J. H. MELVIN.

TELEPHONE CALLING MECHANISM AND SYSTEM.

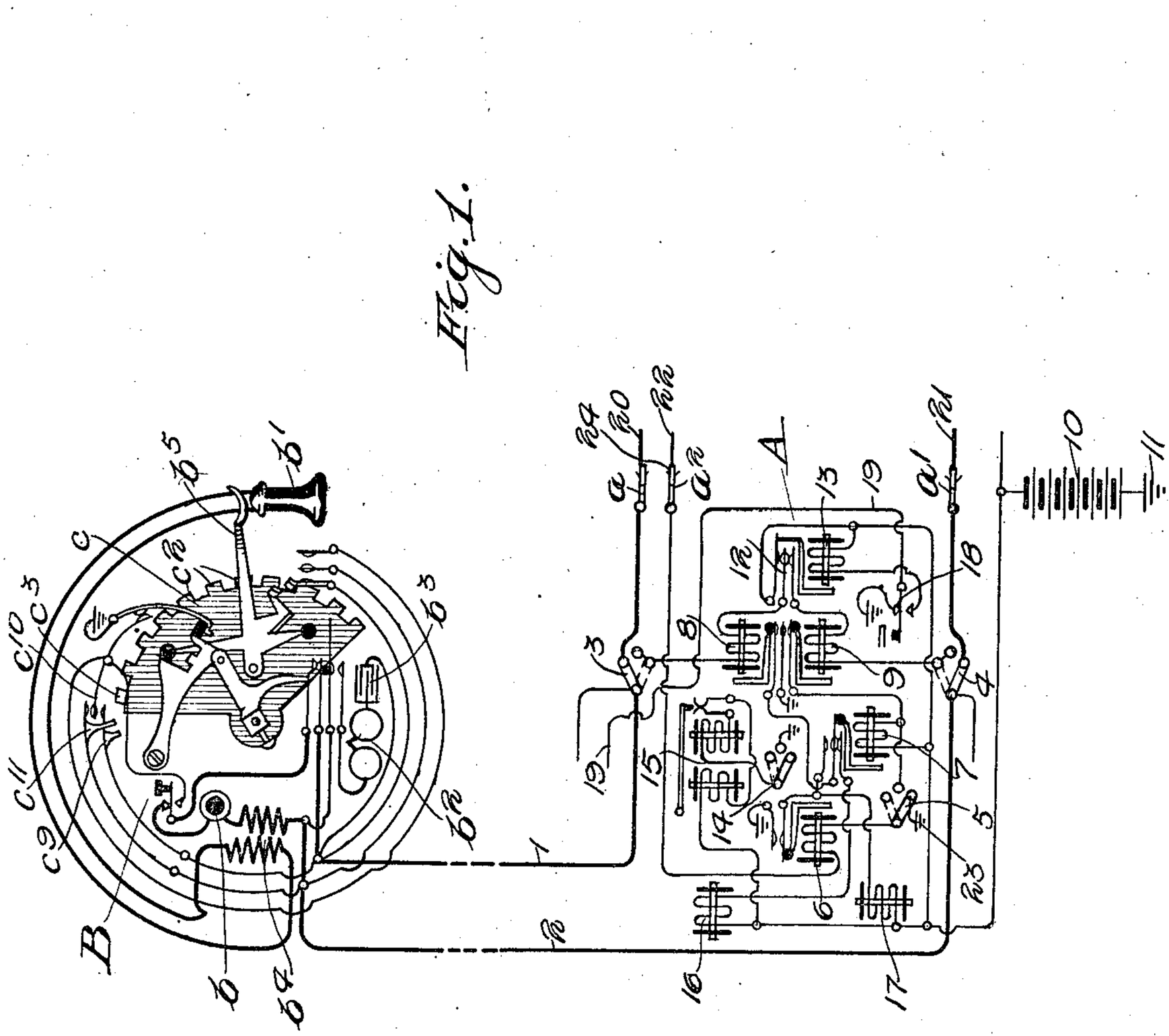
APPLICATION FILED JAN. 20, 1909.

1,166,620.

Patented Jan. 4, 1916.

3 SHEETS—SHEET 1.

Fig. 1.



