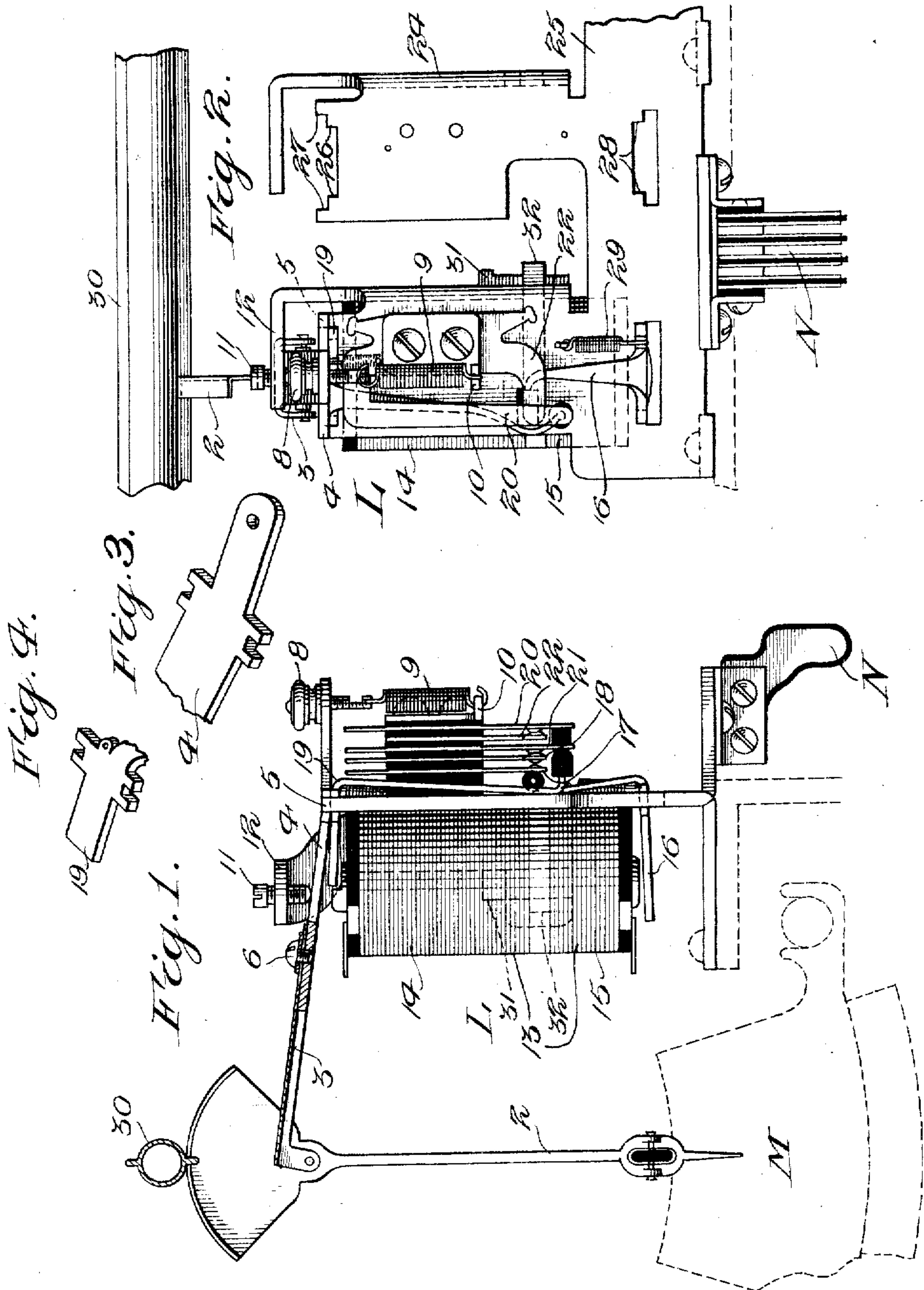


A. E. KEITH.
TELEPHONE EXCHANGE TRUNKING SYSTEM.
APPLICATION FILED AUG. 28, 1908. RENEWED DEC. 5, 1914.

1,151,543.

Patented Aug. 24, 1915.

3 SHEETS—SHEET 1.



Witnesses:
R. H. Burfield
A. B. Sperry.

Inventor:
Alexander E. Keith,
By Bulkeley and Drury,
Attorneys.

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TELEPHONE EXCHANGE TRUNKING SYSTEM.

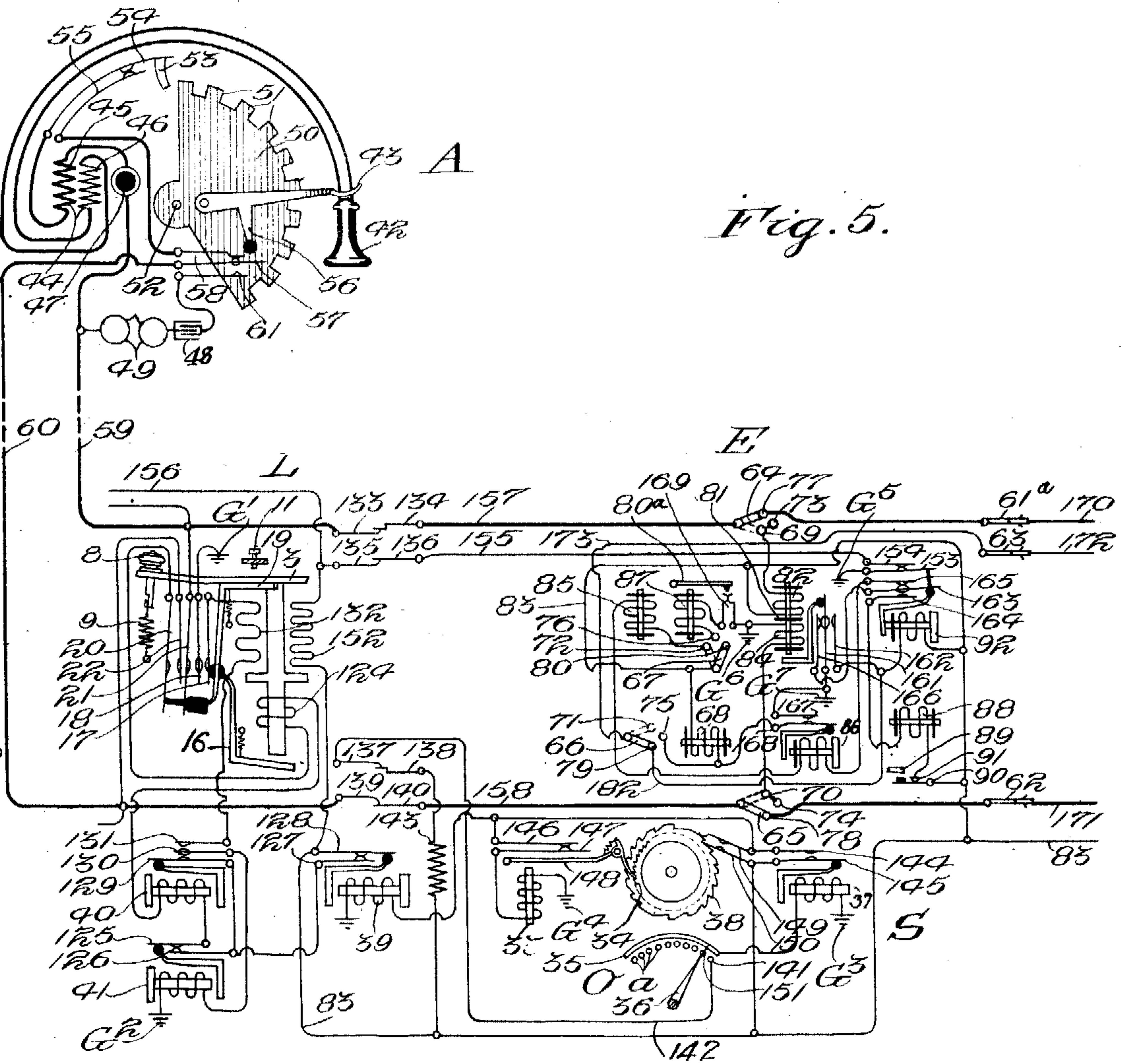
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3 SHEETS—SHEET 2.

Fig. 5.



Witnesses:
P. H. Burpines
R. B. Spruy

Inventor:
Alexander E. Keith,
By Charles A. Spruy,
Attorneys.

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3 SHEETS—SHEET 3.

1,151,543.

