

Nov. 17, 1936.

R. D. SMITH

2,060,833

SPEED GOVERNED MOTOR

Filed April 9, 1929

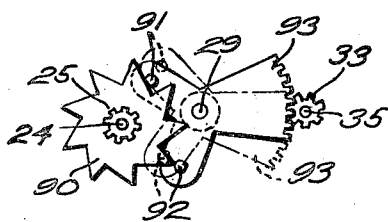
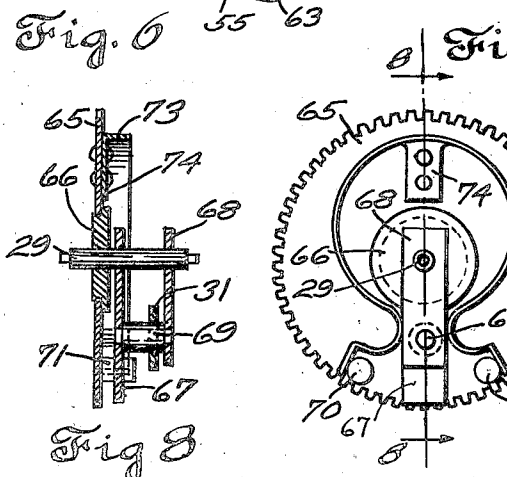
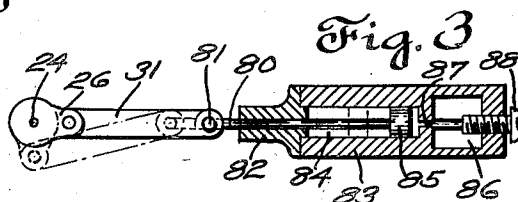
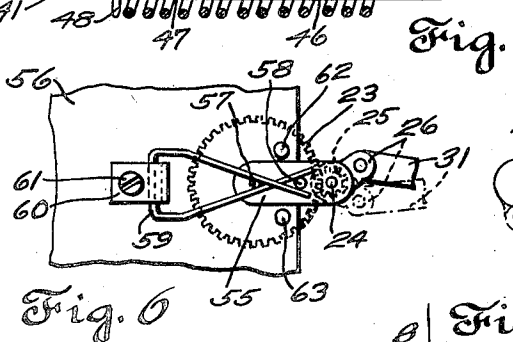
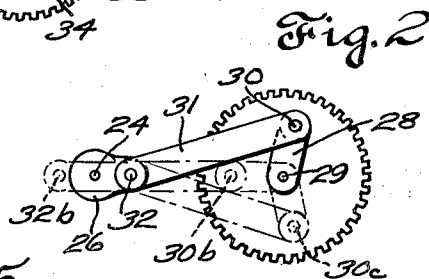
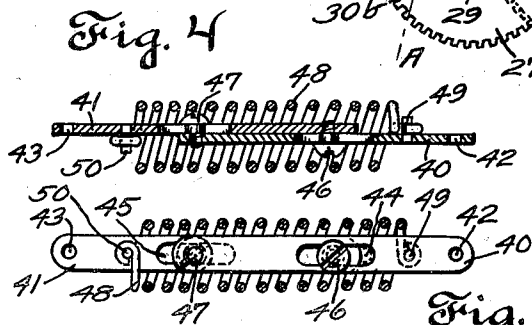
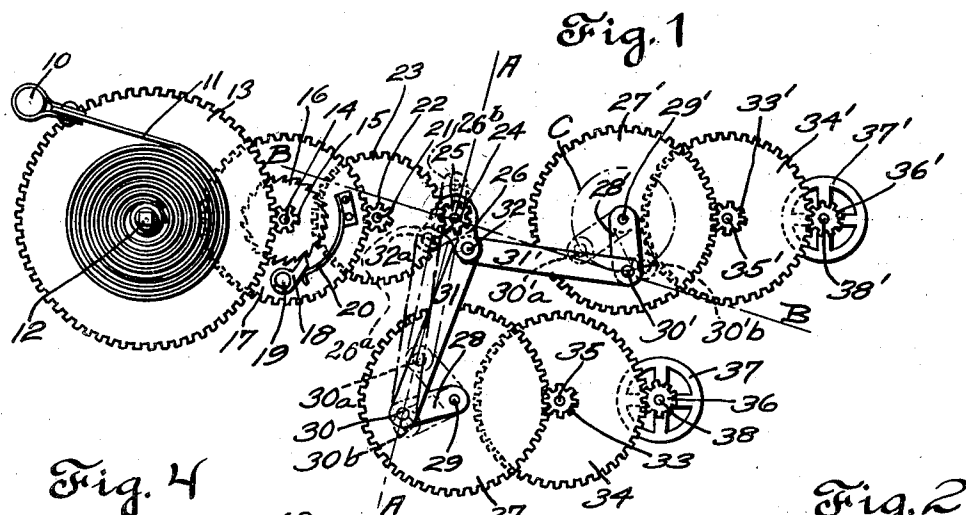


Fig. 9

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2,060,833

SPEED GOVERNED MOTOR

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Application April 9, 1929, Serial No. 353,792

31 Claims. (Cl. 185—38)

This invention relates to retarding and speed governing mechanism for prime movers, more particularly motors deriving their power from the action of a spring, a weight or electro-magnetism, and to retarding methods.

