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(54) HOROLOGICAL HAIRSPRING REGULATOR

(71) We, TIMEX CORPORATION, a Corporation organized under the Laws of the State of Delaware, United States of America, of Waterbury 20, Connecticut, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to horology and more particularly to a hairspring regulator for a timepiece, for example a watch.

The use of hairspring regulators in timepieces is conventional and many watch designs include regulators which contact the hairspring to vary the effective length thereof. During the life of a watch, the regulator may be adjusted to maintain the timekeeping characteristics by increasing or decreasing the active length of the hairspring.

It is an object of the present invention to provide an improved hairspring regulator for a timepiece.

Another object of this invention is to provide a regulator for imparting a positive isochronism characteristic to an oscillator, which isochronism characteristic will not be disturbed by moving the regulator.

According to the present invention there is provided a hairspring regulator for a timepiece having a balance wheel assembly and a hairspring coupled thereto, the regulator comprising a base portion for mounting coaxially with the balance wheel assembly, and a pair of fixedly spaced arms extending outwardly from the base portion, each of said arms having an axially extending flange with an opening therethrough for accommodating the hairspring and the regulator being arranged to impart a predetermined positive isochronism characteristic thereto.

Also in accordance with the invention there is provided in an electric timepiece having a balance wheel motor and hairspring, a regulator comprising first means engaging the hairspring to limit the effective length thereof, and second means located at a predetermined

constant angle from the first means and having a slot therein of constant dimension through which the hairspring passes, said second means in combination with said first means imparting a predetermined positive isochronism characteristic to the hairspring which will not be disturbed by moving the regulator.

The hairspring regulator of the present invention imparts a positive isochronism characteristic to the hairspring, namely a characteristic in which the frequency of balance oscillation increases with increase of amplitude of oscillation and vice versa. This facilitates synchronization of the balance particularly with a quartz controlled time standard.

Preferably the regulator comprises a base portion which is rotatably mounted on a balance bridge and two arms, each of which includes an axially extending flange portion with an opening to accommodate the hairspring. The first regulator arm which includes a side portion in contact with the hairspring is used to position the hairspring in the centre of the slot of the second regulator arm and to vary the effective length of the hairspring. The hairspring vibrates within the slot in the second regulator arm. In designing the regulator the angle between the two regulator arms and the width of the slot in the second regulator arm are selected to produce the desired positive isochronism characteristic.

A preferred embodiment of the present invention is shown by way of example in the accompanying drawings, of which:—

Figure 1 is a side view of a balance assembly and a regulator in accordance with the present invention in a watch;

Figure 2 is a perspective view of the regulator;

Figure 3 is a schematic plan view of the regulator;

Figure 4 is a graph illustrating a typical isochronism characteristic effected by the present invention; and

Figures 5 to 7 illustrate schematically the operation of the regulator.

The drawings show only as much of a watch movement as is necessary to illustrate the present invention. The positioning of a hairspring regulator within a watch movement particularly with relation to the balance wheel assembly is well known and it would be within the knowledge of one skilled in the art to assemble the regulator thereto on the basis of the present disclosure.

Referring now to the drawings, a balance staff 10 is journaled at one end in a bearing 11 on a front frame 12. The other end of the staff 10 is journaled in a bearing 13 on a balance bridge 14. A balance wheel 16 is mounted on the staff 10 and a coil 17 is mounted thereon for oscillation past stationary magnets 15 attached to a dial ring 20.

A hairspring 18 is mounted on a hub 19 and is also affixed to a bracket 21. The hairspring 18 is inserted through an aperture 22 in bracket 21 and mounted firmly therein by a tapered pin 23. The hairspring 18, which may be a conventional spring, is used to store the kinetic energy of the balance wheel 16 during oscillation. The movement itself is powered by a cell 25 which transmits power through a contact spring 30 to a contact pin 35 on the balance wheel 16.

A regulator 24 comprises a body portion 34 at one end of which is an end portion or base 26 having a substantially circular configuration with a gap 27 between the respective portions 28 and 29. The portions 28 and 29 are spread apart for mounting on a boss 31 on bridge 14 coaxial with balance staff 10. The regulator 24 is mounted parallel to and slightly below the hairspring 18 in the watch movement.

