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PROVISIONAL SPECIFICATION.

Improvements in or appertaining to Electrical Clocks and similar Instruments.

We, FRANK HOPE-JONES of Prenton Road West, Birkenhead in the County of Chester, Electrician, and GEORGE BENNETT BOWELL of Sissinghurst, in the County of Kent, Electrical Engineer, do hereby declare the nature of this invention to be as follows :—

Whereas in electrical clocks and the like up to the present time considerable difficulty has arisen owing to the unreliability of the electrical contacts and the general complication of the mechanism made use of:

This our invention relates in part to a new device whereby all the energy required to maintain the swinging of the pendulum or balance wheel in the time-piece, or to drive the striking train or other similar mechanism is mechanically transmitted through the electrical contact surfaces, thus ensuring absolute reliability with regard to the electrical circuit or circuits.

As an illustration of one method in which this may be accomplished but without in any way binding ourselves to this alone, we will describe the following :—

Motion is imparted to the clock by means of a weight transmitting its energy through a click and ratchet wheel, a magnet being employed to replace the weight in such a position that it may operate upon the next tooth after it has descended a certain distance. The circuit of the electro-magnet and its battery is closed by a contact of the moving weight with the armature which is at rest, the electro-magnet thus being energized, the armature transmits its energy through the electrical contact, the circuit being broken by the sudden arrest of the said armature against a fixed stop, no such stop being provided for the weight at that point.

This our invention also relates to a contact, one moving part of which is driven against a spring or weight by a ratchet wheel or its equivalent upon the train through the medium of a link. This link is so arranged as to be knocked out of engagement with its driving tooth at the completion of the stroke of the armature of the electro-magnet employed to wind the clock.

It is generally advisable to prevent the pressure being taken off the escapement during the operation of electrical winding, as it is very desirable that a clock which may be used to control other dials should be a reliable timekeeper. It will be obvious that this object has been in view in the design of the controller as above described, particularly with regard to the even tension upon the going train. The maintenance of the pressure upon the going train during electrical winding may be accomplished in the following manner—

The ratchet wheel as described above may be mounted loosely on the arbor connecting it with the train, a spring being arranged between them to transmit the whole or a part of the power derived from the weight. A click is provided in connection with the ratchet wheel in order to prevent a backward movement of the said ratchet wheel when the pressure of the weight is relieved.

Or if desired the electrical driving movement as above described may be in part duplicated and arranged so that one weight or spring exercises its force upon the escapement at the moment of replacement of the other.

Or this may be done by means of an additional electro-magnet controlled by the

same circuit; or the electro-magnet used for winding may also be adapted for this purpose.

It will be understood that we have so far referred to a single electric clock. This clock we term a "controller." When it is desired that time should be indicated in additional places the use of similar clocks with pendulums or balance wheels in such places may be dispensed with.

For this purpose we employ novel methods of propelling and locking the fingers on subsidiary dials or other instruments by means of the intermittent electric current governed by the contact in the "controller" as above described.

One such method consists of toothed wheels driven by pallets entering against the inclined surfaces of their teeth; the pallets being arranged so that by means of springs or similar devices the one may gain upon the other during a portion of the cycle of operations, or the wheels may be so arranged that the wheel being driven by one pallet may be caused to gain upon the wheel being released by the opposite pallet, the object of either of the above arrangements being to carry the hands through that portion of their cycle which would otherwise be a dead centre.

In another method the clock is constructed upon ordinary lines in that it is driven by a spring or weight and controlled by an escapement, the winding of the spring or weight and the action of escapement being simultaneously effected by means of an electro-magnet in the circuit as above described; or the escapement may be combined with the pawl which connects the spring or weight to the wheel work.

It will be obvious that the apparatus above described as the "controller" need not be provided with indicating hands.

It will be readily understood that in the complete system of electrical clocks as above described, convenient switches may be provided by which the hands upon the dials in the circuit may be set on or put back without in any way interfering with the vibrations of the pendulum.

To set the clocks forward a push is provided to operate the circuit of the dials and their battery. To set the clocks back a two way switch is employed, the movement of which disconnects the dials and their battery from the controller and its battery until replaced into its normal position. This switch may be so arranged that it is automatically replaced after any desired interval of time. This may be accomplished by the use of a rotating ratchet wheel and a lever furnished with a click. The switch is held in its normal position by the lever and when the clocks are to be set back the lever is drawn the desired distance away from the switch, the click passing over the teeth of the ratchet wheel, so that in due time, the said lever returns and replaces the switch.

The striking gear is arranged as follows:—

A dividing plate may be driven by any electro-magnetic device, preferably that described above, against an air or other resistance which may take the usual form of a fan or fly, the train being locked on the dividing plate alone by a detent operated by an electro-magnet energized momentarily at the hours or hours and quarters. In some cases it is advisable to provide the detent with a spring which causes it to move in the reverse direction to the dividing plate at the moment of disengagement. To synchronise a series of these clocks they are connected to a line upon which an electrical pressure is exerted at certain periods determined by the standard time-piece; in the event of the clock being fast or slow a circuit is formed from the line through a commutator and one or other of two electro-magnets so arranged as to increase or diminish the free length of the pendulum or its equivalent.

Turret clocks may be controlled by the apparatus above described, whether the said turret clocks are driven by weights, or by hydraulic or electric power.

We will describe our apparatus as being electrically driven from a local circuit though it will be understood that we arrange the same action when making use of weights or water as a motive power, detents or valves and barrels or cylinders being substituted for the parts here described as switches, and electro-magnets.

One part of a circular insulated-gap switch is driven by a "dial" movement from any time circuit governed by a controller as above described; the other portion of the said switch being turned by the centre wheel of the secondary mechanism. This gap-switch closes a local circuit through a motor, this circuit being broken from a part of the going train or by the gap-switch itself. In the case of a turret clock of unusual size, a relay may be employed.

By this arrangement it will be seen that not only is the train governed under normal conditions by the dial movement and gap-switch, but in case of a temporary failure of the local or power circuit, synchronisation is re-established between the primary time circuit and the hands of the turret clock when the failure of the local circuit is rectified.

Dated this 22nd day of January 1895.

WM. P. THOMPSON & Co.,
Of 6 Lord Street, Liverpool, Patent Agents for the Applicants.

COMPLETE SPECIFICATION.

Improvements in or appertaining to Electrical Clocks and similar Instruments.

We, FRANK HOPE-JONES of Prenton Road West, Birkenhead, in the County of Chester, Electrician, and GEORGE BENNETT BOWELL of Sissinghurst in the County of Kent, Electrical Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Whereas in electrical clocks and the like up to the present time considerable difficulty has arisen owing to the unreliability of the electrical contacts and the general complication of the mechanism made use of:

This our invention relates in part to a new device whereby all the energy required to maintain the swinging of the pendulum or balance wheel in the time-piece, or to drive the striking train or other similar mechanism is mechanically transmitted through the electrical contact surfaces, thus ensuring absolute reliability with regard to the electrical circuit or circuits.

The method in which this is accomplished may be described with reference to Figure 1 in which B is a pendulum supported by suspension spring *s*. C C^1 are two adjustable weights on the driving levers or gravity pieces, c^1 c^2 centred at b^1 b^2 and limited in stroke by the banking pins d^3 d^4. *d*, d^1 are armatures also centered at b^1 and b^2, in the fields of the electro-magnets D D^1 and adapted to lift the driving levers alternately by means of the hooks *e* e^1. Said driving levers operate the pendulum through their lower arms and are platinized at the points of contact with the latter c^3 c^4. X is an electrical indicating dial, either of one of the forms to be shortly described or of any known design capable of showing the time-keeping performances of the pendulum B.

In the drawing, the pendulum is shown travelling towards c^3. The lower end of the lever c^2 is in electrical connection with the upper end of the pendulum rod and the circuit is from the battery through line 3 magnet D, line 4, contact c^4, spring S, line 5, dial X and back to the battery. The magnet D is now energised and holds the weight C and lever c^1 in the position shown in the drawing. When however the pendulum has travelled a little further, the driving lever c^2 is arrested by the hook e^1, the circuit above described is broken at c^4, and the driving lever c^1 falls upon the pendulum, thus closing the circuit from the battery through line 6, magnet D^1, line 7 contact c^3 spring S line 5, dial X and back to battery. Magnet D^1 now re-sets weight C^1 with its driving lever c^2 and the pendulum continues to vibrate to the end of its arc and in returning, the driving lever C^1

exercises pressure upon the pendulum for a longer period than it had done during the latter half of the last vibration, thus providing the impulse. The mechanism being symmetrical the cycle of operations is the same on the other side.

If it be desired that the weight be re-set at less frequent intervals than is the case with the above, we prefer to do so not by lengthening the pendulum but by introducing intermediate mechanism as follows :—

Motion is imparted to the clock by means of the weight transmitting its energy through a click and ratchet wheel, a magnet being employed to replace the weight in such a position that it may operate upon the next tooth after it has descended a certain distance. The circuit of the electro-magnet and its battery is closed by a contact of the moving weight with the armature which is at rest, the electro-magnet thus being energized, the armature transmits its energy through the electrical contact, the circuit being broken by the sudden arrest of the said armature against a fixed stop, no such stop being provided for the weight at that point.

The maintenance of the pressure upon the going train during electrical winding may be accomplished in the following manner.—The ratchet wheel as described above may be mounted loosely on the arbor connecting it with the train, a spring being arranged between them to transmit the whole or part of the power derived from the weight. A click is provided in connection with the ratchet wheel in order to prevent a backward movement of the said ratchet wheel when the pressure of the weight is relieved.

