PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION

A Free Pendulum Clock

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

The subject of this my invention is a free pendulum, that is to say, a pendulum which is undisturbed and is free to perform its vibrations under the influence of gravity alone, and subject to no interference whatever, excepting only that caused by imparting to it small mechanical impulses at regular but widely spread intervals, such as once every half-minute, once every minute or at even longer intervals.

The free pendulum which is the subject of this invention is of the type in which the impulse is imparted to it by a falling or rotating lever which then synchronises a slave clock.

Every conception of a free pendulum hitherto has involved the use of two clocks, the free pendulum and a slave clock. The movement of the free pendulum clock has had two functions, firstly to raise or re-set the gravity lever after it has fallen in the act of impelling the pendulum or to store the necessary energy in some other form, and secondly the transmission of a synchronising signal,—usually electrical, to the slave clock. The duty of the slave clock has been to perform the escapement function for the free pendulum by releasing the gravity arm or lever at the right moment.

In this my invention, only the slave clock is required, since the first of the two above-mentioned functions of the free pendulum movement, the re-winding, is performed by the slave clock, and the second, the synchronising, is performed by direct mechanical operation of the slave clock's synchroniser by the fall of the gravity arm after it leaves the impelling pallet of the free pendulum.

The annexed drawings, in which like letters indicate like or equivalent parts, show one form of this my invention and some obvious variations in design and details of construction. They are intended to illustrate the essential features of the invention, without restriction to one particular method of carrying it into effect.

Fig. 1 shows the free pendulum on the right and the slave clock on the left, with motion work and dial removed.

Figs. 2 and 2A show the free pendulum on the left, the slave on the right, and gear-wheel teeth cut away to allow of the drop of the impulse lever.

Figs. 3 and 3A show the two pendulums arranged one immediately behind the other, and two levers, one for impelling the free pendulum and one for re-setting the former after it has done so.

Referring now to Fig. 1, the free pendulum of seconds beat F carries a shaped impulse bracket or an impulse wheel P. The slave clock consists of a half-seconds pendulum A with anchor B and a scape wheel C, the escapement being either recoil, as drawn, or of any known type, such as dead beat, half dead beat or chronometer detent, and may be driven by any known means such as spring or weight or by any known form of electro-magnetic remontoire such as for instance that described in Patent 1587 of 1895, in which case the time indication would be by means of electrical impulse dials.

A gravity arm or lever D is pivoted eccentrically at *d* on the scape wheel C and this gravity arm is in the same plane as the free pendulum and in such a position that when lying horizontally extended to its extreme limit on the right, its end can rest upon the impulse wheel or roller P mounted on the free pendulum when the latter is at or near its zero position and will run down the roller and impart an impulse to the pendulum when it is moving from left to right. A pin or stop K is fixed in the frame or base of the slave clock adapted to engage a shaped pallet on the underside of the lever D or a separate arm of the lever as in the drawing lettered G, the object of which is to receive the lever D G when it falls freely after having passed the vertical position. Having thus fallen against the stop K, the forward progression of the scape wheel C will withdraw the arm G from the stop K and finally permit the gravity arm D

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to rest immediately above the impulse wheel P and very close to it for a period of about half a second whilst the pendulum of the slave clock is passing from right to left and the scape wheel is at rest.

The free pendulum will then be moving through its zero position to the right and will then receive its impulse as a result of the next advancement of the scape wheel C, which will take place at the beginning of the next excursion of the pendulum A of the slave clock from left to right. The lever D, having completed its impulse to the free pendulum, will fall off it, and since the precise point of time at which this free fall of the lever D takes place is dictated by the free pendulum, it can be used as a synchronising signal. Any suitable method of synchronisation can be here employed. It need not necessarily be based upon the correction of a gaining or losing rate intentionally applied to the slave clock, but the type illustrated by way of example only, is that described in patent No. 187,814 and known as the "hit or miss" method.

In this type of synchroniser, the slave pendulum A is given a losing rate and carries a vertical synchronising blade S to engage with the horizontal catch L, pivotted at J and counterbalanced. The catch L is operated mechanically by the fall of the lever D through the medium of the passing spring H, and will engage the blade S if the slave pendulum A is slow. The lever D G will now be hanging pendant and free, but will be carried up on the left on its pivot d until the projecting arbor of the scape wheel C picks it up and carries it into the vertical position from whence it will fall over on to catch K.