The other end of the regulator 24 comprises a pair of arms 32 and 33, which are spaced apart a predetermined distance along the arc of a circle corresponding to the hairspring 18. Another way of stating the spatial relationship of the arms 32 and 33 is to specify the angle α between the arms. The arm 32 runs directly off the body portion 34 while arm 33 is joined thereto by a bridge portion 36 which is positioned at an angle to the body 34.

Regulator arms 32 and 33 each include an axially upwardly extending flange portion 37 and 38 respectively having respective slots 39 and 41 extending therethrough. Arm 32 includes a projecting portion 42 which is located before the slot 39 and contacts the hairspring 18 to limit the effective length thereof. The other purpose of arm 32 is to position the hairspring 18 in the centre of slot 41 when the balance wheel 10 is in the centre of its arc of swing, namely to set a base position for the hairspring in relation to the slot 41. The hairspring 18 normally

vibrates within the slot 41 in a manner to be described hereinafter.

In designing the regulator 24, the angle α and the width s of the slot 41 are determined experimentally to provide a desired isochronism characteristic for the hairspring 18 in question. By taking a conventional hairspring 18 and modifying its characteristics by means of regulator 24, it is possible to obtain a relationship wherein the frequency of balance oscillation is made dependent on the amplitude of oscillation. A typical positive isochronism characteristic achieved by regulator 24 is illustrated in Figure 4, and it will be seen that it differs from the conventional characteristic wherein frequency would be independent of amplitude. This facilitates synchronization of the balance wheel 16 particularly in quartz crystal-controlled watches.

During the operation of the watch, the regulator 24 functions on the hairspring 18 in the manner shown in Figures 5 to 7. Referring to Figure 5 at small amplitudes, for example 80° , the hairspring 18 will vibrate as shown by the arrows between positions denoted by the reference letters a and b and will not touch the regulator arm 33 as it moves back and forth within the slot 41. The effective length of the hairspring 18 is from the inner pinning point to the theoretical outer pinning point (P 80°). The balance wheel will oscillate at a low frequency as may be seen from the graph of Figure 4.

Referring to Figure 6, at larger amplitudes (240°) the hairspring 18 will vibrate between positions a and b and rest for about 40% of the period on the regulator arm 33. The effective length of the hairspring will be from the inner pinning point to the theoretical outer pinning point (P 240°). The frequency of the balance wheel will thus increase.

Referring to Figure 7, at a further increase in amplitude to 560° the hairspring 18 will vibrate between positions a and b and will rest for approximately 80% of the period on the regulator arm 33. The effective length of the hairspring 18 is from the inner pinning point to the theoretical outer pinning point (P 560°) which results in a further increase in balance motor frequency.

An important advantage of the regulator 24 is that the isochronism characteristic will not be disturbed by regulating the timepiece since the angle α and the slot width 41 always remain constant. With the increasing emphasis on accuracy and the use of quartz synchronized systems to attain such accuracy, the regulator 24 proposed herein permits unique advantages.

WHAT WE CLAIM IS:—

1. A hairspring regulator for a timepiece having a balance wheel assembly and a hairspring coupled thereto, the regulator compris-

Figures 5 to 7 illustrate schematically the operation of the regulator.

The drawings show only as much of a watch movement as is necessary to illustrate the present invention. The positioning of a hairspring regulator within a watch movement particularly with relation to the balance wheel assembly is well known and it would be within the knowledge of one skilled in the art to assemble the regulator thereto on the basis of the present disclosure.

Referring now to the drawings, a balance staff 10 is journaled at one end in a bearing 11 on a front frame 12. The other end of the staff 10 is journaled in a bearing 13 on a balance bridge 14. A balance wheel 16 is mounted on the staff 10 and a coil 17 is mounted thereon for oscillation past stationary magnets 15 attached to a dial ring 20.

A hairspring 18 is mounted on a hub 19 and is also affixed to a bracket 21. The hairspring 18 is inserted through an aperture 22 in bracket 21 and mounted firmly therein by a tapered pin 23. The hairspring 18, which may be a conventional spring, is used to store the kinetic energy of the balance wheel 16 during oscillation. The movement itself is powered by a cell 25 which transmits power through a contact spring 30 to a contact pin 35 on the balance wheel 16.

A regulator 24 comprises a body portion 34 at one end of which is an end portion or base 26 having a substantially circular configuration with a gap 27 between the respective portions 28 and 29. The portions 28 and 29 are spread apart for mounting on a boss 31 on bridge 14 coaxial with balance staff 10. The regulator 24 is mounted parallel to and slightly below the hairspring 18 in the watch movement.