This may be described with reference to Figure 2, in which A *a* is the escapement driving the pendulum B. The wheel *b* (which gears with the 'scape wheel A) and the ratchet wheel *c* are mounted on the same arbor b^1. One or other of these wheels is loose upon the arbor and is connected therewith by means of a spring only. The click b^2 pivoted at b^3 prevents a backward movement of the ratchet wheel *c*. C is a weight on a bell crank lever C^2, centered at b^1 which lever may be rigid or may take the form of a spring. The arm C^3 of this lever is provided with a suitable electrical contact surface. The weight C communicates its downward thrust to the ratchet wheel *c* through the medium of the click c^5. D is an electro-magnet having an armature *d* pivoted at d^1 and provided with a contact screw d^2. This armature is limited at each extremity of its stroke by the stops d^3 d^4, and is provided with a resistance spring d^5. The movement of the lever C^2 on its pivot is also limited by the armature contact screw d^2 and the stop c^6. The contact c^3 is in electrical connection with the clock frame while the contact d^2 is in electrical connection with the coils of the magnet D. This magnet D with its armature *d* and stop d^3 is electrically insulated from the frame by insulators D^3. The circuit through the battery and magnet D is therefore only complete when contact c^3 touches contact d^2.

The action of the apparatus is as follows :—

When the pendulum is started, the weighted lever C^2 in its descent causes the contact piece c^3 to approach the contact screw d^2 thereby closing the electrical circuit of the magnet D and causing the armature *d* to be attracted and brought to rest against the stop d^4 carrying the lever C^2 along with it; but as no such stop is provided for the lever C^2 at that point the driven portion of the contact, that is the lever C^2 still continues its motion while the driving portion, or the armature, is carried back to its normal position by the spring d^5. It will be understood that during the operation of electrical winding as above described the spring between the wheels *b c* is maintaining the normal pressure upon the escapement.

If desired the electrical driving movement as above described may be in part duplicated and arranged so that one weight or spring exercises its force upon the escapement at the moment of replacement of the other. This may be described with reference to Figure 3 in which the weight C, click c^5, lever C^2 arm C^3, magnet D and armature *d* constitute the driving mechanism operating wheel *b* and escapement A *a*, as shown in Figure 2.

The similar parts, weight C^1, click c^7, lever C^4 arm C^6, magnet D^1 and

armature d^1 constitute a duplicate driving mechanism also operating wheel b, the two devices working alternately and so keeping a continual force upon the escapement.

We have so far described instruments in which the energy for driving the pendulum or balance wheel has been stored in a weight free to fall, but it must be understood that our invention is equally applicable to instruments in which the energy is stored in a spring in tension. Now a spring does not possess the qualities of a weight with regard to inertia and momentum and it will be observed that the breaking of the contact above described is to some extent assisted by the momentum of its driven portion. In order that this assistance may not be lost when it is desired that the power be stored in a spring, we either retain the weight C and counterbalance it or we provide a flywheel moving on the same arbor or geared thereto. This may be described with reference to Figure 4, which shows the winding apparatus as applied to a portable time piece in which the balance wheel scape wheel 4th, 3rd and centre wheel are of ordinary construction. C^1 is a fly wheel centered at b^7 having a pinion on its arbor gearing with rack b^8 at the extreme end of lever C^2. Spring D^4 provides the turning force. Magnet D, armature d arm C^2, click C^5 *etcetera* operate as in Figure 2.

This our invention also relates to a contact one moving part of which is driven against a spring or weight by a ratchet wheel or its equivalent upon the train, through the medium of a link. This link is so arranged as to be knocked out of engagement with its driving tooth at the completion of the stroke of the armature of the electro magnet employed to wind the clock. This may be described with reference to Figure 5, in which the escapement A a, pendulum B, wheel b, driving disc c with click b^2 and magnet D with armature d are the same as shown in Figure 2. b^4 is a wheel fixed upon the arbor b^1 in rigid connection with the wheel b. The driving disc c is loose on the arbor b^1 and connected therewith by a spring. E is a rod pivoted on the armature at e^2 carrying a link e^3 adapted to engage in the teeth of the wheel b^4 and having at its extreme end a contact spring E^1 adapted to close the circuit of the electromagnet D by its contact with the insulated pillar F. The movement of rod E and link e^3 is guided by the banking pins c^6 and c^6. c^7 is a pawl engaging in the teeth of the wheel c.

The action of the apparatus is as follows :—

When the pendulum is started wheels b b^4 gradually rotate and cause the rod E E^1 to approach the pillar F and touch the same thereby closing the circuit. The magnet D attracts its armature d which rotates the wheel c through the pawl c^7 to the extent of one tooth. The rod E E^1 is simultaneously moved towards E^1 and at the same time is forced upwards by the banking pin c^6 which acts upon the inclined surface of link e^3. Said link e^3 is thus liberated from the tooth by which it was driven just after click b^2 has fallen into the next tooth. The rod E E^1 now falls against banking pin c^6 and the electrical circuit is broken, the spring d^5 causing the armature to return to its normal position.

It will be understood that we have so far referred to a single electric clock. This clock we term a "controller" and it is obvious that it need not be provided with indicating hands. When it is desired that time should be indicated in additional places the use of similar clocks with pendulums or balance wheels in such places may be dispensed with.

For this purpose we employ novel methods of propelling and locking the fingers on subsidiary dials or other instruments by means of the intermittent electric current governed by the contact in the "controller" as above described. One such method consists of toothed wheels driven by pallets entering against the inclined surfaces of their teeth ; the pallets being arranged so that by springs or similar devices the one may gain upon the other during a portion of the cycle of operations ; or the wheels may be so arranged that the wheel being driven by one pallet may be caused to gain upon the wheel being released by the opposite pallet, the object of either of the above arrangements being to carry the hands through that portion of their cycle which would otherwise be a dead centre. This part of

the invention may be described with reference to Figures 6 to 10 in which similar letters indicate similar parts.

In reference first to Figures 6, and 6^A, the former showing a dial movement in which the intermittent current governed by a controller hereinbefore described causes the electro-magnet D to attract the armature d said armature being pivoted at d^1 and having an anchor a with pallets a^1 a^2 attached at its rear end. A is a scape wheel mounted on the arbor b^1, the teeth of which engage the pallets a^1 a^2. A pinion upon the arbor b^1 gears with the centre wheel b connected with the hands in the usual way. The pallets a^1 a^2 are attached to the anchor a, a^1 being in rigid connection therewith and a^2 attached by means of the spring arm a^3 and abutting against the stop screw a^4 as shown in Figure 6^A which is a detail drawing to show the way in which the pallet a^2 is attached to the anchor a. The pallet a^2 is also provided with a knee joint at a^5 and spring a^6 to keep it normally closed. The action is as follows :—When the armature is attracted the pallet a^1 recedes from the scape wheel A, and at the same time the pallet a^2 approaches it and enters against the inclined surface of a tooth. As pallet a^1 has not yet unlocked wheel A, spring arm a^3 will be compressed. When the pallet a^1 has liberated the scape wheel the spring a^3 will turn it forward a short distance and the return of the armature will cause pallet a^1 to enter the next tooth and drive the scape wheel a further distance so that the whole displacement of the wheel is equal to the pitch. It will be observed that the knee joint a^5 is necessary to enable pallet a^2 to escape from wheel A during the return stroke of the armature.

In Figure 7 a magnet D^1 is employed instead of the spring a^3 for the purpose of making one pallet gain upon the other with a view to carrying the hands through that portion of their cycle which would otherwise be a dead centre.

The construction is as follows :—

The pallet a^2 is pivoted upon armature F at f. Said armature is hinged at f^1 and is limited in its outward stroke by stop f^2. n is a spring normally bearing against contact screw n^1 in electrical connection with magnet D but said spring being in the path of armature F will break contact with screw n^1 wherever the armature is attracted. Pallet a^1 is rigidly fixed to armature d and both armatures are held in their normal positions by spring F^1. The action is as follows :—The intermittent current energizes magnets D, D^1 simultaneously, thus withdrawing pallet a^1 and turning wheel A by pallet a^2. Armature F then engages spring n and breaks circuit of magnet D thus allowing pallet a^1 to lock wheel A before pallet a^2 returns.

In Figure 8 the pallets a^1 a^2 are separately centered at a^4 a^5 on each side of the anchor a and are held inwards by the spring a^3, the anchor a by means of projections 1, 2, 3, 4, being adapted to lift one pallet out of engagement with the wheel A and force the other one into engagement with said wheel at every vibration of the armature. The pallets a^1 a^2 will thus gain one upon the other radially and so turn wheel A through that part of its cycle which would otherwise be a dead centre.

In Figure 9 the pallets a^1 a^2 are fixed upon the lever a pivoted upon armature d at a^1 and having a slot at its rear end g. g^1 is a link centered preferably spring tight at g^2 and supporting lever a by a pin running freely in slot g. When the armature d is attracted, the pallet a^1 will release wheel A, and pallet a^2 will enter the wheel in the same direction until the end of the slot meets the pin on link g^1, engaging with it, the pallet a^2 will then change the direction of its movement and will gain upon pallet a^1 circumferentially, thus moving wheel A through that part of its cycle which would otherwise be a dead centre.

In Figure 10 two wheels A c are employed, connected by the springs a^3 and a^6 attached to wheel A which engage the pillar g^3 fixed in wheel c. The pallets a^1 a^2 are rigidly fixed to anchor a attached to armature d. The attraction of the armature drives wheel A half a tooth and the return of the armature drives wheel c half a tooth.

In another method the clock is constructed on ordinary lines in that it is driven

by a spring or weight and controlled by an escapement, the winding of the spring or weight and the action of the escapement being simultaneously effected by means of an electro magnet in the circuit as above described; or the escapement may be combined with the pawl which connects the spring or weight to the wheel work.

This may be described with reference to Figure 11, which shows a dial movement. In this the intermittent current governed by the controller hereinbefore described causes the electro-magnet D to attract the armature d, said armature being pivoted at d^1 and having an anchor a (with pallets a^1) attached at its rear end, and a driving pawl c^1 pivoted upon one of its arms. In this figure, A is a 'scape wheel, the teeth of which engage the pallets a^1. C is a ratchet wheel, the teeth of which are adapted to be engaged by the driving pawl c^1. The 'scape wheel A and the ratchet wheel C are mounted on the same arbor b^1. One or other of these wheels is loose upon the arbor and is connected therewith by means of the spring c^6 only. A pinion upon the arbor b^1 gears with the centre wheel b connected with the hands in the usual way. The click b^2 pivoted at b^3 and held upwards by the spring b^4 prevents a backward movement of the driving wheel.

