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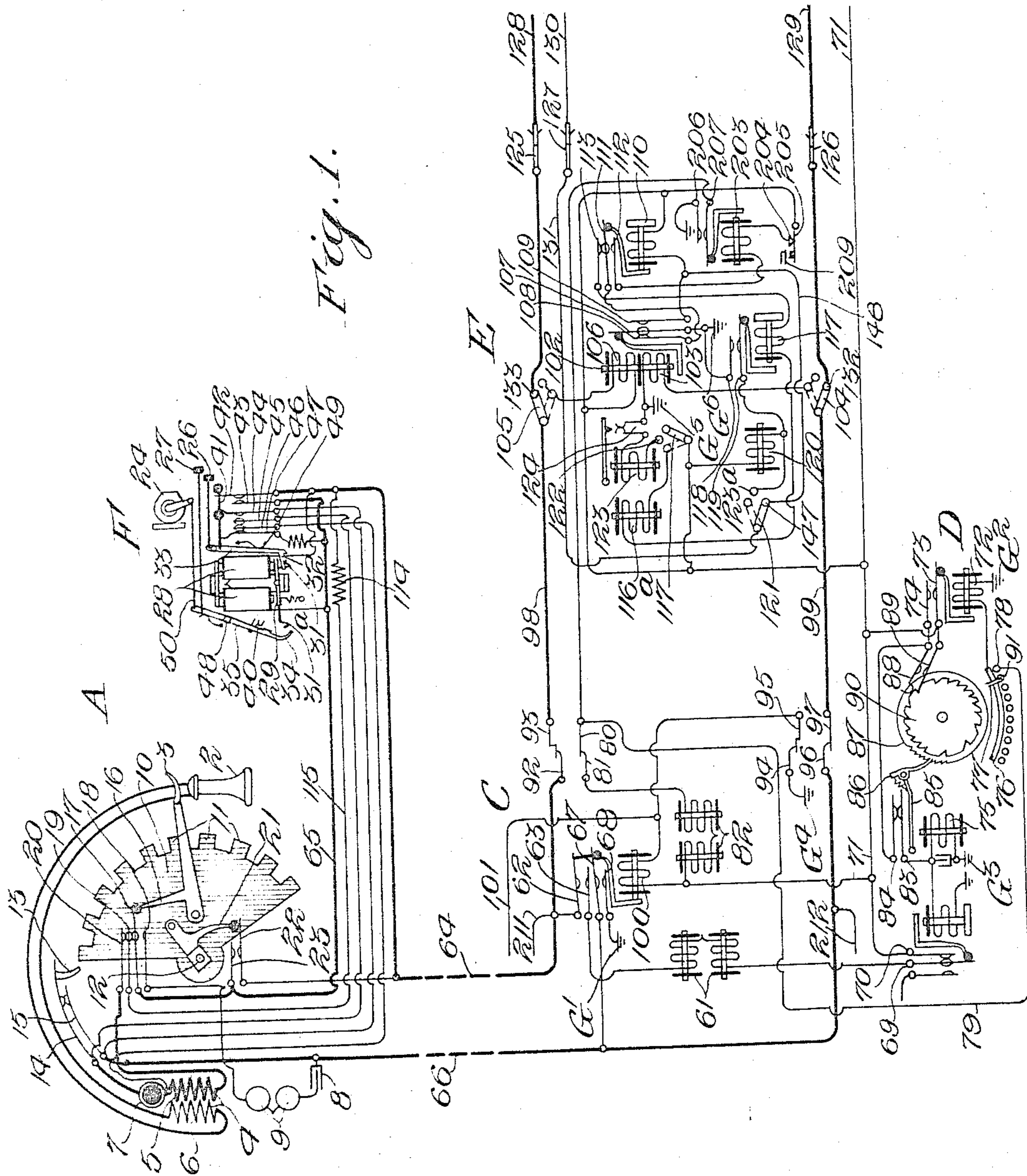
MEASURED SERVICE TELEPHONE SYSTEM.

APPLICATION FILED MAR. 30, 1909. RENEWED NOV. 18, 1916.

Patented July 31, 1917.

4 SHEETS—SHEET 1.

1,235,301.



Witnesses.
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R. H. Burfield

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Patented July 31, 1917.

4 SHEETS—SHEET 2.

1,235,301.

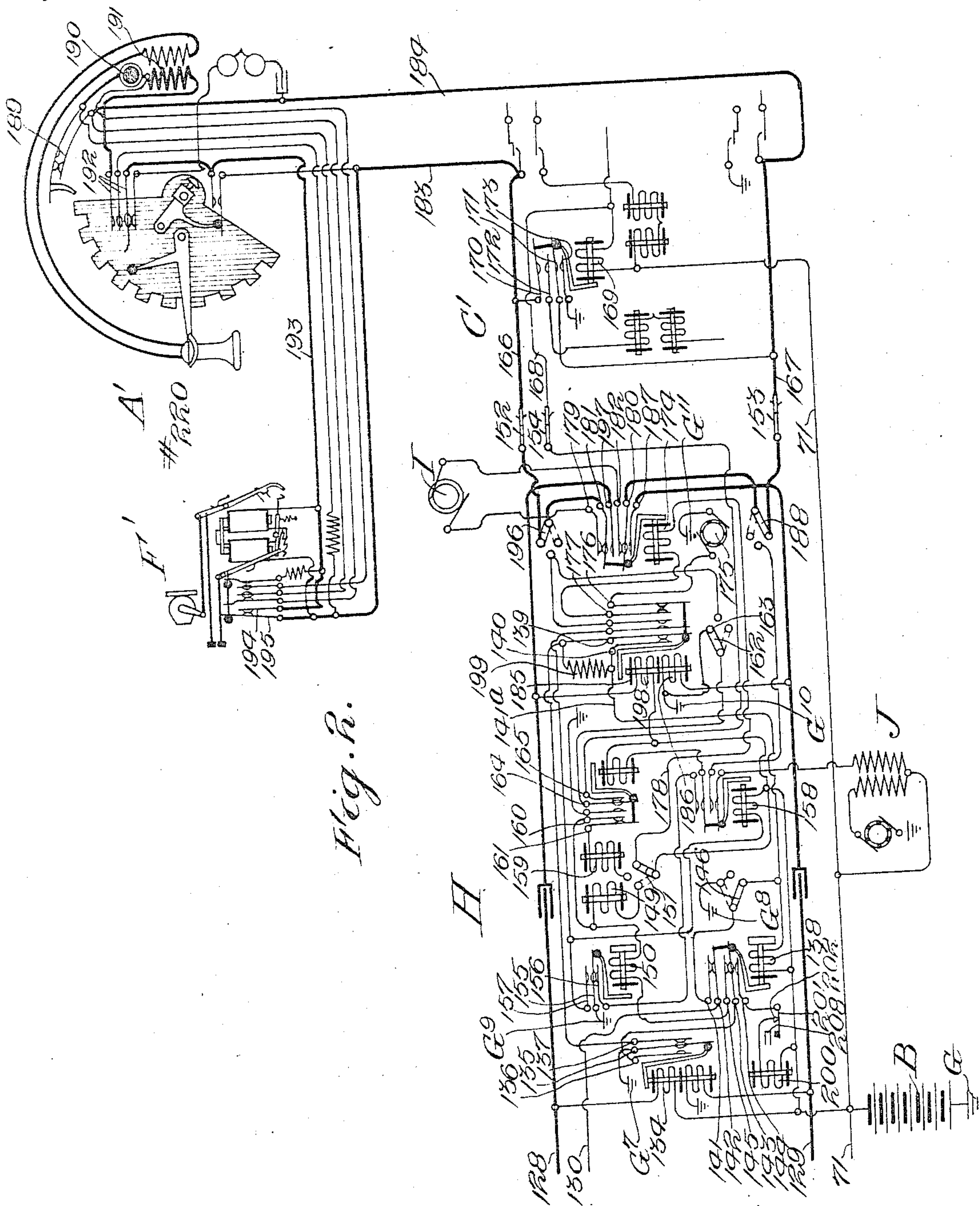


Fig. 2.