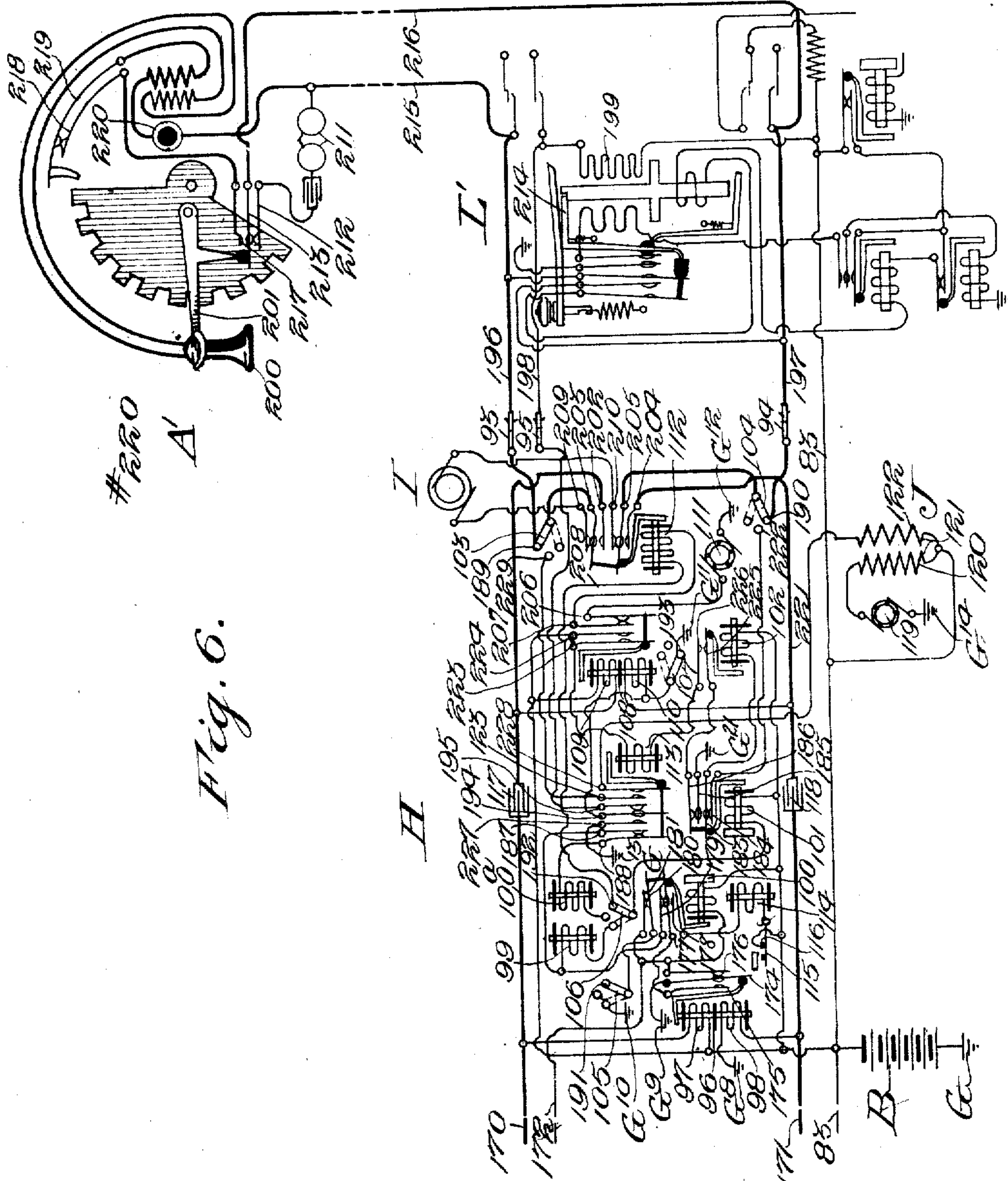


Fig. 6.

Witnesses:
 R. H. Burfield
 A. B. Sperry

Inventor:
 Alexander E. Keith,
 By Bulley & Wand & Drury,
 Attorneys.

UNITED STATES PATENT OFFICE.

ALEXANDER E. KEITH, OF HINSDALE, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE TRUNKING SYSTEM.

1,151,543.

Specification of Letters Patent.

Patented Aug. 24, 1915.

Application filed August 28, 1908, Serial No. 450,673. Renewed December 5, 1914. Serial No. 875,722.

To all whom it may concern:

Be it known that I, ALEXANDER E. KEITH, a citizen of the United States of America, and resident of Hinsdale, Dupage county, Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Trunking Systems, of which the following is a specification.

My invention relates to telephone exchange systems of that particular character in which one or more automatic trunking switches are employed for automatically establishing a trunking connection for any suitable or desired purpose, such, for example, as the establishment of a talking connection between calling and called subscribers in an automatic or semi-automatic telephone exchange system.

Generally stated the object of my invention is the provision of an improved and highly efficient telephone exchange system.

A special object is the provision of an improved and highly efficient trunking switch of such character that it may be economically manufactured and installed at less expense than heretofore.

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

In the accompanying drawings Figure 1 is a side elevation of a line switch embodying the principles of my invention. Fig. 2 is an end view of the same. Figs. 3 and 4 are perspective views of detail parts. Figs. 5 and 6, taken together, represent diagrammatically a calling substation A connected with a called substation A' in a system embodying the principles of my invention.

As shown in Fig. 1, the line switch or non-numerical switch L is an improvement upon that disclosed in English Patent No. 26,301 of 1906. By a non-numerical switch I mean a switch which operates independent of the digits of the called number, that is, the operation of the said non-numerical switch is in no way dependent upon the numerical impulses corresponding to the digit of the called number, in contradistinction to a numerical switch, such as a selector or connector switch. The said switch L comprises the plunger 2 pivotally mounted upon the end of the plunger arm 3. It will be seen that the plunger arm 3 is in two sections; upon one section is mounted the plunger,

and the other section 4 is adapted to rock or move about the point 5. These two sections are rigidly secured by the screw 6. This provision is made in order that the plunger arm may be adjusted so that the plunger 2 will properly enter the bank M. Upon the end of the section 4 there is mounted a thumb-screw 8 which is attached to the spiral spring 9. This spiral spring is in turn secured to the bracket 10. The thumb-screw and spiral spring arrangement admit of a proper tension adjustment for the plunger arm. Above the plunger arm there is a set screw 11 mounted in the bracket 12 for limiting the backward motion of the plunger 2. The magnet 13 is divided into two sections 14 and 15. The section 14 comprises two windings, a trip magnet winding and a bridge-cut-off winding. The end 15 comprises a line relay winding which controls the armature 16. When the winding on the end 15 is energized the armature 16 is attracted and the spring 17 is pressed into contact with the spring 18. The bridge-cut-off armature 19, when attracted, shifts the springs 20 and 21 out of contact with the springs 22 and 18. In Fig. 2 there is shown a line switch L, and to the right a frame or mounting bracket 24 for a second line switch is shown. It will be seen that these brackets or frames are stamped in groups—that is, the frame for the switch L, the frame 24, and still others to the right of the frame 24 may be stamped and formed in one common piece such that when the line switches are assembled on the brackets there is then a plurality of line switches mounted upon the common frame 25. At N (Figs. 1 and 2) there are shown the jacks or terminal connection for the different circuits of the switch, one of these sets of jacks N being provided for each line switch. The means for mounting the armatures of the line switch is best shown in Figs. 4 and 2. The bridge-cut-off armature 19 (Fig. 4) is adapted to rest in the notch 26 (Fig. 2), and the end 4 (Fig. 3) of the plunger arm rests on top of the cut-off armature 19 and in the notch 27. The line relay armature 16 at the bottom of the line switch magnet rests in the notch 28 and is retained in normal position by the coil spring 29. The magnet 13 of the line switch is retained in position by a key 31 which passes through

an eye of the magnet bracket 32 after the bracket has been passed through an opening in the frame.

Since the bracket 32 which separates the two sections 14 and 15 is attached to the frame upon which the armatures of the switch are pivoted, the magnetic circuits of the two sections are separate and distinct. As regards the winding on the end 15, the air-gap between the upper end of the core and the armatures 19 and 4 is short-circuited by the bracket 32, and consequently the energization of the winding on the section 15 serves to operate only the armature 16. Likewise, the energization of either of the windings on the end 14 affects only the armatures 4 and 19. Of the two windings on the end 14, the trip-in winding operates both the armature 19 and the plunger arm 4, while the cut-off winding is strong enough to operate only the armature 19. The cut-off winding is not, however, strong enough to attract the plunger arm 4 out of normal position; but if this arm is once operated it may be held in its operated position by this winding.