It will be obvious that when the armature is attracted and released it will wind one tooth of the driving wheel C, at the same time allowing the 'scape wheel A to progress one tooth.

It will be readily understood that in the complete system of electrical clocks as above described convenient switches may be provided by which the hands upon the dials in the circuit may be set on or put back without in any way interfering with the vibrations of the pendulum.

To set the clocks forward a key is provided to operate the circuit of the dials and their battery. To set the clocks back, a two way switch is employed, the movement of which disconnects the dials and their battery from the controller and its battery until replaced into its normal position.

This switch may be so arranged that it is automatically replaced after any desired interval of time. This may be accomplished by the use of a rotating ratchet wheel and a lever furnished with a click. The switch is held in its normal position by the lever and when the clocks are to be set back the lever is drawn the desired distance away from the switch the click passing over the teeth of the ratchet wheel, so that in due time the said lever returns and replaces the switch. This may be described with reference to Figure 12, in which the circuit of the dials D D D may be disconnected from the pendulum, or controller, B, for any desired length of time by a backward movement of the hand D^2 upon an instrument which we will call a "controller dial" operated by the magnet D^1 shown diagrammatically. In the drawing the lever H and the contact points g^4 g^5 form a two way switch which is normally in such a position that the circuit is from g^6 through the controller B, the dial magnet D^1, the lever H, contact g^4, dials D D D and back to the battery at g^7. When the switch H is reversed the circuit is from g^6 through B D^1 H and g^5 returning to the battery at g^8.

D^1 represents the coils of the magnet which operates the minute hand D^2 by means of any known form of dial movement or those described with reference to Figures 6 to 11. The hand D^2 is spring tight upon its arbor and has a ratchet wheel h^4 in rigid connection with it. h^3 is a similar ratchet wheel in rigid connection with the dial movement. h is a lever pivoted upon the centre wheel arbor and held by the spring h^5 against the short arm of the lever H. h^1 h^2 are clicks pivoted upon the lever h and adapted to engage in the teeth of the ratchet wheels h^4 and h^3.

The mode of action is as follows:—

When the hand D^2 is turned backwards lever h is raised by means of the ratchet wheel h^4 and click h^1 against the spring h^5, causing the switch H to cut the dials D D D and their battery out of circuit, click h^2 in the meantime passing over the teeth of the wheel h^3 and preventing the sudden return of the hand D^2. The progress of the hand, though assisted by the spring h^5 through the medium of wheel h^3 is controlled by the dial movement D^1 in the usual manner. When the

hand has reached the position which it occupied before being moved backwards the switch H is reversed.

If it is desired that sufficient latitude be provided to allow of the hands being turned back several hours, the lever h is mounted on a screw thread so that the number of hours may be recorded by the lateral position of the lever along the screw. This arrangement ensures that the lever h passes clear of the contact lever H at the completion of the first revolution backwards.

This device may be more clearly shown with reference to Figure 13, in which h is mounted on the screw h^9 by means of the collar h^8. h^6 is a detent carrying the clicks h^1 h^2 and is connected to lever h by the runner h^7 passing through a clearance hole in said lever h. h^4 is a ratchet wheel in rigid connection with the minute hand as described in Figure 12, and h^3 is a ratchet wheel rigidly connected to the arbor h^{10} which is driven by any known form of dial movement or those described with reference to Figures 6 to 11. The spring h^5 may be connected to the collar h^8 by a piece of chain or similar flexible material.

Upon commencing to set back the hands of the governing dial several hours, the action of the apparatus is as follows:—

Lever h leaves contact lever H and rotates upon the screw h^9 motion being transmitted to it from the hand by click h^1 detent h^6 with its runner h^7. When the hands have been moved back as far as desired click h^2 prevents their return by engaging ratchet h^3, which gradually rotates with the dial movement above alluded to. Thus it will be seen that if the hands for instance have been turned back $3\frac{1}{2}$ hours the wheel h^3 will not allow lever h to replace the switch H until it has made $3\frac{1}{2}$ revolutions.

The striking gear is arranged as follows:—

A dividing plate may be driven by any electro-magnetic device, preferably that described above, against an air or other resistance which may take the usual form of a fan or fly, the train being locked on the dividing plate alone by a detent operated by an electro-magnet energised momentarily at the hours or hours and quarters. In some cases it is advisable to provide the detent with a spring which causes it to move in the reverse direction to the dividing plate at the moment of disengagement.

This may be described with reference to Figure 14 which illustrates the method we adopt for controlling single stroke electric bells at the hours only. n^2 is an armature lever pivoted at n^3 in the field of the magnet M, said armature being limited in its stroke by stop pin n^4 and contact piece n^5 n^6 is a lever pivoted upon the armature at n^7 and limited in its stroke by stop pin n^8 and contact piece n^9. I is a snail or cam in rigid connection with a minute hand of a clock in any part of the system adapted to raise lever n^6 into contact with n^9 at each hour; the magnet M will then withdraw the lever n^6 but will maintain the contact at n^5. The magnet D, armature d, ratchet wheel c of 78 teeth on arbor b^1, weighted lever C^2, with arm C^3 form the driving gear as described with reference to Figure 2. This or any suitable method of propulsion is employed to drive the dividing plate L on arbor b^1. L^3 is a fan or fly geared to arbor b^1 through the medium of wheels L^1 L^2 and their pinions.

Detent m^1 spring mounted on armature m^2 centred at m^3 in the field of magnet M^1 engages dividing plate L. m^4 is a lever in rigid connection with armature m^2 and adapted to lift spring m^5 from contact piece m^6 when magnet M^1 is energised. N N^1 are single stroke electric bells in the circuit of magnet D.

The action of the apparatus is as follows:—

The circuit of magnet M is closed at the hour by means of wheel I as above described. The circuit of magnet M^1 is now closed at n^9 and n^5 and operates the armature m^2 breaking the circuit at m^6. The dividing plate L being now liberated by detent m^1 will be driven forward by weight C against the fan L^3, and the bell circuit will be closed at d^2 as often as is required, the number of strokes being dependent upon the extent of the travel of dividing wheel L passed detent m^1 between the hour notches on its periphery.

When the hourly-revolving wheel is available adjacent to the striking mechanism, we modify the arrangement as shown in Figure 15. Lever n^6 is pivoted on armature d and is in electrical connection with the dividing plate L being provided with insulated collar n^{10}.

Dividing plate L has insulated sections upon its periphery instead of notches, and detent m^2 takes the form of a contact spring bearing upon it, said contact spring being in electrical connection with contact piece n^9.

The action is as follows :—

At the hour, the wheel I carries the lever n^6 into contact with n^9 and thus closes the circuit of bells N N^1 and magnet D through contact d^2 which is normally closed. The bells ring and the weight C is reset simultaneously. The weight then drives the dividing plate L against fan L^3 and the operation repeats itself until spring m^2 encounters an insulated section of dividing plate when the circuit is broken. To synchronise a series of these clocks they are connected to a line upon which an electrical pressure is exerted at certain periods determined by the standard time-piece; in the event of the clock being fast or slow a circuit is formed from the line through a commutator and one or other of two electro-magnets so arranged as to increase or diminish the free length of the pendulum or its equivalent.

Referring to Figure 16 which shows the details of the synchronising mechanism. In this B^1 is a suspension spring supporting the pendulum rod B of a controller which it is desired to synchronise, and which will in future be referred to as a "subcontroller," B^2 is a frame capable of movement in a vertical direction, at the lower end of this frame are two jaws which fit against the suspension spring and by their position determine the free length of the pendulum B. D^2 D^3 are two electro-magnets operating upon the armature d which is centred at d^1 and carries the forked extension piece d^7 engaging with a pin upon the sliding frame B^2. A commutator J mounted upon the wheel b in the going circuit of the pendulum to be synchronised, that is to say either mechanically or electrically connected with the pendulum B is so arranged that if the pendulum to be synchronised is either fast or slow, the periodic current from the master clock energises one or other of the electro-magnets D^2 D^3.

The action of the apparatus is as follows :—

Suppose the sub-controller to be say ½ a minute slow at the time of synchronisation, then commutator J will complete a circuit from the line through magnet D^3 enabling the synchronising current to energise it, attract the armature d and thus shorten the effective length of the pendulum. This will put a gaining rate upon the clock and the commutator will eventually reach such a position that the synchronising current will energise the magnet D^2 and so lengthen the pendulum.

It will be understood that the length of pendulum required for absolutely correct time keeping is somewhere between the limits of variation allowed by the sliding frame B^2.

Turret clocks may be controlled by the apparatus above described whether the said turret clocks are driven by weights or by hydraulic or electric power. We will describe our apparatus as being electrically driven from a local circuit though it will be understood that we arrange the same action when making use of weights or water as a motive power, detents or valves and barrels or cylinders being substituted for the parts here described as switches and electro magnets.

One part of a circular insulated gap switch is driven by a "dial" movement from any time circuit governed by a controller as above described, the other portion of the said switch being turned by the centre wheel of the secondary mechanism. This gap switch closes a local circuit through a motor, this circuit being broken from a part of the going train or by the gap switch itself. In the case of a turret clock of unusual size, a relay may be employed.

This may be described with reference to Figure 17 in which R is a motor driven from a local circuit, its speed being reduced by the gear wheels R^1 R^2 R^3 and R^4, the last named being in connection with the minute hand of the dial on arbor r.

b is a wheel mounted loosely upon arbor r and revolved hourly by means of pawl r^1 click r^2 armature d and magnet D or by means of any suitable dial movement such as those described with reference to Figures 6 to 11 in the time circuit of any controller. r^3 is an arm mounted loosely on arbor r in electrical connection with motor R and connected with wheel b by means of spring r^4 being held in the position shown by pin r^5 fixed in wheel b. r^6 is a contact piece mounted on wheel R^4 and in electrical connection with motor R.

