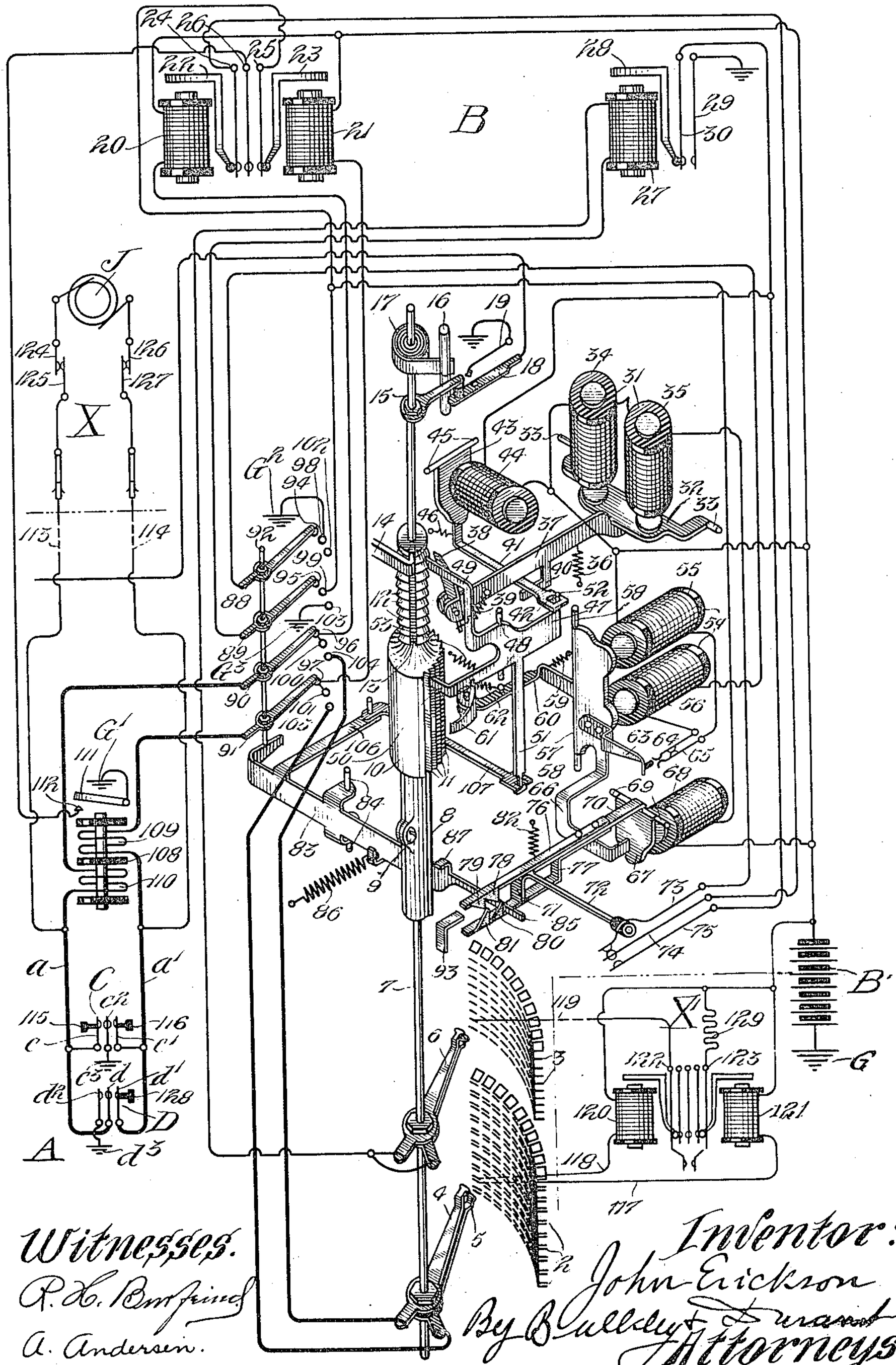
No. 831,846. PATENTED SEPT. 25, 1906.

J. ERICKSON.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED DEC. 30, 1904.



UNITED STATES PATENT OFFICE.

JOHN ERICKSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS.

AUTOMATIC TELEPHONE SYSTEM.

No. 831,846. Specification of Letters Patent. Patented Sept. 25, 1906.

Application filed December 30, 1904. Serial No. 238,904.

