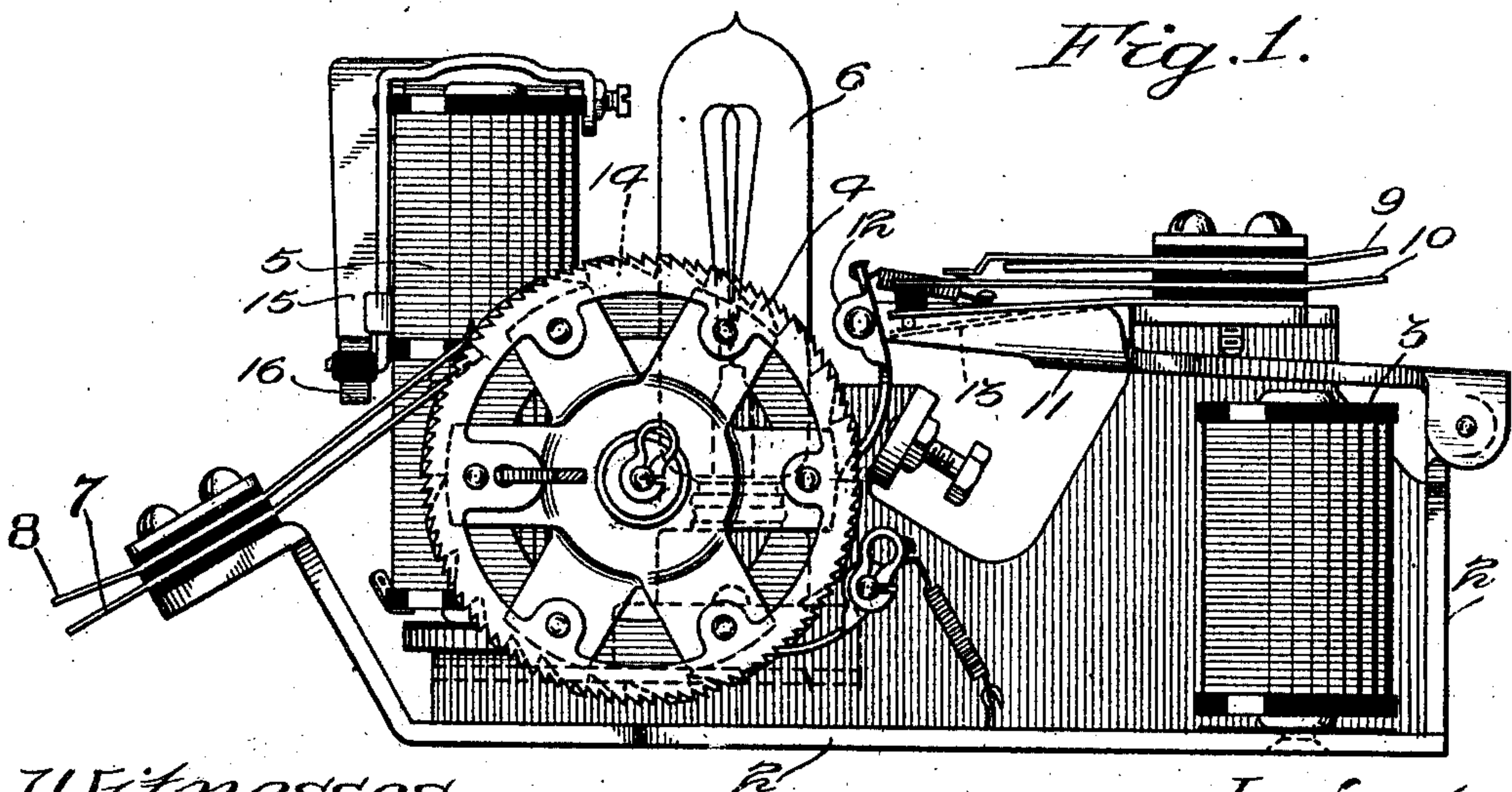
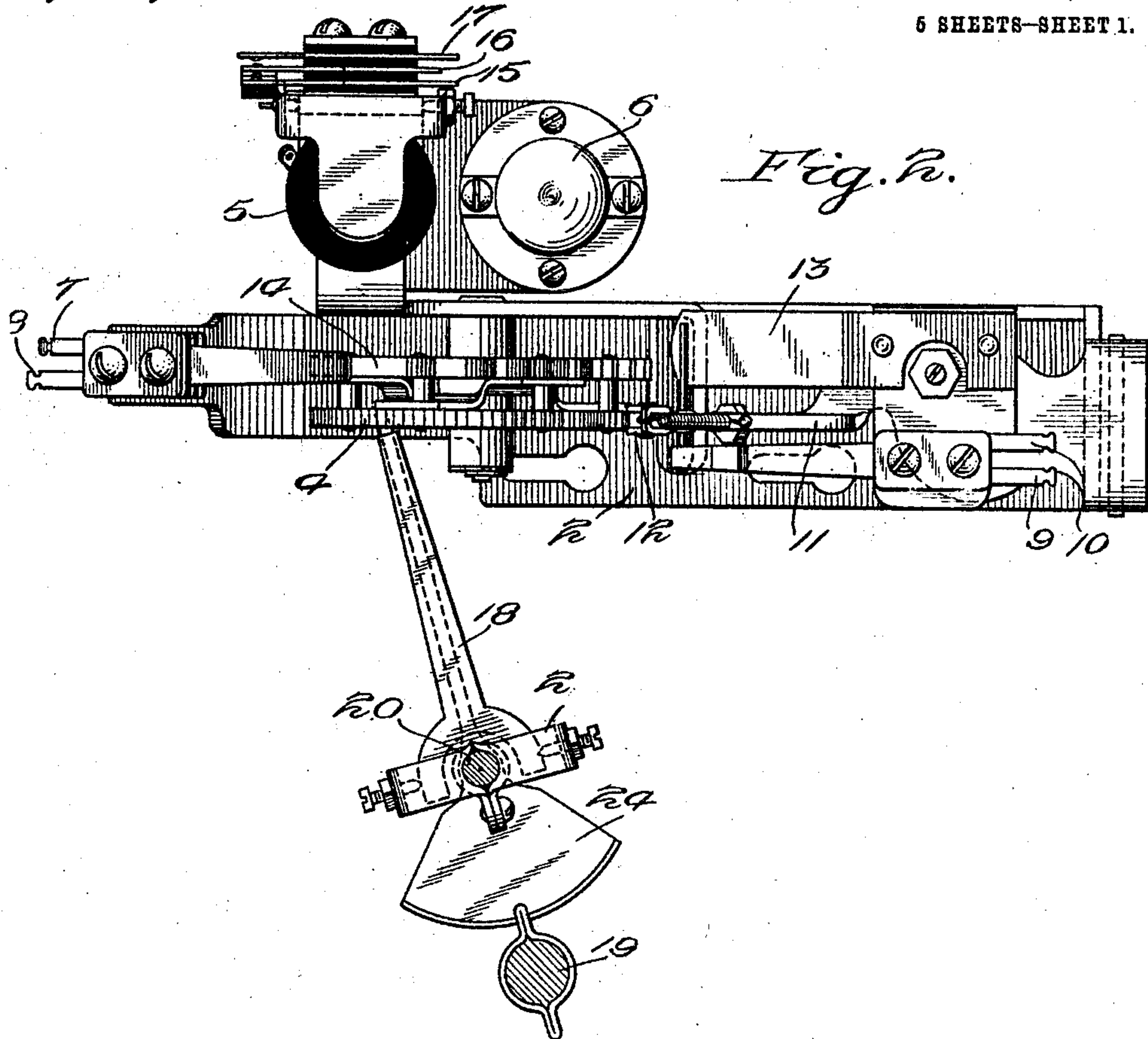


A. E. KEITH.
TELEPHONE EXCHANGE TRUNKING SYSTEM.
APPLICATION FILED JULY 21, 1908.

1,078,685.

Patented Nov. 18, 1913.

5 SHEETS—SHEET 1.



Witnesses.
A. Anderson
S. B. Sperry.