The present improvements concern principles of mechanical action which may be embodied in a great variety of mechanisms but which differ from any prior expedients in this art for accomplishing the same purpose by clearly defined distinctions of mechanical theory and practice hereinafter set forth and claimed.

It is the general purpose of this invention to oppose the rotative tendency of the prime mover, or of some part rotated thereby in a continuous direction, by causing the prime mover or the said part impelled thereby to produce a reciprocating movement of some mechanical element the characteristics of whose movement, as necessary to permit motion of the prime mover, shall be determined by a novel arrangement of mechanism or mechanisms and operatively transmitted in a novel manner to the prime mover for the purpose of governing its speed and characteristic of action.

It will be seen from the following description that the prime mover may employ a crank and connecting link, or an ordinary form of escape wheel and vibrator co-acting therewith as common to the alarm train of ordinary clock work for instance, for some of the purposes of this invention and that for other purposes of the invention including that of avoiding the undesirable results of sudden starts and stops in the action of the mechanism, a variety of expedients is provided some alternatively and some jointly usable.

A particular object of this invention is to provide a retarding and speed governing mechanism of isochronous qualities approaching or equaling the pendulum as well as the marine type of clock escapements, but of greatly more compact nature than the former and substantially independent of the factor of gravity, while greatly more rugged and durable and independent of lubrication and larger in size than are the conventional types of marine escapements employing hair springs and like delicate parts.

In the drawing, Fig. 1 is a diagrammatic view of a prime mover in the form of the ordinary train of a spring motor to which is shown applied one form of my novel retarding and time governing means.

Fig. 2 shows a modification of the arrangement for connecting my retarding means to the prime mover.

Fig. 3 shows a substitute for the swing-gear retarding mechanism, a plurality of which may be employed for some of the same advantages residing in the use of two or more co-acting swing gear systems.

Fig. 4 is a sectional view of a resilient connecting link which may be employed for connecting the retarder to the prime mover.

Fig. 5 is a face view of the same resilient link.

Fig. 6 shows a yielding bearing construction for the crank.

Fig. 7 shows a resilient means for transmitting force to and from the slow gear of the swing-gear system.

Fig. 8 is a view in vertical section taken on the plane 8—8 in Fig. 7 looking in the direction of the arrows.

Fig. 9 shows an escape wheel and verge which may be substituted for the crank and connecting link of Figs. 1, 2, 3, 7 and 8.

Referring to the parts of the drawing in the foregoing figures and with particular reference to Fig. 1, I designate the usual parts of a spring motor as the frame post 10, the coiled band spring or power spring 11, the squared winding pinion 12 to which the inner end of spring 11 is made fast, the main or first gear 13, the second spindle 14, to which is made fast the pinion 15 (which is in mesh with gear 13) together with the ratchet wheel 16. Loosely rotatable on spindle 14 is the second gear 17 carrying the click pawl 18 pivoted to gear 17 by the stud 19 and yieldingly pressed into engagement with the teeth of ratchet wheel 16 by the spring 20 mounted on gear 17. The third spindle 21 carries in fixed relation the pinion 22 (in mesh with gear 17) and the gear 23. The fourth spindle 24 carries the pinion 25 (in mesh with gear 23) and fast to pinion 25 the crank 26.

I am aware that it is old to provide a crank such as part 26 with a connecting link extending therefrom to some swinging member which the turning of the crank will cause to oscillate as a means of performing some work, or even idly, for the purpose of slowing up the turning of crank 26 and thereby the speed of the spring motor as a whole including winding arbor 12, but I have found all prior devices for this purpose, so far as known to me, to be of extremely poor isochronous quality and quite useless for many needs to which it would otherwise be of great advantage to apply a swinging retarder as a substitute for pendulums and marine movement escapements. A practical purpose for which this need is particularly apparent resides in the desire to control with time keeping precision the time of auto-

matic action of some relatively heavy mechanism such as an electric switch or a gas valve in which use, for timing accuracy, it is necessary to employ a relatively fast moving wheel of a clockwork train and it is well known in the art that any wheel of an ordinary clock train traveling as fast, say, as to complete one revolution in fifteen minutes, or even in a longer period such as one half hour, must be so geared from the source of power that it is capable of exerting very little torque for the reason that there is so little gear reduction between a wheel of this speed and the escape wheel in the design of conventional marine movements, this condition being necessitated by the inability of marine escapements to handle much power if exerted upon the verge and the lever by the escape wheel.

