Feb. 16, 1954 E. BREDIMUS ET AL 2,669,087

GRAVITY OPERATED TIMING DEVICE

Filed Jan. 19, 1949

3 Sheets-Sheet 1

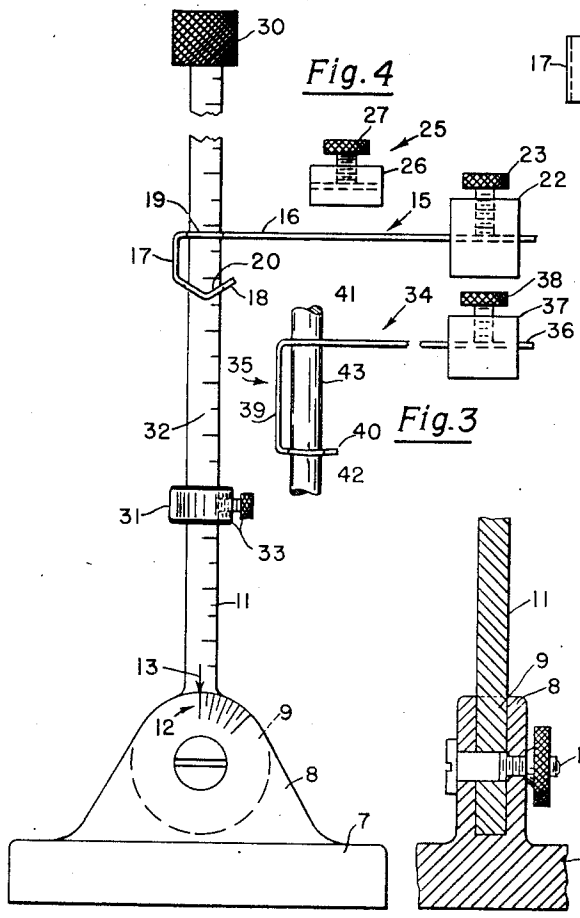


Fig. 4

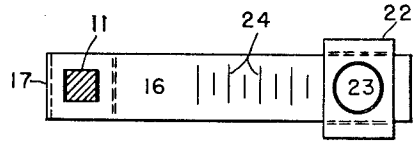


Fig. 5

Fig. 3

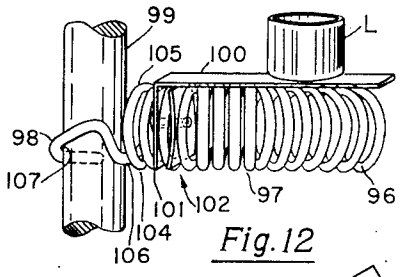


Fig. 12

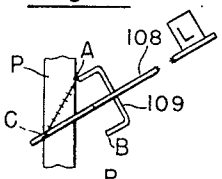


Fig 13

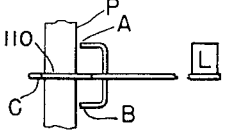


Fig. 14

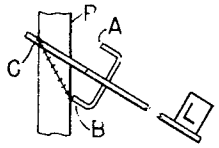


Fig. 15

Fig. 1

Fig. 2

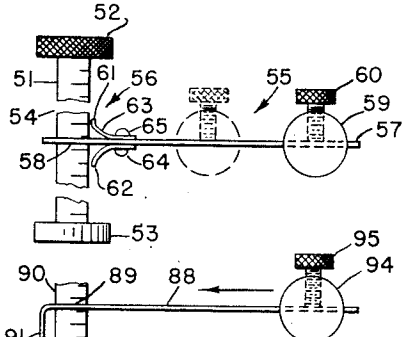


Fig. 6

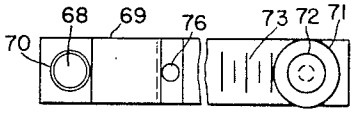


Fig. 8

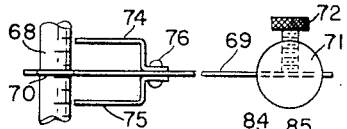


Fig. 7

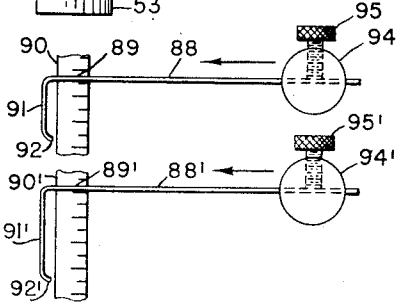


Fig. 10

Fig. 11

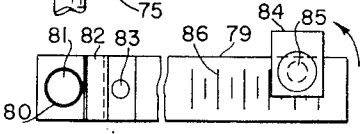


Fig. 9

Inventors

Elsie Bredimus

Warren Dunham Foster

By

Warren Dunham Foster

Attorney

Feb. 16, 1954 E. BREDIMUS ET AL 2,669,087

GRAVITY OPERATED TIMING DEVICE

Filed Jan. 19, 1949

3 Sheets-Sheet 2

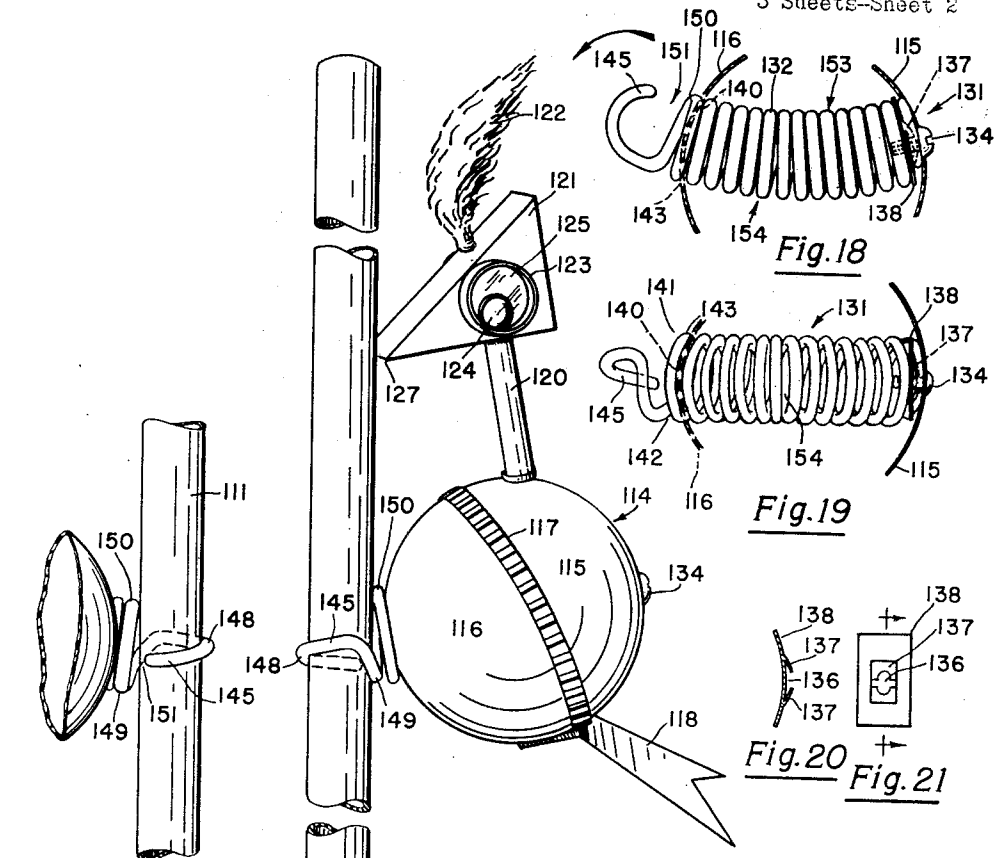


Fig. 17

Fig. 18

Fig. 19

Fig. 20

Fig. 21

Fig. 16

Elsie Bredimus Inventors
Warren Dunham Foster

By

Attorney

Feb. 16, 1954 E. BREDIMUS ET AL 2,669,087

GRAVITY OPERATED TIMING DEVICE

Filed Jan. 19, 1949

3 Sheets-Sheet 3

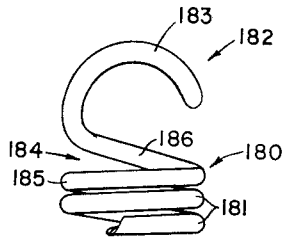


Fig. 25

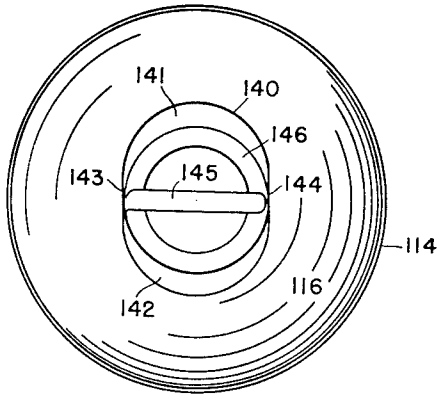


Fig. 22

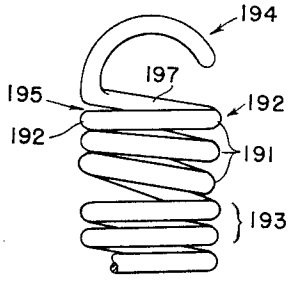


Fig. 26

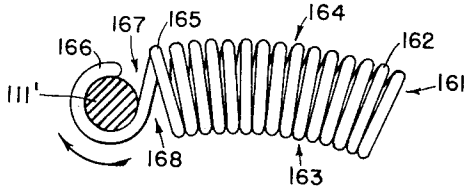


Fig. 23

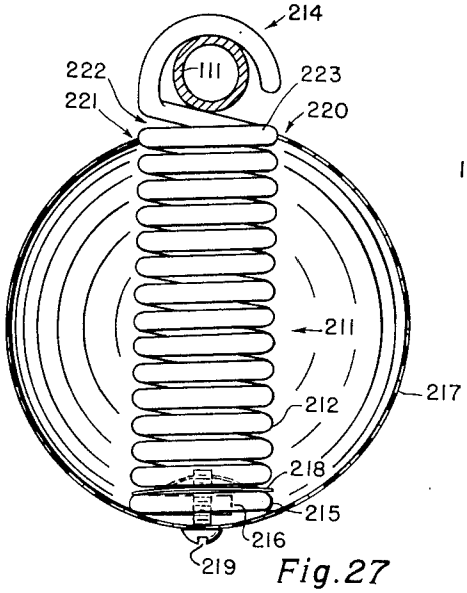


Fig. 27

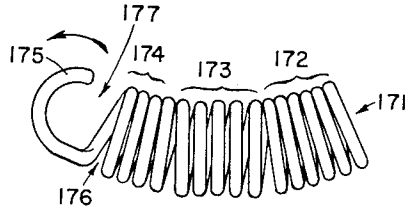


Fig. 24

Elsie Bredimus
Warren Dunham Foster
Inventors

By Warren Dunham Foster

Attorney

Patented Feb. 16, 1954

2,669,087

UNITED STATES PATENT OFFICE

2,669,087

GRAVITY OPERATED TIMING DEVICE

Elsie Bredimus, Oakland, N. J., and Warren Dunham Foster, Eustis, Fla.; said Foster assignor to Foster and Foster, a partnership

Application January 19, 1949, Serial No. 71,702

8 Claims. (Cl. 58—1)

1

A primary purpose of this invention is to control the application of the force of gravity by the application of the frequency of vibration inherent in a spring to form what is in effect a spring motor with a "walking escapement" embodied therein. Such a device may consist essentially of a spring, leaf or helical, with one end free to vibrate and the other end formed into an escapement which when placed about a post or other elongated support which is disposed in a more or less upright position descends at a rate of speed which is carefully pre-controlled as desired, according to the methods and instrumentalities which are described and claimed herein. For convenience, the end nearer a support and embodying or carrying an escapement is called "near" or "inner" and the opposite and free end "far" or "outer." The speed of descent is determined by the effect of gravity, load and the vibrational characteristics of the spring employed, all as conditioned by and in turn conditioning the escapement by which the motor is attached to its support.

In its essence, therefore, our invention may be considered as including or comprising a cantilever spring and an escapement, each being conditioned by the other and the escapement serving to attach the spring to its support. The support is sufficiently upright so that the force of gravity conditioned by the characteristics of the spring and its load and controlled by the escapement is utilized to bring the motor and its load downwardly with predetermined timing. The inclination of the support from the perpendicular is one factor in our control of the rate of descent. The spring itself may be of a flat or leaf form with one or a far end free and the other or near end formed into or carrying an escapement and attaching structure or it may be a spring wire preferably circular in cross section and wound in the form of a helix one or a far end of which is free and the other or near end of which terminates in a loop, generally in a plane at right angles to that of the coils of the helix, which forms an escapement by means of which the motor is attached to its support and its descent controlled.