To all whom it may concern:

Be it known that I, JOHN ERICKSON, 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 Automatic Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems of that particular character in which the switching apparatus by which the subscribers automatically establish connection between the different lines comprises what are commonly known as "first selector-switches" or other suitable switches which are each individual to a subscriber's line and which are employed by the subscribers for automatically establishing connection between the calling-subscriber's line and a trunk-line, it being understood that in an automatic telephone system of this particular character each subscriber when calling another subscriber first uses the "selector" allotted to the calling-subscriber's line for automatically establishing connection with a trunk-line and then afterward employs one or more switches in completing the connection with the called-subscriber's line.

More especially, my invention relates to an automatic telephone system of the foregoing general character in which each of the said so-called "first selector-switches" or other individual switches is provided with a pair of relays which are normally bridged across the subscriber's line to which the switch is allotted and which are commonly known as the "vertical" line-relay and the "rotary" line-relay.

Generally stated, the object of my invention is to provide an improved construction and arrangement whereby the said bridged relays will not be operated when current is thrown upon the line-circuit for the purpose of ringing the bell at the called-subscriber's station.

A special object is the provision of an improved construction and arrangement whereby the desired feature of thus calling the called subscriber without operating or chattering the said relays may be accomplished or realized without the necessity of either cutting off or opening up the connections by which the said relays are normally bridged across the circuit.

It is also an object to provide certain details and features of improvement tending to increase the general efficiency and serviceability of a "selector-switch" arrangement of this particular character.

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

The single figure of the accompanying drawing is a diagram showing the line and first selector-switch of the called subscriber and showing connection established by the act of the calling subscriber between the ringing-generator and the called-subscriber's line.

As thus illustrated, A indicates any suitable apparatus or equipment at the called-subscriber's station, and B the first selector-switch or other suitable individual switch. It will be understood that the subscriber's apparatus or equipment at station A is suitably connected with the said selector-switch by means of a couple of line-wires a and a'. As shown, the said subscriber's equipment includes a switch C, comprising contacts c and c', connected to opposite sides of the line, and a third spring c^2, connected to ground at c^3. With this arrangement the line conductor a can be grounded by pushing the spring c^2 into contact with the spring c. In a similar manner the line conductor a' can be grounded by pushing the spring c^2 into contact with spring c'. Another switch D is provided for releasing the apparatus after the conversation is completed, it being understood that the switch C is employed for operating the switch B, and thereby establishing connection with some other subscriber's line. The said switch D, as shown, comprises springs d and d', connected to opposite sides of the line, and a third spring d^2, which is grounded at d^3. By pushing all three springs into contact with each other the two sides of the line will be brought together and connected to ground.

At the central station or at any other suitable point the said selector-switch, as illustrated, is represented at B in the drawing. In connection with said first selector are shown the line and private banks 2 and 3, respectively, one above the other. These banks are made up of trunk-line terminals that are supported beneath the switch-frame. The switch may put the line conductors in connection with any one of said line-terminals by means of the contact-making arms 4

and 5 and the private wiper 6 in engagement with any corresponding private-terminal contact. Through the line-banks line-trunking is done and by the private banks privacy of service is maintained and certain vital and well-known restoring operations are accomplished. The usual switch-shaft 7 is vertically disposed on the front of the switch and retained connected therewith by bearings, which are not shown. The shaft may be moved longitudinally in said bearings and then rotated by ratchet-and-pawl electromagnetically-operated mechanism, the vertical or longitudinal movements occurring first.

Among the functions of the shaft an important one is that of holding and operating the line-wipers 4 and 5 and the private wiper 6. The first two comprise a set distinct from the latter; but both sets are located within range of the contacts of their respective banks 2 and 3. Said wipers are not only insulated from the shaft, but from each other as well. Among the details that are associated with the shaft is a cam-piece 8, which is of a split-sleeve design and secured to the shaft by a screw 9. The general shape of said cam in cross-section is that of an oval, with the smaller end thereof on the side farthest away from the said screw. Said cam abuts on a hub 10, which is shrunk to the shaft near the middle of the latter. This hub carries a set of longitudinal ratchet-teeth 11, that serve, as will be disclosed, to enable the forward rotation of the shaft and as a means of locking against backward rotation of same. On the neck portion of said hub there is formed a set of circular ratchet-teeth 12, that serve in turn as a means through which the raising of the shaft is accomplished and for locking it when raised. These circular ratchet-teeth are traversed by a groove 13, into which the end of a so-called "shaft-rest" 14 normally projects; but when the shaft is rotated any one of the said circular teeth which may be at the proper height then slides onto the end of said rest. The end of said rest is of course adapted to fit the circular grooves between said circular teeth. The upper surface of the engaging end of the rest is level; but the under side is chamfered to form a bevel that corresponds to the upper slope of the circular teeth. Above the hub 10 the shaft also carries an arm 15, known as the "normal-post" arm and which while the shaft-rest 14 occupies the slot 13 is retained against the normal post 16 by the coil-spring 17. Said normal-post arm controls a couple of springs 18 and 19, which when the shaft is released are maintained separated; but when the switch is in use they are permitted to engage in contact.

