Nov. 10, 1931. A. F. POOLE 1,831,260

ELECTRIC CLOCK MECHANISM

Filed April 4, 1927 3 Sheets-Sheet 1

Fig. 1

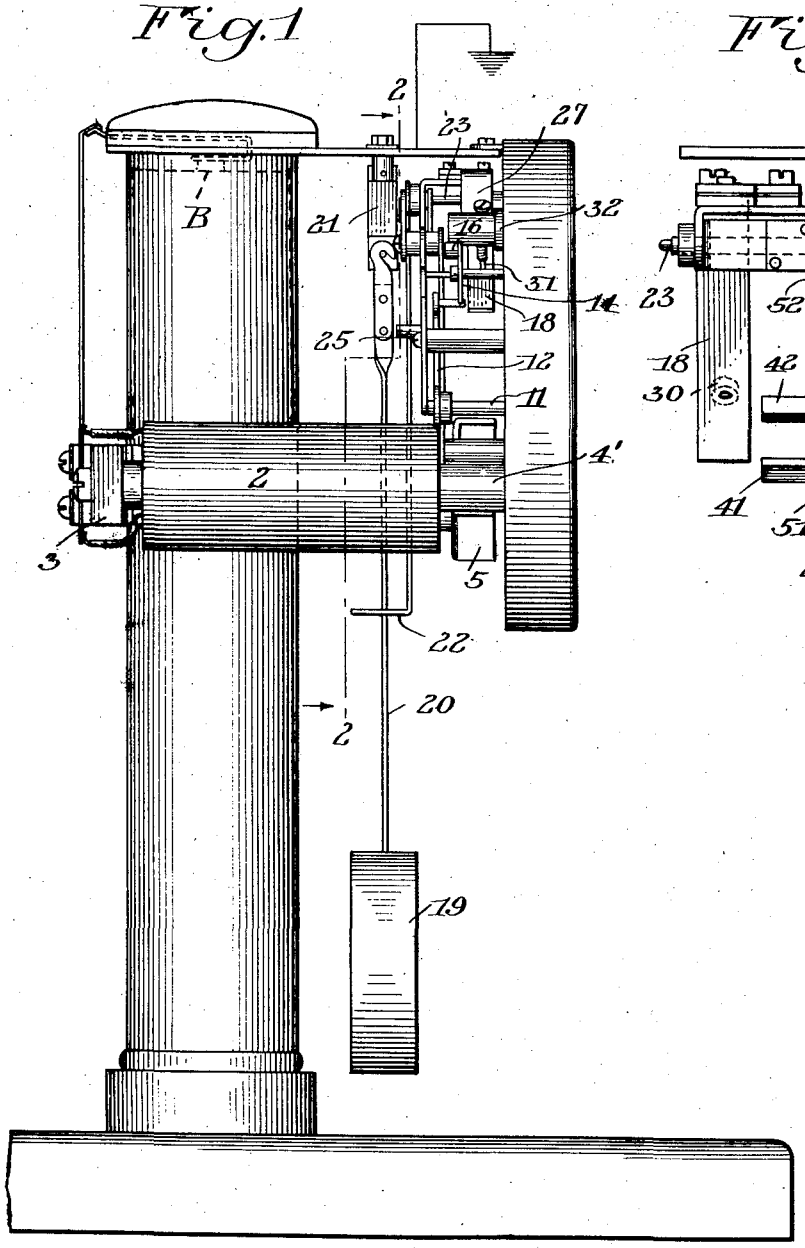
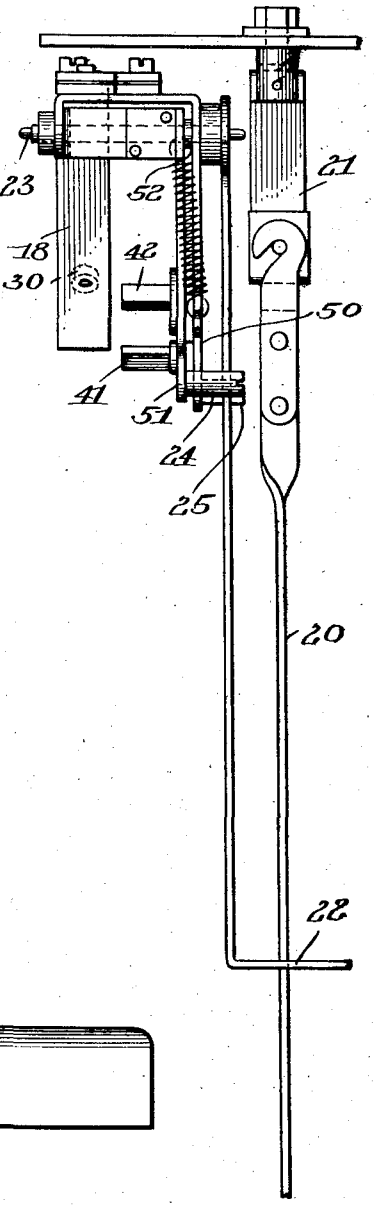