The action of the apparatus is as follows—

The intermittent current from the controller will revolve wheel b by means of the pawl and ratchet movement shown, and the switch r^3 r^6 will be closed. The motor R will then revolve until the contact r^6 on wheel R^4 has been carried out of the range of arm r^3.

By this arrangement it will be seen that not only is the train governed under normal conditions by the dial movement and the gap switch, but in case of a temporary failure of the local or power circuit, synchronisation is re-established between the primary time circuit and the hands of the turret clock when the failure of the local circuit is rectified.

In order to avoid the too constant starting and stopping of the motor, it is sometimes convenient to adjust its speed only slightly in excess of that required to revolve wheel R^4 hourly and insert a rheostat in the motor armature circuit to be mechanically operated by a slight movement of contact piece r^6 so that upon the advance of the train a certain distance electrical resistance is thrown into the motor armature circuit by the separation of the pin r^6 and arm r^3 and thus the motor R is slowed down; it may be considerably but is not absolutely stopped. Such a rheostat may consist for example of a series of carbon plates placed between the pin r^6 and arm r^3 or so connected with these parts that as the distance between said pin and arm increases the plates are less pressed together and their resistance therefore increased.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In an electric apparatus for driving a pendulum (in which the power required to maintain its swing is mechanically transmitted through the surfaces of the contact) the use of two gravity pieces or arms so arranged as to be alternately raised or operated by two electro magnets, the contacts for the control of which are made on the pendulum itself by the said gravity arms, substantially as described.

2. In an electric clock, the combination of a going train, a winding device actuating the same, an electro magnet capable of periodically winding up the driving device on completion of the circuit, a vibrating armature to said electro magnet and a contact device formed of a moving part of the driving device and the said armature whereby when the driving device has run down to a given extent it shall make contact with the armature and thus close the circuit and allow the electro magnet to wind or set up the winding device.

3. In an electric clock the combination of an escapement device A, a driving wheel C, oscillating lever c having pawl c^1 and contact arm c^3, the electro magnet and armature d with an electric circuit controlling the magnet and made whenever the lever arm c^3 comes in contact with the armature whereby whenever the arm c is caused to descend sufficiently by the weight C^1 a contact is made, the magnet draws in the armature which throws up the lever, thus rewinding the clock.

4. An electric clock in which the driving device is automatically wound up by an electro magnet in part duplicated and arranged so that one weight exercises its force upon the escapement at the moment of replacement of the other substantially as and for the purposes described.

5. An electric clock in which the driving device is automatically wound up by

an electro magnet (as described with reference to Figure 2) and in which the power required to drive it is stored in a spring instead of in a weight, the use of a geared fly wheel substantially as and for the purposes described.

6. In an electric clock in which the driving device is automatically wound up by an electro magnet, a contact, one moving part of which is driven against a spring by a ratchet wheel, through the medium of a link, which link is knocked out of engagement at the completion of the stroke of the armature of the electro magnet employed to wind the clock substantially as described and shown with reference to Figure 5.

7. In an electric clock in which the contact link is raised by the going train, forming said link with a wedge shaped surface and in combination therewith a pin C^6 or its equivalent substantially as and for the purposes described.

8. In a clock dial apparatus in which an intermittent electric current is employed to revolve the hands, a scape-wheel operated upon by two pallets, one of which is spring mounted upon a knee joint so that it may gain upon the other, circumferentially during the cycle of its movement substantially as and for the purposes described.

9. In a clock dial apparatus in which an intermittent current is employed to revolve the hands, an auxiliary magnet and armature as and for the purpose described.

10. In a clock dial apparatus in which an intermittent current is employed to revolve the hands an anchor adapted to lift one pallet out of engagement with the driving wheel and to force the other into engagement with said wheel alternately in such a manner that they may gain one upon the other radially substantially as and for the purposes described.

11. In a clock dial apparatus in which an intermittent electric current is employed to revolve the hands, a scape wheel with pallets for driving the same, said pallets being mounted upon a lever hinged to the armature of the electro-magnet at one end and slotted upon a radius arm at the other end, so that one pallet may change the direction of its movement and gain upon the other circumferentially as and for the purpose described.

12. In a clock dial apparatus in which an intermittent electric current is employed to revolve the hands, an anchor with two pallets rigidly attached thereto and two wheels coupled together by springs so arranged that each pallet drives its wheel to a given extent before the other wheel is unlocked substantially as and for the purpose described.

13. In a clock dial apparatus an electro-magnetic device actuating the escapement and the winding device simultaneously, whereby at each stroke of the escapement the apparatus is wound up to the exact extent to which it would be run down by the movement of the escapement.

14. The combination of the electro-magnet D, the armature *d*, the anchor *a*, carried thereby, the pawl c^1 carried by mechanism *d a*, and actuating the winding wheel C, whereby the clockwork is wound up simultaneously with the action of the escapement, substantially as described in Figure 11.

15. The combination of the electro magnet D, the vibrating armature lever *d*, the anchor *a*, the pawl c^1 driving wheel C, and the spring c^5 connected at its ends to the arbor of the escape wheel, and driving wheel C respectively.

16. The method of setting back the time of a circuit of electric clocks which consists in connecting the hand of one dial with a contact making device in such manner that by putting back the said hand the contact device shall cut out the circuit from the other clocks until its dial has returned into synchronisation with the others.

17. In an electric clock installation the combination in a single dial of a contact device actuated by the backward movement of the hand in the main circuit whereby if the hand of this governing dial be set back a given amount the circuit through the remaining dials is cut off until the governing dial has again arrived at the point of synchronisation with the other dials.

18. The combination of the hand D^2, the wheel h^4, the lever h having a pawl device h^1 holding wheel h^4 from turning in one direction, the contact lever H with the two circuits, the main circuit g^6, B, D^1, H. g^4, D, D, D, g^7 and the extra circuit g^6, B, D^1, H, g^5 g^8.

19. The combination of the hand D^2, the wheels h^4 and h^3, lever h carrying pawls h^1 and h^2, the contact lever H and the main circuit and the extra circuit substantially as described.

20. In a governing dial the mechanism substantially as described with reference to Figure 13 for allowing the hands to be turned back to the extent of several revolutions.

21. In electric clocks, a striking device consisting of a train of wheels, a resistance such as a fan, and a ratchet on the slowest member of that train, a dividing plate having spaces proportionate to the numbers 1 to 12 inclusive, with pawl catching into the dividing plate, a rotating projection synchronously connected with the minute hand and adapted to liberate said pawl by means of an electro-magnet and a rewinding electro magnetic device and contact brought into action by the partial running down of the said motive device.

22. In electric clocks, a striking device consisting of a train of wheels, a resistance such as a fan and a ratchet on the slowest member of that train, a dividing plate having insulated sections proportionate to the Nos. 1 to 12 inclusive, with a contact brush resting upon dividing plate, a rotating projection synchronously connected with the minute hand and adapted to close the circuit of the rewinding electro magnetic device.

23. The combination with the suspension spring of an electric clock pendulum of two electro magnets having their poles substantially opposite each other and close together, a vibrating armature between the two magnets and connected to this armature, a frame terminating in a fork on each side of the suspension spring, whereby according as the armature is lifted up or down by the respective magnet the pendulum is made to gain or lose.

24. The method of synchronising electric clocks which consists in causing a synchronising current independent of the ordinary working current to impart to the pendulum a gaining or losing rate substantially as described.

25. In a synchronising device for electric clocks the combination of the electro magnets D^2 D^3, the vibrating lever armature d d^7, the sliding frame R^2, the suspension spring B^1 and the pendulum B substantially as described.

26. The combination of an electro-motor in a local circuit with an electric clock dial apparatus adapted to revolve by a step by step movement in a time circuit, in which the motor operates the hands of a turret clock by the progression of the dial movement in such a manner that in the event of temporary failure of the motor circuit synchronisation is re-established between the primary time circuit and the hands of the turret clock when the failure of the local circuit is rectified substantially as described.

Dated this 22nd day of October 1895.

WM. P. THOMPSON & Co.,
Of Liverpool, Manchester, Birmingham, and London, Patent Agents.

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SHEET 1.

FIG. 1.

