# PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION.

## Improvements in or relating to Electrical Time Transmitters.

I, FRANK HOPE-JONES, M.I.E.E., F.R.A.S., of 32 & 34, Clerkenwell Road, E.C.1, in the County of London, Electrical Engineer, British Subject, do hereby declare the nature of this invention to be as follows:—

This invention has for its object improvements in the methods of time counting and releasing the gravity lever in electric clocks of the type described in Patents Nos. 6066 of 1905, and 1945 of 1907, and modifications thereof now in general use.

In clocks of this type, which are known as electrical time transmitters, a count wheel is mechanically propelled or gathered by the pendulum usually picking up or pushing one tooth at each double swing and this wheel discharges a catch or latch which supports the gravity arm or enables the pendulum itself to discharge it by directing an arm against it usually once every half minute or minute.

The mechanical methods of performing these functions hitherto known and now in use are open to the following objections:—

The work of time counting and releasing takes a considerable amount of energy out of the pendulum which varies according to changing conditions of friction.

The wheel can only conveniently be propelled by the pendulum when swinging in the same direction, resulting in minimum steps of two seconds in the case of a seconds pendulum.

The count wheel cannot conveniently be mounted centrally with the pendulum.

These features present insurmountable obstacles to the provision of a dial indicating seconds mounted centrally in front of the pendulum in the upper part of the clock case.

This my invention constitutes a novel method of time counting and releasing which is free from these objections.

It substitutes for the mechanical methods of performing these two functions electro-magnetic means directly derived from the pendulum itself. The essence of the problem is to obtain from the pendulum electrical impulses at a point in the phase of its vibrations which shall be before it arrives at zero in each direction, this point being adjustable at will, and constant in the position when fixed; further that it shall be as nearly as possible frictionless, offering minimum interference with the pendulum, such interference being uniform.

According to this my invention, a magnetic or electro-magnetic couple is applied to the pendulum when swinging through its zero position, operating an electro-magnet adapted to release the gravity arm and also operating an electrical impulse dial movement or time counter which may conveniently be mounted on the head of the pendulum case. The release of the gravity arm could be effected at every vibration or every second in the case of a seconds pendulum, but this is undesirable, and therefore an electrical impulse dial movement is used to direct impulses to a releasing magnet at infrequent periodic intervals such as every 30 seconds.

In one form of the invention, a permanent magnet is mounted on the pendulum, adapted to pass in close proximity to a coil of insulated wire fixed in the middle of the case at or near the pendulum bob. The current induced in the coil operates a dial movement of any suitable kind. The dial movement is adapted to submerge 29 out of 30 current impulses, passing on the 30th only to the releasing magnet or alternatively it will operate the releasing magnet by contact and battery.

In another form of this my invention, a pair of contact springs is mounted upon a suitably insulated base and one or both of these springs carry armatures so disposed that a small permanent magnet attached to the pendulum swinging adjacent to them may deflect the springs into substantial contact one with the other without armatures and magnet actually touching each other. This arrangement can of course be reversed, the magnets being fixed and the contact springs mounted upon the pendulum.

A dial movement of any known kind operated by this contact, usually every second, may serve to make other contacts

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at longer intervals such as once every half-minute or minute. or to shunt one of the pendulum's contacts. at similar infrequent intervals, to operate an electro-magnet adapted to release the gravity arm which drives the pendulum.

In another form of this invention, the contact is in any known type of sealed tube containing mercury, lightly pivotted and provided with an armature adjacent to the magnet so that the passing of the pendulum will rock it or reverse its position through a point of unstable equilibrium at each swing thereby transmitting impulses for time-counting and releasing as above described.

It is an important feature of this my invention that the magnet and coil or armature shall be opposite one another when the pendulum is at zero, that being the point where interference is least harmful to time keeping and where the energy available is at its greatest, and so disposed that the release of the gravity lever of a clock of the type described in Patent No. 1945 of 1907 whether accomplished directly by a contact made by a dial movement or by the shunting of a pendulum made contact, shall be effected just before zero, so as to enable the impulse of the gravity lever to be imparted equally before and after zero. The precise point in the phase position of the pendulum at which the magnetic couple is effective is readily controlled by the width of the magnetic field in the line of motion. i.e., the lateral dimension of the poles of the magnet and/or the armature or coil and their position up or down the pendulum and it is a feature of this invention that this important matter is now capable of exact and easy adjustment, without affecting the fulfilment of the essential condition of concentration of the impulse at zero or uniformity of such interference as may be necessary on each side of zero.

Dated the 2nd day of September, 1930.

F. HOPE-JONES.

## COMPLETE SPECIFICATION.

## Improvements in or relating to Electrical Time Transmitters.

I, FRANK HOPE-JONES, M.I.E.E., F.R.A.S., of 32 & 34, Clerkenwell Road, E.C.1, in the County of London, Electrical Engineer, British Subject, 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:—

This invention has for its object improvements in the methods of time counting and releasing the gravity lever in electric clocks of the type described in Patents Nos. 6066 of 1905, and 1945 of 1907, and modifications thereof now in general use.