Fig. 6



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ELECTRIC CLOCK MECHANISM

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Fig. 2

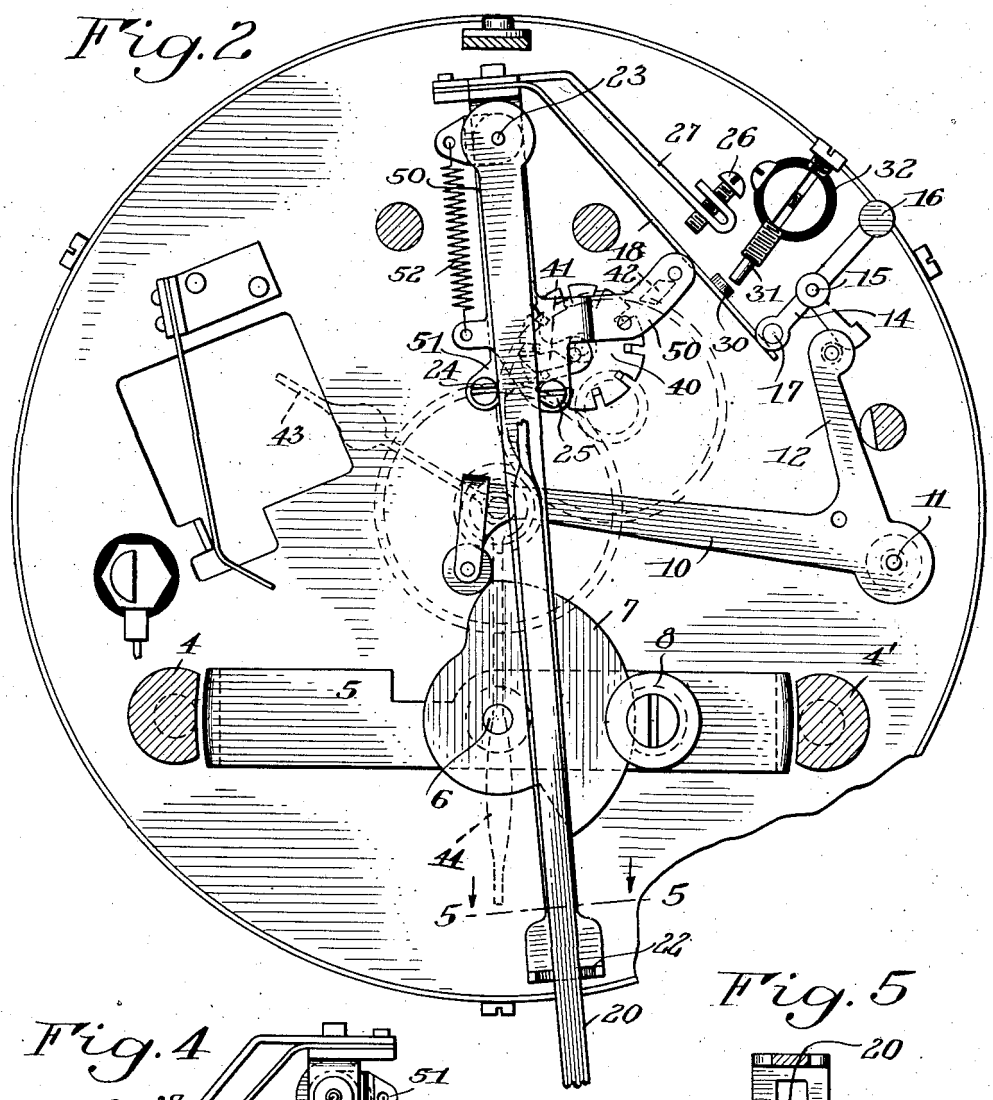


Fig. 5

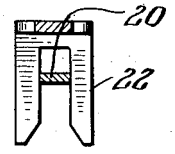
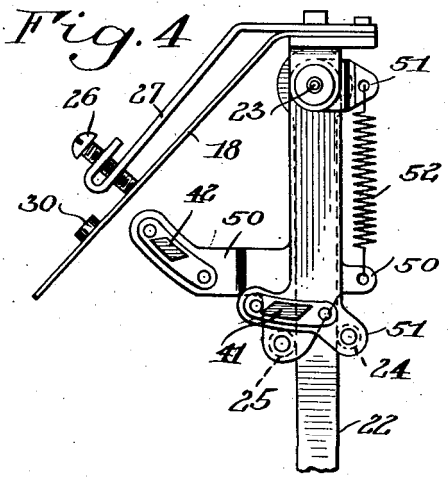


Fig. 4



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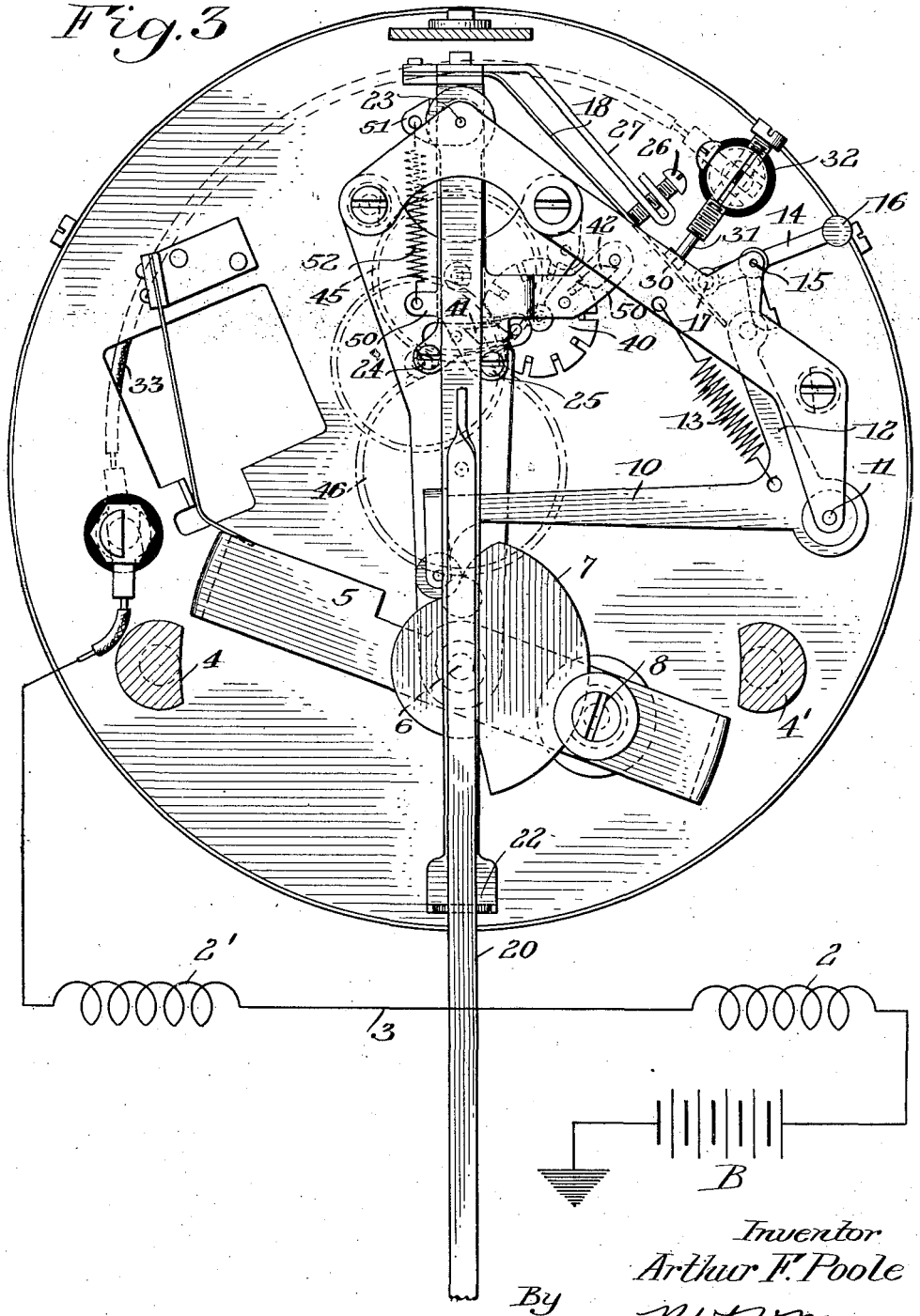
ELECTRIC CLOCK MECHANISM

Filed April 4, 1927 3 Sheets-Sheet 3

Fig. 3



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Patented Nov. 10, 1931 1,831,260

UNITED STATES PATENT OFFICE

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ELECTRIC CLOCK MECHANISM

Application filed April 4, 1927. Serial No. 180,830.