An important element of our invention is that the escapement is attached to a support at three spaced points, two on one side and at least one on the other side, such spacing between points on the same side being of appreciable distance. The results of our invention cannot be secured, for example, by merely a single opening in a leaf spring. It is important to note that the characteristics of the escapement condition the vibration of the spring and the vibration of the spring and its application to the escapement condition the action of the escapement. The result is a couple of reciprocating forces, each acting on the other and the net total determining the timing.

2

At this point it will be useful briefly to review the operation of certain of the physical factors of which we make use. The method and means by which we fully utilize these factors will be clear from the following portion of this specification, the present outline being preliminary. It will be assumed that by hand, reversal of a support, or the use of power one of our motors, for convenience described as of the leaf type, is placed in position at the top of a support with the far end of the spring inclined upwardly from a horizontal plane. This spring should carry a load, both for utility and in many cases for optimum operation, especially when a timer or the like is the object to which we apply our invention. The force of gravity will then cause the far end of the spring to fall until it is checked by a lower point of the escapement. This arrest of movement must be at a point before the inherent travel of the spring due to the force of gravity has been completed. When this check is applied at the near end the free end of the spring therefore will continue to move downwardly thus storing power in the spring which immediately is utilized to move the free or outer end of the spring upwardly until this movement in turn is arrested by an upper element of the escapement. It is essential that the power thus stored in the spring in relation to the characteristics of the spring and the weight which is applied and the position of this upper point of the escapement be sufficient so that this upward movement will continue until is is arrested following contact of the near end of the spring and by the upper point of the escapement. The amplitude of the vibration of the spring and hence the point at which it is to be arrested is conditioned by the distance of the contact points of the escapement from the support and from each other.

Intermediate the beginning and the end of both the downward and upper phases of the complete cycle there is a moment at which the entire device is free from the clamping action of the escapement and is drawn bodily downwardly by the force of gravity. This bodily descent must be clearly differentiated from the upward and downward movements of the spring itself, controlled by its frequency and other characteristics and its load and the construction of the escapement. It will of course be understood that the arrest of

the spring in its upward and downward travel is checked respectively by the clamping action of the upward and downward points of engagement of the escapement on the near side of the support in cooperation with the one or two points of contact of the escapement upon the opposite side of this support. Certain definite steps or constructions are necessary to secure satisfactory clamping action at the end of each phase of each cycle and also and more important to afford closely pre-controlled and regular oscillation. All of the above factors are later presented more fully and with necessary formulae and directions.