The other end of the regulator 24 comprises a pair of arms 32 and 33, which are spaced apart a predetermined distance along the arc of a circle corresponding to the hairspring 18. Another way of stating the spatial relationship of the arms 32 and 33 is to specify the angle α between the arms. The arm 32 runs directly off the body portion 34 while arm 33 is joined thereto by a bridge portion 36 which is positioned at an angle to the body 34.

Regulator arms 32 and 33 each include an axially upwardly extending flange portion 37 and 38 respectively having respective slots 39 and 41 extending therethrough. Arm 32 includes a projecting portion 42 which is located before the slot 39 and contacts the hairspring 18 to limit the effective length thereof. The other purpose of arm 32 is to position the hairspring 18 in the centre of slot 41 when the balance wheel 10 is in the centre of its arc of swing, namely to set a base position for the hairspring in relation to the slot 41. The hairspring 18 normally

vibrates within the slot 41 in a manner to be described hereinafter.

In designing the regulator 24, the angle α and the width s of the slot 41 are determined experimentally to provide a desired isochronism characteristic for the hairspring 18 in question. By taking a conventional hairspring 18 and modifying its characteristics by means of regulator 24, it is possible to obtain a relationship wherein the frequency of balance oscillation is made dependent on the amplitude of oscillation. A typical positive isochronism characteristic achieved by regulator 24 is illustrated in Figure 4, and it will be seen that it differs from the conventional characteristic wherein frequency would be independent of amplitude. This facilitates synchronization of the balance wheel 16 particularly in quartz crystal-controlled watches.

During the operation of the watch, the regulator 24 functions on the hairspring 18 in the manner shown in Figures 5 to 7. Referring to Figure 5 at small amplitudes, for example 80° , the hairspring 18 will vibrate as shown by the arrows between positions denoted by the reference letters a and b and will not touch the regulator arm 33 as it moves back and forth within the slot 41. The effective length of the hairspring 18 is from the inner pinning point to the theoretical outer pinning point (P 80°). The balance wheel will oscillate at a low frequency as may be seen from the graph of Figure 4.

Referring to Figure 6, at larger amplitudes (240°) the hairspring 18 will vibrate between positions a and b and rest for about 40% of the period on the regulator arm 33. The effective length of the hairspring will be from the inner pinning point to the theoretical outer pinning point (P 240°). The frequency of the balance wheel will thus increase.

Referring to Figure 7, at a further increase in amplitude to 560° the hairspring 18 will vibrate between positions a and b and will rest for approximately 80% of the period on the regulator arm 33. The effective length of the hairspring 18 is from the inner pinning point to the theoretical outer pinning point (P 560°) which results in a further increase in balance motor frequency.

An important advantage of the regulator 24 is that the isochronism characteristic will not be disturbed by regulating the timepiece since the angle α and the slot width 41 always remain constant. With the increasing emphasis on accuracy and the use of quartz synchronized systems to attain such accuracy, the regulator 24 proposed herein permits unique advantages.

WHAT WE CLAIM IS:—

1. A hairspring regulator for a timepiece having a balance wheel assembly and a hairspring coupled thereto, the regulator compris-



ing a base portion for mounting coaxially with the balance wheel assembly, and a pair of fixedly spaced arms extending outwardly from the base portion, each of said arms having an axially extending flange with an opening therethrough for accommodating the hairspring and the regulator being arranged to impart a predetermined positive isochronism characteristic thereto.

2. A regulator in accordance with Claim 1 wherein the flange of the first regulator arm includes a portion which contacts the hairspring in order to determine a base position of the hairspring relative to the opening of the second regulator arm flange and limit the effective length of the hairspring.

3. A regulator in accordance with Claim 1 or Claim 2 wherein the base portion is bifurcated and has a substantially circular configuration.

4. In an electric timepiece having a balance wheel motor and hairspring, a regulator com-

prising first means engaging the hairspring to limit the effective length thereof, and second means located at a predetermined constant angle from the first means and having a slot therein of constant dimension through which the hairspring passes, said second means in combination with said first means imparting a predetermined positive isochronism characteristic to the hairspring which will not be disturbed by moving the regulator.

5. A hairspring regulator for a timepiece constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

6. A watch fitted with a regulator as claimed in any one of claims 1 to 3 or 5.

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