Referring now to Fig. 2, in which the only part of the free pendulum shown is the impulse roller P on the left in its zero position, the slave clock takes the form of a dead beat escapement B C, with pendulum of any convenient length, provided its period is precisely divisible into the period of the free pendulum, whatever length that may be. Mounted rigidly on the scape wheel arbor is a gear wheel with some teeth cut away, corresponding with similar missing teeth in the gear wheel M engaging with it. The gravity lever D is rigidly mounted on the arbor of, and in front of, the gear wheel M, and is shown supported on the catch K, where it has been placed by wheel M. Catch K is disengaged at the appropriate moment by a pin N on the scape wheel C through the medium of the cranked lever n^1 centred at n^2, and the gravity lever D is free to give its impulse to roller P on the free pendulum, owing to the missing teeth, and to perform its synchronising function and to fall into the position shown in Fig. 2A, whence it will be carried round and lodged upon catch K in due course.

Referring now to Fig. 3, in which the free pendulum is represented by its impulse roller P placed immediately in front of the slave clock, the gravity lever D is pivotted on the baseplate of the slave clock at d^1 underneath and behind which is a re-setting lever Q pivotted at q, counterbalanced on the left, and provided with an arm engaging with a cam R on the scape wheel C adapted to replace the gravity arm D on the catch K after the latter has been released by a pin N on the scape wheel C.

Fig. 3A shows the gravity arm D after having imparted its impulse to the free pendulum roller and about to perform the synchronising function (not shown in this illustration). It also shows the lever Q about to fall off the cam R and to re-set lever D on to its catch K.

It will be observed that in this my invention, the pendulum is free from all disturbance except that involved in its reception of an impulse; that the act of comparison takes place when both pendulums are at or near zero; that the correction of the slave pendulum is effected when it is travelling out and home from and to zero, and that the operations may be accomplished electro-magnetically if desired.

Dated the 25th day of November, 1935.
FRANK HOPE-JONES.

COMPLETE SPECIFICATION

A Free Pendulum Clock

I, FRANK HOPE-JONES, M.I.E.E., F.R.A.S., of 32 & 34, Clerkenwell Road, 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:—

The subject of this my invention is a free pendulum, that is to say, a pendulum which is undisturbed and is free to perform its vibrations under the influence of gravity alone, and subject to no interference whatever, excepting only that caused by imparting to it small mechanical

impulses at regular but widely spaced intervals, such as once every half-minute, once every minute or at even longer intervals.

The free pendulum which is the subject of this invention is of the type in which the impulse is imparted to it by a falling or rotating lever which then synchronises a slave clock.

Every conception of a free pendulum hitherto has involved the use of a slave clock working with it. The free pendulum is impelled by a gravity lever which, after it has fallen in the act of giving an impulse to the pendulum transmits a synchronising signal—usually electrical, to the slave clock. The duty of the slave clock is to perform the escapement function for the free pendulum by releasing the gravity arm or lever at the right moment, usually by electrical means.

There has previously been proposed a combination of a timing pendulum, a gravity lever or impulse spring which gives an impulse to the timing pendulum once in each cycle, a driving pendulum maintained in oscillation by electro-magnetic impulses or a rotary electro-motor, which re-sets the gravity lever or spring after each impulse delivered to the timing pendulum and means whereby the electro-magnetic impulse circuit of the driving pendulum or motor is closed in each cycle at an instant determined by the movement of the timing pendulum and opened at an instant determined by the movement of the driving pendulum. But such a combination necessarily involves the use of a gravity arm engaged by the timing pendulum almost continuously and always at one end of every swing, and consequently it cannot be called a free pendulum.

In this my invention, only the slave clock is provided with a movement and it performs all the necessary functions mechanically. It releases the gravity lever, it receives synchronisation from it after it has impelled the pendulum and it replaces the gravity lever on its catch.

The only mechanically impelled free pendulum clock at present successfully introduced has an independent slave clock whose pendulum is virtually of the same length but is rated a little slow and is kept in synchronism with the free pendulum by a hit-and-miss synchroniser.