This invention relates to electric clocks, and has for its object the provision of a simple and accurate clock driving mechanism, in which the usual clock-springs and weights are eliminated; and to provide a method of driving clockwork by which the electric power is applied to the time determining element in small periodic impulses of definite force, without the necessity of storing up mechanical energy for any considerable length of time. Other objects of the invention are to relieve the escapemnt wheel of the load of driving the pendulum; to maintain the strength of the periodic impulses substantially independent of the ordinary variations in the driving force; to prevent damage to the escapement through careless handling of the pendulum; and various other objects as will become apparent, all with a view to producing a simple, practical and accurate clock mechanism.

In the drawings forming part of this specification and illustrating one embodiment of the invention,

Fig. 1 is a side elevation of an electric clock mechanism, showing the general relations of parts in a typical construction.

Fig. 2 is a rear elevation of the clock actuating mechanism, taken on the line 2—2 of Fig. 1, looking in the direction of the arrows, showing the relation of the parts at the moment the electric contact is broken, and the driving impulse is being delivered to the pendulum.

Fig. 3 is a somewhat similar elevation of the clock actuating mechanism as viewed from the rear, illustrating the relation of the parts at the moment when the electric contact is being made, and before the actuation of the driving mechanism.

Fig. 4 is a detail view showing one form of the driving spring, yieldable crutch and pallet holding mechanism.

Fig. 5 is a cross-section of a second crutch mechanism, the section being taken on the line 5—5 of Fig. 2, looking in the direction of the arrows.

Fig. 6 is a detail side elevation of the crutch mechanism, one form of pendulum support, yieldable pallets and drive spring, giving another view of the parts illustrated in Fig. 4 and Fig. 5.

Similar reference numerals refer to the same parts thruout the various views.

Referring now to Fig. 1, Fig. 2 and Fig. 3, the energy of the battery B or other source of electricity is delivered to the solenoids 2 and 2′, which are connected together by a magnetic bridge 3 across the back so as to form an effective electro-magnet, having the pole pieces 4 and 4′. Between the poles 4 and 4′ is located an iron armature 5, which is pivotally mounted at the point 6, so that it may oscillate. A cam 7 is clamped to the armature 5 by means of the screw 8, so as to oscillate with the armature, and this armature member 5, 7, 8, is unbalanced relative to the pivot 6, so that when the solenoids 2, 2′, are not energized the armature will drop down to the position shown in Fig. 3 of the drawings.

Coacting with the cam 7 is a cam follower consisting of a lever 10 provided with a roller on its end to engage the cam 7, which is designed to give a quick positive stroke. The lever 10 by way of illustration is shown in the form of a bell crank pivoted at 11 and having an extension finger 12—the weight of this bell crank being partially supported by the spring 13. It will become apparent to those skilled in the art as the description proceeds that the particular form of this lever 10—12 is immaterial and the shape shown in the drawings is only for the purposes of illustration. The function of the parts described is to transmit suitable impulses from the solenoids 2, 2′ to the impulse controlling element 14, which delivers the measured impulse to the pendulum or other time determining device.

The power delivered by the cam 7, while more than ample to drive a clock mechanism, is not in a form suitable for precise regulation. In the present invention the element 14, which determines the amount of the energy delivered to the spring 18 driving the pendulum parts, consists of a lever pivoted at 15, and arranged to be engaged by the finger 12. The lever 14 may be provided with a counter weight 16 or other means for re-

turning it to position. At the operative or driving end of the lever 14 is a pin 17, preferably a jewel, which is adapted to engage the spring 18 when the lever 14 is actuated—in which case the lever is swung to a position substantially at right angles to the spring 18, as shown in Figure 2, for reasons that will be described.

