PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION.

Improvements in and relating to Electrical Step-by-step Mechanisms, as used for Propelling the Hands of Electrical Impulse Clocks.

We, ISAAC HARDY PARSONS, of the Croft, Kibworth Harcourt, near Leicester, Electrical Engineer, and ALFRED ERNEST JOSEPH BALL, of 212, East Park Road, Leicester, Clockmaker, do hereby declare the nature of this invention to be as follows:—

This invention relates to electrical step-by-step mechanisms, as used for propelling the hands of electrical impulse clocks, and has for object a mechanism which operates noiselessly, and which is, at the same time, suitable for working with a current impulse of short duration, such as that which is controlled by the voltage and self-induction of the circuit, and which is automatically terminated when the current value reaches a predetermined point.

In accordance with this invention we provide a mechanism in which the armature and propelment pawl or equivalent are free to retract and acquire a potential position with a current impulse of short duration, but in which the return or working movement of these parts is performed slowly so that the propelling means operate gently, and without concussion and noise.

On considering previous practice in connection with mechanisms designed with a view of obtaining noiseless working as referred to, (but which has failed to achieve the desired result), it is found that appreciable noise is produced in such mechanisms by what is known as "knock" or side-shake in the bearings of the moving parts on the direction of motion being changed or reversed, or on the tension on the bearings or pivots being released.

One object of this invention is to eliminate noise produced by "knock" by, for instance, arranging the magnetic tension on the armature pivots or bearings, and disposing the mechanical tension—as is produced by the weight of the armature for instance on such pivots or bearings, and in such relation to the magnetic pull and the potential position, so that on the sudden cessation of the magnetic attraction, there is no appreciable change in the direction of strain which would produce side movement, rebound, or spring in the bearings which would, in turn, produce "knock". With such mechanical "knock" eliminated there only remains the "magnetic click" of the molecules of the iron of the magnet and armature, and a slight metallic "ring" of the iron in the magnet circuit produced by the sudden release of the magnetic tension on same. These latter sounds are, however, of such low value as to be negligible, being inaudible in practice.

We may adapt known forms of magnets and armatures to obtain the herein-described working conditions, or we may employ the forms described below.

It is also found that in previous practice noise was produced by the driving pawl or equivalent coming into contact with the ratchet wheel or equivalent at too high a rate of speed, notwithstanding that "slowing down" means have been employed, with the result that concussion occurred on mechanical contact taking

place between the pawl and wheel or equivalent, and further noise was also produced on the moving parts coming to rest against a fixed limiting stop, and by the falling of the back stop click.

In accordance with this invention, we make the return movement and propelling action take place more slowly than heretofore, the return action occupying, say, from half a second to a full second or longer, with the result that the driving pawl engages a tooth of the ratchet wheel with a gentle action, thus avoiding concussion. Subsequent movement of the ratchet wheel and back stop click and the final rest of the moving parts is also effected gently and without noise.

In carrying this, our invention, into effect, and with reference to the electro-magnet and armature used in connection therewith, we employ types in which we can arrange that the magnetic tension be slightly biased towards one pole, and that the strongest attraction be in the direction of the gravity pull on the armature.

The armature may be mounted on springs to permit of the necessary movement, or it may be mounted on pivots. When pivots are employed, these may preferably take the form of knife-edges, the actual knife-edges of the bearings always being in the direction of gravity, and also at the same time in the direction of the greatest magnetic tension, the whole being arranged so that there is no tendency for the knife-edges to move off the bearings while operating.

An example of a magnet and armature of this latter form consists of an electro-magnet with its poles disposed at a suitable distance apart, and with an armature which is pivotted slightly excentrically, and disposed between the poles of the magnet, the arrangement being that the armature is attracted at its two ends, and in a direction which tends to turn the armature on its pivots, the disposition of the armature being such that its ends may swing past the poles of the electro-magnet with a reciprocal action.

We arrange that the weight of the armature together with any other normal strain, is in the same direction as the magnetic attraction at the moment of the cessation of the magnetic flux. The object to be held in view is that the knife-edges or other form of pivot be drawn toward their bearings, no motion or "shake" taking place other than the desired reciprocal turning motion.

In order to ensure the above results, we prefer to deliberately give the armature a slight magnetic bias in the direction of the normal strain produced by the gravity of the armature and its co-operating parts.

The feature of the arrangement we employ is that mechanical "knock", which occurs in a pronounced manner, for instance, in mechanisms with swinging armatures which are attracted on one side only, is eliminated. We operate our step-by-step mechanisms with the magnet and armature above described in the following manner:—

We provide a lever (which we term the operating lever) and secure same to the armature or its arbor, and we attach pivotally to the lever a light pawl. We dispose the ratchet wheel in a position in relation to the pawl, so that, on the latter being withdrawn from the wheel an indefinite distance, a padded limiting stop fixed to and moving with the operating lever prevents the said pawl from falling too far, and so engaging more than one tooth on the return stroke. We also provide a return limiting stop on the operating lever which is so disposed that it engages the ratchet wheel after a tooth has been moved forward.

As a further means of ensuring that one tooth only may be engaged, even with an indefinite but ample movement of the operating lever, we employ a ratchet wheel of small diameter, and with a comparatively low number of teeth, approximately 10, and, of say, 20 diametrical pitch. In lieu of a ratchet propellment, we may employ a cam action or other rotary propellment.

The motion of the herein described operating lever, driving pawl, and armature under attraction of the electro-magnet takes place noiselessly, due to the herein-described construction and disposition of the parts, and the absence of a rigid stop for the armature. The cessation of the action of the armature may in one form be, for instance, the natural one which takes place when the magnetic lines of force approximate the shortest path. Oscillation is prevented by the dash-pot mentioned below, which may also be employed to limit the movement of the armature.

An alternative form of magnet and armature which fulfils the requirements of this, our invention, may consist of an armature, spring supported and designed to move bodily into the magnetic field between the two magnet poles, the spring being in a line approximately with the lines of force through the armature, so that while the spring permits of some movement of the armature, its relative

position prevents the armature from being pulled into contact with one of the poles.

We arrange that the armature may pass between and past the poles, and we provide means for connecting the armature to the operating lever of the mechanism.