Since synchronisation of this kind demands (1) that the act of comparison shall take place when the pendulums are at zero, and (2) that the act of correction shall take place when the slave pendulum is travelling out and home from zero, it follows that the slave clock must release a gravity arm (to give the free pendulum an impulse) before zero, and that a time absorbing element has to be introduced to bring the operations into the phase necessary to fulfil the above conditions, by bridging the gap between the zero of the two pendulums.

This my invention depends upon the fact that, given two pendulums of different lengths, the shorter one may serve as a slave to the longer one (the free pendulum) providing the latter with occasional impulses, without the intermediary of any time absorbing device, yet fulfilling the phase requirements above mentioned.

The two pendulums may be of any length relatively to one another, provided that the occasions when they swing in identically the same phase are not too far apart for the repetition of the impulse frequently enough to maintain the free pendulum in oscillation.

It is to be observed that the greater the difference between the lengths of the two pendulums, the shorter will be the duration of the impulse which will be imparted to the free pendulum. The duration of the impulse is also to some extent under the control of the escapement selected to drive the slave clock.

When a Graham dead-beat escapement is used to drive the slave clock, the sequence of events is as follows, the free pendulum being located on the right and the slave on the left:—

The gravity arm having been raised and lodged immediately above the impulse wheel on a pin or projection by the slave clock the release of the next tooth of the escape wheel will cause it to draw the gravity arm off the pin or otherwise release it and drop it on to the impulse wheel of the free pendulum. At that moment the slave pendulum is approaching its zero from the right and the free pendulum is approaching its zero from the left. Whilst the latter (the free pendulum) is receiving its impulse, the slave pendulum will have reached its zero and gone beyond it, completing its swing to the left and will get back to its zero on its excursion to the right in time to meet the impulse lever when it has fallen off the impulse wheel on the free pendulum or the obstructive member of the hit-and-miss synchroniser depressed by it, correction (if called for) being effected immediately during the slave's pendulum's continued travel to the right out and home.

With a free pendulum of seconds beat, the duration of the impulse will be about half a second in the case of a half-seconds slave pendulum driven by a dead-beat escapement and it may be called upon to perform at any even number of seconds. In the case of a three-quarter seconds beat

slave with similar escapement, the duration of the impulse will be about three quarters of a second and it is capable of performing every six seconds if desired. With a slave pendulum of seven-eighths of a second beat the duration is seven-eighths of a second, and is capable of operating every fourteen seconds.

Thus the duration of the impulse is determined by the difference in the periods of the two pendulums, and the acts of comparison and correction fall into phase without any artificially applied time absorbing device.

The annexed drawings indicate like or equivalent parts by means of like letters and they are intended to illustrate the essential features of the invention without restriction to one particular method of carrying it into effect.

In the drawings accompanying the provisional specification:—

Fig. 1 shows the free pendulum on the right and the slave clock on the left, with motion work and dial removed.

Figs. 2 and 2A show the free pendulum on the left, the slave on the right, and gear-wheel teeth cut away to allow of the drop of the impulse lever.

Figs. 3 and 3A show the two pendulums arranged one immediately behind the other, and two levers, one for impelling the free pendulum and one for re-setting the former after it has done so.

The drawing accompanying the complete specification shows a similar arrangement in which both levers are reset by a Synchronome remontoire.

Referring now to Fig. 1, the free pendulum of seconds beat F carries a shaped impulse bracket or an impulse wheel P. The slave clock consists of a half-seconds pendulum A with anchor B and a scape wheel C, the escapement being either recoil, as drawn, or of any known type, such as dead beat, half dead beat or chronometer detent, and may be driven by any known means such as spring or the weight M^1 suspended on the cord N^1 from barrel O, or by a rotary electro-motor, or by any known form of electro-magnetic remontoire such as for instance that described in Specification 1587 of 1895, in which case the time indication would be by means of electrical impulse dials.