Witnesses.
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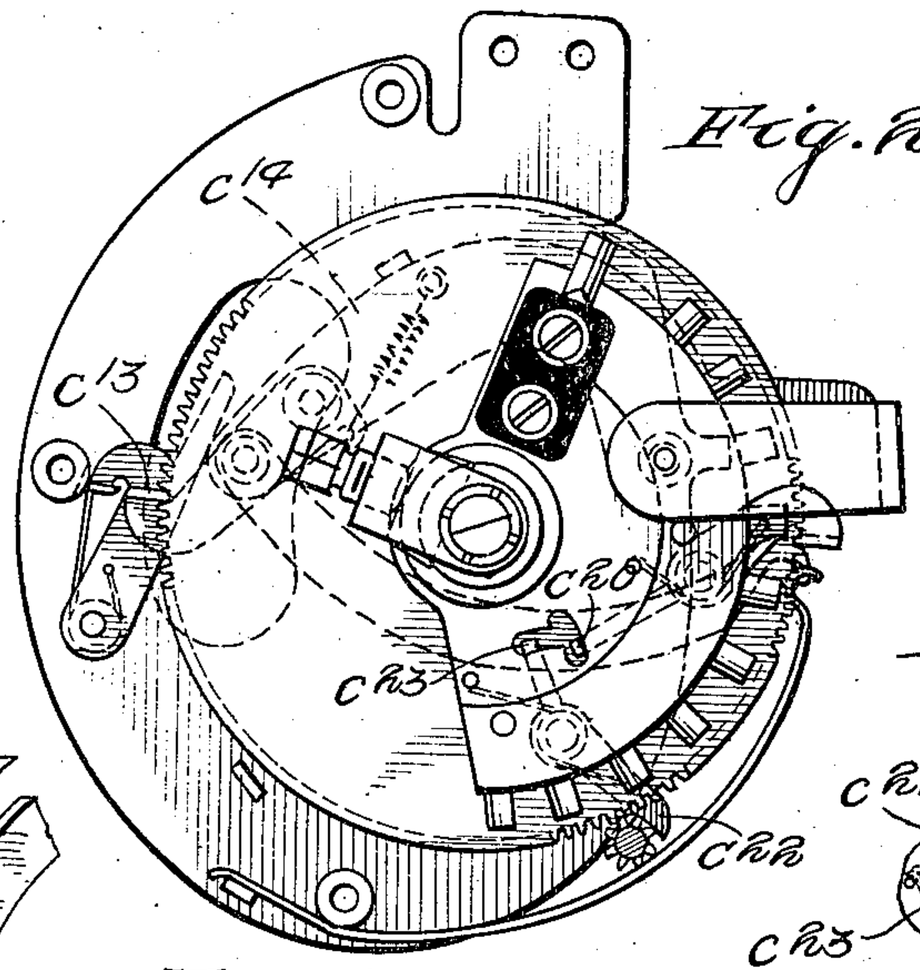


Fig. 5.

Fig. 8.

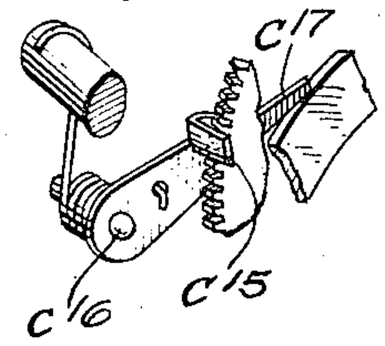


Fig. 6.

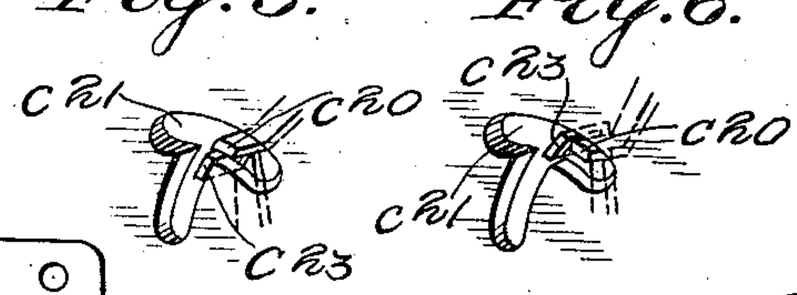


Fig. 7.

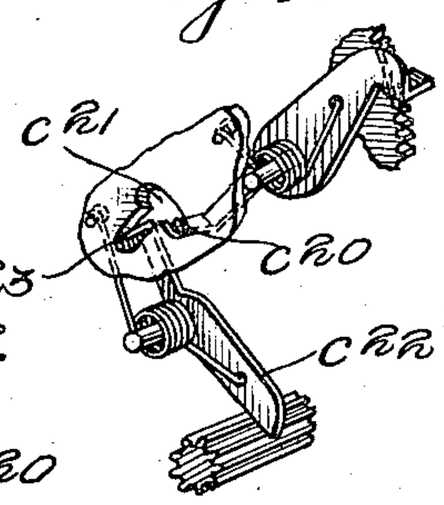


Fig. 3.

