

Oct. 14, 1969

R. JACKLE

3,472,020

ELECTRICALLY POWERED TIMEPIECE

Filed April 24, 1967

9 Sheets-Sheet 1

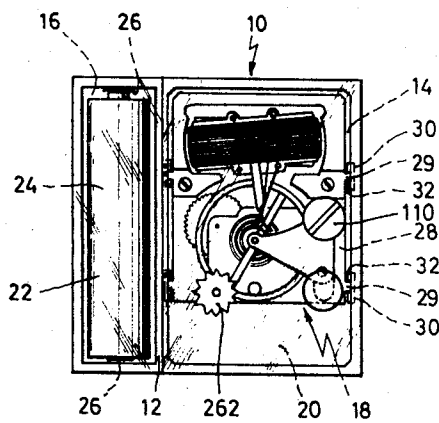


Fig. 1

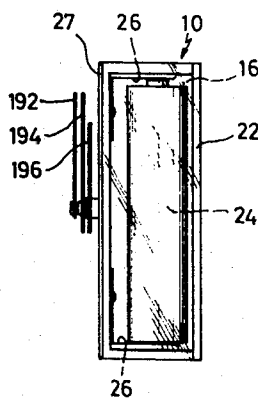


Fig. 2

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9 Sheets-Sheet 2

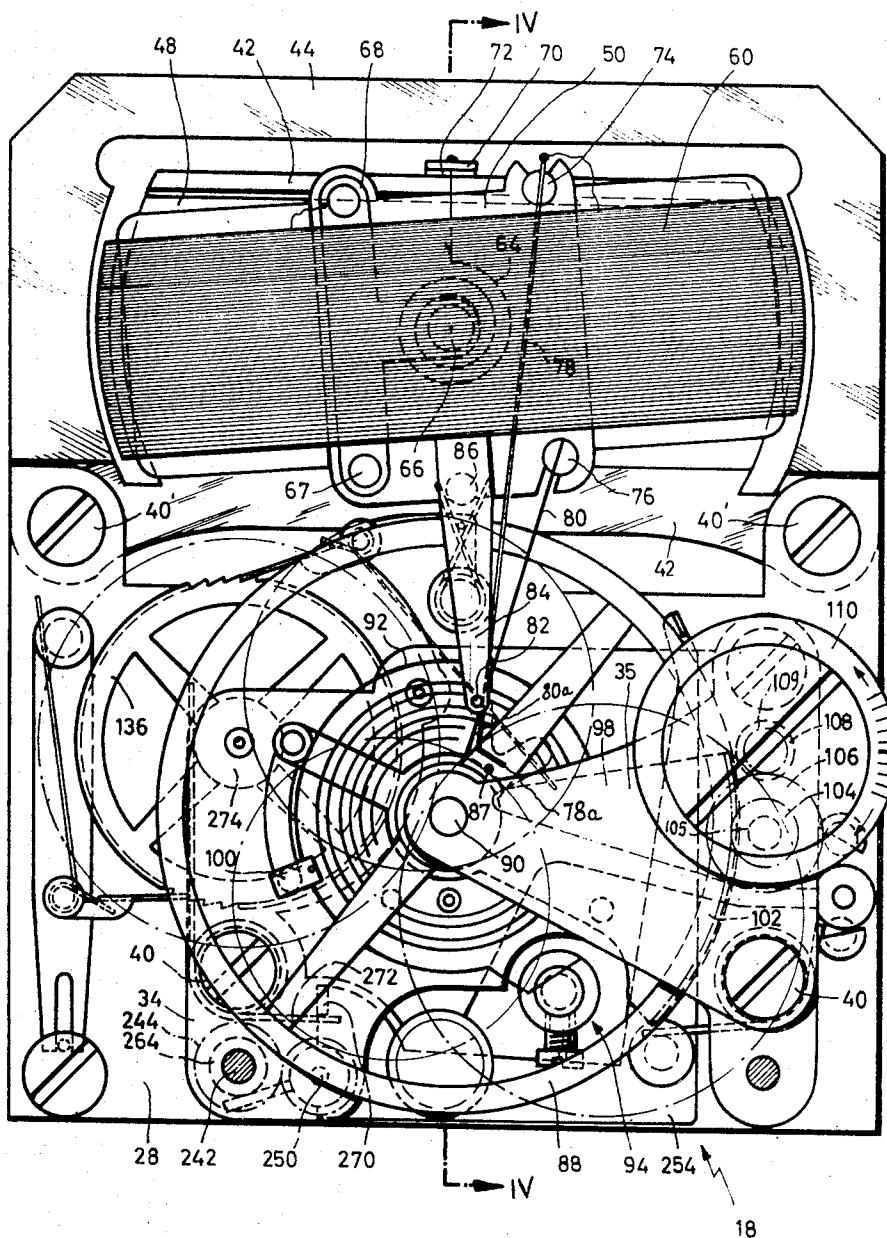


Fig. 3

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1. General Note
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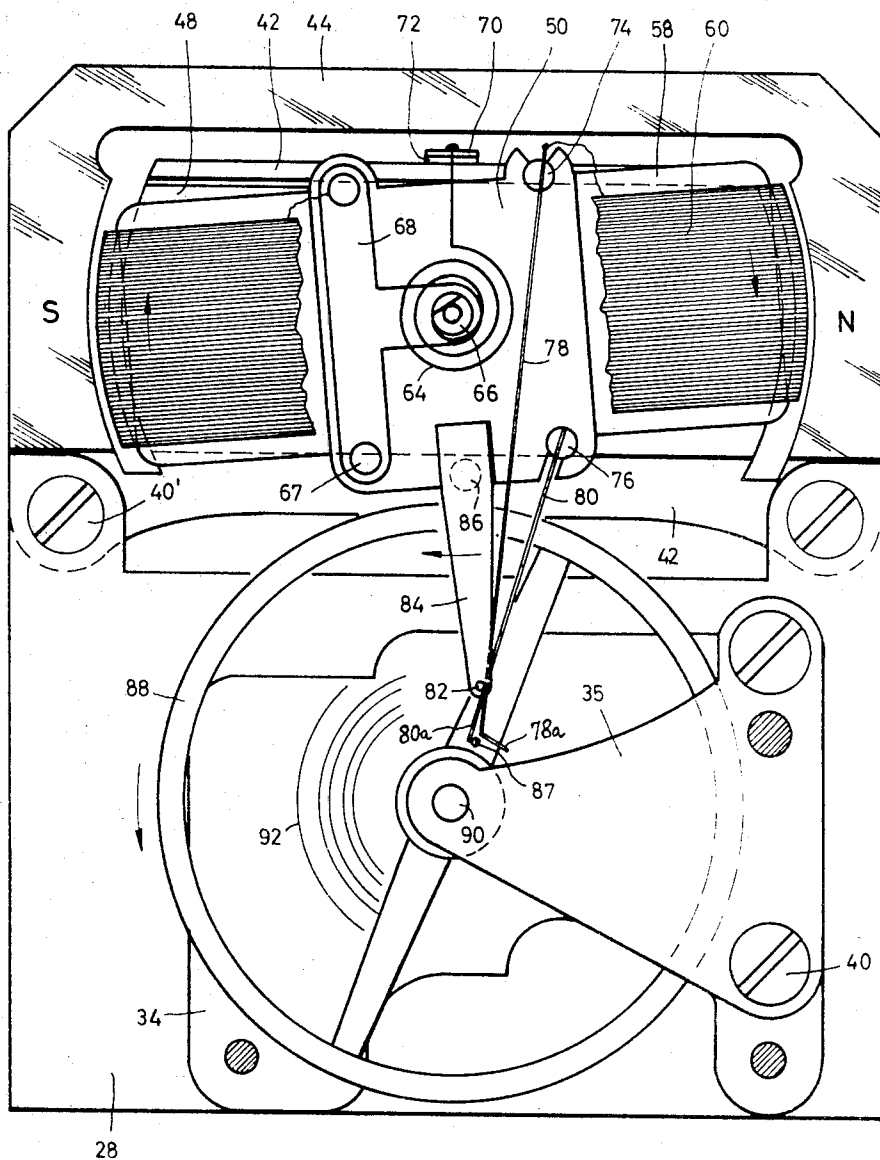