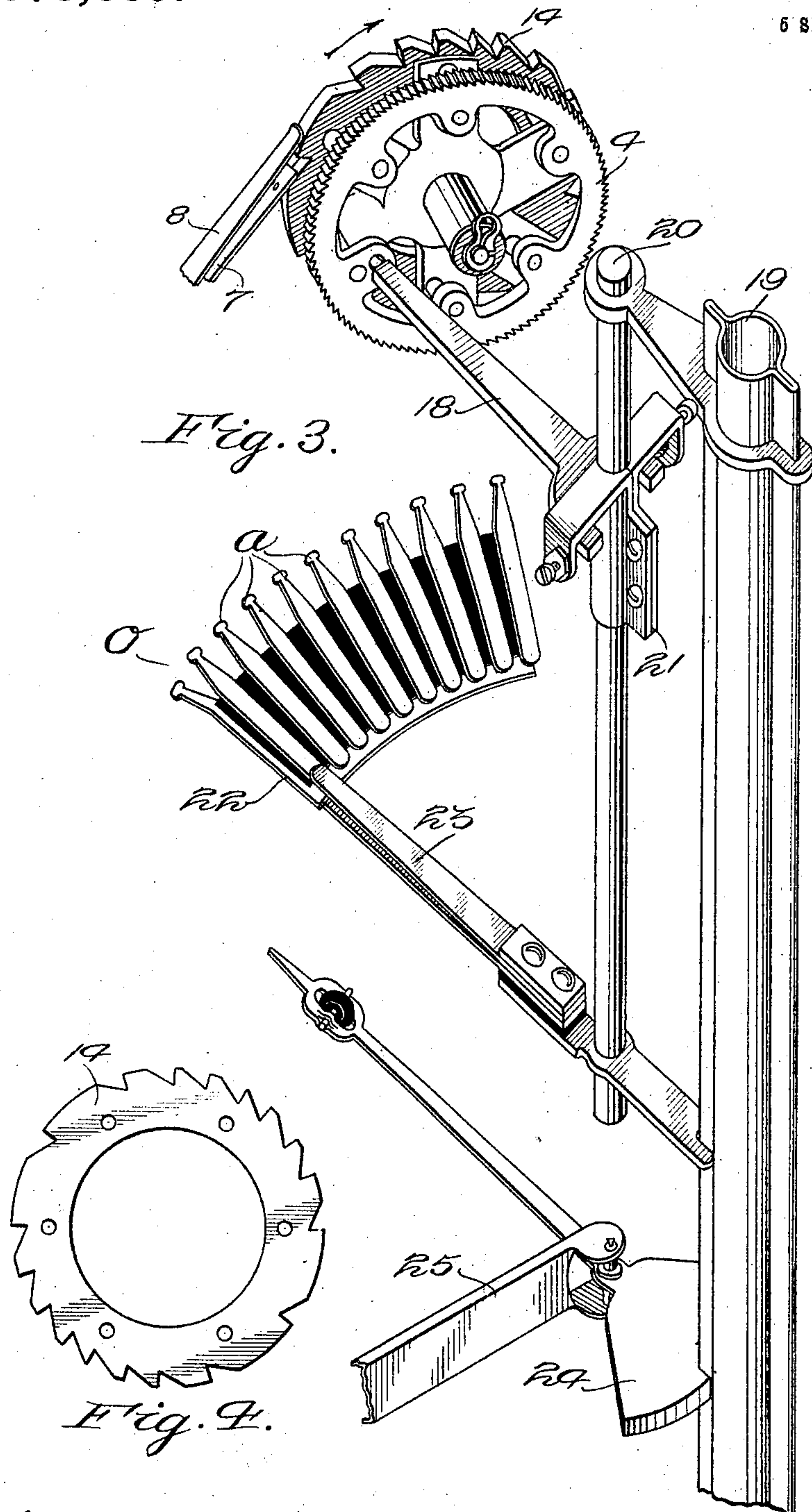
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6 SHEETS—SHEET 2.



Witnesses.
A. Andersen.
A. B. Sperry

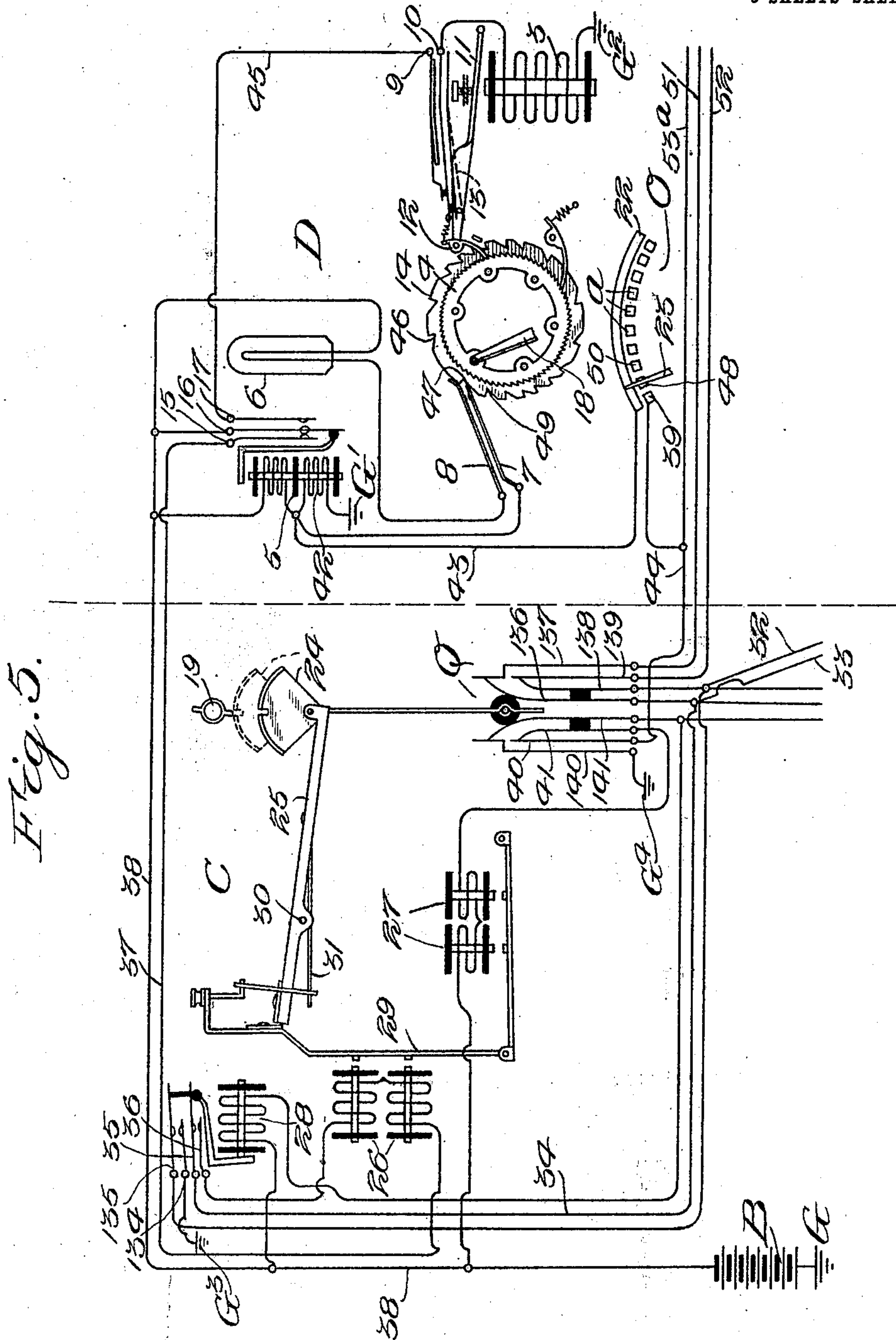
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6 SHEETS—SHEET 3.



Witnesses.
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5 SHEETS—SHEET 4.

