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BALANCE WHEEL ASSEMBLY FOR AN ELECTRIC TIMEPIECE

Filed July 25, 1962 4 Sheets-Sheet 1

Fig. 1

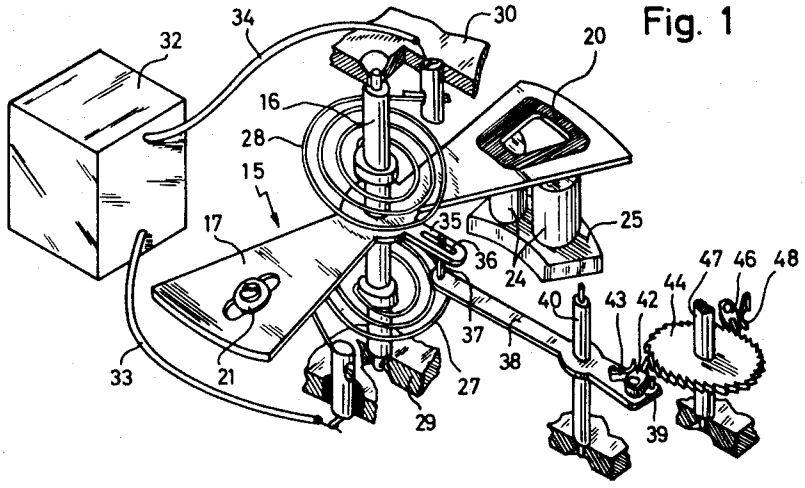


Fig. 2

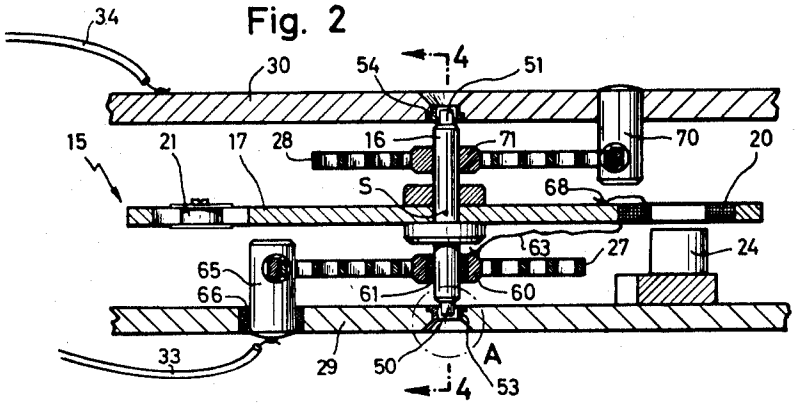
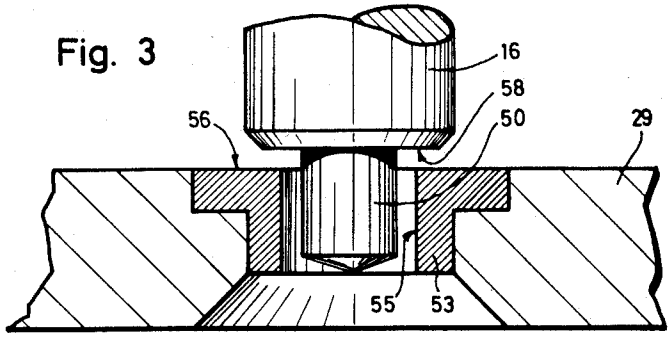


Fig. 3



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BALANCE WHEEL ASSEMBLY FOR AN ELECTRIC TIMEPIECE

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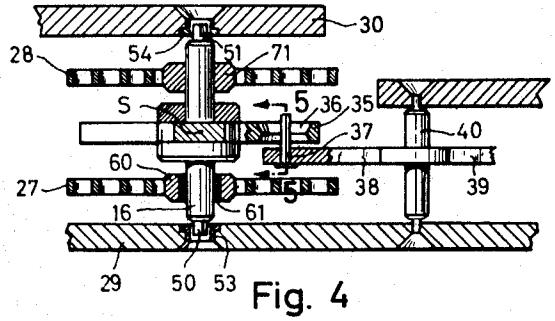

