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TELEPHONE SYSTEM.

No. 505,308. Patented Sept. 19, 1893.

Fig 1.

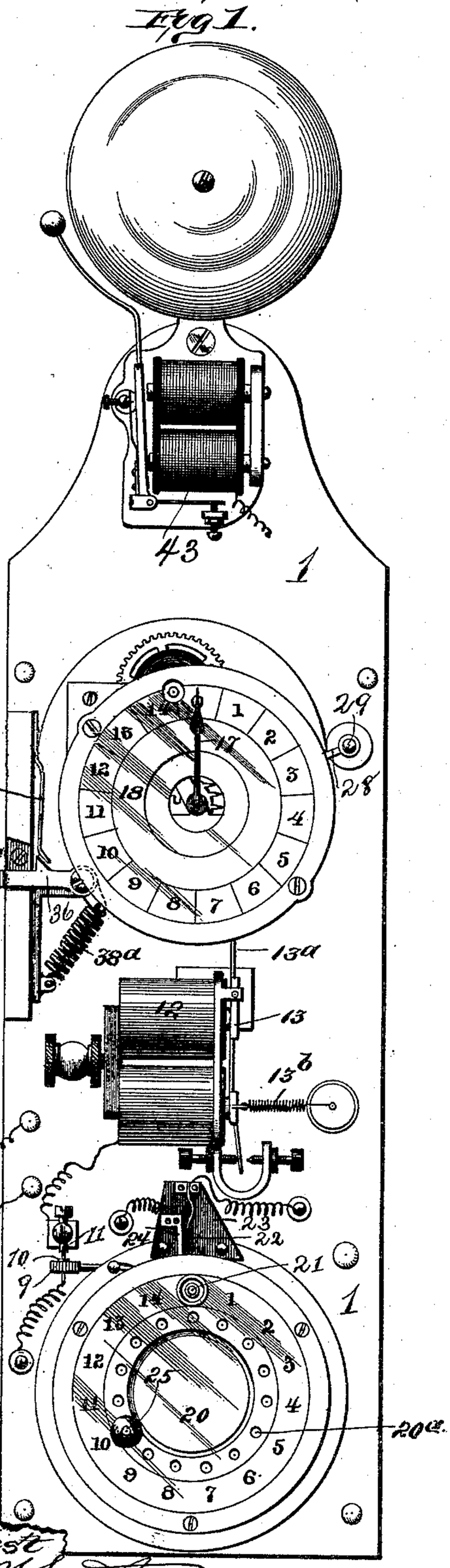
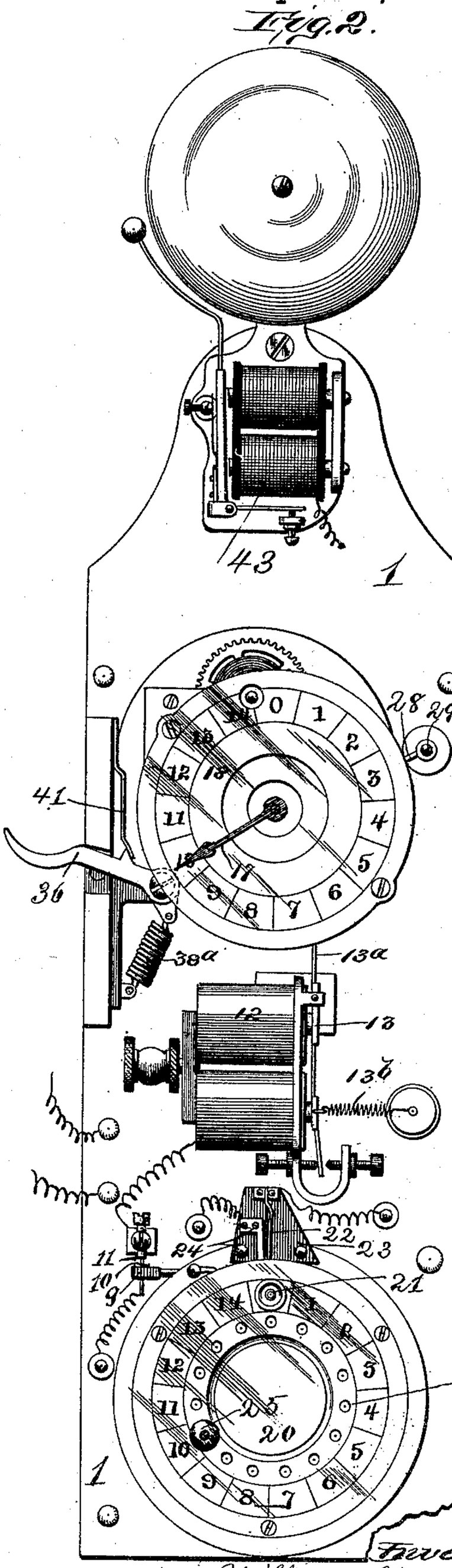


Fig. 2.



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TELEPHONE SYSTEM.

No. 505,308. Patented Sept. 19, 1893.

Fig 3

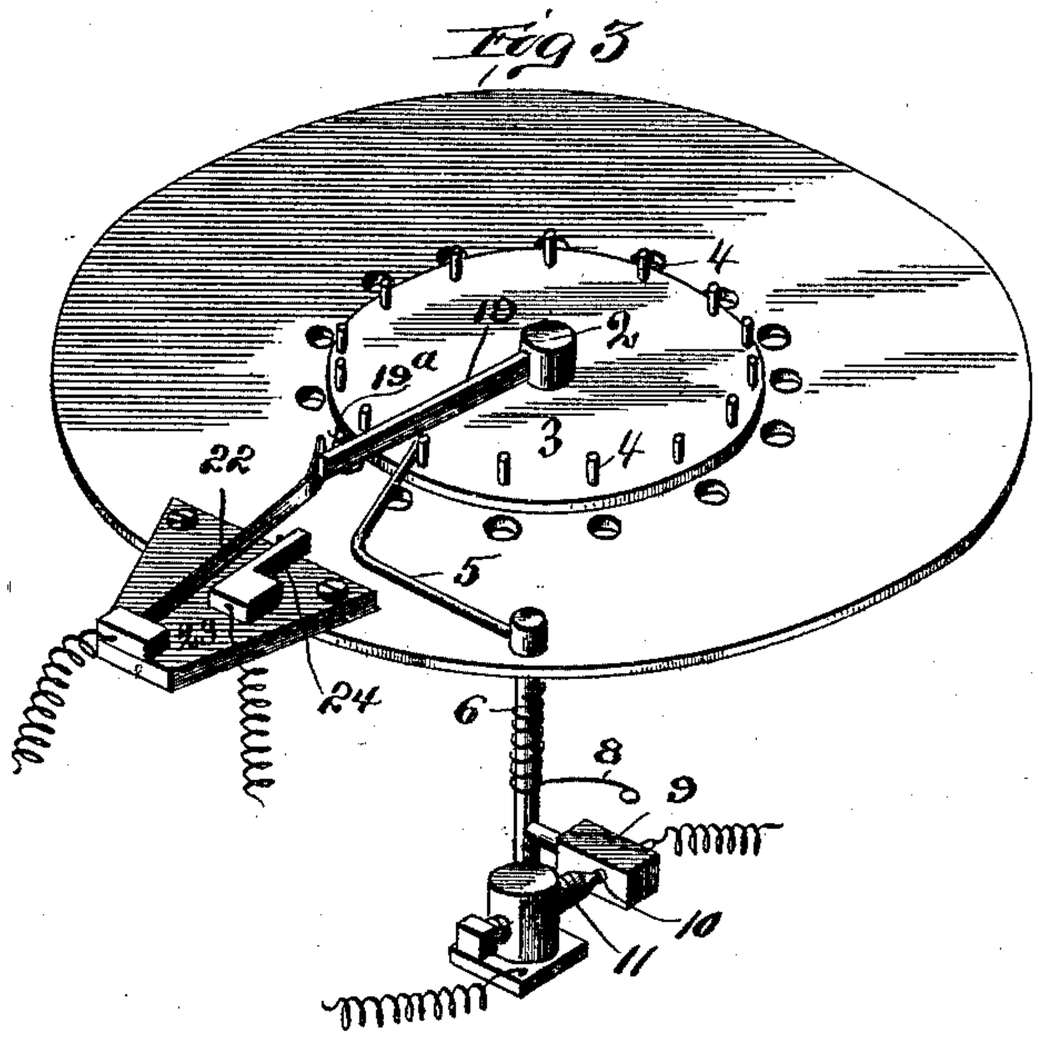


Fig 4.