A gravity arm or lever D is pivoted eccentrically at *d* on the scape wheel C and this gravity arm is in the same plane as the free pendulum and in such a position that when lying horizontally extended to its extreme limit on the right, its end can rest upon the impulse wheel or roller P mounted on the free pendulum when the latter is at or near its zero position and will run down the roller and impart an impulse to the pendulum when it is moving from left to right. The slave clock is drawn having a scape wheel of 30 teeth and a half-seconds pendulum, this cycle of operations will be repeated once every half-minute. A pin or stop K is fixed in the frame or base of the slave clock adapted to engage a shaped pallet on the underside of the lever D or a separate arm of the lever as in the drawing lettered G, the object of which is to receive the lever D or its arm G when it falls freely after having passed its top vertical position. Having thus fallen against the stop K, it permits the gravity arm D to rest immediately above the impulse wheel P and very close to it for a period of about half a second whilst the pendulum of the slave clock is passing from right to left and the scape wheel is at rest.

The free pendulum will then be moving through its zero position to the right and the next forward progression of the scape wheel C of the slave clock will withdraw the arm G from the stop K and permit the lever D to fall upon the free pendulum which will then receive its impulse whilst continuing its motion to the right. The last mentioned advancement of the scape wheel C, took place near the beginning of the excursion of the pendulum A of the slave clock from left to right towards its zero. The lever D, having completed its impulse to the free pendulum, will fall off it, and since the precise point of time at which this free fall of the lever D takes place is dictated by the free pendulum, it can be used as a synchronising signal and is so used in this case by meeting the slave's pendulum on its arrival at zero. Any suitable method of synchronisation can be here employed. It need not necessarily be based upon the correction of a gaining or losing rate intentionally applied to the slave clock, but the type illustrated by way of example only, is that described in specification No. 187,814 and known as the "hit or miss" method.

In this type of synchroniser, the slave pendulum A is given a losing rate and carries a vertical synchronising blade S to engage with the horizontal catch L, pivoted at J and counterbalanced clockwise. The catch L is operated mechanically by the fall of the lever D through the medium of the passing spring H on the clatch L, and will engage the blade S if the slave pendulum A is slow. The lever D G will now be hanging pendant and free, but will be carried up on the left on its pivot *d* until the projecting arbor of the scape wheel C picks it up and carries it into the vertical position from whence it will fall over on to pin K.

Referring now to Fig. 2, in which the only part of the free pendulum shown is the impulse roller P on the left in its zero position, the slave clock takes the form of a dead beat escapement B C, with pendulum of any convenient length, provided its period is precisely divisible into the period of the free pendulum, whatever length that may be. Mounted rigidly on the scape wheel arbor is a gear wheel with some teeth cut away, corresponding with similar missing teeth in the gear wheel M engaging with it. The gravity lever D is rigidly mounted on the arbor of, and in front of, the gear wheel M, and is shown supported on the catch K where it has been placed by wheel M. Catch K is disengaged at the appropriate moment by a pin N on the scape wheel C through the medium of the cranked lever n^1 centred at n^2, and the gravity lever D is free to give its impulse to roller P on the free pendulum, owing to the missing teeth, and to perform its synchronising function and to fall into the position shown in Fig. 2A, whence it will be carried round and lodged upon catch K in due course.

Referring now to Fig. 3, in which the free pendulum is represented by its impulse roller P placed immediately in front of the slave clock, the gravity lever D is pivoted on the baseplate of the slave clock at d^1 underneath and behind which is a re-setting lever Q pivoted at q, counterbalanced on the left and provided with an arm engaging with a cam R on the scape wheel C adapted to replace the gravity arm D on the catch K after the latter has been released by a pin N on the scape wheel C.

Fig. 3A shows the gravity arm D after having imparted its impulse to the free pendulum roller and about to perform the synchronising function (not shown in this illustration). It also shows the lever Q about to fall off the cam R and to re-set lever D on to its catch K.

Referring now to the drawing accompanying the complete specification the slave clock is shown immediately behind the free pendulum as before, and a typical method of driving or "self-winding" it is shown in dashed lines. Its maintenance is provided by the gravity arm W pivoted at w^1 which drives the ratchet wheel U^1 through the medium of the pawl w^2 and is re-set by the armature A^1 and magnet M when in its fall it encounters the contact screw A^2 set in the end of the armature A^1, and thereby energises the magnet M.

On the same arbor as the ratchet wheel U^1 is mounted a gear wheel U engaging a pinion V^1 driving the escape wheel C through the medium of gear wheel V and pinion C^1. Thus the lever W will be thrown up on to the next tooth of the ratchet wheel by the electro-magnet M in the well-known manner commonly called the Synchronome Remontoire.