The spring 18 is attached to the pendulum or time determining mechanism, and swings as a part thereof, so that it is periodically brought to a position where the pin 17 may engage it. This spring 18 is the actual driving element which operates the pendulum, by virtue of the mechanical energy stored in the spring 18 by the action of the impulse element 14. In the preferred form the time determining element is of the pendulum type—though a balance wheel or other equivalent device might be used—and consists of a pendulum bob 19 carried on the rod 20 suspended from the flat spring 21. The rod 20 is driven thru a crutch 22 mounted on the pivot 23. The crutch 22 is driven thru a second crutch 24, 25, having a special construction as will be later described, and a part of this second crutch 25 has attached to it the spring member 18, thru which the driving impulses are received.

The spring member 18 preferably consists of a flat spring, and its tension and position is adjusted by the adjusting screw 26 mounted in the rigid arm 27, which is secured to the crutch member 25. Thus the spring 18, arm 27, as well as the crutches and pendulum proper swing as part of the pendulum element. The spring 18 carries a contact button 30 which is adapted to make contact with the adjustable electric contact screw 31 near the end of a swing, completing a circuit which energizes the electro-magnetic portion of the mechanism. The contact screw 31 is insulated from the frame by the insulation 32, and the electric circuit, when closed, may be traced from one terminal of the battery B thru the solenoids 2 and 2′, then thru the wire 33 to the contact screw 31, contact button 30 and thru the spring 18 to the other terminal of the battery B—the spring 18 and one terminal of the battery being grounded to the frame.

The operation of the portion of the mechanism that delivers periodic impulses to the pendulum elements will now be described, after which the manner of driving the clock will be shown.

As the pendulum swings to the right, the contact button 30 in the spring 18 meets the contact screw 31 and closes the electric circuit described. The electro-magnets 4 and 4′ are momentarily energized and attract the armature 5, rotating it into the position shown in Fig. 2 of the drawings, and rotating the cam 7 with it. This operates the cam follower and lifts the lever 10, swinging its extension 12 to the right, and moving the driving end of the element 14 downward so that the pin 17 engages the spring 18 and forces it slightly back, breaking the electric circuit at the contact button 30. This de-energizes the electro-magnets 4 and 4′ and the armature 5, and the cam and levers 7, 10, 12, fall back to their original position. The element 14, however, does not immediately fall, but is held in the position shown in Fig. 2 by the pressure of the spring 18, owing to the fact that the impulse element 14 is then substantially at right angles to the driving spring 18. The impulse is given the driving spring 18 by the extra flexure given it when the pin 17 swings down against it, thus storing up energy in the spring to operate the pendulum. As the pendulum swings back, it absorbs this driving energy, and as it progresses the screw 26 on the arm 27 picks up the spring 18 again, and carries the spring 18 away from the pin 17, whereupon the element 14 returns to its former position.

The increment of energy is stored in the spring 18 at each vibration of the pendulum—or possibly at alternate vibrations—but it is not necessary to store energy up for any considerable number of vibrations, as in previous constructions. It will be obvious to those skilled in the art that in place of the armature 5 being retracted by gravity, the magnetic elements may be arranged to rock the armature back and forth, so that alternate vibrations of the pendulum will receive the driving impulse. But in either event the apparatus is characterized by the fact that as soon as the motor element is retracted its driving stroke ensues on the next vibration of the pendulum, thus reducing to a minimum the period during which stored mechanical energy is retained.

The action of the impulse element 14 in relation to the driving spring 18 has several advantages, in addition to retaining itself in working position thru friction as described. It will be understood that accurate time keeping is largely dependent on delivering driving impulses of uniform strength and intensity. To do this, various difficulties must be overcome, as for example, the power of the original electro-magnetic force will vary somewhat as the battery weakens; the initial power is relatively large and not suitable for regulation; and the mechanism must be such that slight variations in the parts, such as occur in commercial production, will not seriously affect the uniformity of the operation of the time determining element.

In the present invention the power is transmitted by bending the spring 18 when swinging the pin 17 thru an arc which in its later portion approaches tangency to the spring. It will be seen, therefore, that slight variations in the length of this arc, such as might occur thru variations in the strength of the electric power, or slight variations in the mechanical parts, thru wear or otherwise,

will have little effect on the amount of energy actually delivered to the driving spring 18.

This method of transmitting repeated small and controlled increments of energy directly to a driving spring which oscillates with the pendulum also makes possible a method of operating a clock mechanism which has certain advantages in simplicity and accuracy. It will be recalled that in the ordinary clock the power drives the escapement wheel, and the escapement wheel drives the pendulum—the pressure of the escapement teeth giving a slight impulse to the pendulum at each swing. In the present invention, on the contrary, the power is put in thru the pendulum and taken out thru a crown wheel 40, for example, or equivalent gear, in place of the ordinary escapement—the crown wheel being fed along tooth by tooth thru the power supplied to it by the pendulum. The driving friction in the clockwork is thus made light and uniform, with a resultant increase in accuracy and durability.