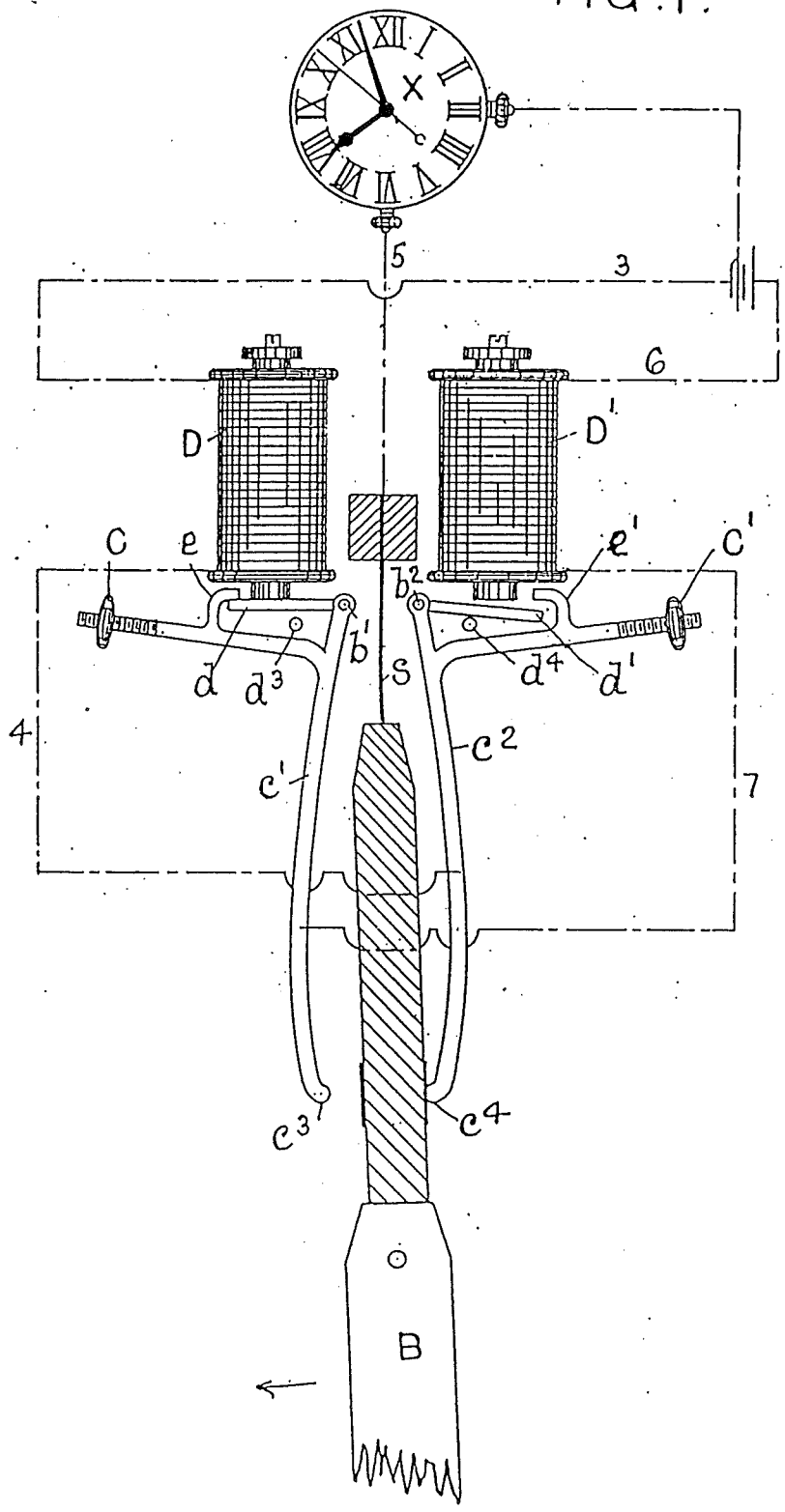

FIG. 2.

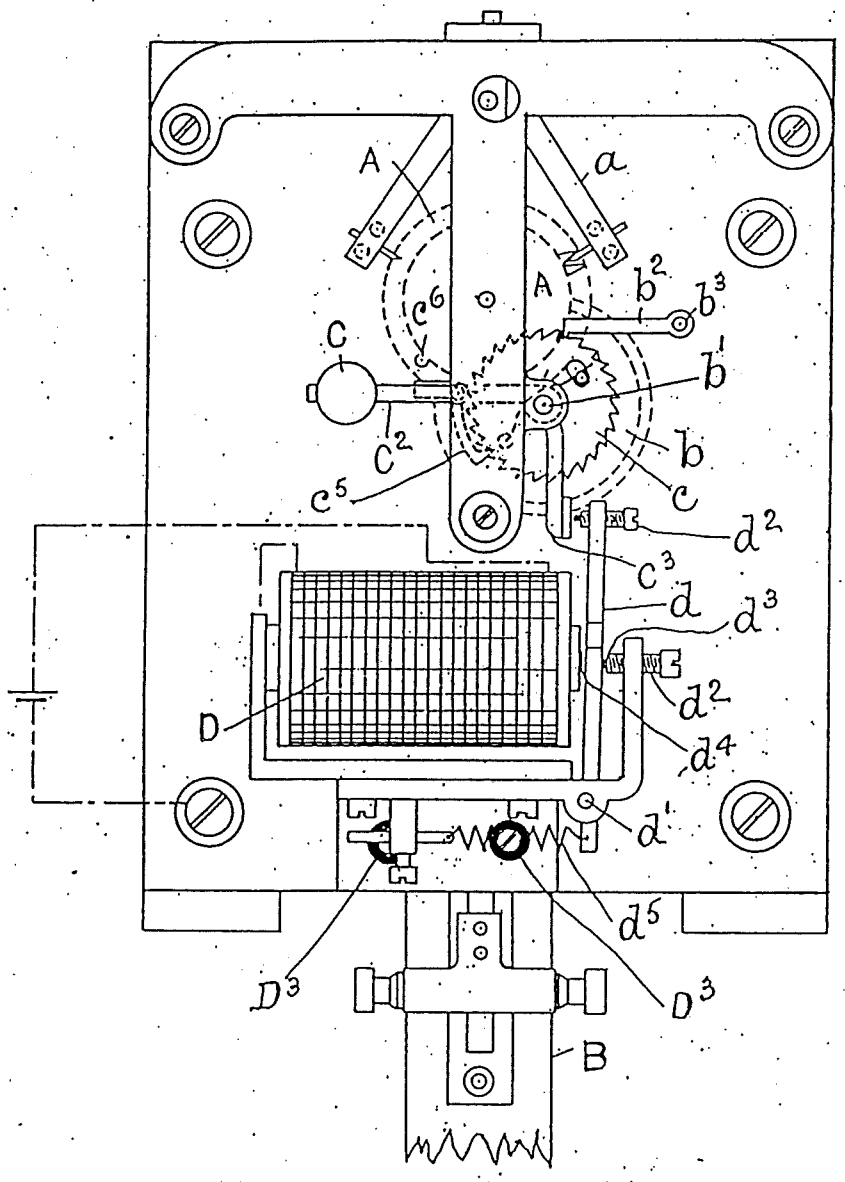

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FIG. 3.

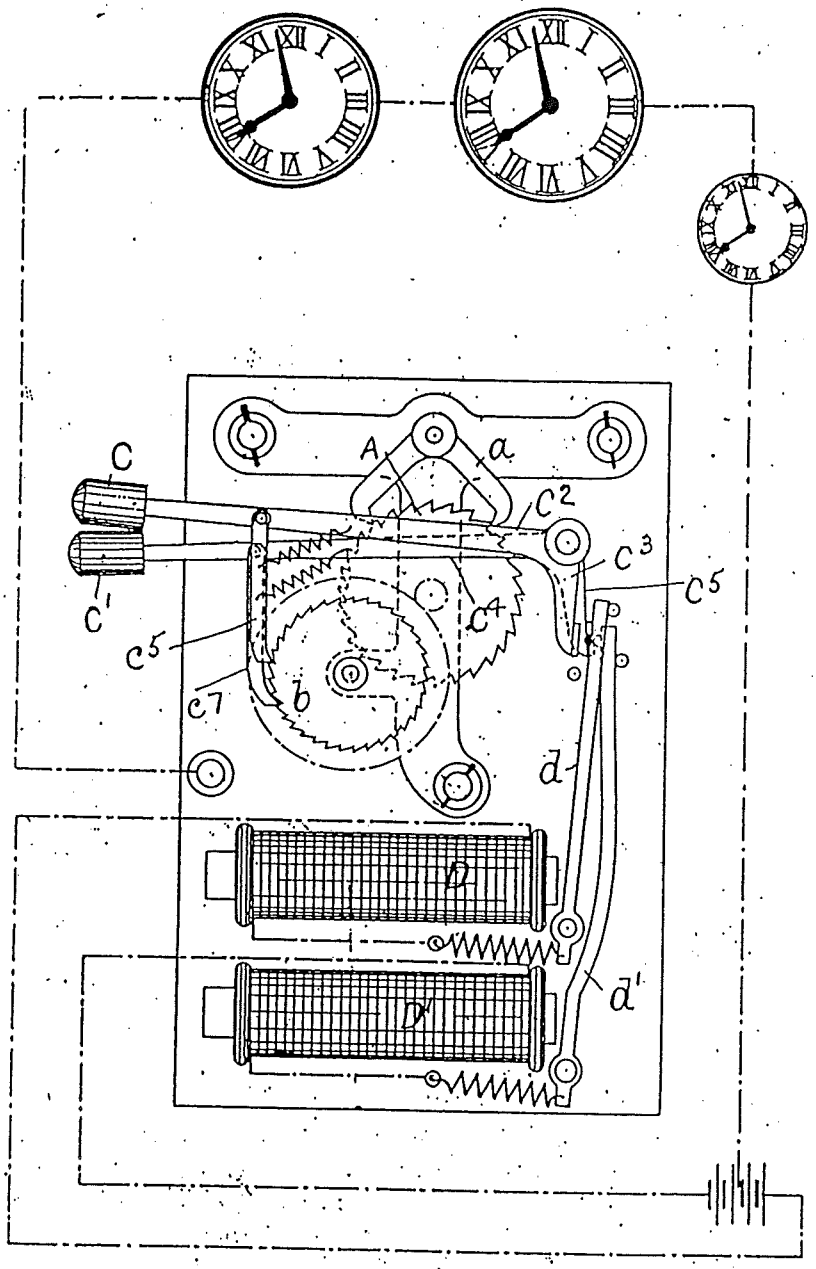

FIG. 4.