Among the magnets alloted to the first selector some are used as relays and others as operating-magnets. The magnets 20 and 21 are among the former kind and are known, respectively, as the "vertical" and "rotary" line-relays. Said relays by means of their respective armatures 22 and 23 control the springs 24 and 25 with respect to the ground-spring 26. All of said springs are comprised in energizing-circuits of the operating-magnets that raise and rotate the shaft. The magnet 27, with its armature 28 and springs 29 and 30, constitutes the back-release relay and is used for restoring the switch after the latter has seized the trunk-line and when such release is desired.

Of the operating-magnets the magnet 31 is known as the "vertical" magnet and has allotted to it a so-called "vertical" armature 32, supported by pivots 33 beneath said vertical magnet. Whenever the coils 34 and 35 of said magnet become energized, the armature is attracted, and when the magnetism ceases the retracting-spring 36 restores said armature to its normal position. The upward movement of the armature is limited by the pole-pieces of the magnet-coils 34 and 35, and the lower limit is marked by a section of the switch-frame that passes under the arm 37. Said arm is known as the "vertical" arm and extends forward from the vertical armature 32, of which it is a part. The vertical arm carries on its end a so-called "vertical" pawl 38, which when the vertical armature is attracted engages with some one of the circular ratchet-teeth 12 to raise the shaft. Normally the under surface of the upper section of said pawl rests against a piece that is secured to the switch-frame and that retains the pawl away from the circular teeth. When the vertical armature is attracted, as the pawl rises a retracting-spring 39 thrusts the upper side of the pawl forward toward the circular teeth 12. As soon as said pawl clears or disengages its normal rest and by the time that the vertical armature strikes the pole-pieces the vertical pawl strikes with the rear surface of its upper section a bumper-piece which constitutes a part of the switch-frame. Therefore the shaft is prevented from being raised more than one notch at a time by its own momentum. It is clear then that the pawl 38 not only raises the shaft, but that it also acts as a lock at the end of each stroke. The vertical arm has also an L-shaped piece 40 on its under edge that engages a so-called "release-link" 41 of flexible spring material. Said link has an aperture 42 in its front end and is secured to the armature 43 of an operating-magnet 44, known as the "release-magnet." Said armature is suspended from the frame by the supports 45 and is normally retained by the spring 46 away from the pole-piece of the release-magnet. A stop is suitably provided behind said armature to limit its movement when retracted. The first selector is provided with a peculiarly-shaped mechanism

47, known as the "double dog," and which is pivoted so that it may swivel about a vertical axis that passes through the pivots 48. On its front side said double dog divides into two dogs 49 and 50, that are so disposed that the dog 49 may operate in conjunction with the circular teeth 12 while the switch-shaft is raised and in normal rotary position and so that the dog 50 may engage the longitudinal teeth 11 when the shaft is being rotated. To the right of the pivots 48 the body of the double dog extends rearwardly, and projecting down therefrom is an arm 51, that comes into play very prominently during the releasing of the switch. Near the extremity of said body and on the upper side thereof a pin or lug 52 projects upwardly. Said lug is normally caught in the aperture 42 of the release-link 41, and then because of the tension in the spring 46 the dogs 49 and 50 are retained away from the shaft.

The vertical magnet 31 actuates the shaft longitudinally one step at a time by means of the armature 32 each time the said magnet is energized. At the first step of the vertical armature the link 41 is drawn away from the lug 52 by the piece 40, and then the double dog is so moved by the retracting-spring 53 that the dog 49 falls under the first circular tooth in order that when the vertical armature returns to its normal position the said shaft will be retained by said dog in its new position. The release-link 41 while the double dog is free rests with its end upon the lug 52, but out of locking engagement therewith. When the vertical armature is attracted a second time, the shaft is raised a second step, and the dog 49 at the second stroke passes from under the first tooth to a position under the second tooth, holding the shaft again as before.