In lieu of mounting the armature on a spring, we may attach a rigid bar (or bars) to the armature, and provide knife-edge bearings at the extremity of the bar or bars. the said bars occupying the position which would otherwise be occupied by the spring. In lieu of knife-edges we may provide a short spring (or springs) at the extremity of the said bars.

In order that the return action of the operating lever may be performed noiselessly, we control, the rate of return movement of same by a dash-pot or equivalent, or other retarding device, which we construct so that it permits the armature to move freely and quickly to its potential position, but only permits of a slow movement in the opposite direction. While we state that a convenient rate of movement for the return to be effected is approximately from half a second to a full second, a much slower rate may be employed, but a rate slower than two seconds would interfere with the operations of advancing and setting to time when automatically performed by the transmitter or master clock.

Instead of arranging that the back stop click suddenly drops into position, we form the face which engages the perpendicular side of the tooth at a slight angle so that it glides into position at a rate controlled by the motion of the dash-pot. We may make the ratchet wheel of metal or of fibre, or other material softer than metal.

The dash-pot or retarding device may be of any suitable tvpe or design. In one form it may consist of a shallow receptacle, of comparatively large diameter, provided with a flexible diaphragm on its open side.

In this form we attach the diaphragm at the edges or rim of the receptacle in an airtight manner, and stiffen or support in a rigid manner a large portion of its centre so as to make same non-flexible, the object being to compel the centre of the diaphragm to move bodily, and thus control a larger quantity of air than it otherwise would. We may render the centre of the diaphragm non-flexible for this purpose by supporting it between two comparatively large washers.

We provide the shallow receptacle with a non-return valve, which admits the air quickly, say, on its outward movement, while on its return movement permits only a slow escape of air, the escape taking place either through the slight porosity of the diaphragm, or through a hole or holes provided for the purpose.

The diaphragm may consist of leather, rubber, gold-beaters skin, silk, or other flexible material. As an alternative we may use a dash-pot consisting of metal casing, into which slides a solid plunger of plumbago or other anti-friction material. To lessen any risk of sticking, the plunger may be a somewhat easy fit within the cylinder, and the freedom thus given may be employed to permit the slow escape of air in lieu of perforations.

With the plunger pattern of dash-pot, an air-cushion may be provided at the top of its stroke to prevent oscillation of the armature, and with the diaphragm pattern the full extension of the diaphragm may be utilised for the same purpose.

When employing leather for the flexible diaphragm of the dash-pot, we arrange the strength of the electro-magnet so that the minimum motion it imparts to the diaphragm during the worst working conditions is well above the requirements of the propellment action.

We may dispose the diaphragm horizontally so that its movement may be vertical, and we connect its rigid portion to the operating lever by means of a rod arranged approximately vertical, and connect its upper end to the operating lever by means of a pivotal or a spring connection. We may balance the operating lever and provide the vertical rod or the gripping washers of the diaphragm with the driving weight or spring, as by placing the weight or spring in this position instead of on the operating lever, we eliminate "knock" from the upper end of the vertical rod, which would otherwise take place, due to the change in the direction of strain.

It is obvious that any other form of retarding device which operates noiselessly may be employed in lieu of the devices herein described.

Dated this 4th day of June, 1919.

I. HARDY PARSONS.
ALFRED E. J. BALL.

COMPLETE SPECIFICATION.

Improvements in and relating to Electrical Step-by-step Mechanisms as used for Propelling the Hands of Electrical Impulse Clocks.

We, ISAAC HARDY PARSONS, of the Croft, Kibworth Harcourt, near Leicester, Electrical Engineer, and ALFRED ERNEST JOSEPH BALL, of 212, East Park Road, Leicester, Clockmaker, 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 relates to electrical step-by-step mechanisms, as used for propelling the hands of electrical impulse clocks, and has for object a mechanism which operates noiselessly, and which is, at the same time, suitable for working with a current impulse of short duration, such as that which is controlled by the voltage and self-induction of the circuit, and which is automatically terminated when the current value reaches a predetermined point.

In accordance with this invention we provide a mechanism in which the armature and propelment pawl or equivalent are free to retract and acquire a potential position with a current impulse of short duration, but in which the return or working movement of these parts is performed slowly so that the propelling means operate gently, and without concussion and noise.

On considering previous practice in connection with mechanisms designed with a view of obtaining noiseless working as referred to, (but which has failed to achieve the desired result), it is found that appreciable noise is produced in such mechanisms by what is known as "knock" or side-shake in the bearings of the moving parts on the direction of motion being changed or reversed, or on the tension on the bearings or pivots being released.

One object of this invention is to eliminate noise produced by "knock" by, for instance, arranging the magnetic tension on the armature pivots or bearings, and disposing the mechanical tension—as is produced by the weight of the armature for instance on such pivots or bearings, and in such relation to the magnetic pull and the potential position, so that on the sudden cessation of the magnetic attraction, there is no appreciable change in the direction of strain which would produce side movement, rebound, or spring in the bearings which would, in turn, produce "knock". With such mechanical "knock" eliminated there only remains the "magnetic click" of the molecules of the iron of the magnet and armature, and a slight metallic "ring" of the iron in the magnet circuit produced by the sudden release of the magnetic tension on same. These latter sounds are, however, of such low value as to be negligible, being inaudible in practice.

We may employ special forms of magnets and armatures to obtain the herein described working conditions, or adapt known forms to our requirements.

It is also found that in previous practice noise was produced by the driving pawl or equivalent coming into contact with the ratchet wheel or equivalent at too high a rate of speed, notwithstanding that "slowing down" means have been employed, with the result that concussion occurred on mechanical contact taking place between the pawl and wheel or equivalent, and further noise was also produced on the moving parts coming to rest against a fixed limiting stop, and by the falling of the back stop click.

In accordance with this invention, we make the return movement and propelling action take place more slowly than heretofore, the return action occupying, say, from half a second to a full second or longer, with the result that the driving pawl engages a tooth of the ratchet wheel with a gentle action, thus avoiding concussion. Subsequent movement of the ratchet wheel and back stop click and the final rest of the moving parts is also effected gently and without noise.

In carrying this, our invention, into effect, and with reference to the electromagnet and armature used in connection therewith, we employ types in which we can arrange that the magnetic tension be slightly biased towards one pole, and that the strongest attraction be in the direction of the gravity pull on the armature.