My invention refers to pendulum clocks of the type known as electrical time transmitters, wherein a count wheel is propelled or gathered under the control of a pendulum, under which control the count wheel is advanced one tooth at each double swing and this wheel discharges a catch or latch which supports the gravity arm or enables the pendulum itself to discharge it once every half minute or minute.

The methods of performing these functions hitherto known and now in use are open to the following objections:—

The gathering and releasing have been accomplished mechanically by the pendulum itself, and take a considerable amount of energy out of the pendulum which varies according to changing conditions of friction.

The wheel can only conveniently be propelled by the pendulum when swinging in the same direction, resulting in minimum steps of two seconds in the case of a seconds pendulum.

The count wheel cannot conveniently be mounted centrally with the pendulum.

These features present insurmountable obstacles to the provision of a dial indicating seconds mounted centrally in front of the pendulum in the upper part of the clock case.

A clock has previously been proposed, in Specification 5687, 1909, where a permanent magnet on the pendulum magnetically closes an electric switch for a circuit which effects the gathering tooth by tooth of a ratchet wheel; this wheel, once each rotation, releasing a gravity arm which thereupon closes an electric circuit for electro-magnetically giving an impulse to the pendulum.

In contra-distinction to this, my invention is concerned solely with that type of clock wherein the gravity arm, controlled by a count wheel, give a direct impulse to the pendulum.

This my invention constitutes a novel method of time counting and releasing which is free from the above objections.

It substitutes for the mechanical methods of performing these two functions electro-magnetic means directly derived from the pendulum itself. The essence of the problem is to obtain from the pendulum

electrical impulses at a point in the phase of its vibrations which shall be before it arrives at zero in each direction, this point being adjustable at will, and constant in the position when fixed; further, that it shall be as nearly as possible frictionless, offering minimum interference with the pendulum, such interference being uniform.

According to this my invention, a magnetic or electro-magnetic couple is applied to the pendulum when swinging through its zero position, operating an electro-magnet adapted to release the gravity arm and also operating an electrical impulse dial movement or time counter which may conveniently be mounted on the head of the pendulum case. An electrical impulse dial movement is used to direct impulses to a releasing magnet at infrequent periodic intervals such as every 30 seconds.

In one form of this my invention, a pair of contact springs is mounted upon a suitably insulated base and one or both of these springs carry armatures so disposed that a small permanent magnet attached to the pendulum swinging adjacent to them may deflect the springs into substantial contact one with the other without armatures and magnet actually touching each other. This arrangement can of course be reversed, the magnets being fixed and the contact springs mounted upon the pendulum.

A dial movement of any known kind operated by this contact, usually every second, may serve to make other contacts at longer intervals such as once every half-minute or minute, or to shunt one of the pendulum's contacts, at similar infrequent intervals, to operate an electro-magnet adapted to release the gravity arm which drives the pendulum.

In another form of this invention, the contact is in any known type of sealed tube containing mercury, lightly pivotted and provided with an armature adjacent to the magnet so that the passing of the pendulum will rock it or reverse its position through a point of unstable equilibrium at each swing thereby transmitting impulses for time counting and releasing as above described.

It is an important feature of this my invention that the magnet and armature shall be opposite one another when the pendulum is at zero, that being the point where interference is least harmful to time keeping and where the energy available is at its greatest, and so disposed that the release of the gravity lever of a clock of the type described in Patent No. 1945 of 1907 whether accomplished directly by a contact made by a dial movement or by the shunting of a pendulum made contact, shall be effected just before zero, so as to enable the impulse of the gravity lever to be imparted equally before and after zero. The precise point in the phase position of the pendulum at which the magnetic couple is effective is readily controlled by the width of the magnetic field in the line of motion, i.e., the lateral dimension of the poles of the magnet and/or the armature or coil and their position up or down the pendulum and it is a feature of this invention that this important matter is now capable of exact and easy adjustment, without affecting the fulfilment of the essential condition of concentration of the impulse at zero or uniformity of such interference as may be necessary on each side of zero.

Referring to the annexed drawings, in which like letters indicate like or equivalent parts, Fig. 1 is a general view in perspective of a method in which polarised mechanisms are operated by reversed impulses derived from a battery or other source of electrical current under the control of contacts made by a permanent magnet carried on the pendulum.

Fig. 2 is a perspective view of another method of time-counting and releasing, employing uni-directional impulses originating in a contact made by a permanent magnet carried by the pendulum.

Figs. 3 to 8 show alternative methods of constructing the electrical contact operated by the permanent magnet.

Referring now to Fig. 1, in which P is a pendulum beating half-seconds, suspended at $P^1$, swinging freely and touching nothing. It carries an impulse bracket J associated with the gravity lever G and electro-magnet T and vertical armature $A^1$ of the well-known method of impulse and remontoire, or any equivalent means of restoring the gravity lever G or re-energising the pendulum.