The same principles, including the recurrent cycles each of two phases, apply to the operation of a spring motor of the helical type, although they are not so obvious. Certain added factors later discussed arise from the travelling waves or oscillations of the helix along its longitudinal axis. The arrest of the helix at the end of the downward phase at a point prior to the expenditure of the complete effect of the force of gravity sets up a response in the spring which raises it through the neutral point and to that at which its upward phase is arrested by an upward escapement point, provided of course that the principles stated above and elaborated hereinafter are carefully followed. It should be noted that a helical spring made of round wire is six times as efficient in the amount of energy which it will store per cubic inch or pound of metal in the spring in relation to a flat spring of uniform cross section with a concentrated load. (Mortimer F. Sayre, Kent's Mechanical Engineer's Handbook, 10-21, Eleventh Edition.)

This invention also includes the provision of methods of adjustment and instrumentalities whereby when desired a motor and its load may be caused bodily to move about the rod in a helical descending path of its own. Such movement is also closely pre-set and conditioned. To accomplish this result we utilize a predetermined imbalance of a vibrating instrumentality as for example by a couple of forces produced by freedom of vibration along one side of a helical spring and damping along the other, or by an unbalanced load.

Although our invention can be applied as a timer or as motive power for toys and is so illustrated herein it is not so restricted. Our invention can be used in any device in which it is desired to utilize the force of gravity as pre-controlled by an escapement-operated spring. In short our invention can be applied where ever it is desired to cause gravitational force intermittently and in a series of pre-set, short and regular oscillations to move an object downwardly along a generally upright support.

The objects and characteristics of our invention therefore include the provision of new and improved means and methods whereby the force of gravity may be utilized in a pre-controlled and uniform manner to determine the descent of an object along a predominantly upright post or other support in a series of pre-timed regular intermittent movements and if desired its rotation thereabout, and to utilize such methods and means as the motivating force for toys, timers, and other devices. Other objects are to condition predeterminedly the operation of a gravitational escapement by a spring which is attached to a support thereby and predeterminedly to condition the operation of the escapement in turn by the characteristics and control of said spring. Still other objects and characteristics will be apparent from the remainder of this specification, consideration of the drawings and the subjoined claims. It will be readily understood that for purposes of illustration only we are showing certain preferred embodiments of our invention but changes may be made therein without departing from the spirit of our invention or the scope of our broader claims.

In the drawings:

Figure 1 is an elevational side view of a timing device utilizing one embodiment of our invention, called for convenient identification the "J form," by which we illustrate our invention when utilizing a leaf spring.

Figure 2 is a fragmentary side view largely in section corresponding to Figure 1.

Figure 3 is a fragmentary side elevation which corresponds to Figure 1 and shows a variant thereof.

Figure 4 is a side elevation which shows a weight which may be employed with the structures of Figures 1, 3 and 4 hereof.

Figure 5 is a top plan view of the structure of Figure 1 partially in section.

Figure 6 is an elevational view of an important modification of our invention wherein the escapement is known for convenience as of the "trident" form.

Figure 7 is a fragmentary showing in side elevation of a modification of the structure of Figure 6, the tines of the trident being placed further from the fulcrum of the vibrating cantilever and being further spaced at their point of contact with the support thus decreasing each period of arrested movement of the escapement and hence increasing the speed of travel.

Figure 8 is a top plan view corresponding to Figure 7.

Figure 9 is a top plan view of a variation of the structure of Figures 6, 7 and 8, showing how we may secure rotation about a support by imbalance caused by offsetting a weight.

Figures 10 and 11 are elevational views illustrating an escapement, known for convenience as of the "L type," which represent modifications of the J and trident forms previously mentioned. Figure 11 is a modification of Figure 10 wherein the cross bar of the L is elongated thus increasing the rate of descent.

Figure 12 is an illustration in modified isometric of our invention as practiced with a helical spring, the load being attached to a motor adjacent the support, escapement being of the three point type.

Figures 13, 14 and 15 are diagrammatic showings, in the form of side elevations very much exaggerated, illustrating the operation of our escapement, the form used in this example being of the trident type. Figure 13 shows the escapement in its upper or ascending limiting position, Figure 14 in its neutral or free or descending position, and Figure 15 in its lower or descending limiting position.

Figure 16 (Sheet 2) is an isometric view of a toy woodpecker which is one means by which we illustrate our invention when utilizing a helical spring.

Figure 17 is a fragmentary isometric view corresponding to Figure 1 partly broken away but taken from an opposite point of view.

Figure 18 is a top plan view of our escapement and motor in which a helical spring is employed.

Figure 19 is a side elevational view corresponding to Figure 18.

Figure 20 is a vertical section taken on the line 20—20 of Figure 21 and looking in the direction of the arrows.

Figure 21 is a side elevational view of a particular fastening for attaching a motor and its load to a platform.

Figure 22 is a front elevational view of the body of this motor with its support removed.

Figure 23 corresponds to Figure 18 but is a variant illustrating change in direction of rotation following a change in relative position of the damped and undamped portions of a helical spring.

Figure 24, corresponding to Figures 18 and 23, shows in part how we pre-set the bodily rotation of a motor of our helical type.

Figures 25 and 26 are fragmentary top plan views showing how differences in angle between the escapement loops and the first coil of a helix cause difference in rapidity of bodily rotation.

Figure 27 is a view largely in top plan and partially in section showing an important variant wherein we provide a partial substitute for the damping arrangements as shown in Figures 18, 19, 23 and 24.

As already indicated this invention may be embodied in a motor making use of either a leaf or a helical spring. We shall first describe and illustrate our invention as utilizing a leaf spring. Before stating the characteristics of leaf springs which accomplish our purposes, the principles underlying the construction of our escapement and the methods by which the load is determined we shall describe certain embodiments of our invention.

Figures 1 to 5 illustrate our invention as applied to a timer, such as can be used for photographic and many other purposes, with a spring motor in the form of a leaf spring and so formed at its near end as to embody both an attachment by which it can be mounted upon its support and also an escapement. Such a timer can be readily electrically or mechanically connected to any object which it is desired to control, but such connections form no part of the present invention and hence are not presented hereby. Also, for another example of its use, it can be applied as a timing agitator, a test tube, for example, being mounted on or adjacent the free end of a cantilever spring.

For illustrating our invention as it is applied to a timer it is desirable to introduce another controlled variant in the form of a pre-set difference of inclination of a support. Therefore base 7, which preferably is made rather heavy both for solidity and to discourage sympathetic vibrations in response to those of a timing spring, includes two upstanding parallel plates 8 between which a disc 9 is rotatably supported upon a set screw 10. Preferably the base and upstanding supports are made of one piece as by casting. Support or post 11 is fastened to disc 9 in any appropriate fashion or may be made integral therewith. Calibrations 12 indicating either the degree of inclination of the support or the factor which must be applied to the wanted determinations because of this inclination are placed upon a side of one of the plates. After the set screw is loosened the support 12 may be rotated to any desired angle as indicated between calibrations 12 and arrow 13 on the side of the support. Thus a user may readily determine the angle at which the support is set or at once note its effect upon a timing operation and fasten the post by tightening the thumb screw 10. Inclination of course decreases speed of descent of the motor and its load by introducing increased sliding friction at the free interval of the escapement cycle.