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Fig. 4.

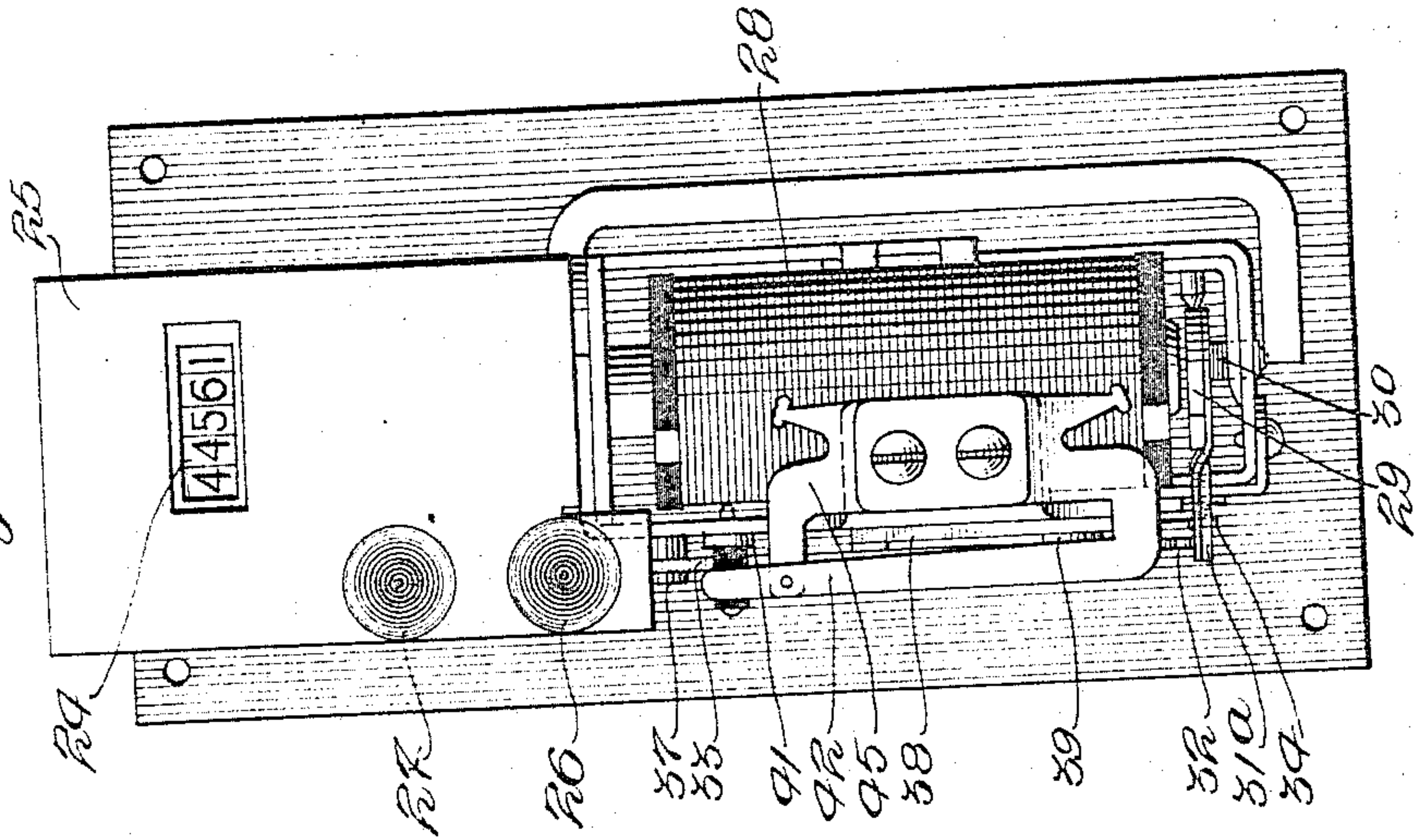
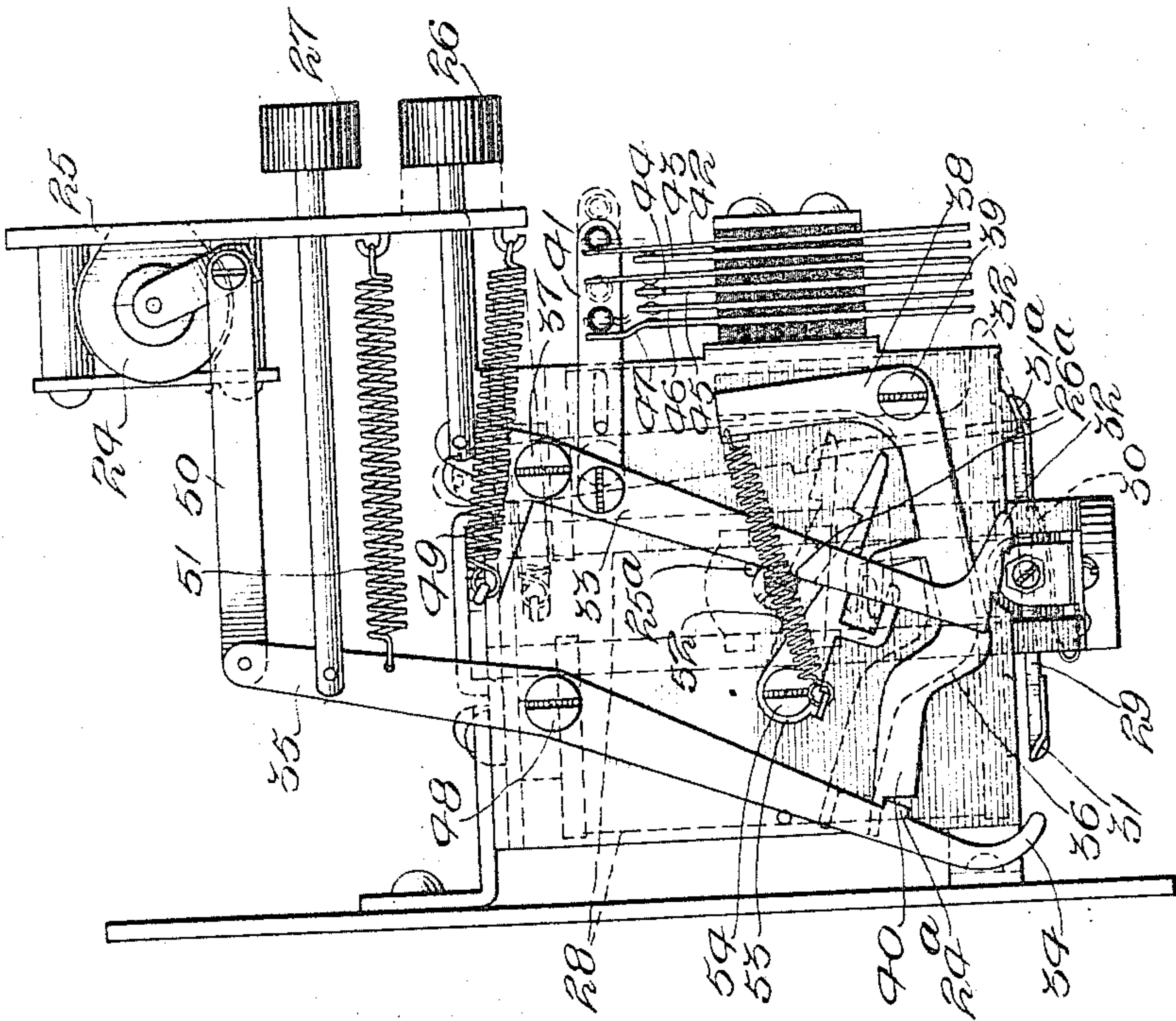


Fig. 3.



Witnesses.

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Patented July 31, 1917.

4 SHEETS—SHEET 4.

1,235,301.

Fig. 6.