The pendulum also carries a permanent magnet M, the latter passing freely underneath two soft iron armatures B $B^1$, attached to leaf springs C $C^1$, mounted on the base of the clock case, and so disposed that when the permanent magnet M passes in its excursion in either direction, it will draw down the armatures B $B^1$, and springs C $C^1$, on to electrical contact studs $C^2$ $C^3$. Or the permanent magnet may be a fixture and the contact springs may be mounted upon the pendulum, the insulated leads being carried out at the top near the suspension spring.

In its normal position, gravity arm G is supported by step L on catch K pivoted at $F^1$. The catch K is also provided with other steps $L^1$ $L^2$ $L^3$, associated with an armature $A^2$, pivoted at $F^2$. Mounted on

the armature $A^2$ is a spring step Q which is always tending to move upwards in a vertical direction. Tail $Q^1$ is integral with Q and in normal position is forced under $P^3$ by spring W causing the working surface of catch Q to be in such a position that it will engage with step $L^2$.

A polarised dial movement of any known type is shown at D, provided with two independent electro-magnets E $E^1$, controlled by the contacts $C^1$ $C^3$ and C $C^2$. The magnets E $E^1$ rotate the wheel $N^1$ on which is located a pin $P^2$ one revolution every half-minute, through the medium of armature $A^3$ click $N^2$ and backstop $N^3$.

Pin $P^2$ on wheel $N^1$ closes the contacts S $S^1$ after the pendulum P has passed through its zero position from left to right. This zero position is midway between the contacts C $C^2$, $C^1$ $C^3$, consequently if the pendulum stops for any reason these contacts will remain open. The contact S $S^1$ remains closed until the pendulum has completed its excursion to the right and returned to its zero position on its swing to the left, with the result that the impulses caused by the closing of the contact C $C^2$ will be shunted through the release magnet H. The first of these two impulses will be submerged, the second impulse, viz., that resulting from the passage of the pendulum from left to right, will release the catch K.

The operation of the clock and the release of the catch K, as a result of a double impulse, may be described as follows:—

Assuming that the pendulum P has passed through zero position on its excursion to the right, and it is just about to complete the 29th second, the permanent magnet M closes contacts $C^1$ $C^3$, which permits a current to flow from battery, through lines $a^3$ $a^2$, electro-magnet E, returning to battery by $a^1$, thereby advancing wheel $N^1$ one tooth, and completing the 29th second, also bridging the contacts S $S^1$. The pendulum on its return excursion to the left again closes $C^1$ $C^3$, allowing another impulse to flow through $a^3$ $a^2$ and electro-magnet E, and returning to battery by $a^1$. This does nothing more than confirm that E received its impulse. The pendulum continuing through zero to the left closes contact C $C^2$, permitting a current to flow through $a^3$ $a^4$, electro-magnet $E^1$, returning to battery by $a^1$. This operates armature $A^3$ of movement D which sets click $N^2$ into the next tooth and waits for the next impulse to drive it forward, also as the contact S $S^1$ is already bridged, current will flow through lines $a^3$ $a^5$, release coil H, through $a^5$ and $a^1$ and back to battery. This parallel impulse through H effects the initial release of gravity arm G from L on to step $L^1$ of catch K, which has been operated by armature $A^2$ and part Q under the influence of coil H. $A^2$ is returned under the influence of spring W to its normal position with tail $Q^1$ of spring step Q under $P^3$ to await the next impulse. K cannot follow because G is now on step $L^1$.

The pendulum returning on its excursion to the right again closes C $C^2$, permitting another impulse to go through lines $a^3$ $a^4$, electro-magnet $E^1$ (confirming that $E^1$ has received an impulse). The contact C $C^2$ also closes the circuit $a^3$ $a^5$, releases coil H, continuing through $a^5$ $a^1$ back to battery, operating armature $A^2$ which effects the release of catch K by allowing catch Q to escape from $P^3$ and to fly up on to step $L^3$, thus moving K to the right, with the result that step $L^1$ allows G to fall on to pallet J. $A^2$ returning forces the tail $Q^1$ under $P^3$ placing working face of Q in correct position to receive step $L^2$ of catch K after G has been replaced by remontoire action of T G $A^1$. Step $L^2$ then comes to rest against face of catch Q under the action of spring $W^1$ so soon as G has risen above $L^1$ L, and by the time that the momentum in G has been expended, it finds L in its normal position to receive it; meanwhile the pendulum continuing its excursion through zero to the right operates contacts $C^1$ $C^3$, permitting a current to flow through lines $a^3$ $a^2$, electro-magnet E to battery via $a^1$, energising E which completes the 30th impulse in the cycle and advances wheel $N^1$, thus opening contacts S $S^1$.

Thus the functions of time counting and releasing are accomplished with the electrical efficiency always resulting from the use of polarised action; the precise point in the phase swing of the pendulum at which the gravity arm is released may be before zero and may be determined at will and if and when the pendulum stops from any cause, the contacts C $C^2$, $C^1$ $C^3$ will remain open.