A leaf spring generally indicated as 15 is attached to this post by an escapement of the type which for convenience herein is designated as the "J form." For convenience herein we occasionally use capital letters as descriptive of certain constructions, with their orientation as the letters appear in print. Thus "an upright leg" of a J is the portion which in a letter J in type is upright although in a drawing or in fact it may be disposed on its side. The main body or upright leg 16 of the leaf spring is bent backwardly upon itself into a descending portion 17 and a portion 18 which is again turned upon itself to complete the J form. Openings 19 and 20 are formed respectively in the long leg or main portion of the J and the upright or short leg 18, generally parallel thereto, respectively, through which the post passes. The clearance between the edges of these openings and the post in relatively small, a matter of a very few thousandths of an inch depending upon the particular use to which a device is to be put. In the illustrations herein for clarity these clearances are exaggerated. The escapement of this form has four points created by the opposite sides of the two openings 19 and 20. In order to condition the vibration of the spring and consequently the operation of the escapement we preferably apply a weight within certain specified limits, all in a manner later explained. A weight 22 may be moved along the surface of the main portion 16 of the spring and by screw 23 be set according to calibrations 24. In Figure 4 we show another similar weight 25 having a body 26 and a set screw 27, of less weight than the device shown in Figure 2. Consequently we may vary the frequency of operation of the spring motor not only by moving the weights along the surface of the spring but by substituting weights of different magnitudes. Thus by a comparatively few weights each separately or in combination disposed as desired along the main arm of the spring we are able to secure as many different frequencies as are required for all ordinary purposes.

In order to limit the travel of the spring motor along the support 11 a top stop 30, preferably removable, is supplied and a bottom adjustable stop 31 which may be placed along calibrations 32 at any desired point and held there by a set screw 33. Also, an upper stop of the type shown as the lower stop and movable along the post may be substituted, thus further increasing the combinations which may be secured.

One great advantage of the J form of our invention is exemplified by Figure 3. A spring of this type may readily be constructed so that the critical factors are easily changed in advance. In Figure 3 we show a spring motor generally indicated as 34 having an escapement and support generally indicated as 35. A main upright arm 36 of the J carries a weight 37 having a set screw 38 and calibrations not shown such as previously described and as illustrated in Figure 5. The forward end of this spring is turned downward into a cross arm 39 and then backwardly upon itself into a short upright arm 40; these arms being horizontally disposed and generally parallel. Openings 41 and 42 in the long and short arms respectively embrace a support 43 which in this case is shown as circular in cross section but otherwise may be constructed and mounted as is post 11. By comparison with Figure 2 it will be seen that cross arm 39 is much longer than cross arm 17 previously described and that the angle in

short upward arm 40 is much less than that in arm 20 of the previous construction.

The lengthening of the short arm 39, as for example compared with short arm 17 of Figure 1, decreases the amplitude of each vibration and also the time during which the lower portion of the escapement in each phase of each cycle is in clamping contact with the post. Since the frequency of vibration is not changed the net result is a relative increase in the positioning of the escapement in its central or neutral position, with consequently a more rapid bodily descent. Changing the angle of the short upward leg of the J in relation to the cross bar in effect increases the diameter of the opening 42. As will later be explained in more detail, the widening of this opening increases the amplitude of vibration of the spring. To a light extent this increase also postpones clamping action in each phase of each cycle and thus further increases the speed of descent. We have found this second factor of relatively less importance than the others which are set out herein.

In the forms of our invention in which we make use of a leaf spring and to a less extent in those in which we employ a helical spring we have found it possible to use a battery of motors simultaneously. We have placed a plurality of escapement-supports in different positions relative to the circumference of a round support or upon different sides of a square support and arrange for them to support a common load. Thus we are able to increase carrying capacity. For the majority of purposes, however, a single motor as herein described is sufficient.

Our motor, of whatever type, may be raised to starting position by hand or, as in the case of the form about to be described, merely by inversion of its support. Alternatively and for certain applications such inversion or raising may be by power.

Figures 6, 7 and 8 show various forms of a highly important "trident" form of our invention, wherein the escapement is in the form of a U (in Figure 6 more nearly resembling the Greek capital upsilon) each of the ends of the upright arms of which engage one side of the support while the escapement clamp on the other side is formed by the leftward wall, as viewed in the drawings, of an opening of the main spring which intersects the center of the U parallel to its upright legs and embraces a supporting post. This construction is particularly simple, inexpensive and versatile. One great advantage of this form is that the entire structure readily can be turned from one end to the other. Therefore it is not necessary to move the motor by hand or otherwise from the bottom of the support to the top for successive operations.

As is fully shown in Figure 6 a support or post 51 shown as square in cross section has a top stop 52, which may be made removable, or movable along the post, or both, and a base 53. Preferably the post is calibrated as shown at 54. A spring motor generally indicated as 55 includes an escapement generally indicated as 56. A single leaf spring 57 has an opening 58 which embraces post 51. A weight 59 controlled by a set screw 60 may be moved along the surface of spring 57 according to calibrations which are not shown but may be similar to those of Figures 5, 8 and 9. The escapement consists of a U-shaped structure consisting of bent sheet metal strips 61 and 62 representing the upright legs of the U fastened as by a rivet 65 or spot welding to spring 57 at the outer or leftward side of opening 58. The inner or rightward side does not engage the post as a part of the escapement cycle.

Figures 7 and 8 show a variation of the structure of Figure 6. They illustrate how a still further increase of the versatility of the structure of Figure 6 can be secured at a very low cost. Post 68, shown as circular, may be mounted as illustrated in Figure 6. A leaf spring 69 is formed with an opening 70, corresponding to 58 previously described, embracing the post. A weight 71 with a set screw 72 is movable along the surface of the spring in accordance with calibrations 73. The remainder of the escapement mechanism—namely the components of the U portion of the escapement trident—may be formed of two L-shaped pieces of spring metal 74 and 75 with the short or cross arms offset and extended along the surface of spring 69 to give space for the application of a rivet 76 or spot welding. The operation of this form of our device is the same as that shown in Figure 6 with the important exception that the legs 74 and 75 of the U are considerably longer and also further spaced from each other. Thus while frequency of engagement with the post is not changed the duration of that engagement and consequently the clamping action are less and the motor descends more rapidly. Provided the points of contact of the near side (right as viewed) of the escapement are equally spaced from a support, amplitude of vibration of our cantilever spring is decreased by an increase of the vertical distance of these near points of contact from the horizontal plane intersecting the far or leftward point.

As a practical manufacturing operation we prefer to furnish a plurality of spring motors of this kind each with a U portion of the trident with legs of different lengths rather than to make the U portion removable or adjustable. Costs are thus lessened in this manner and certainty of results increased. With a plurality of spring-motors and a plurality of weights, each costing very little indeed, one device of the type of Figures 6, 7 and 8 can readily meet any reasonably desired condition.

As stated more at length in connection with the later discussion of spring motors of the helical form it is often desirable to cause the spring motor to rotate bodily about its support, again in accordance with conditions which are carefully pre-set. As previously stated any condition of imbalance in the motor will accomplish this result. The most simple procedure when a leaf spring is used is to off-set the weight from the longitudinal axis of the spring motor. As shown in top plan in Figure 9 a leaf spring 79 having an opening 80 embraces a support 81 which is circular in cross section. The escapement is composed of the left side of this opening as viewed in this figure and the points of a horizontally disposed U-shaped component added to the central line of the trident with its base or cross bar bisected thereby in the form of arms 82 attached as by a rivet 83 or spot welding. A weight 84 attached by a set screw 85 and set upon one side of the center of the spring and movable in accordance with calibrations 86 causes this structure to rotate anti-clockwise in the direction of the arrow as indicated.

Figures 10 and 11 show the form of our invention applied to a leaf spring which for purposes of convenience herein is called the "L form." A leaf spring 88 having an opening 89 embraces post 90. A downwardly extending leg 91 repre-

senting the cross bar of the L terminates in an off-set point 92 engageable with the support. The sides of the opening 89 and this point compose the elements of the escapement. A weight 94 controlled by a set screw 95 can be moved along the calibrated surface of spring 88.