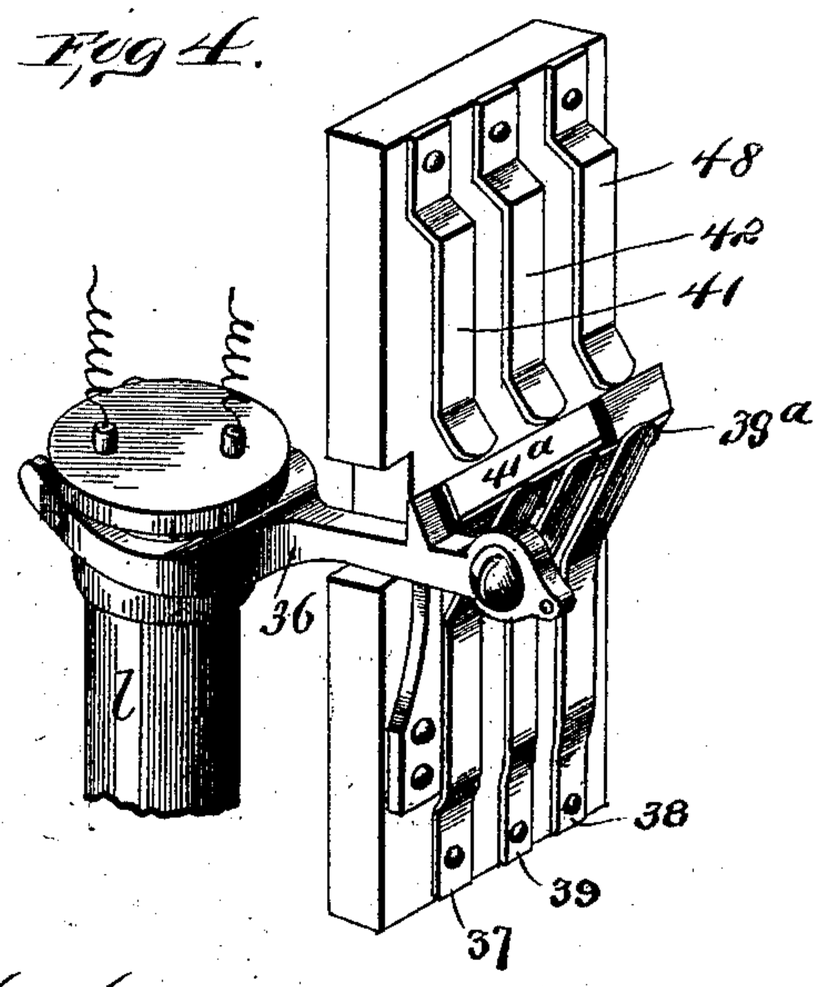
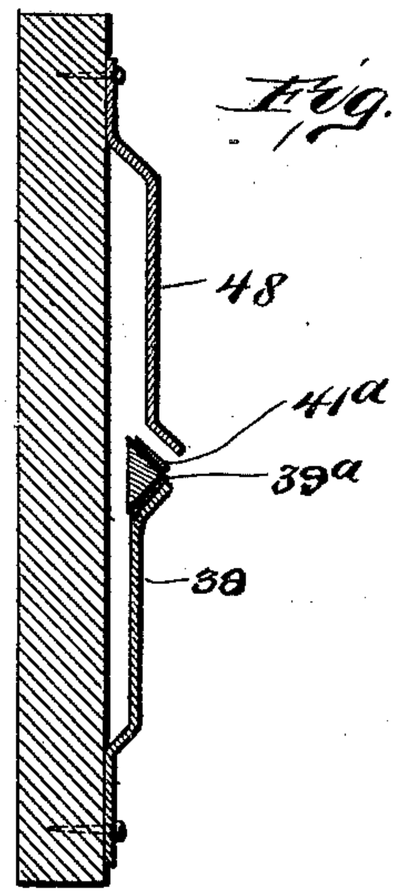


Fig. 5.



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TELEPHONE SYSTEM.

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Fig. 6.

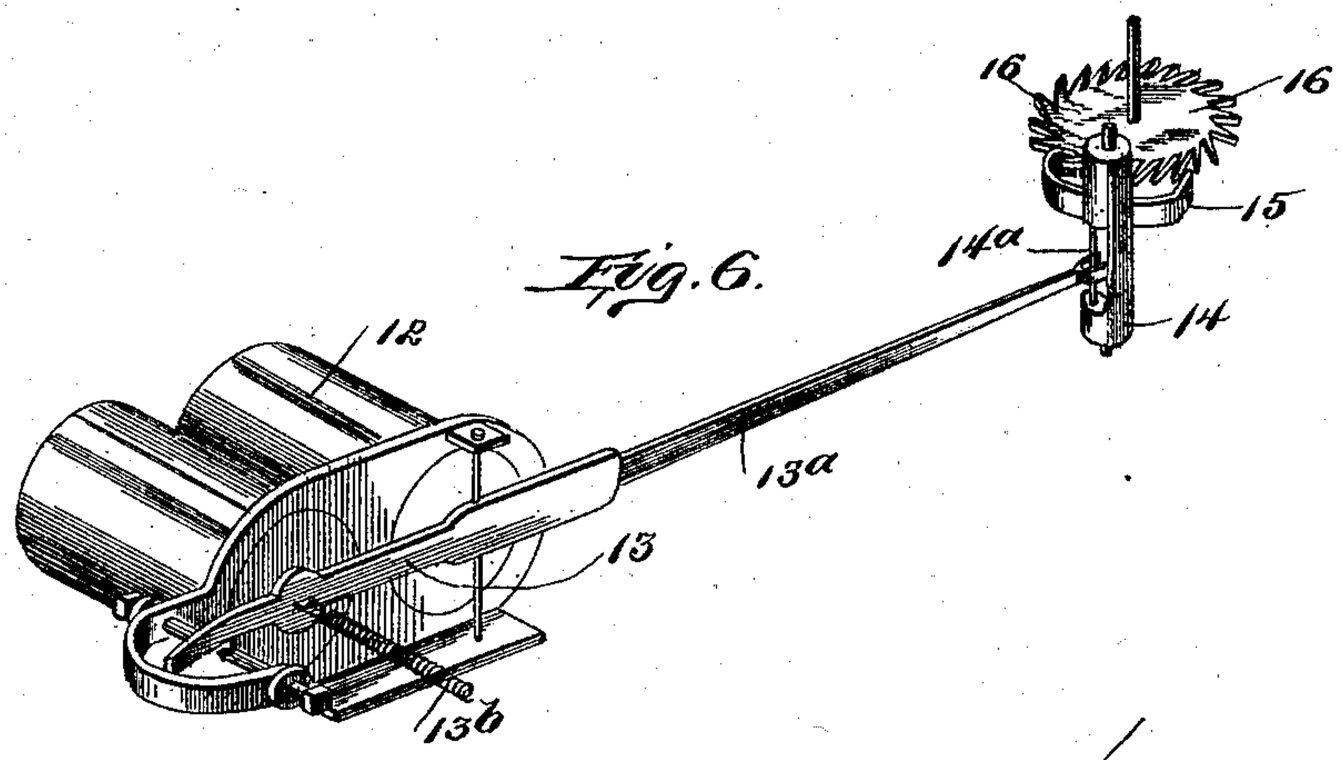

Fig. 7.

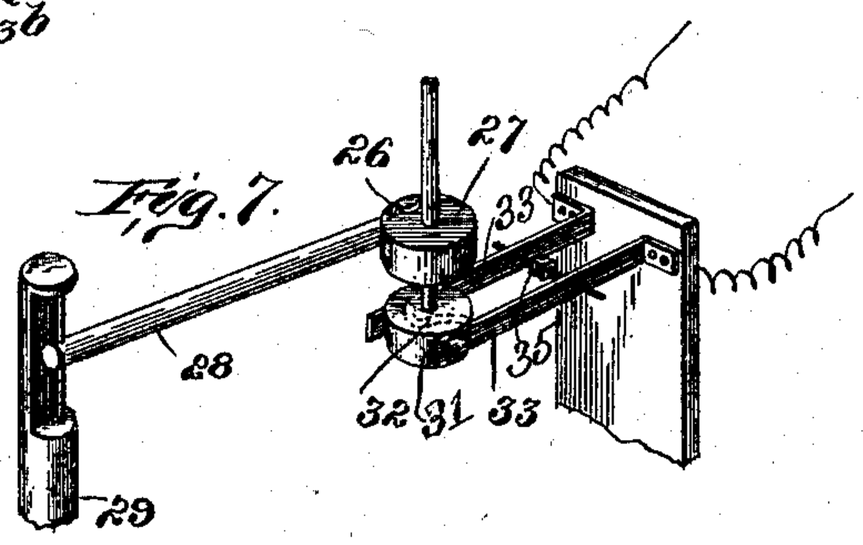

Fig. 8.