Referring now to Fig. 2, in which P is a pendulum of seconds beat suspended at $P^1$, swinging freely and touching nothing. It carries an impulse bracket J, and a permanent magnet M, the latter passing freely underneath a soft iron armature B attached to a leaf spring C and so disposed that when the magnet passes through its central or zero position in its excursion in either direction, it will draw the armature B down and make an electrical contact at $C^2$. The impulses thus produced every second in the case of a pendulum beating seconds pass through the circuit $b$, $b^1$, $b^2$, $b^3$, and battery to the electro-magnet E of an electrical impulse

dial movement of any known type.

A gravity arm G, centred at F and provided with an impulse wheel or roller $R^1$ is normally held up on the catch K, which catch being an armature centred at $F^3$ is adapted to be withdrawn by the electro-magnet H.

The wheel $N^1$ of the electrical impulse dial is provided with 60 teeth. The arbor of this wheel carries a seconds hand which may operate as an inset circle on the clock's dial or as a "sweep" or centre-seconds, operating cencentric minute and hour hands also. The wheel $N^1$ also carries two pins $P^4$ and $P^2$. A pair of contact springs S $S^1$ is mounted on the base plate in such a position that one of the pins $P^2$ $P^4$ will close the circuit every half-minute as a result of which every 30th impulse resulting from the contact made by the permanent magnet will be shunted through the circuit $b^6$ $b^5$ to the releasing magnet H, $b^4$ $b^3$ $c^2$ and battery.

The gravity lever G then falls and delivers an impulse to the pendulum, and is immediately restored by the electro-magnet T through the medium of its armature $A^1$, according to the well-known method described in the above-mentioned Patents.

It will be observed that the impulse is imparted to the pendulum when it is passing from left to right. It may of course be reversed, but the release must always take place when the pendulum is moving in the same direction. In Fig. 2 the electro-magnetically operated contact $C^2$ B shown, is of that type which operates when the pendulum is swinging in either direction. It is therefore desirable to provide against the possibility of the time counting movement getting out of phase by one step and dropping the gravity arm G when the impulse bracket J is approaching the roller $R^1$ instead of receding from it. For this purpose a pin $P^5$ is fixed horizontally on the gravity arm G adapted to engage a spring $P^6$ mounted on the pendulum in the event of the gravity arm having been prematurely released and riding at a lower level. This completes the circuit $P^6$, $b^7$, $b^3$, $b^2$, $b^1$, $b^8$, $E^3$, G, $P^5$, and transmits an additional or extra impulse to the electro-magnet E of the time counting movement.

In clocks of this type, where the pendulum is driven by the fall of a gravity lever at widely spaced intervals of say half a minute, it has been customary to provide mechanical means for accelerating or retarding the groups of electrical impulse dials which are usually operated in that circuit controlled by the remontoire action of gravity arm G, armature $A^1$, and electro-magnet T, dials being inserted in the circuit in Fig. 2 shown by dotted line $b^8$. According to this my invention this acceleration or retardation is accomplished by electrical means solely as shown by the circuits in dotted lines emanating from the studs N.R.A. When the control lever is at N (Normal), the operations occur in the sequence and at the periodicity above described, but when the control lever is in circuit with the stud R, indicating Retard all the operative circuits are broken, unless it is desired to leave the master pendulum running, in which case the movement of the control lever to R is arranged to disconnect the series circuit of electrical impulse dials operated by the remontoire G $A^1$ T, leaving the other circuits operative. When the control lever is on the stud A, indicating Accelerate, the circuit normally open at S $S^1$ is closed through $b^1$, $b^9$, $b^4$, $b^3$, B, $C^2$, $b$ and back to battery, so that the magnet H may release catch K at every swing of the pendulum.

Referring now to Figs. 3 to 8, which show the construction of the contacts adapted to be operated by the permanent magnet carried by the pendulum. On the left of each of these Figures, the contact is shown in sectional elevation, whilst on the right appears a plan view showing how it is carried on the baseplate of the clock or of its case.

It is convenient to case these contacts in glass tubes which may be exhausted or filled with an inert gas and they are shown in the drawings in double lines designed for this purpose with interchangeable sockets which provide for the necessary electrical connections.

C is the contact spring customarily made of spring brass, carrying an armature B on its under side. $C^1$ is the contact point, usually made of platinum, and M is the permanent magnet, usually of horse-shoe form, carried by the pendulum.

The glass tubes are closed at the open end with a plug, which is a convenient medium for carrying the contact springs, and which may be a tight push-in fit into a socket made of ebonite or similar material, where it will engage with brass studs connected to the line wires.

In Fig. 3, the spring C banks against a stop Z in its upward position.

In Fig. 4, the spring C carrying the contact plate banks against the bent wire Z with point turned downwards, and spring $C^1$ banks against bent wire $Z^1$.

Fig. 5 is a plan, and Fig. 6 is an elevation of two armatures B, B, applied to springs $C^5$ $C^6$, on which are also mounted contact points C, C. These springs are

mounted on a common holder $C^4$. These springs move horizontally instead of vertically and are provided with insulated stop pins $P^7$ arranged centrally between them in such a manner that when the magnet M on the pendulum sweeps past them, they will be dragged sideways and when the pendulum stops it stops at zero, the contacts C, $C^1$ remain open, because the insulated stop pins $P^7$ meet and prevent contacts C $C^1$ from closing. This arrangement is desirable for the contact used in association with the clock described in Fig. 2 as otherwise if the pendulum were stopped from any cause whatever, the contact would remain closed when the pendulum came to rest at zero.