Fig. 5

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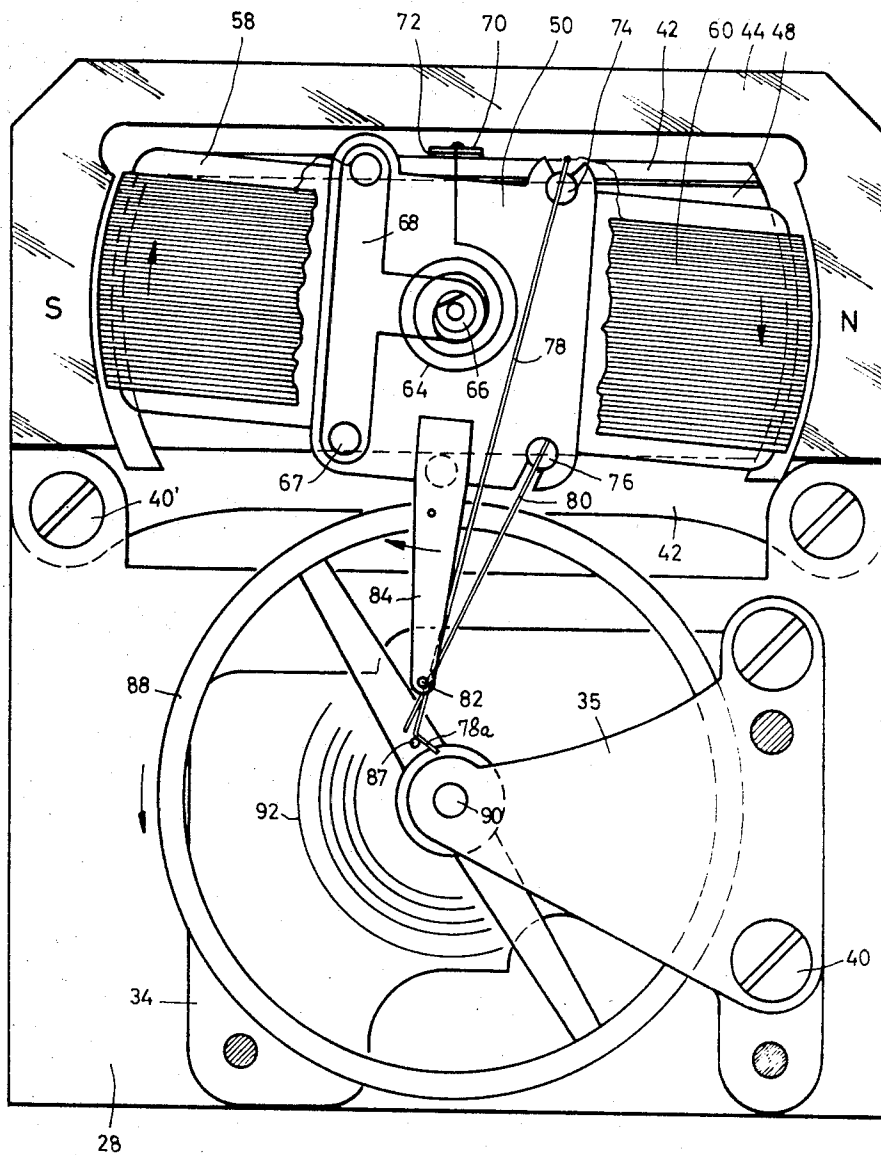


Fig. 6

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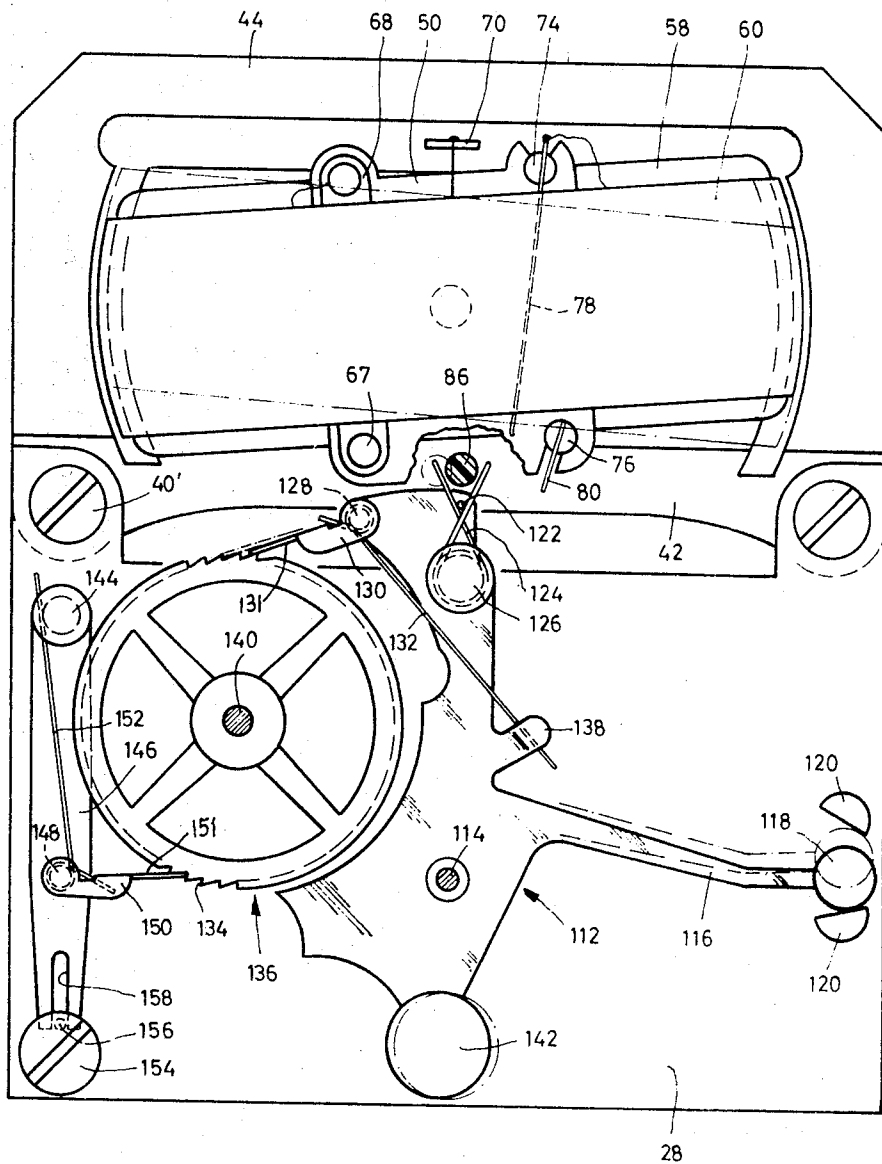