The progression of each tooth of the ratchet wheel will permit contact to take place at A^2 once every thirty seconds because the gearing of the wheels U and V to the escape wheel C of the half-seconds pendulum is so numbered that the period of rotation of the ratchet wheel U^1 is divisible into exact half-minutes.

The free pendulum F is again placed immediately in front of the slave clock and carries its impulse wheel P on a bracket. The gravity lever D is pivoted on the base plate at d^1 and carries behind its right hand end a step to engage catch K and a pin d^2 adapted to engage the strut K^2 which will be mentioned later. The gravity arm D also carries a pendant arm G adapted to operate the synchronising lever L centred at J. The gravity lever D is supported by catch K so that it normally rests immediately above the impulse wheel P and is free to be unlatched when the arm N on the escape wheel C deflects the lever n centred at n^1 and rigid with the catch K. Underneath and behind these is the resetting lever Q pivoted at q^1 and heavily counterbalanced at q^2. The catch or strut K^2 holds it in a horizontal position by engaging its tip at K^1 but when the gravity arm D falls and when it has given its impulse to the free pendulum and deflected the synchronising spring by means of its pendant arm G, the pin d^2 on the right hand end of D knocks out the strut K^2 and the counterbalance q^2 sinks and lifts D up again, lodging it upon its catch K. The resetting lever Q rotates about its pivot q^1 until its vertical arm q^3 rests upon a stop A^3 in the armature A^1 and remains there until the Synchronome Remontoire next has occasion to operate when the resetting lever Q will then be replaced and held horizontally by the strut K^2 which engages its left hand end K^1.

The action of the apparatus is as follows:—

The slave clock with half-seconds pendulum being driven by the weighted lever W, an arm N on the scape wheel engages the lever n and releases gravity lever D by means of catch K. The free pendulum F is then approaching its zero in its motion from left to right so D falls on the impulse wheel P and having fallen off it, the arm G depresses the synchroniser spring L so that it may hit or miss the spring S on the slave pendulum A and at the same time releases the catch K^1 and K^2 thus allowing the resetting lever Q to re-

place it on its own catch K. The Synchronome self-winding or Remontoire action may be set to take place at any time during the half-minute elapsing between the impulses imparted to the free pendulum. When this remontoire action occurs, the driving lever W and the resetting lever Q will be lifted and lowered respectively replaced, the former on the next tooth of the ratchet wheel U^1 and the latter under its catch K^2.

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 clock having two pendulums, one being a slave pendulum which controls both the time-indicating mechanism and a gravity lever, which latter on release gives an impulse to the second pendulum and then acts on mechanical means to synchronise the slave pendulum, and the second pendulum being an entirely free pendulum which controls the fall of the gravity lever and thereby controls the action of the synchroniser, the gravity lever being thereafter re-set automatically.

2. In a clock as claimed in claim 1, a falling gravity arm pivoted eccentrically on the scape wheel, lifted thereby, lodged on a fixed support and released at an appropriate moment, by the further rotation of the scape wheel substantially as described and illustrated with respect to Fig. 1 of the drawing accompanying the Provisional Specification.

3. A slave clock which impels a free pendulum by means of a falling lever periodically raised and released by the slave clock and which has gear wheels with missing teeth whereby the lever is dropped at precisely the right moment to impart the impulse to the free pendulum, and is replaced at each revolution of the scape wheel, said slave clock being held firmly in synchronisation with the free pendulum by the further fall of the impulse lever after it has impelled the free pendulum, and which further fall effects mechanical synchronisation substantially as described with reference to Figs. 2 and 2A of the drawing accompanying the Provisional Specification.

4. In a clock as claimed in any of the preceding Claims, a resetting lever adapted to replace the gravity lever as soon as it has fallen and a cam on the scape wheel which replaces said resetting lever at any convenient time between the impulses imparted to the free pendulum as described and illustrated with respect to Figs. 3 and 3A of the drawing accompanying the Provisional Specification.

5. In a clock as claimed in any of the preceding claims, a resetting lever adapted to replace the gravity lever as soon at it has fallen, combined with an electromagnetic remontoire which drives the clock and which also replaces said resetting lever at any convenient time between the impulses imparted to the free pendulum, as described and illustrated with respect to the figure of the drawing accompanying the Complete Specification.