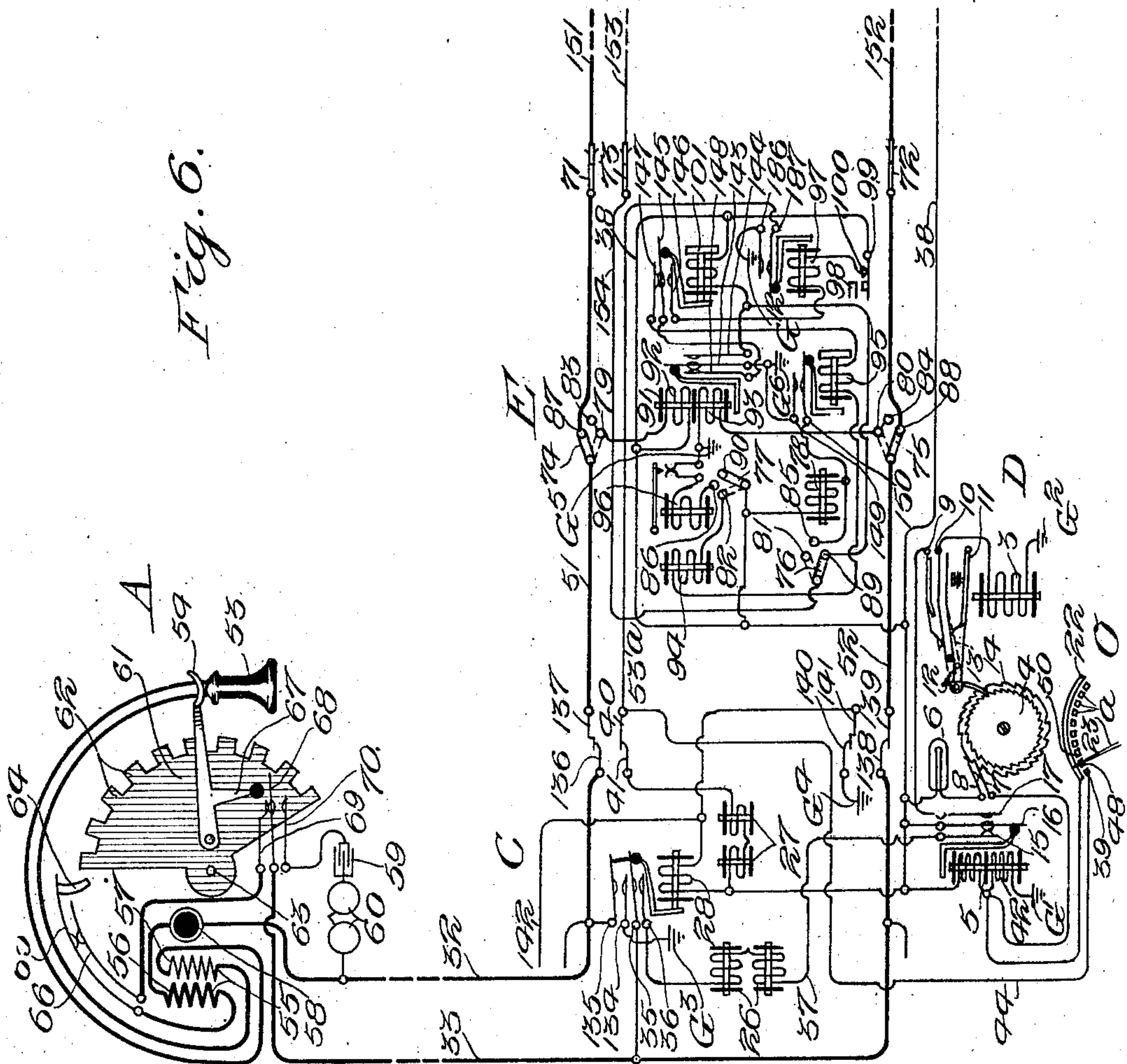


Fig. 6.

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5 SHEETS—SHEET 5.

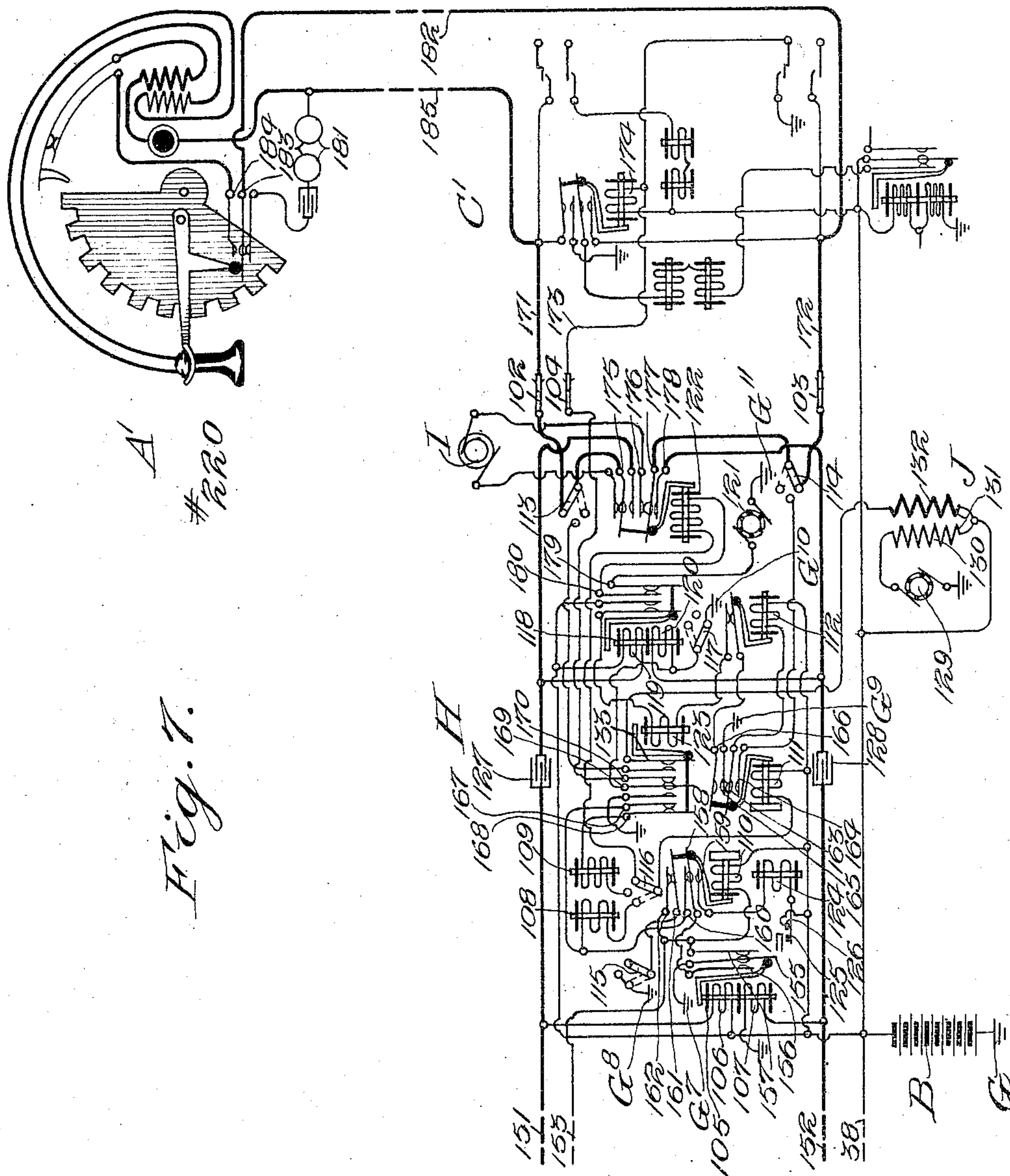


Fig. 1.

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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE TRUNKING SYSTEM.

1,078,685.

Specification of Letters Patent.

Patented Nov. 18, 1913.

Application filed July 21, 1908. Serial No. 444,649.

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 the automatic selection of idle trunks in a telephone exchange system.

Prior to my invention various ways have been proposed for automatically selecting idle trunks in a telephone exchange system. For example, master switches have been employed which were adapted to automatically select idle trunks ahead of the calls, so that each calling subscriber got a preselected idle trunk as soon as he removed his receiver from the hook, or as soon as he began operating the calling dial. In certain instances these master switches have been provided with wipers or traveling switch members adapted to move from one contact to another to select idle trunks, and when the last trunk was reached said wiper or switch member was then given a quick jump back to the first trunk or original starting point, from whence it then again traversed the various trunk terminals in the automatic selection of idle trunks. In other words, with a certain class of master switches the wipers thereof had a back and forth movement over a row or bank of terminals corresponding to the different trunk-lines, but the automatic selection of trunks occurred only during the movement of the said wipers in one direction, and the movement in the opposite direction was merely for carrying the same back to the first trunk or the original starting point. Furthermore, and with a certain construction of these switches, the wipers thus operated were not lockingly connected with the actuating mechanism—that is to say, were not so connected as to be incapable of moving in any other way in exact synchronism with the said actuating mechanism, such, for example, as a ratchet and pawl mechanism. It is obvious that with such a construction as this the switch was subject to more or less unnecessary wear and tear, together with some uncertainty of operation, due very largely to the fact that after the last trunk had been seized for use it was necessary for the traveling switch

member to go back to the original starting point before it could begin over again to automatically select idle trunks.

My invention contemplates, therefore, an automatic trunk-selecting switch provided with a back and forth traveling wiper adapted to select idle trunks in each direction—that is to say, a switch having a wiper or traveling contact maker adapted to have a step-by-step motion in one direction to select idle trunks, and adapted to also select idle trunks while returning in a step-by-step manner in the opposite direction.

It further contemplates an automatic trunk-selecting switch of this character in which the ratchet and pawl mechanism for actuating the wiper or traveling contact maker may travel constantly in one and the same direction, and in which means are provided for converting this continuous motion in one direction into a back and forth or reciprocating motion on the part of the said wiper or traveling contact maker. Again, the uniformity of the distance of travel of the wiper or contact maker, in passing from one contact to another, is obtained by giving the ratchet wheel a variable rotation—that is to say, by providing means for giving the ratchet wheel an intermittent rotation made up of steps which are not uniform or equal in length, said steps or partial rotations varying in length according to the extent of rotation necessary to give the wiper the desired extent of travel, the terminals or bank contacts upon which the wiper travels being equally spaced and arranged at regular intervals along a curved line. Thus the wiper has a step-by-step motion in a back and forth manner, the distance traveled by the wiper between terminals being all of the same length in each direction. This uniformity of motion is obtained, as stated, by means of a ratchet wheel that rotates constantly in one direction in a step-by-step manner, the said steps varying in length, the length of each step depending upon where the wheel is at that time relative to the wiper. For example, the minimum movement of the ratchet wheel is used for giving the wiper the desired distance of travel at the center of the bank or row of terminals, while the maximum movement of the ratchet wheel is used for giving the wiper a step-by-step motion at either end of said bank or row of terminals. In this way,

as stated, a fixed or locking connection can be used between the wiper and the ratchet wheel, rather than a sliding or more or less loose connection, such as was heretofore employed. An advantage of this construction consists in the fact that the wiper operates in a step-by-step manner in each direction, selecting idle trunks in both directions, and is never under the necessity of being brought back by a quick and sudden jump to starting point. Hence, there is never any jar or sudden shock during the operation of the switch, and there is consequently no danger of breakage or dislocation of the various operative parts in conjunction with which the master switch is designed to operate, or at least the possibility of such trouble is minimized. The nature and advantages of my invention will, however, hereinafter more fully appear.