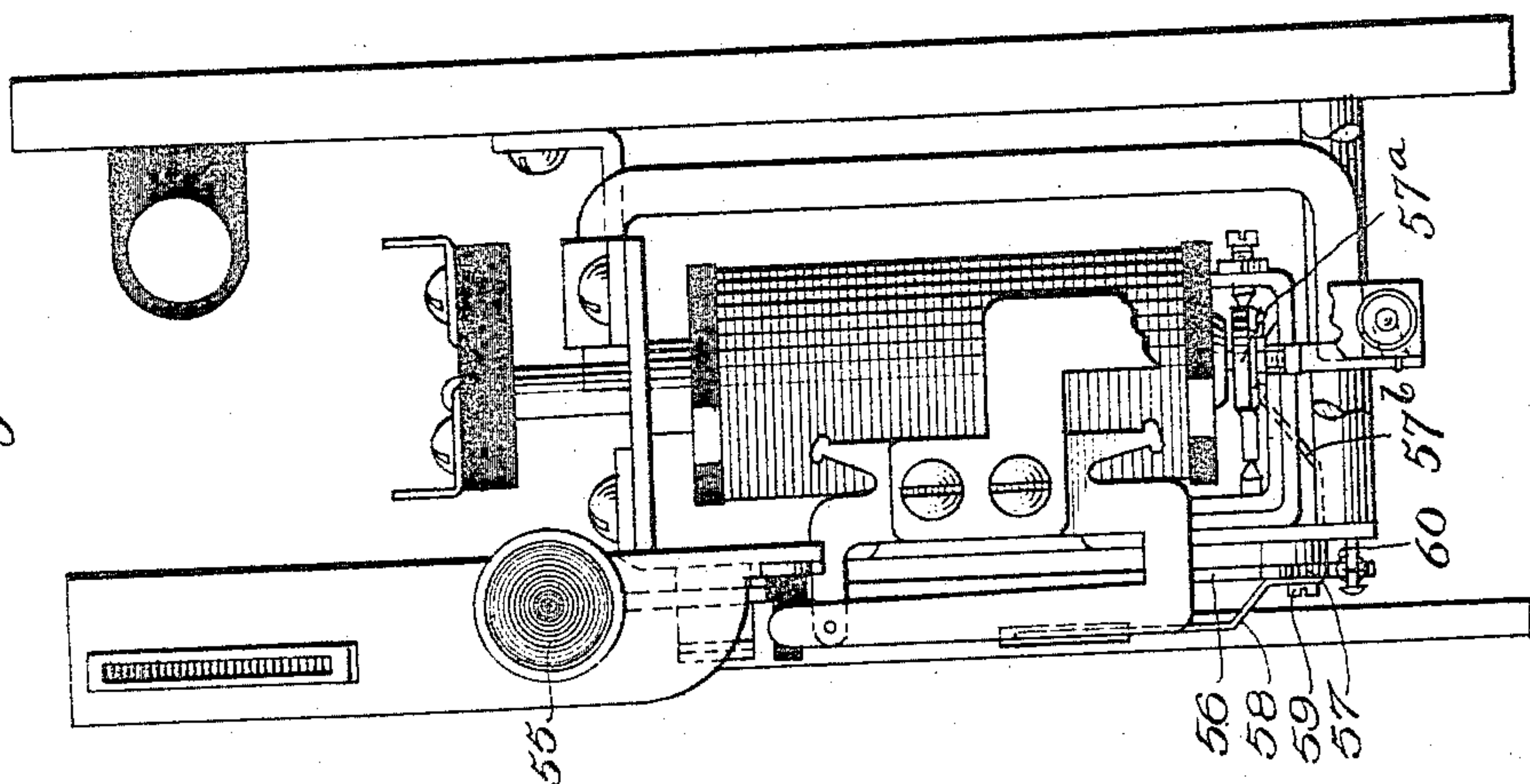
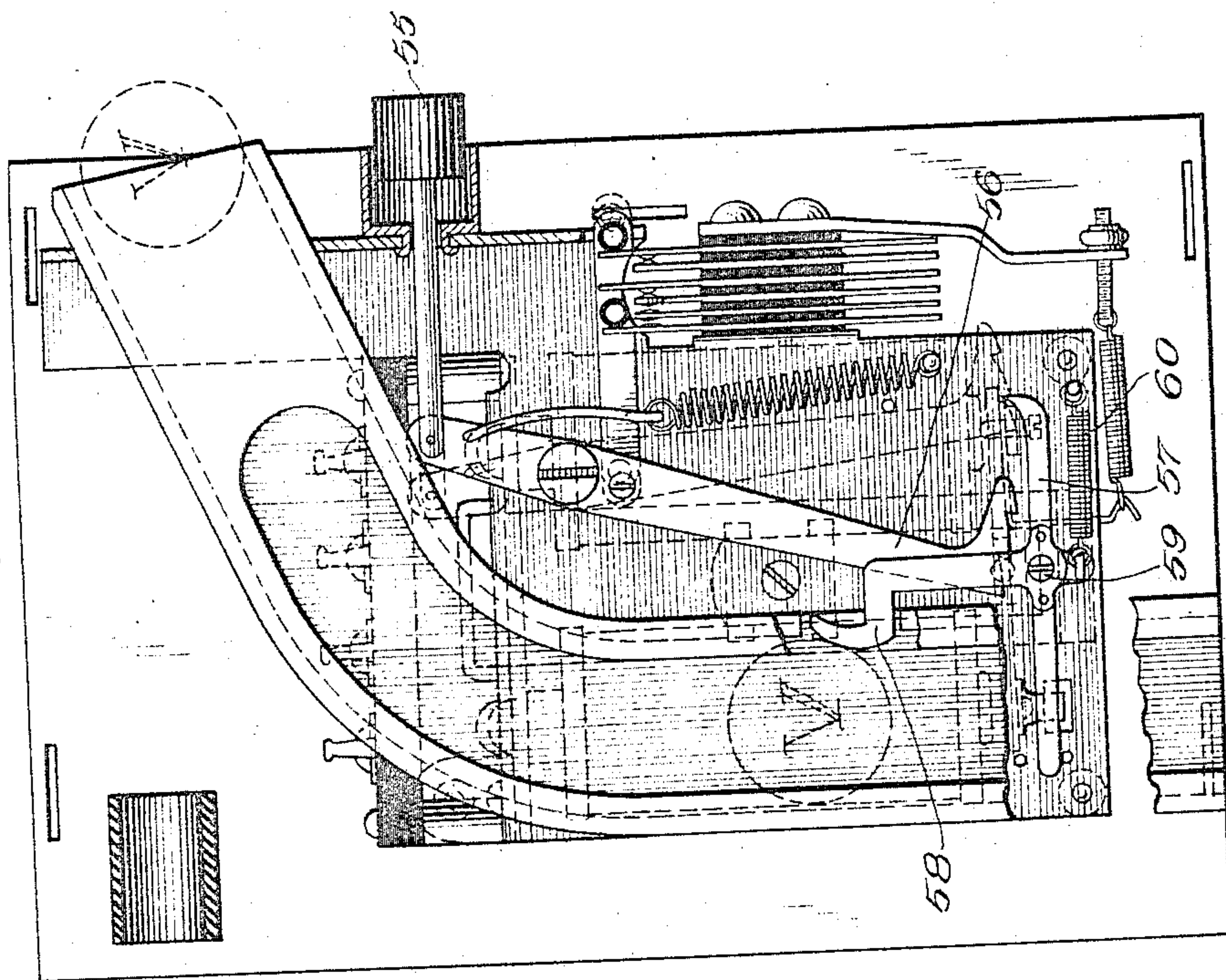


Fig. 5.



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UNITED STATES PATENT OFFICE.

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MEASURED-SERVICE TELEPHONE SYSTEM.

1,235,301.

Specification of Letters Patent. Patented July 31, 1917.

Application filed March 30, 1909, Serial No. 486,724. Renewed November 18, 1916. Serial No. 132,206.

To all whom it may concern:

Be it known that I, JOHN ERICKSON, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented a certain new and useful Improvement in Measured-Service Telephone Systems, of which the following is a specification.