The crown wheel 40 is rotated by the alternate engagement of the pallets 41 and 42 with the teeth or pins of the crown wheel as the pendulum swings to and fro. These pallets have faces properly inclined to feed the crown wheel 40 around one tooth at a time. The crown wheel 40 turns the hands 43 and 44 thru the reduction gearing 45, 46, etc. of ordinary clockwork. In order to prevent possible damage to the teeth of the crown wheel 40 which might occur thru careless handling if the pallets 41 and 42 were rigidly secured to the pendulum, the pallets are arranged so that they may yield against a spring in case of excessive stress. The pallet 41 is attached to a member 51 which carries the pin 24, and the pallet 42 is attached to a member 50 which carries the pin 25—the members 50 and 51 being mounted on the pivot 23 and held together by the tension of the spring 52, so that the pins 24 and 25 form a crutch, connecting to the ordinary crutch 22 and pendulum 19. The spring 52 is sufficiently strong to hold the crutch 24, 25 together in all normal operation, so that the pallets 41 and 42 normally act as though they were rigid with the pendulum: but in case of an excessive accidental stress the pallets will yield before damaging a tooth.

While I have in the foregoing disclosed my invention and described it by way of illustration in a preferred embodiment, it is subject of course to various modifications as will be evident to those skilled in the art. The particular arrangements, shape and proportions of the parts will vary to accommodate various forms of clocks, and the particular form of electric circuit is immaterial, provided it is periodically varied.

While I have explained and described my invention by certain specific examples, it will be understood that these are only by way of illustration, and that the apparatus is susceptible to various modifications and adaptations as will be apparent to those skilled in the art, without departing from the scope of the invention, which is specified in the following claims.

Claims:

1. In a time keeping mechanism, the combination of a time determining element having a periodic motion, a driving spring attached thereto, an impulse member adapted to be swung in an arc terminating substantially tangent to said spring, whereby the spring may be flexed and power applied to the time determining element, an electric contact operated by the motion of the time determining element, and an electrically operated mechanism controlled by said contact whereby the impulse member is driven to flex the spring, the electric contact being opened by the action of the impulse member on the spring.

2. In a time keeping mechanism, the combination of a time determining element having a periodic motion, a spring attached thereto so as to oscillate therewith, an adjusting screw for adjusting the position of the spring, an electric contact screw for making electric contact with said spring, and an electrically operated impulse means controlled thru said contact and adapted to flex the spring a definite amount, the contact screw and impulse means being so arranged that as the spring swings toward them it will first make electric contact with the contact screw, after which the resulting action of the impulse means against the spring will break the electric contact at the spring and deliver a power impulse to said time determining element.

3. In a time keeping mechanism, the combination of a time determining element having a periodic motion, a spring attached thereto so as to oscillate therewith, an adjusting screw for adjusting the position of the spring, an electric contact screw for making electric contact with said spring, and an electrically operated impulse means controlled thru said contact and adapted to flex the spring a definite amount, the adjusting screw, contact screw, and impulse means being so arranged that as the spring swings toward them it will first strike the contact screw making electrical contact and breaking the mechanical contact between the adjusting screw and spring, after which the action of the impulse means will break the electric contact and deliver a power impulse to said time determining element.

4. In a time keeping mechanism, the combination of a time determining element having a periodic motion, a spring attached thereto so as to oscillate therewith, an adjusting

screw for adjusting the position of the spring, an electric contact screw for making electric contact with said spring, and an electrically operated impulse means controlled thru said contact and adapted to flex the spring a definite amount, the contact screw and impulse means being so arranged that as the spring swings toward them it will first make electric contact with the contact screw, after which the resulting action of the impulse means will break the electric contact and deliver a power impulse to said time determining element, the impulse means being retained in position to transmit said power impulse thru frictional contact with the spring.

5. In a time keeping mechanism, the combination of an electro-magnetic device having a movable armature, a cam operated by said armature, a lever operated by said cam, an impulse member operated by said lever, a spring, said impulse member being arranged to give substantially uniform impulses to said spring regardless of moderate variations in the travel of said impulse member, an electric contact operated by said spring and adapted to be opened by the action of the impulse member against the spring, whereby the electro-magnetic device is periodically energized to deliver impulses to the spring, a crutch attached to said spring, and a pendulum element in said crutch, whereby the spring may drive the pendulum.

