

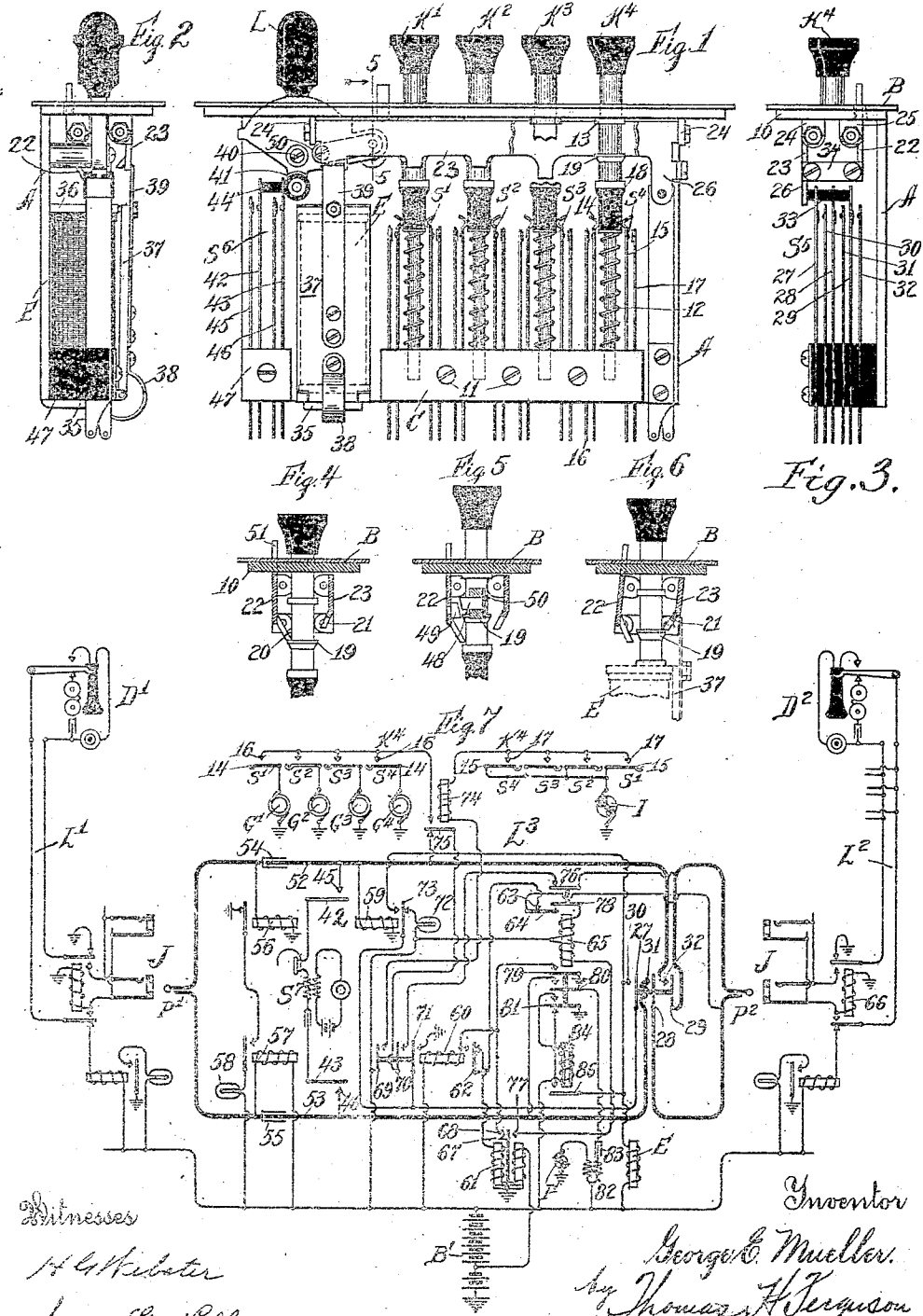
G. E. MUELLER,
TELEPHONE KEY.

APPLICATION FILED MAR. 1, 1907.

1,134,282.

Patented Apr. 6, 1915.

2 SHEETS-SHEET 1.



Witnesses

H. G. Kibitzer

James F. Kellogg

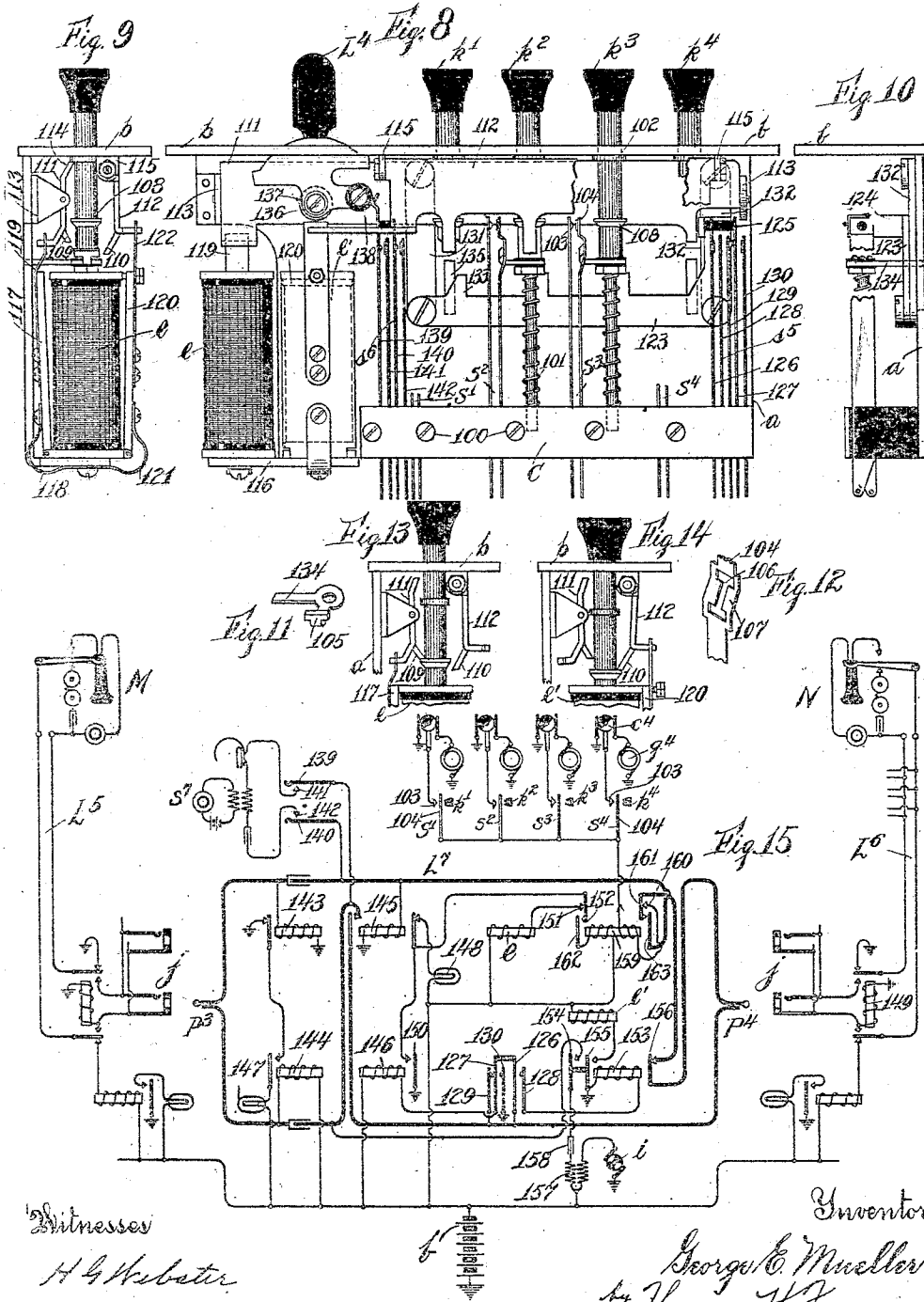
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UNITED STATES PATENT OFFICE.