The elements of our invention shown in Figure 11 resemble those of Figure 10 except that the cross bar of the L is further extended thus increasing the relative speed of bodily descent, as previously explained in connection with the comparison of the form of Figures 7 and 8 with that of Figure 6 and that of Figure 3 with that of Figure 1. Care must be taken not to make this bar sufficiently long and of such characteristics as to set up independent vibration. In view of the similarity of the structure of Figures 10 and 11, except as to the relative length of bars 91 and 91', the description of Figure 10 is not being repeated as applied to Figure 11. The reference characters of Figure 10 are therefore applied to Figure 11 with a prime character added. Increase of this length lessens amplitude of vibration.

In selecting a proper leaf spring to carry out any of the several forms of our invention hereinabove described, certain critical factors should be applied although they may be determined within a relatively wide latitude.

In determining the characteristics of a leaf spring, it is first necessary to find the stiffness in pounds per inch of deflection, a factor known as "*k*." The formula given in "Art and Science of Spring Making" (fourth edition, by Barnes, Gibson and Raymond) is as follows:

$$F=\frac{PL^3}{3EI}$$

wherein:

F=deflection in inches.
L=length of lever arm in inches or 3.375".
P=load in pounds, assuming unit as I.
E=modulus of elasticity 30,000,000 for steel.
$I=\frac{1}{12}\ bC^3$ the moment of inertia, where $b=\frac{1}{2}$", $C=.015$".

The specific values are in accordance with one illustration of our invention as built in accordance with Figure 6. Substituting:

$$F=\frac{1\times(3.3.75)^3}{3\times30{,}000{,}000\times\frac{1}{12}\times\frac{1}{2}\times(.015)^3}$$

$$F=\frac{38.44}{12.65}$$

F=3" deflection per pound load, or in pounds per inch.
F=.33 lb. per inch of deflection.

The next step is to find the natural frequency of a flat or leaf spring which carries an attached load. As given by Kent's "Mechanical Engineer's Handbook," chapter 10, page 20, 11th edition, the formula is as follows:

$$\text{Frequency}=3.12\sqrt{k/(W_L+C_1W_s)}\text{ cycles per sec.}$$

where

k=stiffness of spring in pounds per inch of deflection.
W_s=weight of spring itself.
W_L=weight of load carried by spring.
C_1=constant ¼ for cantilever springs of uniform cross section.

Substituting known factors for a spring used in the above illustration:

$$F=3.12\sqrt{.33/(.024+\tfrac{1}{4}\times.007)}$$
$$=3.12\sqrt{.33/(.02575)}$$
$$=3.12\sqrt{12.8}$$
$$=3.12\times3.58=11.16\text{ cycles per second}$$

A weight of lead of .024 lb. is used.

From the above formulae, certain general principles may be readily understood. With an increase of the weight of the load (W_L), the rate of vibration is correspondingly decreased. Conversely, a decrease of a rate of vibration makes possible the carrying of a load of greater weight under the same conditions. Likewise, with an increase in stiffness (k), the rate of vibration is increased, or by decreased stiffness the rate of vibration is decreased. An increase of the cross-section area of a spring I, the moment of inertia, increases the stiffness which is expressed in deflection in pounds per inch. Likewise decreasing the cross-section area of the spring decreases the stiffness. Also, increase in the length of lever arm (L) increases deflection and decrease of the length decreases deflection. By keeping the above formulae and principles in mind, as well as those previously outlined and later discussed more fully as to our method and means applied to an escapement, it is possible to meet any reasonable set of conditions.

As previously stated, we may practice our invention by providing a motor which is powered by a helical instead of a leaf spring, as first and generally illustrated in Figure 12. Since the operation of the escapement in either form of the invention is the same whether a leaf or a helical spring is employed we are briefly describing this one embodiment utilizing a helical spring at this time and before we discuss in detail the operation of the three point escapement as shown by schematic Figures 13, 14 and 15. Thereafter we shall describe fully the construction and operation of the forms of our invention utilizing a helical spring and illustrate its use.

As is shown schematically in Figure 12 a motor is operated by a helical spring having free coils 96 and damped coils 97. The operation, purpose, significance and modifications with damped and undamped coils will be fully discussed later. The motor is attached by an escapement hook 98 to a support 99 shown as round. An L-shaped platform having a horizontal supporting portion 100 representing the normally upright leg of the L and an attaching right angled portion 101 representing the cross bar is attached to the helical spring by means generally indicated as 102 which will be described at length later in connection with Figures 18 to 21 inclusive and 27. A load conventionally shown as L appears upon the platform. This "load" may be a carefully determined weight which in accordance with calibrations such as those previously described may be set at different points along the platform or it may be the body of a toy as illustrated in Figure 16 and described in connection therewith or any other load which may be desired either for purposes of utility or in order to control the frequency and amplitude of vibration of the spring or the speed of bodily descent of the entire device. It will be particularly noted that the escapement hook 98 extends from a free coil 104 about the post with a point of contact 105 at the top of coil 104 and a point of contact 106 at the

bottom of the coil, both on the near or right side of the post, and a third and final point of contact 107 on the leftward side of the support. Figure 17 upon Sheet 2 shows substantially the same escapement construction from the opposite point of view. In this latter instance the three point suspension or contact is as indicated at points 148, 149 and 150.

We shall now discuss the method of operation of our escapement, with particular reference to diagrams of Figures 13, 14 and 15 which are very greatly exaggerated for purposes of clarity. While we have elected to illustrate the operation of the escapement by a three point contact of the trident form of our invention it will be understood that the principles are the same whether exemplified in this form or in the J, L, helical or other forms. In these diagrams support or post P corresponds to supports 11, 43, 51, 68, 81, 90', 99, 111 and 111'. The escapement is shown diagrammatically as being attached to or embodied in a leaf spring 108 (corresponding to all of the several springs flat or helical herein illustrated and described) and a U-shaped escapement component diagrammatically indicated as 109 and having an opening 110 which embraces post P.

The escapement contact or suspension points in this form of our invention include the ends A and B of each leg of U 109 and the edge C of the opening 110 of spring 108. Side D is shown as so far removed from the post as to exert no escapement effect. If desired it may also be positioned so as to be utilized to supplement the clamping action of either point A or B but such an arrangement is not necessary. The downward phase of the first cycle is powered both by inertia due to gravity and preferably by the resilience of the spring, but the resilience of the spring alone brings the motor back to the position of Figure 13.

It is assumed then that regular cyclic operation begins with the mechanism returned by resilience to the position of Figure 13. Thereupon the force of gravity augmented by the inertia of the load L and the energy stored by the upward phase after the moment of arrest carries the motor through the neutral position of Figure 14 to that of Figure 15. At this moment points B and C engage post P and form a clamp which arrests the downward movement of that portion of the motor which is adjacent the support. As previously stated in outline this check in this downward motion must come at a time when inertia will carry the free end of the spring still further downwardly thereby storing power therein. This power thereupon is operative to bring spring 108 back through the position of Figure 14 to that of Figure 13. At this point another clamping operation is carried out by points A and C and further upward movement at least of that portion of the motor adjacent the support is arrested. Since the force of gravity will be operative hereinafter to carry the structure downwardly it is not necessary that the free end of the spring have sufficient resilience left to continue its upward movement after the escapement has anchored the leftward end thus storing up power which augments the following downward movement, but such additional movement of the free end of the spring is most highly desirable. Thereupon gravity, whether or not augmented by the power stored in the spring by continued upward movement of its end, is operative to release the clamp AC and at this point to cause the motor to return to the position of Figure 15 through that of Figure 14. In both the upward and the downward cycles it will be noted that when the motor is in the position of Figure 14 points A, B and C do not engage the post and hence the entire structure is free to slip bodily downwardly along the post free of contact therewith for a small fraction of a second. These cycles are thereupon indefinitely continued until the motor has bodily fallen to the lower end of its support.