The resort to the crank and connecting link method of retarding a clock train as heretofore practiced has failed to be successful from the standpoint of good time keeping and of even, regular beat of the reciprocating retarder because of the employment for the purposes of such retarder of a pivoted or swinging body of considerable weight relative to the other parts of the movement and performing as a rule less than one complete turn of oscillatory movement as the time retarding means for slowing up the action of the prime mover or power train of the spring motor. The characteristic of running action produced has been jerky, noisy, and of poor isochronous effect and in attempting to work with this kind of retarding device I have been compelled to devise and resort to a quite different principle of mechanical arrangement and action to secure desirably good time keeping and uniformity and quietness as well as desirable slowness of "beat".

Specifically, in a preferred form of my invention, I have substituted for a relatively heavy oscillating retarder of small angular movement, a series of inter-geared wheels which may individually be as light in weight as the usual wheels of a power train and in fact some of the same kind of wheels may be used with resulting simplicity and economy of manufacture. I may term this retarding system of light inter-geared wheels a "swing-gear" and will so hereinafter refer to it and while it is comprised entirely of old and well known elements, its employment for this purpose and its combination with the ordinary elements of a power train is believed to be new and is known to produce a distinctly novel and advantageous result of time keeping action.

Referring to Fig. 1 an example of such swing-gear system is comprised in the gear 27 which may turn fixedly with the arm 28 on spindle 29, the arm 28 in the arrangement shown having pivoted at 30 to its free end the link 31 the other end of which is pivoted at 32 to the free end of crank 26. In mesh with gear 27 is the pinion 33 which turns fixedly with the gear 34 on spindle 35. In mesh with gear 34 is the pinion 36 which turns fixedly with a light balance wheel 37 on the spindle 38.

Rotative movement of the crank 26 between positions 26a and 26b will cause the arm 28 to swing back and forth between the limits of its travel indicated by broken lines at 30a and 30b, this limit of travel being produced purely by the relation between the radial length of crank 26, the radial length of arm 28 and the distance between spindles 24 and 29. As will be observed in Fig. 1 this relation, as there shown, makes a full turn of the crank 26 swing the arm 28 less

than 180 degrees rotation and of course by adjusting the radial length of crank 26 to be shorter or the radial length of arm 28 to be longer, or both, the amount of angular swing of gear 27 corresponding to a complete turn of crank 26 will be reduced and the torque exerted by crank 26 will have a correspondingly greater leverage upon the arm 28, both of these factors resulting in lessening the retarding effect of the swing-gear upon the power train and thereby permitting the power train to run at a faster speed under the urge of a constant power in the power spring 11. Conversely to adjust the radial length of crank 26 to be greater in proportion to the radial length of arm 28 causes a slower speed of the power train because of the torque of crank 26 exerting a smaller leverage upon arm 28 and causing a greater oscillating of arm 28. With all of this possible variation of leverage and movement relationship, there is represented in the employment of relatively far moving, light weight parts such as wheels 34 and 37 caused to perform multiple rotations by the relatively small degree of swinging movement of arm 28, a form of mechanical resistance or work to be done by the gear 27 in its swinging movements which is quite different in nature and resultant action than would be accomplished by the old expedient of substituting for the gear 27 a heavier swinging weight to be moved by arm 28 for affording a corresponding retarding load, or would be accomplished by the use in place of the parts on spindle 35 of a correspondingly heavier weight than gear 34 to be rotated in fixed relation with the pinion 33. In other words, the novel proposal of this invention is that any desired increase in retarding load be accomplished by the addition of light weight and relatively far moving members instead of by increasing the weight of one or two relatively small moving members, because the time keeping qualities which result from the former construction, possessing relatively high potential inertia as compared with kinetic inertia, are much inferior to the time keeping qualities resulting from the latter construction possessing relatively small potential inertia as compared with its kinetic inertia, as a form of resistance to the turning tendency of crank 26.

Other advantages result from the less total weight of the mechanism, the ability to secure in a compact, low cost mechanism, a slower beat with equal dependability of action, and a better time keeping evenness of beat, less requirement for careful attention to the parts being accurately balanced or operating in any particular position with relation to the pull of gravity, and freedom from the delicacy, lack of power, liability to disarrangement, breakage, etc. of hair spring escapements. For instance, when such a movement is operating with its spindles in a vertical rather than a horizontal position, the absence of relatively heavy parts does away with the variable hindrance to good time keeping characteristic of a heavy rotating member having its weight supported by the end thrust of its hub.