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TELEPHONE-KEY.

1,134,282.

Specification of Letters Patent.

Patented Apr. 6, 1915.

Application filed March 1, 1907. Serial No. 360,116.

To all whom it may concern:

Be it known that I, GEORGE E. MUELLER, a citizen of the United States, residing at Aurora, in the county of Kane and State of Illinois, have invented new and useful Improvements in Telephone-Keys, of which the following is a specification.

The present invention relates to telephone keys such as are commonly used by operators in the manipulation of their link-circuit connecting apparatus and has to do more particularly with that type which is used in connecting the operator's telephone set in circuit and applying ringing current to the line for signaling substations and especially for signaling one of a number of substations on the line.

The principal object of the present invention is to provide a key of the character indicated having certain features of construction including novel catch mechanism for maintaining the various actuating members in their different operating positions, together with a novel arrangement of parts which enable the key to be economically manufactured, while leaving it compact and simple in construction and efficient in operation.

In the present application, the invention is illustrated in two forms. In each of these a plurality of ringing-keys of the plunger type is shown in association with a listening-key of the lever type, all mounted compactly upon an elongated frame. In each of these forms, each longitudinally movable key has three operating positions, a normal, a fully depressed, and an intermediate position. In one form, the fully depressed position is a ringing position and the intermediate position is an indicating position. In the other form, the fully depressed position is a "busy" position and the intermediate position is a ringing position. In both of these, the catch mechanism, which cooperates with these keys in holding them in their different operating positions, includes two pivotally mounted catch-bars which extend lengthwise of the frame along opposite sides of the row of keys and are provided with catches which engage corresponding catch projections on the said keys. Electromagnets having armature mechanism cooperating with said catch-bars are provided for operating the catch-bars in accordance with predetermined circuit conditions brought

about by specific acts performed while establishing a conversational circuit between two subscribers.

The invention also includes other features and details which, together with the above, will be more fully understood upon reference to the following detailed description taken in connection with the accompanying drawing, and the scope of the invention will be particularly pointed out in the appended claims.

Referring to said drawings, Figures 1 to 7 inclusive illustrate a combined ringing and listening key constituting one form of the invention, while Figs. 8 to 15 inclusive illustrate a similar combined ringing and listening key constituting a second form. Fig. 1 is a side elevation of the key constituting the first form; Fig. 2 is an elevation of the same, viewed from the left; Fig. 3 is a similar elevation viewed from the right; Figs. 4, 5 and 6 are sectional views indicating different operating positions of a ringing key, Fig. 5 being taken on a plane indicated by the line 5-5 of Fig. 1; and Fig. 7 is a diagram of circuits illustrating one use for the key. Figs. 8, 9 and 10 are views, similar to Figs. 1, 2 and 3, of the key constituting the second form of the invention; Figs. 11 and 12 are details of certain cooperating parts of this key; Figs. 13 and 14 are sectional views illustrating different positions of a ringing key; and Fig. 15 is a diagram of circuits illustrating one application of said key.

Throughout these views, like characters refer to like parts.

Referring first to the key illustrated by Figs. 1 to 7 inclusive, A designates the main supporting frame which consists of a plate having a short horizontal flange 10 upon which a face-plate B is mounted. The face-plate and flange are provided with suitable openings through which the listening-key lever L and each of a plurality of ringing-keys K¹-K²-K³-K⁴ extend. The keys K¹-K²-K³-K⁴ extend downwardly into a position to engage the upwardly extending sets of contact springs S¹-S²-S³-S⁴ respectively. These springs are secured at their lower ends by a suitable insulating member C preferably secured to the frame-plate A by screws 11 and arranged so as to properly space the springs of each set of contacts in the manner illustrated. The member C is provided with suitable guid-

ing openings through which the lower ends of the keys $K^1-K^2-K^3-K^4$ are adapted to pass. The guiding ends of these keys are reduced in diameter and each is provided with a coiled returning spring 12 lying in close proximity to it and bearing at its opposite ends against the member C and a shoulder on the corresponding key. Each of the keys $K^1-K^2-K^3-K^4$ is adapted to occupy three operating positions referred to as normal, indicating, and ringing positions. In the normal position, a collar 13 on the shank of each key rests against the under face of the flange 10 of the plate A; and the tips of the spring-contacts 14-15, which cooperate with the adjacent spring-contacts 16-17, rest against the insulating portion 18 of the key and out of engagement with each other. As the key is moved downward, the spring-contacts 14 and 15 are moved into engagement with the associated spring-contacts 16 and 17 respectively, by the wedging action of the upper part of the insulating portion 18. Each key is also provided with a collar 19 forming a catch-engaging-projection which cooperates with the catches 20 and 21 on the catch-bars 22 and 23 respectively. These bars are pivoted at their opposite ends adjacent to the under side of the flange 10, the bar 22 being pivoted to the posts 25, and the bar 23 to similar posts 24. The bar 23 is provided at one end with a downward projection 26 which acts upon a set of springs S^5 mounted upon, and insulated from, the frame plate A at a point adjacent to the end of the insulating member C. This set includes the movable contact-springs 27-28-29, which cooperate respectively with the springs 30-31-32, the springs 27, 28 and 29 being united at their upper ends by the insulating piece 33. These springs, in acting upon the projection 26, tend to maintain the bars 22 and 23 in the position illustrated in Fig. 4—that is, with the catch 20 in engaging position and the catch 21 out of engaging position. The movement of the bar 22 is communicated to the bar 23 through a connecting link 34 extending between the bars adjacent to the set of contact-springs S^5 . Normally, when a key is depressed, the inclined portion of its collar 19 presses against the cooperating catch 20 and rocks the bars 22 and 23 about their pivots, thereby moving all catches 20 out of engaging position and releasing any previously engaged key. As the collar 19 on the depressed key passes the catch 20, the latter springs into engaging position and the key is held thereby in its ringing position. It is intended that the key be released from this position upon the energization of an electromagnet E, which is secured to the frame-plate A between a projecting flange 35 and a pole-piece 36. This electromagnet is arranged in line with the sets of spring