In the accompanying drawings Figure 1 is a side elevation of my improved master switch. Fig. 2 is a plan view of the master switch, showing the arm that connects the master switch with the plunger shaft, and through the medium of which the plunger shaft is operated. Fig. 3 is a perspective view of the master switch ratchet wheel associated with the plunger shaft. Fig. 4 is a detail view of the master switch interrupter wheel. Fig. 5 represents diagrammatically the master switch and a line switch and the circuit connections thereof. Figs. 6 and 7 represent diagrammatically an established connection between a calling substation A and a called substation A' employing central station apparatus comprising my improved master switch.

The master switch, as shown in Fig. 1, comprises a frame 2 upon which the various operative parts are mounted, the motor magnet 3, the ratchet wheel 4, motor magnet 5, resistance lamp 6, springs 7 and 8 and the interrupter springs 9 and 10. Also pivotally mounted on the frame 2 is the motor magnet armature 11 upon the end of which there is a pawl 12 that engages a tooth of the ratchet wheel 4 when the motor magnet energizes. When the motor magnet 3 energizes and attracts its armature 11, the interrupter springs 9 and 10 are separated. The means for restoring the armature 11 to normal position when once attracted is the spring 13 mounted upon the bracket of the interrupter springs 9 and 10. Rigidly secured to the ratchet wheel 4 is a notched fiber interrupter wheel 14 (Figs. 2 and 3) designed to control the circuit-closing springs 7 and 8. The motor magnet relay 5 controls the springs 15, 16 and 17, and when energized operates to close the springs 16 and 17 in contact, whereby an energizing circuit is closed through the motor magnet 3. Connected with the ratchet wheel 4 is the connecting link 18, which latter is in turn piv-

otally secured to the plunger shaft as a whole which comprises the members 19 and 20 (Fig. 3). This connecting link is so arranged that when the ratchet wheel 4 is rotated in the direction indicated by the arrow in Fig. 3, the plunger shaft 19 is then given a backward and forward motion about the shaft 20. The connecting link 18 engages a hole in the ratchet wheel 4 and at the shaft 20 is pivotally secured in a bracket clamp 21. At A there is shown the master switch bank comprising ten individual contacts *a* and one common metallic segment 22. Sliding over these contacts in unison with the backward and forward movement of the plunger shaft 19 is the bank wiper 23 adapted to at all times maintain some one of the individual segments *a* in electrical connection with the common segment 22. Below the master switch bank O there is shown a plunger 24 and a plunger arm 25 in locking engagement with the plunger shaft 19.

The line switch for the control of which the master switch is designed may be of the general character disclosed in English Patent No. 26,301 of 1906, and comprises the well-known trip magnet 26 (Fig. 5), the release magnet 27 and the bridge-cut-off relay 28. The trip magnet 26, when energized, moves its armature 29 from engagement with the plunger arm 25, thereby permitting the plunger arm to move about the pivot points 30, due to the tension of the spring 31, and thrust the plunger 24 into the bank terminal Q.

The operation of the master switch may be more clearly understood by reference to the circuit drawing in Fig. 5. In this figure the line conductors 32 and 33 lead to the subscriber's substation. When the subscriber at the substation turns the dial for the first digit the rotary line conductor 33 is momentarily grounded. This momentary grounding provides an energizing circuit for the trip magnet 26 extending from the substation to the line conductor 33, conductor 34, through the bridge-cut-off relay springs 35 and 36, through the winding of the trip magnet 26, conductor 37, through the motor magnet relay springs 15 and 16 to the battery lead 38, thence through battery B to ground G. The trip magnet 26, upon energizing, attracts its armature and permits the plunger 24 to engage the bank terminal Q, pressing the bank springs 40 and 41, 140 and 141, 136 and 137, and 138 and 139 into contact. For convenience of explanation it will be assumed that when the plunger 24 entered the bank terminal Q the master switch wiper 23 was in engagement with the bank contact 39. In that event, and when the plunger 24 enters the bank terminal Q and closes the springs 40 and 41 in contact, an energizing circuit is

established through the motor magnet relay 5 which extends from ground G' through the winding 42, conductor 43 to the common segment 22, through the wiper 23, individual segment 39, conductor 44, through the springs 40 and 41, winding of the release magnet 27 to the battery lead 38, thence through battery B to ground G. It will be seen that this circuit includes the release magnet 27 and winding 42 of the relay 5, but the release magnet 27 being of a comparatively low resistance does not operatively energize when thus included in a circuit with the winding 42. The relay 5 thereupon energizes and presses the springs 16 and 17 into contact, which closes an energizing circuit through the motor magnet 3, said circuit extending from ground G' through the winding of the motor magnet 3, interrupter springs 10 and 9, conductor 45, motor magnet relay springs 17 and 16 to the battery lead 38, thence through battery B to ground G. The motor magnet, upon energizing, attracts its armature 11. The pawl 12 engages a tooth of the ratchet wheel 4 and moves the latter one step. When this occurs the spring 8 engages the spring 7 (bearing in mind that the spring 7, prior to this operation, engages a notch 46 of the toothed wheel 14), and when the ratchet wheel 4 is given one step the spring 8 slides off from the top of the notch and engages the spring 7. When this occurs a new energizing circuit is provided for the winding 42 of the relay 5, said circuit extending from ground G' through the winding 42, springs 7 and 8, resistance lamp 6 to the battery lead 38, thence through battery B to ground G. Furthermore, the motor magnet, when energized, separates the interrupter springs 9 and 10, thereby breaking its own circuit in a manner similar to that of a buzzer. The motor magnet 3 continues to operate in this manner as long as the springs 7 and 8 engage and energize the relay 5, which latter provides the energizing circuit for the motor magnet 3. The motor magnet continues to operate, rotating the ratchet wheel in a clockwise direction (Fig. 5) until the springs 7 and 8 engage the notch 47. When this occurs the spring 7 passes out of engagement with the spring 8, thereby opening the circuit through the winding 42. The relay 5 deenergizes, and the spring 16 returns to normal position in engagement with the spring 15, thereby breaking the energizing circuit for the motor magnet 3. When the notch 47 is rotated to the position shown in Fig. 5 the wiper 23 is rotated to the individual segment 48—that is, the notch 47 corresponds to the segment 48 in the same manner in which the notch 46 corresponds to the segment 39; also, the notch 49 corresponds to the segment 50. It will be seen that the spaces between the notches 46 and

47, and 47 and 49 are not equal, although the distances between the segments 39 and 48, and 48 and 50 are equal. This arises from the fact that when the wiper 23 occupies the first contact 39 the connecting link 18 is at the limit of its motion, and a greater rotary motion of the ratchet wheel 4 is required to move the wiper 23 the same distance than is required when the wiper 23 occupies some central contact *a* in the bank O and the connecting link 18 occupies some central position in this machine. Suppose, however, that when the wiper 23 engages a contact 48 a guarding potential is present. In that event an energizing circuit is closed through the motor magnet relay 5 which extends from the contact 48 through the wiper 23, common segment 22, through the winding 42 to ground G' in the same manner as previously traced. The motor magnet relay 5 again energizes and closes the circuit for the motor magnet 3. The motor magnet 3 operates as before, and the wiper 23 is carried to the next contact 50 and the springs 7 and 8 to the tooth 49 of the wheel 14. It will be understood, of course, that when the relay magnet operates and moves the connecting link 18 from one position to another, the plunger shaft 19 and all plungers 24 which are in locking engagement with the said shaft are moved to a new position opposite an idle terminal similar to the terminal Q. When the bank terminal Q is engaged by the plunger 24, as previously explained, the subscriber's line conductors 32 and 33 are extended to the trunk conductors 51 and 52 which lead to a selector switch of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson. The selector switch is in turn adapted to make connection with the connector, which may in turn be operated by the subscriber to establish connection with any subscriber's line in the desired group, as is well known. It will be understood that the plunger shaft 19 may control a group of plungers, and that when any line switch is operated to seize a trunk-line an energizing circuit is established through the motor magnet relay 5 in the manner previously explained, and the master switch operates to carry the idle plungers opposite the next bank segment. If a multiple of this bank segment is engaged a guarding potential is established at the corresponding segment of the master switch, and the motor magnet relay again energizes and closes the circuit through the motor magnet. This continues as long as the wiper 23 engages bank contacts upon which there is a guarding potential.