The forces exerted between a magnet and an armature being equal and opposite, it follows that the downwards pull of the armature involves an upwards pull of the magnet. This will have an accelerating effect upon the pendulum, which may be used with advantage in the compensation of circular error, but if these effects are not desired, the vertical components of the magnetic attraction may be neutralised by the arrangement shown in Fig. 7, in which two contact springs C $C^1$ are used, embraced by the poles of the permanent horse-shoe magnet M.

Fig. 8 is another example of the permanent magnet M embracing the contact. In this case, one armature only is used, and this is pivoted so that a rotary movement of small angle makes contact at C, $C^1$.

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

1. A pendulum clock of the type in which a count wheel is propelled or gathered one tooth at each double swing of the pendulum, and a gravity arm is released every half-minute to give a direct impulse to the pendulum, characterised by a permanent magnet attached to the pendulum and passing over or under an armature which is so mounted as to permit of its moving through a sufficient distance under the influence of the attraction of the magnet to make a reliable electrical contact but without touching the magnet.

2. A pendulum clock of the type herein before referred to, in which the counting of its vibrations is achieved by the momentary passage of a permanent magnet attached to the pendulum over or under an armature which is so mounted that the motion of the armature under the influence of the attraction will make a reliable electrical contact without touching the magnet, substantially as described in Figs. 1, 3, 4, 7 and 8.

3. A pendulum clock of the type herein before referred to, in which the counting of its vibrations is achieved by the momentary passage of a permanent magnet attached to the pendulum over or under an armature which is so mounted that the motion of the armature under the influence of the attraction will make a reliable electrical contact without touching the magnet, substantially as described in Figs. 2, 5 and 6.

4. A pendulum clock of the type herein before referred to, in which the counting of its vibrations is achieved in the manner described in the above Claims, and the counting mechanism operated thereby is so designed as to pass on the impulse required to unlock the maintenance or re-energise the pendulum at definite periods consisting of any even number of semi-vibrations.

5. A pendulum clock of the type herein before referred to, operated as described in the previous Claims in which means are provided for altering the semi-vibration in which the selected impulse is given to the next semi-vibration by means of a supplementary contact substantially as described in Fig. 2.

6. In a pendulum clock of the type herein before referred to operated as described in the previous Claims, means for the electrical advancing of a circuit of electrical impulse dials in half-minute impulses, or temporarily disconnecting them, substantially as described in Fig. 2.

7. An electric clock in which the contact is operated by a permanent magnet carried past it by a pendulum substantially as described and illustrated in Fig. 3.

8. An electric clock in which the contact is operated by a permanent magnet carried past it by a pendulum substantially as described and illustrated in Fig. 4.

9. An electric clock in which the contact is operated by a permanent magnet carried past it by a pendulum, so designed that it will not remain closed when the pendulum comes to rest in its central or zero position, substantially as described and illustrated in Figs. 5 and 6.

10. An electric clock in which the contact is operated by a permanent magnet carried past it by a pendulum substantially as described and illustrated in Fig. 7.

11. An electric clock in which the contact is operated by a permanent magnet carried past it by a pendulum substantially as described and illustrated in Fig. 8.

Dated the 1st day of July, 1931.