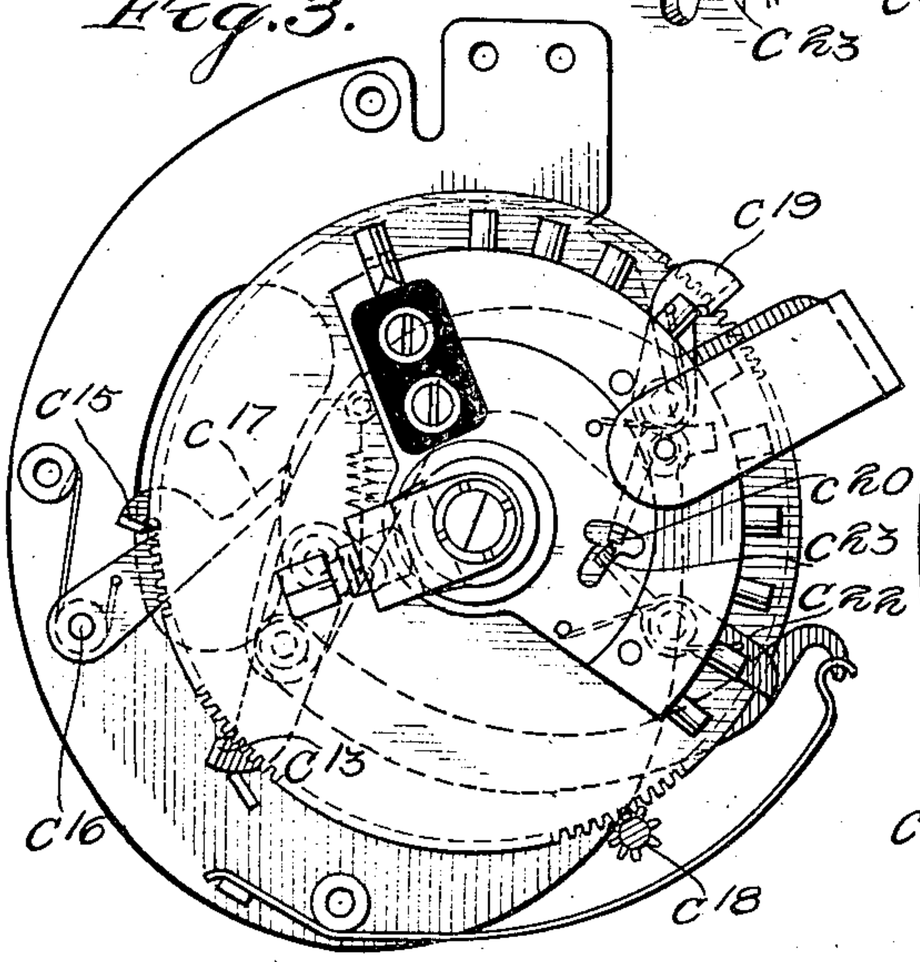
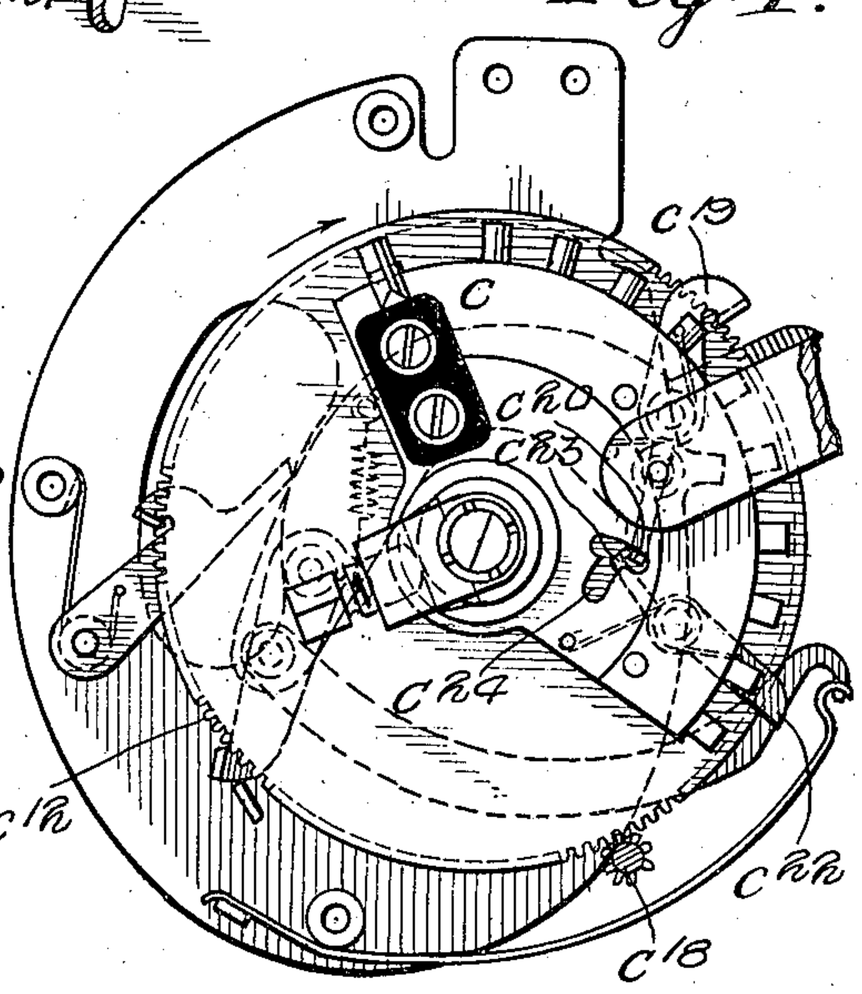


Fig. 4.



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3 SHEETS—SHEET 3.

Fig. 9.