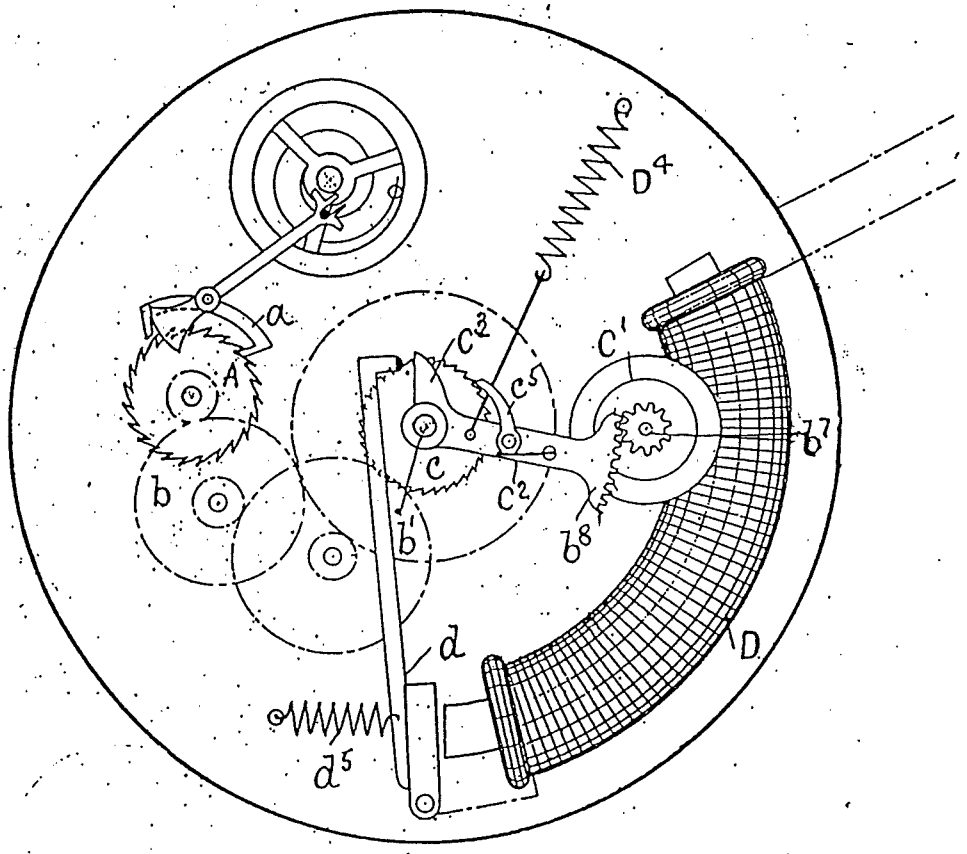

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FIG. 5.

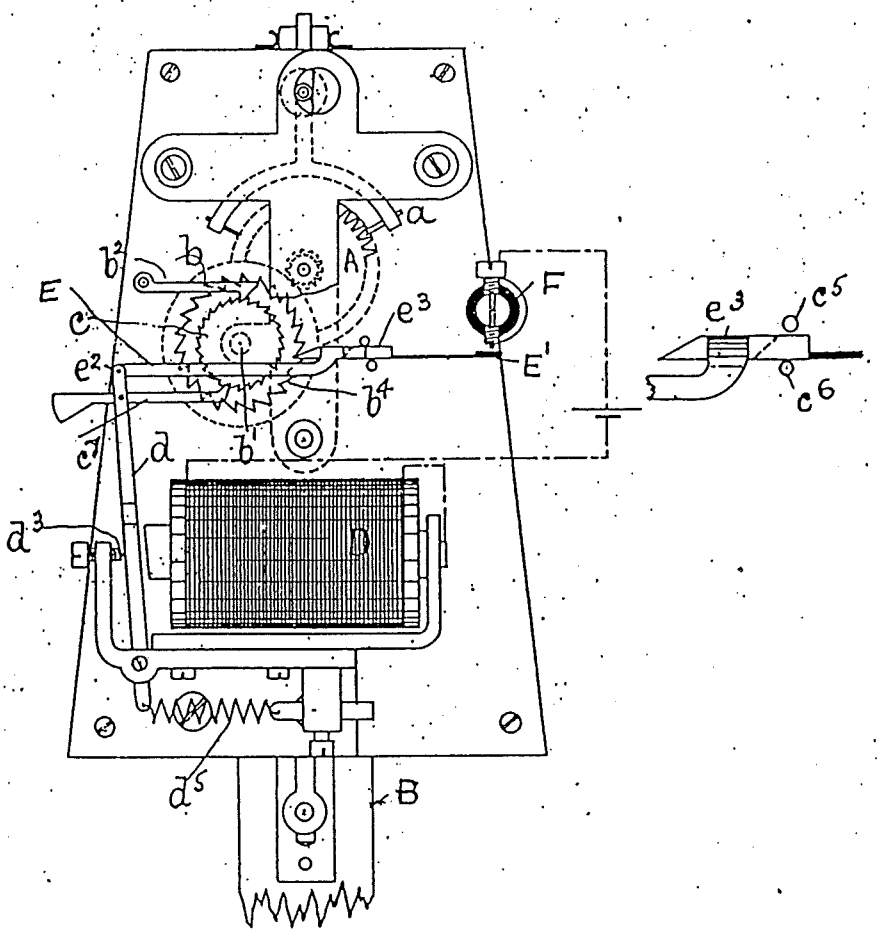

FIG. 6.

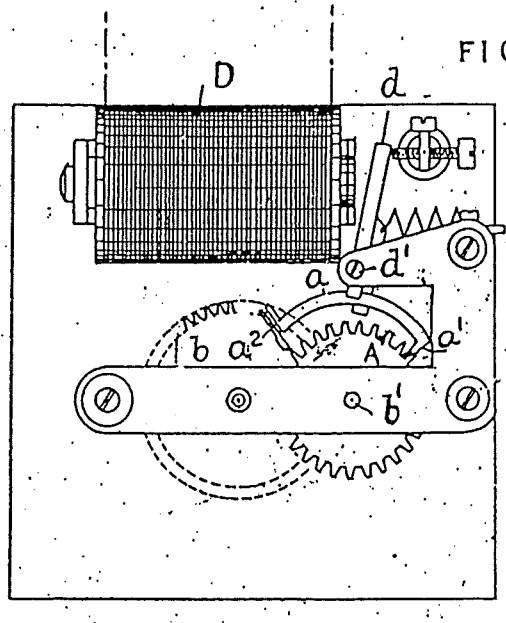

FIG. 6 A

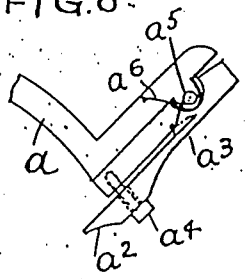

FIG. 7.

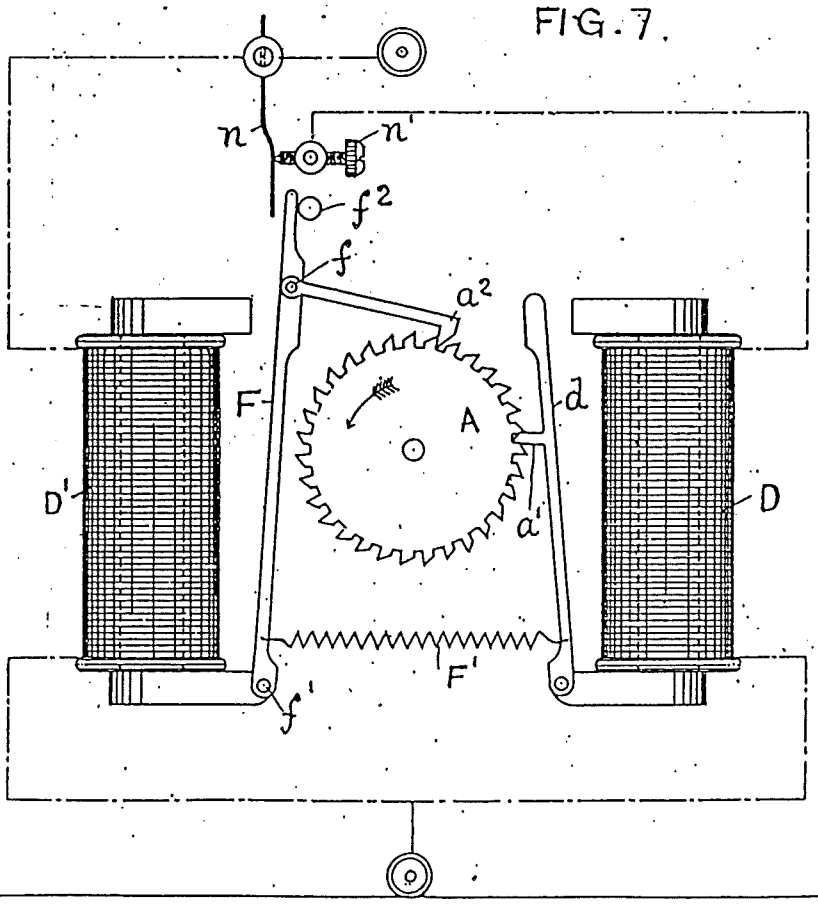

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FIG. 8.

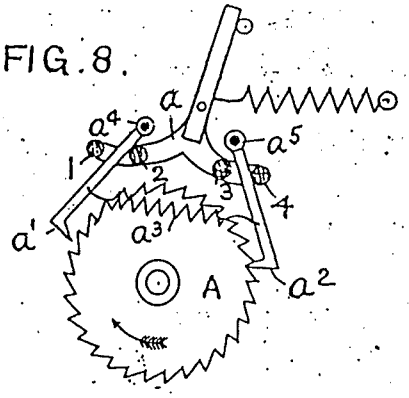

FIG. 9.

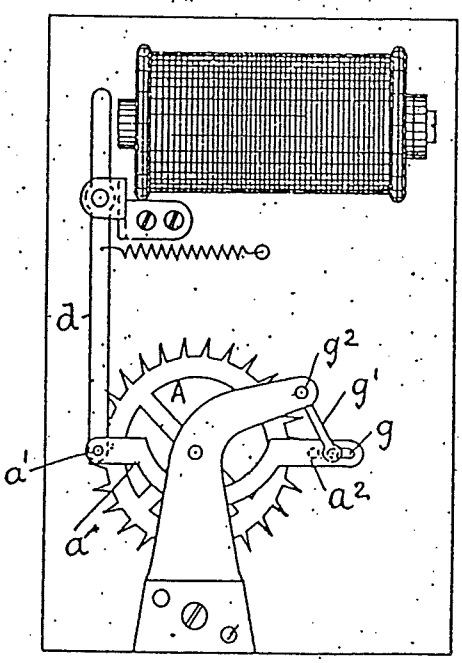

FIG. 10.