The master switch S (Fig. 5) which controls the plunger shaft 30 of the line switches may be of the general type disclosed in the *Western Electrician* of January 25, 1908, and in the *American Telephone Journal* of May, 1908. The said master switch S comprises the usual motor magnet 33 adapted to operate the ratchet wheel 34, which latter is in turn linked with the plunger shaft. The master switch bank is shown at O and comprises the individual segments *a* and the common segment 35. The wiper 36 is adapted to maintain some one of the individual segments *a* in electrical contact with the common segment 35. The motor magnet relay 37 is, as usual, arranged to close an energizing circuit through the motor magnet 33. Rigidly secured to the ratchet wheel 34 is the fiber interrupter wheel which operates a pair of springs which are also arranged to close a circuit through the motor magnet. In multiple with the motor magnet 33 is the open main relay 39 which controls the supply of current to the interrupter relays 40 and 41 which are provided for energizing the trip-in winding, as will be explained. The relays 39, 40 and 41 are slow-acting—that is, when the relays are once energized and the circuit then broken the armatures do not instantly return to normal position, but remain in their energized position for a moment. These slow-acting relays 39, 40 and 41 are common to a group of line switches in the same manner that the master switch is common to a group.

The substations may be of any suitable or approved type. As shown, it will be seen that substation A is somewhat different from the usual automatic substation, said

substation A being arranged and modified to operate in connection with a two-wire system—that is, with a system in which no ground connection is used at the subscriber's substation. Substation A, for example, comprises the usual received 42, switch-hook 43, induction coil 44 which consists of the primary winding 45 and the secondary winding 46, transmitter 47, condenser 48, ringer 49, and impulse wheel 50 which has the usual impulse teeth 51. The impulse wheel 50 is secured to the shaft 52, to which shaft there is also secured the dial (not shown). When the dial is turned the impulse teeth 51 are adapted to engage the cam 53 upon the end of the spring 54 and thereby carry the latter out of engagement with the spring 55. Upon the switch-hook 43 there is secured the cam 56 which, when the switch-hook is up, permits the springs 57 and 58 to engage, thereby bridging across the subscriber's line conductors 59 and 60 the primary circuit including the transmitter 47 in series with the primary winding 45; but when the switch-hook is lowered the spring 57 is carried out of engagement with the spring 58 and into engagement with the spring 61, whereby the ringer 49 in series with the condenser 48 is bridged across the line conductors 59 and 60 instead.

The first-selector switch shown at E is of the general type described in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, and, as shown, is modified to adapt it to operate in connection with a two-wire common battery system. Among other details it embodies the following features: The switch shaft (not shown) carries the vertical and rotary wipers 61* and 62, respectively, and the private wiper 63. The side switch is well known and comprises the side switch wipers 64, 65, 66 and 67 which may be designated as the vertical, rotary and private side switch wipers, and the rotary magnet wiper, respectively. The side switch is under the control of the private magnet 68, and when said side switch is in normal or first position the wipers 64, 65, 66 and 67 occupy the contact points 69, 70, 71 and 72, respectively; when in second position the wipers rest on the contact points 73, 74, 75 and 76, respectively; and when in third position the contact points 77, 78, 79 and 80 are engaged by their respective wipers. The windings of the usual vertical and rotary line relays are, in this case, combined into one double-wound relay 81 comprising the winding 82 which is connected with the battery lead 83, and also with the vertical trunk-line conductor, when the side switch wiper 64 is in first or second position. The second winding 84 is connected to ground, and also to the rotary trunk-line conductor, when the side switch wiper 65 is in first or

second position. Through the medium of this double-wound relay, and while the side switch is in first position, the subscriber controls the vertical magnet 85 which operates
 5 to raise the switch shaft and wipers 61^a, 62 and 63 vertically. The line relay 81 also controls the private magnet relay 86, which latter in turn controls the private magnet 68. As usual, the private magnet controls
 10 the side switch. While the side switch is in second position the rotary magnet 87 operates to carry the switch shaft and wipers 61^a, 62 and 63 step-by-step in a rotary direction. The release magnet 88 provides means
 15 for restoring the selector switch to normal position. Upon the switch shaft which carries the wipers 61^a, 62 and 63 there is mounted the arm 89 which, when the shaft is raised one or more steps, permits the spring
 20 90 to engage the contact point 91, whereby the release magnet 88 is connected to the battery lead. The release relay 92 is provided for closing the energizing circuit of the release magnet 88 after the switch is op-
 25 erated. Furthermore, the relay 92, upon energizing, provides an energizing circuit for the cut-off relay winding of the line switch to maintain the line switch in its operated position. The relays 86 and 92 are
 30 slow-acting relays—that is, they are so provided with a copper shield that when energized and the energizing circuit then broken, the said relays remain in an operated position for a moment or so. In other words,
 35 they do not instantly return to normal position after the energizing circuit is broken.

The connector switch H is a modified form of the connector switch disclosed in United States Letters Patent No. 815,176, granted
 40 March 13, 1906, to Keith, Erickson and Erickson. The connector switch shaft (not shown), like the switch shaft of the selector, carries the line wipers 93 and 94 and a private wiper 95. The connector switch is
 45 also controlled by the calling subscriber through the medium of a double-wound line relay 96. The line relay 96 is provided with the windings 97 and 98. One terminal of the winding 97 is connected to the battery
 50 lead, while the other terminal is connected with the vertical trunk-line conductor. The winding 98 is connected with ground and also with the rotary trunk-line conductor. This line relay 96 directly controls the ver-
 55 tical magnet 99. The purpose of the vertical magnet 99 is to give the shaft and shaft wipers a vertical motion, and the rotary magnet 100 imparts to the shaft and shaft wipers a rotary or circular motion. The
 60 connector switch is also provided with the slow-acting release relay 100 which is the same as the release relay 92 of the first-selector switch. As usual, the private magnet relay 101 controls the private magnet 102, which latter controls the side switch wipers

103, 104, 105, 106 and 107. The back-bridge relay 108, comprising the windings 109 and 110, provides the means whereby the called subscriber is furnished with battery current for talking purposes.

As here shown, my connector switch is of the automatic ringing type—that is, the signaling of the called subscriber is not dependent upon the calling subscriber pressing a signaling button when he calls a line; for
 70 as soon as connection is established with the desired line the interrupter 111 intermittently closes an energizing circuit through the ringer relay 112, whereby the terminals of the ringer generator I are intermittently
 75 bridged across the normal conductors of the called line. The relay 113 is so arranged that if a busy line is called the connector side switch is locked in second position, and the calling subscriber is given the busy-sig-
 80 nal. The means whereby the connector switch may be restored to normal position is provided by the usual release magnet 114 which, when the connector switch shaft is raised one or more steps, is connected to the
 85 battery lead through the normal springs 115 and 116. By means of the condensers 117 and 118 the circuit through the connector switch is divided into two sections. The busy-signaling apparatus J comprises the
 90 interrupter 119 in series with the winding 120 of the induction coil 121. The winding 122 is connected with the spring 228, and when the relay 113 energizes, as will be explained, the busy-signaling apparatus is con-
 95 nected with the connector side switch wiper 103.

The operation of my improved line switch may be more clearly understood from an explanation of its operation when one sub-
 100 scriber operates the central office switches to establish connection with the line of a second subscriber. It will be assumed that the subscriber at substation A wishes to call the subscriber at substation A', to which latter
 105 is allotted the number 220. To call the number 220 (substation A', Fig. 6) the subscriber at substation A (Fig. 5) removes his receiver from the switch-hook and operates the calling device for each digit in the well-
 110 known manner—that is, when the receiver is removed from the switch-hook a preliminary impulse provides an energizing circuit for the trip-in winding of the line switch L, whereby the line switch L is operated to
 115 seize an idle and waiting or preselected trunk-line leading to a first-selector switch. The dial is turned for the first digit, and upon returning to normal position operates the first-selector switch to establish con-
 120 nection with an idle trunk-line leading to a connector switch. In a similar manner the impulses delivered by the dial for the last two digits are directed toward the connector H, which latter operates to place the shaft
 125 130

wipers in connection with the contacts corresponding to the desired station. The preliminary impulse for operating the line switch occurs when the receiver 42 is removed from the switch-hook 43 and the cam arm 56 permits the spring 57 to engage the spring 58, thereby removing the ringer from across the line and bridging the primary circuit instead. When the primary circuit is thus bridged across the line an energizing circuit is completed for the line relay winding 124, said circuit extending from ground G' through the springs 18 and 21 to the line conductor 59, through the primary circuit of the substation to the line conductor 60, through the springs 22 and 20, winding 124, through the winding of the interrupter relay 40, springs 125 and 126, springs 127 and 128 to the battery lead 83, thence through battery B to ground G. This circuit includes two relay windings in series which operatively energize and attract their respective armatures, the relay 40 placing the springs 129, 130 and 131 in contact, and the armature 16 placing the springs 17 and 18 in contact. When this operation of the windings 40 and 124 occurs, an energizing circuit is established through the trip-in winding 132 extending from ground G' through the springs 18 and 17, winding 132, springs 131, 130 and 129, springs 127 and 128 to the battery lead 83, thence through battery B to ground G. Also, when the relay 40 energizes, a circuit is closed through the interrupter relay 41 extending from ground G' through the relay 41, springs 130 and 129, springs 127 and 128 to the battery lead 83, thence through battery B to ground G. The relay 41, upon energizing, operates to disengage the springs 125 and 126, whereby the circuit through the line relay winding 124 in series with the interrupter relay 40 is broken. This permits the two relay armatures to restore their respective springs to normal position. Furthermore, when the trip-in winding 132 becomes energized, as explained, the armature 19 and the plunger arm 3 are attracted against the core. The attraction of the armature 19 results in the separation of the springs 20 and 22, and 21 and 18, whereby the line conductors 60 and 59 are disconnected from the line switch springs 20 and 18.