My invention relates to telephone exchange systems in general, but more particularly to systems in which the calls are extended in whole or in part by automatic switches, and especially to systems in which measured service devices are employed at the substations, whereby calling subscribers may not converse with called subscribers until after the successful call is either paid for or registered at the calling substation—that is to say, not until after toll is assessed in some suitable manner.

My invention contemplates, therefore, a measured service system in which the means at the substation for transmitting an impulse or impulses to the central station are normally short-circuited, whereby the calling subscribers must first remove such short-circuit before impulses of current for operating purposes can be transmitted to the central station, and in which the act of removing the said short-circuit, as by operating a push-button or other switch, for calling purposes serves also to establish another short-circuit around the calling subscriber's talking transmitter, thus making it necessary for the subscriber to perform some other act suitable for removing the short-circuit from around the talking transmitter, as by pushing a button or depositing a coin, after he hears the called subscriber answer, and before he can converse with the latter.

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

In the accompanying drawings Figure 1 shows diagrammatically a subscriber's station A equipped with a call registering device F, in a system embodying the principles of my invention. The line conductors at substation A terminate at the central office in the line switch C; the master switch D is provided for operating the plunger shaft of the group of line switches of which C is a member; and at E there is shown a first selector switch.

In Fig. 2 there is shown a connector

switch H for operating in connection with the line and selector switches of Fig. 1; the central office ringer generator is shown at I and a busy-signaling machine at J; the subscriber's station A¹ is also equipped with a call register F¹; and the line conductors at the substation A¹ terminate in the line switch C¹.

Fig. 3 is a side elevation of the call register, and Fig. 4 is a front elevation of the same.

In Fig. 5 the call registering device is shown with slight modifications to adapt it to operate in connection with a coin device.

Fig. 6 is a front view of Fig. 5.

Figs. 1 and 2 taken together represent diagrammatically the central office switching apparatus involved in establishing a connection between two subscribers' stations. A central office battery is shown at B (Fig. 2) having its positive terminal preferably grounded at G.

The central office switching apparatus is of a well-known type, but modified to adapt it to operate as a two-wire system—that is, a system in which the operating impulses are transmitted over the two usual line conductors in series. The subscribers' stations, it will be seen, are also somewhat modified for the same purpose, to operate in a two-wire system, and with the central office switches of the two-wire system. Substation A, for example, comprises the usual receiver 2, switch-hook 3, induction coil 4 which consists of the primary winding 5 and secondary winding 6, transmitter 7, condenser 8, ringer 9, and impulse wheel 10 which has the usual impulse teeth 11. The impulse wheel 10 is secured to the shaft 12, to which shaft there is also secured the dial (not shown). When the dial is turned and thereafter released the impulse teeth 11 engage the cam 13 upon the end of the spring 14, and thereby carry the latter out of engagement with the spring 15. Upon the switch-hook 3 there is a cam 16 which, when the hook rises, carries the spring 17 out of engagement with the spring 18 and into contact with the springs 19 and 20. Also secured to the shaft 12 is the normal arm 21 which controls the springs 22 and 23.

The line switch C and the master switch D are of the general type described in English Patent No. 26,301 of 1906, *Western Electrician* of January 25, 1908, Chicago, 110

Illinois, and the *American Telephone Journal* of Chicago, Illinois, dated June 6, 1908. The circuit connections, however, are modified to adapt the switches to operate in connection with the two-wire system.

The first selector switch E is of the general type shown in United States Letters Patent No. 815,321, issued March 13, 1906, to Keith, Erickson and Erickson. As shown in Fig. 1, the bridge-cut-off relay and the normal conductors have been omitted and the circuits otherwise changed to operate conjointly with the line switch C. The connector switch H shown in Fig. 2 is of the general type of connector switch shown in United States Letters Patent No. 815,176, issued March 13, 1906, to Keith, Erickson and Erickson. Like the line switch C and the first selector switch E it is also arranged to operate in a system in which the central office apparatus is controlled by impulses delivered over two sides of the calling line in series.

The call registering device F (Fig. 3) comprises a meter 24 mounted upon a bracket 25. The push-button 26 controls a group of springs, and the button 27 controls the operation of the meter 24 and also the button 26, as will be explained. The polarized relay 28 controls an armature 29. The armature 29 is maintained in normal position by a spring 30, and upon opposite ends of the armature 29 are the fingers 31 and 31^a. The finger 31^a at the right of the armature is adapted to be engaged by the lower part 32 of the member 33, and the finger 31 on the left of the armature 29 is adapted to be engaged by the end 34 of the member 35. The locking dog 36 is also provided for locking the member 35 in normal position, as shown. When the button 26 is pressed the member 33 is moved about the pivot screw 37 and the bottom part or end 32 is carried into engagement with the finger 31^a of the armature 29. When this occurs the member 33 engages the top part 38 of the locking dog 36. The locking dog is then moved about the pivot screw 39 until the notched end 40 is raised to the position indicated by dotted lines and out of engagement with the member 35. When the button 26 is thus pressed the arm 41 moves to the right, permitting the springs 42 and 43, and 44 and 45 to disengage, and the springs 46 and 47 are carried into contact with the spring 45. The finger 31^a on the armature 29 engages the tooth sections of the end 32 nearest the heel and maintains the button 26 in its operated position. The button 27, when pressed, moves the member 35 about the pivot screw 48, thereby carrying the end 34 into engagement with the finger 31 on the left end of the armature 29. As the end 34 presses against the finger 31 the armature 29 is moved from its normal position, thus mov-

ing the finger 31^a out of engagement with the end 32 of the member 33, and the button 26 is restored to normal position due to the tension spring 49. Also, when the button 27 is released the member 35 moves about the pivot screw 48 and the link 50 operates the meter 24 one step. The push-button 27, when released, always restores to normal position, owing to the tension in the spring 51. After the button 27 and the member 35 are fully restored the end 40 of the locking dog 36 again falls to normal position, thereby locking the member 35. The spring 52 is provided for restoring the locking dog 36 and also for moving the locking dog 53 about the pivot screw 54.

The object of the pawl member 53 is to prevent a fraudulent operation of the meter mechanism—that is, after a call has been made and the meter mechanism operated the pawl 53 is arranged to lock the member 33, which is controlled by the button 26, in normal position until the member 35, which is controlled by the button 27, is fully restored. After the button 26 has been pressed and a connection established, then before the calling subscriber may be heard by the called subscriber the button 27 must be pressed in order that the member 33 and springs controlled by the arm 41 may return to normal position. Suppose, however, that when the button 27 is pressed it is retained in its depressed position; the subscriber intending to press the button 26 and make another call in the meantime retaining the button 27 depressed, so that it will not be necessary to operate the meter and thus register the second call. This is prevented, for when the button 27 is pressed the finger 24^a on the member 35 passes beneath the end 40, since the mechanism is now in its operated position indicated by the dotted lines. The pawl member 53 is also raised to the position indicated by dotted lines. Now, when the end 34 engages the finger 31 and operates the armature 29, so that the end 32 is released from the finger 31^a, the member 33 restores to normal position against the stop 25^a, where the finger 26^a of the member 33 falls behind a tooth of the pawl member 53 and is thereby retained locked in its normal position until the member 35 fully restores to normal and the finger 24^a passes from behind the end 40 and permits the latter to restore, whereby the pawl 53 is also restored and the member 33 unlocked. When the mechanism thus restores to normal it will be seen that the button 27 and member 35 are locked in normal position by the end 40 falling in front of the finger 24^a.