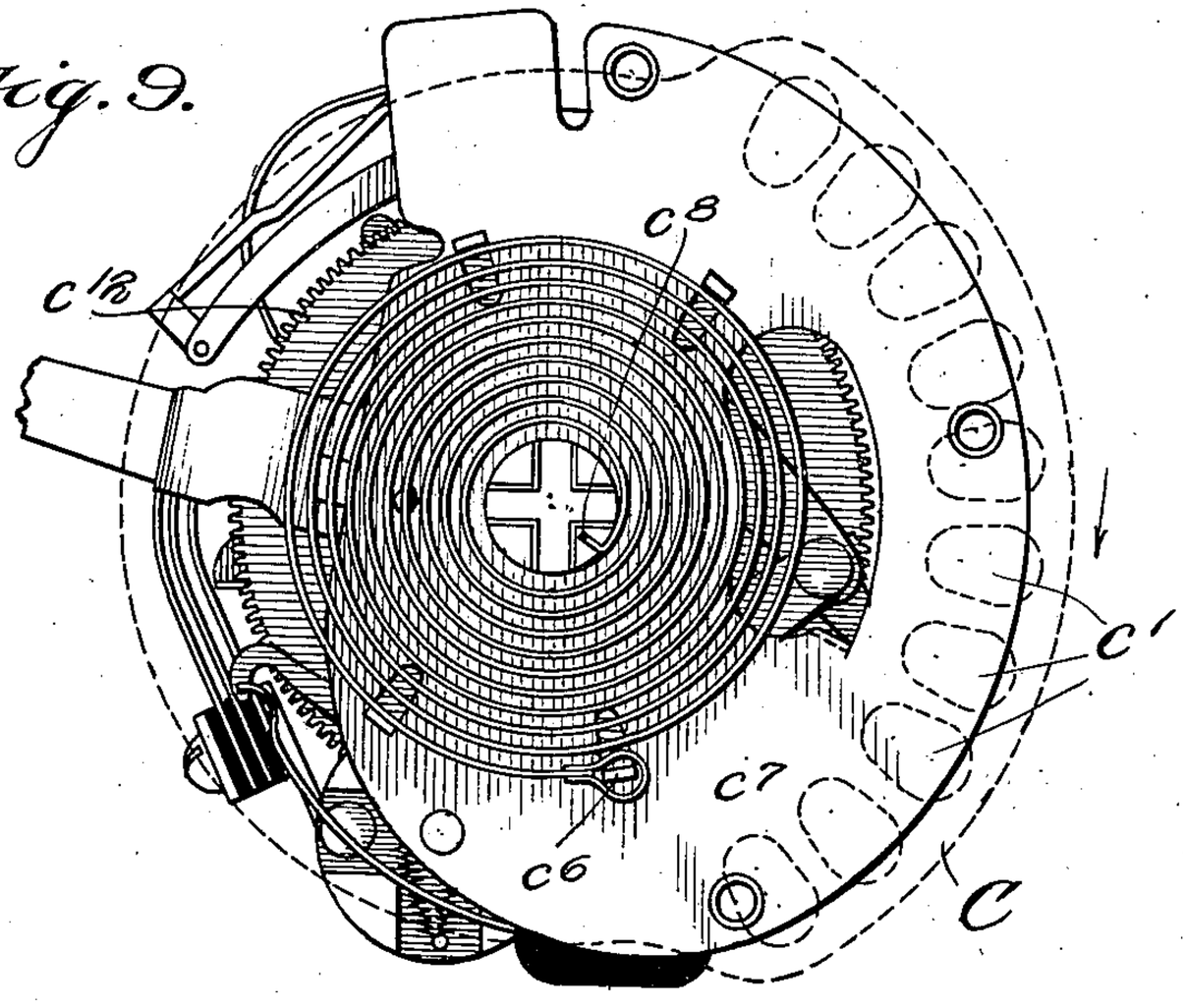


Fig. 11.

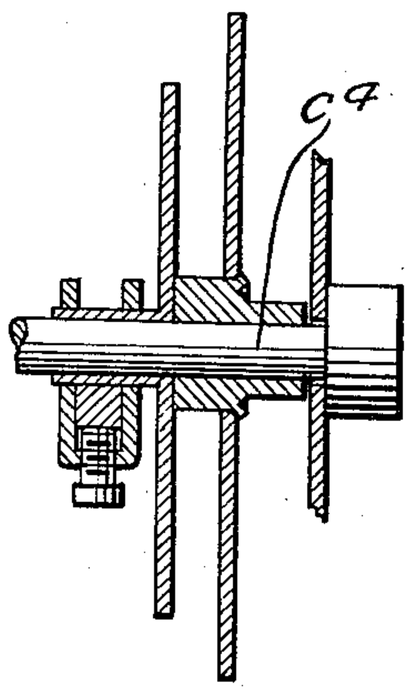
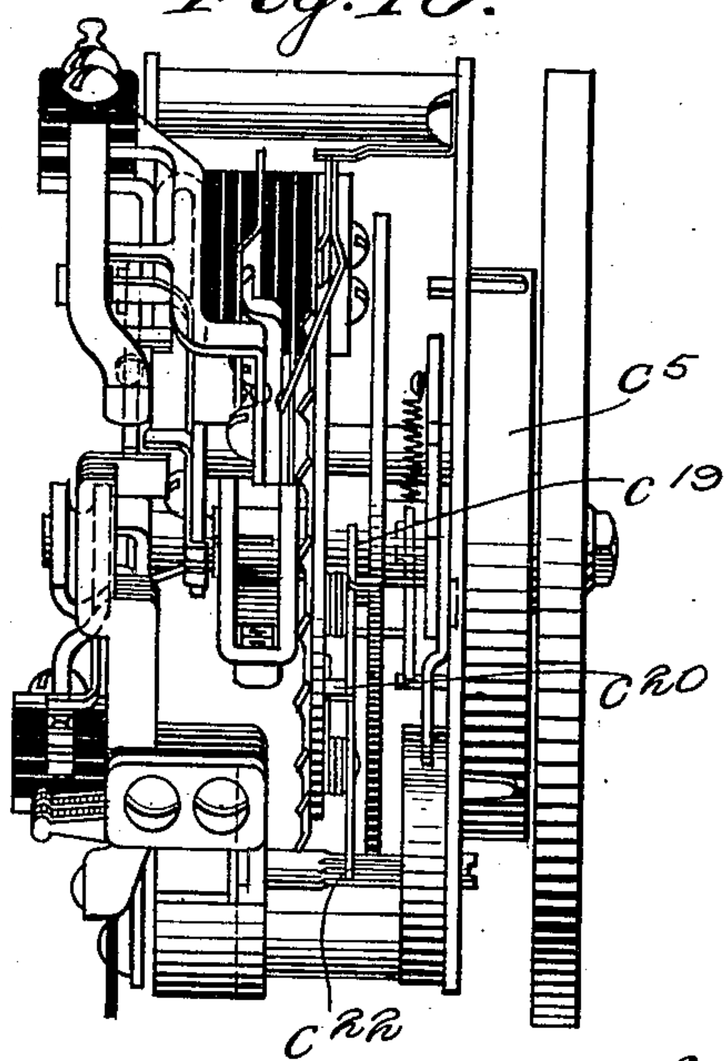


Fig. 10.