Dated the 23rd day of November, 1936.
F. HOPE-JONES.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1937.

FIG.2.

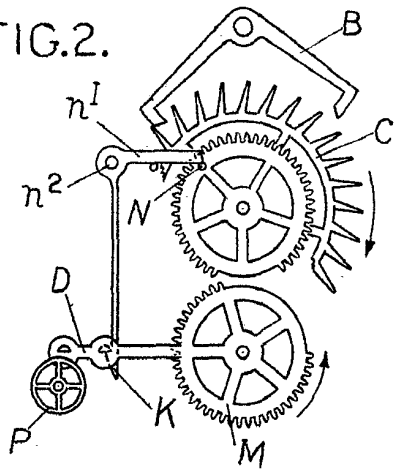


FIG.2A.

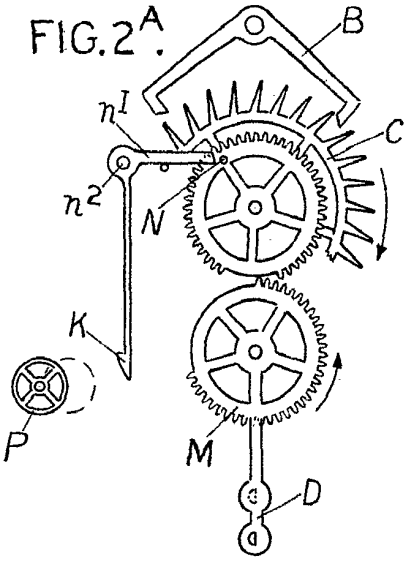


FIG.1.

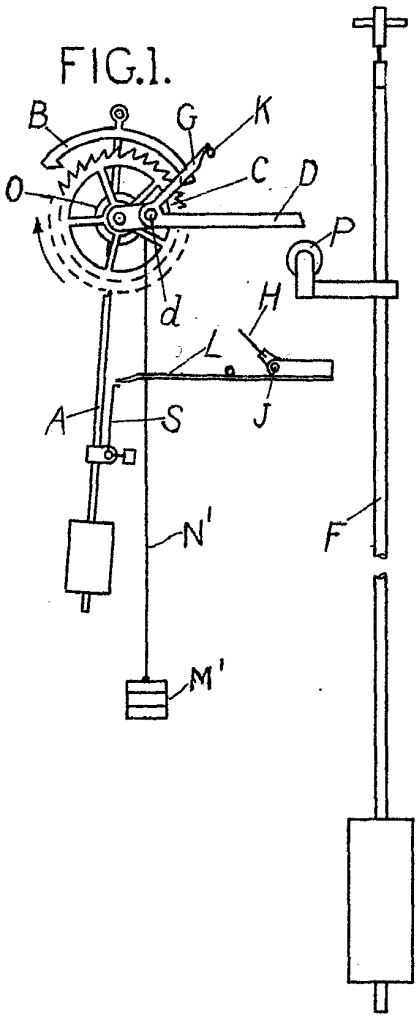


FIG.3.

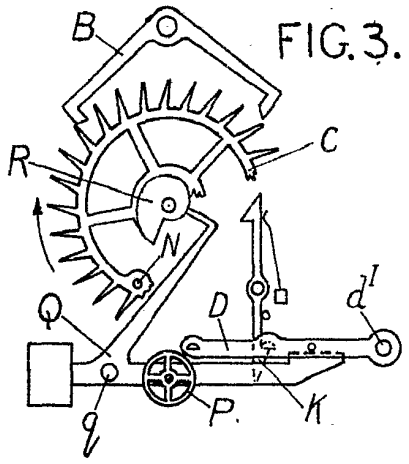
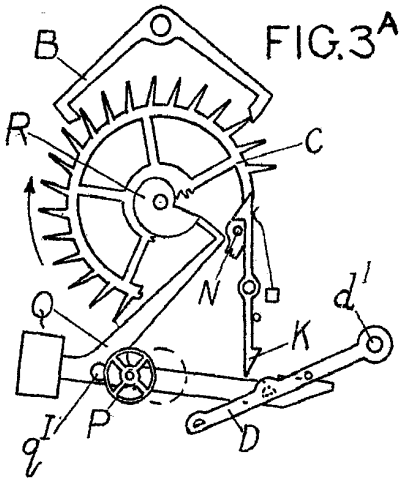


