a normally open energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the necessary condition of the circuit until after the armature of said magnet regains its normal position, whereby the said armature always reaches its position of rest just prior to the automatic change of conditions in the said circuit.

40. The combination of step-by-step switching mechanism, an energizing-circuit for effecting the operation of said step-by-step mechanism, switch-contacts in said circuit, and a magnet also in said circuit, together with means whereby said contacts are alternately opened and closed by the alternate energizing and deenergizing of said magnet, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the open condition of the circuit until after the armature of said magnet regains its normal position, and until after the said armature reaches the limit of its non-propulsive stroke, whereby the said armature always reaches its position of rest just prior to the automatic closing of said circuit.

41. The combination of an electromagnet, an energizing-circuit for said magnet, normally closed contacts in said circuit, means operated by said magnet for alternately opening and closing said contacts, and step-by-step mechanism operated by the alternate make-and-break action produced by said magnet in its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the open condition of the circuit until after the armature of said magnet regains its normal position, and until after

the said armature reaches the limit of its non-propulsive stroke, whereby the said armature always reaches its position of rest just prior to the automatic closing of said circuit.

42. The combination of an electromagnet, an energizing-circuit for said magnet, means for closing said circuit, means operated by said magnet for alternately opening and closing its own circuit, and step-by-step mechanism dependent for its operation upon the make-and-break action produced by said magnet in its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the open condition of the circuit until after the armature of said magnet regains its normal position, and until after the said armature reaches the limit of its non-propulsive stroke, whereby the said armature always reaches its position of rest just prior to the automatic closing of said circuit.

43. The combination of a rotatable switch-shaft, an electromagnet, an energizing-circuit for said magnet, switching means operated by said magnet for alternately opening and closing its own circuit, and a pawl-and-ratchet device for rotating said shaft and dependent for its continued operation upon the make-and-break action produced by said magnet in its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the open condition of the circuit until after the armature of said magnet regains its normal position, and until after the said armature reaches the limit of its non-propulsive stroke, whereby the said armature always reaches its position of rest just prior to the automatic closing of said circuit.

44. The combination of an electromagnet, a rotatable switch-shaft, a pawl-and-ratchet device for rotating said shaft in a step-by-step manner, means actuated by said magnet for operating said pawl-and-ratchet device, an energizing-circuit for said magnet, and means also actuated by said magnet for alternately opening and closing its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the open condition of the circuit until after the armature of said magnet regains its normal position, and until after the said armature reaches the limit of its non-propulsive stroke, whereby the said armature always reaches its position of rest just prior to the automatic closing of said circuit.

45. The combination of a step-by-step switching mechanism, an electromagnet for actuating said mechanism, a normally open energizing-circuit for said magnet, electromagnetic means for closing said circuit, and means operated by and adapted to open said circuit when the said electromagnet is energized, said magnet-operated circuit-controlling means being adapted and timed in its

operation to each time maintain the open condition of the circuit until after the armature of said magnet regains its normal position, and until after the said armature reaches the limit of its non-propulsive stroke, whereby the said armature always reaches its position of rest just prior to the automatic closing of said circuit.

46. A "selector" for automatic telephone systems, comprising a step-by-step switching mechanism, and means for automatically continuing the operation of said step-by-step mechanism until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the open condition of the circuit until after the armature of said magnet regains its normal position, and until after the said armature reaches the limit of its non-propulsive stroke, whereby the said armature always reaches its position of rest just prior to the automatic closing of said circuit.

47. In an automatic telephone apparatus, an automatic selective step-by-step switching device comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the open condition of the circuit until after the armature of said magnet regains its normal position, and until after the said armature reaches the limit of its non-propulsive stroke, whereby the said armature always reaches its position of rest just prior to the automatic closing of said circuit.

48. In an automatic telephone apparatus, an automatic selective step-by-step switching mechanism comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, a normally open energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, said magnet-operated circuit-controlling means being adapted and timed in its operation to each time maintain the open condition of the circuit until after the armature of said magnet regains its normal position, and until after the said armature reaches the limit of its non-propulsive stroke, whereby the said armature always

reaches its position of rest just prior to the automatic closing of said circuit.

49. The combination of step-by-step switching mechanism, an energizing-circuit for effecting the operation of said step-by-step mechanism, switch-contacts in said circuit, and a magnet also in said circuit, together with means whereby said contacts are alternately opened and closed by the alternate energizing and deenergizing of said magnet; and the said magnet-operated circuit-breaking means comprising an arm rigid with the armature of said magnet, normally closed switch-springs, and an intermediate spring, said arm having its end portion adapted to bear upon the end portion of one switch-spring, when the magnet is energized, and to thereby flex all three springs; but adapted to slip off from such spring just as the armature reaches the limit of its propulsive stroke; and adapted to then be engaged by said intermediate spring for the purpose of opening or separating said switch-springs, the circuit through the magnet being thus held closed until after the armature reaches its position of rest, and the said end portion of the arm being adapted to pass between the said intermediate spring and the end portion of the same switch-spring when the armature moves back to its normal position, the circuit being thus held open until after the armature reaches its position of rest.