F. HOPE-JONES.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1932.

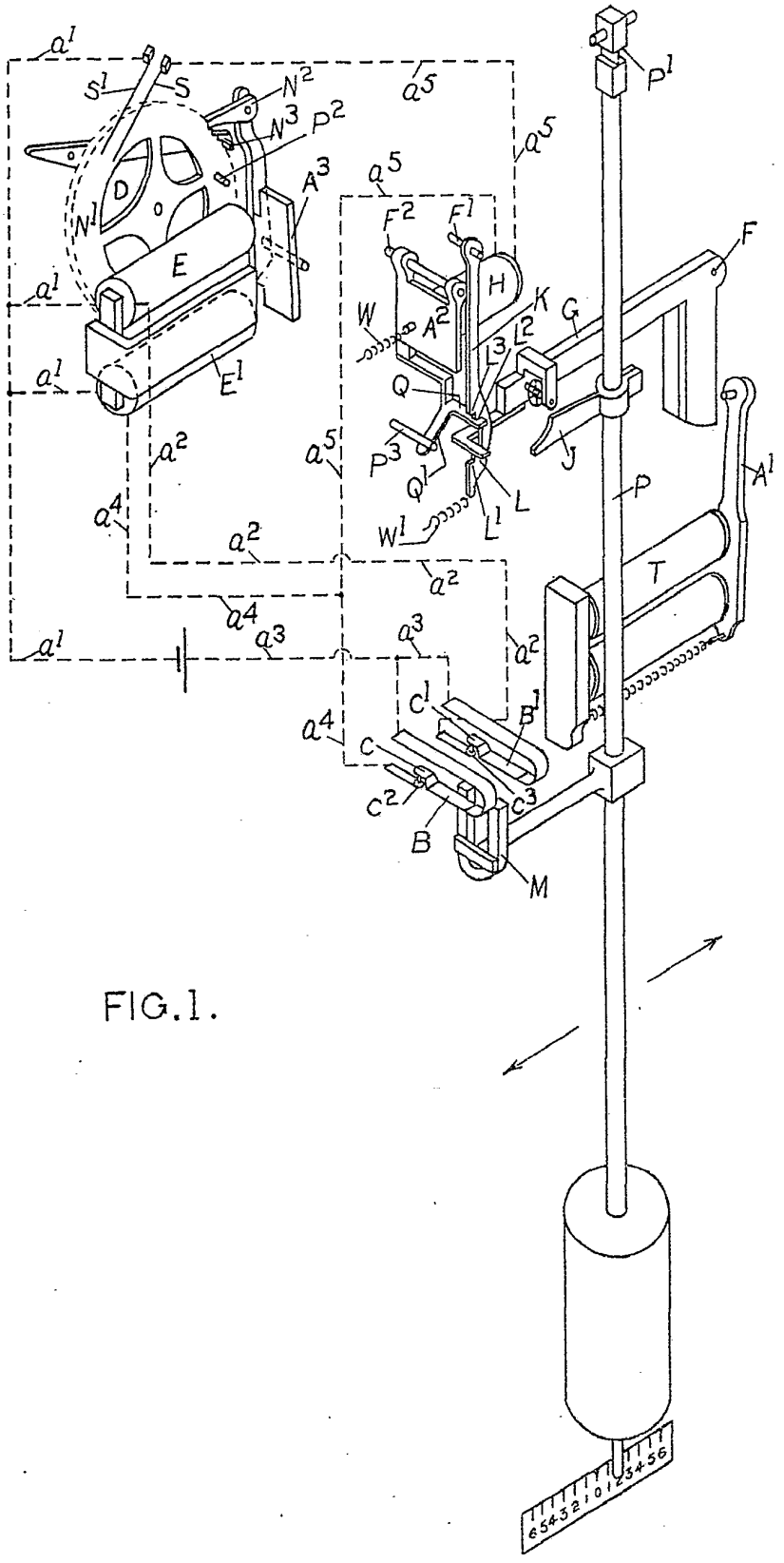



FIG. 1.

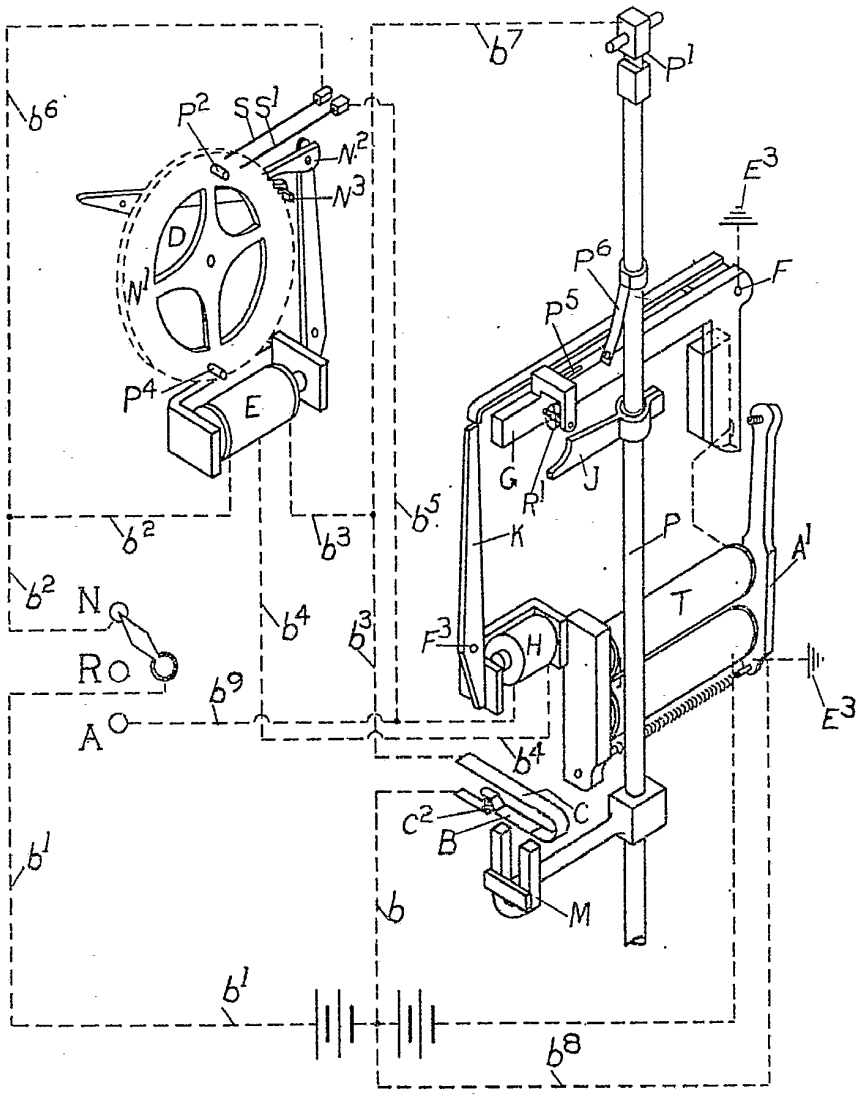
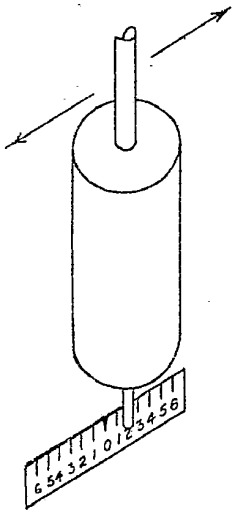