Fig. 4

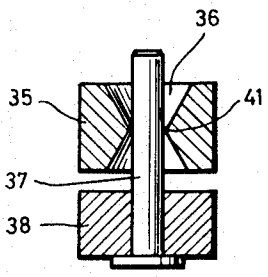

Fig. 5

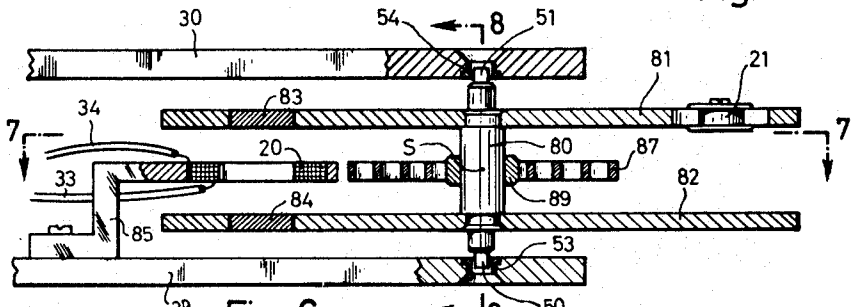

Fig. 6

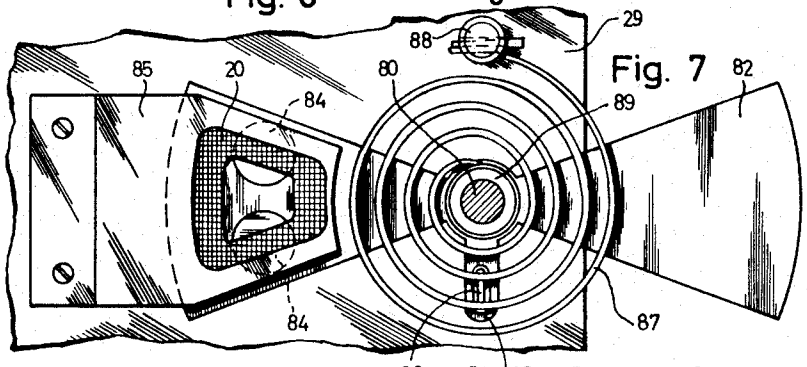

Fig. 7

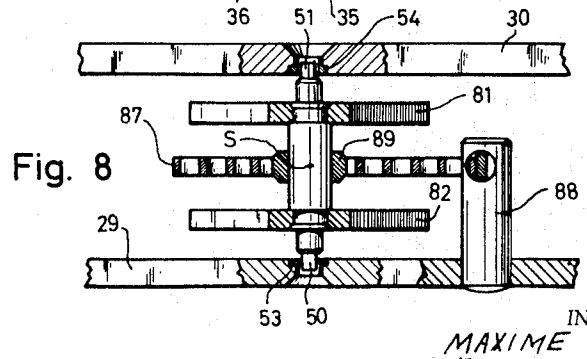

Fig. 8

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BALANCE WHEEL ASSEMBLY FOR AN ELECTRIC TIMEPIECE

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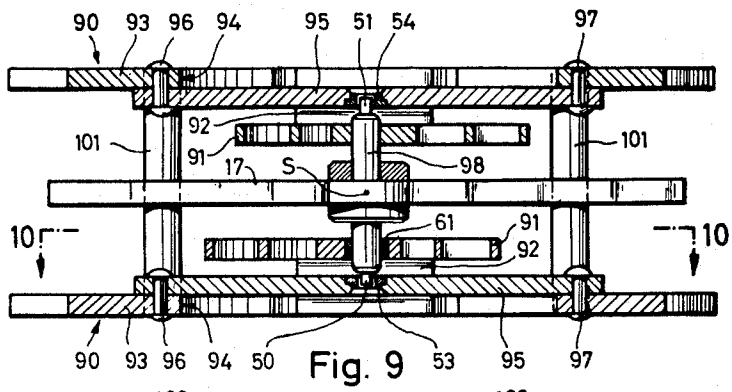