The release-magnet 44 is composed of two coils, like the vertical magnet 31; but for convenience of illustration only one coil is shown. If while the shaft is raised the release-magnet should be energized, the release-armature 43 is then attracted and the release-link 41 thrust forward to catch the lug 52 in the aperture 42. Upon the deënergization of the release-magnet the retracting-spring 46 then withdraws the dogs 49 and 50 from the shaft, which being deprived of its temporary support falls to normal position by its own weight. After the shaft is once raised it may be rotated by a second operating-magnet 54, known as the "rotary" magnet. Said magnet has two coils 55 and 56 and, unlike the vertical magnet, has its armature 57 pivoted in a vertical plane. Said armature may be moved about a vertical axis that passes through the pivots 58. The limit of the movement of said armature toward the rotary magnet is determined by the rotary magnet itself. The motion of the armature in the opposite direction is produced by the retracting-spring 59 and is limited by a stop-piece (not shown) behind the so-called "rotary" arm 60. This arm, like the so-called "vertical" arm, carries a so-called "rotary" pawl 61. Similarly to the vertical pawl, said rotary pawl rests against a stop that retains it away from the longitudinal teeth, and when the rotary armature is attracted it is drawn into engagement with the longitudinal teeth by a spring 62, that is attached to the rotary arm by one end and to the rear of said pawl by the other. By the time that the rotary armature strikes the pole-pieces of the rotary magnet the rotary pawl also strikes a bumping-post, as does the vertical pawl, and locks the shaft against further movement by the force of its own momentum. At the end of the first rotary step the dog 50 falls behind the first longitudinal tooth, so that when the rotary pawl falls back the shaft is held. It should be evident that as the shaft is rotated the vertical dog 49 is extricated from the groove of the circular tooth below which it has been resting by the passage of the rotary dog 50 across the longitudinal tooth over which it has to slide at the time; but at the beginning of the rotation the tooth which has been caught by the vertical dog slides onto the shaft-rest 14, and the shaft is thus provided with a new support in lieu of the vertical dog 49 and is still held raised after the rotation begins.

The rotary armature is provided with a so-called "interrupter-finger" 63, that separates the interrupter-springs 64 and 65 whenever the rotary armature is attracted, and also with a rotary armature-finger 66, that exercises certain controlling influences over the armature 67 of one of the operating-magnets—namely, the private magnet 68. The said private armature 67 works in a vibratory manner about a horizontal axis that passes through the supporting-points 69. This armature is formed with a forwardly-projecting arm 70, having two flat surfaces in an approximately horizontal plane. Furthermore, the end 71 of the arm 70 is bent downwardly at a right angle, and said arm carries certain mechanical details—namely, a lateral arm 72, which is designed to control circuits comprising the private springs 73, 74, and 75, and a tooth-escapement which includes two flexible springs 76 and 77, each of which is riveted by one end to the arm 70, one on the upper side and the other on the lower. The upper spring is straight and has formed on its end two tooth projections 78 and 79, which extend downwardly, while the lower one is bent down and at a right angle again to the front. This double angle on the lower spring is so designed that the latter may clear the bent portion 71 of the private arm, against which the said spring rests with a requisite degree of tension and so that space

is afforded in front of said bent portion to receive two other tooth-shaped upwardly-projecting pieces 80 and 81, that are formed on the forward end of the escapement-spring 77 and sustained in juxtaposition to the upper tooth, but slightly to the rear thereof. A retracting-spring 82, suitably located, holds said armature normally away from the private-magnet pole-piece A well-known auxiliary switching mechanism common to such switches is the so-called "side" switch. It is shown in connection with the first selector and comprises an arm 83, which is secured to the switch-frame in such manner that it may be made to swing in a vertical plane about the pivots 84. The right extremity of said arm is drawn into a finger 85, that works in conjunction with the escapement-teeth previously described. Said teeth, in a manner to be explained, convert the outward movement of the side switch into a step-by-step motion, which is produced by a retracting-spring 86.