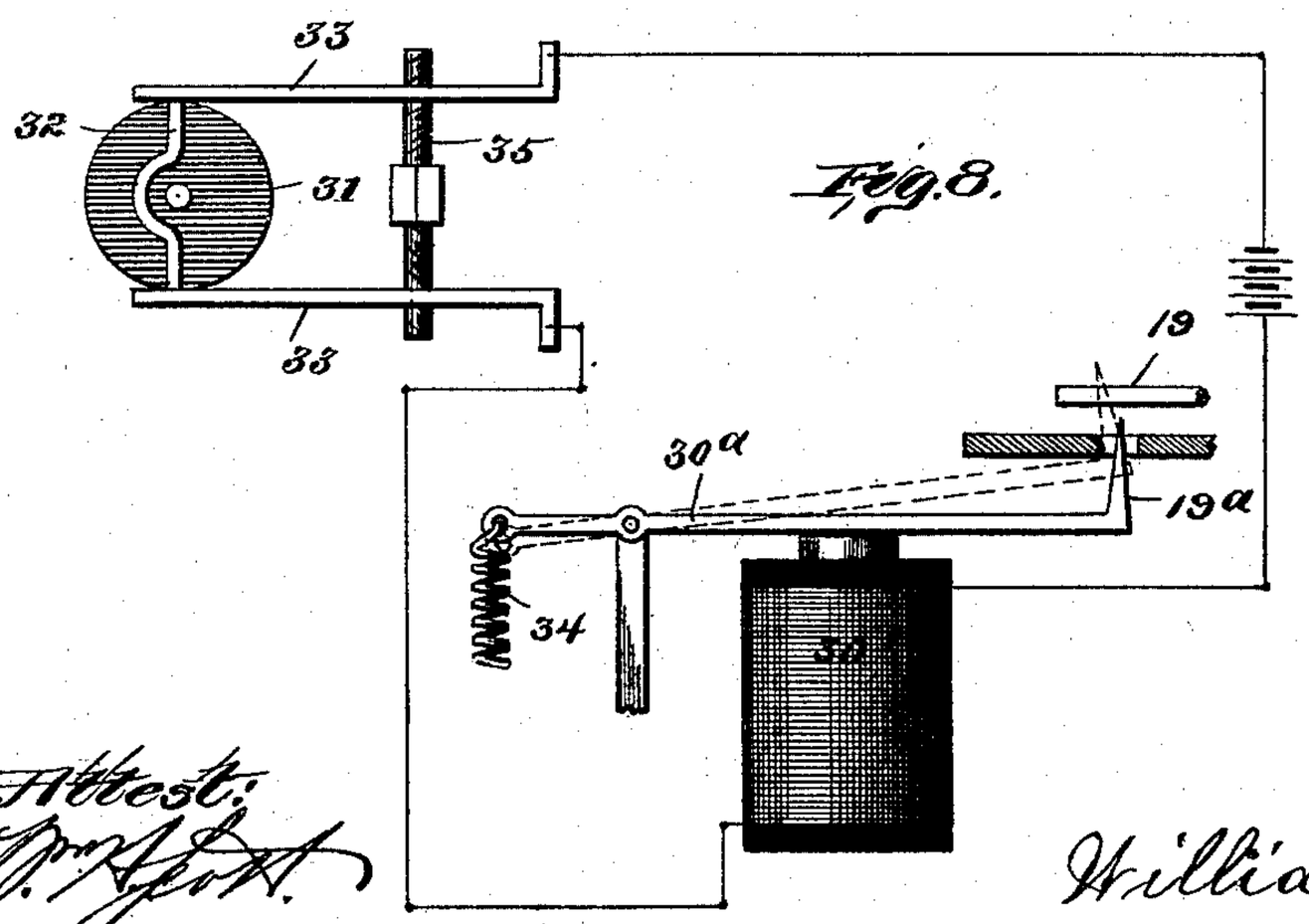

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Fig. 9.

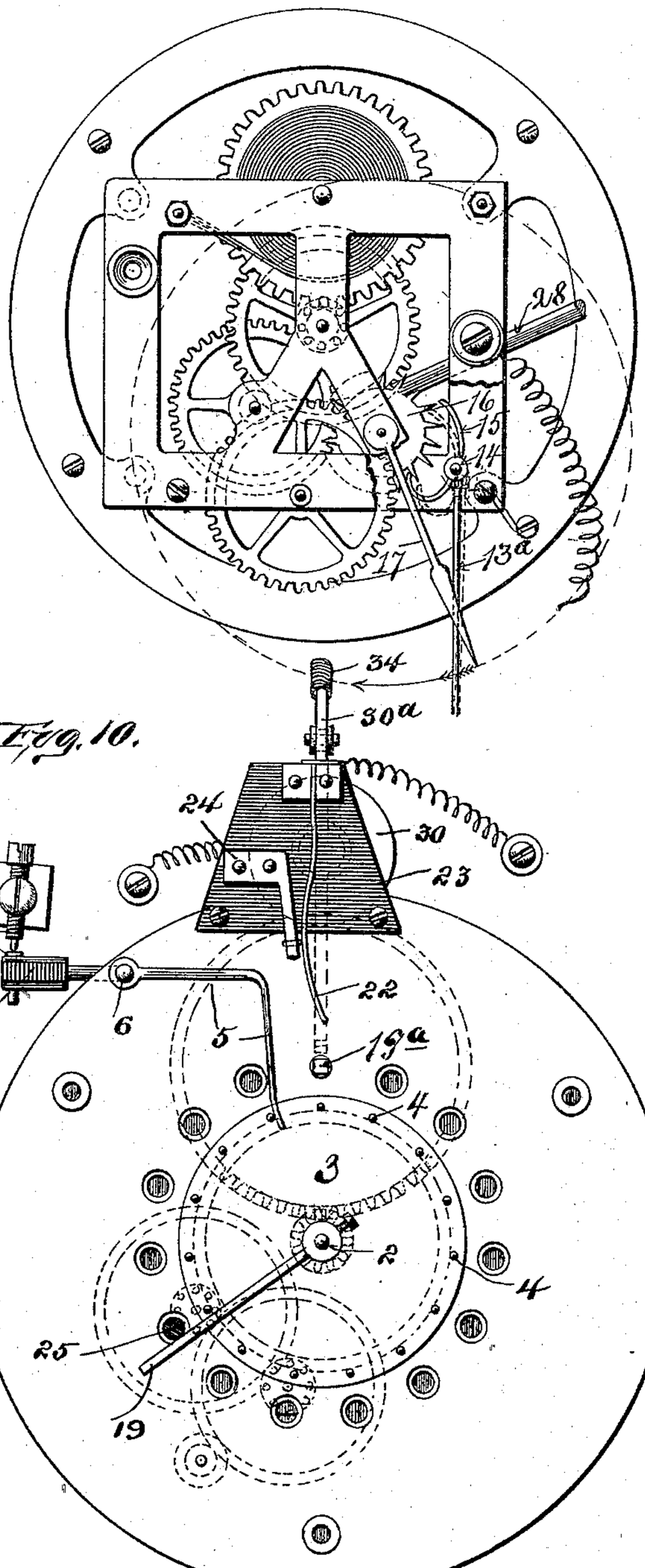

Fig. 10.

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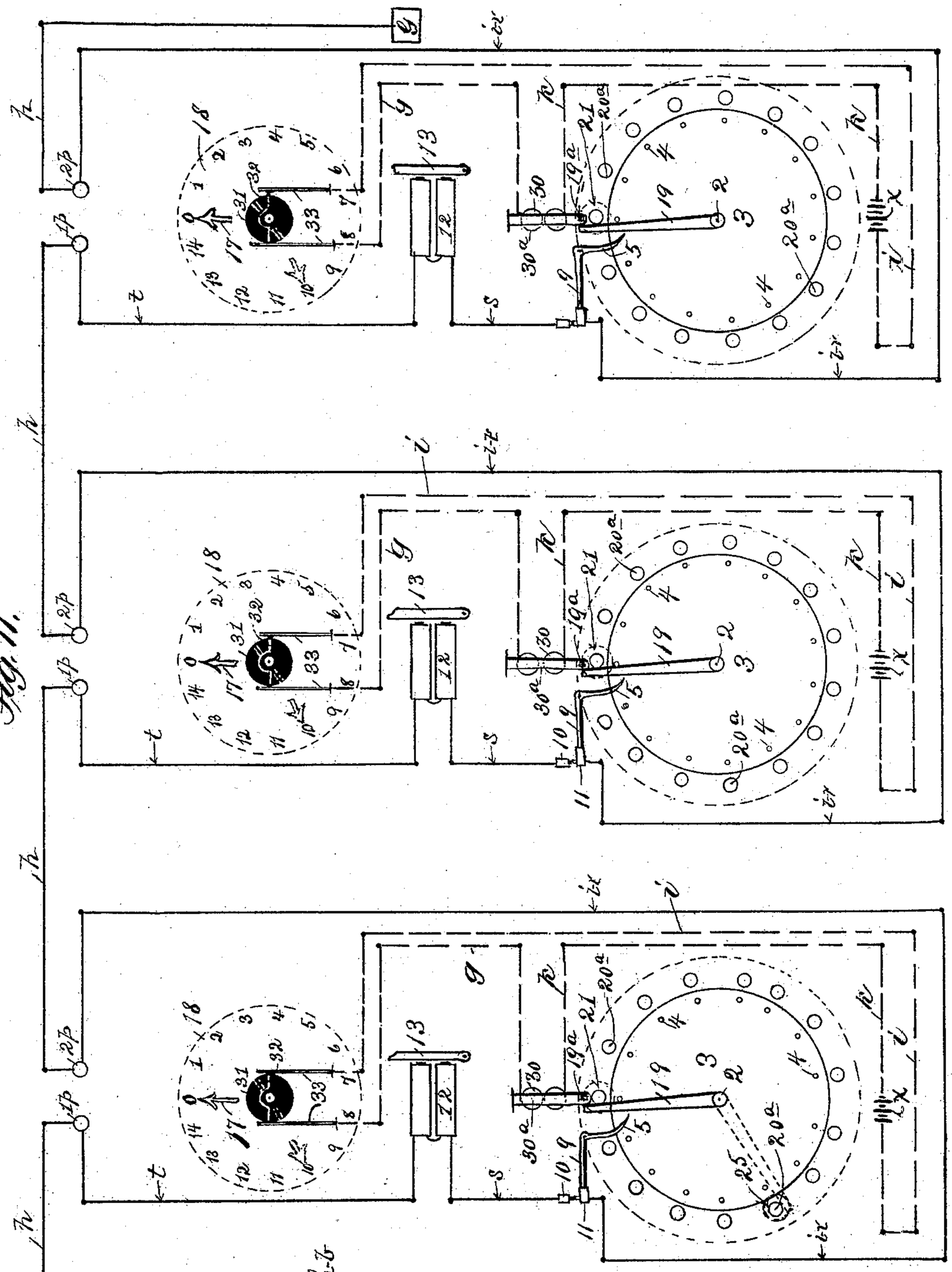