FIG.2.

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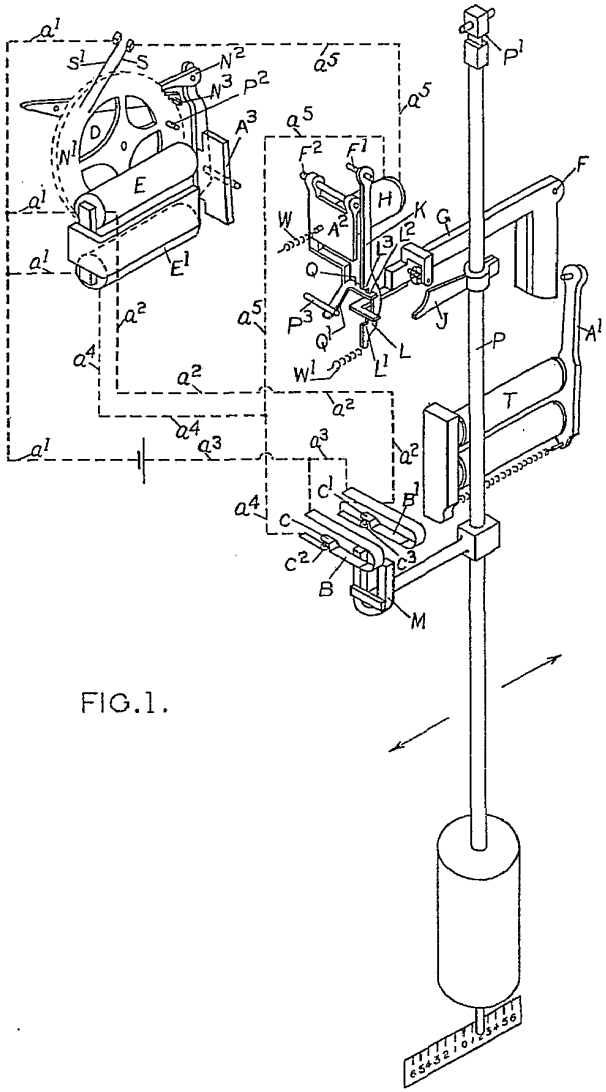

FIG.1.

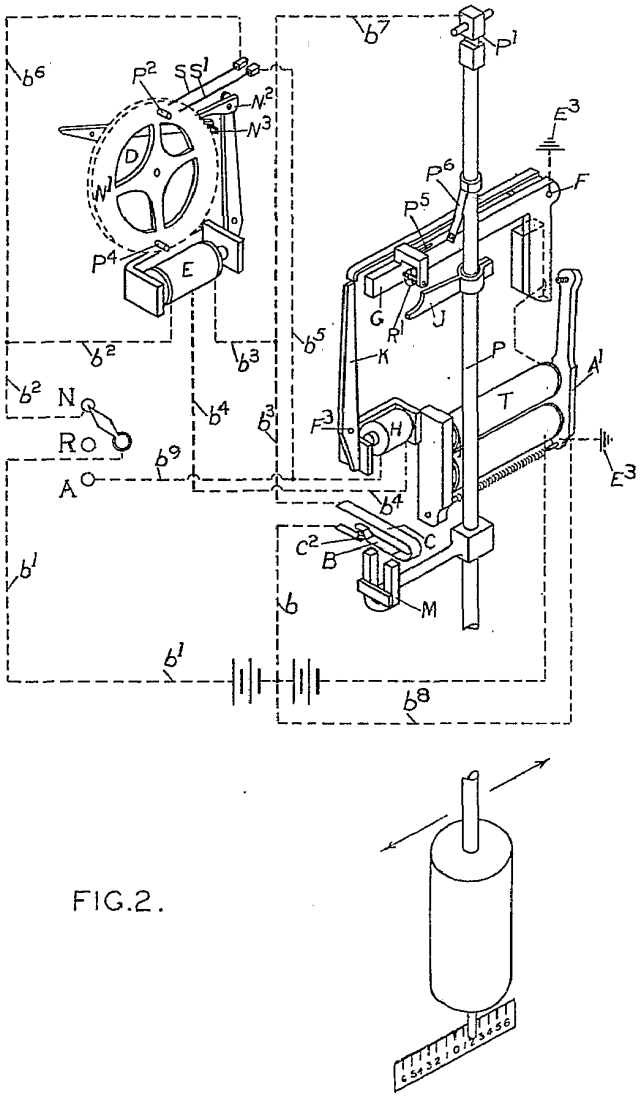

FIG.2.