To secure satisfactory clamping action at the end of each phase of each cycle and also and more important to afford closely pre-controlled and regular oscillation certain principles must be followed, as outlined above. We have found that the separation of the two points on the same side of the post must be considerable. A practicable rule is that the diameter or width of a supporting post should be at least twice the separation of the two escapement points which are on the side of a post adjacent the body of the motor. That is, the distance between the escapement points on the one side of a post should be no less than one half of the distance representing the length of a horizontal line between a vertical line connecting them and the third point on the other side of the post when the device is disposed in the central or free neutral position. This clamping action of the escapement becomes important in connection with the minimum rather than the maximum weight. It must be sufficient so that with a given minimum weight there is no slippage as distinct from the regular, pre-controlled and wanted bodily descent in each phase of each cycle in the position of Figure 14. When we are designing a device in which we desire maximum speed of vibration or frequency the spring which we choose must be completely without slippage before any load is applied. It will be readily realized that this condition or in fact any satisfactory operation cannot be reached with a device in which a leaf spring no matter what its thickness is mounted on a support by means of a central opening. Such mounting shows no escapement action whatsoever. It oscillates during short periods, but irregularly, and slides, slips and wobbles. No control is effective, we have found, unless the above factors are carefully included.

It will be understood that the further the escapement points on the same side of the support are separated in a vertical plane, their distance from that support in a horizontal plane being the same, the less the amplitude of vibration of the free end of the cantilever spring, and that on the other hand with increase of effective separation from a support in a horizontal plane, the vertical separation being the same, the greater the amplitude. Also, when the escapement consists of a construction having four points of contact, arranged in pairs, the members of each pair being disposed in a horizontal plane, separation of those planes results in less amplitude while increase of the separation of the points of a pair within its horizontal plane results in increased amplitude.

In considering forms of our invention in which a lower clamping point is relatively far removed from an upper point, as in Figures 3, 7 and 11, it should be noted that we sacrifice some holding or clamping force, according to the ordinary laws of leverage, but unless the weight of the load is unusually light this loss is not of importance, provided the above qualifications are

met, notably that an unloaded spring does not slip at this point. A balance must be maintained between undue separation of escapement points on the same side of a support, with consequent failure to limit amplitude so that impact is not made while the spring is still powered by its inertia, and undue proximity which inhibits clamping at the end of each phase of the cycle, i. e., before the inertia of the free end of the spring is exhausted. The latter fault causes unwanted and irregular slippage at an end of each phase while the former causes such slippage in the neutral or central portion of each phase—both equally harmful to our results.

Two simple criteria will determine an ideal escapement. First, a given spring without load should not slip, except regularly and as wanted in the neutral zone of each phase. Second, although the maximum weight in all cases must be below that which prevents the completion of the upward cycle, the ideal condition is one which results in the storage of amounts of energy which as nearly as possible are equal in each phase.

As a matter of practical operation in determining maximum but not necessarily an ideal load of a given motor, we add weight until the spring just fails to complete its upward phase. Then we remove just enough weight to permit its completion. With a given spring and arrangement of escapement points such a weight causes the slowest possible descent. It will thus be seen that for a given spring the limits are between an unloaded motor which does not slip at the ends of each phase, which descends most rapidly, and a motor with the greatest load which it can carry to the completion of the upward phase, which descends most slowly. The particular use to which we put our invention determines what point we choose between these extremes.

Repeated tests of our device have proved that when all of the conditions stated herein are carefully followed it operates with amazing accuracy and uniformity. There is no appreciable or in fact readily measurable difference in time of falling of any given device in successive operations.

We have now illustrated our invention as carried out with a spring motor based upon a leaf spring embodying or carrying an escapement and have fully explained certain constructions, steps and principles applying to the choice of characteristics for a leaf spring and the construction and operation of an escapement either for use with a helical or flat spring. There remain an illustration of our spring motor made from a helical spring and a description of the steps and principles to be applied to the choice of such a spring. At this point it should again be emphasized that a helical spring, as a device for storing power, is much more efficient than a flat spring, and has the added advantage, when constructed according to the principles of this invention, of furnishing a simple, exact and efficient means of providing regular and pre-controlled bodily rotational descent about a circular support in addition to the primary vertical descent.

As previously stated, a spring motor based upon a helical spring may be employed to time the descent of any load. We are illustrating such a motor as applied to a simulated woodpecker which descends and bodily rotates about a circular support in closely pre-set oscillations, appearing constantly to peck at the support.

We shall first describe the external characteristics of this toy and then our characteristic motor and escapement and thereafter the physical principles and formulae which are involved.

An upright support or post, shown in the form of a tube 111 or a solid post 111' circular in cross section (Figure 23) is mounted upon a horizontal block 112 which serves not only to hold the support vertical but also as a sounding board for the noise which is characteristic of this form of our invention. In one embodiment which we have found inexpensive and particularly attractive the bird consists of a body member generally indicated as 114 and made up of two plastic members 115 and 116 which are placed together and joined by a projecting edge 117 to form a ball. This edge simulates or at least indicates wings. These balls do not need to be especially made for this device. We prefer to use gay and different colors. A simulated tail 118 is preferably formed of flexible material so that when the woodpecker on its downward travels reaches the base 112 the tail is bent upwardly so that the simulated bird may reach the very end of its travels. A neck 120 is merely a metallic tube or small wooden elongated cylinder which supports a triangular head 121, which is formed of wood, with a plume 122. Each of the eyes of the woodpecker, of which only one is fully shown, consists of an annulus 123 having within it a disc 124 of a color strikingly different from that of the head of the bird and contained by a piece of cellulose acetate 125 or the like. The forward portion or beak of this head terminates in an edge 127.

The helical form of our spring motor and its embodied escapement, which as stated above, may be used to power not only this woodpecker and other toys as described above but any other object which it is desired to advance intermittently and regularly by force of gravity, will next be described.

A helical spring generally indicated as 131 forms the basis of this device. For purposes of illustration only and in the following formulae we are presenting this helical spring as having certain specified characteristics but others may be substituted in the manner which has been and is to be explained. We show a spring motor of fourteen active coils of an outside diameter minus wire size of six hundred and twenty-five thousandths. The rate of this particular spring, as later defined, is ninety-one pounds per inch of deflection and the weight of active mass in the spring runs to ninety-six thousandths of a pound. We later explain how these important factors may be changed in order to secure desired results and the formulae and principles which must be employed in so doing.

We anchor the rearward end of this helix within the ball 114 by attaching it to member 115 thereof by a screw 134 which passes through a suitable opening in wall 115 and engages an opening 136 formed between resilient lips 137 pressed from a "speed nut" 138. See Figures 19, 20, 21 and 27. We pass the other or frontward or left end of helix 131 through an opening 140 formed in member 116 of ball 114. As will be best seen from Figure 22 this opening has free spaces 141 and 142 above and below respectively the point of emergence of the helix but at the sides 143 and 144 engages the helix fairly closely. This end of the spring terminates in an escapement loop 145 the angular relation of which to the body of the helix and the first coil 146 is important as will later appear.

The foregoing arrangement of opening 140 and the forward or escapement end of the helical spring will be clearly seen from Figure 22. Provision of the relatively large opening 141 and 142 above and below the leading coil 146 of the helix and the close restriction of the opening at the sides 143 and 144 is to make the escapement action possible. As the spring oscillates it is necessary to supply space for an up-and-down movement above and below the leading end of the spring but to prevent side sway by close restriction. Limitation of this movement must be by engagement between the elements of the escapement and the support, according to principles previously described.