50. The combination of an electromagnet, an energizing-circuit for said magnet, normally closed contacts in said circuit, means operated by said magnet for alternately opening and closing said contacts, and step-by-step mechanism operated by the alternate make-and-break action produced by said magnet in its own circuit, and the said magnet-operated circuit-breaking means comprising an arm rigid with the armature of said magnet, normally closed switch-springs, and an intermediate spring, said arm having its end portion adapted to bear upon the end portion of one switch-spring; when the magnet is energized, and to thereby flex all three springs; but adapted to slip off from such spring just as the armature reaches the limit of its propulsive stroke, and adapted to then be engaged by said intermediate spring for the purpose of opening or separating said switch-springs, the circuit through the magnet being thus held closed until after the armature reaches its position of rest, and the said end portion of the arm being adapted to pass between the said intermediate spring and the end portion of the same switch-spring when the armature moves back to its normal position, the circuit being thus held open until after the armature reaches its position of rest.

51. The combination of an electromagnet, an energizing-circuit for said magnet, means for closing said circuit, means operated by

said magnet for alternately opening and closing its own circuit, and step-by-step mechanism dependent for its operation upon the make-and-break action produced by said magnet in its own circuit, and the said magnet-operated circuit-breaking means comprising an arm rigid with the armature of said magnet, normally closed switch-springs, and an intermediate spring, said arm having its end portion adapted to bear upon the end portion of one switch-spring, when the magnet is energized, and to thereby flex all three springs; but adapted to slip off from such spring just as the armature reaches the limit of its propulsive stroke, and adapted to then be engaged by said intermediate spring for the purpose of opening or separating said switch-springs; the circuit through the magnet being thus held closed until after the armature reaches its position of rest, and the said end portion of the arm being adapted to pass between the said intermediate spring and the end portion of the same switch-spring when the armature moves back to its normal position, the circuit being thus held open until after the armature reaches its position of rest.

52. The combination of a rotatable switch-shaft, an electromagnet, an energizing-circuit for said magnet, switching means operated by said magnet for alternately opening and closing its own circuit, and a pawl-and-ratchet device for rotating said shaft and dependent for its continued operation upon the make-and-break action produced by said magnet in its own circuit, and the said magnet-operated circuit-breaking means comprising an arm rigid with the armature of said magnet, normally closed switch-springs, and an intermediate spring, said arm having its end portion adapted to bear upon the end portion of one switch-spring, when the magnet is energized, and to thereby flex all three springs; but adapted to slip off from such spring just as the armature reaches the limit of its propulsive stroke, and adapted to then be engaged by said intermediate spring for the purpose of opening or separating said switch-springs, the circuit through the magnet being thus held closed until after the armature reaches its position of rest, and the said end portion of the arm being adapted to pass between the said intermediate spring and the end portion of the same switch-spring when the armature moves back to its normal position, the circuit being thus held open until after the armature reaches its position of rest.

53. The combination of an electromagnet, a rotatable switch-shaft, a pawl-and-ratchet device for rotating said shaft in a step-by-step manner, means actuated by said magnet for operating said pawl and ratchet device, an energizing-circuit for said magnet, and means also actuated by said magnet for alter-

nately opening and closing its own circuit, and the said magnet-operated circuit-breaking means comprising an arm rigid with the armature of said magnet, normally closed switch-springs, and an intermediate spring, said arm having its end portion adapted to bear upon the end portion of one switch-spring, when the magnet is energized, and to thereby flex all three springs, but adapted to slip off from such spring just as the armature reaches the limit of its propulsive stroke, and adapted to then be engaged by said intermediate spring for the purpose of opening or separating said switch-springs, the circuit through the magnet being thus held closed until after the armature reaches its position of rest, and the said end portion of the arm being adapted to pass between the said intermediate spring and the end portion of the same switch-spring when the armature moves back to its normal position, the circuit being thus held open until after the armature reaches its position of rest.

54. The combination of a step-by-step switching mechanism, an electromagnet for actuating said mechanism, a normally open energizing-circuit for said magnet, electromagnetic means for closing said circuit, and means operated by and adapted to open said circuit when the said electromagnet is energized, and the said magnet-operated circuit-breaking means comprising an arm rigid with the armature of said magnet, normally closed switch-springs, and an intermediate spring, said arm having its end portion adapted to bear upon the end portion of one switch-spring, when the magnet is energized, and to thereby flex all three springs, but adapted to slip off from such spring just as the armature reaches the limit of its propulsive stroke, and adapted to then be engaged by said intermediate spring for the purpose of opening or separating said switch-springs, the circuit through the magnet being thus held closed until after the armature reaches its position of rest, and the said end portion of the arm being adapted to pass between the said intermediate spring and the end portion of the same switch-spring when the armature moves back to its normal position, the circuit being thus held open until after the armature reaches its position of rest.