The pay station or measured service device shown in Fig. 5 is merely a modified form of the meter mechanism shown in Fig. 3—that is, instead of having two push-buttons 26 and 27 as in Fig. 3, one push-button 55 is

provided for operating the group of springs, as explained in connection with Fig. 3. When the button is operated the arm 56 is locked in its operated position by the arm 57 which is pivoted at 59. The button for restoring the mechanism is omitted, and in its stead the coin-controlling mechanism is provided for restoring the push-button 55 to normal position. When a coin V is dropped in the slot it rolls down the chute and comes in contact with the arm 58. The weight of the coin is sufficient to move the arm, and the arm 57 is moved about the pivot point 59, thereby unlocking the member 56 and permitting the button 55 to return to normal position. The armature 57^a of the electromagnet carries an arm 57^b which is adapted to engage the arm 57 to disengage the said arm 57 from the arm 56. Thus it will be seen that the coin chute and the arm 58 merely take the place of the push-button 27 and provide means for restoring the mechanism to normal position after once being operated. The spring 60 provides tension for the arm 57 and maintains the latter in a position to engage the member 56 when operated.

A clearer understanding of my improved meter mechanism may be had from a consideration of its operation when a subscriber calls another subscriber. Suppose, for example, that the subscriber at substation A (Fig. 1) desires to establish connection with the subscriber at substation A¹ (Fig. 2), the number of which latter is arbitrarily chosen as #220. To call the number 220 the subscriber at substation A removes the receiver from the switch-hook and operates the calling device for each digit in the well-known manner. When the receiver is removed from the switch-hook, however, and the spring 17 is carried out of engagement with the spring 18 and thrust into contact with the springs 19 and 20, an energizing circuit is established through the trip magnet 61 of the line switch C. The trip magnet thereupon energizes and operates the plunger to seize an idle trunk terminal leading to the selector switch E. The selector switch E then operates in response to the first digit to select an idle trunk line leading to the connector switch H (Fig. 2). The connector switch H is in turn operated by the impulses for the last two digits to establish connection with the terminals of the desired line. When the receiver is removed from the switch-hook and the springs 17, 19 and 20 engage, the energizing circuit through the trip magnet 61 extends from ground G¹ to the springs 68 and 67, line conductor 66, through the impulse springs 15 and 14, transmitter 7, primary winding 5, springs 20, 19 and 17, conductor 65, springs 42 and 43 of the meter F to the line conductor 64, through the springs 62 and 63, trip magnet 61, springs 69 and 70 to the battery lead 71, thence through battery B and to ground G. The trip magnet thereupon energizes and attracts its armature, permitting the plunger arm to thrust the plunger into an idle bank terminal. When the plunger enters the bank terminal the relay 72 energizes and operates to close the springs 73 and 74 into contact, whereby an energizing circuit is established through the motor magnet 75 of the master switch D. The motor magnet then operates to advance all idle plungers that are in locked engagement with the plunger shaft opposite the next idle bank terminal similar to the one just engaged. The circuit through the motor magnet relay 72 extends from ground G² through the motor magnet relay 72, common segment 76 of the master switch bank, wiper 77, individual segment 78, conductor 79, bank springs 80 and 81, through the winding of the release magnet 82 and to the battery lead 71, etc. The relay 72 thereupon energizes and places the springs 73 and 74 in contact, whereby a circuit is closed through the motor magnet 75 extending from ground G³ through the magnet 75, interrupter springs 83 and 84, springs 74 and 73 and to the battery lead 71, etc. The motor magnet 75, upon energizing, attracts its armature 85, and the pawl 86 engages a tooth of the ratchet wheel 87 and moves the latter one step. When this occurs the spring 89 engages the spring 88 (bearing in mind that the spring 89, prior to this operation, rests in a notch of the toothed wheel 90), and when the ratchet wheel 87 is given one step the spring 89 slides to the top of the next tooth and engages the spring 88. The engagement of these two springs provides a new energizing circuit for the motor magnet 75, said circuit extending through the springs 88 and 89 to the battery lead 71 instead of through the springs 73 and 74. Furthermore, the motor magnet, when energized, separates the interrupter springs 83 and 84, thereby breaking its own circuit in a manner similar to which a buzzer operates. The motor magnet 75 continues to operate in this manner as long as the springs 88 and 89 remain in engagement. When the next succeeding notch on the wheel 90 advances far enough the spring 89 disengages from the spring 88, thereby opening the energizing circuit for the motor magnet. By the time this last notch disengages the springs 88 and 89, the master switch wiper 77 has passed from the first contact 78 to the second contact 91. Suppose, however, that when the wiper 77 engages the individual segment 91 there is a guarding potential present. In that event an energizing circuit is closed through the motor magnet relay 72, said circuit extending from the contact through the wiper 77, common segment 76 of the master switch bank, through the wind-

ing of the relay 72 to ground, as previously traced. The motor magnet relay again energizes and closes the circuit for the motor magnet 75. The motor magnet operates as before, and the wiper 77 is carried to the next contact and the next notch of the wheel 90 separates the springs 88 and 89. This operation continues as long as the wiper 77 continues to find contact segments with protecting potentials. Of course, it will be understood that when the motor magnet 75 thus operates the plunger shaft end of the plungers that are in locking engagement with the said shaft are moved to a new position opposite an idle bank terminal similar to the one engaged by the line switch C. At the instant that the plunger enters the bank the following springs are pressed into contact: 92 and 93, 94 and 95, 96 and 97, and 81 and 80. The engagement of the springs 92 and 93 and 96 and 97 extends the calling subscriber's line conductors 64 and 66 to the trunk conductors 98 and 99, which latter terminate in the first selector switch E. The engagement of the bank springs 94 and 95 provides an energizing circuit for the bridge-cut-off relay 100 extending from ground G⁴ through the bank springs 94 and 95, bridge-cut-off relay 100 to the battery lead 71, thence through battery B to ground G. The bridge-cut-off relay thereupon operates to separate the springs 62 and 67 from the springs 63 and 68, respectively. By this operation the trip magnet 61 is disconnected from the subscriber's line conductors 64 and 66. The engagement of the springs 94 and 95 also provides a guarding potential over the private normal conductor 101 to the connector bank contact corresponding to the line of substation A, thereby protecting the calling line against seizure by some calling subscriber. Furthermore, when the subscriber's line conductors 64 and 66 are thus extended to the trunk conductors 98 and 99, an energizing circuit is established through the line relay 102 of the selector switch E. The circuit through this relay extends from ground G⁵ through the winding 103, side switch wiper 104, conductor 99, bank springs 97 and 96, line conductor 66, through the substation impulse springs 15 and 14, transmitter 7, primary winding 5, springs 20, 19 and 17, conductor 65, springs 43 and 42 to the line conductor 64, bank springs 92 and 93, trunk conductor 98, side switch wiper 105, through the winding 106 to the battery lead 71, thence through battery B to ground G. The relay 102 thereupon energizes and operates to carry the spring 107 from engagement with the spring 108 and into engagement with the spring 109, thereby providing an energizing circuit for the slow-acting release relay 110, which in turn operates to carry the spring 111 out of contact with the spring 112 and into engagement with the spring 113.

The foregoing operation of the central office mechanism occurs when the calling subscriber removes the receiver from the switch-hook and bridges the primary circuit across the line conductors 64 and 66. The normal position of the meter mechanism and circuit is shown at F¹ in Fig. 2. It will be seen that the impulse springs are short-circuited by the springs of the meter mechanism, and before any impulses can be sent to the line conductors 64 and 65 the short-circuit produced by the meter springs must be removed. The calling subscriber, therefore, presses the button 26 and operates the springs 42, 43, 44, 45, 46 and 47 to the position shown at F in Fig. 1; the springs 42 and 43 are separated thereby breaking the short circuit around relay 28 and resistance 114. The energizing circuit for the line relay 102, however, is maintained through the resistance 114 and the polarized relay 28 in multiple. The circuit through the resistance 114 extends from the conductor 64 through the winding 114, conductor 115, through the springs 19 and 20, and through the primary winding 5, transmitter 7 and impulse springs 14 and 15 to the line conductor 66. The disengagement of the springs 44 and 45 removes the short-circuit or shunt from the impulse springs 14 and 15, and when the dial returns to normal position for the first digit 2 the impulse springs 14 and 15 are separated twice, thereby breaking the energizing circuit through the line relay 102 twice. The line relay 102, upon deenergizing, permits the spring 107 to engage the spring 108, thereby breaking the circuit through the release relay 110. As previously stated, the relay 110 is slow-acting—that is, slow to deenergize, and when its energizing circuit is momentarily broken during the transmission of impulses the said relay does not deenergize, but remains in an operated position with the springs 111 and 113 in contact. Thus when the spring 107 engages the spring 108 two impulses are transmitted to the vertical magnet 116 extending from ground G⁶ through the springs 107 and 108, springs 111 and 113, private magnet relay 117, vertical magnet 116, side switch wiper 117^a to the battery lead 71, thence through battery B to ground G. Two impulses being delivered, the vertical magnet 116 is thereby energized twice, and the shaft wipers are given two vertical steps in the well-known manner. It is thus seen that the private magnet relay 117 is included in the energizing circuit of the vertical magnet 116. This relay energizes on the first impulse, and being a slow-acting relay it maintains its armature attracted until all of the impulses are of the digit transmitted. When the relay 117 energizes, the springs 118 and 119 are closed in contact and an energizing circuit is established through the