Referring to Fig. 6 it will be seen that the 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 station. Substation A, for example, comprises the usual receiver 53, switch-hook 54, induction-coil 55 which consists of a primary winding 56 and secondary winding 57, transmitter 58, condenser 59, ringer 60, impulse wheel 61 which has the usual impulse teeth 62. The impulse wheel is secured to the shaft 63 which is also secured to the dial (not shown). When the dial is turned the impulse teeth 62 are adapted to engage the cam 64 upon the end of the spring 65, thereby carrying the latter out of engagement with the spring 66. Upon the switch-hook 54 there is a cam 67 which, when the switch-hook is up, permits the springs 68 and 69 to engage, thereby bridging across the subscriber's line conductors 32 and 33 the primary circuit including the transmitter 58 in series with the primary winding 56; but when the switch-hook is down the spring 68 is carried out of engagement with the spring 69 and into engagement with the spring 70, whereby the ringer 60 in series with the condenser 59 is bridged across the line conductors 32 and 33. The first-selector switch shown at E is of the general type described in said selector patent, and, as shown, is modified to adapt it to operate in connection with a two-wire system. Among other details it embodies the following features: The switch shaft (not shown) carries the vertical and rotary wipers 71 and 72, respectively, and a private wiper 73. The side switch is well known and comprises the side switch wipers 74, 75, 76 and 77 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 78, and when the side switch is in normal or first position the wipers 74, 75, 76 and 77 occupy the contact points 79, 80, 81 and 82, respectively. In second position the wipers rest on the contact points 83, 84, 85 and 86, respectively, and when in third position the contact points 87, 88, 89 and 90 are engaged by their respective wipers. The windings of the usual vertical and rotary line relays are in this case combined with one double-wound relay 91 comprising the winding 92 which is connected with the battery lead 38 and also with the vertical trunk conductor when the side switch wiper 74 is in first or second position. The second winding 93 is connected to ground and also to the rotary trunk-line conductor when the side switch wiper 75 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 94 which operates to raise the shaft and wipers 71, 72

and 73 vertically. The line relay 81 also controls the private magnet relay 95, which latter in turn controls the private magnet 78. As usual the private magnet controls the side switch. While the side switch is in second position the rotary magnet 96, which operates to carry the switch shaft wipers 71, 72 and 73 in a rotary direction, is energized. The release magnet 97 provides means for restoring the selector switch to normal position. Upon the switch shaft which carries the shaft wipers 71, 72 and 73 there is mounted the arm 98 which, when the shaft is raised one or more steps, permits the spring 99 to engage the contact point 100, whereby the release magnet 97 is connected to the battery lead. The release relay 101 is provided for closing the energizing circuit at the release magnet 97 after the switch is operated. The relays 101 and 95 are slow-acting relays—that is, they are so provided with a copper shield that when energized, and the energizing circuit then broken, said relays remain in an operated position for a moment or so. In other words, 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 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 102 and 103 and a private wiper 104. The connector switch is also controlled by the calling subscriber through the medium of a double-wound line relay 105. The line relay 105 is provided with the windings 106 and 107. One terminal of the winding 106 is connected to the battery lead, while the other terminal is connected with the vertical trunk-line conductor. The winding 107 is connected with ground and also with the rotary trunk-line conductor. This line relay 105 directly controls the vertical magnet 108. The function of the vertical magnet 108 is to give the shaft and shaft wipers a vertical motion, and the rotary magnet 109 imparts to the shaft and shaft wipers a rotary or circular motion. The connector switch is also provided with the slow-acting release relay 110, which is the same as the release relay 101 of the first-selector switch. As usual, the private magnet relay 111 controls the private magnet 112, which latter controls the side switch wipers 113, 114, 115, 116 and 117. The back-bridge relay 118, comprising the windings 119 and 120, provides the means whereby the called subscriber is furnished with battery current for talking purposes. As here shown, the connector switch is of the automatic ringing type—that is, a signaling of the called subscriber is not dependent upon the calling subscriber pressing

a signaling button when he calls a line not his own; for as soon as connection is established with the desired line the interrupter 121 intermittently closes an energizing circuit through the ringer relay 122, whereby the terminals of the ringer generator I are intermittently bridged across the normal conductors of the called line. The relay 123 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-signal. The means whereby the connector switch may be restored to normal position is provided by the usual release magnet 124 which, when the connector switch shaft is raised one or more steps, is connected to the battery lead through the normal springs 125 and 126. By means of the condensers 127 and 128 the circuit through the connector switch is divided into two sections.

The busy-signaling apparatus J comprises the interrupter 129 in series with the winding 130 of the induction-coil 131. The winding 132 is connected with the spring 133, and when the relay 123 energizes, the busy-signaling apparatus is connected with the connector side switch wiper 113.

It will be assumed that the subscriber at substation A wishes to call a subscriber at substation A' (Fig. 7), to which latter substation is allotted the number 220. To call the number 220 the subscriber at substation A' (Fig. 6) removes his receiver from the switch-hook and operates the calling device for each digit in a well-known manner—that is, when the receiver is removed from the switch-hook a preliminary impulse provides an energizing circuit for the trip magnet 26 of the line switch C, whereby the said line switch C is operated to seize a pre-selected idle trunk-line leading to the first-selector switch E. The dial is turned for the first digit 2, and upon returning to normal position operates the first-selector switch to establish connection with an idle trunk-line leading to a connector switch H (Fig. 7). The impulses delivered by the dial for the last two digits are directed toward the connector H, which latter operates to place the shaft wipers in connection with the contacts corresponding to the desired substation. The primary impulse for energizing the trip magnet 26 occurs when the receiver 53 is removed from the switch-hook 54, and the cam arm 67 permits the spring 68 to engage the spring 69, thereby removing the ringer from across the line and bridging the primary circuit instead. When the primary circuit is thus bridged across the line the energizing circuit for the trip magnet 26 is completed and extends from ground G³ through the springs 134 and 135 to the line conductor 32, through the primary circuit at the substation to the

line conductor 33, through the bridge-cut-off springs 35 and 36, trip magnet 26, conductor 37, through the springs 15 and 16 to the battery lead 38, thence through battery B to ground G. As soon as the trip magnet 23 energizes, its armature is attracted and the plunger is thrust into the bank terminal Q. When the plunger engages the bank terminal an energizing circuit is established through the motor magnet relay 5, which in turn operates to close an energizing circuit through the motor magnet 3 of the master switch D. The motor magnet then operates to advance all idle plungers that are in locking engagement with the shaft 19 to a point opposite the next idle bank terminal similar to the terminal just engaged. The circuit through the relay 5 extends from ground G' through the winding 42 of the relay 5 to the common segment 22; wiper 23 to the individual segment 39, conductor 44, through the bank springs 40 and 41, release magnet 27 to the battery lead 38, thence through battery B to ground G. The relay 5, upon energizing, operates to place the springs 16 and 17 in engagement, forming a circuit to the battery lead 38, thence through battery B to ground G. The motor magnet then operates, as previously explained, to advance the shaft and the engaging plungers opposite the next idle trunk-line. At the instant that the plunger enters the bank terminal the following springs are pressed into contact: 136 and 137, 138 and 139, 140 and 141, and 40 and 41. The engagement of the springs 140 and 141 closes a circuit through the bridge-cut-off relay 28 extending from ground G⁴ through the springs 140 and 141, through the winding of the bridge-cut-off relay 28 to the battery lead 38, thence through battery B to ground G. Said relay, upon energizing, operates to carry the springs 135 and 35 out of engagement with the springs 134 and 36, respectively. When these springs disengage, the line conductors 32 and 33 become disconnected from the line switch C.

The engagement of the bank springs 136 and 137 extends the line conductor 32 to the trunk-line conductor 51. In a similar manner the engagement of the springs 138 and 139 extends the line conductor 33 to the trunk-line conductor 52. Furthermore, the engagement of the springs 140 and 141 establishes a guarding potential by way of the normal conductor 142 to the connector private bank contacts corresponding to the line that terminates in the line switch C, to prevent any other subscriber from calling this line after the calling subscriber at substation A removes his receiver preparatory to making a call. The subscriber thus operates the line switch C to establish connection with the selector switch E, which latter

is now operated by the impulses that are delivered when the dial returns to normal position for the first digit. When the subscriber's line conductors 32 and 33 are thus extended to the selector switch E, an energizing circuit is established through the line relay 91, said circuit extending from ground G⁵ through the winding 93, side switch wiper 75, trunk conductor 52, bank springs, line conductor 33, through the substation primary circuit to the line conductor 32, through the bank springs and trunk-line conductor 51, side switch wiper 74, through the winding 92 to the battery lead 38, thence through battery B to ground G. The relay 91, upon energizing, operates to place the springs 143 and 144 in contact, whereby an energizing circuit is established through the release relay 101 extending from ground G⁶ through the springs 144 and 143, through the winding of the relay 101 to the battery lead 38, thence through battery B to ground G. The relay 101, upon energizing, carries the spring 145 out of engagement with the spring 146 and into engagement with the spring 147. This is the condition of the first-selector switch E when the subscriber operates the dial for the first digit. The first digit being 2, the impulse spring 65 is thus carried out of engagement with the impulse spring 66. As a result the energizing circuit through the line relay 91 is broken twice, and the spring 143 comes into contact with the spring 148 twice. After the two impulses are thus transmitted, the line relay 91 again energizes and carries the spring 143 into contact with the spring 144. As previously explained, the relay 101 is slow-acting—that is, slow to deenergize, and when this energizing circuit is momentarily broken during the vertical impulses just delivered, the said relay does not deenergize, but remains in an operated position with the spring 145 in engagement with the spring 147. When the spring 143 engages the spring 148 twice two impulses are transmitted to the vertical magnet 94 from ground G⁶ through the springs 143 and 148, springs 145 and 147, through the private magnet relay 95, through the vertical magnet 94, side switch wiper 77 to the battery lead 38, thence through battery B to ground G. The impulses being transmitted, the vertical magnet 94 is thereby energized twice, and the shaft wipers are given two vertical steps in the well-known manner. It will be seen that the private magnet relay 95 is included in the energizing circuit of the vertical magnet 94. This relay also energizes, but being a slow-acting relay it energizes on the first impulse and remains so until all the impulses are transmitted. This relay, upon energizing, operates to close the springs 149 and 150 in contact, whereby an energizing circuit is established through the

private magnet 78 extending from ground G⁶ through the springs 149 and 150, private magnet 78 to the battery lead 38, thence through battery B to ground G. The private magnet relay 95 deenergizes for the last impulse, since this energizing circuit is no longer extended after the springs 145 and 148 disengage; hence the said relay deenergizes, permitting the springs 149 and 150 to disengage, whereby the energizing circuit through the private magnet 78 is in turn broken. The private magnet now deenergizes and permits the side switch to pass from first to second position, whereby the side switch wipers 76 and 77 engage the contact points 85 and 86, respectively.