Fig. 7

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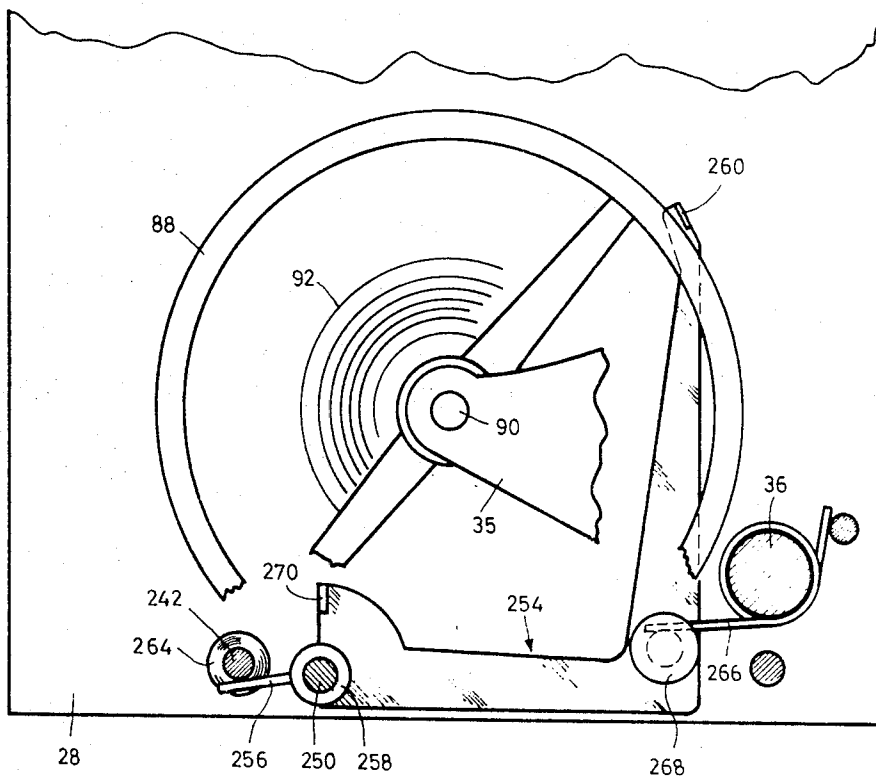


Fig. 8

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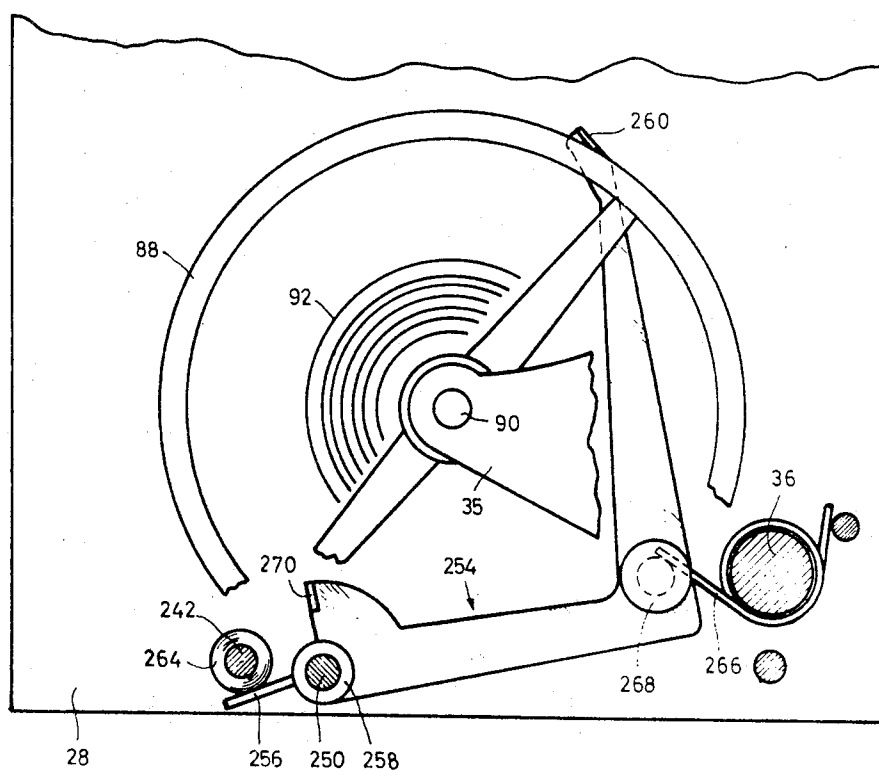


Fig. 9

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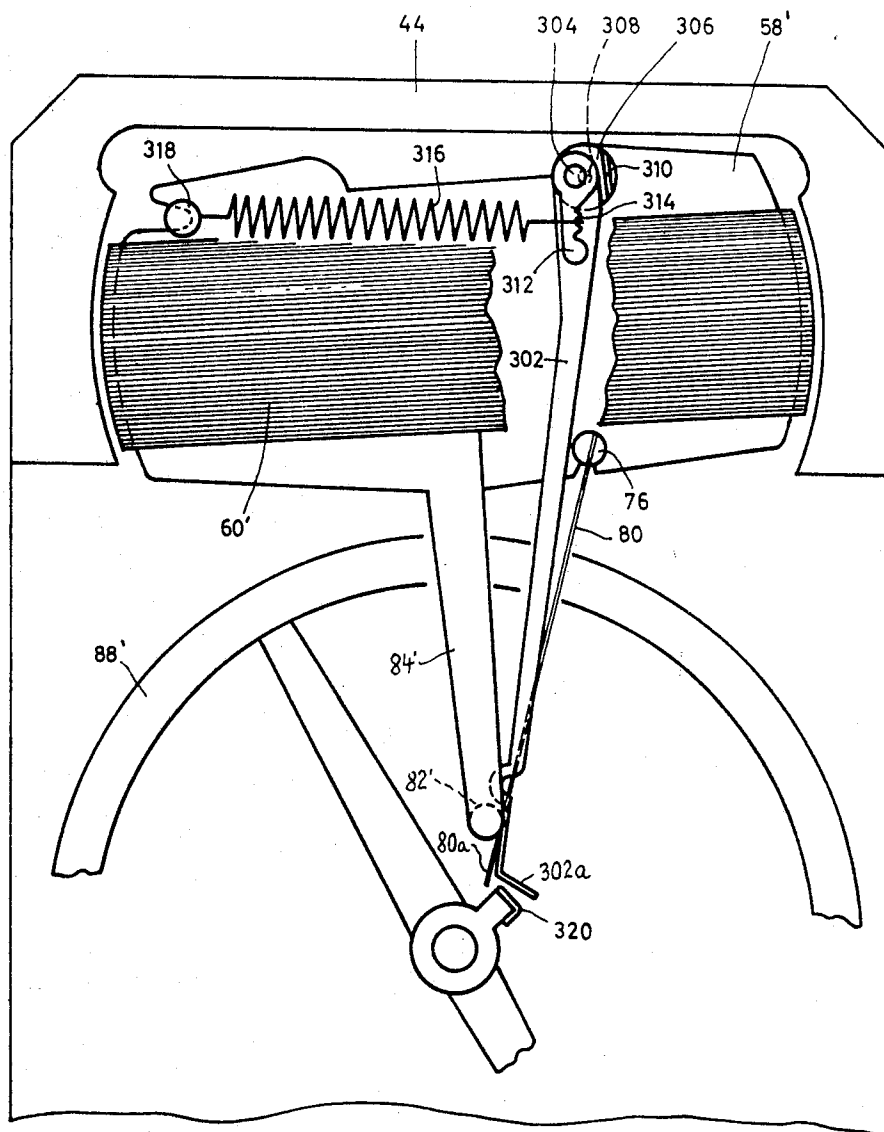


Fig. 10

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ELECTRICALLY POWERED TIMEPIECE

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St 25,633

Int. Cl. G04c 3/04

U.S. Cl. 58—28

29 Claims

ABSTRACT OF THE DISCLOSURE

The power assembly of an electric timepiece comprises an oscillatable coil and an elastic contact member which can complete the circuit of the coil in response to engagement with a pin or shoe provided on a balance wheel. When the balance wheel is rotated by its hairspring, it engages the contact member and completes the circuit of the coil whereby the coil turns and the contact member rotates the balance member in a direction to wind the hairspring. The balance member is disengaged from the rapidly moving contact member so that a return spring can move the coil back to starting position because the circuit of the coil is then deenergized. The train which drives the hands receives motion from the holder for the coil while the latter turns in response to completion of its circuit.