private magnet 120 extending from ground G^6 through the springs 118 and 119, private magnet 120 to the battery lead 71, thence through battery B to ground G. The private magnet relay 117 deenergizes after the last vertical impulse, since this energizing circuit is no longer maintained after the springs 107 and 108 disengage; hence the said relay deenergizes, permitting the springs 118 and 119 to disengage, whereby the energizing circuit for the private magnet 120 is in turn broken. The private magnet now deenergizes and permits the side switch to pass from first to second position, thus permitting the side switch wipers 117^a and 121 to engage the contact points 122 and 123^a, respectively. The closure of contact between the side switch wiper 117^a and the contact point 122 sets up an energizing circuit for the rotary magnet 123. This energizing circuit extends from ground G^5 through the interrupter springs 124, rotary magnet 123, contact point 122, side switch wiper 117^a to the battery lead 71, thence through battery B to ground G. The said rotary magnet then operates to rotate the shaft wipers 125, 126 and 127 of the selector switch 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 128, 129 and 130 lead to the connector switch H (Fig. 2). If the first trunk line is busy, however, and the wipers have to pass over busy contacts, then as soon as the private wiper 127 engages the first private bank contact the private magnet 120 again energizes, locking the side switch in second position. The energizing circuit for the said private magnet extends from the grounded terminal G of the battery B through an occupying switch (not shown), through the private wiper 127, thence through the conductor 131, side switch wiper 121, contact point 123^a, through the private magnet 120 to the battery lead 71, thence through battery B to ground G. The private magnet 120, upon thus becoming energized, locks the side switch wiper 117^a in engagement with the contact point 122, whereby the rotary magnet 123 will be energized step by step, and 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 120 is destroyed, and as a result the selector side switch passes to third position. If there are no busy trunk lines the private magnet 120 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 trunk line conductors 98 and 99 are extended to the conductors 128 and 129 which, in this case, it is assumed lead to the

connector switch H (Fig. 2). The extending of the line occurs, of course, as soon as the side switch wipers 104 and 105 engage the contact points 132 and 133, respectively. When the trunk line is thus extended to the connector switch H an energizing circuit is established through the line relay 134 in the same manner in which the energizing circuit was established through the line relay 102 of the selector switch E. The relay 134, upon energizing, operates to shift the spring 135 out of engagement with the spring 136 and into contact with the spring 137. When the springs 135 and 137 engage, an energizing circuit is established through the slow-acting relay 138. This circuit extends from ground G^7 through the springs 135 and 137, back-bridge relay springs 139 and 140, conductor 141^a, through the relay 138 to the battery lead 71, thence through battery B to ground G. The relay 138, upon energizing, operates to close the springs 141 and 142 in contact and also to shift the spring 143 from the spring 144 into contact with the spring 145. The engagement of the springs 141 and 142 provides a guarding potential to the private bank contact corresponding to the trunk conductors 128 and 129. This potential extends from ground G^8 to the side switch wiper 146, springs 141 and 142, conductor 130 to the private bank contact engaged by the private wiper 127. Furthermore, a new energizing circuit is provided for the release relay 110 of the selector switch E. This circuit extends from ground G^8 at the connector switch H to the private wiper 127, as explained, through the conductor 131, side switch wiper 121, contact point 147, conductor 148 to the release relay 110, thence to the battery lead 71, and through battery B to ground G. This primary operation of the relays 134 and 138 of the connector switch H occurs at the instant that the side switch wipers 104 and 105 of the selector switch E pass to third position and extend the subscriber's line conductors 66 and 64 to the trunk conductors 129 and 128.

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 14 is twice carried out of engagement with the impulse spring 15, thereby momentarily deenergizing the line relay 134 of the connector switch twice. The spring 135 thereby engages the spring 136 twice, thus sending two impulses to the vertical magnet 149 from ground G^7 through the springs 135 and 136, springs 143 and 145, private magnet relay 150, vertical magnet 149, side switch wiper 151 to the battery lead 71, thence through battery B to ground G. The private magnet relay 150 energizes when the first impulse is delivered, and since the said relay is slow-acting it remains

in an operated position until all of the vertical impulses are sent. The relay 138 is slow-acting and it also remains in its operated position. The vertical magnet 149, upon being energized, operates one step at a time to carry the shaft wipers 152, 153 and 154 two steps to a point opposite the second level. The private magnet relay 150, upon energizing, operates to carry the spring 155 out of engagement with the spring 156 and into contact with the spring 157. When the springs 155 and 157 engage, an energizing circuit is established through the private magnet 158 from ground G^9 to the springs 155 and 157, private magnet 158 to the battery lead 71, thence through battery B to ground G. The relay 150, being a slow-acting relay, remains in an operated position while the vertical impulses are being sent; but after all of the impulses are delivered, and the line relay 134 returns to its operative position, the circuit through the relay 150 becomes broken, thus permitting the spring 155 to return to normal position. When the springs 155 and 157 disengage, the circuit through the private magnet 158 becomes broken, thereby allowing the said magnet to deenergize, whereby the side switch passes 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 134 ten times. Each time that the line relay springs 135 and 136 engage, an energizing circuit is established through the rotary magnet 159 from ground G^7 through the springs 135 and 136, springs 143 and 145, private magnet relay 150, springs 160 and 161, through the winding of the rotary magnet 159, side switch wiper 151 to the battery lead 71, thence through battery B to ground G. Again the private magnet relay 150 energizes, as in the previous case, remaining so until all of the impulses are transmitted, thereby retaining the private magnet also energized. The rotary magnet 159 operates to rotate the shaft wipers into engagement with the terminals of the desired line #220. If this line is busy at the time, the connector will be locked in second position, and the calling subscriber is given the busy-signal, thus making it impossible to extend the calling line into connection with the called line. As soon as the line relay 134 ceases to operate for the last digit, and if the called line is idle, the private magnet relay 150 deenergizes, as heretofore explained, permitting, in this instance, the side switch to trip to third position. When the side switch wiper 162 engages the contact point 163 a guarding potential is completed at the private wiper 154 for protecting the seized line from interference while the connection is established.