I have further found this form of retarder to be a successful compromise between the relatively more delicate forms of escapement employed in time pieces and the relatively high speed, continuous direction forms of retarders such as fans, friction governors, vibrators, and so forth. The latter are customarily geared up so far from their source of power that the member of the power train acted upon by the fan, friction brake, or vibrator, possesses very little

torque and while quite sure to keep going when once started, possesses so little surplus power for starting purposes that it tends to be unreliable and relatively unsuitable for uses where frequent self starting is called for. I have found in the forms of retarding mechanism constituting this invention an easy and dependable ability to start, a good time keeping characteristic of action, a freedom from the disadvantages of parts of high speed and low torque requiring freedom from friction and dependence upon lubrication, and a considerably greater tendency to remain constant in running speed despite variations in the power exerted by spring 11 in Fig. 1 resulting from different degrees to which the latter is wound.

In my work with this form of retarding mechanism there developed a strong tendency of the crank 26 to "whip" or snap past its dead center relation to the connecting link 31 as, for instance, from its full line position 26 in Fig. 1 to its dotted line position 26a. Such whip or snap was evidently due to even such small looseness at the pivots and in the mesh of the gears as is essential to free running in practical construction, for even this small amount of looseness, however good the fits be made, permitted a substantial uncontrolled angular movement of crank 26 to either side of its dead center relation to crank 31 represented by the line A—A in Fig. 1. This whip of the crank occurs, of course, when the arm 28 is at the very extreme of its swing and therefore about to reverse its movement in which condition the members of the swing-gear system are at rest or moving with least speed. Therefore after the crank has completed its whip past dead center its speed of motion is abruptly checked as the slack of the fits is taken up and it begins to pull the swing-gear into opposite motion, with the result that a sharp "crack" of surprising intensity occurs making an undesirably loud noise for many purposes where a quietly running movement is desired such as in the time control of radio circuits, domestic table appliances such as bread toasters and so forth for cutting off the supply of current thereto.

I have devised and found successful a variety of means for overcoming this objectionable characteristic which will now be described. The first and most complete of these is shown in Fig. 1 where any swinging body possessing inertia, or if desired, a duplicate of the first described swing-gear system may be provided and furnished with a connecting link 31' connecting the arm 28' to the same pivot 32 on crank 26 to which is connected the link 31 and for simplicity it may be assumed that all the parts of this secondary swing-gear system are identical in construction and action with the first described swing-gear. I have therefore designated each of the corresponding parts by the same reference numeral primed. It is not necessary, however, that the mechanism providing inertia to be overcome by link 31' take any definite form and to obtain its useful function of controlling and checking the movement of crank 26 past its dead center relation to link 31 it is only necessary that the crank 26 be so connected by link 31' as to be obliged to do work in its temporarily and otherwise uncontrolled travel from full line to dotted line position in Fig. 1, and that the work presented to the crank for this purpose consists preferably and mainly of inertia rather than of friction.

It will be understood that crank 26 travels past the line A—A at two diametrically opposite positions one of which is, during its travel from position 26 to position 26a and the other of which is proximate position 26b in Fig. 1 and the link 31' must therefore be governed to exert this same checking effect upon the crank twice during each complete revolution of the crank. It will be found an effective silencing arrangement to connect the end of link 31' to a swinging retarder so disposed that said end of the link is caused to travel in a circular arc such as C and that a line drawn through the pivot 24 of crank 26 shall be tangent to this arc C and substantially at right angles to the line A—A. For clearness of understanding such a line is shown on the drawing in Fig. 1 and labeled B—B. I am not limited, of course, to connecting the crank ends of links 31 and 31' to the same pivot 32 on crank 26 nor to the employment of two similar links, nor to any of the exact construction and arrangement pictured in Fig. 1.

Fig. 2 shows an arrangement wherein the pivot 24 of crank 26 is so positioned relative to the pivot 29 of arm 28, and to the equal lengths of the crank 26 out to the pivot 32 thereon for link 31, and of arm 28 out to the pivot 30 thereon for the same link, that the length of link 31 just reaches from pivot 30 to pivot 32 when both the crank 26 and the arm 28 extend to the left in alignment with each other as indicated in broken lines in Fig. 2. This condition makes it possible for arm 28 to continue its swing past a dead center relationship to link 31 which it can never assume in the relationship of parts shown in Fig. 1 and the resultant action is that starting from the full line position of parts in Fig. 2 the first half swing of the crank brings pivot 32 to the position 32b and the pivot 30 to the position 30b. The crank 26 and the gear 27 continue turning in their same respective directions so that when the pivot 32 has completed a full turn to its full line position again, the pivot 30 has traveled to the position 30c. A similar kind of action takes place on the continued rotation of crank 26 in the same direction resulting in travel of pivot 30 between its full line position to the position 30c in alternate directions respectively at each successive full rotation of the crank 26. This arrangement and the resulting action 50 causes the gear 27 and any other additional retarding members such as 33, 34 and 36 inter-gearred with same, to perform a longer duration of movement in a continuous direction than is the case in Fig. 1 but is likewise free from any non-starting or dead center relation of parts that might cause the stopping of the movement for lack of power at any point. It should further be noted in connection with this modification that because of the fact that the arm 28 and the crank 26 are both in full motion at the time of passing their dead center relation to link 31 relief is obtained from the objectionable tendency of the crank to be brought up sharp and noisily after passing its dead center position.

