PATENT SPECIFICATION

DRAWINGS ATTACHED

828,357

Date of Application and filing Complete Specification: March 20, 1957.

No. 9078/57.

Application made in United States of America on Oct. 11, 1956.

Complete Specification Published: Feb. 17, 1960.

Index at acceptance:—Class 139, A5X.

International Classification:—G04c.

COMPLETE SPECIFICATION

Improvements in or relating to a Watch or Clock

We, BULOVA WATCH COMPANY, INC., of 75—20 Astoria Boulevard, Flushing 70, New York, United States of America, a Corporation organised under the laws of the State of New York, 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 a watch or clock the timepiece mechanism of which is driven by a vibrator, preferably of the tuning-fork type. The vibrator and the timepiece are so interconnected with each other that the rate at which the timepiece mechanism is driven is proportional to the natural frequency of oscillation of the vibrator.

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

According to the present invention there is provided a watch or clock having a timepiece mechanism and a tuning-fork type vibrator for driving the timepiece mechanism, wherein the vibrator and the timepiece mechanism are so interconnected with each other that the rate at which the timepiece mechanism is driven is proportional to the natural frequency of oscillation of the vibrator, means being provided for varying the natural frequency of the vibrator, said means being associated with at least one tine of said vibrator and comprising a deformable element attached to said tine, said element being capable of deformation into any of a plurality of differing configurations so as to vary the disposition of the centre of gravity of said element with respect to the axis of oscillation of said tine.

Exemplatory embodiments of the present invention are diagrammatically illustrated in the accompanying drawing, in which:

Fig. 1 is a schematic representation of a vibrator for driving a timepiece mechanism, the natural frequency of oscillation of which vibrator is adjustable; and

Fig. 2 is a fragmentary view of a further embodiment of a vibrator the natural frequency of which can be varied.

Referring now to the drawing, and to Fig. 1 thereof in particular, there is shown a tuning-fork type vibrator 1 having a base portion 2 and a pair of tines 3 and 4, the vibrator being soldered, welded or otherwise fixedly secured to a member 5 which, in turn, is suitably fixed to the base plate of the timepiece, as, for example, by a pair of screws 5a, in such a manner that the tines are freely oscillatable about their respective axes of oscillation 3^1 and 4^1.

A pawl 6 which has a natural frequency considerably greater than, and preferably at least twice as great as, the maximum obtainable frequency of the vibrator is attached to the tine 4, the other end of the pawl, which may be in the form of a leaf spring, being in engagement with a ratchet wheel 7. The ratchet wheel 7 is preferably so positioned that its axis of rotation is normal to the plane of oscillation of the vibrator.

Each of the tines carries at or near its free end an electrical oscillating component in the form of a magnetic drum 8 which is composed of a cup-shaped member 8a and a bar magnet 8b made of a very strong magnetic material such as Alnico. Each of the drums is thus formed with an inner annular chamber 8c.

[*Price 3s. 6d.*]

A pair of tubular carriers 9 project into the two chambers 8c, respectively, each of these carriers being at one of its ends either directly or indirectly secured to the base plate. One of the carriers carries a coil 10 and the other carries a coil 11 which has approximately five to six times as many turns as the coil 10, the arrangement of the parts being such that each carrier 9 encompasses the respective bar 8b with clearance and that each cup-shaped member 8a encompasses the respective coil with clearance, so that the magnetic drums are freely movable relative to the stationary carriers and coils. Oscillation of the tines 3 and 4 is therefore not impeded, and each of the coils together with its magnetic drum forms an electro-mechanical transducer.

One terminal of the coil 10 is connected to the base B of a transistor which is preferably of the Germanium junction-type, and the other terminal of the coil 10 is connected to one terminal of a parallel circuit incorporating a resistor 12 and a capacitor 13. The other terminal of this parallel circuit is connected to the negative terminal 14 of a battery or other voltage source the positive terminal 15 of which is connected to the transistor emitter *E*. One terminal of the coil 11 is connected to the transistor collector *C* and the other terminal of the coil 11 is connected to the negative terminal 14.

The above circuit is a self-regulating one in that it will cause the tines to oscillate not only at their natural frequency, but also at a substantially constant amplitude. In practice, the amplitude of oscillation of the tines will be maintained between such maximum and minimum amplitudes that the length of the stroke of reciprocation of the pawl, in a direction tangent to the ratchet wheel at the point of engagement between the pawl and the ratchet wheel, will be at least as great as the pitch P of each ratchet tooth but not more than 2P, so that the vibrator will cause the ratchet wheel to be rotated at a rotational speed directly proportional to the frequency of oscillation of the vibrator.

In order to increase the accuracy obtainable from the timepiece, suitable means are provided for varying or pre-setting the natural frequency of the vibrator. According to the present invention, these means are in the form of a deformable element or elements carried either by one tine or by both, the position of the center of gravity of which element or elements can be adjusted relative to the axis of oscillation of the respective tine.