When the plunger arm 3 is attracted the plunger 2 is thrust into an idle bank terminal, pressing the following springs into contact: 133 and 134, 135 and 136, 137 and 138, and 139 and 140. The engagement of the springs 133 and 134 and 139 and 140 extends the subscriber's line conductors 59 and 60 to the line relay 81 of the first-selector switch E. When the bank springs 137 and 138 engage, an energizing circuit is established through the motor magnet relay 37, which latter in turn operates to close an energizing circuit

through the motor magnet 33 of the master switch S. The motor magnet then operates to advance all idle plungers that are in locking engagement with the shaft to a point opposite the next idle bank terminal similar to the terminal just engaged. The circuit through the relay 37 extends from ground G' through the winding of the relay 37 to the common segment 35, thence through the wiper 36, through the segment 141, conductor 142, bank terminal springs 137 and 138, through the winding of the common resistance coil 143 to the battery lead 83, thence through battery B to ground G. The relay 37, upon energizing, operates to place the springs 144 and 145 in contact, whereby a circuit is completed through the motor magnet 33, said circuit extending from ground G' through the winding of the motor magnet 33, interrupter springs 147 and 146, motor magnet relay springs 144 and 145 to the battery lead 83, thence through battery B to ground G. The motor magnet 33, upon energizing, attracts its armature 148, whereby the pawl engages the ratchet wheel 34, advancing the latter one step. When the armature 148 is attracted against the magnet cores the springs 146 and 147 disengage, thereby breaking the energizing circuit through the motor magnet 33 and permitting the armature 148 to return to normal position. When the ratchet wheel 34 is given one step the fiber wheel permits the springs 149 and 150 to engage, thereby closing a new circuit through the motor magnet 33. These springs 149 and 150 maintain the circuit through the motor magnet until the next succeeding tooth on the fiber wheel 38 permits the springs 149 and 150 to disengage; but by that time the master switch bank wiper 36 has reached the next individual segment 151, and if the trunk corresponding to this trunk is busy a new circuit is closed through the motor magnet relay 37, which relay again operates to close a circuit through the motor magnet 33 which also again operates, as previously explained. This operation of the master switch continues as long as the master switch bank wiper 36 continues to find individual segments *a* upon which there are guarding potentials. As soon as an idle segment is found, however, the energizing circuit through the motor magnet relay 37 is broken, at which time the said relay in turn breaks the energizing circuit for the motor magnet 33 until the next subscriber calls. The open main relay 39, as previously stated, energizes in multiple with the motor magnet 33 and, when energized, main battery (the non-grounded pole of the battery) is disconnected from the interrupter relay 40. This provision is made in order that no line switch of the group may be tripped-in while the master switch is op-

erating to select an idle trunk. When the bank springs 135 and 136 engage, an energizing circuit is established through the bridge-cut-off winding 152 extending from
 5 ground G⁵ at the first-selector E, as will be explained, through the springs 153 and 154, over the private trunk conductor 155, through the bank springs 136 and 135, through the bridge-cut-off winding to the
 10 battery lead 83, thence through battery B to ground G. The bridge-cut-off winding thereupon energizes the magnet core and maintains the plunger arm 3 in its attached position. The engagement of the bank
 15 springs 135 and 136 also establishes a guarding potential by way of the normal conductor 156 to the connector private bank contacts corresponding to the line that terminates in the line switch L to prevent any
 20 subscriber from calling the said line after the calling subscriber at substation A removes his receiver preparatory to making a call, as explained. Also, the closure of connection between the springs 137 and 138
 25 establishes a guarding potential at the master switch bank contact 141. It will be understood that the said bank terminal (the one just engaged), being the first bank terminal of the line switch bank, corresponds
 30 to the first segment 141 of the master switch bank and, therefore, to the trunk-line the conductors 157, 158 and 155 of which terminate in the first selector switch E. This guarding potential protects the seized trunk
 35 conductors 157, 158 and 155 from being seized by other plungers, as already explained.

The closure of connection between the springs 133 and 134 extends the calling subscriber's line conductor 59 to the trunk conductor 157 and the side switch wiper 64 of the first-selector switch E. The closure of
 40 contact between the springs 139 and 140 in a similar manner extends the subscriber's line conductor 60 to the trunk conductor 158 and to the side switch wiper 65 of the selector E. The subscriber has thus established connection with the selector switch, which is now
 45 operated by the impulses that are delivered when the dial returns to normal position for the first digit. The operation of the switches up to this point has occurred before the subscriber releases the dial for the first digit. When the subscriber's line conductors 59
 50 and 60 are thus extended to the first-selector switch E an energizing circuit is established through the line relay 81 extending from ground G⁶ through the winding 84 to the contact point 70, side switch wiper 65, trunk
 55 conductor 158, through the bank springs 140 and 139 to the line conductor 60, through the springs 57 and 58, impulse springs 55 and 54, primary winding 45, transmitter 47 to the line conductor 59, through the bank springs 133 and 134, trunk conductor 157, side

switch wiper 64, contact point 69, through the winding 82 to the battery lead 83, thence through battery B to ground G. The relay 81, upon energizing, operates to place the
 70 springs 161 and 162 in contact, whereby an energizing circuit is established through the release relay 92 extending from ground G⁷ through the springs 161 and 162, relay 92 to the battery lead 83, thence through battery
 75 B to ground G. The release relay 92, upon energizing, operates to carry the spring 163 out of engagement with the spring 164 and into engagement with the spring 165, and the spring 153 into engagement with the spring 154. This is the condition of the
 80 first-selector switch E when the subscriber operates the dial for the first digit. The first digit being 2, the impulse spring 54 is twice carried out of engagement with the impulse spring 55. As a result the energiz-
 85 ing circuit through the line relay 81 is broken twice, and the spring 161 comes into contact with the spring 166 twice. After the two impulses are thus transmitted, the line relay 81 again energizes and carries the
 90 spring 161 into contact with the spring 162. As previously explained, the relay 92 is slow-acting—that is, slow to deenergize; and when this energizing circuit is momentarily broken during the vertical impulses just de-
 95 livered, the said relay does not deenergize, but remains in an operated position with the spring 163 in contact with the spring 165. Then when the spring 161 engages the spring 166 two impulses are transmitted to the
 100 vertical magnet 85 from ground G⁷ through the springs 161 and 166 to the springs 163 and 165, through the private magnet relay 86, through the winding of the vertical magnet 87, contact point 72, side switch wiper
 105 67 to the battery lead 83, thence through battery B to ground G. Two impulses being transmitted, the vertical magnet 85 is thereby energized twice, and the shaft wipers are given two vertical steps in the well-known
 110 manner. It will be seen that the private magnet relay 86 is included in the energizing circuit of the vertical magnet 85. The relay 86 also energizes, but being a slow-acting relay it energizes on the first impulse
 115 and remains so until the impulses are transmitted. This relay, upon energizing, operates to close the springs 167 and 168 in contact, whereby an energizing circuit is established through the private magnet 68. This
 120 circuit extends from ground G⁷ through the springs 167 and 168, private magnet 68 to the battery lead 83, thence through battery B to ground G. The private magnet relay 86 deenergizes after the last vertical im-
 125 pulse, since the energizing circuit is no longer maintained after the springs 161 and 166 disengage. Hence the said relay deenergizes, permitting the springs 167 and 168 to disengage, whereby the energizing
 130

circuit through the private magnet 68 is in turn broken, which magnet now deenergizes and permits the side switch to pass from first to second position, thus permitting the side switch wipers 66 and 67 to engage the contact points 75 and 76, respectively.