BACKGROUND OF THE INVENTION

The present invention relates to timepieces in general, and more particularly to improvements in electrically powered timepieces.

It is already known to provide a timepiece with an electric power assembly and with a balance wheel which receives impulses from a moving part of the power assembly. Such conventional timepieces can be classified as (a) those wherein the balance wheel receives impulses directly and (b) those wherein the operative connection between the balance wheel and the power assembly is indirect. In timepieces wherein the electric power assembly is arranged to transmit impulses indirectly, the balance wheel is driven mechanically by a spring which is repeatedly wound by an electrically operated winding unit of the power assembly. In other words, the power assembly causes the spring to store such energy which has been dissipated during transmission of an impulse to the balance wheel. For example, the winding unit may include an electric motor or an electromagnet whose armature acts upon the spring. The motion transmitting connection between the motor or electromagnet and the balance wheel includes a power take-off which drives a train serving to rotate customary pinions and wheels which drive the hands. An advantage of such timepieces is that the force acting upon the balance wheel assembly is independent of the force which is generated by the winding unit of the power assembly. On the other hand, such timepieces are rather bulky, complicated, expensive and prone to malfunction because their movement must include a complete balance wheel assembly, a complete train for transmission of motion to the hands, an assembly which regulates the amplitude and frequency of oscillation of the balance wheel assembly, and a winding unit which generates impulses for maintaining the balance wheel assembly in oscillatory motion. The component parts of the train must be finished with utmost precision in order to avoid fluctuations in the magnitude of force which could affect the operation of the balance wheel assembly.

In electrically powered timepieces wherein the power assembly is arranged to operate the balance wheel assembly directly, the balance wheel drives the train which

in turn transmits motion to the hands. Such mode of operation results in substantial savings in space and requires fewer parts; however, the amplitude of the balance wheel is directly dependent on the force of the electric power assembly, for example, on the force transmitted by the moving coil of an electromagnet. Such force of the power assembly, in turn, depends on the voltage supplied thereto by a battery or the like. If such voltage fluctuates, the force which is transmitted to the balance wheel also fluctuates and changes the amplitude of the balance wheel. Since the voltage furnished by a commercially available battery is not constant, the accuracy of electrically powered timepieces which utilize such direct driving connections between the balance wheel assembly and the power assembly is often very unsatisfactory.

Certain chronometers utilize a combination of the aforescribed conventional systems. In such chronometers, the electromagnet of the power assembly is resiliently coupled with a motion transmitting lever by means of a spring. The lever is pivotable on a plate of the movement and its end extends into the path of movement of a post on the balance wheel. The lever is further connected with a restoring spring and the balance wheel carries a contact pin which can engage a contact spring one side of which conducts current so that it can complete an electric circuit when the balance wheel turns in one direction. The balance wheel and the contact spring are arranged in series and are connected in the circuit of the electromagnet so that the latter is energized at intervals and transmits impulses to the balance wheel through the intermediary of the aforementioned contact spring. The train receives motion directly from the electromagnet so that the oscillations of the balance wheel are not affected by the train. This insures satisfactory accuracy even if the parts of the train are not finished with a high degree of precision.

It is an important object of the present invention to provide an electrically powered timepiece which constitutes an improvement over the just described chronometers and to construct and assemble the timepiece in such a way that its movement comprises a reduced number of parts without affecting its accuracy.

Another object of the invention is to provide a movement which need not be provided with an escape mechanism.

A further object of the invention is to provide a movement wherein the train receives motion directly from the moving coil of an electrically operated power assembly or prime mover and wherein the circuit of such power assembly is completed by the balance assembly.

An additional object of the invention is to provide a novel operative connection between the electrical power assembly and the balance assembly of a timepiece.

A concomitant object of the invention is to provide a movement for use in electrically powered timepieces wherein the train comprises fewer parts than in presently known movements.

SUMMARY OF THE INVENTION

One feature of my invention resides in the provision of a movement for electrically powered timepieces. The movement comprises a power assembly, a balance assembly, and a train which drives the hands. The power assembly comprises an electric circuit including magnetic field generating means, a coil which is oscillatable between two end positions and tends to assume one of its end positions but turns to the other end position in response to completion of the circuit, a return spring which biases the coil to the one end position, and an elastic contact member which is oscillatable with the coil and may assume the form of a leaf spring or the form of a lever which is pivot-

ally attached to the holder of the coil. The balance assembly comprises a balance member (preferably a wheel) which is oscillatable between first and second positions, resilient means (preferably a hairspring) for biasing the balance member to the first position, and a circuit-completing portion provided on the balance member and arranged to engage the contact member during movement of the balance member toward first position to complete the circuit whereby the coil turns toward its other end position and the contact member imparts to the balance member through the intermediary of the circuit-completing portion an impulse which propels the balance member to second position against the opposition of the resilient means.

The train comprises an input member which preferably resembles a pallet and receives motion from the holder for the coil when the latter moves toward its other end position, and such input member then drives a wheel for one of the hands, preferably the fourth wheel. Each other hand receives motion from the wheel which is driven by the input member.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved timepiece itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a rear elevational view of an electrically powered timepiece which embodies one form of my invention and which constitutes an alarm clock;

FIG. 2 is a side elevational view of the timepiece as seen from the left-hand side of FIG. 1, with a portion of the case broken away;

FIG. 3 is an enlarged rear elevational view of the movement in the timepiece of FIGS. 1 and 2;

FIG. 4 is a transverse vertical section as seen in the direction of arrows from the line IV—IV of FIG. 3;

FIG. 5 is a rear elevational view of the movement but with several parts omitted for the sake of clarity, the moving coil being illustrated in one of its end positions;

FIG. 6 is a similar rear elevational view but showing the coil in the other end position;

FIG. 7 is another rear elevational view of the movement, showing the details of the input member for the train and the manner in which the input member cooperates with the moving coil and fourth wheel;

FIG. 8 is a fragmentary rear elevational view of the movement and illustrates the details of a starter mechanism for the balance wheel, the starter lever of this mechanism being shown in idle position;

FIG. 9 is a similar fragmentary rear elevational view but showing the starter lever in operative position; and

FIG. 10 is a fragmentary rear elevational view of a modified movement.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing in detail, and first to FIGS. 1 and 2, there is shown an electric alarm clock which comprises a transparent case or housing 10 provided with internal walls or partitions 12 serving to divide its interior into a first chamber 14 for the movement 18 and a second chamber 16 which accommodates one or more batteries 24. The first chamber 14 further accommodates an alarm assembly 20. The rear wall of the case 10 includes a cover 22 for the second chamber 16 which is detachable from the remainder of the case to afford access to the battery 24. The poles of the battery 24 contact two terminals 26 which are riveted to the case 10 in the second chamber 16 and connect the battery 24 in the circuit of the power

assembly in the movement 18 as well as with the alarm assembly 20. The front wall of the case 10 is constituted by a thin metallic plate 27 which is connected with the remainder of the case by screws or analogous fasteners (not shown). The side walls of the case 10 preferably consist of suitable synthetic plastic material.