Witnesses.

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UNITED STATES PATENT OFFICE.

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TELEPHONE CALLING MECHANISM AND SYSTEM.

1,166,620. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed January 20, 1909. Serial No. 473,272.

To all whom it may concern:

Be it known that I, JOHN H. MELVIN, a citizen of the United States of America, and resident of Columbus, Franklin county, Ohio, have invented a certain new and useful Improvement in Telephone Calling Mechanisms and Systems, of which the following is a specification.

My invention relates to telephone systems in general, but more particularly to systems of that type in which switches having both vertical and rotary motion are employed, and more especially to systems of this kind in which the vertical and rotary motions of the switches at the central station are controlled by electrical impulse-transmitting devices located at the substations, each device having a rotary dial by which the transmission of impulses is governed in accordance with the number of the called subscriber. In a system of this character the operation of the said impulse-transmitting mechanism is ordinarily as follows: The rotary dial is operated for the first digit of the called number, 5, for example, and when it is released the mechanism returns to normal. It is during this return motion of the mechanism to normal position that the five impulses are transmitted over the so-called vertical side of the subscriber's line, for the purpose of raising the first-selector to the fifth level. This motion also results in the transmission of a single impulse on the so-called rotary side of the line, this single rotary impulse being subsequent to the transmission of the so-called vertical impulses on the other side of the line. The first-selector, as is well known, has a side switch, and it is for the purpose of operating this side switch that the said rotary impulse is transmitted over the line. Obviously, therefore, each operation of the dial for any particular digit of the called number is accompanied by the transmission of a certain number of so-called vertical impulses, and also by the transmission of a single rotary impulse. The said rotary impulse occurs just before the dial ceases to rotate—that is to say, immediately after the vertical impulses have been transmitted and just before the dial comes to rest in its normal position. It has been found that, for various reasons, the said rotary impulse will not always be transmitted—that is to say, its transmission, will occasionally not occur. For example, suppose the subscriber operates the dial in the usual manner and releases the same, allowing it to return to its normal position, thereby transmitting the vertical impulses. Suppose also, however, that the subscriber interrupts the motion of the dial before it reaches the limit of its backward or return motion, and thus stops the operation of the impulse-transmitting mechanism before the rotary impulse has been sent. In other words, the transmission of the rotary impulse is contingent upon the return of the dial to normal position, and occasionally a subscriber will fail to do this and will catch the dial and whirl it forward again before the limit of its backward rotation has been reached. This, of course, results in a wrong operation of the switches at the exchange, and the subscriber does not obtain connection with the desired line. It is with a view to insuring the transmission of the said rotary impulse, whereby the side switches of the selectors and connectors are operated, that I have provided an arrangement for locking the dial against forward rotation until after it has fully reached the limit of its backward rotation. With my improved arrangement of the dial may be rotated forward in the usual manner, and when released returns to normal position under the propelling action of the spring; but while returning to a normal position the dial is held in locked relation to a gear wheel that can only rotate in one direction, namely the direction in which the mechanism must move in order to transmit the impulses, and hence the dial must each time be allowed to rotate backward to its normal position before it can again be rotated forward. It can be stopped in its backward rotation, but when thus stopped its motion cannot be reversed, and hence the dial, after once starting backward, must always be allowed to reach its normal position before it can be again rotated forward for another digit of the called number. In this way the transmission of the single or so-called rotary impulse, which always occurs at the end of a group of so-called vertical impulses, is made absolutely certain, and the desired operation of the selectors and con-

nectors at the central station is insured. The subscribers cannot do otherwise than operate the dials in the proper and required manner, and the rotary impulse will always be properly sent or transmitted at the end of each group or series of vertical impulses. The insuring of the proper operation of the dials in this manner practically insures the correct and desired operation of the apparatus at the central station.

The nature and advantages of my invention will, however, hereinafter more fully appear.

In the accompanying drawings Figure 1 is a diagram showing a subscriber's substation connected with a first-selector at the central station of a telephone exchange system embodying the principles of my invention. Fig. 2 is a rear elevation of the subscriber's calling mechanism illustrated in Fig. 1, showing the means for locking the dial against forward rotation until after it has fully reached the limit of its backward rotation. Fig. 3 is a view similar to Fig. 2, but showing the switch-hook released, and showing the impulse wheel in a forwardly rotated position, said wheel being ready to rotate back to normal position to transmit the vertical and rotary impulses. Fig. 4 is a view similar to Fig. 3, but in this view it is assumed that the limit of the forward rotation of the impulse wheel has been reached, and that the same is now returning to normal position, the dial and gear wheel being locked together, whereby the dial cannot be given a farther forward rotation until after it has fully returned to its normal position. Fig. 5 is a detail perspective view of the locking device shown in Figs. 2, 3 and 4, illustrating the manner in which the locking action is prevented from taking place while the dial is rotating in a forward direction. Fig. 6 is a view similar to Fig. 5, but showing the said locking elements in a locked condition—that is to say, in the same condition in which they are shown in Fig. 4. Fig. 7 is a detail perspective view of the two elements by which the locking action is obtained, showing also fragments of the gear wheel and the pinion which coöperate with the same to produce the locking and unlocking operations. Fig. 8 is a detail perspective view of the dog or ratchet device by which the gear wheel is prevented from rotating in one direction while the dial is in operation, and while the switch-hook is in its released or elevated position. Fig. 9 is a front elevation of the mechanism shown in Figs. 2, 3 and 4, showing the rotary dial in dotted lines. Fig. 10 is a side elevation of the mechanism shown in Fig. 9. Fig. 11 is a detail sectional view showing the arrangement of certain elements on the rotary shaft to the outer end of which the dial is secured.