contacts $S^1-S^2-S^3-S^4$ and in compact relation with the other parts of the key structure. The electromagnet actuates armature 37 which is pivoted at the lower end of the magnet and is yieldingly held retracted by a spring 38. The armature, through the agency of an upward extension 39 engaging the lower edge of the catch-bar 23, operates, when actuated, to rock the bars 22 and 23 about their pivots to the position illustrated in Fig. 6. As soon as this position is reached, any fully depressed key will at once return under the influence of its spring 12 until its collar 19 engages the adjacent contact 21. This occurs when the key has reached its intermediate or indicating position. As long as the armature 37 remains attracted, the key thus engaged is held in this position. Upon the retraction of the armature, however, the key is restored by its spring to its normal position.

As previously indicated, the key structure includes the listening-key lever L which is pivoted at the point 40 to the frame-plate A and is provided with a projection having an insulated covering 41 which cooperates with a set of listening-key contacts S^6 . In the present instance, the spring contacts 42-43 are bound together at their upper ends by an insulating piece 44 and are moved against their spring tension into engagement with the cooperating spring-contacts 45-46 respectively. The spring-contacts 42-43-45-46 are secured at their lower ends to the lower edge of the frame-plate A by means of a suitable insulating member 47 arranged in line with the bar C and at the opposite end of the frame from the set of spring contacts S^5 . The listening-key lever L is adapted to be retained in its actuated position by the engagement of a yielding catch 48, carried by the lever, with a catch 49 carried by the catch-bar 22. As the lever L is thrown to the right in Fig. 1, the catch 48, shown clearly in Fig. 5, is carried downward and its inclined face engages that of the catch 49 and the catch 48 is moved against the tension of its supporting spring 50 until it has passed by the catch 49. The upper face of the catch 48 then engages the lower face of the catch 49; and the listening-key lever is retained in its actuated position until such time as the catch-bar 22 is rocked. As previously indicated, this will occur upon the attraction of the armature 37 of electromagnet E, or upon the depression of a ringing key K^1 , K^2 , K^3 or K^4 . For the purpose of manually rocking the catch-bars 22 and 23, the catch-bar 22 is provided with an upward extension 51 extending through a suitable opening in the flange 10 and the face-plate B into a position to be readily actuated by the thumb or finger at the will of the operator.

In the diagram of Fig. 7, I have illus-

trated a cord-circuit in which the combined ringing and listening-key above described may be employed. This diagram illustrates two telephone lines L^1 — L^2 extending from substations D' — D^2 to the central office where they are provided with suitable jacks J which are adapted to be connected by a link-circuit L^3 , including the talking strands 52—53 uniting the tip and sleeve contacts of the plugs P^1 and P^2 and divided into sections by interposed condensers 54—55. The answering end of the link-circuit L^3 is provided with a tip supervisory relay 56 and a sleeve supervisory relay 57 which control the supervisory lamp 58. The calling end of the link-circuit is provided likewise with a tip supervisory relay 59 and a sleeve supervisory relay 60 which cooperate with other relays and apparatus which will best be understood by outlining the operation of the system. Assuming that a party at substation D' has been answered by the operator, and the operator has learned that connection is desired with the line L^2 . The previous insertion of the answering plug P^1 into the jack J of the called line will have connected the line limbs to the strands 52—53 of the link-circuit and, by energizing both supervisory relays 56 and 57, will have prevented the display of the supervisory lamp 58. As soon as the operator threw over her listening-key lever L to place her telephone set S^1 in circuit with the calling party, she closed contacts 42—45 and 43—46 and, by reason of the catches 48—49, these contacts are held closed as long as the catch-bar 22 remains in its normal position. After learning the number of the called-for party, the operator will insert the plug P^2 into the jack of the line L^2 and depress the appropriate ringing-key K^1 , K^2 , K^3 or K^4 . In the diagram, the contacts of each of the sets S^1 — S^2 — S^3 — S^4 , controlled by these keys, are shown separated.

Assuming that the line L^2 is idle at the time the plug P^2 is inserted into the jack of said line, then current will flow from the intermediate tap of the battery B' which may, for example, supply current at a pressure of eight volts, through the polarized relay 61, normal contact 62 of sleeve supervisory relay 60, contact 63—64 of the relay 65, plug and jack sleeve contacts and the winding of cut-off relay 66 to ground. The direction of this current flow is such as to move the armature 67 of the polarized relay 61 to the left into engagement with contact 68, thereby completing a circuit for the sleeve supervisory relay from the live pole of the battery B' , which may supply current at a pressure of, say, twenty-four volts, through the winding of the relay 60 and contact 68—67 to ground, thus energizing said relay to move its contact 62 to its alternate position and thereby interrupt the energizing circuit for the polarized relay 61 and complete a new path for current through the winding of supervisory relay 60 which may be traced from said winding, through alternate contact 62, closed contact 63—64, 70 plug and jack sleeve contacts and cut-off relay 66 to ground. The energization of relay 60 also closed its contacts 69, 70 and 71. By the closing of contact 71, a path is completed through supervisory lamp 72 which extends from the live pole of the battery B' through said lamp, the normal contact 73 of tip supervisory relay 59 and closed contact 71 to ground, thereby causing the illumination of said lamp. The closing of contact 69 completes a path for current from the live pole of the battery through said closed contact and through the winding of the so-called "flip-flop" relay 74 to the contacts 17 of the ringing-keys. The closing of contact 70 likewise completes a path from contact 75 of the "flip-flop" relay 74 through closed contact 70, closed contact 76 of relay 65 to the tip of the calling plug P^2 . With the parts in this condition, the operator will then depress the proper ringing key to actuate the call signal at substation D^2 . Preferably, selective signaling is employed and preferably in the manner illustrated in United States Patent No. 779,533, issued January 10, 1905. According to this, the call signals at the stations on the line are tuned to severally respond to the application of ringing current to the line from generators G^1 , G^2 , G^3 and G^4 , in the present instance shown connected between ground and the contacts 14 of each of the sets of spring contacts S^1 , S^2 , S^3 and S^4 . Assuming that the key K^4 is depressed for the purpose of supplying ringing current to actuate the call signal at substation D^2 , then upon the full depression of the key the contacts 14—16 and 15—17 of the set S^4 will be engaged respectively, and the key will be held in this position by the engagement of the catch 20 with the collar 19 in the manner illustrated in Fig. 4. This depression of the key K^4 will rock the catch-bars sufficiently to disengage catches 48—49 and thereby free listening lever L to allow it to return to normal. The contacts 15 are connected to ground through an interrupter I so that, as soon as contacts 15—17 of key K^4 are moved into engagement, a circuit is completed through the "flip-flop" relay 74 and the interrupter I to ground. As the interrupter rotates, the relay 74 will be successively energized and deenergized to move its contact 75. When this contact is in its alternate position, current will be supplied from the generator G^4 through the contacts 14—16 of key K^4 , alternate contact 75, closed contact 70, closed contact 76, plug and jack tip contacts, thence to the tip limb of the line (the cut-off relay 66 having been energized to