The movement 18 includes a front plate 28 having four laterally extending projections or pins 29 abutting against rubber cushions 32 inserted into recesses 30 provided in the case 10 to reduce noise. As shown in FIGS. 3 and 4, the movement 18 further includes a rear plate 34 and a bridge 35 for the balance assembly which will be described later. The connection between the parts 28, 34, 35 includes pillars 36, spacer sleeves 38 and bolts 40. These parts 28, 34, 35 constitute a very simple supporting frame or skeleton for the remaining parts of the movement 18. Additional pillars, spacer sleeves 36' and bolts 40' serve to attach to the front plate 28 a plate-like carrier 42 which consists of diamagnetic material and a yoke 44 of iron which carries a front cover 46. The carrier 42 mounts a substantially prismatic permanent magnet 48 which is provided with cylindrical pole faces. The magnet 48 accommodates a bearing sleeve 50 which is press-fitted into the carrier 42 and whose ends carry ring-shaped antifriction bearings 52 for the shaft 54 of a moving coil 60. That end portion 56 of the shaft 54 which is remote from the carrier 42 constitutes a smaller-diameter stub and extends into and is affixed to a coil holder 58 of synthetic plastic material. Portions of the moving coil 60 are accommodated in air gaps provided between the iron yoke 44 and the permanent magnet 48 to intersect the magnetic force lines of a homogeneous magnetic field. The coil 60 is of substantially rectangular outline and its center of gravity is located on the axis of the shaft 54. This coil is secured to its holder 58 by a suitable adhesive. It was found that the utilization of a substantially rectangular moving coil 60 brings about several important advantages.

The coil holder 58 has an annular recess 62 whose center is located on the axis of the shaft 54. This recess 62 accommodates a helical return spring 64 of metallic material one end of which (namely, the inner end) is connected to a metallic ring 66, this ring 66 being mounted on a contact plate 68 affixed to the holder 58 by fasteners 67. The contact plate 68 is further connected with one end of the moving coil 60. The other or outer end of the return spring 64 is soldered to one end of an elongated strip-shaped metallic conductor 70, the latter being mounted on an insulator 72 attached to the carrier 42 and being connected with a conductor wire 70a which is in conductive contact with the positive terminal of the battery 24. The two magnetic poles N, S of the yoke 44 are shown in FIG. 6.

Referring now to FIGS. 5 and 6, the holder 58 for the moving coil 60 carries a pair of elongated leaf springs 78, 80 whose lower end portions 78a, 80a cross each other in space and which are respectively mounted in cylindrical studs 74, 76. The spring 78 serves as a current-conducting output member of the power assembly and the spring 80 serves to transmit motion to the coil 60. The springs 78, 80 do not contact each other (see FIG. 4) and are installed in slightly stressed condition by bearing against a stop pin 82 provided on an extension or arm 84 of the holder 58. The extension 84 extends from the axis of the shaft 54 toward the staff 90 of a metallic balance wheel 88. The upper end portion of the leaf spring 78 is connected with the other end of the moving coil 60 (see FIG. 3). The upper end of the extension or arm 84 further carries an actuating pin 86 which transmits motion to the train. Due to the fact that the holder 58 is provided with the aforementioned recess 62 and that its extension or arm 84 is offset rearwardly from the return spring 64, the springs 64, 78 and 80 can be accommodated within the confines of the moving coil (see particularly FIG. 4) without any danger of undesirable conduc-

tive contact between these parts. Such manner of mounting the springs and the moving coil contributes to compactness of the movement 18, particularly as regards the height of this movement.

The aforementioned balance wheel assembly includes the balance wheel 88 which carries a circuit-completing pin 87. The balance staff 90 is journaled in the bridge 35 and rear plate 34 (see FIG. 4). The balance wheel 88 is flanked by the leaf springs 78, 80 and by a resilient element in the form of a hairspring 92. Such mounting of the balance assembly also contributes to greater compactness of the movement 18. The balance wheel 88 is relatively large but lightweight, i.e., its moment of inertia is large but the wear on the bearings is small. The hairspring 92 consists of bimetallic material to compensate for temperature changes and constitutes a conductor for electric current from the negative pole of the battery 24 to the circuit-completing pin 87 on the balance wheel 88. This hairspring 92 is indirectly mounted on the front plate 28; one of its ends is connected with a clamp 94 (FIG. 3) and its other end is affixed to a hub 96 (FIG. 4) of the balance wheel 88.

The regulating mechanism which changes the effective length of the hairspring 92 includes a toothed segment 98 (shown in FIG. 3) whose left-hand end carries a lockable key 100. The right-hand end of the segment 98 is provided with teeth 102 meshing with a pinion 104 which is located between the rear wall 34 and bridge 35 and is mounted on a shaft 105 journaled in each of the parts 28, 34, 35 which together form the aforementioned frame of the movement 18. The shaft 105 further carries a gear 106 meshing with a pinion 108 on a shaft 109 which is journaled in the same way as the shaft 105 and further carries a manually turnable graduated disk 110 which is accessible at the rear side of the movement 18 (see also FIG. 1). In order to eliminate play between the elements of the regulating mechanism 98-110, the latter further comprises a suitable spring (not shown) which biases the segment 98 to one of its end positions. The key 100 carries two customary regulator pins between which is placed the outermost coil or overcoil of the hairspring 92; moving the key 100 through the intermediary of the disk 110 causes the pins to move to shorten or lengthen the active length of the hair spring 92 and to cause the balance wheel 88 to vibrate faster or slower. The segment 98 is turnable about the axis of the balance staff 90.

The train of the movement 18 is constructed as follows: FIG. 7 illustrates an input member in the form of a pallet 112 mounted on an arbor 114 between the front and rear walls 28, 34. The fork 116 of the pallet 112 carries at its free end a roller 118 which consists of soft elastomeric synthetic plastic material and can oscillate between two adjustable banking pins 120. These banking pins are turnable about axes which are normal to the plane of FIG. 7 to change the angle of oscillation of the fork 116. The pallet 112 is further provided with a stop post 122 for the ends of a torsion spring 124 which is convoluted around a bolt 126. This bolt is also mounted on the pallet 112 and the ends of the spring 124 define between themselves a triangular space for the actuating pin 86 of the extension 84 of the holder 58. It will be seen that the spring 124 constitutes a coupling between the moving coil 60 and the train, i.e., the input member or pallet 112 of the train. The spring 124 consists of spring steel and has a precision finished smooth external surface which can stand long periods of use without appreciable wear. Furthermore, and since the spring 124 is elastic, its ends yield when the actuating pin 86 strikes against them so that such impact of the pin 86 produces negligible noise. In order to prevent excessive (long-lasting) vibration of the holder 58 when the pin 86 of its extension 84 strikes against the spring 124, the ends of this spring preferably make an acute angle which is clearly shown in FIG. 7. Such mutual inclination of the ends of spring 124 insures that, when the holder 58 assumes either one of its end positions,

forces transmitted to the respective end of the spring 124 invariably include a first component which is normal and a second component which is parallel to the respective spring end. This guarantees that the holder 58 comes to a standstill not later than upon completion of one or two vibratory movements. Vibration of the holder 58 is highly undesirable because it could have an adverse effect upon the cooperation between the aforementioned circuit-completing pin 87 and the leaf springs 78, 80. This is due to the fact that not only the entry of pin 87 into the triangular space between the lower ends 78a, 80a of the leaf springs 78, 80 but also its exit from such triangular space must take place in exactly determined angular positions of the balance wheel 88.