At the base of the finger 85 a lug 87 is bent to the front and adapted to strike the cam 8 at a suitable time. Near its left extremity the arm 83 carries a number of wipers 88, 89, 90, and 91, suitably mounted upon a pin 92 and insulated therefrom and from each other. Said wipers are known as the "side-switch" wipers and adapted to be operated by the private magnet and escapement device previously described. If the private magnet is energized once, the private armature 67 is then drawn down once and then restored to its normal position. The escapement-finger 85 then passes from behind the tooth 80 onto the rear of the tooth 78 upon the downward stroke of the private armature and from behind the latter tooth upon the return stroke. As soon as the escapement-finger clears or disengages the latter tooth the retracting-spring 86 then draws the side switch to the second position, where it is stopped by the lug 87 when it strikes the cam 8. Immediately then, as will be shown, the rotary magnet becomes energized, the shaft is rotated, and the cam passes out of reach of the lug 87, and then the finger 85 of necessity falls against the tooth 81 because of the tension in the spring 86. The rotation of the shaft results when the rotary armature 57 is attracted by the rotary magnet; but at the same time the rotary-armature finger 66 depresses the private armature 67 and causes the finger 85 to disengage from the tooth 81 and to advance against the tooth 79, and then as the rotary armature returns to normal position when the rotary magnet deënergizes the private armature upon following the finger 66 permits the escapement-finger 85 to escape from the last tooth 79, at which instant the side switch then passes to the third position, with the said finger 85 resting against the side-switch stop 93. In their normal positions the side-switch wipers 88, 89, 90, and 91 engage, respectively, with the contact-points 94, 95, 96, and 97. This position is known as the "first" position of the side switch, at which time it will be clear the finger 85 is held behind the escapement-tooth 80. In the second position while the said finger is between the teeth 81 and 80 the said side-switch wipers engage instead with the contact-points 98, 99, 100, and 101, respectively, and when the said finger 85 falls against the stop 93 the wipers change their positions into contact with the contact-points 102, 103, 104, and 105, respectively.

Between the pivots 84 and the wiper-supporting pin 92 a rearwardly-extending arm 106 on the side-switch arm 83 supports on its end pivotally one end of a link 107, the other end of which being bifurcated engages with the lower end of the double-dog arm 51, the end of which latter is shaped like an inverted T. Should the release-magnet be energized while the shaft is rotated, the release-link 41, being attached to the release-armature 43, is thrust forward when the release-armature is attracted and catches the lug 52 in the aperture 42. Then when said release-armature is restored the spring 46, as before described, withdraws the dog 50 from the longitudinal teeth 11. At the same time the arm 51 drives back the link 107, which latter then rotates the side-switch arm 83 about the pivots 84 against the tension of the side-switch-retracting spring 86, and thus drives the finger 85 between the springs 76 and 77 to a position behind the tooth 80, locking the side switch in the first or normal position. The switch-shaft being unlocked by the removal of the dog 50 and being thus left free is then rotated by the coil-spring 17 until the end of the shaft-rest enters the slot 13, at which time the shaft drops to its normal position. Therefore after the switch has been operated the energization and deënergization of the release-magnet is sufficient to restore the entire switch to its normal position. It will be noticed that the vertical magnet 31 is connected normally between the line-relay spring 24 and the battery B′ and that the private magnet 68 is connected between the line-relay spring 25 and the battery B′. In this way the vertical line-relay 20 controls the local circuit of the vertical magnet 31 and the rotary line-relay 21 controls the local circuit of the private magnet 68. Whenever said relays are energized, the switch-shaft 7, as has been described, is operated by means of the vertical and private magnets, and since said magnets are controlled by the line-relays 20 and 21, that are normally bridged across the line conductors a and a', it will be easy to understand how the operation of the first selector-switch shaft may be brought about by the subscriber at the substation A by grounding the line conductors a

and a' in a suitable manner, considering that the said line-relays are connected with the non-grounded pole of the battery at a point between them. In other words, the subscriber at substation A can manipulate the calling device in such a manner as to raise the switch-shaft 7 to a proper level, causing it to then rotate automatically until the desired trunk-line is selected that leads to some connector-switch of suitable character and which may be operated in turn in any suitable manner to connect the calling-line with the desired line.