The armature may be mounted on springs to permit of the necessary movement, or it may be mounted on pivots.

When pivots are employed, these may preferably take the form of knife-edges, the actual knife-edges of the bearings always being in the direction of gravity, and also at the same time in the direction of the greatest magnetic tension, the whole being arranged so that there is no tendency for the knife-edges to move off the bearings while operating.

An example of a magnet and armature of this latter form consists of an electro-magnet with its poles disposed at a suitable distance apart, and with an armature which is pivotted slightly excentrically, and disposed between the poles of the magnet, the arrangement being that the armature is attracted at its two ends, and in a direction which tends to turn the armature on its pivots, the disposition of the armature being such that its ends may swing past the poles of the electro-magnet with a reciprocal action.

We arrange that the weight of the armature together with any other normal strain, is in the same direction as the magnetic attraction at the moment of the cessation of the magnetic flux. The object to be held in view is that the knife-edges or other form of pivot be drawn toward their bearings, no motion or "shake" taking place other than the desired reciprocal turning motion.

In order to ensure the above results, we prefer to deliberately give the armature a slight magnetic bias in the direction of the normal strain produced by the gravity of the armature and its co-operating parts.

The feature of the arrangement we employ is that mechanical "knock", which occurs in a pronounced manner, for instance, in mechanisms with swinging armatures which are attracted on one side only, is eliminated. We operate our step-by-step mechanisms with the magnet and armature above described in the following manner:—

We provide a lever (which we term the operating lever) and secure same to the armature or its arbor, and we attach pivotally to the lever a light pawl. We dispose the ratchet wheel in a position in relation to the pawl, so that, on the latter being withdrawn from the wheel an indefinite distance, a padded limiting stop fixed to and moving with the operating lever prevents the said pawl from falling too far, and so engaging more than one tooth on the return stroke. We also provide a return limiting stop on the operating lever which is so disposed that it engages the ratchet wheel after a tooth has been moved forward.

As a further means of ensuring that one tooth only may be engaged, even with an indefinite but ample movement of the operating lever, we employ a ratchet wheel of small diameter, and with a comparatively low number of teeth, approximately 10, and, say, half an inch in diameter. In lieu of a ratchet propelment, we may employ a cam action or other rotary propelment.

The motion of the herein described operating lever, driving pawl, and armature under attraction of the electro-magnet takes place noiselessly, due to the herein-described construction and disposition of the parts, and the absence of a rigid stop for the armature. The cessation of the action of the armature may in one form be, for instance, the natural one which takes place when the magnetic lines of force approximate the shortest path. Oscillation is prevented by the dash-pot mentioned below, which may also be employed to limit the movement of the armature.

An alternative form of magnet and armature which fulfils the requirements of this, our invention, may consist of an armature, spring supported and designed to move bodily into the magnetic field between the two magnet poles, the spring being in a line approximately with the lines of force through the armature, so that while the spring permits of some movement of the armature, its relative position prevents the armature from being pulled into contact with one of the poles.

We arrange that the armature may pass between and past the poles, and we provide means for connecting the armature to the operating lever of the mechanism.

In lieu of mounting the armature on a spring, we may attach a rigid bar (or bars) to the armature, and provide knife-edge bearings at the extremity of the bar or bars, the said bars occupying the position which would otherwise be occupied by the spring. In lieu of knife-edges we may provide a short spring (or springs) at the extremity of the said bars.

In order that the return action of the operating lever may be performed noiselessly, we control, the rate of return movement of same by a dash-pot or equivalent device functioning in a similar manner, which we construct so that it permits the armature to move freely and quickly to its potential position, but only permits of a slow movement in the opposite direction. While we state that a convenient rate of movement for the return to be effected is approximately from half a second to a full second, a

much slower rate may be employed, but a rate slower than two seconds would interfere with the operations of advancing and setting to time when automatically performed by the transmitter or master clock.

Instead of arranging that the back stop click suddenly drops into position, we form the face which engages the perpendicular side of the tooth at a slight angle so that it glides into position at a rate controlled by the motion of the dash-pot. We may make the ratchet wheel of metal or of fibre, or other material softer than metal.

The dash-pot or retarding device may be of any suitable type or design. In one form it may consist of a shallow receptable, of comparatively large diameter, provided with a flexible diaphragm on its open side.

In this form we attach the diaphragm at the edges or rim of the receptacle in an airtight manner, and stiffen or support in a rigid manner a large portion of its centre so as to make same non-flexible, the object being to compel the centre of the diaphragm to move bodily, and thus control a larger quantity of air than it otherwise would. We may render the centre of the diaphragm non-flexible for this purpose by supporting it between two comparatively large washers.

We provide the shallow receptacle with a non-return valve, which admits the air quickly, say, on its outward movement, while on its return movement permits only a slow escape of air, the escape taking place either through the slight porosity of the diaphragm, or through a hole or holes provided for the purpose.

The diaphragm may consist of leather, rubber, gold-beaters skin, silk, or other flexible material. As an alternative we may use a dash-pot consisting of metal casing, into which slides a solid plunger of plumbago or other anti-friction material. To lessen any risk of sticking, the plunger may be a somewhat easy fit within the cylinder, and the freedom thus given may be employed to permit the slow escape of air in lieu of perforations.

With the plunger pattern of dash-pot, an air-cushion may be provided at the top of its stroke to prevent oscillation of the armature, and with the diaphragm pattern the full extension of the diaphragm may be utilised for the same purpose.

When employing leather for the flexible diaphragm of the dash-pot, we arrange the strength of the electro-magnet so that the minimum motion it imparts to the diaphragm during the worst working conditions is well above the requirements of the propelment action.

We may dispose the diaphragm horizontally so that its movement may be vertical, and we connect its rigid portion to the operating lever by means of a rod arranged approximately vertical, and connect its upper end to the operating lever by means of a pivotal or a spring connection. We may balance the operating lever and provide the vertical rod or the gripping washers of the diaphragm with the driving weight or spring, as by placing the weight or spring in this position instead of on the operating lever, we eliminate "knock" from the upper end of the vertical rod, which would otherwise take place, due to the change in the direction of strain.

It is obvious that any other form of retarding device which operates noiselessly may be employed in lieu of the devices herein described.