Fig. 11.

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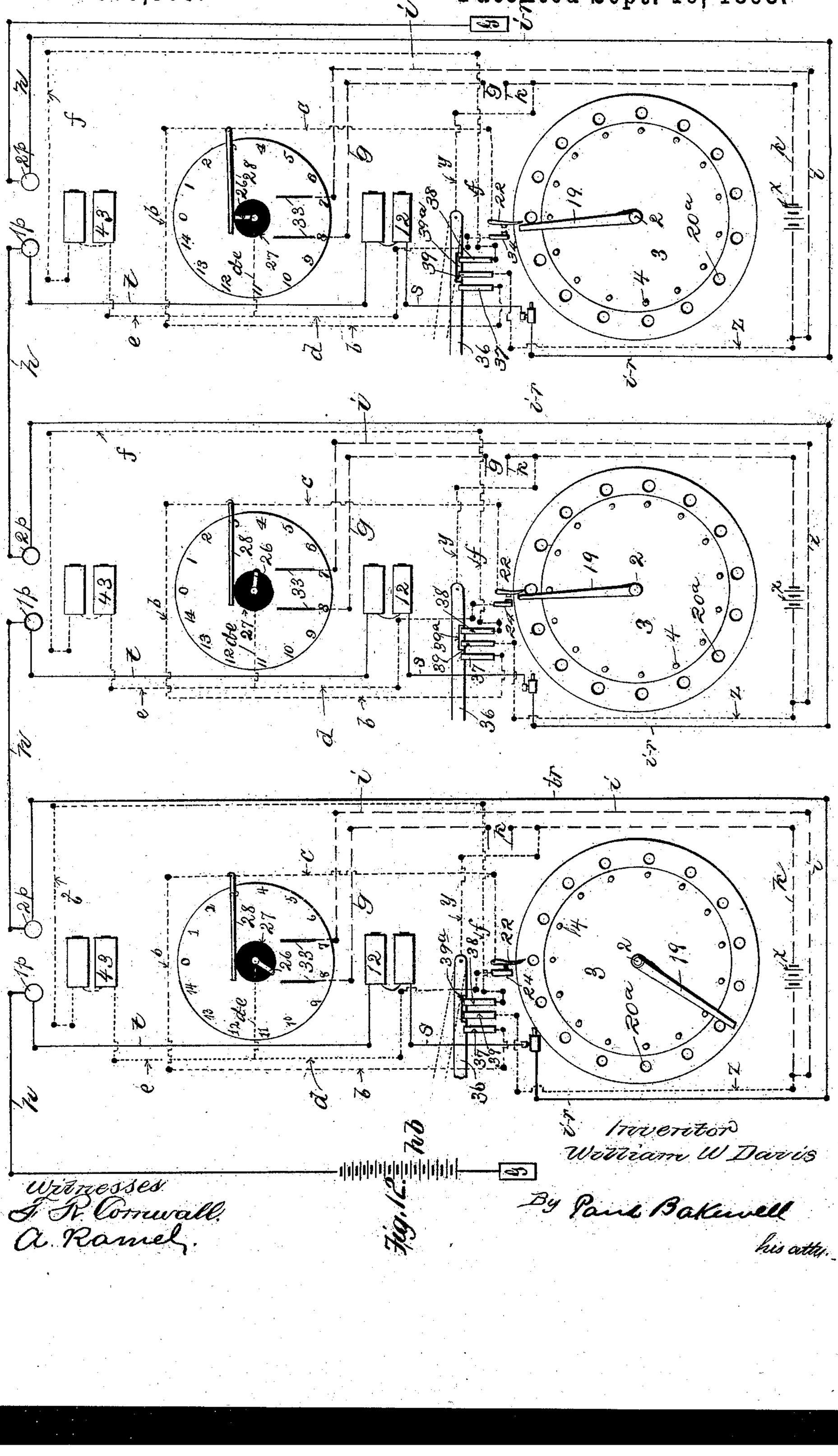

Fig. 12. hb

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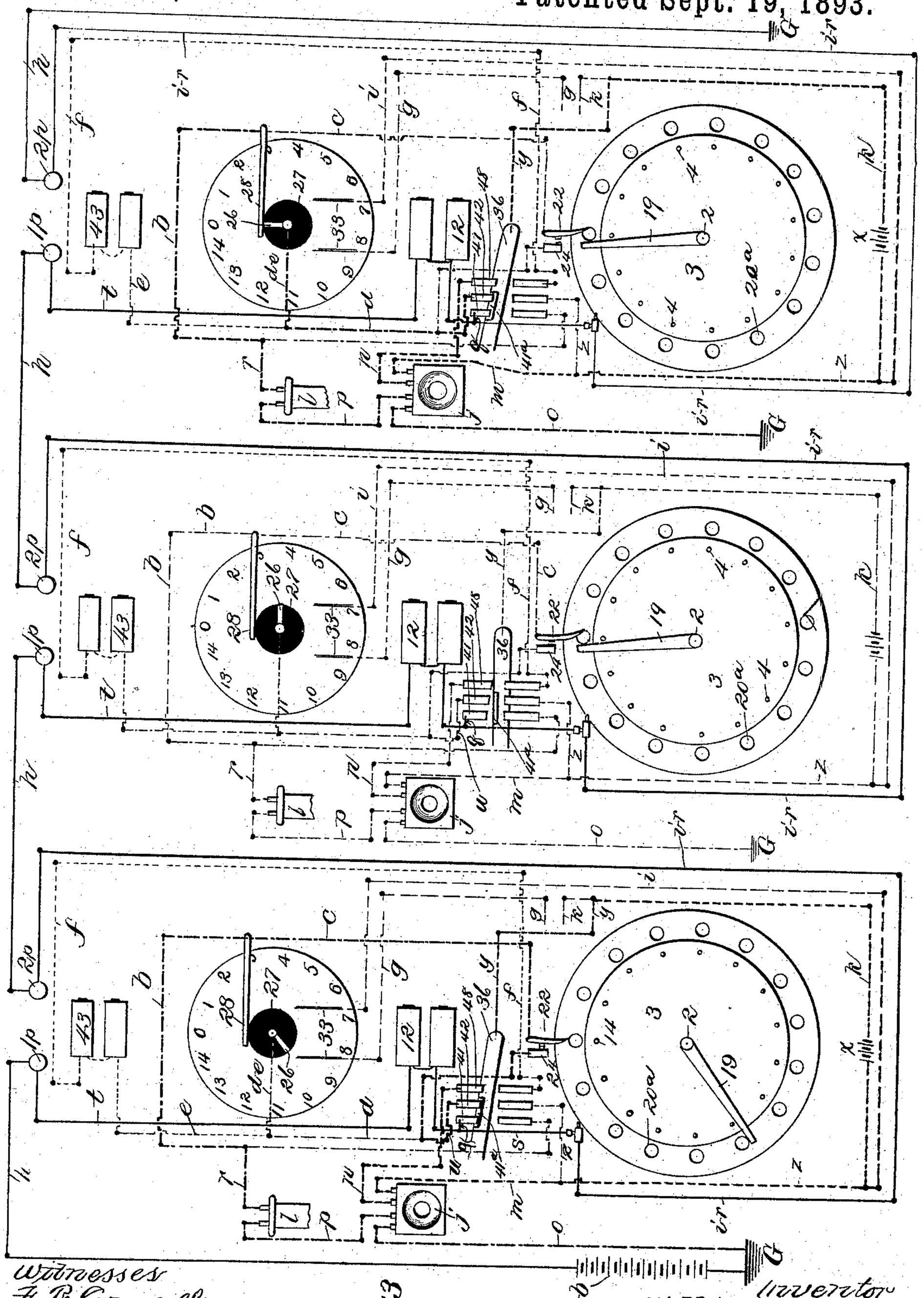

Witnesses
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Fig. 13

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 505,308, dated September 19, 1893.