interrupt the normal line connections and to connect the line limbs with the contacts of the jack J) through the substation, back over the sleeve limb and through the winding of the cut-off relay to ground. By reason of the action of the relay 74, this ringing current is intermittently applied and this intermittent application is continued until the called-for party responds. As soon as he does this by removing his receiver from its hook, a path for battery current is completed through the sleeve supervisory relay 60 to the winding of the cut-off relay 66 as before, thence by one path through said winding to ground, and by another over the sleeve limb of the line, through the substation, back over the tip limb of the line, through the plug and jack tip contacts, closed contacts 76, closed contact 70 and normal contact 75, as soon as it assumes this position in its to-and-fro movements, and the winding of tip supervisory relay 59 to ground. The closing of this circuit will energize supervisory relay 59 and, by moving its contact 73 to its alternate position, interrupt the circuit through the supervisory lamp 72 to cause its extinguishment and close a circuit through electromagnet E which controls the movement of the catch-bars 22—23 of the ringing and listening key. This circuit is completed from the live pole of the battery B' through the winding of said electromagnet, alternate contact 73 of tip supervisory relay 59, and closed contact 71 of sleeve supervisory relay 60 to ground.

As soon as electromagnet E is energized, its armature 37 is attracted and the catch-bars 22—23 are rocked to the position illustrated in Fig. 6, whereupon the actuated key K⁴ is free to return, under the force of its spring 12, to its indicating position. As illustrated in said figure, when in this position, the catch 21 engages the collar 19; and if at any time it becomes necessary to again signal the party at substation D², the operator can readily see that key K⁴ was last depressed, since no other keys will occupy this intermediate position at this time. The movement of the catch-bar 22, as a result of the energization of electromagnet E, will, as previously indicated, operate the set of spring contacts S⁵. The engagement of contacts 28—31 and 29—32 of this set will complete the talking circuit through the link-circuit strands; and the engagement of contacts 27—30 will provide a new path for current through the electromagnet E by way of said contacts and the closed contact 71 of supervisory relay 60 to ground. At the end of conversation, the parties restore their receivers to their hooks and thus cause the illumination of supervisory lamps 58 and 72 in the usual manner; as a signal to the operator to take down the connection. As soon as she removes the plug P² from

the jack J of the line L², while performing this operation, the previous circuit through the sleeve supervisory relay 60 and the cut-off relay 66 will be interrupted with a consequent interruption of the circuit through electromagnet E at contact 71 of said supervisory relay. As soon as this magnet is de-energized, its armature 37 will be retracted by its spring 38; and by reason of the disengagement of catch 21 with the collar 19 of key K⁴, said key will return, under the action of its spring, to its normal position. In the operation of the key mechanism, only one key K¹, K², K³ or K⁴ will be depressed at one time. Thus if key K³ is depressed while key K⁴ is in its fully depressed position, the catch-bar 22 will be rocked about its pivot by the engagement of the inclined face of the collar 19 on key K³ with the associated catch 20; and consequently the catch 20, engaging the collar 19 of depressed key K⁴, will be disengaged and the latter key will return to its normal position. Again, if key K³ be depressed while key K⁴ is in the position illustrated in Fig. 6, the catch-bar 23 will be similarly rocked through the similar engagement of collar 19 of key K³ with the associated catch 21, and the catch 21 of key K⁴ will be disengaged and said key will be restored to its normal position.

Assuming that the line into which the plug P² has been inserted is busy, then there will exist at the sleeve contacts of the jacks of the line L² a potential resulting from the connection of the sleeve contact of one of said jacks with the live pole of the battery B' either by way of the sleeve supervisory relay 57 and the answering plug P', or the supervisory relay 60 and the sleeve contact of the calling plug P², of another link-circuit. This potential will be sufficiently above that of the intermediate tap of the battery B' so that, upon the insertion of the plug, current will flow from the sleeve contact of the jack through the sleeve contact of the plug P², closed contact 64—63, normal contact 62 of supervisory relay 60, and polarized relay 61 to the intermediate tap of the battery B'. This current flow will result in actuating the polarized relay 61 to move its contact 67 to the right into engagement with contact 77, thereby completing a circuit from the live pole of the battery B' through the lower winding of relay 65 and closed contacts 77—67 to ground. The closing of this circuit will energize relay 65 to open its normally closed contact 76, close contacts 78—64, followed by the opening of contacts 63—64, close contacts 79 and 80, and moves contact 81 from its normal to its alternate position. The opening of contact 63—64 interrupts the path for current through the polarized relay 61; but since this interruption occurs after the clos-

ing of contacts 64—78, the relay 65 is maintained in its actuated position by reason of a flow of current through its upper winding, closed contact 78—64, plug and jack sleeve contacts and the winding of cut-off relay 66 to ground. The opening of contact 76 interrupts a possible connection for ringing current to the tip side of the circuit. The closing of contact 79 completes a circuit through the winding of supervisory relay 60 and closed contact 79 to ground.