Referring to the annexed drawings in which like letters indicate like or equivalent parts:—

Fig. 1 shows diagramatically the complete mechanism omitting the base or frame and 12—1 hand gear.

Figs. 2 & 3 show details of the driving pawl.

Fig. 4 shows in detail a form of knife-edge bearing for the armature.

Figs. 5 & 6 show alternative forms of magnets, the former being shown spring mounted, and the latter pivotted.

Fig. 7 shows an alternative form of dash pot with a flexible diaphragm.

Fig. 8 shows a form with a plumbago plunger.

Fig. 9 shows a complete mechanism in compact form.

Fig. 10 shows an alternative form of propelment.

Referring to Fig. 1 which shows diagrammatically a mechanism with the frame and 12—1 gear omitted for the sake of clearness, A shows the armature which is pivotted approximately centrally at A^1, and which also carries the operating lever D on its arbor.

B & B^1 show the electro-magnet, and B^2 and B^3 its poles which are partly cut away at their ends to correspond with the movement of the armature, the clearance or air gap being greater between the top end of the latter at A^2 and the pole B^2 than at the parts A^3 and B^3.

E shows a light wire pawl which may be of steel or phosphor bronze which is pivotted in the U-shaped end of the lever D which is shown in fragmental drawing

Fig. 2 which shows the parts in plan and the padded stop E^1, against which the weighted extension E^2 of the driving pawl E rests when the lever is raised to its potential position. In Fig. 1 a part of the extension E^2 is shown, but underneath the stop E^1 to limit the motion of the pawl E.

Referring to Fig. 3 which is also a fragmental drawing showing detail of the pawl E and adjacent parts, E^3 shows a different form of an extension of the pawl E. In conjunction with this form, we may provide a shaped guard as shown at E^4 which engages the pawl E at the point E^3 and so compels it to fall and engage the next tooth of the ratchet wheel F.

With further reference to Fig. 1 the back stop click F^4 has its acting end F^5 preferably formed at an angle which prevents the end of same from dropping into engagement with the next tooth with a sudden motion. The ratchet wheel F, and the stop D^5 are preferably made of fibre or other material slightly softer than metal, so as to prevent the slight noise produced by contact, or the stop D^5 may be faced with soft material.

The dash-pot H is connected to the operating lever D by the perpendicular rod H^4 which is jointed to the operating lever by means of a block D^2 preferably of fibre and a shouldered screw D^2 or by other pivotal means.

The operating lever is preferably counter-balanced at D^1 and the whole of the power necessary to operate the mechanism is preferably applied to the rod. By this arrangement the "shake" at the joint D^2—D^3 is always kept in one direction during both the retractive and operative strokes of the lever D and the noise known as "knock" consequently eliminated.

In the form shown in this figure, the necessary weight to furnish the driving power is provided by the thick disc H^3 which is made heavy for the purpose.

The mechanism operates as follows:—On the magnet B B^1 being energised by the periodic impulse of short duration, the armature A is attracted in line with the poles B^2 and B^3 and the lever D which is fixed to the same arbor as the armature, is consequently retracted to its potential position, the dash-pot H permitting of a quick movement in the upward direction by the lifting of the non-return valve H^7 which then permits air to flow quickly through the large orifice, H^6 in the base. In the meantime the pawl E acquires the position shown in Fig. 3, the extension E^2 resting on the stop E^1.

The armature A and the lever D is prevented from oscillating by the closing of the non-return valve, and the dash-pot then permits only of a slow return of the parts to their normal position.

The dash-pot is secured to the base or frame of the mechanism by means of the bracket H^8 and the flexible diaphragm is held in position on the body or base of the dash-pot by the band H^5 which is provided with over-lapping ends, the band being drawn tightly in position by a comparatively long screw engaging suitable projections on the band.

The central portion of the flexible diaphragm is rendered non-flexible by means of the two large discs H^2 and H^3, the diaphragm being gripped between these discs by means of the threaded end of the rod H^4 and the nut H^9. The leather flap H^7 forming the non-return valve is screwed to the base by a washer H^{11} and countersunk screw H^{10}, and a light weight is usually provided at H^{12} to assist in closing the valve. The gear ratio between the pinion F^2 and wheel G is such that the latter rotates once per hour and usually carries the minute hand, the hour hand being driven through 12 to 1 reduction gear not shown.

Referring to Fig. 4, A shows the armature, D the operating lever, D^1 the counter weight of the lever, and A^1 one of the pivots of the armature which is shown as a knife-edge. C shows a fragmental part of the frame, in which a knife-edge pivot is fulcrumed in a suitably shaped bearing hole. The lever is so shaped that the pivot, when off its seat, cannot move sufficiently far to displace the relative positions of the mechanism. The back pivot may also be of knife-edge form or of circular form.

Referring to Figures 5 and 5^A, these figures show an armature mounted on a spring in lieu of pivots. A shows the armature which moves bodily between the poles B^2 and B^3 on the magnet being energised.

A^1 shows the spring which has an upward bias supporting the armature and the operating lever, the bias being overcome by the dashpot weight, the remainder of the mechanism being generally as shown in Fig. 1 and as referred to under that figure. The use of the spring as shown also prevents motion and consequent "knock" at the fulcrum, and therefore, conduces to silent working.

To reduce "twist" we may use two springs side by side but arranged some little distance apart.

Referring to Fig. 6 which shows a form

of mechanism in which the armature also moves bodily between the poles of a magnet, D shows the operating lever which is pivotted at A^1.

A shows the armature which is rigidly fixed to an extension D^1 of the operating lever D. On the magnet B—B^1 being energised the armature is drawn between the poles and the operating lever consequently lifted. The air gap between the armature end A^3 and the pole B^3 is deliberately made less than the air gap between the armature end A^2 and the pole B^2 so that the pivot or knife-edge A^1 is held firmly to its seat or bearing (not shown) so that the "knock" or "shake" is prevented. The remaining parts of the mechanism in the figure are generally as described in reference to Figure 1.