Figs. 4 and 5 show a different expedient for silencing the abrupt whip of the crank in the form of a connecting link to take the place of link 31 and formed as a compound member comprised of the relatively and lengthwise slidable parts 40 and 41 carrying respectively a hole 42 for pivot 30 and a hole 43 for pivot 32 and constrained in surface engagement and in lengthwise alignment by the slots 44 and 45 engaged respectively by the screw studs 46 and 47.

The distance between holes 42 and 43 is maintained at a normal dimension by the spring 48 engaging at one end a stud 49 in part 40 and at the other end a stud 50 in part 41. It will be clear that this spring can compress or elongate and permit a corresponding relative sliding movement of the link parts 40 and 41 to act as a shock absorber and noise deadener when this link is employed in the place of link 31 in the constructions shown in Figs. 1 and 2 or in any other applications where a resilient link is desirable.

In Fig. 6 I show the crank pinion 25 in mesh with the gear 23 of the power train but having its spindle 24 supported by a frame bracket 55 which may be pivoted outside the main frame plate 56 and preferably pivoted at a point substantially concentric with the pivot of gear 23. I designate that point as 57 and its position may be varied with relation to the pivot of gear 23 but the distance between pivot 57 and pivot 24 should not be less than the distance between pivot 24 and the pivot of gear 23. The frame bracket 55 carries a spring stud 58 pressed upon in opposite directions respectively by the free ends of a spring 59 clamped in fixed position to the frame 56 by the strap 60 and the screw 61. Bracket 55 is therefore free to yield about its pivot 57 against the resistance of spring 59 within limits determined by frame pins 62 and 63. The travel of crank 26 from its full line to its dotted line position in Fig. 6 represents that proportion of its travel past the line A—A in Fig. 1 during which it tends to whip or snap and the ability of the bracket 55 to yield in a manner that will permit compensating movement of pivot 24 while maintaining the correct mesh between pinion 25 and gear 23 constitutes a shock absorbing and noise deadening expedient.

Another way in which I may absorb the whip of the crank 26 is shown in Figs. 7 and 8 wherein the gear 65 corresponds to the gear 27 of the swing train and may be made fast to the spindle 29 by a press fit thereon of its hub 66. Loosely turnable on spindle 29 I may provide the double armed member composed of arm 67 and arm 68 solidly riveted together by the stud 69 the latter corresponding to the pivot 30 for the connecting link 31. Two pins 70 and 71 are carried near the periphery of the gear 65 to act as limits for the relative movement of the arm 67 and the gear 65. The arm 67 is normally maintained midway between these two pins 70 and 71 by a horse-shoe shaped, leaf spring 73 mounted on the gear 65 at 74 and having the position of its free ends determined by resting on the pins 70 and 71. This construction will be self explanatory, the force transmitted to and from the gear 27 and the arm 28 (or in the modification illustrated, between the gear 65 and the arm 67—68), acting through the resiliency of the spring 73 with shock absorbing effect to dampen the whip of the crank 26 and silence its noise. This construction could likewise be interposed between pinion 25 and crank 26 or between pinion 33 and gear 34, etc.

In Fig. 3 as a substitute for any of the retarding devices referred to in the foregoing disclosure is shown a construction whereby the crank 26 and link 31 act upon a piston rod 80 to which link 31 is pivoted at 81 and which is guided in the cap 82 completely closing one end of a container body 83 to form the cylinder or cavity 84 in which works the piston 85 which travels with the rod 80. The body 83 contains an auxiliary chamber 86

having communication with the cylinder 84 by means of a small orifice 87 the opening of which into chamber 86 may be controlled by the needle valve screw 88. Chamber 86 may be made as large as desired and given a vent to the exterior, or not, as may be desired. The fluid contained for impeding the action of piston 85 may be a gas or a liquid. The resistance to the travel of piston 85 will depend on the degree of opening of vent 87 into the chamber 86 or if vent 87 is entirely closed by the screw 88 the loose fit of piston 85 in its cylinder or the provision of valves in the piston may permit a retarding passage of the contained fluid from one side of the piston to the other.