Application filed December 30, 1892. Serial No. 456,772. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM W. DAVIS, a citizen of the United States, residing at California, in the county of Moniteau, State of Missouri, have invented certain new and useful Improvements in Telephone Systems and Apparatus Therefor, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

In the accompanying drawings, forming a part of this specification, wherein like symbols of reference refer to like parts in the different views, Figure 1 is a front elevation of my improved apparatus, showing the interference plug in position for calling before the releasing button is pulled. Fig. 2 is a view, similar to Fig. 1, of the apparatus at a station after it has been called. Fig. 3 is a perspective detail view of the mechanism for making and breaking the circuit which controls the index dial. Fig. 4 is a perspective view of the hand phone hook and its associated contact points. Fig. 5 is an end elevational view of the hook contact bar and associated contact springs. Fig. 6 is a detail perspective of the magnet and its armature, for operating the index mechanism. Fig. 7 is a perspective view of the circuit-establishing devices on the shaft of the index hand. Fig. 8 is a diagrammatical view of the mechanism and circuit for the non-interference device, and means for controlling the circuit therefor. Fig. 9 is a plan-view of the index-hand operating mechanism. Fig. 10 is a plan-view of the circuit-breaking mechanism for operating the index-hands, and the means for controlling the same, with the dial or front plate removed, to more conveniently show the clock mechanism by which it is operated, also showing the device whereby a supplemental circuit is established when the circuit is broken at the index-hand shaft, as hereinafter explained. Fig. 11 is a diagrammatic view of the circuits at three stations, illustrative of the means for calling any station from any other, also illustrating the means for preventing any second station from effecting a "call" until the line is restored to its normal condition by the original "calling" station, and the arrangement of the circuits and manipulating devices at the "calling," "called," and another station. Fig. 12 is a diagrammatic view of the arrangement of the circuits, similar to Fig. 11, but showing, in addition thereto, the local circuits for ringing the signaling devices at the "called" and "calling" stations, and the means by which such circuits are established in each instance; and Fig. 13 is a diagrammatic view of the circuits at the three stations for talking purposes between the "calling" and "called" stations, to the exclusion of the other stations on the line, showing the essential features of the circuits, of what is shown in Figs. 11 and 12, but in addition thereto the local arrangements of the hand phone and transmitter local circuits and the means for connecting the same to the main line and grounding the main line at the "calling" and "called" stations.

My invention relates to new and useful improvements in telephone systems, local circuits therefor, and apparatus to effect the necessary changes in the same, and consists, generally stated, in a system of telephony in which a single line wire is adapted to be used to connect a number of different instruments, and, in the apparatus, in the details of improvement by which the necessary changes in the local circuits, &c., are effected to place any two desired instruments in connection with each other and ring the call-bells thereat, and that to the exclusion of the other instruments in the system. This apparatus consists in mechanism peculiarly adapted to place all instruments in the system in such condition that the transmitting, receiving, and signaling devices are normally out of circuit, and adapting an operator at any instrument in the system to call up and be connected with any other instrument in the system, and, in so doing, cut out and prevent from being used, all instruments other than the two between which communication was originally established, until after the operator at the first, or calling, instrument has reestablished the normal condition as at first. In this manner, I am enabled to dispense with a central station or exchange.

Another feature of invention resides in the

adaptation of the use of the main-line to cut in the local bell circuits to ring the signaling bells at the calling and the called stations.

Other features of invention reside in providing means whereby the local circuits of transmitters, receivers, and signaling bells are normally cut out of circuit and the main-line always cut through coils of the indication magnets, whereby, when an operator at one instrument, which, for the sake of convenience, I will call a station, has called another station, the indicators at all stations are similarly affected, showing to an attempting user that the main-line is in use, and, in addition to this, in providing means, when one station has called and is in communication with another, for at once locking, at all other instruments, the circuit-breaking devices, by which the indicators are operated, against any subsequent use prior to the re-establishment of the normal condition of the line by the discontinuance of its use by the first parties.

Still other features of invention reside in providing means, consequent on the above-mentioned features, for preventing any but the parties at the two stations originally connected being able to participate in the conversation, that is, in providing means whereby, when any two stations are connected and in communication with each other, an operator at any other station is prevented from hearing what is passing between the first parties, *i. e.*, establishing a strictly private line between the first two parties connected.

In the drawings, see Figs. 1 and 2, 1 indicates a back board on which is supported the different parts of my operating mechanism, and which, in connection with the transmitter, which is preferably independently supported, and the local battery, or batteries, I shall term an instrument, and comprises all the necessary parts for a "set" at one station.

Secured near the lower end of the board 1, is a train of spring-actuated mechanism which is adapted to rotate a shaft 2 (see Figs. 3 and 10) to the outer end of which is connected a disk 3 provided with pins or studs 4, the function of which, when the disk is made to rotate, is to engage with and vibrate the finger 5. The finger 5 (see Fig. 10) is mounted on the rock-shaft 6 surrounding which is a torsion spring 8. One of the offices of the spring 8 is to always hold the finger 5 in a position of interference in the path of the pins or studs 4 when they are revolved by rotation of the disk 3.

Projecting laterally from the rock-shaft 6 is an arm carrying on its end an insulation-block 9 in which is carried a contact point 10, which contact point is adapted to make electrical contact with an adjustable contact point 11, mounted in a suitable support. Electrical connection is made with these two points, respectively, from the other parts of the instrument as will be explained later on. Electrical contact between the two points 10 and 11 is normally maintained by the spring 8, except at such times that the arm 5 is oscillated by the movement of the pins 4, when the points are temporarily separated and the circuit therethrough broken. The main line, as hereinafter explained, is permanently connected through these points and also through the coils of the magnets 12 (see Figs. 1, 2, and 6) so that when the points 10 and 11 are separated, in the manner described, the circuit through the magnets 12 is for the instant broken and its armature 13 released. The movement of this armature is limited by set screws, in the usual manner. The end of the long extending arm 13^a of the armature is slotted or forked so as to embrace and engage with a longitudinally disposed pin 14^a in the shaft 14. The shaft 14 carries an escapement fork 15 which engages with and controls the rotation of the escape-wheel 16 in a manner similar to the escapement of clock movement in general.

On the escape-wheel shaft, is an index-hand 17 (see Fig. 9) which travels in front of a dial-plate 18 (see Figs. 1 and 2), the face of which is provided with a series of index numbers corresponding in number to the number of teeth in the escape-wheel 16.

It is evident that an escapement could be designed that would of itself force the escape-wheel 16, and, with it, the index-hand 17, around in the right direction by the oscillation of the armature arm 13^a, but, to insure the positive forward movement of the index-hand, and to impose as little work as is possible on the magnets 12, I preferably utilize power to force the escape-wheel always forward, which consists in a train of spring-driven gear-wheels, similar to a clock-movement, as illustrated in Fig. 9. The pins or studs 4 on the disk 3 correspond in number with the number of teeth on the escape-wheel 16; hence, in the rotation of the disk 3, the pins 4 successively engaging with the free end of the arm 5, the contact points 10 and 11 are separated a number of times corresponding to the number of indices on the dial-plate 18—that is, the circuit through the magnets 12 is broken that number of times, which in turn, through its armature 13 and extension 13^a and its retractive spring 13^b, actuates the escapement fork the same number of times, causing the index-hand 17 to make one complete revolution. In this manner, it is evident, that if we stop the rotation of the disk at any particular point we may in this manner predetermine the resultant position of the index-hand 17. This is accomplished in the following manner: Mounted on the extreme outer end of the shaft 2, is a radially-disposed arm 19 (see Figs. 3 and 10), which is rigidly secured thereto and therefore rotates with the disk 3. Projecting from the under side of a dial-plate 20 (shown in Figs. 1 and 2, but removed in Figs. 3 and 10) is a spring stop-pin 21 which extends far enough from the rear side of the plate 20 to normally