Referring to Fig. 7 which shows an alternative form of dashpot, H shows a base or body without the rim shown in Fig. 1. The base consists of a flat but comparatively thick disc to the edge of which is secured the flexible diaphragm, the diaphragm being previously pressed to a cup like form to facilitate its use in this manner. The weighted disc H^3 is in practice first screwed tightly against the diaphragm H^1 so that the latter is firmly held between the former and the disc H^2. The purpose of the gap in this drawing and in Fig. 1 is to prevent a confusion of lines and to better illustrate the ends of the rods H^4. The unequal diameter of the two discs shown in the two figures has the advantage of distributing the wear on the diaphragm and also facilitates the rapid movement of the diaphragm in the upward direction and retards the return of the diaphragm during the downward stroke, this latter action being due to the larger and uppermost disc controlling the greater diameter of the diaphragm.

Referring to Figure 8 which shows a dashpot of the plunger type, H shows a casing of metal and H^1 a plunger or piston preferably of plumbago but may be of metal. H^3 shows a block of metal which acts partly as a weight and which secures the plunger to the lower end of the rod H^4 while H^9 shows a nut which secures the plunger at its upper end to the said rod. H^7 shows the non-return valve. While this latter is shown as a ball it may take any known form. H^6 shows the orifice for the admission of air. A leak-hole may be provided but in practice the slight air space round the plunger usually suffices to permit of its return within the required limits of time.

Fig. 9 shows a compact form of the mechanism which is shown mainly diagrammatic in Fig. 1. In this present figure the complete base and frame are shown, and the position of the 12 to 1 reduction hour gear outlined. A clip H^4 controlled by a screw is shown on the rod H^4 to enable the complete dashpot to be removed without disturbing the rod H^4 and also to enable adjustments in height to be made.

Fig. 10 shows the alternative form of propelment. On the front of the lever D is disposed a roller E which engages the cam F, which is also disposed in front of the lever D so as to clear same. On the arbor F^1 of the cam F, but behind the lever D is secured a counter-weight E^2. This form of propelment operates as follows:—

On the armature A being attracted by the magnet B as already described in reference to Fig. 1, the lever D together with the roller E is lifted to its potential position, the roller E clearing the highest point of the cam F. The weight E^2 descends to its lowest position moving the highest point of the cam F to the left, and at the same time underneath the roller E. On the roller descending it causes the cam F to rotate anti-clockwise when disposed as shown, until it regains its original position as illustrated. The gear ratio between the pinion F^2 on which the cam F is fixed, and the wheel G (or equivalent wheel-work) must be based on one complete revolution of the pinion F^2 per impulse.

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 step-by-step clock mechanism, an armature disposed and attracted between the poles of an electromagnet a step-by-step propelment operated by the said armature, a dashpot device retarding the retraction of the armature, or an equivalent device functioning in a similar manner, a driving weight applied to the dash-pot device and a lever (balanced by a spring or weight) attached to the armature, and moved by the said driving weight, the whole being devised so that the tension of the driving force, and the pressure on the pivots of the moving parts are always in one direction, so that noise, due to the reversal or change of the direction of strain in the bearings as hereindescribed, is eliminated.

2. In an electric step-by-step clock mechanism, an armature disposed between

two poles of an electro-magnet and otted approximately centrally, and h the greater attraction of the magnet the direction of gravity, a step-by-step pelment operating on the retraction of said armature, a dash-pot device re-ding the retraction of the armature, an equivalent device functioning in a ilar manner, a driving weight applied the dash-pot device, and a balanced er attached to the armature and moved the said driving weight, the whole ing devised so that the tension of the iving force and the pressure on the ots of the armature are always in one ection, so that noise, due to the reversal change of the direction of strain in the arings as hereindescribed, is eliminated.

3. In an electric step-by-step clock echanism as in Claims 1 & 2, an air con-lled retarding device comprising a fixed dy which may or may not be dished, a n-return valve, a flexible diaphragm tached to and operating in connection ith the fixed body, a means whereby the eater portion of the surface of the dia-phragm is rendered non-flexible, the dia-phragm being flexible only at and near its edge.

4. In an electric step-by-step clock mechanism as in Claims 1 & 2, an air controlled retarding device as in Claim 3, two rigid discs clamped to and covering the greater portion of the surface of the flexible diaphragm so as to render such portion non-flexible as and for the purpose hereindescribed.

5. In an electric step-by-step clock mechanism as in Claims 1 & 2, an air controlled retarding device as in Claim 3, discs of unequal diameters clamped to the flexible diaphragm, the diameters varying so as to vary the position of the bending action on the said flexible diaphragm, as and for the purpose herein described.

6. An electric step-by-step clock mechanism constructed and operating substantially as herein described and illustrated.

Dated this 5th day of December, 1919.

I. HARDY PARSONS,
ALFRED E. J. BALL.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1920.

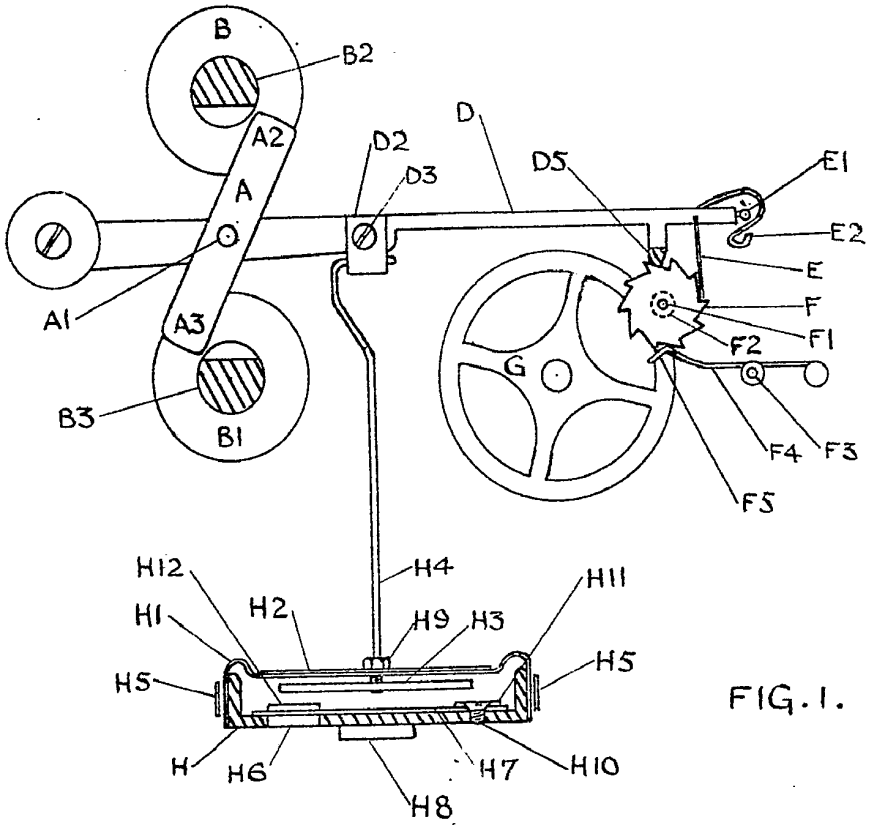


FIG. 1.