The pallet 112 of FIG. 7 further carries a pivot 128 for a U-shaped pawl 130 which is biased by a torsion spring 132. The spring 132 is coiled around the pivot 128 and its shorter leg bears against the pawl 130 to bias it in a counterclockwise direction, as viewed in FIG. 7. The longer leg of the spring 132 is anchored in a lug 138 of the pallet 112. The pawl 130 has a springy tang 131 which cooperates with the teeth 134 of a fourth wheel or seconds wheel 136. The latter has sixty teeth 134. The arbor 140 of the fourth wheel 136 is journaled in the rear plate 34 and extends through a bearing sleeve 141 (see FIG. 4) riveted to and projecting forwardly of the front plate 28. In order to insure that the center of gravity of the pallet 112 will be located on the axis of its arbor 114, the pallet carries a counterweight 142 shown in the lower parts of FIGS. 4 and 7. The configuration of the pallet 112 is selected with a view to insure that its center of gravity is located on the axis of the arbor 114 and also with a view to place it at the approximate level of the fourth wheel 136. The tang 131 of the aforementioned pawl 130 on the pallet 112 drives the wheel 136 in forward direction, i.e., anticlockwise as viewed in FIG. 7. Backward rotation of the wheel 136 is prevented by a lever 146 which is rockable on a pivot 144 carried by the front plate 28 and supports a pivot 148 for a second U-shaped pawl 150 whose tang 151 cooperates with the teeth 134. The angular position of the lever 146 may be adjusted by an eccentric 154 which is turnably mounted on the front plate 28 and has a pin 156 extending into a slot 158 of the lever 146. The pawl 150 is biased in a counterclockwise direction, as viewed in FIG. 7, by a torsion spring 152 which is convoluted around the pivot 148 and has a longer leg abutting against the pivot 144. When the fourth wheel 136 rotates in a counterclockwise direction, as viewed in FIG. 7, the tang 151 of the pawl 150 merely rides over the teeth 134.

The remainder of the train includes customary wheels and pinions which receive motion from the fourth wheel 136 to drive the minute hand 194 (FIG. 2), the hour hand 196 and the mechanism of the alarm 20. Certain rotary parts of such remainder of the train are illustrated in FIG. 3. The second hand 192 (FIG. 2) is affixed to the aforementioned arbor 140. The exact manner in which the hands 194, 196 receive motion from the fourth wheel 136 forms no part of the present invention.

The setting mechanism for the minute and hour hands 194, 196 includes a stem 242 which is journaled in the plates 28, 34 and carries a clutch wheel 244 (see FIG. 3). The stem 242 is movable axially to thereby place the clutch wheel 244 into mesh with a further wheel (not shown) which can effect rotation of the hands 194, 196 in response to rotation of the stem 242.

Since the power assembly of the movement 18 is not self-starting, the latter must be provided with a starter mechanism which can set the balance wheel 88 in oscillatory motion when the coil 60 of the power assembly is idle. This starter mechanism comprises an L-shaped starter lever 254 (see FIGS. 3 and 8) which is fulcrumed on a pivot 250 mounted in the plates 28 and 34. The starter lever 254 is rigid with a collar 258 which surrounds the pivot 250 and carries a projection 256. The free end of the lever 254 is provided with a friction shoe 260 which

is automatically moved into frictional engagement with the peripheral surface of the balance wheel 88 when the lever 254 is rocked in a counterclockwise direction, as viewed in FIG. 8, in response to axial movement of a shifting knob 262 (FIG. 1) for the stem 242 of the setting mechanism. The stem 242 carries a cone 264 (FIG. 8) which rocks the starter lever 254 through the intermediary of the projection 256. Thus, the projection 256 constitutes a follower which tracks the tapering face of the cone 264 to rock the starter lever 254 and to thereby move the shoe 260 into frictional engagement with the balance wheel 88 in automatic response to such axial movement of the stem 242 which is necessary to establish a motion transmitting connection between the clutch wheel 244 and the hands 194, 196. That angular position of the starter lever 254 in which the shoe 260 bears against the peripheral surface of the balance wheel 88 is shown in FIG. 9. If the setting stem 242 is then returned by knob 262 to its normal axial position in which the clutch wheel 244 is disengaged from the properly adjusted hands 194, 196, the starter lever 254 is automatically rocked by a return spring 266 whereby the shoe 260 transmits to the balance wheel 88 an impulse and turns the balance wheel about the axis of the staff 90 to set the clock in motion in a manner to be fully described hereinafter. The spring 266 is a torsion spring and is convoluted around one of the pillars 36 (see FIGS. 8 and 9). One end of this torsion spring 266 bears against a retainer 268 on the starter lever 254 and tends to turn the latter in a clockwise direction to urge the follower or projection 256 against the tapering face of the cone 264. The lever 254 is further provided with a lug 270 which is adjacent to the collar 258 and serves as a retainer for one end of a further torsion spring 272 (FIG. 3). The other end of the spring 272 bears against a cylindrical hub 274 on the arbor 140 of the fourth wheel 136. The spring 272 performs the function of a brake to insure smooth angular movement of the second hand 192. Such braking action is particularly desirable when the second hand 192 is rather long and has a large inertia; in the absence of the braking action, the second hand 192 would tend to vibrate after each angular displacement of the fourth wheel 136. The hub 274 may form an integral part of the wheel 136.

The operation is as follows:

Referring to FIG. 5, it is assumed that, in order to start the movement 18, the balance wheel 88 must be turned in a counterclockwise direction so that the circuit-completing pin 87 travels in a direction from the right to the left whereby this pin 87 enters the aforementioned triangular space between the lower ends 78a, 80a of the leaf springs 78 and 80. The studs 74, 76 for the upper ends of the springs 78, 80 are located to the right of the shaft 54 for the moving coil 60; therefore, the lower ends 78a, 80a of the springs 78, 80 travel downwardly (as viewed in FIGS. 5 or 6) when the coil 60 is caused to turn in a clockwise direction. When the balance wheel 88 is started by means of the aforementioned friction shoe 260 on the starter lever 254 and turns in a counterclockwise direction, its pin 87 moves into engagement with the lower end 80a of the leaf spring 80 and the pin 87 then turns the coil 60 and its holder 58 in a clockwise direction against the opposition of the return spring 64. As the balance wheel 88 continues to turn in counterclockwise direction, the studs 74, 76 travel about the axis of the shaft 54 and the spring 78 moves to a lower level until its bent-over lower end 78a actually engages the pin 87. Not only the lower end 78a but also the pin 87 preferably consists of or is coated with a material which is a very good conductor of electric current to insure that current can invariably flow between the balance wheel 88 and leaf spring 78 when the latter engages the pin 87. The circuit between the poles of the battery 24 is then completed from the positive pole through the strip-shaped conductor 70, return spring 64, metallic ring 66, contact plate 68, one end of the moving coil 60, through this coil, leaf