rest in the path of and engage with the end of the arm 19, when the arm has made one complete revolution. To release the arm 19, to allow it to revolve, the spring stop-pin 21 is simply pulled forward and then allowed to spring back to normal position. To stop the rotation of the disk 3, it is only necessary to obstruct the arm 19 at the desired point. To do this, I make use of an interference pin 25, for the insertion of which there are provided a number of holes 20ª in the plate 20 concentrically arranged about the center of revolution of the arm 19 and within the radial limits of the same. (In Fig. 10, the upper plate of the movement is shown as provided with a series of perforations corresponding to the perforations 20ª in the plate 20.) The number of holes 20ª correspond with the number of pins or studs 4 and the insertion of the interference pin 25 in hole 1 (see Figs. 1 and 2) will stop the rotation of the disk 3 after one pin 4 has engaged with the arm 5—*i. e.*, after the main-line circuit has been broken once—the magnet armature 13 allowed to make one oscillation, and the index-hand 17 moved one step forward. In this manner, if the interference pin 25 is inserted in the "10" hole, as shown in Figs. 1, 2, and 10, the index-hand will move to number 10 on the dial, that is, the disk 3, after the stop-pin 21 has been withdrawn to release the arm 19 from its position of rest will be stopped in its rotation, by the arm 19 striking against the pin 25, after ten of the pins 4 have engaged with the arm 5 and broken the main-line circuit a corresponding number of times. It will be understood, from what was said before, that inasmuch as the magnets 12 at all the stations are "in line," they will be all similarly affected, and that all the index-hands will be pointing to the "ten" number on the dials. For the sake of illustration, we will, in the future description, assume that the number of the called station is "10" and that of the calling station is "1." Placed so that its end lies in the path of the end of the arm 19, is a contact spring 22 which is supported on the insulation-block 23 and is adapted to normally make contact with the contact-block 24. The end of the spring 22 is so placed relative to the path of revolution of the arm 19 that the end of the arm bears against the spring 22, breaking its contact with the block 24, when the arm is in its normal position of rest against the stop-pin 21, but so arranged that, when the arm 19 is released, the spring 22 gives, allowing the arm to pass, making contact with the block 24 by the time one of the pins 4 have engaged with and passed the end of the arm 5. The reason for this will be evident later. Secured rigidly to the shaft of the escape-wheel—the index-hand shaft—are two disks 27 and 31 of rubber or similar insulating material. The free end of a pivoted arm 28 rides and is held constantly in contact with one of these disks, as 27, Fig. 7, either by gravity or by spring tension. The arm 28 is delicately pivoted in a standard or post 29 with which it is in electrical contact. In the disk 27, is secured a contact pin 26 which, while it is always in electrical connection with the index-hand shaft, is so disposed as to make contact with the end of the arm 28 at one particular point in the revolution of the index-hand shaft, and this is predetermined for each instrument, and is such, relative to the index-hand 17, that the point 26 is in contact with the arm 28 when the index-hand 17 is pointing to the number of the station—*i. e.*, at station "No. 10," electrical circuit is established, through the arm 28 and contact-pin 26, from the post 29 to the index-hand shaft, when the index-hand is pointing to "ten" on the dial 18. At all other positions of the index-hand the end of the arm is resting on the disk 27 and the circuit is broken therethrough. The object of this arrangement will appear in the discussion of the different local circuits. The other disk 31 is provided with a diametrically disposed contact-pin, which does not make contact with the shaft on which the disk is supported, but is adapted to make contact, simultaneously, with two tangential springs 33 which make contact generally, in the rotation of the disk 31 with its supporting shaft, with opposite sides of the circumferential surface of the disk. The springs 33 are independently supported on some insulating part of the framing of the instrument and are adjustable toward and from each other, at their free ends, by means of the right and left hand insulation screw stem 35. The diametrical contact-pin 32, or rather the disk 31 by which it is supported, is so disposed with relation to the rotation of the shaft on which it is mounted that it makes contact with and establishes electrical circuit between the springs 33 when the index-hand points to "zero" on the dial 18. At all other positions of the index-hand the circuit which is completed through the springs 33 is broken by the springs riding on the surface of the insulation-disk 31. The object of this device and arrangement is evident from an inspection of Fig. 8, taken in connection with Fig. 10. The springs 33 are the terminals of a circuit extending through a local battery and the coils of a pair of magnets 30 which control the movements of an armature 30ª. The free end of the armature 30ª is provided with a projection 19ª which, when the circuit through the magnet 30 is broken, as described, and the armature 30ª is retracted by the spring 34, is adapted to come into a position of interference in the path of the arm 19, and this immediately in front of the arm when it is in its normal position of rest against the stop-pin 21. See also Fig. 3. The operative feature is this:—Immediately the stop-pin 21 is withdrawn, as when any station is going to call another, the arm 19 is released and it will start to revolve, inasmuch as the index-hands of all the instruments are at "zero" and the circuit through the magnets 30 is closed, as

described, and the stop projection 19ª on the end of the armature 30ª is, for the time being, withdrawn to allow the arm 19 to pass. But, by the time the arm 19, and with it the disk 3, in the particular instrument started, has rotated far enough for one of the studs or pins 4 to have oscillated the arm 5 once, the index-hands 17 on all the machines will have moved one step or number forward, and, thereby, this local circuit in all instruments broken and the interference projection 19ª thrown into a position to prevent the rotation of the arms 19, even if any of the stop-pins 21 are withdrawn by mistake. This is true until all the instruments are returned to their normal condition by the calling station, which is done by the operator thereat, when he has finished his communication with the called station, withdrawing his interference pin 25 and allowing the arm 19, and with it the disk 3 with the pins 4, of his instrument, to complete its rotation and come back to its normal position of rest against the stop-pin 21.

The device and method of operation thereof, just described, constitutes my non-interference locking mechanism.

The non-interference device illustrated in Figs. 7 and 8 is identical in all instruments, as is also the circuit-establishing device, also illustrated in Fig. 7, except that the contact 26 is changed for each instrument to correspond with the number of that station, as stated. That is, for example, when any station, as "No. 1," calls any other station, as "No. 10," as illustrated in Figs. 2 and 10, the contact 26 at the called station will be in contact with the arm 28, and circuit established therethrough at that station, but at all other stations the circuit is broken thereat by the arm 28 resting against the insulation-disk 27 only. And, (as will hereinafter appear from the discussion of the local circuits at the "called" and "calling" stations,) inasmuch as a movement of the arm 19 is necessary for any station to establish connection, (through the instruments thereat, with the main line, and this being prevented by the non-interference device already described, will), as well, prevent any third person from forming a communicating connection with any instrument or station until the first parties are through and have re-established the normal condition of the line. This is further evident from the fact, as will hereinafter appear, that, for communication purposes, circuit has to be established in each instrument in one of two ways:—either at the contact points 22 and 24 or at the contact point 26 with the arm 28. In the first instance, the contact between the spring 22 and the point 24 is broken by the arm 19 at all stations except the calling station, where the arm 19 has left its normal position and has been stopped by the interference-pin 25, and, in the second instance, the only other station where the necessary circuit connections are made is at the called station, where it is completed through the contact 26 as it rests against the arm 28.

To effect the circuit manipulations illustrated in Figs. 12 and 13, to be described later, I make use of the hinged 'phone-hook 36 which is provided with a lateral projection which is adapted in its raised and depressed positions to make contact with two sets of springs. See Figs. 4 and 5. The hook itself is provided with a raising spring 38ª (see Figs. 1 and 2.), which is strong enough to raise the hook when the 'phone is removed from the same but permits the hook to be depressed when the 'phone is suspended thereon (compare Figs. 1 and 2). There are three springs below and three springs above, with which the hook makes contact in, respectively, its depressed and raised position. The hook 36 itself is one terminal of a circuit and makes direct contact with the springs 37 and 48 in, respectively, its depressed and raised positions. The springs 39 and 38 are interposed in the local bell circuit and are electrically connected together, when the hook 36 is in its depressed position—that is, as long as the 'phone 1 is "on the hook"—by both making contact with a contact strap piece 39ª supported by, but insulated from, the lateral projection of the hook 36. In a similar manner the springs 41 and 42 are electrically connected together, when the hook 36 is in its raised position—when the 'phone is "off the hook"—by both making contact with the contact-strap 41ª supported on, and insulated from, the lateral projection of the hook.

By an inspection of Figs. 11, 12, and 13, considered in connection with the preceding figures, the method of manipulation of the circuits at a "calling" and "called" station, and the consequent arrangement of the same, to, first, effect a connection between any two stations, at the same time, establishing conditions preventing any subsequent use of a third party prior to the re-establishment of the normal condition of the line by the "calling" station; second, to effect the operation of the signaling devices at the "called" station to the exclusion of the other stations on the line, and to stop the same; third, to effect a "talking" or communicating connection between the "calling" and "called" stations, and that to the exclusion of a similar connection with the main line being established at any other station; and, fourth, to effect the return of the condition of the main line, and the local connections therewith at the "calling" and "called" stations, to its normal arrangement, preparatory to it being used by any other station.

As illustrated in Fig. 11, the main line *h*, is preferably grounded at each end, and has a main-line battery, *h*—*b*, inserted in the length of the same, either one at both ends, between the terminal stations and the ground connections thereat, or only one, as shown. This main line is looped in at each station on

the line, being connected with the main-line binding posts 1^p and 2^p at each instrument.