As thus illustrated the vertical and rotary line wires 1 and 2 of the subscriber's line lead to a first-selector A (see Fig. 1). The said first-selector has the usual vertical and rotary line wipers a and a' and a private wiper a^2, which wipers are adapted to engage the bank terminals of the trunk line, in the well-known manner. Said selector is also provided with the usual side switch wipers 3 and 4 which are in the talking circuit, and a third side switch wiper 5 that controls the trunk-release circuit through the release relay 6, as well as the busy test circuit through the private magnet 7, which circuits are old and well known. The system is of the bridging type and has the usual vertical and rotary relays 8 and 9 which are normally bridged across the subscriber's line, but which are cut off by the side switch wipers 3 and 4 when the side switch passes to third position. The battery 10 has one pole grounded at 11 and has its other pole normally connected with the middle point of the bridge through the medium of the three relay springs 12, which springs are controlled by the bridge-cut-off relay magnet 13, in the well-known manner. There is also a fourth side switch wiper 14 that opens the circuit of the rotary magnet 15 as soon as an idle trunk is found. The vertical magnet 16 produces the vertical motion of the switch shaft (not shown), and of the line and private wipers a, a' and a^2, in the usual manner, under the control of the vertical relay 8 when the vertical impulses are transmitted over the line wire 1. After each group of vertical impulses there is a single so-called rotary impulse transmitted over the line conductor 2, which impulse energizes the rotary relay 9 and thereby closes the circuit through the private magnet 7, which latter then operates the side switch one step. The first time the side switch is operated the circuit of the rotary magnet 15 is closed by the side switch wiper 14, and the wiper 5 closes the circuit of the private magnet 7, which latter remains energized while the wiper a^2 is passing over busy contacts and until an idle trunk is found. When the idle trunk is found the magnet 7 is deënergized, allowing the side switch to pass to third position, thus opening the circuit of the rotary magnet 15 and thereby stopping the rotary motion of the selector. The trunk-release circuit includes the private wiper a^2 and a third conductor of the trunk line, in the usual manner, and also includes the release relay 6, which latter controls the local circuit through the release magnet 17. The grounded contact 18 places a guarding potential on the subscriber's private normal 19 as soon as the selector makes the first vertical step, whereby after the subscriber begins calling no other subscriber can seize the line wires 1 and 2.

When a connection to the trunk line conductors 20 and 21, and the third trunk conductor 22 is completed, as shown in the diagram, a guarding potential from ground 23 is established at the private bank contact 24, and at all multiple contacts thereof in the other selectors. In this way no other subscriber can seize the same trunk line—that is, not until after it is released by the selector A shown in the drawings. As the said selector is of the general character disclosed in United States Letters Patent No. 815,321, issued March 13, 1906, to Keith, Erickson and Erickson, no further description thereof is necessary.

At the substation B the subscriber's equipment comprises a common battery transmitter b, a receiver b', a bell or ringer b^2 connected in series with a condenser b^3, and an induction coil b^4 having the primary thereof connected in series with the transmitter, and having the secondary thereof connected in a closed loop in series with the receiver. The usual switch-hook b^5 is provided for the receiver and arranged to control certain elements associated therewith, as will be explained. The subscriber's calling mechanism by which the first-selector A is controlled, as well as the second and third selectors, if the same are necessary, and also the connectors, is of that type in which a rotary dial C is employed for operating an impulse wheel c in accordance with the different digits of any called number. This dial is shown in dotted lines in Fig. 9, and has the usual finger holes c', preferably ten in number, although additional holes can be employed if such is desirable. The said dial and impulse wheel c, which latter has ten so-called vertical teeth c^2 and a single so-called rotary tooth c^3, are rigidly secured to the shaft c^4. Immediately back of the dial there is a clock spring c^5 that has its outer end c^6 secured to the frame c^7 of the calling mechanism, and which has its inner end c^8 secured to the shaft c^4 in any suitable manner. With this arrangement a forward rotation of the dial in the direction indicated by the arrow in Fig. 9 serves to wind up the said spring, and when the dial is released the spring will propel the dial and the impulse wheel in a backward direction, in the usual and well-known manner. During the backward rotation of the dial and the impulse wheel the so-called vertical teeth c^2 cause the vertical spring c^9 to be pressed a certain number of times against the ground spring c^{10}, and the final movement of the dial and impulse wheel then cause the single rotary tooth c^3 to press the rotary spring c^{11} against the said ground spring, but only once, because there is only one tooth. The number of vertical impulses will be equal to the value of the digit of the called number, but no matter how many vertical impulses are sent there is only a single rotary impulse transmitted over the rotary side of the line upon the termination of the backward rotation of the dial and impulse wheel.