springs 78, pin 87, balance wheel 88, hairspring 92, clamp 94 (see the lower right-hand portion of FIG. 3) and front plate 28 to the negative pole. Due to such energization of the coil 60, the latter begins to turn (clockwise, as viewed in FIGS. 5 or 6) at a speed which exceeds the speed of the balance wheel 88 (in a counterclockwise direction) until the elastic roller 118 on the fork 116 (FIG. 7) of the pallet 12 reaches one of the banking pins 120. The torsion spring 124 (FIG. 7) then arrests the actuating pin 86 on the extension 84 of the holder 58 whereby the coil 60 comes to a halt. Since the balance wheel 88 trails the coil 60 when the latter turns in response to completion of its circuit, the leaf spring 78 moves away from the stop pin 82 on the extension 84 and its lower end 78a transmits to the balance wheel 88 an accelerating impulse through the intermediary of the pin 87 even though the coil 60 is already arrested by the torsion spring 124. FIG. 6 illustrates the leaf spring 78 in such position in which the latter's lower end 78a has already accelerated the balance wheel 88 through the intermediary of the pin 87 and in which the spring 78 again abuts against the stop pin 82. The pin 87 is about to move away from the lower end 78a. When the pin 87 actually advances beyond the lower end 78a, the circuit of the moving coil 60 is deenergized and the return spring 64 is free to return the coil and the holder 58 back to normal starting position which is shown in FIG. 5. The balance wheel 88 continues to turn in a counterclockwise direction to cause the hairspring 92 to store energy and thereupon reverses the direction of its movement under the bias of the hairspring whereby its pin 87 engages the lower end 80a of the leaf spring 80 and lifts the latter slightly off the stop pin 82. The angular speed of the balance wheel 88 then decreases until the balance wheel reaches the other end position. The just described cycle is then repeated in the aforescribed manner. The pawl 130 turns the fourth wheel 136 through six degrees in response to each oscillation of the balance wheel 88 to thereby drive the second hand 192. The fourth wheel 136 drives the remainder of the train to rotate the hands 194 and 196.

If one disregards the fact that the spring 124 on the pallet 112 limits oscillatory movements of the coil 60, the balance wheel assembly is completely independent of the train which latter receives motion from the actuating pin 86. Therefore, the train cannot influence the frequency of the balance wheel 88. The latter merely determines the frequency of the moving coil 60 and its holder 58. The balance wheel assembly receives working impulses solely from the lower end 78a of the leaf spring 78, i.e., from the output member of the circuit which includes the coil 60. Such mode of operation insures surprisingly high accuracy of the movement 18.

The balance wheel 88 completes one hundred and twenty half oscillations per minute and, since the fourth wheel 136 has sixty teeth 134, the tang 131 of the pawl 130 turns the wheel 136 once per second so that the hand 192 completes one full revolution per minute. Such angular displacement of the hand 192 during each second is highly desirable. Furthermore, the train of the movement 18 includes fewer rotary parts than presently known trains because two wheels are saved due to the fact that the pallet 112 drives the arbor 140 of the second hand 192 directly through the fourth wheel 136. In many presently known trains, the pallet drives an escape wheel and the latter drives the fourth wheel through an escape pinion. Such escape wheel and escape pinion are not needed in the train of my improved movement 18.

Another important advantage of the movement 18 is that the entire power assembly can be detached in response to removal of bolts 40'. This facilitates the work of a repairman as well as the initial assembly of the movement in the manufacturing plant.

FIG. 10 illustrates a modified electrically powered time-

piece wherein the leaf spring 78 is replaced by an output member in the form of a contact lever 302 which is turnable on the pivot pin 304 of an eccentric 306. The shaft 308 of the eccentric 306 is journaled in the oscillatable coil holder 58' and the eccentric 306 is provided with a slot 310 which can receive the working end of a screw-driver or the like in order to change the position of the pivot pin 304. The contact lever 302 is integrally or rigidly connected with a lever-shaped adjusting member or retainer 312 which is closely adjacent to the pivot pin 304 and is connected with one end of a resilient element here shown as a helical contraction spring 316. The retainer 312 is provided with a series of notches 314 each of which can receive the adjoining end of the spring 316. This spring is relatively long and its other end is connected to a retainer or post 318 on the coil holder 58'. The pin 87 of FIGS. 1-9 has been replaced by a curved circuit-completing shoe 320 which is rigid with the balance wheel 88' and can engage with the end portion 80a of the motion transmitting spring 80 as well as with the bent-over resilient end portion 302a of the lever 302. The extension 84' of the holder 58' carries a stop 82' for the end portions 80a and 302a.

Since the point of engagement between the retainer 312 on the contact lever 302 and the right-hand end of the spring 316 is close to the pivot pin 304, the bias of the spring 316 varies very little when the coil 60' moves to its other end position by turning in a clockwise direction, as viewed in FIG. 10. Therefore, the bias of the contact lever 302 upon the contact shoe 320 remains substantially unchanged during the entire interval when the circuit of the coil 60' is completed through the lever 302, shoe 320 and balance wheel 88'. In other words, the balance wheel 88' receives from the contact lever 302 an impulse of predetermined magnitude during each clockwise oscillatory movement of the coil 60' because, contrary to operation of the previously described timepiece, the angular speed of the coil 60' has no bearing on the magnitude of such impulse. Therefore, the amplitude of the balance wheel 88' is constant and does not in any way depend on the charge of the battery which supplies current for energization of the coil 60'. This contributes to greater accuracy of the timepiece. Furthermore, the amplitude of the balance wheel 88' can be changed in a very simple and time saving manner, namely, by placing the right-hand end of the helical spring 316 into a different notch 314 of the retainer 312. Such change in the point of engagement between the spring 316 and retainer 312 changes the bias which is transmitted by this spring to the contact lever 302. The bias of the spring 316 remains substantially constant once its right-hand end has been placed into a selected notch 314 of the retainer 312. The notches 314 are located at different distances from the pivot pin 304. The extension 84' of the holder 58' extends in the general direction of the staff for the balance wheel 88'.

It will be seen that the movement of my improved timepiece can dispense with several component parts of the aforementioned conventional chronometers because the output member 78 or 302 of the electric circuit in the power assembly not only completes the circuit of the coil 60 or 60' in cooperation with the pin 87 or shoe 320 but also serves as a means for transmitting to the balance wheel 88 or 88' an impulse which propels the balance wheel to its left-hand end position (as viewed in FIG. 5 or 10) in which the hairspring 92 stores a maximum amount of energy. In other words, the output member 78 or 302 constitutes the sole means for propelling the balance wheel 88 or 88' against the opposition of the hairspring, such propulsion taking place while the speed of the moving coil 60 or 60' (in response to completion of its circuit) exceeds the speed of the balance wheel to its left-hand end position. My movement can operate properly with a single circuit-completing portion (87 or 320) on the balance wheel 88 or 88' because this portion not only completes the circuit of the coil 60 or 60' but also

receives from the output member 78 or 302 impulses which are necessary to effect full winding of the hairspring. As explained hereinbefore, presently known chronometers utilize two output members each of which oscillates with the coil and two pins on the balance wheel, each such pin cooperating with one of the output members so that one pin completes the circuit of the coil and the other pin receives from the corresponding output member an impulse in response to magnetically induced turning of the coil.

Since the output members 78, 302 are oscillatable with the respective coils 60, 60' about common axes, the power assembly and the balance assembly together comprise only two sets of oscillatable parts, namely, those oscillating about the axis of the shaft 54 and those oscillating about the axis of the staff 90.