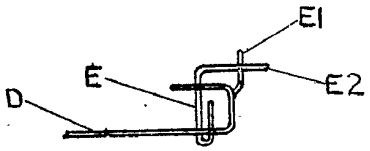
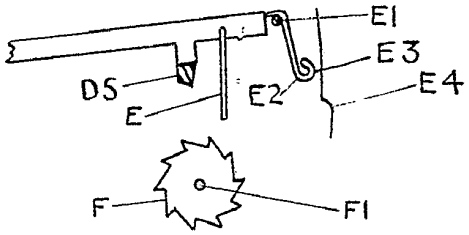


FIG. 2.



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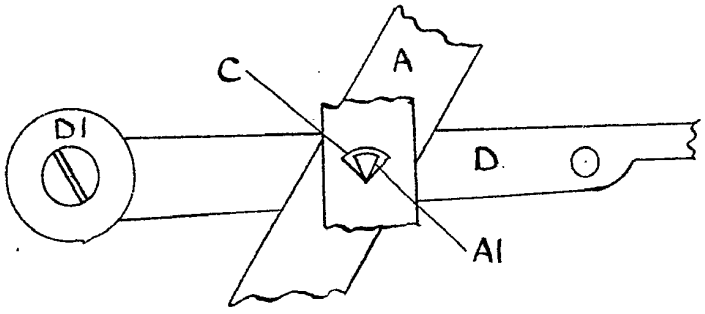
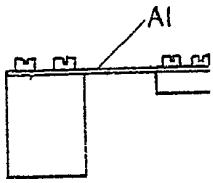
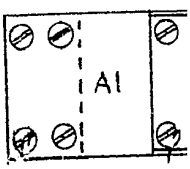


FIG. 4.





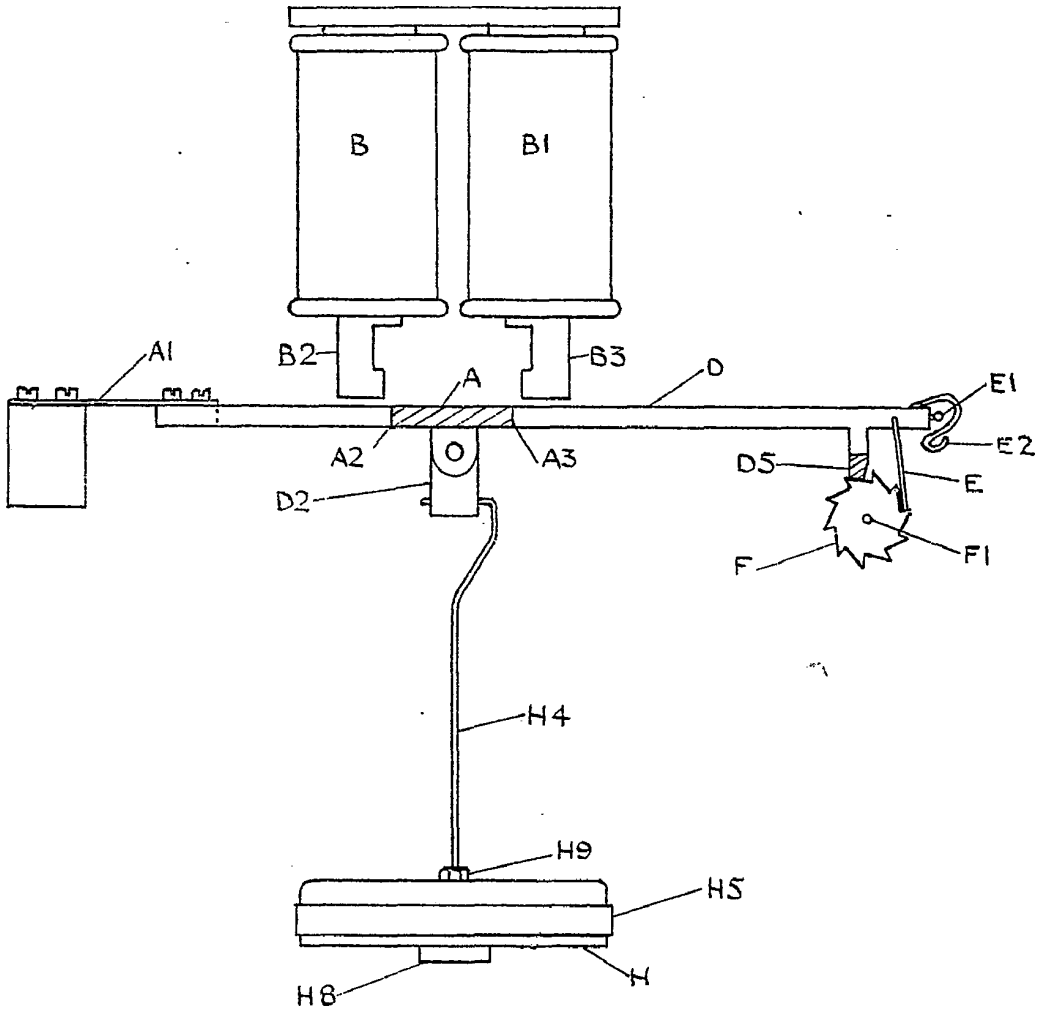


FIG. 5.

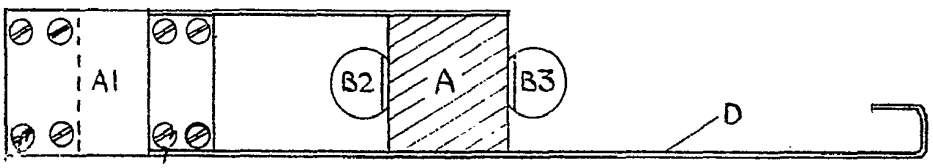


FIG. 5A.

