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FREQUENCY-ADJUSTABLE TUNING FORK TYPE VIBRATOR FOR AN ELECTRICALLY ENERGIZED TIMEPIECE

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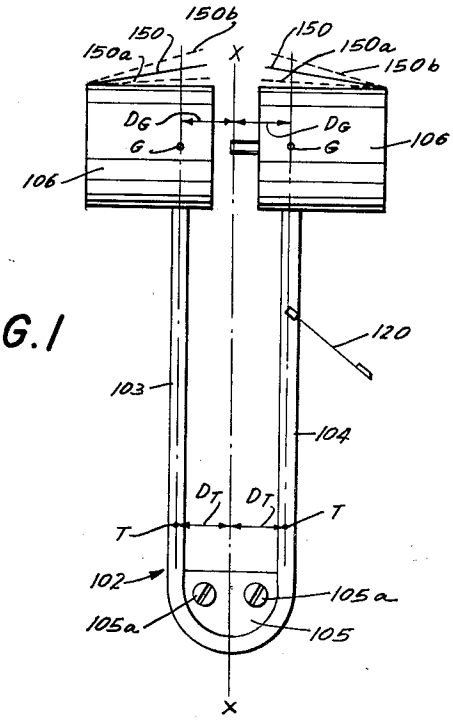

FIG. 1

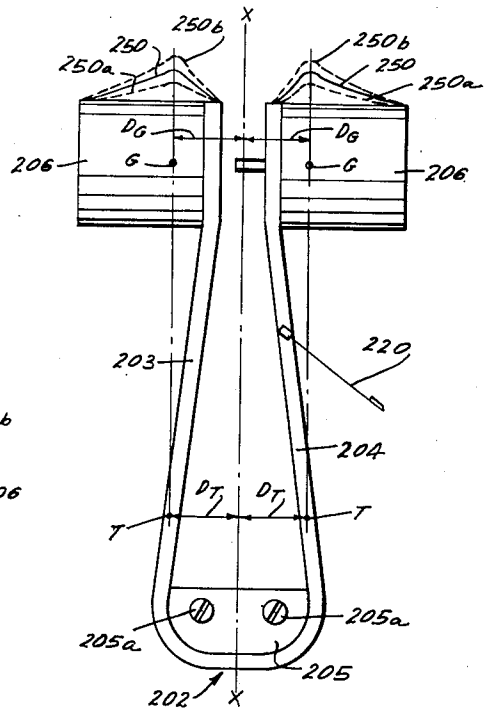

FIG. 2

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FREQUENCY-ADJUSTABLE TUNING FORK TYPE VIBRATOR FOR AN ELECTRICALLY ENERGIZED TIMEPIECE

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The present invention relates to an electrically energized timepiece.

More particularly, the present invention relates to an electrically energized timepiece wherein the oscillatory movement of an electrically driven mechanical vibrator is converted into rotary movement which drives the timepiece mechanism. The timepiece may be of the type disclosed in the copending patent applications, which are now issued as Patents 2,888,582; 2,900,786; 2,929,196; 2,949,727; 2,960,817, and 2,971,323.

The above-mentioned patents concern themselves with an electric timepiece which incorporates suitable electrical means for oscillating a mechanical vibrator, the latter preferably being in the form of a tuning-fork type vibrator. A reciprocatable drive element, such as a pawl, is attached to one of the tines of the vibrator and cooperates with a ratchet wheel so as to cause rotation thereof during oscillation of the tines. The pawl reciprocates with a stroke the length of which is dependent upon the amplitude of oscillation of the tines, and the electrical means for oscillating the tines are capable of normally maintaining the amplitude of oscillation of the tines within a range wherein the stroke or reciprocation of the pawl, in a direction substantially tangent to the ratchet wheel at the point of contact or engagement between the pawl and the ratchet wheel, is at least as great as the pitch of the ratchet teeth but is not greater than twice this pitch. In this way, each oscillation of the tines causes the ratchet wheel to be rotated throughout an angular distance which corresponds to the pitch of the ratchet teeth. Thus, the rotational speed of the ratchet wheel is exactly proportional to the frequency of oscillation of the tines, and since the latter may be maintained constant with an extremely high degree of accuracy, the rotational speed of the ratchet wheel and of the timepiece mechanism which it drives is similarly maintained constant with the same high degree of accuracy.