6. In a time keeping mechanism, the combination of an electro-magnetic device having a movable armature, a cam operated by said armature, a lever operated by said cam, an impulse member operated by said lever, a spring, said impulse member being arranged to give substantially uniform impulses to said spring regardless of moderate variations in the travel of said impulse member, an electric contact operated by said spring and adapted to be opened by the action of the impulse member against the spring, whereby the electro-magnetic device is periodically energized to deliver impulses to the spring, a yieldable crutch attached to said spring, said crutch being arranged to transmit any normal driving force without yielding, but being proportioned to yield in the case of excessive forces, and a pendulum element in said crutch, whereby the spring may drive the pendulum.

7. In a time keeping mechanism, the combination of an electro-magnetic device having a movable armature, a cam operated by said armature, a lever operated by said cam, an impulse member operated by said lever, a spring, said impulse member being arranged to give substantially uniform impulses to said spring regardless of moderate variations in the travel of said impulse member, an electric contact operated by said spring and adapted to be opened by the action of the impulse member against the spring, whereby the electro-magnetic device is periodically energized to deliver impulses to the spring, said spring also serving as a conductor in the circuit of the electro-magnetic means, a yieldable crutch attached to said spring, said crutch being arranged to transmit any normal driving force without yielding, but being proportioned to yield in the case of excessive forces, and a pendulum element in said crutch, whereby the spring may drive the pendulum.

8. In timekeeping mechanism, an oscillating time determining element having periodic motion, a spring arm operatively connected to and oscillating in synchronism with said element, an electric circuit, including an electromagnet, rendered effective by said arm as said arm approaches its limit of oscillation in one direction, and means operated by said electromagnet when said circuit is rendered effective for flexing said arm a short distance in the opposite direction from which it was moving when said circuit was rendered effective, and thereby rendering said circuit ineffective, whereby said arm will then exert a yielding resilient stress on said element urging it towards the opposite limit of its movement, said means for flexing the arm being yieldingly urged in a direction to release said arm and into normal ineffective position, and said arm being operable upon said means to hold the latter against return to normal ineffective position until the arm is substantially unflexed due to its movement in the opposite direction with said element.

9. In a timekeeping mechanism, an oscillating time determining element having periodic motion, a member resiliently and operatively connected to and oscillating in synchronism with said element, an electric circuit rendered effective by said member as said member approaches one limit of oscillation, and including electro-magnetic means, impulse means operable by said electro-magnetic means for forcing said member in the opposite direction from which it was moving when said circuit was rendered effective, and rendering said circuit ineffective, whereby said member will then exert a yieldingly resilient stress on said element urging it towards the opposite limit of its movement, said electro-magnetic means being urged in a direction to release said impulse means when said circuit is rendered ineffective, and said impulse means and said member cooperating with one another to maintain said circuit ineffective until the stress of said member on said element is approximately nil.

10. In timekeeping mechanism, an oscillating time determining element having periodic motion, a spring operatively connected thereto and oscillating synchronously therewith, an electric circuit rendered effective by said spring as said spring approaches one limit of its oscillation, and means controlled by said circuit for stressing said spring in the opposite direction to exert a resilient impulse on

said element in the opposite direction and holding said circuit ineffective until the spring has moved out of a position in which it would render said circuit effective.

11. In timekeeping mechanism, an oscillating time determining element having periodic motion, a member resiliently connected to and oscillating in synchronism with said element, and a power device rendered effective by said member as said member approaches one limit of its movement for moving said member immediately into a predetermined position in which said member exerts a resilient stress on said element tending to move it in the opposite direction and temporarily incapacitating said power device against further movement after said member reaches said position until said element has reached a predetermined point in its movement in the opposite direction.

12. In timekeeping mechanism, an oscillating time determining element having periodic motion, a spring arm operatively connected to and oscillating in synchronism with said element, an electric circuit including contact means closed by engagement therewith of the free ends of said arm as said element and arm approach their normal limit of oscillation in one direction, and means rendered effective by said circuit for flexing immediately said spring arm into circuit opening position and placing a stress on said element tending to force it in the opposite direction, said means holding said spring arm in a position in which said circuit is ineffective until said arm has been moved out of circuit closing position by the return oscillation of said element, whereby said element will receive periodic impulses for maintaining it in oscillation and said circuit will be closed only for a relatively short fraction of the oscillatory period of said element.