Fig. 9

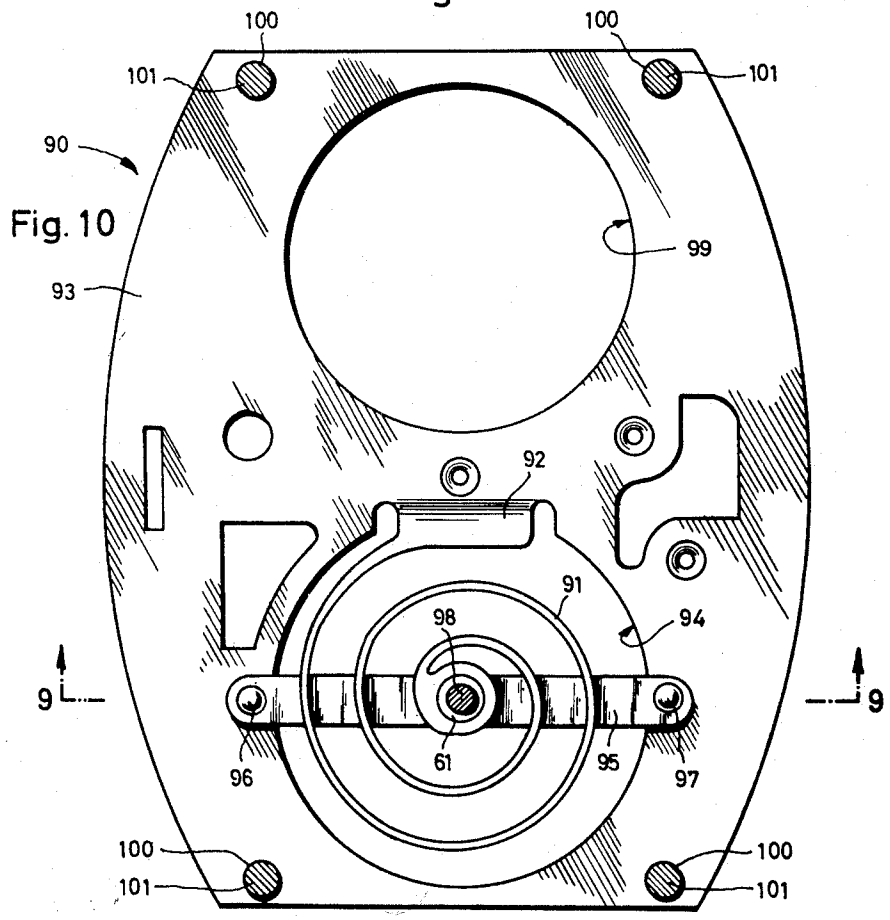

Fig. 10

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Fig. 11

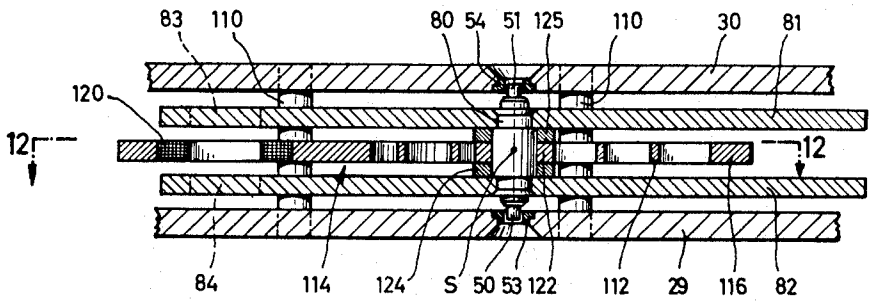
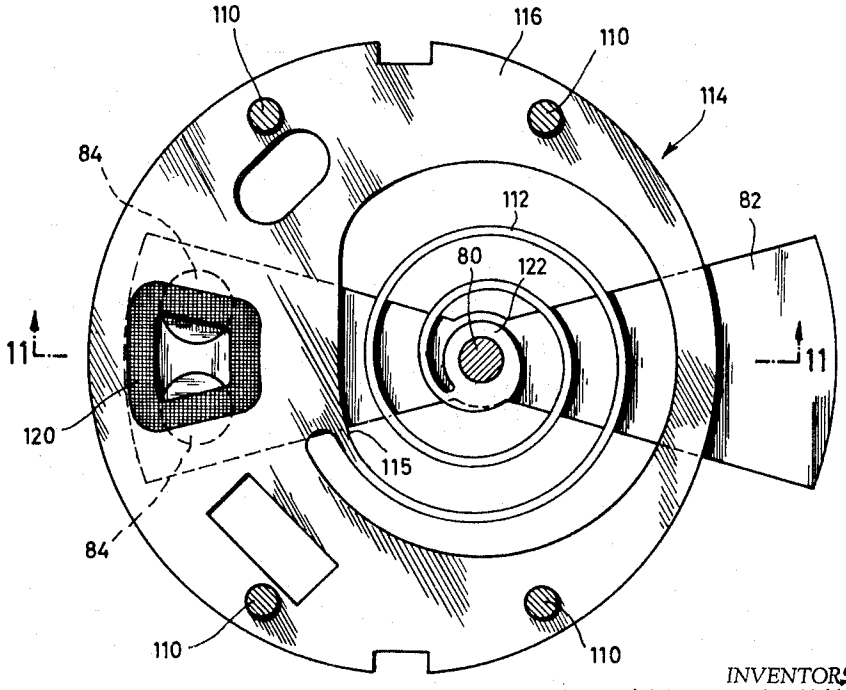