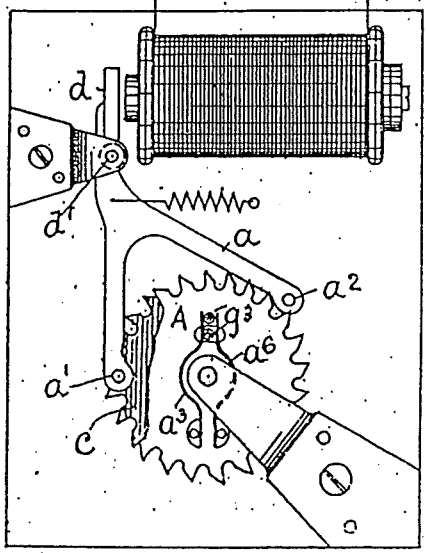

FIG. 11.

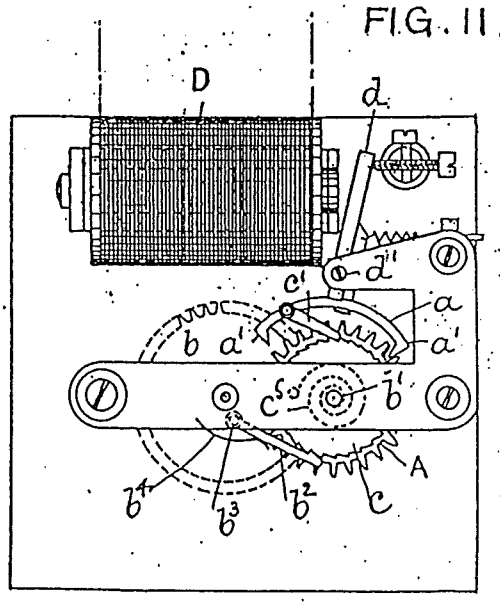

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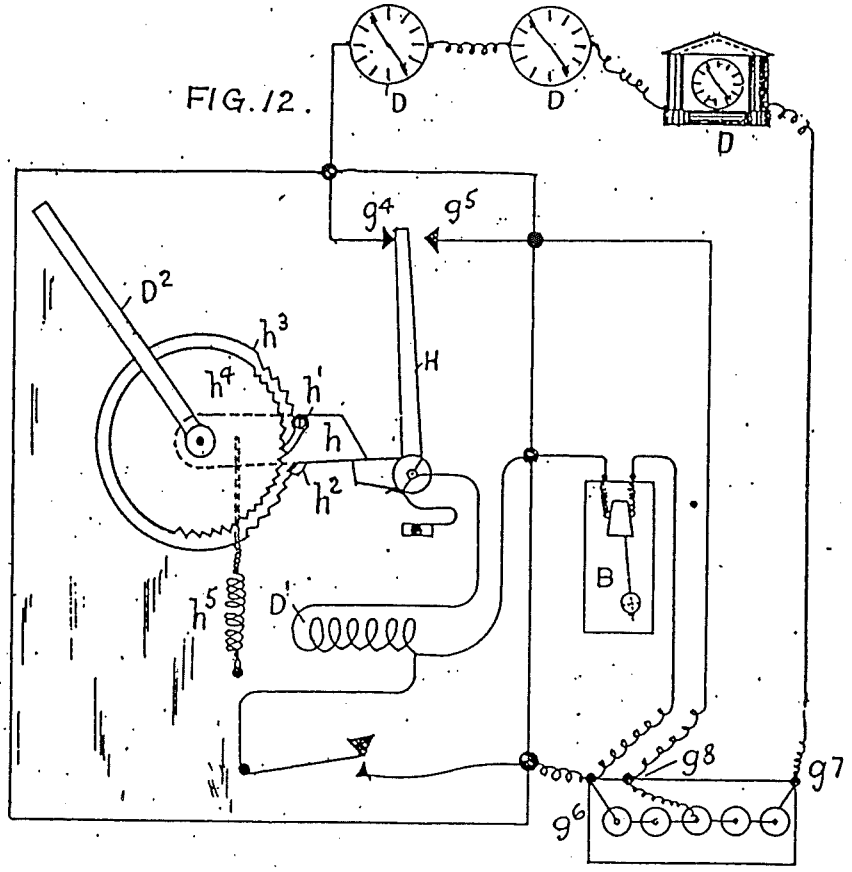
FIG. 12.


D
D
D
g4
g5
D2
h3
h4
h'
h
H
h2
B
h5
D'
g8
g7
g6

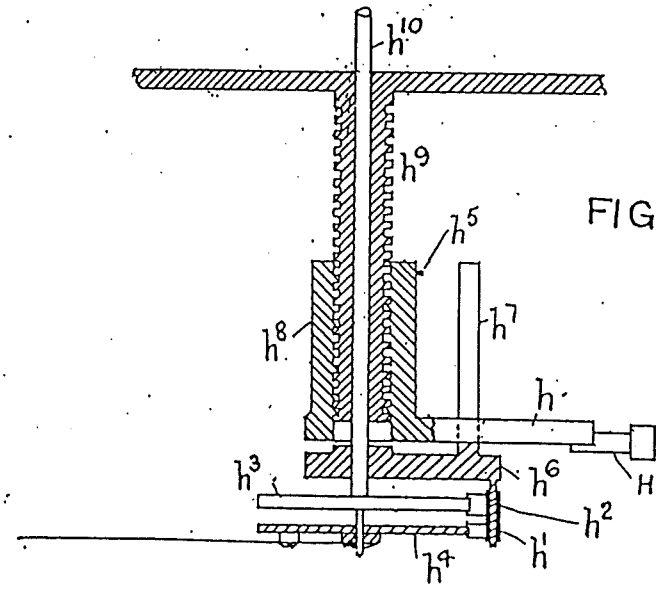

h10
h9
h5
h7
h8
h'
h3
h6
H
h2
h'
h4

FIG. 13.

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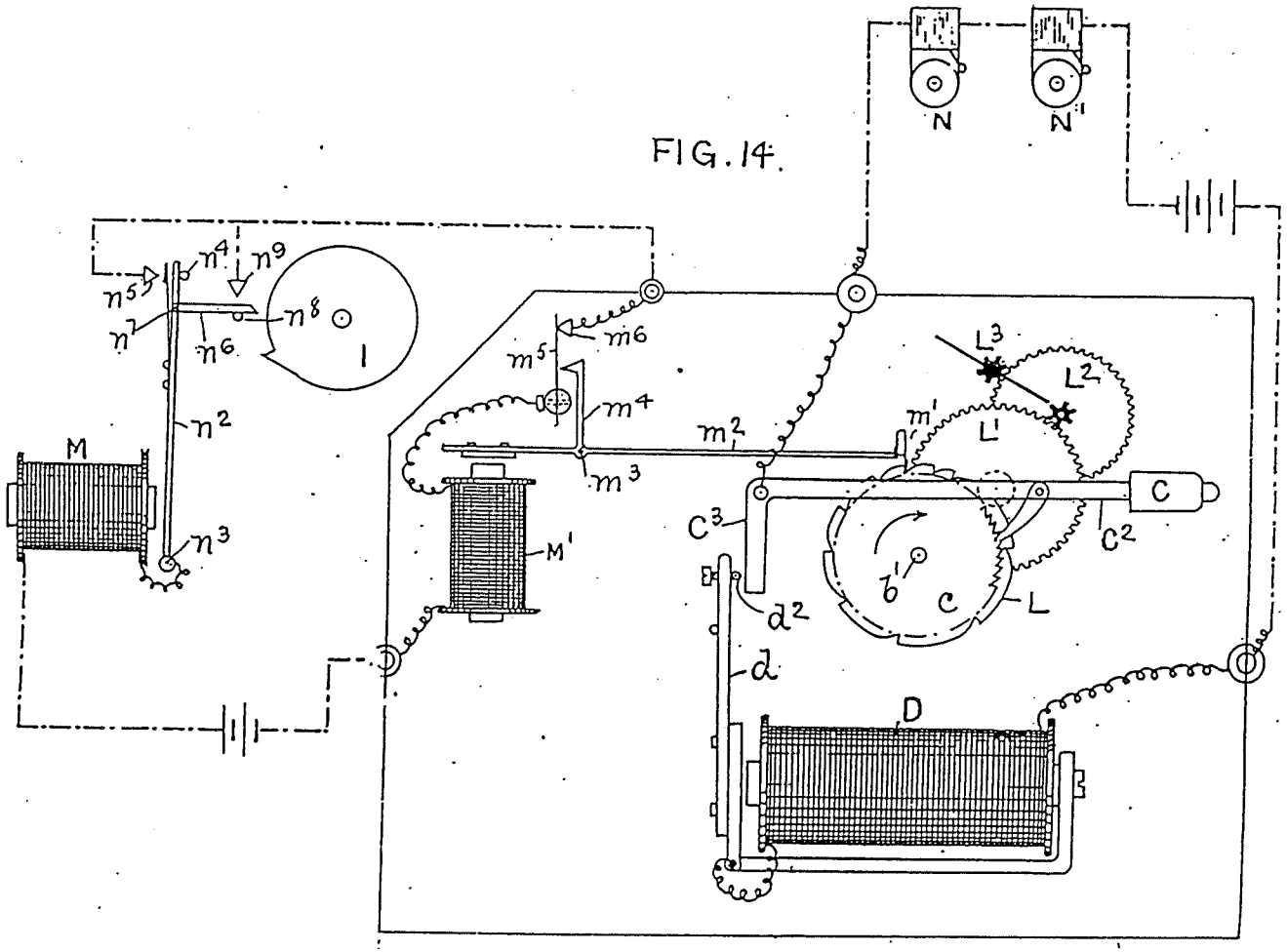
(6 SHEETS) SHEET 10.

FIG. 14.



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SHEET II.

FIG. 15.