The closure of contact between the side switch wiper 77 and the contact point 86 sets up an energizing circuit for the rotary magnet 96 from ground G⁵ through the interrupter springs and winding of the rotary magnet 96, contact point 86, side switch wiper 77 to the battery lead 38, thence through battery B to ground G. The said rotary magnet then operates to rotate the shaft wipers 71, 72 and 73 of the selector E into engagement with the first contact of the second level of the selector banks, from which contact it is assumed that the trunk-line conductors 151, 152 and 153 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 73 engages the first private bank contact the private magnet 78 again energizes, locking the side switch in second position. The energizing circuit for the private magnet extends from the grounded terminal G at the battery B through an occupying switch (not shown), through the private wiper 73, thence through the conductor 154 to the side switch wiper 76, contact point 85, through the winding of the private magnet 78 to the battery lead 38, hence through battery B to ground G. The private magnet, upon thus becoming energized, locks the side switch wiper 77 in engagement with the contact point 86, whereby the rotary magnet 96 will be energized step by step until the wipers are carried beyond the last busy contact. The instant that the private wiper reaches the last busy contact point the energizing circuit through the private magnet 78 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 78 releases the side switch 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 32 and 33 are extended to the trunk conductors 151 and 152, respectively, which in this case it is assumed lead to the connector switch H. When the subscriber's line conductors

are thus extended to the connector H an energizing circuit is established through the line relay 105 in the same manner in which the energizing circuit was established through the line relay 91 of the first-selector E when the subscriber's line conductors 32 and 33 were extended through the switch bank to the trunk conductors 51 and 52. The relay 105, upon energizing, operates to shift the spring 155 out of engagement with the spring 156 and into engagement with the spring 157. When the springs 155 and 157 engage, an energizing circuit is thereby established through the release relay 110. This circuit extends from ground G' through the springs 155 and 157, through the winding of the release relay 110 to the battery lead 38, thence through battery B to ground G. The relay, upon energizing, operates to shift the spring 158 out of engagement with the spring 159 and into engagement with the spring 160; also, the spring 161 is pressed into contact with the spring 162. This operation of the connector switch H occurs at the instant that the side switch wipers 74 and 75 of the selector switch E pass to third position and extend the subscriber's line conductors 32 and 33 to the connector switch H. The engagement of the springs 161 and 162 establishes a guarding potential for protecting the trunk-line conductors 151, 152 and 153 against seizure by another selector switch. This potential extends from ground G^a to the side switch wiper 115, springs 161 and 162 to the private conductor 153, thence to the multiple contacts of the first-selector banks. The operation of the dial for the last two digits affects the connector switch, and when the dial is operated for the next digit 2 the impulse spring 65 is thus carried out of engagement with the spring 64, thereby momentarily deenergizing the line relay 105 twice, whereby the springs 155 and 156 engage twice, thus sending two impulses to the vertical magnet 108 from ground G' through the springs 155 and 156, springs 158 and 160, through the winding of the vertical magnet 108, side switch wiper 116, through the winding of the private magnet relay 111 to the battery lead 38, thence through battery B to ground G. The private magnet relay 111 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 102, 103 and 104 two steps to a point opposite the second level. The private magnet relay 111, upon energizing, shifts the spring 163 out of engagement with the spring 164 and into engagement with the spring 165; also, the spring 166 is carried out of engagement with the spring 165.

When the springs 163 and 165 engage, an energizing circuit is established through the private magnet 112 from ground G^a through the springs 165 and 163, winding of the private magnet 112 to the battery lead 38, thence through battery B to ground G. The relay 111 being a slow-acting relay, as explained, remains in an operated position while the vertical impulses are being sent; but after all the impulses are delivered the line relay 105 returns to its operated position. The circuit through the relay 111 becomes broken, thus permitting the springs 163 and 166 to resume their normal positions. When the springs 163 and 165 disengage, the circuit through the private magnet 112 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 105 ten times. Each time that the line relay springs 155 and 156 engage, an energizing circuit is established through the rotary magnet 109 from ground G' through the springs 155 and 156, springs 158 and 160, springs 167 and 168, through the winding of the rotary magnet 109, side switch wiper 116, through the winding of the private magnet relay 111 to the battery lead 38, thence through battery B to ground G. Again the private magnet relay energizes, and, as in the previous case, remains so until all the impulses are transmitted, thereby retaining the private magnet energized also. The rotary magnet 109 then operates to rotate the shaft wipers into engagement with the desired line #220. As soon as the line relay 105 ceases to operate for the last digit the private magnet relay 111 deenergizes, as explained, but in this instance permitting the side switch to trip to third position. The result is that the side switch wipers 113, 114, 115, 116 and 117 engage their respective contact points in the third position. When the side switch wiper 117 engages its third-position contact point a guarding potential is established at the private wiper 104 for protecting the seized line from outside interference while the connection is established. This guarding potential extends from ground G¹⁰ through the side switch wiper 117, locking relay springs 169 and 170 to the private wiper 104. Not only does this guarding potential prevent other connectors from seizing the same line over multiples of the normal conductors 171, 172 and 173, but it also provides means for energizing the cut-off relay 174 of the line switch C'. Of course, when the side switch wipers 113 and 114 engage their third-position contact points, the calling subscriber's line is then placed in connection with the called subscriber's line over the heavy conductors

shown passing through the ringer relay springs 175 and 176 on one side and 177 and 178 on the other. As soon as connection is thus established the ringer relay 122 is energized over the circuit established when the side switch wiper 116 engaged its third-position contact point. The energizing current flows from ground G^{11} through the interrupter 121, springs 179 and 180, ringer relay 122, through the side switch wiper 116, through the private magnet relay 111 to the battery lead 38, thence through battery B to ground G. It will be seen that as the interrupter 121 revolves, the energizing circuit of the ringer relay 122 will be broken periodically so as not to ring the called subscriber continuously. As a result ringing current is sent over the called line for energizing the bell 181. However, as soon as the called subscriber answers, the back-bridge relay 118 is energized by a flow of current from ground G^{10} , through the winding 120, through the ringer relay springs 178 and 177, shaft wiper 103, normal conductor 172, line conductor 182, through the substation springs 183 and 184, thence through the primary circuit of the substation A to the line conductor 185, normal conductor 171, shaft wiper 102, ringer relay springs 175 and 176, through the winding 119 of the relay 118 to the battery lead 38, thence through battery B to ground G. When the back-bridge relay 118 is once energized the energizing circuit for the ringer relay 122 is interrupted at a point between the springs 179 and 180, thus making it impossible for the ringer relay to energize as long as the called subscriber is on the line. The two substations being thus connected, the subscribers may communicate over the conductors indicated by the heavy lines in Figs. 6 and 7.

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 68 and 69, thereby initiating the release of all the switches. This release is as follows: At the instant that the circuit is broken between the springs 68 and 69 the double-wound line relay 105 and the release relay 110 of the connector H deenergize. When the slow-acting release relay 110 and the line relay 105 deenergize, the energizing circuit for the release magnet 124 is closed at a point between the springs 158 and 159, and 155 and 156, and a flow of current is therefore set up from ground G^7 through the springs 155 and 156, springs 158 and 159, through the winding of the release magnet 124, normal springs 125 and 126 to the battery lead 38, thence through battery B to ground G. The release magnet instantly releases the connector switch and the side switch, thereby breaking the energizing circuit through the back-bridge relay

118 if the called subscriber has not in the meantime restored his receiver, and also the energizing circuit through the bridge-cut-off relay 174 of the called line switch C' . As soon as the connector switch shaft reaches its lowest position it breaks the circuit for the release magnet 124 by separating the normal springs 125 and 126, at which instant the release magnet of the connector is also restored. The operation of the line relay 105 and the slow-acting release relay 110 not only causes the release of the connector, as described, but also the release of the first-selector switch E, because the ground connection with the private conductor 153 is also removed, and thus an energizing circuit is no longer maintained for the release relay 101 of the selector switch E. This relay 101 then deenergizes and places the springs 145 and 146 in contact, whereby a circuit is completed through the release magnet 97, said circuit extending from ground G^8 through the springs 143 and 148, through the release magnet 97, normal springs 110 and 99 to the battery lead 38, thence through battery B and to ground G. The release relay 101 for the selector switch E is dependent upon a ground from the switch ahead to maintain it in an energized position, and hence when this ground is removed the relay deenergizes. The release magnet 97, upon energizing, places the springs 186 and 187 in contact, whereby a circuit is closed through the release magnet 27 of the line switch C. This circuit extends from ground G^{12} through the release magnet springs 186 and 187, conductor 53^a, bank springs 40 and 41, through the release magnet 27 to the battery lead 38, thence through battery B to ground G. The first-selector switch shaft, upon restoration to normal position, separates the normal springs 99 and 100, thereby destroying the energizing circuit of the magnet 27 of the line switch C. The line switch C returns to normal position, and the bank springs are separated, thus preventing any other action from the trunk. After the switches are thus restored the calling subscriber may, of course, then proceed to make another call. It will be understood that the subscriber at substation A' may call a subscriber at substation A, and that any subscriber in the exchange may call any other subscriber of the exchange in a similar manner.