When the timepiece is first manufactured, the vibrator is so constructed that the natural frequency of the tines is such as to cause the vibrator to drive the timepiece mechanism with an accuracy of approximately plus or minus three minutes per day, i.e., while the vibrator will drive the timepiece mechanisms at a constant rate which is exactly proportional to the natural frequency of the tines, this natural frequency will probably be such that the timepiece mechanism is driven either slightly too fast or slightly too slow so that the timepiece will gain or lose a certain constant amount each day.

It is therefore an object of the present invention to overcome the above disadvantage by providing a very fine adjustment whereby the natural frequency of the tines, and consequently the rate at which the vibrator drives the timepiece mechanism, may be regulated to extremely close limits.

It is another object of the present invention to provide

an adjustment for a vibrator-driven timepiece whereby the natural frequency of the vibrator and consequently the rate at which the timepiece mechanism is driven thereby may very easily be regulated after the timepiece has been completely assembled.

With the above objects in view, the present invention mainly resides in that improvement in a timepiece having a timepiece mechanism which includes mechanical vibrator means operatively associated with the timepiece mechanism for driving the same at a rate proportional to the natural frequency of oscillation of the vibrator means, and means operatively associated with the vibrator means for varying the natural frequency thereof.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings in which:

FIG. 1 is a diagrammatic representation of a vibrator carrying an adjusting means according to a preferred embodiment of the present invention; and

FIG. 2 is a diagrammatic representation of a modified vibrator carrying an adjusting means according to another embodiment of the present invention.

Referring now to FIG. 1, there is shown a tuning fork **102** having a pair of tines **103** and **104** each of which carries a magnetic drum. These drums are associated with drive and phase-sensing coils in a transistor circuit, described for example in Patent 2,971,323, which serves to excite and maintain the tuning fork in vibration.

The vibrator is adapted to be secured to the base plate of a timepiece by means of a member **105**, the latter being screwed onto the base plate by means of screws **105***a*, and the tine **104** carries a pawl **120** which cooperates with a ratchet wheel (not shown) whereby the oscillatory motion of the vibrator is transformed into rotation.

The arrangement of the parts is such that the center of gravity G of each drum **106** is spaced a distance D_G from the plane of symmetry X—X of the vibrator which is substantially equal to the distance D_T which the axis of oscillation of each respective tine is spaced from this plane.

Each of the drums carries a deformable element which may be in the form of an elongated wire **150** connected at one of its ends to the drum. The wire is capable of assuming different configurations, two of which are shown in dotted lines at **150***a* and **150***b*, wherein the center of gravity of the combined mass constituted by each drum and wire is spaced different distances from the axis of oscillation T of the respective time. The wire may readily be bent in such a manner that irrespective of its configuration, when the tines are at rest the center of gravity of the oscillatable portion of the vibrator remains spaced from the plane X—X substantially the same distance D_G.

By virtue of the above arrangement wherein the natural frequency of each time may be adjusted individually, it is possible to vary the natural frequency of the vibrator while maintaining the natural frequencies of the two tines equal to each other. In this way, no energy transfer from one tine to the other takes place during oscillation so that the efficiency of the vibrator may be maintained exceedingly high.

In the embodiment illustrated in FIG. 2 the tines **203** and **204** of the tuning fork **202** are inclined toward each other and converge toward each other as they approach their free ends so that the tuning fork has a substantially triangular configuration. A pair of magnetic drums **206** are fixed at their end faces to the outer faces of the free ends of the tines, respectively, the arrangement of the parts being such that the center of gravity G of each drum is spaced a distance D_G from the plane of symmetry X—X of the vibrator, this distance being substantially equal to the distance D_T which the axis of oscillation T of each respective tine is spaced from this plane.

The vibrator is adapted to be secured to the base plate of a timepiece by means of a member **205**, the latter being fixedly secured to the base plate, as, for example, by means of screws **205***a*. The tine **204** carries a pawl **220** which cooperates with a ratchet wheel (not shown) whereby the oscillation of the vibrator is transformed into the rotary movement of the timepiece mechanism.

Each drum carries a deformable element which may be in the form of an elongated wire **250** which is connected at one of its opposite ends to the drum and at the other of its ends either to the drum or to the free end of the tine itself. As in the embodiment illustrated in FIG. 1, the wire is capable of assuming different configurations, two of which are shown in dotted lines at **250***a* and **250***b*, wherein the center of gravity of the combined mass constituted by each drum and wire is spaced different distances from the axis of oscillation T of the respective tine. The wire may readily be bent in such a manner that irrespective of its configuration, when the tines are at rest the center of gravity of the oscillatable portion of the vibrator remains spaced from the plane X—X substantially the same distance D_G.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of vibrators differing from the types described above.