The closure of contact between the side switch wiper 67 and the contact point 76 sets up an energizing circuit for the rotary magnet 87 from ground G^6 through the interrupter springs 169, through the winding of the rotary magnet 87, contact point 76, side switch wiper 67 to the battery lead 83, thence through battery B to ground G. The said rotary magnet then operates to rotate the shaft wipers 61, 62 and 63 of the selector E into engagement with the first contact of the second level of the selector banks, from which contact it is assumed the trunk-line conductors 170, 171 and 172 lead to the connector switch H. If the first trunk-line is busy, however, and the wipers have to pass over busy trunk-lines, then as soon as the private wiper 63 engages the first private bank contact the private magnet 68 again energizes, locking the side switch in second position. The energizing circuit for said private magnet extends from ground G^9 , springs 174 and 176, conductor 172, through the private wiper 63, thence through the conductor 173 to the side switch wiper 66, contact point 75, through the winding of the private magnet 68 to the battery lead 83, thence through battery B to ground G. The private magnet 68, upon thus becoming energized, locks the side switch wiper 67 in engagement with the contact point 76, whereby the rotary magnet 87 will be energized to operate the mechanism step by step until the wipers are carried beyond the last busy trunk-line. At the instant that the private wiper leaves the last busy contact point the energizing circuit through the private magnet 68 is destroyed, and as a result the selector side switch passes to third position. If, however, there are no busy trunk-lines, the private magnet 68 releases the side switch to third position as soon as the wipers are carried into engagement with the first trunk-line. As soon as the side switch passes to third position, as stated, the subscriber's line conductors 59 and 60 are extended to the conductors 170 and 171 which, in this case, it is assumed lead to the connector switch H. The extending of the line occurs, of course, as soon as the side switch wipers 64 and 65 engage the contact points 77 and 78, respectively. When the subscriber's line conductors are thus extended to the connector switch H an energizing circuit is established through the line relay 96 in the same manner in which the energizing circuit was established through the line relay 81 of the selector switch E when the line conductors were extended to the first selector. The en-

energizing circuit through the line relay 96 extends from ground G^8 through the winding 98, trunk conductors 171 and 158 to the line conductor 60, thence through the substation to the line conductor 59, trunk conductors 157 and 170, thence through the winding 97 to the battery lead 83, and through battery B to ground G. The line relay 96, upon energizing, operates to shift the spring 174 from the spring 175 to the spring 176, whereby an energizing circuit is established through the release relay 100 extending from ground G^2 through the springs 174 and 176, relay 100 to the battery lead 83, thence through battery B to ground G. When the relay 100 energizes, the spring 177 is shifted out of contact with the spring 178 and into contact with the spring 179, and the spring 180 is shifted into engagement with the spring 181. This primary operation of the connector relays 96 and 100 occurs at the instant that the side switch wipers 64 and 65 of the selector E pass to third position and extend the subscriber's line conductors to the connector H. The engagement of the springs 181 and 180 establishes a guarding potential for protecting the trunk-line conductors 170, 171 and 172 against seizure by another line and first-selector switch. This potential extends from ground G^{10} to the side switch wiper 105, springs 180 and 181, conductor 172 to the private bank contact engaged by the shaft wiper 63. Furthermore, when the side switch of the selector E passes to third position a new energizing circuit is established through the release relay 92, said circuit extending from ground G^{10} at the connector switch to the conductor 172, through the shaft wiper 63, side switch wiper 66, conductor 182, through the release relay 92 to the battery lead 83, thence through battery B to ground G.

The operation of the dial for the last two digits affects the connector switch, and when the dial is operated for the second digit 2 the impulse spring 54 is twice carried out of engagement with the spring 55, thereby momentarily deenergizing the line relay 96 twice, whereby the spring 174 twice engages the spring 175, thus sending two impulses to the vertical magnet 99 from ground G^9 through the springs 174 and 175, springs 177 and 179, through the vertical magnet 99, side switch wiper 106, private magnet relay 101 to the battery lead 83, thence through battery B to ground G. The private magnet relay 101 energizes when the first impulse is delivered, and since the said relay is slow-acting it remains in an operated position until all the vertical impulses are sent. The vertical magnet, upon being energized, operates one step at a time to carry the shaft wipers 93, 94 and 95 two steps to a point opposite the second level. The relay 101, upon energizing, shifts the

spring 183 out of engagement with the spring 184 and into engagement with the spring 185; also, the spring 186 is shifted out of engagement with the spring 185.

When the springs 185 and 183 engage, an energizing circuit is established through the private magnet 102 from ground G^{21} through the springs 185 and 183, private magnet 102 to the battery lead 83, thence through battery B to ground G. The relay 101, being a slow-acting relay, remains in an operated position while the vertical impulses are being sent; but after all the impulses are delivered, and the line relay 96 returns to its operated position, the circuit through the relay 101 becomes broken, thus permitting the springs 183 and 186 to return to normal position. When the springs 183 and 185 disengage, the circuit through the private magnet 102 becomes broken, whereby the said magnet deenergizes, permitting the side switch to pass from first to second position. The calling subscriber now operates the calling device for the last digit 0, thereby transmitting ten impulses and operating the line relay 96 ten times. Each time that the line relay springs 174 and 175 engage, an energizing circuit is established through the rotary magnet 100^a from ground G^2 through the said springs 174 and 175, and through the springs 177 and 179, locking relay springs 187 and 188, through the rotary magnet 100^a, thence through the side switch wiper 106, and through the private magnet relay 101 to the battery lead 83, thence through battery B to ground G. Again the private magnet relay energizes, as in the previous case, remaining so until all the impulses are transmitted, thereby retaining the private magnet energized also. The rotary magnet 100^a then operates to rotate the shaft wipers into engagement with the desired line #220. If this line is busy at the time, the connector side switch will be locked in second position in a manner to be described, and the calling subscriber is given the busy-signal, thus making it impossible to extend the calling line into connection with the called line.

Before describing the results that follow when the connector finds a busy line, the description of how a connection is established will be completed. As soon as the line relay 96 ceases to operate for the last digit, the private magnet relay 101 deenergizes, as heretofore explained, in this instance permitting the side switch to trip to third position. The result is that the side switch wipers 103, 104, 105, 106 and 107 engage the contact points 189, 190, 191, 192 and 193, respectively. When the side switch wiper 107 engages the contact point 193 a guarding potential is completed at the private wiper 95 for protecting the seized line against outside interference while the connection is established. This guarding potential extends from ground G^{11} to the contact point 193, thence by way of the side switch wiper 107, locking-relay springs 194 and 195 to the private wiper 95. Not only does this guarding potential prevent other connectors from seizing the same line over multiples of the normal conductors 196, 197 and 198, but it also provides means for energizing the bridge-cut-off relay winding 199 of the line switch L' , whereby the switch L' is prevented from operating when the called subscriber removes his receiver 200 from the switch-hook 201. It will also be seen that when the side switch passes to third position the trunk-release conductor 172 that runs between the first-selector and the connector is provided with guarding potential from ground G^2 through the line relay springs 174 and 176 to the conductor 172. However, while the side switch is in first or second position a guarding potential for this trunk conductor 172 is also provided from ground G^{10} , but through the side switch wiper 105, release relay springs 180 and 181. The reason for this is that the guarding potential from ground G^2 is interrupted while the line relay 96 is operating, and there is some liability of some other selector similar to the first-selector E stopping on the same trunk-line. After the side switch passes to third position, however, there is no such liability, and the potential is provided from ground G^2 through the line relay springs, as stated. Of course, when the side switch wipers 103 and 104 engage the third-position contact points 189 and 190, the calling subscriber's line is placed in connection with the called subscriber's line over the heavy conductors shown, passing through the ringer relay springs 202 and 203 on one side, and 204 and 205 on the other side. As soon as connection is thus established the ringer relay 112 is energized over the circuit established when the side switch wiper 106 engages the contact point 192, the energizing current flowing from ground G^{12} through the interrupter 111, through the back-bridge relay springs 206 and 207, ringer relay 112, conductor 208, contact point 192, side switch wiper 106, private magnet relay 101 to the battery lead 83, thence through battery B to ground G.