Fig. 12



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United States Patent Office 3,186,157 Patented June 1, 1965

3,186,157

BALANCE WHEEL ASSEMBLY FOR AN ELECTRIC TIMEPIECE

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Filed July 25, 1962, Ser. No. 212,264
Claims priority, application Germany, Aug. 24, 1961, U 8,295
4 Claims. (Cl. 58—28)

The present invention relates to a balance-like regulator for timekeeping instruments.

In the case of portable watches such as pocket or wristwatches, it is known to use as a regulator a swinging balance which comprises a swinging body having a swinging disk (balance wheel) which is fastened to a balance staff. The staff is supported in the case of the customary watch constructions in thrust and radial bearings. There is also arranged on the swinging body a spiral spring which serves for the restoration of the swinging body. In order to reduce the friction in the bearings, it is known to support the swinging body in radial bearings and to keep it floating in axial direction by means of a magnetic device or a helical spring device. These two types of floating supports of swinging bodies require a relatively large amount of space and for this reason cannot be used for portable watches in which smallness is of importance. The suspension by means of a helical spring furthermore demands a vertical position of the balance staff in space and cannot be used for this reason for portable watches.

The object of the present invention is to provide a balance-like regulator in which neither radial nor axial bearing friction occurs at the bearings. This object is attained, in the case of balance-like regulators for timekeeping instruments, particularly in balances for watches, including electric watches having a swinging body, by having at least one spiral spring which is fastened on the one end to the swinging body and on the other end to a stationary part; and furthermore the bearing device keeps the swinging body floating, in accordance with the invention, because the spiral spring holds and/or guides the swinging body both in axial direction and in lateral direction. In order to be able to achieve this object, the spiral spring must not only be sufficiently strong to produce the restoring force, but it must also be sufficiently strong so that the swinging body swings substantially only around its central axis and is substantially immovable in the axial direction.

Such a swinging body contacts no parts whatsoever of the timekeeping instrument, aside from its connection with the spiral spring, so that, because of the absence of all bearing points, neither radial nor axial friction occurs. In this way, there exists a regulation which is independent of any friction, which constitutes a considerable advantage over the known regulators which are supported in jewels or pivots. In the case of the later, the friction exerts a particularly unfavorable influence on the regulation, especially because, as the friction does not remain uniform over long periods of time, the change of friction unfavorably affects the regulation.

The regulator of the invention can be used for all types of clocks and watches, i.e., mechanical or electrical timekeeping instruments, but it is especially suitable for electric watches which carry out a relatively large number of vibrations per unit of time, since friction in the bearings has a particularly unfavorable effect in case of such rapid vibrations. Furthermore, there is a certain types of electric watch drive in which the regulator effects a relatively small oscillation and in which the spiral spring can, without any disadvantage, be made so strong

that a favorable supporting and guiding of the swinging body is obtained.

Another advantage of the suspension of the swinging body, in accordance with the invention, is that the swinging body can move away in any desired manner upon the occurrence of a shock so that anti-shock devices are no longer required.

The construction can, for instance, be such that a single spiral spring is arranged preferably approximately in the central plane of the swinging body, in which case inertia and/or drive elements can then be arranged on both sides of the spiral spring or else a spiral spring can be arranged on both sides of the center of the spring body. Of course, more than two spiral springs can also be used.

As a result of the free suspension of the swinging body and its possibility of movement, it is preferable that the feeding and/or removal of energy to the swinging body take place so that the swinging body does not thereby change its position, and in particular is not tilted. This can, for instance, be effected so that the feed and/or removal of the energy takes place approximately in a plane passing through the center of gravity of the swinging body.