In the embodiment illustrated in Fig. 1, the adjusting means for adjusting the natural frequency of each tine are in the form of a deformable wire or the like 16 which is attached at one of its ends to the magnetic drum 8, it being understood, however, that the wire 16 may be attached to the tine directly. The wire is capable of assuming different configurations, two of which are shown in dotted lines at 16^{1} and 16^{11} wherein the center of gravity of the wire is spaced different distances from the axes of oscillation 3^{1}, 4^{1} of the tines 3, 4, respectively.

It will be understood that inasmuch as the natural frequency of a tuning fork type vibrator is the average of the natural frequencies of its tines, the effective natural frequency of the entire vibrator can be adjusted simply by varying the natural frequency of one of the tines. However, by providing individual frequency adjusting means for each tine, the natural frequency of the vibrator can be regulated 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 is very high.

Also, it has been found that the frequency energy consumption of the vibrator may be kept exceedingly small by positioning the drums 8 in such a manner that their centers of gravity G, when the tines are at rest, are spaced from the plane of symmetry X—X of the vibrator a distance D_G which is substantially equal to the distance D_O which the axis of oscillation of each tine is spaced from this plane of symmetry. The wires 16 are therefore mounted on the drums 8 in such a manner that irrespective of the natural frequency at which the tines are adjusted to oscillate, the center of gravity of the combined mass constituted by each drum 8 and wire 16, when the tines are at rest, is still spaced the same distance D_G from the plane of symmetry X—X.

The embodiment illustrated in Fig. 2 differs from the above-described one only in that each of the wire weight elements 16 is attached at both of its ends to one of the drums 8, with different configurations of the wire being shown at 16^{1} and 16^{11}.

WHAT WE CLAIM IS:—

1. A watch or clock having a timepiece mechanism and a tuning-fork type vibrator for driving the timepiece mechanism, wherein the vibrator and the timepiece mechanism are so interconnected with each other that the rate at which the timepiece mechanism is driven is proportional to the natural frequency of oscillation of the vibrator, means being provided for varying the natural frequency of the vibrator, said means being associated with at least one tine of said vibrator and comprising a deformable element attached to said tine, said element being capable of deformation into any of a plurality of differing configurations so as to vary the disposition of the centre of gravity of said element with respect to the axis of oscillation of said tine.

2. A watch or clock according to claim 1, wherein said element is constituted by a deformable wire.

3. A watch or clock according to either of

the preceding claims, wherein both tines of the vibrator are associated with said elements.

4. A watch or clock according to claim 2, wherein both ends of said wire are rigidly coupled to the associated tine.

5. A watch or clock according to any one of claims 1 to 3, wherein both tines carry at or near their free ends electrical oscillating components the centre of gravity of each of which, when the tines are at rest, is spaced from the plane of symmetry of the vibrator the same distance which the axis of oscillation of the respective tine is spaced from the said plane of symmetry, and wherein said deformable elements are carried either by the electrical oscillating components or by the tines themselves in a region near the respective electrical oscillating component and are so constructed and arranged that the centre of gravity of the combined mass constituted by each electrical oscillating component and deformable element, will, when the tines are at rest, still be spaced the same distance from said plane of symmetry irrespective of the natural frequency at which the tine is adjusted to oscillate.

6. A watch or clock substantially as hereinbefore described with reference to the accompanying drawings.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1960.
Published by The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

828,357 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

FIG. 1.

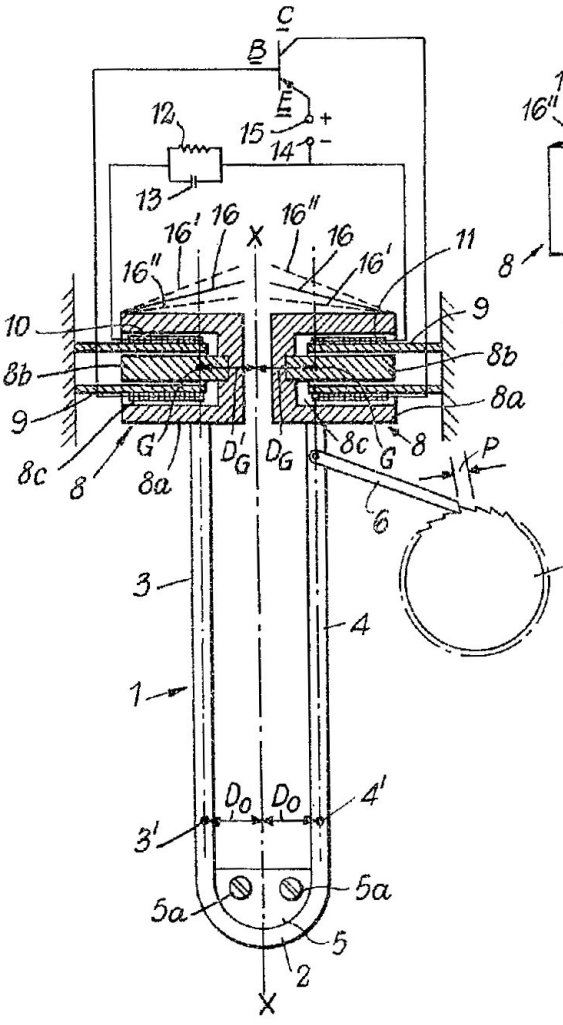

FIG. 2.