It will be seen that as the interrupter 111 revolves, the energizing circuit of the ringer relay 112 will be broken periodically, so as not to ring the called subscriber continuously. It will be seen that each time that the ringer relay is energized the springs 203 and 205 are separated from the ringer relay springs 202 and 204, thereby breaking the calling line from the called line, and pressing the springs 203 and 205 onto the springs 209 and 210, which latter are the terminals of the ringer generator I. As a result ring-

ing current is sent over the called line for energizing the bell 211 while the springs 212 and 213 are in contact. The guarding potential from ground G^{11} to the shaft wiper 95 also provides an energizing circuit for the bridge-cut-off winding 199, said circuit extending from ground G^{11} to the wiper 95, as traced, through the conductor 198, winding of the bridge-cut-off relay to the battery lead 83, thence through battery B to ground G. The strength of the magnetism produced by the bridge-cut-off winding is not sufficient to attract the plunger arm and thrust the plunger into a bank terminal. The bridge-cut-off armature 214, however, is attracted, and the bridge-cut-off springs separated, thereby disconnecting the subscriber's line conductors 215 and 216 from the line switch L' . The ringer relay continues to energize intermittently each time that the interrupter 111 closes the circuit. However, as soon as the called subscriber answers, the back-bridge relay 108 is energized by a flow of current from ground G^{11} , contact point 193, side switch wiper 107, winding 110 of the back-bridge relay 108, ringer relay springs 204 and 205, side switch wiper 104, contact point 190, line wiper 94, normal conductor 197, line conductor 216, switch-hook springs 213 and 217, impulse springs 218 and 219, transmitter 220, line conductor 215, normal conductor 196, line wiper 93, contact point 189, side switch wiper 103, ringer relay springs 203 and 202, winding 109 of the back-bridge relay 108, thence to the battery lead 83, and through battery B to ground G. When the back-bridge relay 108 is once energized, however, the energizing circuit for the ringer relay 112 is interrupted at a point between the springs 206 and 207, thus making it impossible for the ringer relay to energize as long as the called subscriber is on the line. The subscribers thus connected may communicate over the main talking conductors indicated by the heavy lines and including on one side the condenser 117 at the connector H, and on the other side the condenser 118. After the subscribers are through talking, if the calling subscriber hangs up his receiver he opens the line circuit at a point between the springs 57 and 58, thereby initiating the release of all the switches. This release is as follows: When the circuit is broken between the said springs 57 and 58, the double-wound line relay 96 and the release relay 100 of the connector H deenergize. The deenergization of the slow-acting relay 100 and the line relay 96 closes the energizing circuit for the release magnet 114 at points between the springs 177 and 178 and between the springs 174 and 175. A flow of current is, therefore, set up from ground G^9 through the springs 174 and 175, through the springs 177 and

178 to the release magnet 114, thence through said magnet to the off-normal spring 115, to the contact point 116 and to the battery lead 83, thence through battery B to ground G. The release magnet instantly releases the connector switch shaft and side switch, thereby breaking the energizing circuit through the back-bridge relay 108, if the called subscriber has not in the meantime restored his receiver, and also the energizing circuit through the bridge-cut-off relay 199 of the called line switch L' . As soon as the connector switch shaft reaches its lowest position it breaks the circuit for the release magnet 114 by separating the off-normal spring 115 from the contact point 116, at which instant the release magnet of the connector is also restored. The operation of the line relay 96 and of the slow-acting relay 100 not only causes the release of the connector, as described, but also the release of the preceding switches, because the ground connection from ground G^9 to the trunk-release conductor 172 is interrupted by both of these relays. Since the release relay 92 is dependent upon this ground for its energized condition, as already explained, it follows that it will fall back, with the following results: As soon as the release relay 92 of the first-selector E deenergizes, the spring 163 falls back into normal engagement with the spring 164, thereby closing an energizing circuit for the release magnet 88 from ground G^7 through the springs 161 and 166, through the springs 163 and 164 to the release magnet 88, thence to the contact point 91, off-normal spring 90 to the battery lead 83, thence through battery B to ground G. As soon as the release magnet 88 energizes, the first-selector side switch and switch shaft are restored, which latter, upon reaching its lowest position, opens up the release circuit at a point between the off-normal spring 90 and the contact point 91, whereby the release magnet 88 is restored also. Furthermore, when the release relay 92 deenergizes and separates the springs 153 and 154, the energizing circuit through the bridge-cut-off winding 152 of the line switch L is broken. When this circuit becomes broken the magnet core deenergizes and permits the plunger arm 3 to return to normal position and withdraw the plunger from the bank terminal. After the switches are thus restored the calling subscriber can, of course, then proceed to make another call.

Returning now to that stage of the call where the calling subscriber was operating the connector switch in accordance with the last digit 0, it will be explained what takes place in the event that the desired line is busy. When the line #220 is calling, or when it has been called by someone, the private bank contacts in which the normal con-

ductor 198 terminates are connected to ground. If another connector switch has called the line this guarding potential is supplied through the connector switch from
 5 a ground terminal similar to the ground terminal G^{11} in the connector switch H, as already explained; but if the line switch L' is calling, a guarding potential is established from the first-selector release relay ground,
 10 as in Fig. 1, thence to the private bank contact. Therefore, when the subscriber at substation A sends in the last impulse the private wiper 95 is carried onto the grounded contact; and when the slow-acting relay 101
 15 of the connector deenergizes, instead of the side switch tripping to third position, as in the case where the line is not busy, it is locked and the calling subscriber is then given the busy-signal. The method by
 20 which this side switch is locked is as follows: The slow-acting relay springs 183, 184 and 185 are so arranged that as the relay 101 deenergizes, the spring 183 engages the spring 184 before it leaves the spring 185,
 25 and in this way the private magnet 102 is prevented from deenergizing, because the spring 184 is connected with the private wiper 95 at the time over the following circuit: from the private wiper 95 to the locking spring 195, thence to the spring 194, and
 30 through the winding 110 of the back-bridge relay 108 to the talking line conductor 221, thence through the ringer relay springs 204 and 205 to the side switch wiper 104, contact point 222 (the side switch being in second position) to the slow-acting relay spring
 35 184. Therefore, when the spring 183 engages the spring 184 the private magnet 102 is not deenergized, since the energizing circuit is maintained from the private wiper 95 to the said spring 184, as described, thence through the spring 183, and through the private magnet 102 to the battery lead 83,
 40 thence through battery B to ground G. The private magnet therefore remains energized, retaining the side switch in second position. It will be seen that at the same time the back-bridge relay 108 energizes in series with the private magnet 102 over this circuit
 45 from the private wiper 95. Therefore, the back-bridge relay 108, upon energizing, presses the springs 223 and 224 into contact, thereby energizing the locking relay 113 over the following circuit: from ground G^{11}
 50 through the slow-acting relay springs 185 and 186, through the private magnet springs 225 and 226, through the said relay 113, and through the back-bridge relay springs 223 and 224 to the battery lead 83, thence
 55 through battery B to ground G. It will be seen that when the relay 113 energizes, the connection between the rotary magnet 100^a and the battery lead 83 is broken at a point between the springs 187 and 188. The object of this arrangement is to prevent the

calling subscriber from further rotating the connector switch if he should attempt to operate his dial while receiving the busy-signal—that is, while the connector switch is locked in second position. It will also be
 70 seen that when the relay 113 energizes, the circuit for maintaining the private magnet 102 energized is shifted from the private wiper 95 to the spring 227, which latter is connected to ground G^{11} . The object of this
 75 arrangement is to prevent the side switch from unlocking and passing to third position, if the switch that is maintaining the called line busy should be released while the calling subscriber A (Fig. 1) is receiving
 80 the busy-signal. It will be evident that if the ground G^{11} were not substituted for the ground at the private wiper 95, the private magnet 102 would deenergize if the switch that is supplying ground at the private
 85 wiper 95 should release, which would, of course, be undesirable. It will also be seen that the relay 113, upon energizing, closes the springs 228 and 123 in contact, thereby establishing the busy-circuit as follows:
 90 from the secondary winding of the busy coil 121 through the springs 228 and 123 to the second-position side switch contact point 229, side switch wiper 103, ringer relay springs 203 and 202, through the condenser
 95 117, through the substation A to the other side of the line, then over this side back to the connector H, through the winding 98 of the line relay 96 to ground G^8 , to the interrupter ground G^{14} , through the inter-
 100 rupter 119 to the primary winding of the busy coil 121 and back to the secondary winding. When the calling subscriber receives the busy-signal he understands that the line is busy and hangs up his receiver.
 105 The line circuit is open, as already explained, with the result that the line and slow-acting relays 96 and 100 of the connector H deenergize, causing the release of the connector and all other switches, as heretofore explained. It will, of course, be seen
 110 that as soon as the side switch is restored the energizing circuit for the back-bridge relay 108 (which includes the winding 110 thereof) and for the private magnet 102 is broken, when the side switch wiper 104 leaves the contact point 222. Now, since the energizing circuit for the locking relay 113 is controlled by the back-bridge relay 108,
 115 the said locking relay is also deenergized, and the connector switch is left in normal condition.

Heretofore the windings of the different relays and operative magnets of the line switches have been upon separate or individual spools and cores, but in my present switch all of the windings are wound upon the same spool and core and are so arranged that each performs its proper function without interfering with the others. When the
 120
 125
 130

winding 124 carries current the armature 16 alone is affected thereby; also, when the bridge-cut-off winding, which is wound upon the same end of the core with the trip-in winding 132, carries current the bridge-cut-off armature 19 is attracted against the magnet core, and the springs it controls are separated, but the plunger arm is not operated; but when the trip-in winding 132 carries current the magnetism produced in the core is sufficient to attract the armature 19 and also the plunger arm 3, which latter in turn thrusts the plunger into the bank. When the plunger enters the bank an energizing circuit is closed through the bridge-cut-off winding 152. The magnetism produced in the core by this winding is ample to maintain the plunger arm in its attracted position after being operated by the trip-in winding 132.