Insofar as there are concerned regulators for electric watches, one or more spiral springs can be used for feeding the current to the swinging body. For instance, a spiral spring can consist of two electrically insulated parts so that a single spiral spring can be used as double electric line.

As a result of the free suspension, it is no longer necessary for the swinging body to have the customary construction with inertia disk arranged on a shaft, but rather the shaft can be completely eliminated and the swinging body can be concentrated essentially on a small piece. With such a construction, the height of the regulator is substantially less than that of the known regulators, which has a favorable effect on the structural height of small watches.

In order to limit a deflection of the swinging body, particularly on the occurrence of blows, it is preferable for stops to be arranged on stationary parts of the watch which cooperate with the corresponding parts of the swinging body and limit the lateral and/or axial movement thereof. It is, however expressly pointed out that in normal operation the swinging body does not touch the stops. For instance, in one such construction, there can be provided on the swinging body two axial projections in the form of pins which engage in stop bushings for the limiting of the lateral and/or axial deflection.

In the case of electrically driven watches, it is preferred to insulate electrically at least one stop, or possibly also a projection pin, at least at the possible contact surface.

The spiral spring, such as used in the construction of the invention, can be manufactured in customary manner as a separate part which then has its one end fastened to the swinging body and its other end to a stationary part. It is merely necessary—as already mentioned—that the spiral spring have such a strength that it bears and guides the swinging body in the desired position. Since such spiral springs required for the construction of the invention consist of a relatively strong material, it is possible to form such a spiral spring from part of a stationary body with which the spiral spring is then integral. For this purpose, there is preferably used a plate or cock, a part of the timekeeping device which must in any event be present, from which the spiral spring is punched or otherwise machined. In this construction, the outer end of the spiral spring is then con-

nected integrally with the plate or cock and only the inner end of the spiral spring need be fastened to the swinging body.

Such a spiral spring, which is integral with the supporting part, can be arranged in the plane of said supporting part, but in certain instruments it may be advisable to space the spiral spring from the said plane, in the manner of an offset.

As material for spiral springs in accordance with the invention, there can be used any known spring material, in particular metal having temperature compensating properties.

Embodiments of the invention are shown in the drawing, in which:

FIG. 1 is a schematic perspective view of a drive device for electric watches, with the use of a first embodiment of a regulator in accordance with the invention;

FIG. 2 is a longitudinal section through the regulator of FIG. 1, on a larger scale;

FIG. 3 is a partial section along the dot-dash circle A of FIG. 2, on a larger scale than the latter;

FIG. 4 is a partial section along the line 4—4 of FIG. 2;

FIG. 5 is a partial section along the line 5—5 of FIG. 4, on a larger scale than the latter;

FIG. 6 is a longitudinal section through a second embodiment of a regulator in accordance with the invention;

FIG. 7 is a section along the line 7—7 of FIG. 6;

FIG. 8 is a section along the line 8—8 of FIG. 6;

FIG. 9 is a longitudinal section along the line 9—9 of FIG. 10 through a third embodiment of the invention;

FIG. 10 is a section along the line 10—10 of FIG. 9;

FIG. 11 is a longitudinal section along the line 11—11 of FIG. 12 through a fourth embodiment of the regulator in accordance with the invention;

FIG. 12 is a section along the line 12—12 of FIG. 11.

In FIG. 1 there is shown schematically a drive arrangement for an electric watch with the use of a regulator in accordance with the invention. In this figure, a swinging body as a whole is marked 15, it having a swinging body shaft 16 and a swinging disk (balance wheel) 17 which is fastened to the said shaft. The swinging disk 17 bears an electric coil 20 and opposite said coil a weight compensation 21 is adjustably arranged. The coil 20 cooperates with two magnets 24 which are fastened to a magnet holder 25.

The swinging-body shaft 16 is connected via a first spiral spring 27 and a second spiral spring 28 with plates 29 and 30 respectively. Furthermore, there is also provided a drive unit 32 shown schematically merely in the form of a small box, which is connected via electric lines 33 and 34 with the regulator. The details of the above construction will be taken up further below.