It will be understood that the forward rotation of the dial is made variable and regulated by a finger stop (not shown, but well known) adapted to be engaged by the finger of the subscriber to limit the forward rotation of the dial in accordance with the particular hole selected for that purpose. As previously explained, the vertical impulses produce the vertical motion of the first-selector A, and are also used afterward for producing the vertical motion of the second-selector and the third-selector. The vertical impulses sent over the line are also used for producing the vertical motion of the connector by which the called line is seized, and in the connector switch the impulses over the vertical side of the line circuit are then also used for producing the rotary motion of the switch shaft and wipers thereon in order to bring the same into position to engage the bank contracts of the called line. Connectors of this character are well known and well understood, being of the general type disclosed in United States Letters Patent No. 815,176, issued March 13, 1906, to Keith, Erickson and Erickson. In the present illustration, of course, such a connector will necessarily be modified for common battery purposes, as in Fig. 1 of the drawings the apparatus at the substation is of the common battery type.

The single rotary impulse which always follows every group of vertical impulses is used for operating the different side switches of the selectors and connectors, and the desired trunking operation through the exchange and the final connection with the called line cannot occur unless these rotary impulses are properly sent and are received in such manner as to do the required work. It is with a view of insuring the proper transmission of these rotary impulses, and the proper operation of the selectors and connectors at the exchange, that I make a special provision in the subscriber's calling mechanism as follows: The gear wheel c^{12} is loose on the shaft or axle c^4, and is normally locked against rotation by the dog c^{13} carried by an arm c^{14} of the switch-hook b^5. When the switch-hook rises, as shown in Fig. 3, the dog c^{13} is disengaged from the said gear wheel, and a spring-pressed dog c^{15} takes its place. This latter dog, it will be seen, is pivoted at c^{16} upon the frame of the mechanism, and is provided with an arm c^{17} adapted to be engaged by the arm c^{14} of the switch-hook. In this way the replacing of the receiver on the switch-hook, and the consequent downward motion of the latter, causes the arm c^{14} to engage and push the arm c^{17} upwardly, thereby disen-

gaging the dog c^{15} from the gear wheel. When this is done the dog c^{13} engages the gear wheel, as shown in Fig. 2. Before rotating the dial it is, therefore, necessary to remove the receiver from the switch-hook, so that the said gear wheel may be free to rotate in one direction only, as shown by the arrow in Fig. 4. The removal of the receiver is also necessary in order that the rotation of the impulse wheel may cause the proper grounding of the line, but as this is old and well understood it need not be explained. The switch-hook also controls the line circuit and certain release circuits, but as these are old and well understood it will not be necessary to describe them. The said gear wheel operates a pinion c^{18} that drives a governor (not shown, but well known) of any suitable character, whereby the return or backward motion of the dial and impulse wheel is regulated and made sufficiently slow to insure the proper transmission of the different impulses. A dog c^{19} is pivoted upon the impulse wheel c and is adapted to engage the teeth of the gear wheel c^{12} in the manner shown in Figs. 2, 3 and 4. This dog will slide readily over the teeth of the gear wheel when the dial is rotated in a forward direction, but is adapted to catch in the said teeth and cause the gear wheel to rotate in unison with the backward rotation of the dial and impulse wheel. The said dog has its rear end provided with an arm c^{20} adapted to vibrate in a slot c^{21} in the flat body portion of the impulse wheel. Another dog c^{22} is pivoted upon the impulse wheel and provided with an arm c^{23} adapted to work in a slot c^{24} in the impulse wheel. It will be seen that this second slot is arranged at right-angles to the slot c^{21}, and that its upper end communicates with the latter slot at about the middle thereof, whereby the two slots form a substantially T-shaped opening in the flat body portion of the impulse wheel. These dogs c^{19} and c^{22} are, it will be understood, controlled by suitable springs, so that the former normally tends to engage the gear wheel, while the latter tends normally to occupy the position shown in Fig. 4. When the mechanism is in its normal condition the dog c^{22} engages the pinion c^{18}, and the strength of the clock spring c^5 is such that the upper end portion or arm c^{23} of the said dog is held at the bottom or lower end of the slot c^{24}, as shown in Fig. 2. When the dial is rotated forward the dog c^{19} moves up and down and slides readily over the teeth of the gear wheel, and in so doing causes its end or arm c^{20} to vibrate rapidly from one end to the other of the slot c^{21}, as shown in Fig. 3. While the mechanism is thus in motion the arm c^{23} cannot enter the slot c^{21}, because it is held effectually barred therefrom by the rapid back and forth motion of the arm c^{20}, and this condition of the parts continues until the dial and impulse wheel have reached the limit of their forward rotation and have been released.