In the following description of the method of operation in manipulating the local circuits at a "calling" and "called" station, as well as the other stations not "called" as illustrated by the third "set" in the drawings (Figs. 11, 12, and 13), to effect the desired connections, it will be understood that the circuit manipulating devices and internal connections are identical in all instruments, or stations, and for the sake of illustration, that the "calling" station is the one to the left in the figures, the "called" station, the one to the right, and stations on the line not "called" and the conditions of the local circuits thereat, are illustrated by an intermediate station represented by the middle station or "set" in the figures; and further, that the "calling" station is "No. 1" and the "called" station is "No. 10," which can, as far as the conditions are concerned, be, in either case, a terminal as well as an intermediate station.

Between the two main-line binding posts 1^p and 2^p, the internal circuit, at each station, of the main line is as follows:—From the binding post 1^p, by wire *t*, to one terminal of the index operating magnet 12 (see Figs. 6 and 9), from the other terminal thereof, by wire *s*, to one of the contact points 10 and 11 of the circuit breaking device (see Figs. 3 and 10), from the other contact point, by wire *i*—*r*, to the other binding post 2^p.

Station "No. 1" desires to call "No. 10." The operator at the former station (the one to the left in the drawings) pulls his stop pin 21 (see Figs. 1 and 2), thereby releasing the arm 19 of his instrument, he having previously inserted his interference pin 25 (see Fig. 10) in the hole 20^a, corresponding in number to the station he desires to call—No. 10 in this instance. The arm 19 is allowed to revolve until it strikes against the interference pin. The disk 3 revolves with the arm 19, and the pins 4 engage with and oscillate the arm 5 a number of times corresponding to the number of the station desired to be called (10), and this, in turn, at the contact points 10 and 11 (see Figs. 3 and 10), breaks the main-line circuit, thereby oscillating the armature 13. The oscillation of the armature 13, through its long arm 13^a (see Fig. 6) vibrates the escapement 15 allowing the escape-wheel 16 to rotate a similar number of steps forward, which moves with it the index hand 17 to the number of the desired "called" station (see Figs. 2, 6, and 9). This serves to describe the method, at any station, of calling up a station and the operation of rotating the index mechanism and effecting the circuit changes and connections, by the devices attached thereto and operated thereby, which I will now proceed to describe. In all the instruments on the line, the index mechanism is similarly affected, the different circuit connections effected thereby being consequent on the different arrangement of the features of detail in the circuit manipulating devices operated thereby, as will be explained later. As shown in Fig. 11, the arm 19 of the circuit breaking mechanism at the calling station is the only one, in the first instance, in the series of instruments on the line, that has moved from its normal position of rest, at "zero," against the stop 21, and, as will appear from the following description, is the only one that can move after any one station has started to call another, until the first station has returned the normal condition of the line, by allowing the arm 19 of his instrument to return to "zero" by the removal of his interference pin 25. As shown in Fig. 11, the terminals of the exciting coils of the non-interference device, illustrated in Fig. 8 (see also Fig. 7) are connected, respectively, by the wires *g* and *k* to one of the contact springs 33 and one terminal of the local battery *x*, the local circuit being completed, by the wire *i*, from the other spring 33 to the remaining terminal of the battery *x*. As described, and as shown in Fig. 11, the springs 33 are in electrical connection with each other, through the diametrically disposed circuit-completing pin 32, carried by the insulation disk 31 secured to and rotating with the shaft of the escape wheel 16 (compare with Figs. 7 and 8), when the index hands 17 are at "zero," and the circuit completed through the magnets 30, thereby attracting the armature 30^a and retracting the pin 19^a on the end of the armature arm from a position of interference in the path of the arm 19. But when, as described, a "calling" station has allowed the arm 19 of his instrument to move one or more steps forward (which, by the way, will be a position of his arm 19 beyond the influence of the projecting pin 19^a), the disks 31, and with them the diametrical pins 32, of all the instruments will have moved far enough to open the circuit between the contacting ends of the springs 33, thereby allowing the retraction spring 34, of the armatures 30^a, to act and bring the armatures 30^a to the dotted line position shown in Fig. 8, and, in this manner, place an obstruction to prevent the forward rotation of the arms 19 from their normal position of rest, at all instruments except at the "calling" station. This condition will remain until the "calling" station has allowed the arm 19 of his instrument to return to "zero," (by the removal of his interference pin 25. In thus returning the arm 19 at the "calling" station to "zero," the main-line circuit will be again broken a number of times and the armatures 13 influenced to rotate the disks 31 to again bring the diametrical pins 32 to their normal position for closing the circuit between the ends of the springs 33; when the condition of "closed circuit" for the magnets 30, attraction of the armatures 30^a and consequent freedom of movement of the arms 19, will be re-established. It is evident that after the arm 19 and disk 3, with pins 4, at the

"calling" station, which I will for convenience, call "No. 1" (the one to the left in the drawings), has been released and stopped by the interference pin 25, inserted in the hole 20ª, corresponding to the number of the station it is desired to call, "No. 10" (the one to the right in the drawings), the circuit through all the magnets 12 will have been broken a number of times and the index hands of all the instruments connected with the line will have been moved, and the cross-connecting bar 32 at all stations, including stations not called as "No. 5" (the intermediate one in the drawings), be moved to break the circuit at the springs 33, through the magnets 30, as shown by the dotted lines positions shown in Fig. 11.

Turning now to Fig. 12, in which the local circuits for the signaling device (the vibrating bells shown in Figs. 1 and 2, the operating magnets 43 of which are shown in the figure under discussion) are added to what is illustrated in Fig. 11. Inasmuch as the circuit of the local battery *x* for the non-interference magnets 30 is open, as described, at all times, except when the index hands are at "zero"—*i. e.*, at all times when it is desired to operate the signaling devices, I preferably make use of the same battery, *x*, for operating the magnets 43 of the signaling devices at the "calling" and "called" stations. As shown in Fig. 7, there is secured to the shaft of the index hand 17 a disk 27 of insulating material, which carries the radially disposed contact pin or arm 26, in electrical connection with the shaft and framing of the index mechanism, and adapted to make electrical contact with the lever arm 28 at one of the positions of revolution of the index hand 17, as described. The position of this contact pin 26 is differently set circumferentially for each different machine, *i. e.*, set so as to make contact with the lever arm 28 when the index hand 17 is pointing to the number on the dial 18 corresponding to the number of the station "10" at station "No. 10," as shown at the "called" station in Fig. 12. There is placed in each instrument a circuit breaking device 22—24 (see Figs. 3 and 10) operated by the end of the arm 19, to open the circuit connected therethrough when the arm 19 is resting at "zero," as shown in Fig. 3, and, at the "called" and intermediate station, in Fig. 12. At the station "No. 1," the "calling" station, the arm 19 having been allowed to start and leave its normal position of rest at "zero," the circuit is closed at the circuit breaker 22—24. The local circuit to the signaling magnets 43 is connected in "parallel circuit," in each instrument, through the circuit closing device 26—28 and the circuit breaking device 22—24, and it is necessary that one of these devices be "closed" to close the circuits for the magnets 43. It is further evident, from what has been said, and from an inspection of the local circuits outlined in Fig. 12, considered in connection with the following description, that it is only at the "calling" and at the "called" stations that it is possible for either of these conditions or "closed circuit" to exist.

The local circuit for operating the signaling devices, at all the stations, is as follows:—From one terminal of the operating magnets 43, by wire *e* and the branch circuits *d*—*e* and *d*, to, respectively, the framing of the index mechanism, *i. e.*, the contact pin 26, and one of the contact points, as 24, where this local circuit is broken by the end of the arm 19 when it is at "zero;" from the other contact point 22, and the contact arm 28, by branched circuit *c* and *b*, to the contact spring 37, which is adapted, when the phone-hook is depressed, to make contact with the shank of the hook 36; from phone-hook 36, the circuit is continued, by the wire *y*, and the wire *k*, to one terminal of the battery *x;* from the other terminal of the battery *x* the circuit is continued, by wire *z*, to the contact spring 39 which is one of two springs adapted to make contact in the depressed position of the phone-hook, with an insulation plate 39ª secured to the phone-hook; the other contact spring 38 is connected, by wire *f*, to the remaining unoccupied terminal of the coils of the magnets 43, thereby completing the circuit when manipulated as I will now describe:—The circuit to the non-interference magnets 30, shown in Fig. 11, including the battery *x*, may be disregarded in the discussion of the local circuits for the signaling magnets 43, inasmuch as the same is open now, at all instruments, between the contact springs 33. At the calling station, the local circuit to the magnets 43, as described, will evidently be closed, at the contact points 22 and 24, as soon as the arm leaves its position at "zero," and remain so until the arm 19 is returned to its normal position thereat, by the operator at that station, when he has finished his communication. At all other stations, inasmuch as the arms 19 have not been and cannot now be, moved from their position at "zero," the circuit is open at this point. At the called station, "No. 10" in this instance, the shaft of the index mechanism has been rotated, in the manner described, and carried with it the radial contact pin 26, until it is in a position to make contact with the arm 28 and close this local circuit thereat. At all the other stations, the circuit is open at this point. In this manner, the signal bell at the "called" station and at the "calling" station is being rung through the operation of the magnets 43. As described, the circuit is completed through the hook 36 and the spring 37, so that when, at the "calling" or "called" stations, the hand-phone is removed from the hook 36 and the hook allowed to "raise," *i. e.*, come to the dotted line position shown in Fig. 12 at stations No. 1 and No. 10, the circuit will be opened thereat and the bells stopped ringing. When the operator at the calling station, after he has

completed communication, removes his interference pin 25 and allows the arm 19 of his instrument to return to "zero," the circuit just described will be open, at all stations, both at the contact points 22—24 and at the contact pin 26.