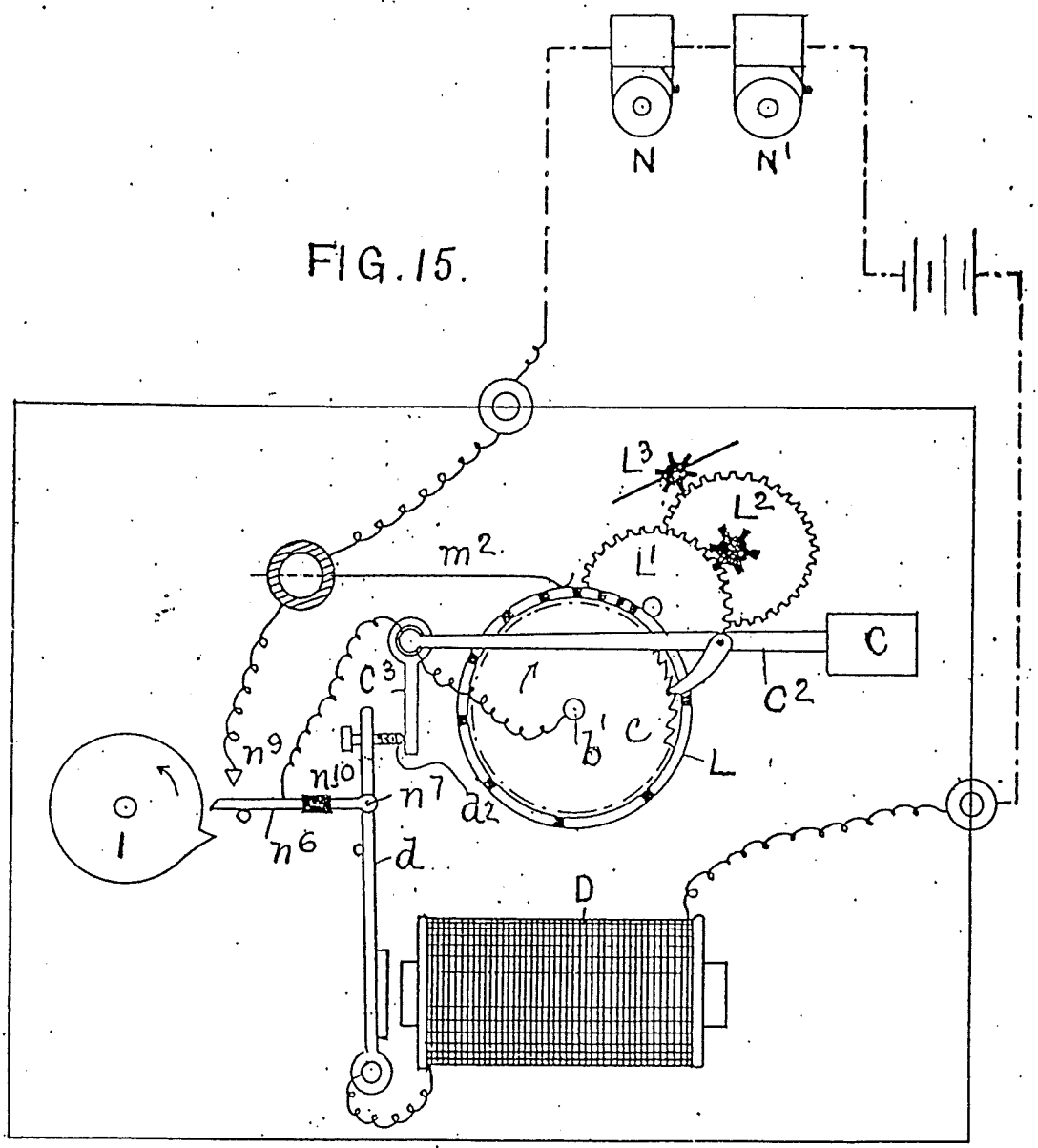
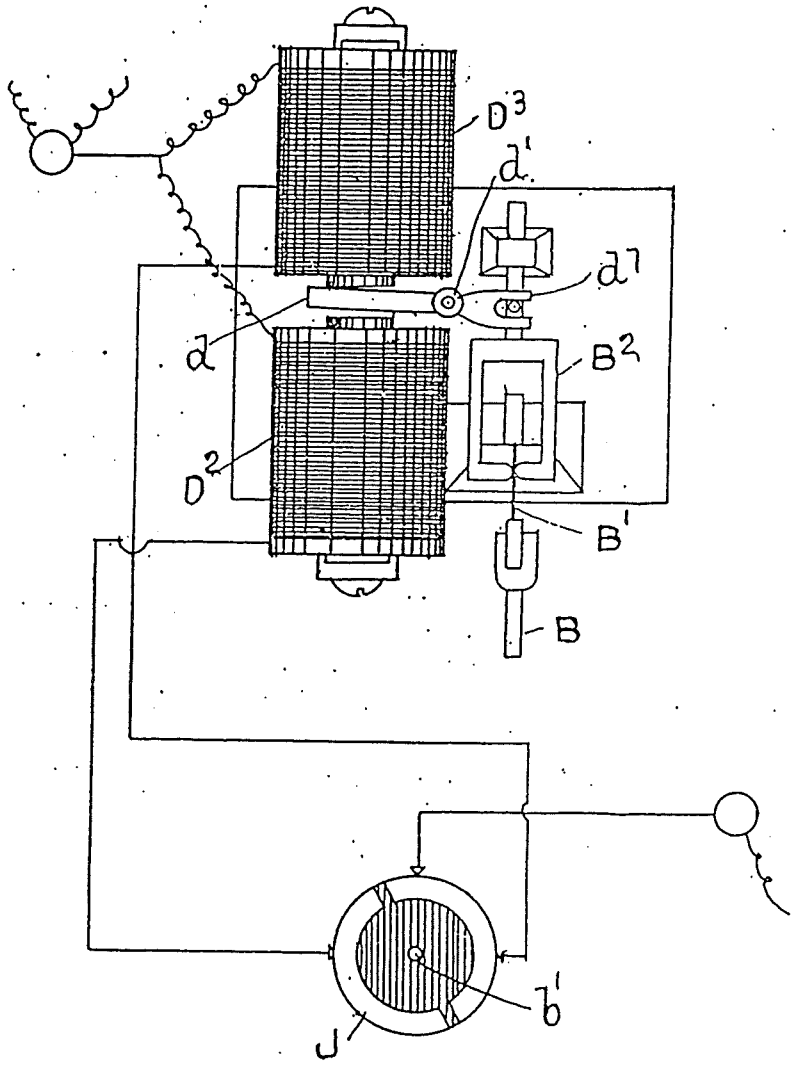


FIG. 16.



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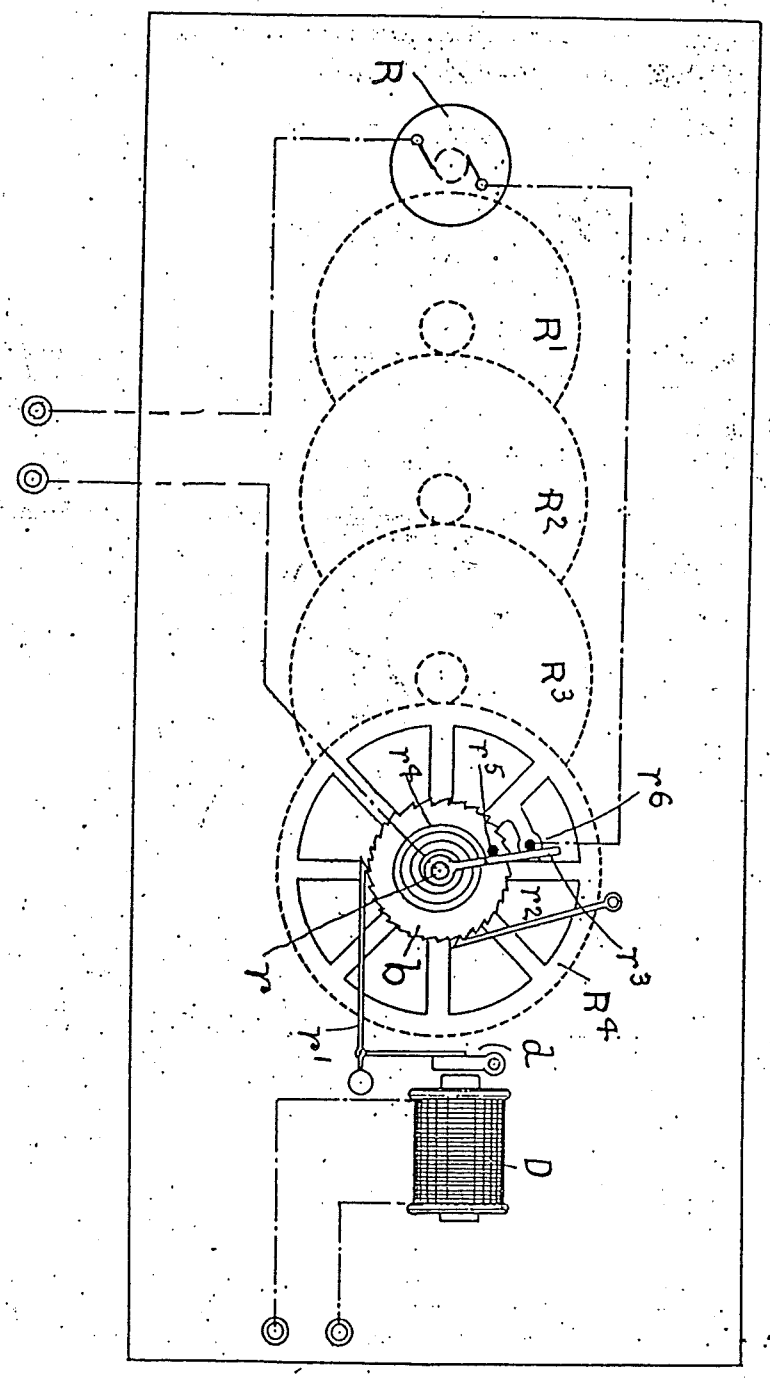

FIG. 17.

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