55. A "selector" for automatic telephone systems, comprising a step-by-step switching mechanism, and means for automatically continuing the operation of said step-by-step mechanism until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, and the said magnet-operated circuit-breaking means comprising an arm rigid with the armature of said magnet, normally closed switch-springs, and an intermediate spring,

said arm having its end portion adapted to bear upon the end portion of one switch-spring, when the magnet is energized, and to thereby flex all three springs, but adapted to slip off from such spring just as the armature reaches the limit of its propulsive stroke, and adapted to then be engaged by said intermediate spring for the purpose of opening or separating said switch-springs, the circuit through the magnet being thus held closed until after the armature reaches its position of rest, and the said end portion of the arm being adapted to pass between the said intermediate spring and the end portion of the same switch-spring when the armature moves back to its normal position, the circuit being thus held open until after the armature reaches its position of rest.

56. In an automatic telephone apparatus, an automatic selective step-by-step switching device comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, an energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, and the said magnet-operated circuit-breaking means comprising an arm rigid with the armature of said magnet, normally closed switch-springs, and an intermediate spring, said arm having its end portion adapted to bear upon the end portion of one switch-spring, when the magnet is energized, and to thereby flex all three springs, but adapted to slip off from such spring just as the armature reaches the limit of its propulsive stroke, and adapted to then be engaged by said intermediate spring for the purpose of opening or separating said switch-springs, the circuit through the magnet being thus closed until after the armature reaches its position of rest, and the said end portion of the arm being adapted to pass between the said intermediate spring and the end portion of the same switch-spring when the armature moves back to its normal position, the circuit being thus held open until after the armature reaches its position of rest.

57. In an automatic telephone apparatus, an automatic selective step-by-step switching mechanism comprising a step-by-step mechanism, and means for automatically maintaining the step-by-step mechanism in operation until the desired result is obtained, said means including an electromagnet, a normally open energizing-circuit for said magnet, and means operated by said magnet for alternately opening and closing its own circuit, and the said magnet-operated circuit-breaking means comprising an arm rigid with the armature of said magnet, normally closed switch-springs, and an intermediate spring, said arm having its end portion adapted to bear upon the end portion of one switch-

spring, when the magnet is energized, and to thereby flex all three springs, but adapted to slip off from such spring just as the armature reaches the limit of its propulsive stroke, and adapted to then be engaged by said intermediate spring for the purpose of opening or separating said switch-springs, the circuit through the magnet being thus held closed until after the armature reaches its position of rest, and the said end portion of the arm being adapted to pass between the said intermediate spring and the end portion of the same switch-spring, when the armature moves back to its normal position, the circuit being thus held open until after the armature reaches its position of rest.

58. The combination of an electromagnet, an energizing-circuit for said electromagnet, and a normally closed switch in said circuit, together with an armature associated with said magnet and connected for operating said switch, the said switch being adapted and timed in its operation to maintain the continuity of the circuit until after the said armature reaches the limit of its movement toward the said magnet, whereby the movement of said armature ceases just prior to the automatic opening of said circuit, and the said electromagnet is adapted to alternately and automatically energize and deenergize itself as long as the said circuit remains closed at all points other than at the said switch.

59. The combination of an electromagnet, an energizing-circuit for said magnet, an armature for said magnet, and a switch controlling said circuit and operated by said armature, said switch being adapted and timed in its operation to maintain the necessary condition of the said circuit until after the said armature reaches the limit of its movement in one direction, whereby the motion of the said armature ceases just prior to the automatic change or reversal of conditions in said circuit, and the said electromagnet is adapted to alternately and automatically energize and deenergize itself as long as the said circuit remains closed at all points other than at the said switch.

60. The combination of an electromagnet, an energizing-circuit for said magnet, an armature for said magnet, and a switch controlling said circuit and operated by said armature, said switch being adapted and timed in its operation to maintain the open condition of said circuit until after the said armature reaches the limit of its stroke or movement away from the magnet, whereby the motion of the armature ceases just prior to the automatic closing of said circuit.

61. The combination of an electromagnet, an energizing-circuit for said magnet, an armature for said magnet, and a switch controlling said circuit and operated by said armature, said switch being adapted and timed

in its operation to maintain the continuity of the said circuit until after the armature reaches the limit of its motion toward the magnet, and to preserve the open condition in said circuit until after the said armature reaches the limit of its movement in the opposite direction.