Directing our attention now to Fig. 13, in which the "talking" circuit is outlined, in addition to what is shown in Fig. 11, I will describe the arrangements of the local circuits and the means by which a "talking set" can be connected at the "calling" and "called" stations, to the main line. Main line circuit is effected by grounding the main line at the "calling" and "called" stations, after having arranged the local circuits as will appear from the following description.

It will be understood that to use the instrument for talking, or other means of intercommunication, between the "called" and "calling" station, it is preferable that no use can be made of such instrument for such purpose without effecting the circuit changes in the following manner: In the use of a "set," such as illustrated, I make use of the "raising" of the phone-hook from which the hand-phone is usually suspended. First, one terminal of the primary of the induction coil of the transmitter *j* is connected, by wire *n*, the contact spring 48, which is adapted to make contact with the body of the phone-hook 36, which, as already described, is connected by the wire *y* to one terminal of the battery *x*. The other terminal of the primary of the transmitter coil is connected, by wire *m* and the wire *z*, to the other terminal of the battery *x*, thereby completing the circuit, when the phone-hook is "raised," for the primary of the transmitter *j;* second, one terminal of the secondary of the transmitter *j* is connected to ground by the wire *o;* the other terminal being connected, through the coil of the hand-phone *l*, by the wires *p* and *r*, to the branched circuit which is connected by wires *b* and *c* to, respectively, the contact arm 28 and the contact point 22. Finally, the internal main line circuit wire *s* is connected, by wire *q*, to one of two springs, as 41, which are adapted to make contact with, and be electrically connected by, the insulated plate 41^a supported on the phone-hook 36, and the branched circuit, connected, respectively, to the framework of the index-mechanism, *i. e.*, the contact pin 26, and the contact point 24, by the wires *d* and *d—e*, is connected, by the wire *u* to the other spring 42, referred to. The only difference in the circuit manipulating devices in Fig. 13, from what is shown in Fig. 12, being that the phone-hooks at the "called" and "calling" stations are in their "raised" positions. This opens the local circuit to the signaling magnets by the hook 36 leaving the contact spring 37. As far as the "talking set" is concerned, it electrically connects the springs 41 and 42 together, and the spring 48 with the phone-hook 36. The latter, as described, completes the circuit for the primary of the transmitter *j*.

The "talking" circuit is as follows:—The main line is, as already stated, grounded at the "calling" and at the "called" stations, this being the means of effecting the circuit therebetween. Beginning then at the ground, at station No. 1, the circuit is as follows:—From the ground, by wire *o*, to the transmitter; thence, by wire *p*, to the hand-phone *l*; thence, by wires *r*, *b*, and *c* to the contact point 22—it cannot go over the arm 28 as the circuit is open there; from the contact point 24, which at this—the "calling"—station is in contact with the point 22, by wires *d* and *u* to the contact spring 42, across the plate 41^a to the spring 41; thence, by wire *q*, to the internal main line wire *s*, through the circuit breaking device 10—11, which is closed; over the wire *i—r* to the binding post 2^p; and over the main line *h* toward the called station, No. 10. At intermediate stations, as "No. 5," in the drawings, the circuit is looped through the instrument and goes in at the binding post 1^p, through the main line magnets 12, by wires *t*, *s*, and *i—r*, out at the other binding post 2^p. At the "called" station, No. 10, the internal circuit is identical with that described for No. 1, the "calling" station, except that the branched circuit including the contact pin 26 and arm 28 and the contact points 22 and 24 is closed at the contact pin 26 it being in contact with the arm 28 when this station is called.

From the foregoing description, it is evident that the only part of an instrument at any station other than the "calling" and the "called," as the intermediate station in the drawings, that is, or can be, in circuit are the index operating magnets 12, it being impossible to establish a local ground thereat inasmuch as the local circuits, as described, are open at both the pin 26 and arm 28 and at the contact points 22—24, the arm 19 not being able to leave its position at "zero," even if the stop pin 25 is withdrawn, because of the interference of the pin 19^a, as described. It is also evident that at the "calling" and "called" stations when the local grounds are placed on the main line for communication purposes, there will be a divided ground circuit established thereat, inasmuch as the main line is already grounded at each end. The resistance of the branch to the permanent main line ground, even in the extreme cases when the stations using the line happen to be the terminal stations, can be so adjusted that this ground does not materially affect the use of the main line for communication purposes over the temporary grounds established as described. After the desired communication has been had between the "calling" and "called" stations, and the hand-phones have been replaced on the phone-hooks, the operator at the "calling" station removes his interference pin 25, allowing his arm 19 to re-

turn to "zero," thereby returning the whole line and the different instruments, to their normal condition, as illustrated in Fig. 11.

It is evident that, by completing the local bell-circuits through the spring 37, and the hook 36, when it is in its depressed position, an additional precautionary means is provided to call the attention of the operator at the calling station to withdraw his interference pin 25 and allow the arm 19 and, with it, the disk 3, to return to its normal position, thereby bringing all instruments back to their normal, or "zero" indication, position; that is, when he has finished his conversation with the called station, he will naturally hang his 'phone on the hook, which will depress the hook, thereby closing his local bell-circuit and cause his bell to ring until he has withdrawn his interference pin 25 and allowed his instrument, and, with it, all the other instruments in the system, to come back to normal.

Having thus described my invention and its method of operation, what I claim, and desire to secure by Letters Patent, is—

1. In a telephone system, the combination with a main line, and a battery therefor, of a series of magnets permanently connected in said line, an armature for each of said magnets, a circuit breaker in the main line for each of said main line magnets, power driven mechanism for actuating said circuit breaker, a step-by-step escapement mechanism which is operated by the armature of the main line magnet, and means, actuated by the escapement mechanism, for controlling a local circuit in which is inserted a magnet, the armature of which is adapted to control the said power driven mechanism and its operated circuit breaker, substantially as and for the purposes specified.

2. In a telephone system, the combination with a main-line and its battery, of a series of magnets inserted therein, a step-by-step mechanism, whose escapement is controlled by the armature of said magnets, power driven mechanism for breaking the main line circuit, and a local circuit comprising two parallel branches one of which branches being controlled by the movement of the escapement mechanism and the other by the movement of the said power driven mechanism, substantially as and for the purposes specified.

3. In a telephone system, the combination with a main line, a magnet, battery, and circuit breaker inserted therein, of a step-by-step mechanism operated by the armature of said main line magnet, a local-circuit controlling device operated by the escapement mechanism when the same is at its normal position, said local circuit being effective, through the medium of a magnet and battery inserted therein, to control the operation of said main-line circuit breaker, and a second local signaling circuit controlling device, operated by the said escapement mechanism, when the same is at a position other than its normal, substantially as and for the purposes specified.

4. In a telephone system, the combination with a main line, a magnet, a battery, and a circuit breaker inserted in the same, of the herein-described means for operating the circuit-breaker, consisting in a revoluble disk provided with projecting pins adapted to engage with and operate the circuit breaker, a removable stop for retaining the revoluble disk at its normal position, an adjustable stop for stopping the disk at any position other than its normal, substantially as and for the purposes specified.

5. In a telephone system, the combination with a main line, a series of magnets, a battery, and a series of circuit breakers inserted in the main line, of means for operating the circuit breakers, consisting in a revoluble disk provided with projecting pins adapted to engage with and operate the circuit breakers, a removable stop for retaining the revoluble disk at its normal position, an adjustable stop for stopping the disk at any position other than its normal, and means for locking all other revoluble disks against rotation when any one disk has been started, substantially as and for the purposes specified.

6. In a telephone system, the combination with a main line, a magnet, a battery, and a circuit breaker inserted in the main line, of means for operating the circuit breaker, consisting in a revoluble disk provided with projecting pins adapted to engage with and operate the circuit breaker, a radially projecting arm secured to the supporting shaft of the said disk, a stationary disk provided with a series of holes corresponding in number to the pins on the revoluble disk, and a pin, or pins, adapted to be inserted in the holes and engage with the said radial arm, substantially as and for the purposes specified.

In testimony whereof I herewith affix my signature, in presence of two witnesses, this 21st day of November, 1892.

WILLIAM W. DAVIS.

Witnesses:
A. RAMEL,
HUGH K. WAGNER.