13. In a timekeeping mechanism, the combination of a time determining element having a periodic motion, a spring attached thereto so as to oscillate therewith, and an impulse member adapted to be swung in an arc terminating substantially tangent to said spring, and retained in that position by friction while flexing said spring.

14. In a timekeeping mechanism, the combination of a time determining element having a periodic motion, means for delivering small periodic impulses thereto comprising a spring attached to said time determining element so as to oscillate therewith, and an impulse member adapted to engage said spring with a sliding motion of diminishing angularity relative thereto, so that the movement of the point of contact of said impulse member will approach parallelism to the spring toward the end of the impulse, whereby a substantially definite impulse is given to the spring and time determining element regardless of minor variations in the stroke of said impulse member.

15. In timekeeping mechanism, an oscillating time determining element having periodic motion, a spring arm operatively connected to and oscillating in synchronism with said element, an electric circuit, including an electromagnet, rendered effective by said arm as said arm approaches its limit of oscillation in one direction, means operated by said electromagnet when said circuit is rendered effective for flexing said arm a short distance in the opposite direction from which it was moving when said circuit was rendered effective, and thereby rendering said circuit ineffective, whereby said arm will then exert a yielding resilient stress on said element urging it towards the opposite limit of its movement, said means for flexing the arm being yieldingly urged in a direction to release said arm and into normal ineffective position, and said arm being operable upon said means to hold the latter against return to normal ineffective position until the arm is substantially unflexed due to its movement in the opposite direction with said element, and an abutment movable with said element in fixed relation thereto, and against which said arm is resiliently urged when released, whereby the normal position of said arm relatively to said element will be definitely fixed.

16. In timekeeping mechanism, an oscillating time determining element having periodic motion, a spring arm operatively connected to and oscillating in synchronism with said element, an electric circuit, including an electromagnet, rendered effective by said arm as said arm approaches its limit of oscillation in one direction, means operated by said electromagnetic when said circuit is rendered effective for flexing said arm a short distance in the opposite direction from which it was moving when said circuit was rendered effective, and thereby rendering said circuit ineffective, whereby said arm will then exert a yielding resilient stress on said element urging it towards the opposite limit of its movement, said means for flexing the arm being yieldingly urged in a direction to release said arm and into normal ineffective position, and said arm being operable upon said means to hold the latter against return to normal ineffective position until the arm is substantially unflexed due to its movement in the opposite direction with said element, and an abutment movable with said element and adjustable in relation thereto, and against which said arm is resiliently urged when released, whereby the normal position of said arm relatively to said element may be selectively and adjustably determined.

17. In timekeeping mechanism, an oscillating time determining element having periodic motion, a spring operatively connected thereto and oscillating synchronously

therewith, an electric circuit rendered effective by said spring as said spring approaches one limit of its oscillation, means controlled by said circuit for stressing said spring in the opposite direction to exert a resilient impulse on said element in the opposite direction and holding said circuit ineffective until the spring has moved out of a position in which it would render said circuit effective, and an abutment oscillating in fixed relation to said element and against which said spring is yieldingly urged when free from said stressing means.

18. In timekeeping mechanism, an oscillating time determining element having periodic motion, a spring operatively connected thereto and oscillating synchronously therewith, an electric circuit rendered effective by said spring as said spring approaches one limit of its oscillation, means controlled by said circuit for stressing said spring in the opposite direction to exert a resilient impulse on said element in the opposite direction and holding said circuit ineffective until the spring has moved out of a position in which it would render said circuit effective, and an abutment oscillating in fixed relation to said element but adjustable in relation thereto and against which said spring is yieldingly urged when free from said stressing means.

19. In timekeeping mechanism, an oscillating time determining element having periodic motion, a spring arm operatively connected to and oscillating in synchronism with said element and adjustable relatively to said element in the direction of oscillation, an electric circuit including contact means closed by engagement therewith of the free ends of said arm as said element and arm approach their normal limit of oscillation in one direction, and means rendered effective by said circuit for flexing immediately said spring arm into circuit opening position and placing a stress on said element tending to force it in the opposite direction, said means holding said spring arm in a position in which said circuit is ineffective until said arm has been moved out of circuit closing position by the return oscillations of said element, whereby said element will receive periodic impulses for maintaining it in oscillation and said circuit will be closed only for a relatively short fraction of the oscillatory period of said element.

In witness whereof I have hereunto set my hand this 1st day of April, 1927.

ARTHUR F. POOLE.