FIG.3A



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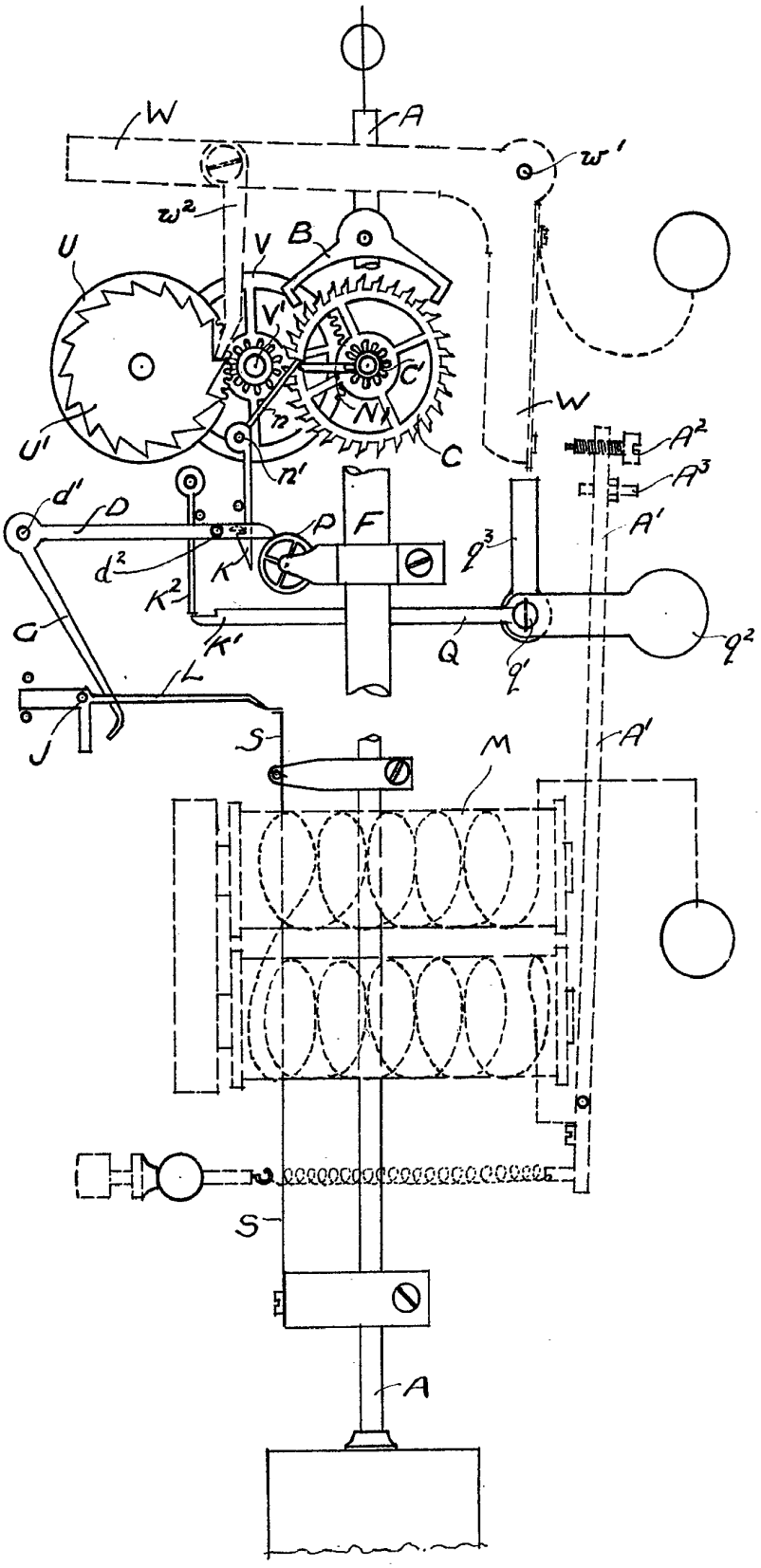

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