The closing of contact 80 completes a circuit by which a characteristic signal is transmitted from the interrupter I' , back over the line of the calling party, as an indication to him that the called-for line is busy. This circuit is of the usual character and includes a primary circuit extending from the live pole of the battery B' through the primary winding of induction coil 82 and the interrupter I' to ground; and a secondary circuit extending through the secondary winding of induction coil 82, condenser 83, and closed contact 80 to the sleeve side of the circuit. The secondary circuit is completed to ground from the tip strand of the link-circuit through any of the grounds existing thereon. Having inserted the plug P^2 into its jack, the operator will now depress the appropriate ringing key K' , K^2 , K^3 or K^4 . This will not result in the application of ringing current to the line because of the interruption of the connection therewith at contact 76, although the circuit for the "flip-flop" relay 74 will be established by the closing of contact 69 of supervisory relay 60. The operator will be apprised of the busy condition of the line by the display of the usual disconnect signal. Thus upon the energization of relay 65, the sleeve supervisory relay 60 is energized and the associated supervisory lamp 72 is lighted. As soon as the calling party receives the busy signal, he will restore his receiver to its hook and thereby deenergize tip supervisory relay 56 and cause the display of the calling supervisory lamp 58. Since the depression of the appropriate ringing-key resulted in its being locked in its fully depressed position, it will be necessary to energize the electromagnet E before said key is returned to its normal position, except that of course the operator may at any time press the upward projection 51 of the catch-bar 22 to release any of the keys not in their normal position. For the purpose of energizing the electromagnet E at this time and thereby relieving the operator of said duty, a slow release relay 84 is provided in circuit with alternate contact 81 of relay 65. Upon the initial energization of relay 65, this circuit was completed and the relay 84 closed its contact 86. This, however, did not complete a circuit through electromagnet E ; but as soon as the connection is taken down and

relay 65 deenergized, the contact 81 returns to its normal position before contact 86 opens, and consequently a circuit for electromagnet E is completed through closed contact 86 and normal contact 81 to ground. The resulting momentary energization of electromagnet E rocks the catch-bars 22—23 first to the position illustrated in Fig. 6, and then to the normal position illustrated in Fig. 5. During this movement of the catch-bars, the actuated key returns to its normal position and the various parts are left in the position illustrated in the diagram of Fig. 7.

Referring now to the form of the invention illustrated in Figs. 8 to 15 inclusive, it will be seen that a similar frame-plate a has a flange b which forms a face-plate through which the listening-key lever L^4 and the longitudinally movable ringing-keys $k'-k^2-k^3-k^4$ extend. As before, these keys extend downwardly through the face-plate in a position to engage sets of contact springs $s'-s^2-s^3-s^4$, two of which are broken away, together with other parts of the structure, for clearness. These spring contacts are secured at their lower ends by a suitable insulating member c preferably secured by screws 100 to the frame-plate a and arranged so as to properly space the springs of each set of contacts in the manner illustrated. The member c also supports a set of contacts s^5 which are adapted to be operated upon the depression of any of the ringing-keys, and a set s^6 of listening-key spring contacts. The member c is provided with suitable guiding openings through which the lower ends of the keys $k'-k^2-k^3-k^4$ are adapted to pass. The guiding ends of these keys are also reduced in diameter and each is provided with a suitable returning spring 101 closely coiled about it and bearing at its opposite ends against the member c and a shoulder of the corresponding key. Each of the keys $k'-k^2-k^3-k^4$ is adapted to occupy three operating positions, namely—a normal, an intermediate or ringing, and a fully depressed or busy position. In the normal position, the collar 102 forming a catch-engaging-projection on the shank of the key bears against the under face of the flange b , and the tips of the spring contacts 103—104 are held out of engagement. Upon the downward movement of the key, the contacts 103—104 remain out of engagement; but upon the return movement of the key, these contacts are brought into engagement. This is accomplished by means of a T-shaped tongue 105 extending through an I-shaped slot 106 in the spring contact 104 and cooperating with an inclined portion 107 formed by bending said spring contact in the manner illustrated in Figs. 8 and 12. In the normal position, the end of the tongue 105 extends through the upper portion of the slot 106; and upon the down-

ward movement of the key, it is carried over the left face of the inclined portion 107 until it reaches the lower end of the I-shaped slot. During this downward movement, the spring contact 104 is forcibly moved against its spring tension from its normal position; and as soon as the end of the tongue 105 reaches the lower end of the slot, the spring contact 104 returns, under its own tension, to its normal position and thereby moves to the left of the tongue 105. Upon the return movement of the key and the tongue 105, the broad end of the tongue engages the right-hand face of the inclined portion 107 and forces the spring contact 104 to the left into engagement with its associated contact 103. This engagement continues until the key reaches its normal position, at which time the broad end of the tongue 105 again reaches the upper end of the I-shaped slot 106 and the spring contact 104 is free to return, under its spring tension, to its normal position, thereby again bringing the end of the tongue 105 to the left of the spring contact. In addition to the collar 102, each key is provided with a collar 108 forming a second catch-engaging-projection having a lower inclined surface. This collar cooperates with the catches 109-110 of the catch-bars 111-112. The bar 111 is pivoted at its opposite ends to the posts 113 extending outwardly from the frame-plate *a* near the under side of the flange *b*. This pivotal connection with the posts 113 is on a line intermediate of the catches 109 at its lower side, and the catches 114 at its upper side. The latter catches cooperate with the collars 102 of the keys to lock them in their normal positions, as illustrated in Fig. 9. The catch-bar 112 on the other hand is pivoted near its upper end to the posts 115 which project downwardly from the flange *b*. The catch-bars 111 and 112 in this case are independently controlled by electromagnets *e-e'*, which are mounted side by side upon a flange 116 extending outwardly from the lower edge of the frame-plate *a*. Each of these electromagnets is provided with an armature pivoted at its lower end and extending upwardly into operative relation with the associated catch-bar. The armature 117 of electromagnet *e* is provided with a restoring spring 118 and an upwardly projecting member 119 which extends through a suitable aperture in a projection of catch-bar 111. Similarly, the armature 120 of electromagnet *e'* is provided with a restoring spring 121 and with an upwardly projecting member 122 which similarly extends through an aperture in a projection of the catch-bar 112. Thus the attraction of the armature 117, due to the energization of electromagnet *e*, rocks the catch-bar 111 so as to move catches 114 out of engaging position and thereby unlock the ringing-keys

$k'-k^2-k^3-k^4$. The key, being thereupon depressed to its lowest position, as illustrated in Fig. 14, will be held in such position provided the electromagnet *e'* is energized, since at such time the appropriate catch 110 of the catch-bar 112 will be in a position to engage the upper face of the collar 108 on the shank of the operated key. Upon the subsequent retraction of armature 120, the key will be free to return to its intermediate position, as illustrated in Fig. 13, provided the armature 117 of electromagnet *e* is attracted at such time. When in this position, the appropriate catch 109 engages the same collar 108. It will be apparent from the arrangement of the catches 109-110, relative to the collar 108, that the depression of any one key will force all the catches out of engaging position and thereby free any key which is at the time in a depressed position. The set of spring contacts *s^5* is operated by means of a reciprocating bar 123 which carries at one end a projection 124 which is adapted to engage an insulating member 125 to actuate the contacts springs 126 and 127, the former to engage contact 128, and the latter to disengage contact 129 and engage contact 130. The reciprocating bar 123 is hung by links 131 and 132, pivotally secured to the frame-plate *a* adjacent to its flange *b*. The reciprocating bar 123 carries a projection 133 corresponding to each ringing-key, which has an inclined edge with which a finger 134, carried by the corresponding key, is adapted to engage to cause the reciprocation of the bar upon the depression of the key. In each case, the finger 134 is guided by a slot 135 in the frame-plate *a*, through which the said finger passes. From this it will be apparent that upon the depression of any one of the ringing-keys $k'-k^2-k^3-k^4$, the reciprocating bar 123 will be operated to actuate the contacts of set *s^5*.