This guarding potential extends from ground G^{10} through the side switch wiper 162, springs 164 and 165 to the shaft wiper 154, which latter engages the private bank contact corresponding to the called line. Not only does this guarding potential prevent other connectors from calling in on the same line over multiples of the normal conductors 166, 167 and 168, but it also provides an energizing circuit for the bridge-cut-off relay 169. This circuit extends from ground G^{10} to the private wiper 154, as explained, then through the bridge-cut-off relay 169 to the battery lead 71, thence through battery B to ground G. The bridge-cut-off relay, upon energizing, shifts the springs 170 and 171 out of contact with the springs 172 and 173, respectively, whereby the switch C^1 is prevented from operating when the called subscriber removes his receiver from the switch-hook. When the side switch wiper 146 passes to third position, ground G^8 is disconnected from the private trunk conductor 130, but a new guarding potential is, however, provided from ground G^7 as follows: From ground G^7 through the springs 135 and 137, through the springs 139 and 140, conductor 141^a, side switch wiper 146, springs 141 and 142 to the conductor 130. When the side switch wiper 151 engages its third-position contact point an energizing circuit is established through the ringer relay 174, said circuit extending from ground G^{11} through the interrupter 175, springs 176 and 177, ringer relay 174, conductor 178, side switch wiper 151 to the battery lead 71, thence through battery B to ground G. The relay 174 therefore energizes intermittently and presses the springs 181 and 180 into contact with the springs 179 and 182 respectively, whereby the terminals of the ringer generator I are bridged across the line conductors 183 and 184 of the called substation. When the called subscriber answers an energizing circuit is established through the back-bridge relay 185 extending from ground G^{10} through the winding 186, through the springs 187 and 180, side switch wiper 188, shaft wiper 153, normal conductor 167, line conductor 184, impulse springs 189, transmitter 190, primary winding 191, springs 192 (which are in engagement after the called subscriber answers), conductor 193, meter springs 194 and 195 to the line conductor 183, normal conductor 166, shaft wiper 152, side switch wiper 196, ringer relay springs 181 and 197, winding 198 of the relay 185 to the battery lead 71, thence through battery B to ground G. The relay 185 thereupon energizes and operates to separate the springs 176 and 177, thus breaking the energizing circuit for the ringer relay 174. The springs 139 and 140 are also separated, but their operation merely introduces the low resistance coil 199 in a

guarding potential circuit. The two substations A and A¹ are now connected over a circuit shown by the heavy line conductors in Figs. 1 and 2. The calling subscriber may hear the called subscriber answer, but before the calling subscriber may be heard by the called subscriber the push-button 27 of the meter F must be pressed, thereby restoring the meter to normal position and removing the short-circuit of the transmitter 7 when the springs 45, 46 and 47 disengage. When the push-button 27 is pressed the member 35 is moved about the pivot screw 48 and the end 34 raises the end 31 of the armature 29 a trifle. When this occurs the finger 31^a is carried out of engagement with the end 32 of the member 33. The push-button 26 and the arm 41, being released, restore to normal position. When the arm 41 restores to normal, the springs 42 and 43, and 44 and 45 are pressed into contact, and the springs 46 and 47 are separated. The engagement of the springs 42 and 43 completes the subscribers' talking circuit, and the disengagement of the springs 45, 46 and 47 removes the short-circuit of the transmitter 7. The subscriber at station A may now talk to the subscriber at substation A¹. When the button 27 is released, as explained, the link 50 is given a forward motion, and this in turn operates to move the meter 24 one step, whereby the call is registered.

The release of the central office switching apparatus occurs when the calling subscriber restores the receiver 2 to the switch-hook 3, thereby opening the energizing circuit for the line relay 134, when the springs 17, 19 and 20 disengage. The relays 134 and 138 thereupon restore to normal position, closing an energizing circuit for the release magnet 200 of the connector switch H. This circuit extends from ground G⁷ through the springs 135 and 136, springs 143 and 144, normal spring 201 and contact point 202, through the release magnet 200 to the battery lead 71, thence through battery B to ground G. The release magnet energizes and operates to restore the connector switch shaft and side switch to normal position. When the springs 141 and 142 of the relay 138 disengage, the energizing circuit for the release relay 110 of the selector switch E is broken. The release relay 110 also deenergizes and permits the springs 111 and 112 to engage, thereby in turn closing an energizing circuit through the release magnet 203, said circuit extending from ground G⁸ through the springs 107 and 108, springs 111 and 112, release magnet 203, contact point 204, normal spring 205 to the battery lead 71, thence through battery B to ground G. The magnet 203 thereupon energizes and closes the springs 206 and 207 in contact, which provides an energizing circuit for the release

magnet 82 of the line switch C. When the switch shaft of the connector switch H restores to normal position the normal arm 208 carries the spring 201 out of engagement with the contact point 202, whereby the circuit for the release magnet 200 becomes broken. The switch shaft of the selector switch E, upon restoring, also operates to carry the spring 205 out of engagement with the contact point 204, in turn breaking the energizing circuit for the release magnet 203. The release magnet 82 of the line switch C, upon energizing, attracts its armature and remains in readiness to withdraw the plunger from the bank terminal when the release magnet 203 of the selector switch E deenergizes. Thus it will be seen that the calling subscriber, upon restoring his receiver to the switch-hook, and opening an energizing circuit for the line relay 134, restores the central office switching apparatus to normal position.

In the foregoing it has been shown how a subscriber may operate his substation and meter to establish connection with another line. Suppose, however, that the call is not successful—that is, assume that the called subscriber does not answer, or that the desired line is busy. In that event the calling subscriber does not press the button 27 to register the call, but merely returns the receiver to the switch-hook and leaves the meter mechanism in operated position. Now, if some other subscriber calls the substation A while the meter F is in its operated position, the connection will extend over the line conductors of the calling subscriber to the normal conductors 211 and 212 of the line switch C. Ringing current is therefore sent from the conductor 212 to the line conductor 66 through the condenser 8, ringer 9, springs 18 and 17, conductor 65, winding of the polarized relay 28 of the meter mechanism F to the line conductor 64, normal conductor 211, back to the ringer generator. The polarized relay, being included in the circuit with the ringer 9, operatively energizes and attracts its armature 29 to engage the core of the relay, and since the relay is polarized the armature is attracted one way only, and the finger 31^a is carried out of engagement with the end 32 of the member 33. The member 33 being relieved responds to the tension of the spring 49 and restores the push-button 26 and the arm 41 to normal position. The springs 42, 43, 44, 45, 46 and 47 also restore to normal position, as shown at F¹ in Fig. 2. Thus it will be seen that the operation of the polarized relay 28 restores the meter mechanism to normal position the same as when the button 27 is pressed. In this case, however, the meter is not operated one step and the previous call, which was not successful, is not recorded.

It will be evident from the foregoing that each subscriber's line may be equipped with the same apparatus. For example, the subscriber's line shown in Fig. 1 is equipped with a telephone A, the call register F and the line switch C, and the subscriber's line shown in Fig. 2 is likewise equipped with the telephone A¹, the call register F¹ and the line switch C¹, being respectively the same as the similar devices in Fig. 1.

In connection with the registering device in Fig. 3, it will be seen that the locking member 33, which is controlled by the push-button 26, is provided at its terminal with two teeth. The use of one of these teeth, the one next the heel, has already been described. The object of the tooth next the toe is to prevent a fraudulent operation of the device, as follows: By the use of this extra tooth it is impossible for anyone to press the button 26 sufficiently to operate the springs 42 to 47, inclusive, without locking the member 33, because if the member 33 is not caught in the tooth next the heel it is bound to be caught by the next tooth, the one next the toe, and in either case it becomes necessary to operate the button 27 before talking connection can be had.

The operation of the meter being fully described for the meter shown in Fig. 3, the operation of the modified form of the meter shown in Fig. 5 is obvious. The subscriber, in operating the meter in Fig. 5, must first press the button 55 for the same reason that he had to press the button 26 in Fig. 3. Then, after the called subscriber answers, he deposits a coin, as indicated, which, in falling, throws the lever 58 to the right, thereby performing the same function that the button 27 does in regard to the unlocking operation of the button previously pressed. Of course, if the subscriber gets the busy signal he hangs up his receiver without depositing a coin. The mechanism in the apparatus of Fig. 5 remains operated as in the case of the apparatus of Fig. 3. Therefore, in making a subsequent call it is not necessary to press the button 55, because this button is already operated. If the subscriber should be called the polarized magnet acts exactly as did the polarized magnet of the previous apparatus.

From the foregoing it will be seen that before the calling subscriber can send current to the central station for calling purposes he must first remove the short-circuit from around the impulse-transmitting means, as by operating a push-button. This, it will be seen, enables him to transmit the calling current to the central station, and at the same time establishes a short-circuit around the transmitter. This does not prevent him from using his receiver, and when he hears the called subscriber answer he must then

remove the short-circuit from around the transmitter. This he may do by any suitable act, as, for example, by pushing a button or by depositing a coin. In this way the vital parts of the substation are successively rendered inoperative, and successively restored to operative condition. When one element is rendered operative the element the subscriber will use next is rendered inoperative. Hence, and until all of the conditions or restrictions placed on the service are complied with, the calling subscriber cannot converse with the called subscriber.