As also will be clearly noted from Figure 22 it is desirable that the extreme forward and front contacting loop 145 of the escapement be initially placed in a plane which intersects the longitudinal axis of the helix and is also horizontal.

As will be most clearly seen from Figures 12, 16 and 17 of this specification this escapement provides a three point contact between the motor and the support. The outer portion 148 (leftward as seen in Figure 16 and rightward as seen in Figure 17) of hook 145 provides contact on the side of support 111 relatively distant from the bird. Points 149 and 150, upon the hook and first coil respectively, form two points of contact upon the other or near side. These three points, of which only two are operative at one time, one on the left side of the post and one of the two on the right side contact are very important in the operation of the escapement as has been pointed out previously. It is to be noted that hook 145 has an open end 151, used in this specification as a point of reference, and important in the operation of our device merely as preventing conflict or damping engagement between the loop and the first coil of the motor.

We have now described a portion of our spring motor and embodied escapement which give to the device its regular and pre-set oscillation in its descent. After having described the means by which rotation is obtained we shall present the physical principles underlying the foregoing.

The direction and rate of bodily rotation of the device are determined by (1) the angle between the portion of the escapement nearer the motor and the adjacent coil of the spring thereof, hereinafter called the "escapement angle," (2) the relation between the damped and un-damped portions of the coils, and (3) the spacial relation between the side of which the coils are damped (or undamped) and the direction of opening of said escapement angle, all of which will be clear from a consideration of Figures 18, 19, 23, 24, 25 and 26 and the following portion of this specification. The second and third factors are more important. "Rate of rotation" reflects the number of times the motor and its load encircles its support in a given distance.

To secure desired rotational characteristics, therefore, we change this escapement angle and also damp a portion or all of the coils on one side of the spring motor and leave the coils on the other side free to vibrate. Thus as will be seen in the figures ordinarily our spring motor takes a slightly arcuate form, the damped coils representing a shorter arc and the undamped coils a longer arc, indicated in Figures 18 and 19 as 153 and 154 respectively. An exception is described in connection with Figure 27.

The first factor is of least relative importance. The spring motor tends to rotate bodily into or toward this angle, thus placing this angle on the trailing side. More important, however, is the positioning and extent of the damping of the coils. The tendency of rotation is away from the damped portion of the coils, the number of damped coils determining the rate of rotation. The increase of the rate of rotation of the motor as it descends, aside from increasing the escapement angle, depends solely upon the number of individual coils which are damped. So long as one coil is moved away from its adjacent coil far enough so that there is no damping no rotational effect is felt from that one coil. Then if one wishes to increase the rate of rotation he merely damps additional coils. The extent of damping between the coils is immaterial so long as the freedom to vibrate between adjacent coils is prevented.

The motors of Figures 23 and 24 are presented to illustrate this feature of our invention and for comparison with the motor of Figure 18.

Motor 161 of Figure 23 consists of a series of coils 162 which are damped on their short arc 163, as defined above, and free for unlimited vibration on the long arc 164. Forward coil 165 is extended to form escapement 166 having opening 167 and embracing solid post 111'. Angle 168 between the escapement and the first coil will be noted as relatively large. Although this angle tends to cause rotation counterclockwise as in Figure 18 this effect is overbalanced by the damping of the coils upon that side. Since the relation between the undamped and damped portions of the coil is more powerful than the size or position of the escapement angle the rotation in this case is clockwise, as indicated by the arrow. Motor 161 may be supported and mounted as previously described. It should be remembered that some damping is always necessary to counterbalance the normal tendency of a helix composed of completely undamped coils to rotate bodily into the escapement angle.

Figure 24 shows a motor as commonly built in accordance with this invention with certain of the coils damped and others free. Ordinarily it is not necessary to carry the damping throughout the entire spring. Motor 171 includes three series of coils of which series 172, most removed from the escapement, is damped upon one side, central series 173 with undamped coils and forward series 174 also damped. Escapement 175 embraces a post 111' and supplies an escapement angle 176. In this instance rotation is counterclockwise as indicated by the arrow in the direction of the arrow and away from the opening 177.

Figure 25, which is convenient for comparison with Figure 26, shows in fragmentary form a motor 180 including coils 181 terminating in an escapement loop 182 having a hook 183 and escapement angle 184 adjacent an outer loop 185. It is by increasing or diminishing this angle that one important factor of the tendency to rotate may be controlled, although as previously stated this angle is of less importance than the damping of the motor coils.

In Figure 26 we show a portion of a spring motor 190 designed to be entirely free of rotation about the post and therefore to descend perpendicularly. Coils 191, a portion of those making up the motor, are damped at 192. The remainder of the coils 193, of which only two are shown, are free. Escapement 194 is as previously described except that escapement angle 195 is

very slight. The slight tendency of angle 195 to cause rotation in a counterclockwise direction is overcome by the tendency of damped coils 192 to cause clockwise rotation. This combination of forces results in perpendicular descent.

Figure 27 shows a convenient form of that embodiment of our invention in which the motor and its load descends perpendicularly, as in Figure 26 and production is even further simplified. In this case a motor 211 is not damped by contact of its coils but a similar effect is obtained. All coils 212 are free to vibrate, except those anchored at the end of the motor relatively distant from the escapement 214 and the one nearest the escapement. The wire of the most distant coil 215 is cut off sharply at 216 at a right angle to its longitudinal axis and near the middle of the coil. It is anchored within a ball 217 as previously described by a "speed nut" 218 and screw 219. As this screw is tightened the cut-off coil 215 causes the entire motor to be drawn slightly to the right and to form a closer contact with the right end 220 of opening 221 than with the left end. This pressure as at point 221 overcomes the tendency of escapement angle 222 between the escapement and first coil 223 to cause the device to rotate in a counterclockwise direction. The two forces being equal the device descends without rotation.

When use is made of a metallic or other strong container for the motor, in place of a light ball as in the structure we use as illustrative, we have found it convenient in production to damp the coils by a method which is not illustrated but can readily be understood by reference to Figure 27. When ball 217 is made of material of sufficient strength helix 211 is placed therein with the cut-off coil 215 well spaced from the container and screw 219 tightened. This action draws the spring, longitudinally considered, into the form of an arc and is a convenient method of forming a structure such as that shown for example in Figure 23, but with the curvature on the opposite side of the helix.

In all forms of the invention the support or post should be formed of relatively hard metal so that its surface is not pitted by the escapement. Such lack of smoothness upon the surface interferes with smooth operation and accurate timing. Another precaution to be observed in such embodiment of our invention as that of the woodpecker toy just described is to make sure that no part other than the contact points of the escapement engages the support and interferes with the smooth operation of the escapement. For example if the beak of the woodpecker engages the post slippage results because the beak then usurps the action of the upper right contact point but so far separated vertically from the plane of the opposite or leftward point that clamping action is destroyed and the entire device slips and falls.

In order to secure the full results of our invention it is desirable carefully to determine and apply certain critical factors to a helical spring, as well as to its escapement, as previously explained in connection with a leaf spring. These factors may be determined within wide latitudes.

It is first necessary to calculate the "spring rate," which is the number of pounds required for each inch of deflection, as follows:

$$R=\frac{P}{F}$$

wherein:

R=rate.
P=load in pounds.
F=deflection in inches.

Unity is assumed. We have found a helical spring of a mean diameter of six hundred and twenty-five thousandths of an inch to be convenient for the toy which we have just described, and with 14 active coils. The diameter of the wire which we employ in inches is .120. The modulus of steel wire is eleven million five hundred thousand.