The swinging disk 17 furthermore has a slot extension 35 in the slot 36 of which there engages a drive pin 37 which is fastened to the drive arm 38 of a swing lever 38/39. This swing lever is fastened to a driveshaft 40 which is rotatably supported in stationary bearings. The pawl arm 39 of the swinging lever bears a pawl 42 which a pawl spring 43 strives to maintain in engagement with a ratchet wheel 44. The ratchet wheel, which is fastened to a rotatable pawl shaft 47, further cooperates with a locking pawl 46 which is also held in engagement with a pawl spring 48.

Such a watch drive is in itself known and for this reason the manner of operation of the arrangement shown in FIG. 1 will be discussed only briefly.

Via the drive unit 32, the coil 20 receives periodic current impulses which, in cooperation with the magnets 24, maintain the swinging of the swinging body, the spiral spring effecting in known manner the return of the swinging body into the rest position. Upon the swinging of the swinging disk, there takes place via the slot extension 35 and the drive pin 37 a swinging of the swinging lever 38/39 which upon each full swing advances the ratchet wheel 44 one tooth further by means of its pawl 42. The further parts of the timing device are then driven from this ratchet wheel or pawl shaft 47.

The regulator of the invention will be described in detail with reference to FIGS. 2 and 5, the same reference numbers being used, however, for the parts as in FIG. 1; to this extent the figures require no further description.

The swinging body shaft 16 has at each of its two ends an extension pin 50 and 51 respectively, each of which engages in a stop bushing 53 and 54 respectively of the plates 29 and 30 respectively. As can be noted particularly clearly from FIG. 3, the extension pin 50 is such a distance from the surfaces of the stop bushing 53 that the projection pin does not touch the stop bushing at all in normal operation. If, however, a deflection of the swinging body shaft occurs, particularly as a result of a blow, the lateral movement of the extension pin is limited by the inner wall 55 of the stop bushing and the axial movement by the inner end surface 56 of the stop bushing which in this case cooperates with a stop shoulder 58 of the swinging body shaft.

The conditions in connection with the extension pin 51 and the stop bushing 54 are the same as described in connection with FIG. 3.

From FIG. 2, there can furthermore be noted the attachment of the spiral springs 27 and 28. The spiral spring 27 has its inner end fastened to a roller 60 and an insulating ring 61 is provided between said roller and the swinging body shaft. The roller 60 is furthermore connected by a connecting wire 63 with the coil 20. The outer end of the spiral spring 27 is fastened in a pin 65 which is fastened with an insulating bushing 66 in the plate 29. The aforementioned electric line 33 is connected to the pin 65 so that current can now flow via the pin 65, the conductive spiral spring 27, the roller 60 and the connecting wire 63 to the coil 20 which in its turn is connected with its one end at 68 to the swinging body which is also electrically conductive, i.e., to ground. The spiral spring 28 is connected in similar manner but without insulation on the one hand with the plate 30 via a pin 70 and a roller 71 with the swinging body shaft 16 which is also electrically conductive. In this way, an electrically conductive connection of the coil 20 with the lines 33 and 34 is produced.

FIGS. 4 and 5 show further details of the ratchet-wheel drive. The slot 36 of the slot projection 35 has a drive edge 41 which is located in the center of the slot and is arranged along the entire inner periphery of the slot. This drive edge can for instance be formed in the manner that the slot widens from the edge toward both sides, in which connection the widening can take place in any desired manner. In this connection, the drive edge 41 need not be sharp-edged, but may also provide for area contact. The purpose of such a development of the slot 36 is not to prevent the desired swingability of the swinging body by the drive parts, and is is readily clear that the transmission of power in the case of the construction described takes place in excellent manner even if the swinging body assumes an oblique position due to a deflection.

As already mentioned in the preamble, it is advisable that the feeding of the energy and the removal of the energy take place in such a manner that the swinging body does not thereby experience any deflection; and in order to achieve this result it is advisable if the feeding of energy or removal of energy takes place in a plane which is transverse to the axis of swing, and passes approximately through the center of gravity of the swinging body marked S in FIGS. 2 to 4. Since the feeding and removal of energy takes place in this embodiment substantially via the swinging disk 17, this swinging disk is arranged in the said plane.

In the embodiment shown in FIGS. 6 to 8, all parts agreeing with the first embodiment shown in FIGS. 1 to 5 are designated by the same numbers. Differing from

the first embodiment, the swinging body shaft 80 bears here a first swinging disk 81 and a second swinging disk 82, both of which are fastened at the same distance from the center of gravity S of the swinging body on the swinging-body shaft. In this case, two permanent magnets 83 and 84 respectively are fastened on the swinging disks, while the coil 20 is arranged in a coil-holder 85 fastened to the plate 29.