62. The combination of an electromagnet provided with an armature, an arm rigid with said armature, a couple of normally closed switch-springs, and an intermediate spring, together with an energizing-circuit for said magnet including said switch-springs in series, the end of said arm being adapted to engage one of said switch-springs and hold the same positively together until the armature reaches the limit of its movement toward the magnet, but adapted to then slip off from said switch-spring and be engaged by said intermediate spring, the said intermediate spring being adapted when thus engaged by the arm to hold the other switch-spring out of contact with the switch-spring engaged by the arm, whereby the motion of the armature ceases just prior to the separation of said switch-springs and the consequent opening of the circuit.

63. The combination of an electromagnet provided with an armature, an arm rigid with said armature, a pair of normally closed switch-springs, an intermediate spring, and an energizing-circuit for said magnet including said switch-springs in series, said arm being adapted to engage one of said switch-springs and thereby keep the two switch-springs in engagement with each other until the armature reaches the limit of its movement toward the magnet, but the arm being adapted to then slip off from the said switch-spring and be engaged by the intermediate spring for the purpose of permitting the latter to thereby hold the other switch-spring out of contact with the switch-spring engaged by the arm, and a portion of said arm being adapted when the armature is retracted to pass between the intermediate spring and the said switch-spring which is engaged by the arm, whereby the motion of the armature ceases just prior to the opening of the circuit, and the circuit then remains open until after the armature reaches the limit of its movement away from the magnet.

64. In a telephone system, the combination of trunk-lines, a bank of terminals for said lines, a trunk-selecting switch mechanism cooperating with said terminals, and a source of operating-current therefor, together with an operating-circuit for said trunk-selecting switch mechanism, the said mechanism having an operating-electromagnet included in said circuit and provided with automatic means for intermittently opening and closing the said circuit at one point therein, mechanical devices for con-

verting the intermittent energization of said magnet into a step-by-step search for an idle trunk-line, and automatic means for maintaining the continuity of said circuit at all other points until the idle trunk-line is found.

65. The combination of a plurality of trunk-lines, terminals for said lines, and a trunk-selecting switch mechanism cooperating with said terminals and having an operating-electromagnet provided with automatic means for intermittently interrupting the flow of operating-current therein until an idle trunk-line is found as a result of the automatic step-by-step search produced thereby.

66. In automatic telephone apparatus, a trunk-selecting switch mechanism, and an automatic current-interrupter operated by said switch mechanism, adapted to intermittently interrupt the operating-current for said mechanism to cause the switch to pass busy trunk-lines, and whereby the switch is automatically retained in operation until it finds an idle trunk-line.

67. In automatic telephone switching apparatus, the combination of an electrically-propelled and step-by-step actuated trunk-selecting switch mechanism, and an automatic current-interrupter individual to said switch mechanism and operated thereby, adapted to intermittently interrupt the operating-current for said mechanism to cause the switch to pass busy trunk-lines, substantially as and for the purpose set forth.

68. In automatic telephone apparatus, the combination of a plurality of trunk-lines, an automatic trunk-selecting switch mechanism therefor, and an automatic current-interrupter individual to said selecting mechanism and operated thereby, adapted to intermittently interrupt the operating-current for said mechanism to cause the switch to pass busy trunk-lines, substantially as and for the purpose set forth.

69. The combination of telephone-trunks, means for selecting an idle trunk, an operating-magnet for said means, an energizing-circuit for said magnet, an interrupter for said circuit, operated by said magnet to produce an intermittent current-flow therein, and additional means for opening and closing said circuit, whereby the flow of interrupted current ceases as soon as an idle trunk is found.

70. In a telephone system, the combination of trunk-lines, and a trunk-selecting switch mechanism, said mechanism provided with an electromagnet, means operated by said magnet, adapted to produce a step-by-step search for an idle trunk-line, an energizing-circuit for said magnet, and an interrupter for said circuit, operated by said magnet, adapted to alternately energize and deenergize said magnet to cause the switch to pass busy lines and stop on the first idle line.

71. In a device of the class specified, the combination of trunks or common talking connections, and a subscriber-operated apparatus for automatically making a step-by-step search for an idle trunk or connection, said apparatus having a step-by-step mechanism provided with an operating-magnet for use in making the search for an idle trunk or connection, an energizing-circuit for said magnet, an interrupter for said circuit, individual to said apparatus, operated by said magnet, adapted to alternately open and close said circuit to produce the step-by-step search for an idle trunk or connection, and means for keeping the circuit closed and the interrupter in operation until an idle trunk or connection is selected.

72. The combination of telephone-lines, and electric-current-operated step-by-step means for selecting the first idle line, said means including a current-interrupter individual thereto and adapted for vibrating or pulsating the operating-current thereof until the first idle line is selected.

Signed by me at Chicago, Cook county, Illinois, this 7th day of February, 1905.

ALEXANDER E. KEITH.

Witnesses:

W. LEE CAMPBELL,
R. C. GIFFORD.