E4

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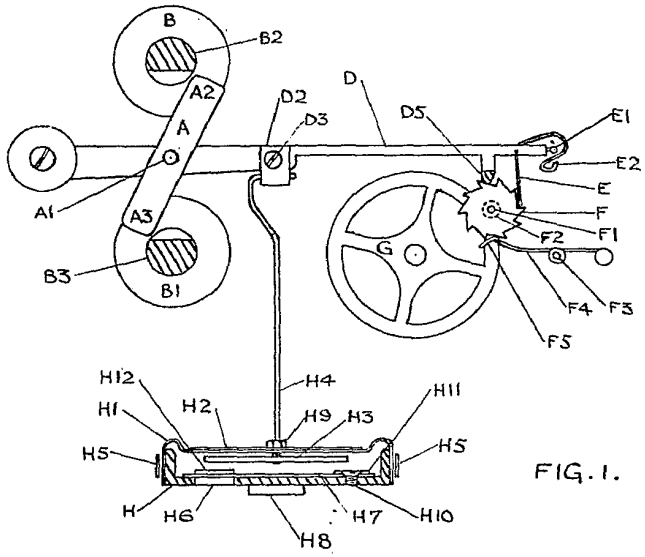


FIG. 1.

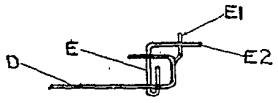


FIG. 2.

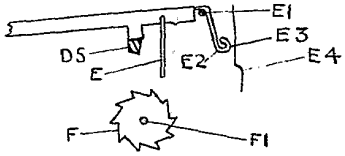
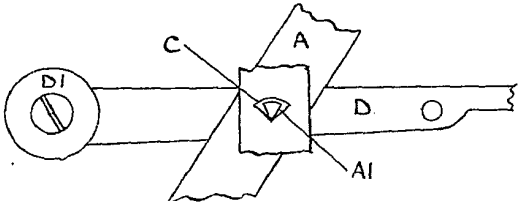


FIG. 3.



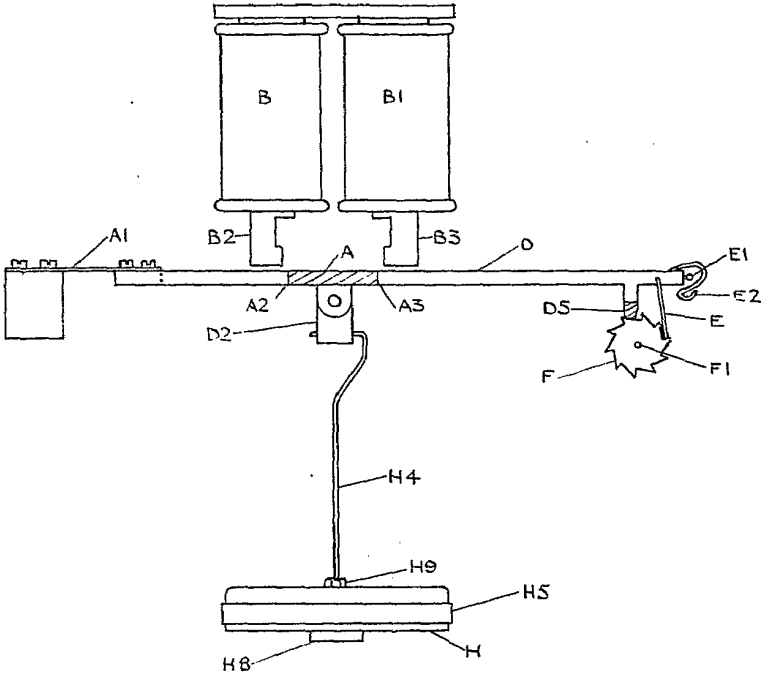


FIG. 5.

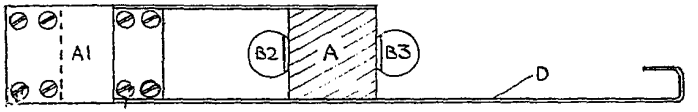


FIG. 5A.

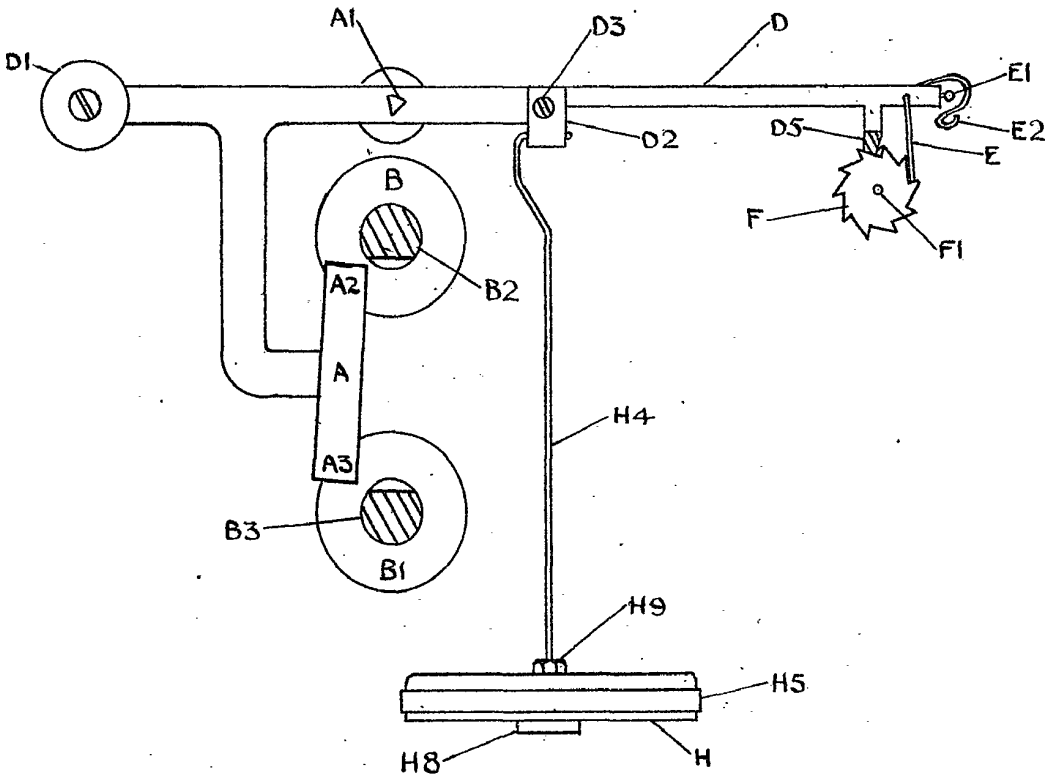


FIG. 6.