The listening-key lever *L^4* is pivoted at 136 to a projection extending from the face of the frame-plate *a* through a suitable opening 137 in the catch-bar 111. The listening-key lever is provided with a suitable projection having an insulated covering 138 which is adapted to actuate the springs 139 and 140 of the set of spring contacts *s^6* to engage their cooperating springs 141 and 142, respectively. This movement is accomplished by throwing the lever *L^4* to the right in Fig. 8. In this form of the invention, the listening-key is independent in its operation of the ringing-keys $k'-k^2-k^3-k^4$.

Referring now to the diagram of Fig. 15, which illustrates two subscribers' lines *L^5-L^6* extending from substations *M* and *N* to a central office provided with a suitable link-circuit *L^7* for uniting the lines for conversation, it will be seen that the line circuits are substantially the same as those shown

in Fig. 7 and that the link-circuit is of the four-relay type, including supervisory relays 143—144 associated with the answering end of the link-circuit, and similar supervisory relays 145—146 associated with the calling end of said circuit, the relays 143—144 controlling supervisory lamp 147, and relays 145—146 controlling supervisory lamp 148. Assuming that a party at substation M has removed his receiver, the operator will respond by inserting the answering plug P^3 into a jack j of the line L^5 , and will place her operator's set s^7 in circuit by depressing her listening-key lever L^4 to close contacts 139—141 and 140—142. Having learned the desired substation to be, for example, substation N on line L^6 , she will insert the calling plug P^4 into a jack j of the line L^6 and depress a ringing-key k^1, k^2, k^3 or k^4 to cause the operation of the call signal at substation N. The insertion of the plug into the jack will complete a circuit from the live pole of battery b through the winding of sleeve supervisory relay 146, closed contacts 127—129, plug and jack sleeve contacts and the winding of cut-off relay 149 to ground. The closing of this circuit will energize the sleeve supervisory relay 146 and the cut-off relay 149—the former to close its contact 150 to cause the illumination of lamp 148, and the latter to interrupt the normal line connection and extend the line limbs to the tip and sleeve contacts of the jacks. As soon as contact 150 is closed, a circuit will also be completed through the winding of electromagnet e by which catch-bar 111 is controlled. This circuit extends from the live pole of the battery b through the winding of said electromagnet, closed contacts 151—152 and closed contact 150 to ground. The resulting energization of electromagnet e rocks the catch-bar 111 so as to unlock the ringing-keys $k^1—k^2—k^3—k^4$. Until this occurs, the operator cannot depress the proper ringing key. Assuming that the operator depresses key k^4 to actuate the call signal at substation N, it will be seen that the ringing circuit will not be completed upon the full depression of the key, since the contacts 103—104 of such key are not closed by this movement; but on the other hand, the spring contact of the set s^5 will be operated by the movement of reciprocating bar 123 to break contact 127—129 and close contact 127—130, and at the same time to close contact 126—128. If the line L^6 is busy at this time, a potential above that of ground will exist at the sleeve contact of the jacks j and, upon the closing of contact 126—128, current will flow from the sleeve contact of the jack over the sleeve side of the link-circuit, through contact 126—128 and the winding of relay 153 to ground, thereby energizing said relay to close its contacts 154—155 and to open its contact 156. The

opening of the latter contact interrupts a possible connection for ringing current to the tip contact of the plug P^4 . The closing of contact 154 sends a "busy" signal over the line to the calling party. This signal may be transmitted through the agency of an interrupter i and an induction coil 157, the interrupter being included in a primary circuit with the primary winding of the induction coil and with the battery b ; and the secondary circuit including a secondary winding of said induction coil, condenser 158, closed contact 154, the sleeve side of the circuit through substation M, and back over the tip side of the circuit to ground through the various ground connections with the tip strand of the link-circuit L^7 . The closing of contact 155 of relay 153 completes a circuit to ground through the winding of electromagnet e' which controls catch-bar 112. The attraction of armature 120, resulting from the energization of electromagnet e' , brings the catches 110 into engaging position, and the key k^4 is thereby held in its fully depressed position. Upon learning the busy condition of the line, as before, the operator will take down the connection, whereupon the electromagnets e and e' will be deenergized; and through the action of the returning spring 101, the key k^4 will be restored to its normal position.

In case the called line is idle at the time the plug P^4 is inserted into its jack, there will be no current flow through relay 153, and consequently electromagnet e' will not be energized and catch-bar 112 will not be actuated to hold the key in its fully depressed position. At this time, however, the catches 109 of catch-bar 111 will be in their engaging position, and the key k^4 will not be free to return to its normal position, but will stop at its intermediate or "ringing" position. Upon this return movement, as was previously pointed out, the associated contacts 103—104 of key k^4 are brought into engagement, with the result of an intermittent application of ringing current from the generator g^4 through the interrupter c^4 and one winding of relay 159 and closed contacts 160—161 to the tip contact of the plug P^4 and thence over the line L^6 and to ground through the cut-off relay 149. The flow of ringing current over this circuit will be of such a character as not to cause the relay 159 to attract its contacts; but as soon as the called-for party responds and thereby completes a path for battery current through the substation, current will flow, as soon as the interrupter c^4 establishes connection between contact 103 of key k^4 and ground, from the live pole of battery b , through the winding of supervisory relay 146, contact 127—129, plug and jack sleeve contacts to the winding of cut-off relay 149; thence by one path through the winding of

said relay to ground, and by another over the line through the substation and back through the plug and jack tip contacts, closed contact 156, closed contact 161—160, the right-hand winding of relay 159, contact 104—103 through the interrupter c^4 to ground. The completion of this circuit will energize relay 159 to close contacts 162—152, followed by the opening of contacts 151—152; and the closing of contact 161—163, followed by the opening of contacts 160—161. The opening of contact 151—152 breaks the circuit of electromagnet e and thereby releases key k^4 from its ringing position and allows it to return to normal. The engagement of contacts 152—162 completes a locking circuit for the relay 159 extending from the live pole of battery b through the left-hand winding of said relay, closed contacts 152—162 and closed contact 150 to ground. The opening of contact 160—161 interrupts the connection to the ringing keys, and the closing of contact 161—163 completes the talking strand at this point. Thus it will be seen that in the operation of the system, the ringing-key can not be depressed until the calling plug has been inserted into the jack. Then, when depressed, if the line is busy, it is retained in its fully depressed position and a busy signal is transmitted to the calling party. However, if the line is not busy, the key is allowed to return to its intermediate or ringing position and it remains in this position until the called-for party responds, whereupon it is freed and allowed to return to its normal position. With the parties connected, the supervisory lamps 147—148 remain dark, by reason of the energization of tip supervisory relays 143 and 145; but at the close of conversation, the restorations of the receivers to their hooks at the substations interrupts the flow of current to these supervisory relays; and upon the return of their contacts to normal, the said lamps are lighted as a signal to the operator to take down the connection.