While the invention has been illustrated and described as embodied in an electric timepiece, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention. For example, the adjustment means shown in FIGS. 1 and 2 may be used in conjunction with a tuning-fork type vibrator wherein one tine carries a balance weight as in Patent 2,929,196. Also, the abutment means may be constructed differently, for example, as disclosed in Patent 2,929,196.

Still further, it will be understood that the wires or other deformable elements shown in the embodiments of FIGS. 1 and 2 need not of necessity be secured to the magnetic drums or balance weight carried by the tines. Instead, these deformable elements may be attached directly to any oscillatable portion of the tines, the term "oscillatable portion" as used throughout the specification and claims being deemed to include any portion of each tine which is spaced from the axis of oscillation of that tine.

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 that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention, and therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a timepiece having a timepiece mechanism and provided with a tuning-fork type vibrator having a pair of tines each of which is capable of oscillating about its own axis of oscillation, said vibrator being operatively associated with the timepiece mechanism for driving the same at a rate proportional to the natural frequency of oscillation of said vibrator and a pair of oscillating components carried by said tines at the respective free ends thereof and fixedly secured thereto; regulating means operatively associated with at least one of said components for varying the distance between the center of gravity thereof and the axis of oscillation of the respective tine carrying said one component, said regulating means including a deformable element attached to said one component and forming part thereof, said element being capable of being manually bent to assume different configurations wherein the center of gravity of the combined mass constituted by said one component and said element thereof is spaced different distances from said axis of oscillation of said respective tine, whereby the natural frequency of said respective tine and consequently the natural frequency of said vibrator may be varied so that the rate at which the timepiece mechanism is driven may be regulated.

2. In a timepiece having a timepiece mechanism and provided with a tuning-fork type vibrator having a pair of tines each of which is capable of oscillating about its own axis of oscillation, said vibrator being operatively associated with the timepiece mechanism for driving the same at a rate proportional to the natural frequency of oscillation of said vibrator and a pair of oscillating components carried by said tines at the respective free ends thereof and fixedly secured thereto; regulating means operatively associated with at least one of said components for varying the distance between the center of gravity thereof and the axis of oscillation of the respective tine carrying said one component, said regulating means including an elongated deformable element attached at one end thereof to said one component and forming part thereof, said element being capable of being manually bent into different configurations wherein the center of gravity of the combined mass constituted by said one component and said element thereof is spaced different distances from said axis of oscillation of said respective tine, whereby the natural frequency of said respective tine and consequently the natural frequency of said vibrator may be varied so that the rate at which the timepiece mechanism is driven may be regulated.

3. In a timepiece having a timepiece mechanism and provided with a tuning-fork type vibrator having a pair of tines each of which is capable of oscillating about its own axis of oscillation, said vibrator being operatively associated with the timepiece mechanism for driving the same at a rate proportional to the natural frequency of oscillation of said vibrator and a pair of oscillating components carried by said tines at the respective free ends thereof and fixedly secured thereto; regulating means operatively associated with at least one of said components for varying the distance between the center of gravity thereof and the axis of oscillation of the respective tine carrying said one component, said regulating means including an elongated deformable element attached at its ends to said one component and forming part thereof, the mid-portion of said element being capable of being manually bent into different configurations wherein the center of gravity of the combined mass constituted by said one component and said element is spaced different distances from said axis of oscillation of said respective tine, whereby the natural frequency of said respective tine and consequently the natural frequency of said vibrator may be varied so that the rate at which the timepiece mechanism is driven may be regulated.

4. In a timepiece having a timepiece mechanism and provided with a tuning-fork type vibrator having a pair of tines each of which is capable of oscillating about its own axis of oscillation, said vibrator being operatively associated with the timepiece mechanism for driving the same at a rate proportional to the natural frequency of oscillation of said vibrator and a pair of oscillating components carried by said tines at the respective free ends thereof and fixedly secured thereto; regulating means operatively associated with said components for varying the distance between the center of gravity of each and the axis of oscillation of the respective tine, said regulating

means including a pair of deformable elements attached to said components, respectively, each of said elements forming part of the respective component and being capable of being manually bent to assume different configurations wherein the center of gravity of the combined mass constituted by each respective component and element thereof is spaced different distances from the axis of oscillation of the respective tine, respectively, whereby the natural frequency of said tines and consequently the natural frequency of said vibrator may be varied so that the rate at which the timepiece mechanism is driven may be regulated.

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