As soon as the calling subscriber releases the dial, and as soon as the spring c^5 commences to rotate the dial and impulse wheel in a backward direction, then the dog c^{19} assumes the position shown in Figs. 4 and 7, thereby allowing the arm or end portion c^{23} to enter the slot c^{21}. It will be observed that this end portion c^{23} is hook-like in form, and when it thus enters the slot c^{21} it catches and securely holds the end of the arm c^{20}, maintaining the same in the position shown in Fig. 4. In such condition the dial and impulse wheel are firmly locked to the gear wheel, because at such time the dog c^{19} is held against rising over the teeth of the gear wheel, and it is then impossible to rotate the dial either one way or the other relatively to the gear wheel. Now it being also true that at such time the gear wheel is locked against motion in one direction, namely in a direction opposite to that indicated by the arrow in Fig. 4, it naturally follows that the dial and impulse wheel cannot be again rotated forward until after they have reached the limit of their backward rotation, and have thereby been released from the gear wheel by the engagement of the dog c^{22} with the pinion c^{18}, as shown in Fig. 2. This, it will be seen, releases the hook-like end portion of the arm c^{23} from engagement with the arm c^{20}, and thus restores the dog c^{19} to normal condition—that is to say, to a condition whereby it is free to be moved forward in a ratchet-like manner over the teeth of the gear wheel when the dial and impulse wheel are again rotated forward for another digit of the called number. After the dial and impulse wheel once start to rotate in a backward direction it is then impossible to stop the dial in an intermediate position and rotate it forward—that is to say, it is impossible to reverse the motion of the dial before it reaches the end of its backward motion, because it is locked to the gear wheel and the latter can only rotate in one direction, namely in the same direction in which the dial and impulse wheel rotate in a backward direction to transmit the impulses. In this way a calling subscriber cannot interfere with the requisite transmission of the final or rotary impulse, which must occur subsequent to the transmission of each group of vertical impulses, because the dial cannot be operated again until after it has been allowed to fully return to its normal position. A subscriber might delay the transmission of the rotary impulse but cannot prevent it, because in any case the dial must eventually return to its normal position before it can again be rotated in accordance with another digit of the called number. Such being the

case the proper operation of the side switches of the selectors and connectors at the exchange is insured and made certain, and calling subscribers will be much more likely to obtain the desired connections.

As previously explained, it has been found by experience that with the old arrangement careless subscribers were liable to so manipulate the calling dials as to interfere with the transmission of the rotary impulses. For example, it would sometimes occur that a subscriber would whirl the dial forward for the first digit of the called number, and would then catch the dial before it had fully returned to its normal position and would then give it another whirl forward for the second digit of the called number. This, of course, prevented the transmission of the rotary impulse which should always follow the vertical impulses, and resulted in improper switching operations at the exchange, and the subscriber did not obtain the desired connection. With my improved arrangement, however, whereby the calling dial cannot be rotated forward from an intermediate position, this sort of trouble is entirely obviated.

I claim broadly the feature of locking the dial against further forward rotation until after the impulses have all been sent. For this reason I do not limit myself to the use of the said locking arrangement in a three-wire system—that is to say, in a system in which the transmission of the impulses is accomplished by grounding the line at the substation, as obvicusly the said feature may be adapted for use in a two-wire system wherein the impulses are all sent over metallic circuits. Neither do I limit myself to a system in which the dial rotates in a forward and back manner, as there are other systems in which the dials can only rotate in a forward direction. Again, there are systems in which the rotary impulse wheel does not have a forward and back rotation, but simply rotates always in a forward direction. For these reasons, therefore, I do not limit myself to the exact construction shown and described, as it is obvious that these various equivalent arrangements can be employed without departing from the principles of my invention so far as the broader aspect thereof is concerned.

What I claim as my invention is:—

1. In a telephone system, a line circuit, means including a rotary impulse wheel for transmitting one or more impulses over one side of the line circuit and a single impulse over the other side thereof, a gear wheel, a governor engaged by said gear wheel to regulate the operation of said impulse wheel, means for preventing the gear wheel from rotating in one direction, a rotary dial for operating said impulse wheel, means for locking the dial and impulse wheel to the gear wheel when the dial is released after being given a forward rotation, and means for automatically unlocking the same when the dial and impulse wheel reach the limit of their backward rotation, whereby the full backward rotation of the dial must always take place before it can again be given a forward rotation.

2. In a telephone system, a line circuit, and means for transmitting impulses over said line circuit, said means comprising a rotary impulse wheel, a rotary dial for operating said impulse wheel, automatic means for preventing initial forward rotation of the dial from any position except normal, and a stop for variably limiting the rotation of said dial.

3. In a telephone system, a line circuit, and means for transmitting impulses over said line circuit, said means comprising a rotary dial provided with a series of holes, an impulse wheel operated by said dial, a governor for regulating the operation of the impulse wheel, a gear wheel for operating the governor, a dog carried by the impulse wheel to engage the gear wheel, another dog carried by the impulse wheel, said dogs having coöperating portions whereby the impulse wheel is locked to the gear wheel during backward rotation of the dial, means engaging the said last-mentioned dog to unlock the impulse wheel from the gear wheel when the dial reaches the limit of its backward rotation, and means for preventing rotation of the gear wheel in one direction.

4. In a telephone system, a subscriber's rotary calling dial, a rotary impulse wheel operated thereby, a gear wheel, means for preventing rotation of the gear wheel in one direction, means by which the backward rotation of the dial rotates the impulse wheel in the other direction, and means including coöperating locking portions, together with slots, for keeping the impulse wheel locked to the gear wheel during transmission of the impulses, and means automatically operating to separate said locking portions when the dial reaches the limit of its backward rotation.

5. In a telephone system, a line circuit, a calling mechanism including a rotary calling dial adapted for forward and backward rotation and provided with finger holds for controlling the same, means controlled by said dial for transmitting a plurality of series of impulses over one side of the line during the backward rotation of said dial, each series being followed by a single impulse over the other side of the line, and means for preventing a second series of impulses being transmitted until said single impulse has been transmitted.

6. In a telephone system, a line circuit, means for transmitting impulses over said

line circuit, said means comprising a rotary impulse wheel, a rotary dial for operating said impulse wheel, and automatic means engaging a movable member of said transmitter for preventing initial forward rotation of the dial from any position except normal.

Signed by me at Columbus, Franklin county, Ohio, this 8th day of January, 1909.

JOHN H. MELVIN.

Witnesses:
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MAX GOLDSMITH.