In Fig. 9 is shown an escapement mechanism which may take the place of the crank 26, the connecting link 31, and the arm 28 and comprises an escape wheel 90 fixed to the pinion 25 to turn on the spindle 24 the passage of the escape teeth when the wheel 90 rotates in clockwise direction rocks the verge pins 91 and 92 alternately back and forth between their full line and broken line positions correspondingly oscillating the gear segment 93 between its full line and broken line positions. The pinion 33 may then be placed in mesh with the segment 93 so that the balance of the parts common to Fig. 1 and not shown in Fig. 9 including the power train and the retarding or swing-gear trains may be applied to co-act with the two pinions 25 and 33 in a manner and for the purposes hereinbefore fully described.

In practical constructions I may find it to advantage in the use of two separate swing-gear systems, or parts thereof, as shown in Fig. 1, to so arrange the wheels and spindles that parts of either or both swing-gear trains are rotatable upon spindles of the power train or upon spindles of the other swing-gear train where two swing-gear trains are employed or upon separate spindles co-axial therewith for the purposes of compactness.

With reference to the parts of the winding ratchet 16, 18, 19 and 20, I am not aware that parts for this purpose have formerly been placed on a higher speed wheel than that carried by the winding arbor 12 which is directly acted upon by the spring 11 in former constructions of clocks and spring motors and the object of so placing this winding ratchet in the present improvement is to secure less angular movement of the winding spindle 12 corresponding to the seating of click pawl 18 in successive teeth of the ratchet wheel 16 because ordinarily I desire to employ the winding arbor 12 to carry some actuating member to perform the time controlled work of tripping or in some manner causing an operative effect upon an electric switch, gas valve or other piece of apparatus. The control, or time setting handle, commonly also carried by winding arbor 12, is thereby given finer possible stages of time setting.

In the use of light inter-geared wheels to comprise my swing-gear system or the power train itself I am not, of course, limited to any small number of such wheels as the quantity may be multiplied indefinitely and their gearing ratio varied at will within the principles hereinafter claimed and I may dispense entirely with any balance wheel member however light such as the parts 37—37' shown in Fig. 1.

It will be obvious that the gear 27 may comprise merely a segment such as 93 or vice versa. I believe it is broadly novel to retard the oscillating verge pins 91 and 92 by means of a seg-

ment such as 93 and a single oscillating weight or a train of light gears such as 35, 34, 36, plus any others that it may be of advantage to add, as it is to so control and retard the movements of a crank such as 26.

To summarize the accomplishments residing in these improvements there is provided a sure starting and good time keeping spring motor which may be heavily powered to exert strong torque usable for mechanical purposes and which does not require the large space and positional accuracy of a pendulum with relation to gravity and which has none of the delicacy, low torque action, and liability to derangement or impairment characteristic of hair spring clock escape-
ments and which possesses a slow measured beat accomplished by small and light parts susceptible to compact arrangement and capable of running smoothly and noiselessly in whatever position placed.

As the means by which these accomplishments have been made possible reside as largely in principles of mechanical action as they do in actual mechanisms in which those principles may be embodied I consider that this invention is one of method as well as one of mechanical combination and it is so defined in some of the following claims which will be interpreted to no less breadth of meaning than is included in the real scope and spirit of this invention and will not be taken as limited to any of the specific constructions pictured and described herein.

In place of giving my novel retarding mechanisms a reversing travel to accompany the alternate deceleration and acceleration from which the load or retarding resistance composed preferably of kinetic inertia is derived, I may employ any of the well known mechanical movements for causing uniform rotary motion of crank 26 to impel my improved swing gear retarder at varying speed in a constant direction, such as by change ratio gears constructed with different portions of their toothed peripheries at respectively different distances from the center so that during one part of a revolution the ratio of pitch radii of the two intermeshed gears is different than at another part of the revolution, or by heart cam and follower mechanism and certain of the following claims will therefore be found not limited to the reversing of the direction of travel of the retarding mechanism.

What I claim is:

1. Retarding means for a prime mover embodying in combination with a non-interrupted rotary member impelled continuously by said mover, an operative system of inter-gearred devices connected to be rotated alternately faster and slower by continuous movement of said member in a continuous direction.

2. In combination with a powered crank and its retarding load, a device for transmitting the power of said crank to said load and constructed to permit increase and decrease of the distance between its points of attachment to said crank and to said load together with resilient means establishing a normal dimension for said distance and yieldingly opposing said shortening and lengthening thereof.

3. Means for resiliently transmitting the power from a swinging driving member to a swinging driven member comprising a resilient element attached to one of said members and engaging the other said member and caused to yield to permit relative displacement of either member in either direction.