In accordance with a further modification of my invention which is not specifically shown in the drawing, the motion transmitting leaf spring 80 can be omitted if the output member 78 or 302 is provided with a bifurcated lower end to replace the end 78a or 302a. For example, and referring to the embodiment of FIGS. 1 to 9, the output member 78 could be formed with a bifurcated lower end having a leading prong and a trailing prong. When the balance wheel 88 turns in a counterclockwise direction, as viewed in FIG. 5, its circuit-completing pin 87 first engages the leading prong and completes the circuit of the coil 60 whereby the coil turns in a clockwise direction and the trailing prong of the bifurcated output member catches up with the pin 87 to transmit to the balance wheel 88 an impulse in the same way as the end 78a of the output member 78. In other words, as soon as the pin 87 engages the leading prong, the circuit of the coil 60 is completed only instantaneously because the rotational speed of the coil exceeds the speed of the balance wheel and the coil immediately moves the leading prong away from the pin 87 to deenergize the circuit. The circuit is completed when the trailing prong catches up with the pin 87 and transmits to the balance wheel 88 an impulse which suffices to wind the hairspring 92. The coil 60 then completes its clockwise rotary movement until the fork 116 of the pallet 112 reaches one of the banking pins 120. However, it was found that such construction is somewhat less satisfactory than the one using the motion transmitting spring 80 because the coil 60 would receive two current impulses per oscillation and this could cause vibrations of the aforementioned prongs on the bifurcated end of the output member. The provision of the aforementioned motion transmitting spring 80 whose lower end 80a extends into the path of the circuit-completing pin 87 when the balance wheel 88 rotates in a counterclockwise direction insures that the circuit of the coil 60 must be completed only once per oscillation because the pin 87 sets the coil in motion through the intermediary of the end 80a and the turning coil 60 (and more particularly its holder 58) then causes the output member 78 to engage the pin 87 and to complete the circuit. It will be seen that the spring 80 does not complete the circuit of the coil 60 but merely causes the holder 58 to turn so that the latter moves the current-conducting output member 78 into engagement with the circuit-completing pin 87.

In the embodiment of FIGS. 1 to 9, the charge of the battery 24 determines the magnitude of the impulse which the lower end 78a of the output member 78 transmits to the pin 87 and hence to the balance wheel 88. This will be readily understood since the charge of the battery determines the speed at which the coil 60 turns when its circuit is completed by engagement between the output member 78 and pin 87. If the speed of the coil 60 is higher, the impulse transmitted to the balance wheel 88 is greater. Such dependency of the frequency of the balance wheel upon the charge of the battery is eliminated by resorting to the solution of FIG. 10. The relatively long spring 316 of FIG. 10 renders the frequency of the

balance wheel 88' independent of the battery charge in a manner which has been fully described above. This will be readily understood since the output member 302 of FIG. 10 is biased by the spring 316 whose bias varies very little when the coil 60' turns in a clockwise direction so that the impulses transmitted by the lower end 302a to the shoe 320 of the balance wheel 88' remain unchanged regardless of the battery charge, i.e., regardless of the speed at which the coil 60' rotates in a clockwise direction. Furthermore, the movement can be adjusted more readily because such adjustment merely necessitates placing of the right-hand end of the spring 316 into another notch 314 of the adjusting member or retainer 312. Adjustments in angular position of the eccentric 306 render it possible to change the distance between the bent-over end portion 302a of the output member 302 and the shoe 320 of the balance wheel 88'.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of my contribution to the art.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. In a movement for timepieces, a combination comprising a power assembly having an electric circuit including magnetic field generating means, a coil oscillatable between two end positions in the magnetic field created by said field generating means, said coil tending to assume one of said end positions and being arranged to turn to the other end position in response to completion of said circuit, and a resilient contact member consisting at least in part of current-conducting material and actuated by said coil; and a balance assembly including a balance member oscillatable independently of said coil between first and second positions, resilient means for biasing said balance member to first position, and a circuit-completing portion provided on said balance member and arranged to engage said contact member during movement of said balance member toward first position to complete said circuit whereby said coil turns to the other end position and imparts to said balance member through the intermediary of said contact member and said circuit-completing portion an impulse which propels the balance member to second position against the opposition of said resilient means.

2. A combination as defined in claim 1 and wherein, in response to propulsion to said second position, the balance member disengages its circuit-completing portion from said contact member whereby the coil is free to return to said one end position.

3. A combination as defined in claim 1, wherein said coil and said contact member are oscillatable about a common axis.

4. A combination as defined in claim 1, wherein said balance member is a wheel and said resilient means comprises a hairspring.

5. A combination as defined in claim 4, wherein said current-conducting portion is a contact pin on said wheel.

6. A combination as defined in claim 2, wherein said power assembly further comprises a holder for said coil and said contact member, and stop means provided on said holder, said contact member normally abutting against said stop means.

7. A combination as defined in claim 6, wherein said stop means is arranged to maintain said contact member in prestressed condition.

8. A combination as defined in claim 2, wherein said magnetic field generating means comprises a permanent magnet oscillatable with said coil, said coil being of rectangular outline and surrounding said magnet.

9. A combination as defined in claim 1, wherein said coil comprises two ends one of which is connected with

said contact member, said circuit further comprising a source of electrical energy having a first pole connected with said circuit-completing portion and a second pole, and a current-conducting connection between said second pole and the other end of said coil.

10. A combination as defined in claim 9, wherein said current-conducting connection comprises a return spring arranged to bias the coil to said one end position.

11. A combination as defined in claim 1, further comprising a train for rotating the hands of the timepiece, said train comprising an input member receiving motion from said coil.

12. A combination as defined in claim 11, wherein said train further comprises a wheel receiving motion from said input member.

13. A combination as defined in claim 12, wherein said wheel is the fourth wheel.

14. A combination as defined in claim 2, wherein said power assembly further comprises a motion transmitting member oscillatable with said coil and extending into the path of said circuit-completing portion to thereby start the movement of said coil from said one end position by simultaneously placing said contact member into engagement with said circuit-completing portion when the movement is started by rotating said balance member in said second direction independently of said contact member.

15. A combination as defined in claim 14, wherein said contact member crosses said motion transmitting member in space.

16. A combination as defined in claim 15, wherein said two last mentioned members have end portions defining between themselves a space of substantially triangular outline into which said circuit-completing portion enters in response to rotation of said balance member in said second direction independently of said contact member to first engage the end portion of said motion transmitting member and to be thereupon engaged by the end portion of said contact member in response to movement of said coil from said one end position.

17. A combination as defined in claim 16, wherein said motion transmitting member comprises a spring.

18. A combination as defined in claim 16, wherein said power assembly further comprises a holder oscillatable with said coil, with said contact member and with said motion transmitting member about a fixed axis and having an extension provided with a stop for the end portions of said contact member and said motion transmitting member.

19. A combination as defined in claim 18, wherein said extension is constituted by an arm which extends from said fixed axis toward the axis of said balance member.

20. A combination as defined in claim 14, wherein said contact member is a leaf spring and said motion transmitting member is also a leaf spring.

21. A combination as defined in claim 1, further comprising banking means for determining said first and second positions of the balance member.

22. A combination as defined in claim 2, wherein said power assembly further comprises a holder oscillatable with said coil and said contact member about a fixed axis, said holder having stop means and said contact member comprising a lever, pivot means securing said lever to said holder, and second resilient means for biasing said lever against said stop means.

23. A combination as defined in claim 22, wherein said pivot means is remote from said stop means and said second resilient means engages with said lever close to said pivot means.

24. A combination as defined in claim 23, wherein said holder comprises a retainer for said second resilient means, said retainer being remote from said pivot means.

25. A combination as defined in claim 22, wherein said second resilient means is arranged to bias said lever against said stop means with a substantially constant force.

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26. A combination as defined in claim 22, further comprising means for adjusting the bias of said second resilient means.

27. A combination as defined in claim 26, wherein said adjusting means comprises a retainer rigid with said lever and having a plurality of notches located at different distances from said pivot means, said second resilient means comprising a helical contraction spring one end of which is received in a selected notch of said retainer.

28. A combination as defined in claim 22, wherein said lever comprises a bent-over end portion of resilient material engageable with said circuit-completing portion and said holder further comprises means for changing the position of said pivot means.

29. A combination as defined in claim 28, wherein the means for changing the position of said pivot means comprises an eccentric rotatably carried by said holder and comprising a pin constituting said pivot means.

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