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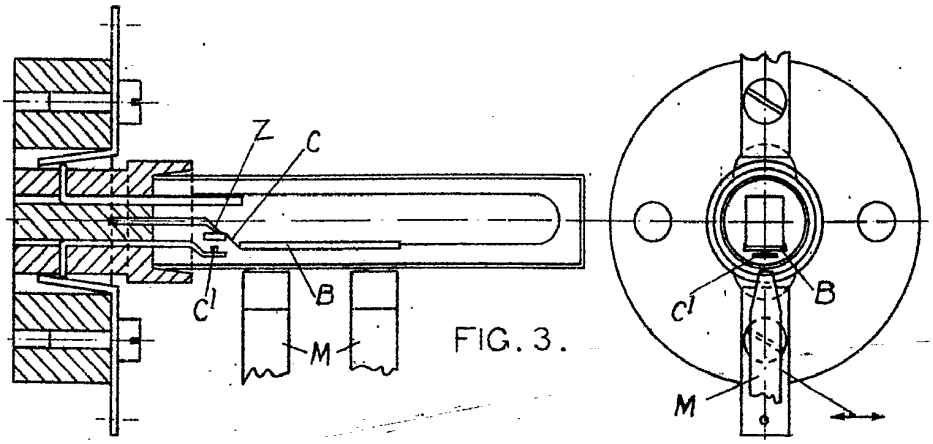


FIG. 3.

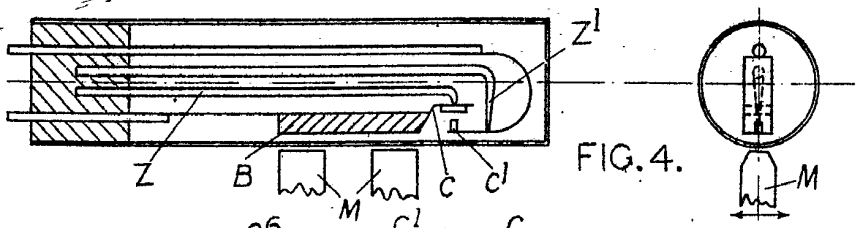


FIG. 4.

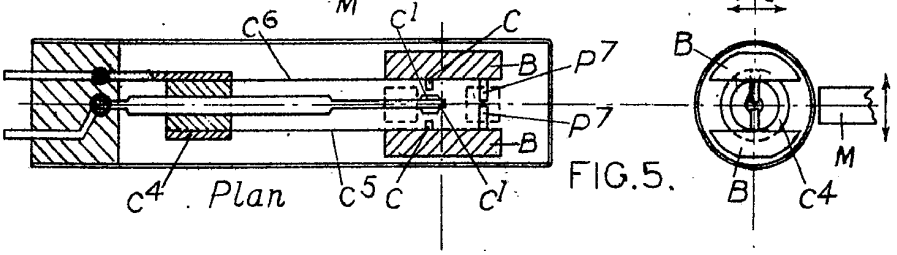


FIG. 5.

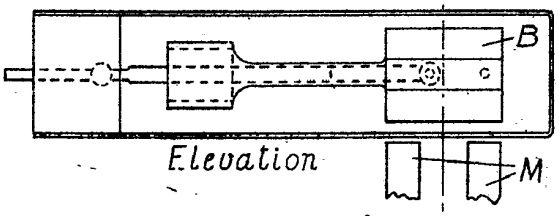


FIG. 6

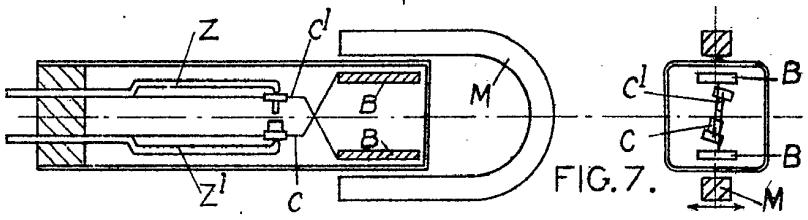


FIG. 7.

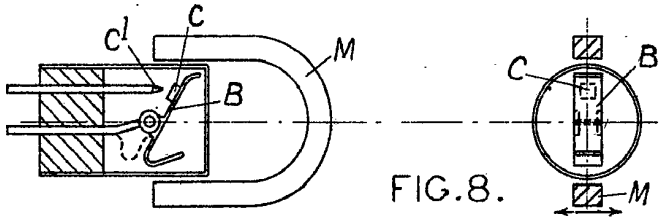


FIG. 8.

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