4. In combination, a member powered to advance rotatively upon an axis, retarding means for effecting a control of the speed of said member, and impelling means for transmitting force and motion in both directions between said member and said retarding means, the said retarding means including a train of intermeshed freely swingable wheels arranged to be unbiased by any force tending to cause movement thereof other than force transmitted through said impelling means.

5. In combination, a member powered to oscillate rotatively upon an axis, retarding means for effecting a periodicity of oscillations of said member, and impelling means for transmitting force and motion in both directions between said member and said retarding means, the said retarding means comprising a movable mass for producing inertia to oppose acceleration and deceleration of said mass by any force transmitted thereto through said impelling means, and the said retarding means including a train of freely rotatable intermeshed wheels constituting component parts of said mass.

6. In combination, a crank powered for rotative movement, a load to derive movement from said crank, a connecting rod pivoted at one end to said crank and connected at its other end to said load so that said load must move to permit movement of the crank except when the crank is rotating through its substantial dead center position relative to said connecting rod, and means for applying an auxiliary load to said crank while it is passing its said dead center position.

7. In combination, a crank powered for rotative movement, a load to derive movement from said crank, a connecting rod pivoted at one end to said crank and connected at its other end to said load so that said load must move to permit movement of the crank except when the crank is rotating through its substantial dead center position relative to said connecting rod, and means for applying an auxiliary load to said crank while it is passing its said dead center position, said auxiliary load consisting of a freely movable mass unbiased to move except by force derived from said crank.

8. In combination, a crank powered for rotative movement, a load to derive movement from said crank, a connecting rod pivoted at one end to said crank and connected at its other end to said load so that said load must move to permit movement of the crank except when the crank is rotating through the vicinity of its dead center position relative to said connecting rod, and means for applying an auxiliary load to said crank while it is passing its said dead center position, said auxiliary load consisting of the kinetic energy of a moving body.

9. In combination, a crank powered for rotative movement, a load to derive movement from said crank, a connecting rod pivoted at one end to said crank and connected at its other end to said load so that said load must move to permit movement of the crank except when the crank is rotating through the vicinity of its dead center position relative to said connecting rod, and means for applying an auxiliary load to said crank while it is passing its said dead center position, said means being arranged to transmit the resistive force of said auxiliary load in a direction approximately perpendicular to the common or dead center alignment of said crank and said rod.

10. In combination, a crank power impelled to rotate in a continuous direction, a mass formed

and mounted to be unbiased and free for movement in different positions thereby to resist movement mainly by its natural potential or kinetic inertia, a second mass also formed and
 5 mounted to be unbiased and free for movement in different positions thereby to resist movement mainly by its natural potential or kinetic energy, an impelling connection between the first said mass and said crank, and an impelling connection
 10 between the said second mass and said crank.

11. A spring motor comprising in combination, a rotary crank-like member, a motor spring to impel said member, a train of intergeared wheels one of which is connected to be caused to oscillate by continuous rotary movement of said member, and a second train of intergeared wheels one of which is connected to be caused to oscillate by continuous rotary movement of said member.

12. In combination, three trains of intergeared wheels, connections between a member of the first train and a member of the second train whereby movement of the first train in a continuous direction causes movements of the second train in alternately reverse directions, and connections between
 20 a member of said first train and a member of the third train whereby movement of the said first train in a continuous direction causes movement of the said third train in alternately reverse directions.

13. Retarding means for a prime mover embodying in combination with a rotary member impelled by said mover, an operated element arranged to be reciprocated by movement of said member in a continuous direction, a separate operated element arranged to be reciprocated by movement of said member in a continuous direction, and two systems of intergeared devices, each system connected to be reciprocated by respectively reciprocative movements of a different one
 30 of said elements.

14. Retarding means for a prime mover embodying in combination with a rotary member impelled by said mover, an operated element arranged to be reciprocated by movement of said member in a continuous direction, a separate operated element arranged to be reciprocated by movement of said member in a continuous direction, and two systems of intergeared devices, each system connected to be rotated alternately faster and slower by the reciprocative movements of a different one of said elements.

15. A speed determining mechanism including in combination with a rotor and a prime mover acting constantly to urge said rotor in the same direction, a prime retarder, and means operated by and in synchronism with the movement of said rotor, and arranged to exert an impelling force upon said retarder first in one and then in the reverse direction, and auxiliary retarding means
 60 connected to be moved directly by said rotor without dependence upon said prime retarder.

16. In combination a train of gears powered and arranged for continuous non-intermittent movement, a second train of gears, and connections between a member of one train and a member of the other train whereby continuous movement of the first train causes successive acceleration and deceleration of the other train.