The usual formula for deflection is, values used by us in the example described being inserted where appropriate:

$$F=\frac{8PD^3N}{Gd^4}$$

wherein (with the above value):

F=deflection in inches.
P=load in pounds (1.00).
D=mean diameter of spring, i. e., outside diameter minus wire size (.625").
N=number of active coils (14).
G=modulus of the material in torsion, i. e. steel, 11,500,000.
d=wire diameter in inches (.120").

When the above stated factors are substituted:

$$F=\frac{8\times1.\times(.625)^3\times14}{11.500{,}000\times(.120)^4}=.011''\text{(deflection with 1 lb.)}$$

Thus with an assumed weight of unity the deflection in inches is .011.

With this value established and by the use of the first formula cited above we secure by the use of the following formula a spring rate as follows in pounds per inch of deflection:

$$R=\frac{P}{F}=\frac{1.00}{.0\ 1}=91\text{ pounds per inch}$$

Thus having learned that the spring rate is ninety-one pounds per inch and by this insertion of the weight of the spring actually used in one example only of our invention by the application of Ricardo's formula the following results are secured:

$$n=531R/W$$

wherein:

n=complete number of free vibrations per minute of the spring as vibrating in itself.
R=rate of spring (91 pounds per inch of deflection).
W=weight of active mass in the spring (.096 lb.).
d=wire diameter (.120").
D=mean diameter (.625").
N=number of active coils (14).

By the application of the above formula with a substitution of known values it has been determined that the spring in question has frequency of 16,344 cycles per minute or 2722 per second as follows:

$$n=531\sqrt{91/.096}=16{,}344\text{ cycles per minute}$$

From the previous portion of this specification it is evidenced that for various applications different inherent vibrational frequencies predetermined are desirable. By varying the "R" and "W" values in Ricardo's formula any desired result can be readily obtained.

We are aware that it has been proposed to use a leaf spring for purposes which have a slight superficial resemblance to ours. For ex-

ample a toy woodpecker has been mounted upon a post by means of a leaf spring and descends "in a series of jerky movements." The proposer goes on to say "There will be a tendency of the bird to wobble sidewise." Such jerking and wobbling are very different from the pre-controlled and regular oscillations and rotation made possible by the present invention.

Although many different applications making use of a flat spring have proved the effectiveness of our spring motors made upon that basis, for many purposes, particularly when a considerable load is to be carried, we have found the relatively greater efficiency per unit of metal of a helical spring very helpful.

The advantages of our invention will have been apparent from the foregoing specification and attached drawings, and reflected in the subjoined claims. They include the provision of method and means whereby the force of gravity and resilience of a spring are utilized to carry a load downwardly, and if desired rotationally, in a series of fully predetermined and pre-timed intermittent steps. They include the provision of an improved spring-powered motor embodying or carrying an escapement.

We claim:

1. In a device of the character described, a generally vertical support, a cantilever spring of which one end is free and the other end embodies an escapement, said escapement consisting of formations spaced and separate from each other for mounting said spring upon said support for bodily descent therealong in regular intermittent movements and with its free end extending outwardly from said support and free of contact therewith, two of said formations being engageable with one side of said support and another formation being engageable with a side of said support opposite that engaged by said two formations, the distance between said two formations upon the same side of said support being at least one half of the width of that portion of said support disposed between said two formations and said other mentioned formation and said support and said escapement during all phases of each cycle of movement and rest being entirely free from engagement with each other except at the points of contact between said formations and said support.

2. In a device according to claim 1, the end of said cantilever spring which embodies said escapement being formed with an opening for said support and then being bent first at substantially a right angle to the main body of said spring and thence back toward said support and with its end engageable with said support at a point spaced from the main body of said spring, sides of said openings and said end thereby acting both as an escapement and as a mount for said spring for intermittent bodily descent therealong in a series of regular intermittent movements, said end and the side of said opening relatively adjacent thereto being engageable with said support upon the same side thereof.

3. A device according to claim 1 wherein said escapement encircles said support and one of said two formations engageable with the same side of said support at said distance is disposed above and the other is disposed below the plane of such encirclement.

4. In a device of the character described, a generally vertical support, a gravity-operated spring motor including an escapement, said spring motor being formed of a leaf spring, said leaf spring being disposed with its flat sides in generally horizontal planes, an end portion of said spring being bent at substantially a right angle to the main body of the spring to form a first extension and then again bent back upon itself at right angles to said first extension in a direction parallel to the main body of said spring to form a second extension, said main body and said second extension each being formed with an opening for the reception of said support, said openings being aligned, the peripheries of said openings in said main portion and said second extension thereby both acting as an escapement and also as a mount for said spring for bodily descent therealong in a series of regular intermittent movements and with the free end of the spring extending away from the said support.

5. In a device of a character described, a generally vertical support, a gravity operated spring motor including an escapement, said spring motor being formed of a leaf spring, said leaf spring being disposed with its flat sides in generally horizontal planes and one free end being disposed relatively distantly from said support, the other end portion of said spring being bent at substantially a right angle of the main body of the spring to form a first extension and then again bent back upon itself in the direction of said free end of said spring to form a second extension, said main body and said second extension each being formed with an opening for the reception of said support, said openings being aligned, the peripheries of said openings in said main portion and said second extension thereof acting both as escapement and also as a mount for such spring for bodily descent along said support in a series of regular intermittent movements.

6. In a timer, a generally upright support, and a gravity-operated spring timing motor including an escapement, said motor including a cantilever leaf spring free to vibrate at one end and the other end of said spring including said escapement, said escapement having formations by which said spring may be mounted upon said support near the top thereof for descent therealong in a series of pre-timed and regular intermittent movements with the free end of said spring extending away from said support, two of said formations engaging one side of said support at vertically spaced points and at least one engaging an opposite side, calibrations upon said leaf spring at different distances from its point of attachment to said support, a weight, and means for fixing said weight to said spring in accordance with said calibrations.

7. In a timer, a gravity-operated spring timing motor, a support therefor, a mount for said support, said mount including means for maintaining said support in a vertical position and at a plurality of angles to the vertical, said motor comprising a cantilever spring and an escapement, said escapement including a plurality of formations by which said cantilever spring may be mounted upon said support near the top thereof for intermittent movement downwardly therealong, two of said formations being engageable with said support upon one side thereof at spaced points and another being engageable with the side of said support opposite to that which is engaged by said two formations and the free end of said spring extending away from said support, calibrations upon said support, a stop movable along said support for limiting the downward travel of said motor, means for fixing said stop to said support in accordance with said calibrations.

calibrations upon said leaf spring at different distances from its point of attachment to said support, a weight, and means for fixing said weight to said spring in accordance with said calibrations.

8. In a device of the character described, a generally vertical support, a gravity-operated spring motor including an escapement, said spring motor being formed of a leaf spring one end of which is free and the other end of which includes escapement means for attaching said motor to its support at substantially a right angle thereto and for intermittent bodily downward movement therealong, said attaching means including two formations engageable with one side of said support at a distance between the lines of engagement of said two formations with said one side of said support no less than one half of the width of said support in a direction along the long axis of said spring and another formation

engageable with said support upon the side thereof opposite that engaged by said two formations, said support and said spring motor during all portions of each cycle of movement and rest being entirely free from engagement with each other except at the points of contact between said formations and said support.

ELSIE BREDIMUS.
WARREN DUNHAM FOSTER.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
350,766	Pattyson	Oct. 12, 1886
1,050,234	Rowe	Jan. 14, 1913
1,649,645	Allen	Nov. 15, 1927
1,677,463	Snedeker	July 17, 1928
2,149,677	Hojnowski	Mar. 7, 1939