From the foregoing it will be seen that I provide a two-wire automatic telephone exchange system in which there is only a single magnet spool for each subscriber's line, the energizing of which magnet is controlled by the subscriber over a complete metallic line circuit. The said spool, it will be seen, has one winding which is energized over the complete metallic line circuit, another winding which is energized over a local circuit, and a third winding which is energized over a third trunk conductor extending to the next switch. The single spool thus provided is sufficient, however, to effect all of the desired operations of the subscriber's line or trunking switch. As shown, the said line or trunking switch L is allotted to a subscriber's line, but it will be readily understood that it is not limited to such use, as it may also be used for extending one trunk-line into connection with another.

What I claim as my invention is:—

1. In a telephone system, a line, a series of trunks, an automatic switch individual to said line for connecting the same with an idle trunk, said switch having a single magnet core provided with a plurality of windings thereon, a circuit including both sides of the line in series for energizing one of said windings, and a local circuit for energizing another of said windings.

2. In a telephone system, a subscriber's line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core having a plurality of windings thereon, a circuit including the two sides of said line in series for energizing one of said windings when the subscriber calls, and a local circuit for energizing another of said windings.

3. In a telephone system, a line, a series of trunks, an automatic switch for establishing connection between said line and an idle

one of said trunks, said switch provided with a single magnet spool having a plurality of windings thereon, a circuit for energizing one of said windings including the two sides of said line in series, a local circuit for energizing another of said windings, and a circuit including a conductor of one of said trunks for energizing a third winding.

4. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core having a plurality of windings thereon, a circuit including a conductor of said line for energizing one of said windings, which circuit is controlled by the magnet, and a local circuit for energizing another of said windings.

5. In a telephone system, a line, a series of trunks, an automatic switch for establishing connection between said line and an idle one of said trunks, provided with a three-wound magnet, a circuit for energizing one of said windings including a conductor of said line, a local circuit for energizing another of said windings, and a circuit including a conductor of one of said trunks for energizing a third winding.

6. In a telephone system, a line, a series of trunks, an automatic switch individual to said line for connecting the same with an idle trunk, said switch having a single magnet core provided with a plurality of windings thereon, a circuit including both sides of the line in series for energizing one of said windings, a local circuit for energizing another of said windings, and an armature for said magnet responsive to the energizing of said first winding to close the local circuit of said other winding.

7. In a telephone system, a subscriber's line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core having a plurality of windings thereon, a circuit including the two sides of said line in series for energizing one of said windings when the subscriber calls, a local circuit for energizing another of said windings, and an armature for said magnet responsive to the energizing of said first winding to close the local circuit of said other winding.

8. In a telephone system, a line, a series of trunks, an automatic switch for establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet spool having a plurality of windings thereon, a circuit for energizing one of said windings including the two sides of said line in series, a local circuit for energizing another of said windings, a circuit including a conductor of one of said trunks

for energizing a third winding, and an armature for said magnet responsive to the energizing of said first winding to close the local circuit of said other winding.

5 9. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core
10 having a plurality of windings thereon, a circuit including a conductor of said line for energizing one of said windings, a local circuit for energizing another of said windings,
15 to the energizing of said first winding to close the local circuit of said other winding.

10. In a telephone system, a line, a series of trunks, an automatic switch individual to said line for connecting the same with an
20 idle trunk, said switch having a single magnet core provided with a plurality of windings thereon, a circuit including both sides of the line in series for energizing one of said windings, a local circuit for energizing
25 another of said windings, and as many armatures for said magnet as there are windings thereon.

11. In a telephone system, a subscriber's line, a series of trunks, an automatic switch
30 for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core having a plurality of windings thereon, a circuit including the two sides of
35 said line in series for energizing one of said windings when the subscriber calls, a local circuit for energizing another of said windings, and as many armatures for said magnet as there are windings thereon.

40 12. In a telephone system, a line, a series of trunks, an automatic switch for establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet spool having a plural-
45 ity of windings thereon, a circuit for energizing one of said windings including the two sides of said line in series, a local circuit for energizing another of said windings, a circuit including a conductor of one of said
50 trunks for energizing a third winding, and as many armatures for said magnet as there are windings thereon.

13. In a telephone system, a line, a series of trunks, an automatic switch for automati-
55 cally establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core having a plurality of windings thereon, a circuit including a conductor of said line for
60 energizing one of said windings, a local circuit for energizing another of said windings, and as many armatures for said magnet as there are windings thereon.

14. In a telephone system, a line, a series of trunks, an automatic switch for establish-

ing connection between said line and an idle one of said trunks, a circuit for energizing one of said windings including a conductor of said line, a local circuit for energizing
70 another of said windings, a circuit including a conductor of one of said trunks for energizing a third winding, and as many armatures for said magnet as there are windings thereon.

15. In a telephone system, a line, a series of trunks, an automatic switch individual to
75 said line for connecting the same with an idle trunk, said switch having a single magnet spool provided with a plurality of windings thereon, a circuit including both sides of the line in series for energizing one of
80 said windings, a local circuit for energizing another of said windings, and a circuit-closing plunger operated by the closure of said local circuit.

16. In a telephone system, a subscriber's line, a series of trunks, an automatic switch
85 for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet spool having a plurality of windings thereon, a circuit including the two
90 sides of said line in series for energizing one of said windings when the subscriber calls, a local circuit for energizing another of said windings, and a circuit-closing plunger operated by the closure of said local
95 circuit.

17. In a telephone system, a line, a series of trunks, an automatic switch for establish-
100 ing connection between said line and an idle one of said trunks, said switch provided with a single magnet spool having a plurality of windings thereon, a circuit for energizing one of said windings including the two
105 sides of said line in series, a local circuit for energizing another of said windings, a circuit including a conductor of one of said trunks for energizing a third winding, and a circuit-closing plunger operated by the
110 closure of said local circuit.

18. In a telephone system, a line, a series of trunks, an automatic switch for automati-
115 cally establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet spool having a plurality of windings thereon, a circuit including a conductor of said line for energizing one of said windings, a local
120 circuit for energizing another of said windings, and a circuit-closing plunger operated by the closure of said local circuit.

19. In a telephone system, a line, a series of trunks, an automatic switch for establish-
125 ing connection between said line and an idle one of said trunks, a circuit for energizing one of said windings including a conductor of said line, a local circuit for energizing another of said windings, a circuit
130 including a conductor of one of said trunks

for energizing a third winding, and a circuit-closing plunger operated by the closure of said local circuit.

20. In a telephone system, a line, a series of trunks, an automatic switch individual to said line for connecting the same with an idle trunk, said switch having a single magnet core provided with a plurality of windings thereon, a circuit including both sides of the line in series for energizing one of said windings, a local circuit for energizing another of said windings, and a battery or centralized means of current-supply for furnishing current to said circuits for operating purposes, and over said line to the calling substation for talking purposes.

21. In a telephone system, a subscriber's line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core having a plurality of windings thereon, a circuit including the two sides of said line in series for energizing one of said windings when the subscriber calls, a local circuit for energizing another of said windings, and a battery or centralized means of current-supply for furnishing current to said circuits for operating purposes, and over said line to the calling substation for talking purposes.

22. In a telephone system, a line, a series of trunks, an automatic switch for establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet spool having a plurality of windings thereon, a circuit for energizing one of said windings including the two sides of said line in series, a local circuit for energizing another of said windings, a circuit including a conductor of one of said trunks for energizing a third winding, and a battery or centralized means of current-supply for furnishing current to said circuits for operating purposes, and over said line to the calling substation for talking purposes.

23. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core having a plurality of windings thereon, a circuit including a conductor of said line for energizing one of said windings, a local circuit for energizing another of said windings, and a battery or centralized means of current-supply for furnishing current to said circuits for operating purposes, and over said line to the calling substation for talking purposes.

24. In a telephone system, a line, a series of trunks, an automatic switch for establishing connection between said line and an idle

one of said trunks, provided with a three-wound magnet, a circuit for energizing one of said windings including a conductor of said line, a local circuit for energizing another of said windings, a circuit including a conductor of one of said trunks for energizing a third winding, and a battery or centralized means of current-supply for furnishing current to said circuits for operating purposes, and over said line to the calling substation for talking purposes.