From the foregoing it will be seen that I provide an automatic trunk-selecting switch wherein the wiper or traveling contact maker is never under the necessity of being brought back by a jump or sudden movement to starting point. For this reason the operation of the switch is never subject to a sudden jar or concussion, which was heretofore the case with certain kinds of apparatus, and hence the plungers on the shaft

are not liable to be disturbed or thrown out of proper position. Also, the wear and tear on the switch is greatly reduced, as well as danger of breakage thereof, and the same is made to work smoothly and evenly, and the motion of the wiper or contact maker in both directions is made use of in the automatic selection of idle trunks. The said wiper or contact maker has, it will be seen, a uniform distance of travel in each direction—that is to say, the distances from one contact to another are all of uniform length, and this is produced by a variable rotation on the part of the ratchet wheel, some forward steps of the ratchet wheel being longer than others, depending upon the position of the ratchet wheel at the time the step is taken, and upon the position of the wiper or contact maker relative to the bank or row of trunk terminals. If the wiper is at the middle of the said bank of terminals, then the minimum motion is given the ratchet wheel, because at this time the wheel is moving directly forward in a horizontal plane. However, when the wiper or contact maker 23 is at either end of the bank, then the ratchet wheel is given the maximum of movement, because at this time the arm is receiving more up and down movement than it is movement in a horizontal plane, and consequently more rotation is required for the ratchet wheel in order to give the wiper the desired extent of motion. The movements of the wiper from one terminal to another are uniform, but each of these movements is made up of a plurality of short steps varying in number according to the position of the wiper on the bank. If the wiper is moving from one middle contact to another in the bank the movement at this time is composed of only a few short steps forward. If, however, the wiper is moving into engagement with one of the end contacts in the bank, then the step forward from one contact to another is made up of a greater number of short steps, because in such case a larger number of the teeth on the ratchet wheel 4 will be successively engaged in order to accomplish the desired extent of movement on the part of the wiper. With the arrangement employed, therefore, the wiper has a uniform distance of travel from one terminal to the other, but has a variable or non-uniform step-by-step motion between terminals—that is to say, the wiper does not always travel at the same speed, because from one middle contact to another it moves comparatively fast, while from one end contact to another it moves much slower, the motion in the first case being made up of a small number of relatively long steps, while the motion in the second case is made up of a greater number of relatively short steps. The result, however, as explained, is simply this, namely that the travel of the wiper from one contact to another is uniform as far as distance is concerned, whereas the travel of the ratchet wheel is uniform as to speed but non-uniform or variable as far as distance is concerned. This being the case, a fixed or locking connection can be employed between the wiper and the ratchet wheel—that is to say, a connection which engages the ratchet wheel at a fixed point, and whereby the wiper must always move when the ratchet wheel moves, regardless of the position of said wiper relative to the ratchet wheel. This, as stated, insures a smooth and uniform mode of operation on the part of the switch, the mechanism always operating without shock or jar, and the automatic selection of idle trunks being accomplished in an improved and exceedingly satisfactory and highly efficient manner. With respect to the combination of this master switch with subscribers' line switches of the character herein disclosed, it will be seen that such combination results in the provision of a line switch having a new mode of operation. Previously the said line switch was provided with plungers which had a step-by-step movement in one direction, but a quick jump, or long sweep in the opposite direction. Now, however, the subscribers' line switches have plungers which have a step-by-step progressive movement in one direction, and a similar step-by-step progressive movement in the opposite direction, whereby both directions of movement are utilized to bring the plungers from one trunk to another, and thus the operation of the plungers is smooth and uniform in each direction. In this way the line switches operate without shock or jar, and with less wear and tear and uncertainty of operation than heretofore. With further respect to the mode of connecting the master switch with the shaft for the plungers of the line switches, it will be seen that this precludes the possibility of the plungers moving independently of the master switch—that is to say, tends to prevent the plungers from running ahead, so to speak, of the motion of the master switch. In certain previous constructions it was found that the plungers had a tendency to swing past the desired position in front of a trunk-line terminal when given a step forward by the master switch, owing to the momentum of the mechanism. With my improved arrangement, however, it will be seen that the plungers are so connected with the master switch that they will always travel to and stop exactly in front of the trunk terminals, inasmuch as the momentum cannot carry the plungers and their shaft any farther after the master switch stops moving. Thus the construction has another distinct advantage, namely that the plungers of the line switches have no surplus

or excess of movement in traveling from one trunk to another, the movement of the plungers that are in engagement with the shaft ceasing instantly upon the cessation of movement on the part of the master switch.

While I have illustrated one particular form of my invention, it will be understood that I do not wish to be limited to such exact structure. Furthermore, certain of the broad features shown herein are not claimed in this application, but are claimed in a co-pending application of mine, Serial No. 311,327, filed April 12th, 1906, to which this application is subordinate.

What I claim as my invention is:—

1. In a telephone system, a set of trunk-lines, a set of terminals corresponding to said trunk-lines, a wiper mounted to engage said terminals, mechanism for causing said wiper to have a back and forth motion and step-by-step movement over said terminals in both directions of motion thereof, and means for including said trunk lines in talking circuits.

2. In a telephone system, a set of trunk-lines, a series of terminals corresponding to said trunk-lines, a wiper adjacent said terminals, means for moving said wiper back and forth over said terminals, and means for causing said wiper to stop on idle terminals corresponding to trunk-lines in each direction of motion thereof.

3. In a telephone system, a set of trunk-lines, a set of terminals corresponding to said trunk-lines, a wiper adjacent said terminals, mechanism for moving the wiper from one terminal to another, adapted to give the wiper a variable number of steps between terminals, but a uniform distance of travel from one terminal to another, and means for including said trunk lines in talking circuits.

4. In a telephone system, a set of trunk-lines, a series of terminals corresponding to said trunk-lines, a wiper adjacent said terminals, a shaft upon which said wiper is mounted, an arm carried by said shaft and pivoted thereon to swing about an axis at right-angles to that of the shaft, a ratchet wheel engaging the free end of said arm to move the same in a circle, a pawl for actuating said ratchet wheel, and means for varying the number of teeth on the ratchet wheel engaged by said pawl in actuating the same to move the wiper from one terminal to another.

5. In a telephone system, a set of trunk-lines, terminals corresponding to said trunk-lines, a shaft provided with a wiper adapted to engage said terminals, an arm pivoted on said shaft to swing about an axis at right-angles to the axis of the shaft, a ratchet wheel engaging the free end of said arm to move the same in a circle, and to thereby move the said wiper back and forth over

said terminals, a pawl engaging said ratchet wheel to actuate the same, a notched wheel rotating with the said ratchet wheel, provided with notches at irregular intervals in the periphery thereof, a magnet for operating said pawl, and means including circuit contacts engaging the periphery of said notched wheel to control the action of said magnet and pawl, whereby the distance of travel of said wiper from one terminal to another is uniform throughout the length of movement thereof, but whereby the wiper is given a variable number of steps between different terminals.

6. In a telephone system, a set of trunk-lines, bank terminals for said trunk-lines, a plunger adapted to travel back and forth in front of said terminals, and means for giving said plunger a variable number of steps between different terminals.

7. In a telephone system, a plurality of trunk-lines, terminals for said trunk-lines, a traveling member adapted to move back and forth in front of said terminals, mechanism for giving the said member a step-by-step motion consisting of a series of successive steps of variable lengths, and means for including said trunk lines in talking circuits.

8. In a telephone system, a plurality of trunk-lines, an automatic switch for seizing idle trunk-lines, automatic mechanism whereby a switching element of said switch is given a variable speed step-by-step motion, and means for including said trunk lines in talking circuits.

9. In a telephone system, a plurality of trunk-lines, terminals corresponding to said trunk-lines, said terminals being uniformly spaced apart, a traveling member adapted to cooperate with said terminals, having a uniform distance of travel from one terminal to another throughout the range of travel thereof, and mechanism for giving said traveling member a variable step-by-step motion between the different terminals.

10. In a telephone system, a plurality of trunk-lines, terminals corresponding to said lines, a wiper engaging and traveling along said terminals, mechanism for giving said wiper a variable speed step-by-step motion, and means for including said trunk lines in talking circuits.

11. In a telephone system, a plurality of trunk-lines, terminals for said trunk-lines, a circuit-closing plunger adapted to travel along in front of said terminals, normally out of contact therewith, and mechanism for giving said plunger a variable step-by-step motion between the different terminals.