Ordinarily the line-relay ground-spring 26 is connected directly to ground to provide the vertical and private magnets 31 and 68 with normally open and grounded local circuits adapted to be opened or closed or controlled at will through the medium of the two line-relays by the calling subscriber. Therefore the two line-relays are normally bridged across the subscriber's line to always be in readiness to be operated by the calling subscriber from his station. Consequently and unless some provision is made to the contrary these two relays 20 and 21 will remain bridged across the subscriber's line when another subscriber calls the subscriber at substation A. This is true, it will be seen, for the reason that when substation A is called the first selector B remains idle, as it is not affected by the operation of establishing connection with the line conductors a and a'. Obviously, therefore, when any subscriber, through the medium of any suitable or well-known apparatus, connects the means for throwing ringing-current onto the line leading to the substation A the relays 20 and 21 are then liable to be operated. Unless some provision is made to the contrary and if these relays are operated by the subscriber calling the subscriber at substation A the first selector B is liable to be disturbed to such an extent that it will not act properly at some later time when the subscriber at the substation A proceeds to make a call—that is, if the ringing-current succeeds in energizing the line-relays 20 and 21, so as to cause the switch-shaft 7 to be operated, the subscriber at substation A will not find the wipers 4 and 5 at their normal or staring points, and the result will be that connection will be established with a wrong line. It is for this reason therefore that the first selector is provided with a special relay 108, having two windings 109 and 110, included one on each side of the metallic line leading to the substation A. This relay is provided with an armature 111, that is connected to ground G′ and which when attracted by the relay 108 engages with the contact-point 112, the latter being directly connected with the line-relay ground-spring 26. With this arrangement neither the vertical nor the private magnets can be operated until the relay 108 is energized and the connection thereby closed from the spring 26 to the ground G′. This of course will take place whenever the subscriber at substation A grounds either or both of the line conductors leading from said station, as a flow of current through these two windings when in multiple or through one winding only will magnetize the core of said magnet 108. In this way the subscriber at substation A can operate the vertical and rotary line-relays 20 and 21 of the selector-switch allotted to his line in the usual and well-known manner; but when the substation A is called by any subscriber and the ringer-generator J is connected across the line conductors a and a' through the normal conductors 113 and 114 in a manner well known the vertical and private magnets 31 and 68 cannot be energized, for the reason that when the calling subscriber by means of the so-called "connector-switch" or any other suitable means at the central station establishes connection between the generator J and the line leading to the substation A current from said generator will pass through the relays 20 and 21 and possibly cause these relays to establish connection between the line-relay springs 24 and 25 and the ground-spring 26. This, however, can do no harm, inasmuch as the magnets 31 and 68 cannot be energized until the relay 108 is magnetized and the ground-spring connected with ground G′. The current from the ringing-generator in passing through the relays 20 and 21 first passes through the windings 109 and 110 of the relay 108 in such a manner as to make the said windings differentially effective—that is, the two windings of the relay 108 are at such times connected in series, and the effect of one is counteracted or neutralized by the flow of current through the other. Consequently the relay 108 is not energized and the vertical and private magnets 31 and 68 are not operated.

With the arrangement shown it will be understood that the generator J, which is located at the exchange or central station and which is employed by the calling subscriber for supplying ringing-current to the called line, is normally disconnected therefrom. For example, when the substation A is called, as described, a connection between the generator J and the called subscriber's line is obtained through the medium of the so-called "connector-switch", the same being merely indicated at X. It will be understood that the construction of each selector-switch is preferably such that the relays 20 and 21 are disconnected from the line-circuit when the selector-switch is employed by the subscriber to whom it is alloted for calling other subscribers. If the subscriber at station A wishes to call some number under the control of the connector-switches that are connected to the second bank-levels of his selec-

tor-switch, he presses his vertical button 115 twice and grounds the vertical line conductor *a* twice. Both the differential relay 108 and the vertical line-relay 20 are energized at each grounding simultaneously by a flow of current from ground c^3 through the springs c^2 and *c*, conductor *a*, winding 110 of the differential coil 108, side-switch wiper 90, vertical line-relay 20, to the non-grounded terminal of battery B′ and to ground G. Therefore the vertical magnet 31 is magnetized each time that the springs 24 and 26 are brought into contact by a flow of current from the grounded terminal G′ through the differential relay-armature 111, contact-point 112, line-relay springs 26 and 24, private-magnet springs 74 and 73, vertical magnet 31 to the non-grounded terminal of battery B′ and to ground G. The vertical magnet then raises the shaft 7 two steps, having disengaged the release-link 41 from the double dog 47 at the first step of the vertical armature 32 in order that the vertical dog 49 may hold the shaft when raised. So much being accomplished, the subscriber then grounds the rotary line conductor *a′* by pressing the rotary button 116 once, energizing the differential and rotary line-relays 108 and 21 together. As a result when the rotary line-relay presses the springs 25 and 26 together the private magnet 68 is operated once and the side switch passes to second position; and then as the side-switch wiper 88 engages the contact-point 98 the rotary magnet 54 is energized by the closing of a circuit that extends from ground G^2 through the side-switch wiper 88 to the rotary magnet 54 and to the non-grounded terminal of battery B′ and to ground G. The shaft is then rotated and the line-wipers 4 and 5, together with the private wiper 6, are brought onto the first set of contacts of the second level of the banks 2 and 3, respectively, from which three conductors 117, 118, and 119 lead to a conductor X′, (indicated by the vertical and rotary line-relays 120 and 121,) and the trunk-release springs 122 and 123. The vertical and rotary wipers 4 and 5 are connected, therefore, with the trunk-line conductors 118 and 117, respectively, and the private wiper 6 with the release-trunk conductor 119, all of which are well known. If the first trunk of the second level of the private banks is busy, the first private-bank contact is charged with a guarding-potential from the grounded terminal of the battery B′ in a well-known manner, so that the private magnet 68 is again magnetized at the instant that the private wiper engages the said ground-contact and before the rotary armature-finger 66 has permitted the side switch to pass to third position. The energizing-current in this case flows from the grounded terminal of battery B′ through the switch that is occupying said trunk and through the bank-multiplying conductors to the private-contact point, with which the private wiper 6 engages, through the back release-relay 27, side-switch wiper 89, private magnet 68 to the non-grounded terminal of battery B′. Of course since the resistance of the private magnet 68 is very high when compared with the resistance of the back release-relay 27 said relay 27 is so adjusted by means of the spring 30 that the armature 28 may not be operated by the small amount of current that passes through the coil.