Approximately in the central plane passing through the center of gravity S, there is arranged a spiral spring 87, which, in a manner similar to that described above, has its one end fastened via a roller 89 to the swinging-body shaft 80 and its other end to the plate 29 via a pin 88.

In the embodiment shown in FIGS. 9 and 10, the same parts have also been provided with the same reference numbers. In this embodiment, a spiral spring 91 is produced from a plate 90, for instance by punching, milling or etching, its outer end being connected integrally via a lug 92 with the actual plate body 93. This lug 92 is so bent out of the plane of the plate body 93 that the spiral spring 91 is arranged in the manner of an offset spaced from and parallel to the plate body 93, as can be clearly noted from FIG. 9. The opening 94 of the plate 90 is bridged by a bridge (cock) 95, which is firmly connected by rivets to the plate body 93 at 96 and 97. In the bridge (cock), there is inserted, in a manner similar to what was the case in the other embodiments, a stop bushing 53 into which there extends the pin 50 and 51 respectively of a swinging-body shaft 98. On the other side of the swinging-body shaft 98, there is provided another plate which can be developed in a manner similar to the plate 90. In the present case, it is assumed that this second plate is entirely identical to the plate 90, but it is expressly emphasized that it is merely necessary that a spiral spring be formed out of each of the two plates. For the sake of simplicity, both plates have been provided in the present example with the same reference numbers.

The further recesses provided in the plates are intended for further parts of the drive mechanism. Since they are without important for the invention, they are not described in further detail. It is merely pointed out that a source of energy can be provided within the recess 99. Furthermore, in the holes 100 there are provided pillars 101 which hold the two plates 90 the correct distance apart.

In a central plane of the swinging body, there is arranged a swinging disk 17 which can be identical to the swinging disks 81 and 82 respectively. This swinging disk and the parts cooperating with it are therefore not described in the present embodiment.

In the fourth embodiment, shown in FIGS. 11 and 12, the two plates correspond to the first embodiment, but in this case spacer pillars 110 are also shown which hold the plates the desired distance apart.

The swinging-body shaft and the two swinging disks arranged at a distance from the center of gravity S can in this connection correspond to the embodiment shown in FIGS. 6 to 8.

Centrally between the two swinging disks, there is arranged here a spiral spring 112 which however is in this case produced out of a supporting piece 114 and is integrally connected at 115 with the supporting body.

The supporting piece is held by the same pillars 110 and also serve to maintain the correct spacing of the plates. In the supporting body 116, there is furthermore also provided a recess in which a coil 120 is fastened so that no special support is required for this stationary coil.

In contradistinction to the embodiment shown in FIG. 8, the two swinging disks here are relatively close to each other and are separated from the central annular piece 122 of the spiral spring 112 by spacer washers 124 and 125 respectively.

We claim:

1. In a portable timekeeping apparatus, a balance wheel assembly comprising a swingable balance wheel and shaft, a first stationary support, a flat spiral spring having one of its ends attached to the wheel assembly and its other end attached to the first support, the flat spiral spring being sufficiently strong to normally support the balance wheel against axial and lateral movement and permit the wheel's radial movement about its axis, a pin extending from both sides of the balance wheel shaft along its axis, a second stationary support, limiting means on each support comprising a bushing within which the ends of the pin are positioned, wherein the two ends of the pin are positioned in their respective bushings with sufficient clearance so that the pins contact the walls of the bushings only during shocks to the assembly, whereby the apparatus may be carried and used in any position.

2. The apparatus of claim 1 wherein the first and second supports are plates parallel to each other and also comprising a second flat spiral spring having one of its ends attached to the wheel assembly and its other end attached to the second support, wherein the second flat spiral spring is sufficiently strong to support the wheel against axial and lateral movement and permit the wheel's radial movement about its axis.

3. The assembly of claim 1 and including means to power the wheel positioned in the plane passing through the center of gravity of the wheel.

4. An assembly as in claim 1 wherein the flat spiral spring consists of two electrically conductive portions separated by an insulator.

References Cited by the Examiner

UNITED STATES PATENTS

2,728,188 12/55 Hettich ---------- 58—107

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