It should be understood that the specific key construction may be modified considerably without departing from the spirit and scope of my invention, and that in the practice of the same, the electromagnets by which the latch mechanism is controlled might be variously connected in existing or novel circuit arrangements. The accompanying diagrams are intended to be merely typical and to illustrate completely an application of each form of the invention.

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

1. A telephone key comprising a supporting frame, suitable contacts carried thereby, a spring returned actuating member for said contacts having three operating positions,

means for holding said member in its second and third positions when moved thereto, and means for operating said holding means.

2. A telephone key comprising a supporting frame, suitable contacts carried thereby, a spring returned actuating member for said contacts having three operating positions, means for holding said member in its second and third positions when moved thereto, and electromagnetically actuated means for operating said holding means.

3. A telephone key comprising a supporting frame, suitable contacts carried thereby, a spring returned actuating member for said contacts having three operating positions, and electromagnetically actuated catches for holding said member in its second and third positions when moved thereto.

4. A telephone key comprising a supporting frame, suitable contacts carried thereby, a spring returned actuating member for said contacts having three operating positions, a pair of catches for severally holding said member in two of said operating positions, and means for simultaneously disengaging one of said catches and moving the other into engaging position to thereby allow the movement of said member from one operating position to another.

5. A telephone key comprising a supporting frame, suitable contacts carried thereby, a spring returned actuating member for said contacts having three operating positions, a pair of catches for severally holding said member in two of said operating positions, and electromagnetically actuated means for simultaneously disengaging one of said catches and moving the other into engaging position to thereby allow the movement of said member from one operating position to another.

6. A telephone ringing-key comprising a supporting frame, suitable contacts carried thereby, a spring returned actuating member for said contacts having a ringing and two other operating positions, means for holding said actuating member in its ringing position when once moved thereto, and means for subsequently freeing said member and allowing it to assume another of its said operating positions.

7. A telephone ringing-key comprising a supporting frame, suitable contacts carried thereby, a spring returned actuating member for said contacts having a ringing and two other operating positions, means for holding said actuating member in its ringing position when once moved thereto, and electromagnetically actuated means for subsequently freeing said member and allowing it to assume another of its said operating positions.

8. A telephone ringing key comprising a supporting frame, suitable contacts carried thereby, a spring returned actuating mem-

ber for said contacts having a ringing and two other operating positions, an electromagnetically actuated catch mechanism operative when in one position to hold said member in its ringing position and when in another position to hold said member in another of its said operating positions.

9. A telephone key comprising a narrow supporting frame, suitable spring contacts carried thereby, a longitudinally movable key for operating said contacts and having a plurality of operating positions, projections on said key and cooperating catches on said frame spaced so as to hold said key in different operating positions, a controlling electromagnet secured to said frame and lying substantially in the plane of said contacts, and an armature actuated by said electromagnet to operate said catches.

10. A combined telephone listening and ringing key comprising a narrow supporting frame, suitable ringing contacts carried by said frame, an actuating member for said contacts having a plurality of operating positions, catch mechanism for holding said actuating member in different operating positions, a controlling electromagnet secured to said frame and lying substantially in the plane of said contacts, an armature for said electromagnet, operative connections between said armature and said catch mechanism, listening contacts lying adjacent to said electromagnet and an actuating member for said listening contacts mounted in said frame adjacent to the end of said electromagnet and in the plane of said magnet and said listening and ringing contacts.

11. A party line telephone ringing-key comprising an elongated supporting frame, a row of sets of spring contacts carried thereby, a plurality of actuating members for said sets of contacts mounted in said frame in a row and each having a plurality of operating positions, catch engaging projections on said actuating members, catch-bars extending lengthwise of said frame in close proximity to said actuating members, catches on said bars for holding said actuating members in their different operating positions, and means for actuating said bars to practically simultaneously operate a plurality of the said catches acting on one of the said actuating members.

12. A party line telephone ringing-key comprising an elongated supporting frame, a row of sets of spring contacts carried thereby, a plurality of actuating members for said sets of contacts mounted in said frame in a row and each having a plurality of operating positions, catch engaging projections on said actuating members, catch-bars extending lengthwise of said frame in close proximity to said actuating members, catches on said bars for holding said actuating members in their different operating po-

sitions, and electromagnetically actuated means for actuating said bars to practically simultaneously operate a plurality of the said catches acting on one of the said actuating members.

13. A party line telephone ringing key comprising an elongated supporting frame, a row of sets of spring contacts carried thereby, a plurality of actuating members for said sets of contacts mounted in said frame in a row and each having a plurality of operating positions, catch engaging projections on said actuating members, catch-bars extending lengthwise of said frame on opposite sides of and in close proximity to said actuating members, catches on said bars for holding said actuating members in their different operating positions, and means for actuating said bars to practically simultaneously operate a plurality of the said catches acting on one of the said actuating members.

14. A party line telephone ringing-key comprising an elongated supporting frame, a row of sets of spring contacts carried thereby, a plurality of actuating members for said sets of contacts mounted in said frame in a row and each having a plurality of operating positions, catch-engaging-projections on said actuating members, catch bars extending lengthwise of said frame on opposite sides of and in close proximity to said actuating members, catches on said bars for holding said actuating members in their different operating positions, and electromagnetically actuated means for actuating said bars to practically simultaneously operate a plurality of the said catches acting on one of the said actuating members.

15. A party line telephone ringing-key comprising an elongated supporting frame, a row of sets of upwardly projecting spring contacts carried thereby, a plurality of downwardly projecting longitudinally movable actuating keys mounted in said frame in a row in positions to engage said sets of contacts respectively when depressed, springs for returning said keys to their normal position, catch-engaging-projections on said keys and cooperating catch-bars extending lengthwise of said frame in close proximity to said keys and having their engaging parts positioned with reference to said projections so as to enable said keys to be held in a plurality of positions.

16. A party line telephone ringing-key comprising an elongated supporting frame, a row of sets of upwardly projecting spring contacts carried thereby, a plurality of downwardly projecting longitudinally movable actuating keys mounted in said frame in a row in positions to engage said sets of contacts respectively when depressed, springs for returning said keys to their normal positions, catch-engaging-projections on said

keys, cooperating catch-bars extending lengthwise of said frame in close proximity to said keys and having their engaging parts positioned with reference to said projections so as to enable said keys to be held in a plurality of positions, an electromagnet located adjacent to one end of said frame, an upwardly extending armature operated thereby, and operative connections between one of said catch-bars and said armature.