17. A speed determining mechanism including in combination with a rotor and a prime mover acting constantly to urge said rotor in the same direction, a swinging prime retarder, a crank and pitman connecting said rotor and said prime retarder and an auxiliary swinging retarder con-

nected to be caused to swing by the swinging movement of said prime retarder but through a greater angle of movement.

18. A speed determining mechanism including in combination with a rotor and a prime mover acting constantly to urge said rotor in the same direction, a prime retarder freely movable and unbiased by forces extraneous to the inertia of its own mass, a crank and pitman operated by the movement of said rotor and arranged to exert an impelling force upon said retarder first in one and then in the reverse direction, and auxiliary retarding means intergeared with said prime retarder.

19. A speed determining mechanism including in combination with a power rotor, a plurality of relatively movable retarding members one of which is directly actuated by said rotor and the others of which are connected to move in synchronism with the said one of said members and through a greater distance of travel than any member from which their movement is derived, and a crank and pitman connecting said rotor and said one of said rotary members.

20. A retarding mechanism consisting in the combination of three or more intergeared members, a source of power for causing the acceleration and deceleration of said members, the gear ratios being such that each member which is driven by another member in mesh therewith performs a greater travel than the member by which it is impelled.

21. A spring motor comprising in combination, a rotary crank-like member arranged for continuous, non-intermittent travel, a motor spring connected to impel said member, and a train of intergeared members, one of which is connected to be oscillated by continuous rotary movement of said member.

22. In combination, a train of gears powered and arranged for continuous non-intermittent movement, a second train of gears, a crank and pitman connecting a member of one train and a member of the other train whereby continuous movement of the first train in the same direction, causes successive movements of the other train in alternately reverse directions.

23. In combination, a train of gears powered and arranged to travel with continuous, non-interrupted movement, a second train of gears, and connections between a member of one train and a member of the other train whereby continuous, non-interrupted movement of the first train in the same direction causes successive movements of the other train in alternately reverse directions.

24. In a speed retarded power motor, in combination, a power transmitting member pivoted to swing about a center, a power receiving member pivoted to swing about a center, and a spring operatively connecting said members and arranged yieldingly to oppose relative rotative movements of said members in both directions, said spring having a resilient portion disposed in part to surround the center about which one of said members swings.

25. In a speed retarded power motor, in combination, a power transmitting member pivoted to swing about a center, a power receiving member pivoted to swing about a center, and a spring operatively connecting said members and arranged to oppose relative rotative movements of said members in both directions, said spring having a resilient portion disposed in part to surround the center about which one of said mem-

bers swings and being further constructed and disposed to have a portion slidably engaging one of said members to compensate for lack of exact conformity in the natural paths of movement of said engaging spring portion and said member at its point engaged thereby.

26. In a speed retarded power motor, in combination, a power transmitting member pivoted to swing about a center, a power receiving member pivoted to swing about a center, and a spring arranged to act between and upon both said members thereby to transmit forces and movement from each of said members to the other member in both directions of their swinging movement, and further constructed and disposed to yield to said forces when transmitting movement from member to member in both directions.

27. Retarding means for a prime mover embodying in combination with a rotary member impelled by said mover, an operated element arranged to be reciprocated by continued rotation of said member, and a system of intergearing devices, said system being connected to be rotated in reverse directions by respectively reverse movements of said element.

28. Retarding means for a prime mover embodying in combination with a rotary member impelled by said mover, an operated element arranged to be reciprocated by continued rotation of said member, and a system of intergearing devices, said system being connected to be rotated alternately faster and slower by the respectively reverse movements of said element.

29. Mechanism for retarding with continued and non-frictional effect the running of a power

urged rotor, comprising in combination with said rotor, a plurality of rotor retarding bodies, means to support and separately to constrain said bodies for movement so that the respective inertias of said bodies may operate as separate forces, and connections arranged to transmit the separate forces of said inertias constantly and simultaneously to said rotor while the latter is running.

30. Mechanism for retarding with continued and non-frictional effect the running of a power urged rotor, comprising in combination with said rotor, a plurality of rotor retarding bodies, means to support and separately to constrain said bodies for movement so that the potential and kinetic inertia of one of said bodies may operate as a force separate from the force of potential and kinetic inertia of a related one of said bodies, and connections arranged constantly to transmit either the potential or the kinetic inertia forces of each of said bodies to said rotor while the rotor is running.

31. Mechanism for retarding with continued and non-frictional effect the running of a power urged rotor, comprising in combination with said rotor, a plurality of rotor retarding bodies, means to support and separately to constrain said bodies for movement so that the potential and kinetic inertia of one of said bodies may operate as a force separate from the force of potential and kinetic inertia of a related one of said bodies, and connections arranged simultaneously to transmit the potential inertia force of one of said bodies and the kinetic inertia force of the other said body to said rotor while the rotor is running.

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