As a result of retaining the side switch in second position the rotary magnet is operated again and the wipers are carried on one step at a time each time that the private wiper 6 strikes a grounded private-bank contact. The first trunk-line being idle, however, the wipers are retained on the first set of contacts, and as the relay-armature returns to normal position after the first attractive stroke the rotary armature-finger 66 permits the escapement-finger 85 to clear or disengage the last tooth 79, and the side switch passes to third position, causing the subscriber's line conductors to be placed in connection with the line-wipers 4 and 5 through the side-switch wipers 90 and 91, respectively, when the latter engage with corresponding contact-points 104 and 105, thus placing a guarding potential at the private wiper 6 and therefore at the contact with which it is engaged at the instant that the side-switch wiper 89 strikes the grounded contact-point 103. The subscriber's line having been connected through to a connector the calling subscriber may then operate said connector a number of times, so that the extended subscriber's line conductors 118 and 117 are, through the well-known connector-line wipers, put in connection with the desired line. Connection having been established, the calling subscriber may, by grounding the vertical line conductor *a*, by pressing the vertical button 115 against the grounded spring c^2, or by operating any other suitable apparatus with which he may be provided, then energize the connector-ringer relay that controls ringer-relay springs, similar to the springs 124, 125, 126, and 127, shown in connection with connector X, so as to cause the ringing-generator J to be thrown across the called line for a moment. When it is desired to destroy the established circuit, the subscriber at substation A presses a release-button 128, which is used in connection with the release-springs *d*, *d′*, and d^2 at D, thereby grounding both sides of the line simultaneously. As a result the connector vertical and rotary line-relays 120 and 121, respectively, are energized at the same time. Through the former of said coils the current passes from ground d^3 through the winding 110 of the differential coil 108, side-switch

wiper 90, vertical line-wiper 4, connector vertical line-relay 120 to the non-grounded terminal of battery B′ to ground G. Through the second relay the current passes from ground d^3 through the winding 109 of the coil 108, side-switch wiper 91, rotary line-wiper 5, connector rotary line-relay 121 to the non-grounded terminal of battery B′, and to ground G. Said relays being magnetized at the same time the trunk-release springs 122 and 123 are brought into contact, thereby establishing an energizing-circuit through the back release-relay 27 of the first selector B and the release-magnet 129 of the connector X′. The current in this case flows from ground G^3 to the side-switch wiper 89 and through the back release relay 27 to the private wiper 6, thence over the release-trunk 119 through the connector trunk-release springs 122 and 123, connector release-magnet 129 to the non-grounded terminal of battery B′, and to ground G. As a result the back release-relay 27 becomes energized and attracts its armature 28, which forces the back release-relay springs 29 and 30 together, thus energizing the release-magnet 44 of the first selector. The connector switch-shaft of course is restored as soon as the connector release-magnet 129 is energized; but the line-relays 120 and 121 and the release-magnet 129 are not restored until after the subscriber releases the release-button 128, at which time the connector line-relays 120 and 121 become deënergized, and the circuit through the back release-relay 27 and the connector release-magnet 129 is destroyed. At that instant the first selector release-magnet 44 also becomes deënergized, and the release-link 41 produces, by the attractive power of the release retracting-spring 46, a full restoration of the first selector. It will be evident of course that the differential relay 108 becomes energized during the release, as well as during the operation of grounding each side of the line and that this energization is essential in case the subscriber should attempt to make a release before the first selector has seized a trunk-line leading to a connector. At such a time the line-relays 20 and 21 become energized simultaneously instead of the connector line-relays 120 and 121, and then the release-magnet 44 gets its connection to ground at the ground-terminal G′ through the armature 111 and contact-point 112 of the differential relay 108. The energizing-circuit through the release-magnet in this case is, since the private magnet 68 at such a time is magnetized, because of the energized condition of the rotary line-relay 21, as follows: from ground G′ through the differential relay-armature 111, contact-point 112, line-relay springs 26 and 24, private-magnet springs 74 and 75, release-magnet 44 to the non-grounded terminal of battery B′, and to ground G. My improved first selector is therefore, as stated before and described, provided with a differential relay that is energized each time that the calling subscriber grounds either or both of his line conductors, but which remains inactive whenever a calling subscriber sends ringing-current over the called line.