17. A party line telephone ringing-key comprising an elongated supporting frame, a row of sets of upwardly projecting spring contacts carried thereby, a plurality of downwardly projecting longitudinally movable actuating keys mounted in said frame in a row in positions to engage said sets of contacts respectively when depressed, springs for returning said keys to their normal positions, catch engaging projections on said keys and cooperating catch bars extending lengthwise of said frame upon opposite sides of and in close proximity to said keys and having their engaging parts positioned with reference to said projections so as to enable said keys to be held in a plurality of positions.

18. A party line telephone ringing-key comprising an elongated supporting frame, a row of sets of upwardly projecting spring contacts carried thereby, a plurality of downwardly projecting longitudinally movable actuating keys mounted in said frame in a row in positions to engage said sets of contacts respectively when depressed, springs for returning said keys to their normal positions, catch engaging projections on said keys, cooperating catch-bars extending lengthwise of said frame upon opposite sides of and in close proximity to said keys and having their engaging parts positioned with reference to said projections so as to enable said keys to be held in a plurality of positions, electromagnetically actuated armature mechanism adjacent to one end of said frame and operative connections between said armature mechanism and said catch-bars.

19. A party line telephone ringing-key comprising an elongated supporting frame, a row of sets of spring contacts carried thereby, a plurality of longitudinally movable actuating keys extending through the face plate of said frame and each having a plurality of operating positions, catch engaging projections on said keys, elongated catch-bar mechanism pivotally secured adjacent to said face-plate and laterally movable toward and from said keys, and catches on said bar mechanism for engaging the cooperating projections on said keys to hold each of said keys in its operating positions.

20. A party line telephone ringing-key comprising an elongated supporting frame,

a row of sets of spring contacts carried thereby, a plurality of longitudinally movable actuating keys extending through the face-plate of said frame and each having a plurality of operating positions, catch engaging projections on said keys, a plurality of elongated catch-bars pivotally secured at points adjacent to the face-plate and on opposite sides of said keys so as to move toward and from the same, and catches on said bars for engaging cooperating projections on said keys to hold each of said keys in its different operating positions.

21. A party line telephone ringing-key comprising an elongated supporting frame, a row of sets of spring contacts carried thereby, a plurality of longitudinally movable actuating keys extending through the face-plate of said frame and each having a plurality of operating positions, catch engaging projections on said keys, a plurality of elongated catch bars pivotally secured at points adjacent to said face-plate and on opposite sides of said keys, catches on said bars for engaging the cooperating projections on said keys to hold said keys in their different operating positions, electromagnetically actuated armature mechanism mounted at one end of said frame and operatively connected to said catch-bars.

22. A telephone key comprising a set of spring contacts, a reciprocating actuating key therefor, a catch-bar mechanism movable transversely of said key, a plurality of catch-projections on said mechanism cooperating with said key whereby said key may be held in a plurality of operating positions, and electromagnetic means independent of said key for actuating said mechanism.

23. A telephone key comprising two sets of contacts, a lever for operating one of said sets of contacts, biased to return to normal when moved therefrom, a catch for holding said lever in its actuated position and a longitudinally movable key for said other set of contacts operative, when depressed, to release said holding means.

24. A telephone key comprising two sets of contacts, a lever for operating one of said sets of contacts biased to return to normal when moved therefrom, a longitudinally movable key for operating said other set of contacts and a catch member operative to hold said lever in its actuated position and to release said lever when said key is subsequently actuated.

25. A telephone key comprising two sets of contacts, a lever for operating one of said sets of contacts biased to return to normal when moved therefrom, a longitudinally movable key for operating said other set of contacts, a catch cooperating pivoted catch-bar, a catch thereon for engaging said lever when moved to its operating position, and

cooperating parts on said key and bar whereby, upon the operation of said key, said bar is actuated to release said lever.

26. A telephone key comprising a frame 5 having a face-plate and a supporting bar lying substantially parallel thereto, two sets of spring contacts secured to said bar and extending toward said face-plate, a key lever projecting through said face-plate into 10 operative relation with one set of spring contacts, a longitudinally movable key projecting through said face-plate into operative relation to said other set of contacts, a rocking catch-bar lying adjacent to said 15 face-plate, a catch on said bar for holding said lever in its operating position and cooperating parts on said key and bar whereby the operation of said key causes a movement of said bar to release said lever.

27. A telephone key comprising a supporting frame, suitable spring contacts carried thereby, an actuating member for said contacts having a plurality of operating positions, a catch member for holding said 25 actuating member in different operating positions, and additional spring contacts actuated by movement of said catch member.

28. A party line telephone ringing key comprising an elongated supporting frame, 30 sets of spring contacts carried thereby, actuating members for said sets of spring contacts, each having a plurality of operating positions, catch bar mechanism extending lengthwise of said frame and operatively 35 related to said actuating members for holding them in different operating positions and additional spring contacts actuated by the movement of said catch bar mechanism.

29. A party line telephone ringing key 40 comprising an elongated supporting frame, sets of spring contacts carried thereby, actuating members for said sets of spring contacts each having a plurality of operating positions, catch bar mechanism extending 45 lengthwise of said frame and operatively related to said actuating members for holding

them in different operating positions, and additional spring contacts lying substantially in the plane of said sets of spring contacts, and in a position to be actuated by 50 the movement of said catch bar mechanism.

30. A party line telephone ringing key comprising an elongated supporting frame, sets of spring contacts carried thereby, actuating members for said sets of spring con- 55 tacts, each having a plurality of operating positions, a catch bar extending lengthwise of said frame and operatively related to said actuating members, additional spring contacts lying substantially in the plane of said 60 sets of spring contacts and in a position to be actuated by the movement of said catch bar, an electromagnet secured to said frame, an armature actuated thereby and operative connections between said armature and said 65 catch bar.

31. A telephone key comprising a supporting frame, suitable sets of spring contacts carried thereby, an actuating member for each set having a plurality of operating 70 positions, a catch member for holding said actuating members in their different operating positions, and additional spring contacts actuated by movement of said catch 75 member.

32. A telephone key comprising a supporting frame, suitable sets of spring contacts carried thereby, an actuating member for each set having a plurality of operating 80 positions, a catch member for holding said actuating members in their different operating positions, additional spring contacts actuated by movement of said members whereby a member is released when a second 85 member is actuated.

In witness whereof, I hereunto subscribe my name this 26 day of February, 1907.

GEORGE E. MUELLER.

Witnesses:

L. D. KELLOGG,
J. G. KELLOGG.