25. In a telephone system, a line, a series of trunks, an automatic switch for establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet spool having three windings thereon, an armature for each winding, a line circuit for energizing one winding, a local circuit closed by the armature of the one winding for energizing another winding, a swinging and endwise movable circuit-closing plunger operated by the energizing of the said other winding, and a circuit including a trunk conductor for energizing the third winding, the armature of the third winding controlling the circuit of the one winding.

26. In a telephone system, a line, a magnet for said line, three windings on said magnet, two armatures for one end of said magnet, a single armature for the other end of said magnet, a traveling plunger operated by one of the two armatures, the circuit through one of said windings controlled by said plunger, and line and local circuits for the other two windings, the line circuit controlled by the other of the said two armatures, said third armature controlling said local circuit.

27. In a telephone system, a magnet individual to the subscriber's line having three windings, each winding controlled by a different circuit, and each winding having a separate armature, together with switching means controlled by said armatures.

28. In a telephone system, a line, a series of trunks, and an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core for controlling both the operation and the release of said switch, said magnet being provided with a plurality of windings, one of said windings adapted to control the operation of said switch and another to control the release of the same after operation thereof.

29. In a telephone system, a line, a series of trunks, and an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core for controlling both the operation and the release of said switch, said magnet being provided with a plurality of windings, one of said

windings adapted to control the operation of said switch and another to control the release of the same after operation thereof, said release winding being energized over
5 a circuit including one of said trunks.

30. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said
10 switch provided with a single magnet core for controlling both the operation and the release of said switch, said magnet being provided with a plurality of windings, one of said windings adapted to control the op-
15 eration of said switch and another to control the release of the same after operation thereof, and means for controlling the operation of said magnet over two sides of the line in series.

31. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said
20 switch provided with a single magnet core for controlling both the operation and the release of said switch, said magnet being provided with a plurality of windings, one of said windings adapted to control the op-
25 eration of said switch and another to control the release of the same after operation thereof, said release winding being energized over a circuit including one of said trunks, and means for controlling the operation of
30 said magnet over two sides of the line in series.

32. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said
40 switch provided with a single magnet core for controlling both the operation and the release of said switch, said magnet being provided with a plurality of windings, one of said windings adapted to control the op-
45 eration of said switch and another to control the release of the same after operation thereof, and a battery or centralized means of current-supply for furnishing current to said circuits for operating purposes, and
50 over said line to the calling substation for talking purposes.

33. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between
55 said line and an idle one of said trunks, said switch provided with a single magnet core for controlling both the operation and the release of said switch, said magnet being provided with a plurality of windings, one
60 of said windings adapted to control the operation of said switch and another to control the release of the same after operation thereof, said release winding being energized over a circuit including one of said

trunks, and a battery or centralized means
65 of current-supply for furnishing current to said circuits for operating purposes, and over said line to the calling substation for talking purposes.

34. In a telephone system, a line, a series
70 of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, said switch provided with a single magnet core for controlling both the operation and the
75 release of said switch, said magnet being provided with a plurality of windings, one of said windings adapted to control the operation of said switch and another to control the release of the same after operation
80 thereof, means for controlling the operation of said magnet over two sides of the line in series, and a battery or centralized means of current-supply for furnishing current to
85 said circuits for operating purposes, and over said line to the calling substation for talking purposes.

35. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between
90 said line and an idle one of said trunks, said switch provided with a single magnet core for controlling both the operation and the release of said switch, said magnet being provided with a plurality of windings, one
95 of said windings adapted to control the operation of said switch and another to control the release of the same after operation thereof, said release winding being energized over a circuit including one of said
100 trunks, means for controlling the operation of said magnet over two sides of the line in series, and a battery or centralized means of current-supply for furnishing current to
105 said circuits for operating purposes, and over said line to the calling substation for talking purposes.

36. In a telephone system, a line, a series of trunks, an automatic switch for auto-
110 matically establishing connection between said line and an idle one of said trunks, a magnet core for said switch, a pair of windings on said magnet core having the same magnetic circuit and adapted to control the operation and release of said switch, and a
115 third winding on said core having a separate magnetic circuit and adapted to control the circuit through one of said first-mentioned windings.

37. In a telephone system, a line, a series
120 of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, a magnet core for said switch, a pair of windings on said magnet core having the same
125 magnetic circuit and adapted to control the operation and release of said switch, a third winding on said core having a separate

magnetic circuit and adapted to control the circuit through one of said first-mentioned windings, and means for energizing said third winding over two sides of the line in series.

38. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, a magnet core for said switch, a pair of windings on said magnet core, a relay, and means for energizing said relay in series with one of said windings to thereby close a circuit through the second of said windings.

39. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, a magnet core for said switch, a pair of windings on said magnet core, a relay, and means for energizing said relay in series with one of said windings over two sides of the line in series.

40. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, a magnet core for said switch, a pair of windings on said magnet core, a relay, means for energizing said relay in series with one of said windings to thereby close a circuit through the second of said windings, and a second relay adapted to be energized in multiple with said second winding upon the energization of said first relay to thereby interrupt the energizing circuit of said first-mentioned relay and winding.

41. In a telephone system, a line, a series of trunks, an automatic switch for automatically establishing connection between said line and an idle one of said trunks, a magnet core for said switch, a pair of windings on said magnet core, a relay, means for energizing said relay in series with one of said windings over two sides of the line in series, and a second relay adapted to be energized in multiple with said second winding upon the energization of said first relay to thereby interrupt the energizing circuit of said first-mentioned relay and winding.

42. In a telephone system, a line, a plurality of trunks accessible thereto at a central office, a non-numerical automatic trunking switch for said line, means for operating the switch for connecting the line with an idle trunk, said means comprising a magnet, a circuit for said magnet comprising two control points, control means at each point having different time constants for closing one point before the other.

43. In a telephone system, a line, a plurality of trunks accessible thereto at a central office, a non-numerical automatic

trunking switch for said line, means for operating the switch for connecting the line with an idle trunk said means comprising a magnet, a circuit for said magnet comprising two control points, one in the line and one in the central office, control means at each point having different time constants.

44. In a telephone system, a line, a plurality of trunks accessible thereto at a central office, a non-numerical automatic trunking switch for said line, means for operating the switch for connecting the line with an idle trunk, said means comprising a magnet, a circuit for said magnet comprising two control points, one in the line and one in the central office, control means at each point having different time constants for holding one point open longer than the other.

45. In a telephone system, a line, a plurality of trunks accessible thereto at a central office, an automatic trunking switch for said line, means for operating the switch for connecting the line with an idle trunk, said means comprising a line relay, a circuit for said relay and a plurality of means for controlling said circuit having different time constants.

46. In a telephone system, a line, a plurality of trunks accessible thereto at a central office, an automatic trunking switch for said line, means for operating the switch for connecting the line with an idle trunk, said means comprising a line relay, a circuit for said relay comprising two control points, control means at each point having different time constants.

47. In a telephone system, a line, a plurality of trunks accessible thereto at a central office, an automatic trunking switch for said line, means for operating the switch for connecting the line with an idle trunk, said means comprising a line relay, a circuit for said relay comprising two control points, control means at each point having different time constants for closing one point before the other.

48. In a telephone system, a line, a plurality of trunks accessible thereto at a central office, an automatic trunking switch for said line, means for operating the switch for connecting the line with an idle trunk, said means comprising a line relay, a circuit for said relay comprising two control points, one in the line and one in the central office, the control means at each point having different time constants.

49. In a telephone system, a line, a plurality of trunks accessible thereto at a central office, an automatic trunking switch for said line, means for operating the switch for connecting the line with an idle trunk, said means comprising a line relay, a circuit for said relay comprising two control points, one in the line and one in the central

office, the control means at each point having different time constants for holding one point open longer than the other.

5 50. In a telephone system, a plurality of lines, a plurality of trunks common to said lines at a central office, a trunk selecting device for said lines comprising means common to all the lines and means individual to each line, a magnet for one of said lines,
10 a circuit for said magnet having two control

points, said common means controlling one and the individual means controlling the other, said common and individual means having different time constants.

Signed by me at Chicago, Cook county, 15 Illinois, this 20th day of August, 1908.

ALEXANDER E. KEITH.

Witnesses:

EDWARD D. FALES,
ETHEL A. EDGELL.

It is hereby certified that in Letters Patent No. 1,151,543, granted August 24, 1915, upon the application of Alexander E. Keith, of Hinsdale, Illinois, for an improvement in "Telephone-Exchange Trunking Systems," errors appear in the printed specification requiring correction as follows: Page 5, line 13, for the word "attached" read *attracted*; same page, line 126, for the word "the" read *this*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 7th day of December, A. D., 1915.

[SEAL.]

R. F. WHITEHEAD,
Acting Commissioner of Patents.

Cl. 179—18.