What I claim as my invention is:—

1. In a telephone system, a subscriber's substation switch for transmitting current to the central station for calling purposes, a short-circuit normally closed around the said switch, a transmitter, a normally open short-circuit around the transmitter, means for simultaneously opening the first short-circuit and closing the second before the said switch can be used for calling, and means for opening the second short-circuit when the calling subscriber hears the called subscriber answer.

2. In a telephone system, a subscriber's impulse-transmitting device, an automatic switch at the central station responsive to said device, a short-circuit around said device, and a measured service device provided with means requiring actuation thereof to open the said short-circuit to render the said device operative for controlling the said automatic switch.

3. In a telephone system, a subscriber's substation impulse-transmitting device, an automatic switch at the central station responsive to said device, a short-circuit normally closed around said device, a transmitter, a normally open short-circuit around said transmitter, and a measured service device providing with means for opening the first short-circuit and closing the second, and with means for then opening the second short-circuit.

4. In a telephone system, an automatic switch, a line, means for controlling said switch over the two sides of the line in series to extend a call in the direction of the called subscriber, a normally closed short-circuit rendering said controlling means normally inoperative, a transmitter for the line, a normally open short-circuit around the transmitter, and a measured service device provided with means for opening the first short-circuit and closing the second, and having means for then opening the second short-circuit to enable the subscriber to use the transmitter.

5. In a telephone system, a subscriber's substation apparatus, means for rendering the same inoperative for holding conversation with another subscriber, and means comprising a polarized magnet whereby

private magnet 120 extending from ground G^6 through the springs 118 and 119, private magnet 120 to the battery lead 71, thence through battery B to ground G. The private magnet relay 117 deenergizes after the last vertical impulse, since this energizing circuit is no longer maintained after the springs 107 and 108 disengage; hence the said relay deenergizes, permitting the springs 118 and 119 to disengage, whereby the energizing circuit for the private magnet 120 is in turn broken. The private magnet now deenergizes and permits the side switch to pass from first to second position, thus permitting the side switch wipers 117^a and 121 to engage the contact points 122 and 123^a, respectively. The closure of contact between the side switch wiper 117^a and the contact point 122 sets up an energizing circuit for the rotary magnet 123. This energizing circuit extends from ground G^5 through the interrupter springs 124, rotary magnet 123, contact point 122, side switch wiper 117^a to the battery lead 71, thence through battery B to ground G. The said rotary magnet then operates to rotate the shaft wipers 125, 126 and 127 of the selector switch 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 128, 129 and 130 lead to the connector switch H (Fig. 2). If the first trunk line is busy, however, and the wipers have to pass over busy contacts, then as soon as the private wiper 127 engages the first private bank contact the private magnet 120 again energizes, locking the side switch in second position. The energizing circuit for the said private magnet extends from the grounded terminal G of the battery B through an occupying switch (not shown), through the private wiper 127, thence through the conductor 131, side switch wiper 121, contact point 123^a, through the private magnet 120 to the battery lead 71, thence through battery B to ground G. The private magnet 120, upon thus becoming energized, locks the side switch wiper 117^a in engagement with the contact point 122, whereby the rotary magnet 123 will be energized step by step, and 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 120 is destroyed, and as a result the selector side switch passes to third position. If there are no busy trunk lines the private magnet 120 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 trunk line conductors 98 and 99 are extended to the conductors 128 and 129 which, in this case, it is assumed lead to the

connector switch H (Fig. 2). The extending of the line occurs, of course, as soon as the side switch wipers 104 and 105 engage the contact points 132 and 133, respectively. When the trunk line is thus extended to the connector switch H an energizing circuit is established through the line relay 134 in the same manner in which the energizing circuit was established through the line relay 102 of the selector switch E. The relay 134, upon energizing, operates to shift the spring 135 out of engagement with the spring 136 and into contact with the spring 137. When the springs 135 and 137 engage, an energizing circuit is established through the slow-acting relay 138. This circuit extends from ground G^7 through the springs 135 and 137, back-bridge relay springs 139 and 140, conductor 141^a, through the relay 138 to the battery lead 71, thence through battery B to ground G. The relay 138, upon energizing, operates to close the springs 141 and 142 in contact and also to shift the spring 143 from the spring 144 into contact with the spring 145. The engagement of the springs 141 and 142 provides a guarding potential to the private bank contact corresponding to the trunk conductors 128 and 129. This potential extends from ground G^8 to the side switch wiper 146, springs 141 and 142, conductor 130 to the private bank contact engaged by the private wiper 127. Furthermore, a new energizing circuit is provided for the release relay 110 of the selector switch E. This circuit extends from ground G^8 at the connector switch H to the private wiper 127, as explained, through the conductor 131, side switch wiper 121, contact point 147, conductor 148 to the release relay 110, thence to the battery lead 71, and through battery B to ground G. This primary operation of the relays 134 and 138 of the connector switch H occurs at the instant that the side switch wipers 104 and 105 of the selector switch E pass to third position and extend the subscriber's line conductors 66 and 64 to the trunk conductors 129 and 128.

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 14 is twice carried out of engagement with the impulse spring 15, thereby momentarily deenergizing the line relay 134 of the connector switch twice. The spring 135 thereby engages the spring 136 twice, thus sending two impulses to the vertical magnet 149 from ground G^7 through the springs 135 and 136, springs 143 and 145, private magnet relay 150, vertical magnet 149, side switch wiper 151 to the battery lead 71, thence through battery B to ground G. The private magnet relay 150 energizes when the first impulse is delivered, and since the said relay is slow-acting it remains

for the line, a normally open short-circuit around the transmitter, and a measured service device provided with means for opening the first short-circuit and closing the
 5 second, and having means for then opening the second short-circuit to enable the subscriber to use the transmitter.

15. In a measured service telephone trunking system, means for establishing a trunking connection between a calling and a called
 10 subscriber's line, a subscriber's receiver partially short-circuited to prevent the subscriber from talking through the same, for enabling the calling subscriber to hear the
 15 called subscriber answer, or to receive the busy signal, and means under the control of the calling subscriber and operative to open the line circuit for releasing trunking connection to the called subscriber.

20 16. In a telephone trunking system, means for establishing a trunking connection between a calling and a called subscriber's line, a subscriber's substation apparatus, means for rendering the same inoperative for holding
 25 conversation with another subscriber, means whereby ringing current transmitted to said substation apparatus will render the same operative for conversation, and means under the control of the calling subscriber
 30 and operative to open the line circuit for releasing trunking connection to the called subscriber.

35 17. In a substation telephone set, the combination with a normally inoperative impulse sender and a normally operative talking equipment, of a call register, subscriber

controlled means for simultaneously rendering the said impulse sender operative and the talking equipment inoperative, and subscriber controlled means for thereafter
 40 simultaneously rendering said talking equipment operative and for operating said register.

18. In a substation telephone set, the combination with a normally inoperative impulse sender and normally operative speech
 45 receiving and transmitting equipment, of a call register, subscriber controlled means for simultaneously rendering the said sender operative and the said speech transmitting
 50 equipment inoperative while maintaining said speech receiving equipment operative, means for thereafter operating said register and additional means controlled in the same operation for rendering said speech transmitting
 55 equipment operative for talking.

19. In a substation telephone set, the combination with a normally inoperative impulse sender and normally operative talking
 60 equipment, of a call register, a switch controlled by the subscriber for rendering said sender operative and said talking equipment inoperative, means for locking said switch
 65 in set position, and subscriber controlled means for simultaneously operating said register and unlocking said switch.

Signed by me at Chicago, Cook county, Illinois, this 24 day of March, 1909.

JOHN ERICKSON.

Witnesses:

BERNARD D. WILLIS,
 EDWARD D. FALES.