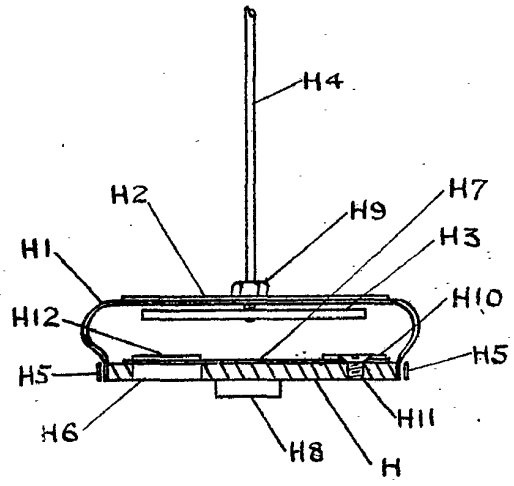


FIG. 7.

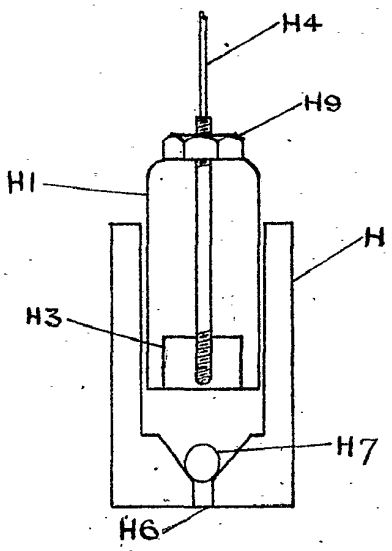


FIG. 8.

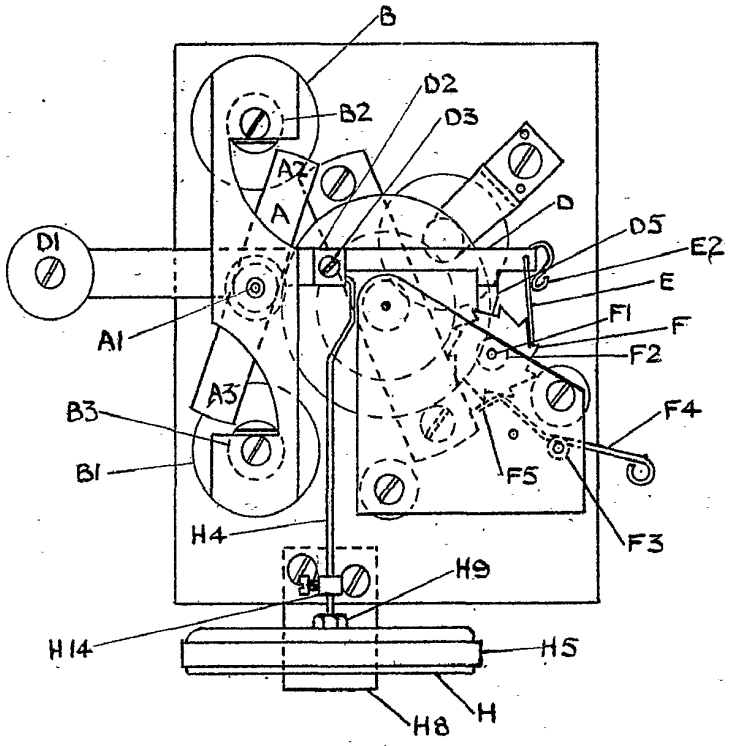


FIG. 9.

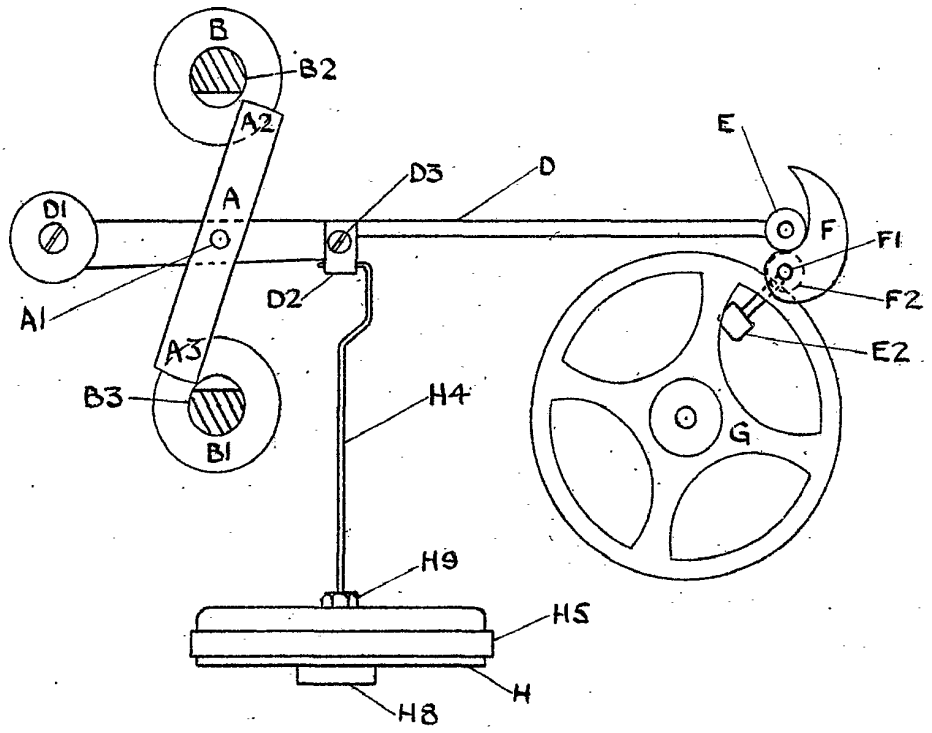


FIG. 10.

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