What I claim as my invention is—

1. An automatic telephone system comprising subscribers' lines, a "selector-switch" allotted to each line, and means at the subscribers' stations for controlling the operation of said "selector-switches;" said "selector-switch" comprising electromagnetically-operated step-by-step mechanism, and including also a pair of line-relays for controlling said step-by-step mechanism, together with a third line-relay adapted also to control the operation of said step-by-step mechanism, said first-mentioned line-relays being normally bridged across the subscriber's line-circuit, and all of said relays being responsive to the different currents employed by the subscriber for operating the said step-by-step mechanism, but the said third line-relay being unresponsive to the currents employed for signaling the said subscriber; together with means for supplying the currents necessary for operating said "selector-switch" when the said subscriber desires to call another subscriber, and means for supplying the currents necessary for signaling the said subscriber.

2. In an automatic telephone system, the combination of an electromagnet having a local energizing-circuit provided with a plurality of normally open switch-points, a subscriber's line, a line-relay having a normally open line-circuit, and an additional line-relay also having a normally open line-circuit, said first-mentioned line-relay being arranged to control one of said normally open switch-points, said additional relay being arranged to control another of said normally open switch-points, and the last-mentioned relay being responsive to those currents employed and intended for energizing the first-mentioned relay.

3. In an automatic telephone system, the combination of a subscriber's line, an electromagnet provided with a local circuit having a plurality of normally open switch-points, a line-relay controlling one of said switch-points, a suitably-operated additional relay for controlling another of said switch-points, together with means for supplying all necessary currents, said first-mentioned relay being responsive to currents employed and intended for effecting the operation of said last-mentioned relay.

4. In an automatic telephone system, the combination of an electromagnet having a local energizing-circuit provided with a plurality of normally open switch-points, a subscriber's line, a line-relay having a normally

open line-circuit, and an additional line-relay also having a normally open line-circuit, said first-mentioned line-relay being arranged to control one of said normally open switch-points, said additional relay being arranged to control another of said normally open switch-points, and the last-mentioned relay being responsive to those currents employed and intended for energizing the first-mentioned relay, together with means at the subscriber's station for effecting the operation of said line-relays by grounding either or both sides of the said line.

5. In an automatic telephone system, the combination of a subscriber's line, an electromagnet provided with a local circuit having a plurality of normally open switch-points, a line-relay controlling one of said switch-points, a suitably-operated additional relay for controlling another of said switch-points, together with means for supplying all necessary currents, said first-mentioned relay being responsive to currents employed and intended for effecting the operation of said last-mentioned relay, together with means at the subscriber's station for effecting the operation of said line-relay by grounding either or both sides of the said line.

6. A telephone system comprising a switch, a switch-actuating electromagnet, and subscriber-controlled differential and line relays conjointly controlling the energizing of said electromagnet.

7. A telephone system comprising a switch, a switch-operating electromagnet, lines leading from said switch, an energizing-circuit for said magnet, said circuit having two switch-points, a differential relay controlling one switch-point, and a relay controlling the other switch-point.

8. A telephone system comprising a trunk-selecting switch mechanism, a local operating-circuit for said mechanism, a differential relay, and subscriber-controlled means contingent on the energization of said relay for closing said circuit.

9. A telephone system comprising an automatic subscriber-controlled switch mechanism, a plurality of lines leading from said mechanism, a local operating-circuit for said mechanism, and subscriber-controlled means including a differential relay for closing said circuit.

Signed by me at Chicago, Cook county, Illinois, this 30th day of November, 1904.

JOHN ERICKSON.

Witnesses:
W. LEE CAMPBELL,
JENNIE NORBY.