12. In a telephone system, a set of trunk-lines, a set of terminals corresponding to said trunk-lines, a wiper mounted to engage said terminals, mechanism for causing said wiper to have a back and forth motion and step-by-step movement over said terminals

in both directions of motion thereof, metallic line circuits, and means for controlling the aforesaid operative elements over said metallic line circuits.

5 13. In a telephone system, a set of trunk-lines, a series of terminals corresponding to said trunk-lines, a wiper adjacent said terminals, means for moving said wiper back and forth over said terminals, means for
10 causing said wiper to stop on idle terminals corresponding to trunk-lines in each direction of motion thereof, metallic line circuits, and means for controlling the aforesaid operative elements over said metallic line
15 circuits.

14. In a telephone system, a set of trunk-lines, a set of terminals corresponding to said trunk-lines, a wiper adjacent said terminals, mechanism for moving the wiper
20 from one terminal to another, adapted to give the wiper a variable number of steps between terminals, but a uniform distance of travel from one terminal to another, metallic line circuits, and means for controlling
25 the aforesaid operative elements over said metallic line circuits.

15. In a telephone system, a set of trunk-lines, a series of terminals corresponding to said trunk-lines, a wiper adjacent said terminals, a shaft upon which said wiper is
30 mounted, an arm carried by said shaft and pivoted thereon to swing about an axis at right-angles to that of the shaft, a ratchet wheel engaging the free end of said arm
35 to move the same in a circle, a pawl for actuating said ratchet wheel, means for varying the number of teeth on the ratchet wheel engaged by said pawl in actuating the same
40 to move the wiper from one terminal to another, metallic line circuits, and means for controlling the aforesaid operative elements over said metallic line circuits.

16. In a telephone system, a set of trunk-lines, terminals corresponding to said trunk-
45 lines, a shaft provided with a wiper adapted to engage said terminals, an arm pivoted on said shaft to swing about an axis at right-angles to the axis of the shaft, a ratchet wheel engaging the free end of said arm to
50 move the same in a circle, and to thereby move the said wiper back and forth over said terminals, a pawl engaging said ratchet wheel to actuate the same, a notched wheel rotating with the said ratchet wheel, pro-
55 vided with notches at irregular intervals in the periphery thereof, a magnet for operating said pawl, means including circuit contacts engaging the periphery of said notched wheel to control the action of said magnet
60 and pawl, whereby the distance of travel of said wiper from one terminal to another is uniform throughout the length of movement thereof, but whereby the wiper is given a variable number of steps between different
65 terminals, metallic line circuits, and means

for controlling the aforesaid operative elements over said metallic line circuits.

17. In a telephone system, a set of trunk-lines, bank terminals for said trunk-lines, a plunger adapted to travel back and forth in
70 front of said terminals, means for giving said plunger a variable number of steps between different terminals, metallic line circuits, and means for controlling the aforesaid operative elements over said metallic
75 line circuits.

18. In a telephone system, a plurality of trunk-lines, terminals for said trunk-lines, a traveling member adapted to move back and forth in front of said terminals, mechanism
80 for giving the said member a step-by-step motion consisting of a series of successive steps of variable lengths, metallic line circuits, and means for controlling the aforesaid operative elements over said metallic
85 line circuits.

19. In a telephone system, a plurality of trunk-lines, an automatic switch for seizing idle trunk-lines, automatic mechanism
90 whereby a switching element of said switch is given a variable step-by-step motion, metallic line circuits, and means for controlling the aforesaid operative elements over said metallic line circuits.

20. In a telephone system, a plurality of
95 trunk-lines, terminals corresponding to said trunk-lines, said terminals being uniformly spaced apart, a traveling member adapted to cooperate with said terminals, having a uniform distance of travel from one terminal
100 to another throughout the range of travel thereof, mechanism for giving said traveling member a variable step-by-step motion between the different terminals, metallic line circuits, and means for controlling the aforesaid
105 operative elements over said metallic line circuits.

21. In a telephone system, a plurality of trunk-lines, terminals corresponding to said
110 lines, a wiper engaging and traveling along said terminals, mechanism for giving said wiper a variable step-by-step motion, metallic line circuits, and means for controlling the aforesaid operative elements over said
115 metallic line circuits.

22. In a telephone system, a plurality of trunk-lines, terminals for said trunk-lines, a circuit-closing plunger adapted to travel
120 along in front of said terminals, normally out of contact therewith, mechanism for giving said plunger a variable step-by-step motion between the different terminals, metallic line circuits, and means for controlling the aforesaid operative elements over said
125 metallic line circuits.

23. In a telephone system, a set of trunk-lines, a set of terminals corresponding to said trunk-lines, a wiper mounted to en-
130 gage said terminals, mechanism for causing said wiper to have a back and forth motion

and step-by-step movement over said terminals in both directions of motion thereof, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

24. In a telephone system, a set of trunk-lines, a series of terminals corresponding to said trunk-lines, a wiper adjacent said terminals, means for moving said wiper back and forth over said terminals, means for causing said wiper to stop on idle terminals corresponding to trunk-lines in each direction of motion thereof, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

25. In a telephone system, a set of trunk-lines, a set of terminals corresponding to said trunk lines, a wiper adjacent said terminals, mechanism for moving the wiper from one terminal to another, adapted to give the wiper a variable number of steps between terminals, but a uniform distance of travel from one terminal to another, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

26. In a telephone system, a set of trunk-lines, a series of terminals corresponding to said trunk-lines, a wiper adjacent said terminals, a shaft upon which said wiper is mounted, an arm carried by said shaft and pivoted thereon to swing about an axis at right-angles to that of the shaft, a ratchet wheel engaging the free end of said arm to move the same in a circle, a pawl for actuating said ratchet wheel, means for varying the number of teeth on the ratchet wheel engaged by said pawl in actuating the same to move the wiper from one terminal to another, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

27. In a telephone system, a set of trunk-lines, terminals corresponding to said trunk-lines, a shaft provided with a wiper adapted to engage said terminals, an arm pivoted on said shaft to swing about an axis at right-angles to the axis of the shaft, a ratchet wheel engaging the free end of said arm to move the same in a circle, and to thereby move the said wiper back and forth over said terminals, a pawl engaging said ratchet wheel to actuate the same, a notched wheel rotating with the said ratchet wheel, provided with notches at irregular intervals in

the periphery thereof, a magnet for operating said pawl, means including circuit contacts engaging the periphery of said notched wheel to control the action of said magnet and pawl, whereby the distance of travel of said wiper from one terminal to another is uniform throughout the length of movement thereof, but whereby the wiper is given a variable number of steps between different terminals, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

28. In a telephone system, a set of trunk-lines, bank terminals for said trunk-lines, a plunger adapted to travel back and forth in front of said terminals, means for giving said plunger a variable number of steps between different terminals, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

29. In a telephone system, a plurality of trunk-lines, terminals for said trunk-lines, a traveling member adapted to move back and forth in front of said terminals, mechanism for giving the said member a step-by-step motion consisting of a series of successive steps of variable lengths, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

30. In a telephone system, a plurality of trunk-lines, an automatic switch for seizing idle trunk-lines, automatic mechanism whereby a switching element of said switch is given a variable speed step-by-step motion, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

31. In a telephone system, a plurality of trunk-lines, terminals corresponding to said trunk-lines, said terminals being uniformly spaced apart, a traveling member adapted to cooperate with said terminals, having a uniform distance of travel from one terminal to another throughout the range of travel thereof, mechanism for giving said traveling member a variable step-by-step motion between the different terminals, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

32. In a telephone system, a plurality of trunk-lines, terminals corresponding to said

lines, a wiper engaging and traveling along said terminals, mechanism for giving said wiper a variable speed step-by-step motion, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

33. In a telephone system, a plurality of trunk-lines, terminals for said trunk-lines, a circuit-closing plunger adapted to travel along in front of said terminals, normally out of contact therewith, mechanism for giving said plunger a variable step-by-step motion between the different terminals, and automatic switches having vertical motion to select groups or divisions of the exchange, and rotary motion to extend connection from said trunk-lines in the direction of the called subscriber.

34. In a telephone system, a set of trunk-lines, terminals for said trunk-lines, sockets for said terminals, a plunger disposed in front of said sockets, mechanism operated to cause said plunger to travel back and forth in front of said sockets, with a step-by-step movement in each direction, to select an idle trunk ahead of the call, and means responsive to the calling subscriber for causing the

plunger to enter the socket at a preselected idle trunk-line.

35. In a telephone system, a set of trunk-lines, terminal sockets for said trunk-lines, each trunk-line having a plurality of said sockets, plungers disposed in front of said sockets, mechanism for moving said plungers back and forth in front of said terminals, with a step-by-step movement in each direction, and instrumentalities whereby each calling subscriber causes one of said plungers to enter the socket in front of which it was resting, and simultaneously therewith causes the other idle plungers to advance one way or the other to a position in front of the terminal sockets of the next idle trunk-line.

36. In a telephone exchange system, a master switch, and trunk terminals therefor, said switch including a switching element and means for moving said element step by step in opposite directions over the trunk terminals, substantially as described.

Signed by me at Chicago, Cook county, Illinois, this 10th day of July, 1908.

ALEXANDER E. KEITH.

Witnesses:

J. N. K.,
F. H. DRURY.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."