United States Patent

Mutter

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[54] MINIATURIZED BATTERY-OPERATED TUNING-FORK TIMEPIECE

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[52] **U.S. Cl.** .....**58/23 TF**, 58/23 BA, 310/25

[51] **Int. Cl.**.....**G04c 3/00**

[58] **Field of Search** 58/23; 310/25, 36, 37

[56] **References Cited**

UNITED STATES PATENTS

3,469,389 9/1969 Nakai et al.....58/23 TF

FOREIGN PATENTS OR APPLICATIONS

444,766 2/1968 Switzerland.....58/23 BA

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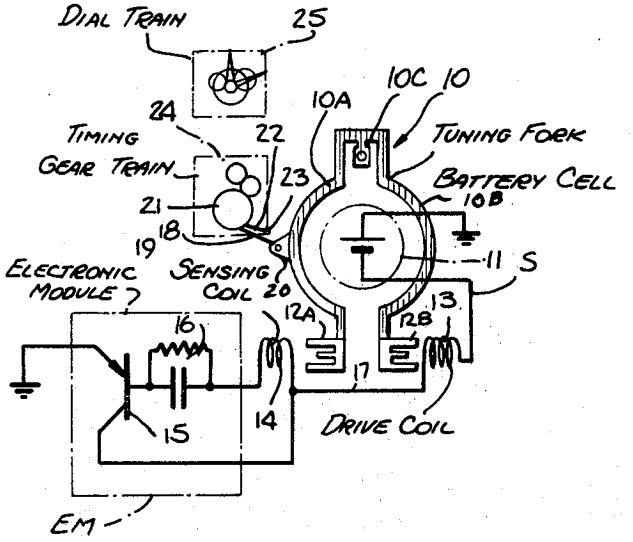
[57] **ABSTRACT**

A miniaturized electronic watch including a tuning-fork resonator which is sustained in vibration by a battery-energized electronic drive circuit and whose vibrations are converted into rotary motion for operating dial pointers. The tuning fork, which is mounted on a pillar plate, is constituted by a pair of tines having a bow-legged formation to define a circular zone. The battery for the electronic drive circuit is seated in the zone within a circular well formed in the pillar plate, thereby conserving space.

5 Claims, 4 Drawing Figures



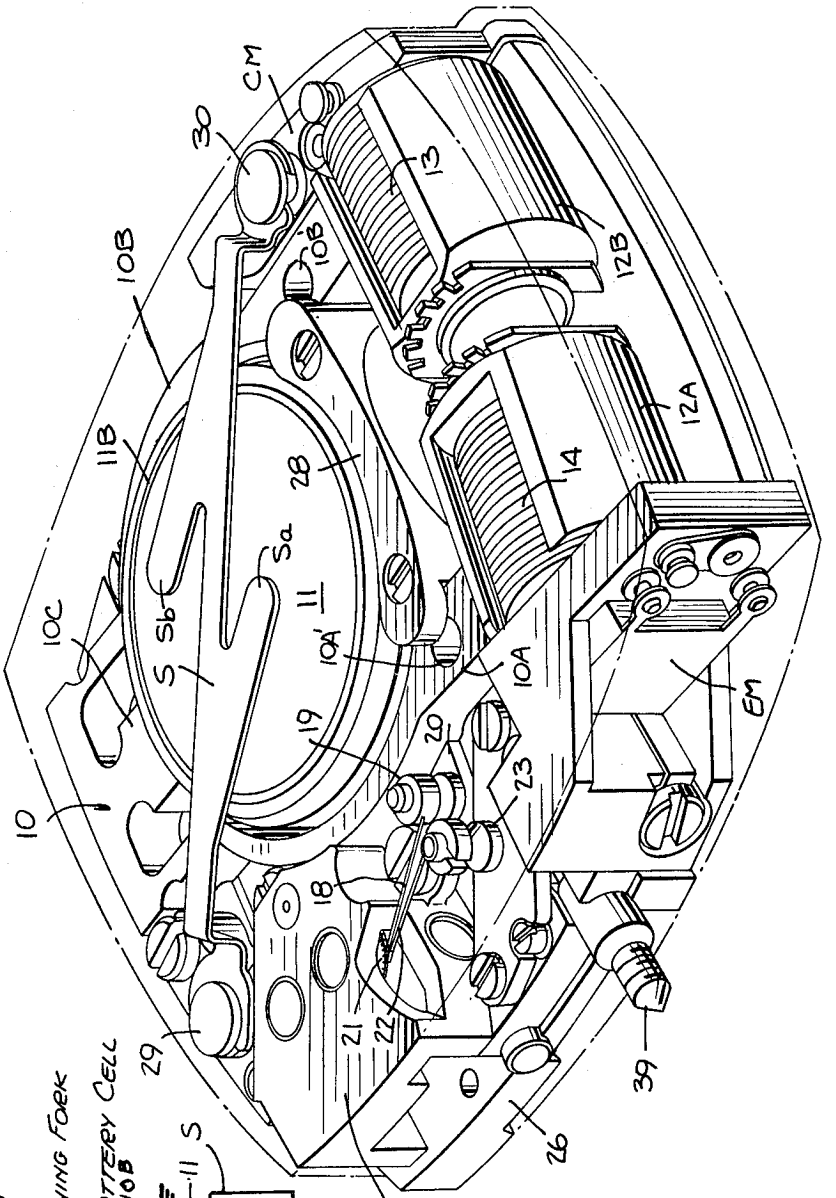


Fig. 2.

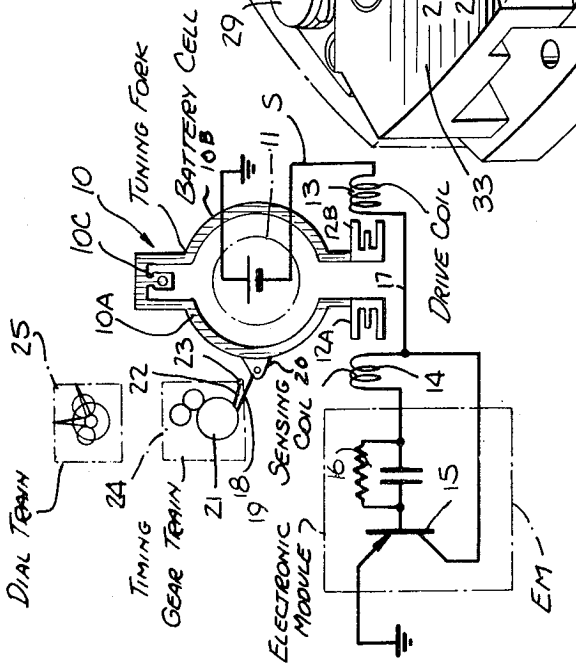


Fig. 1.

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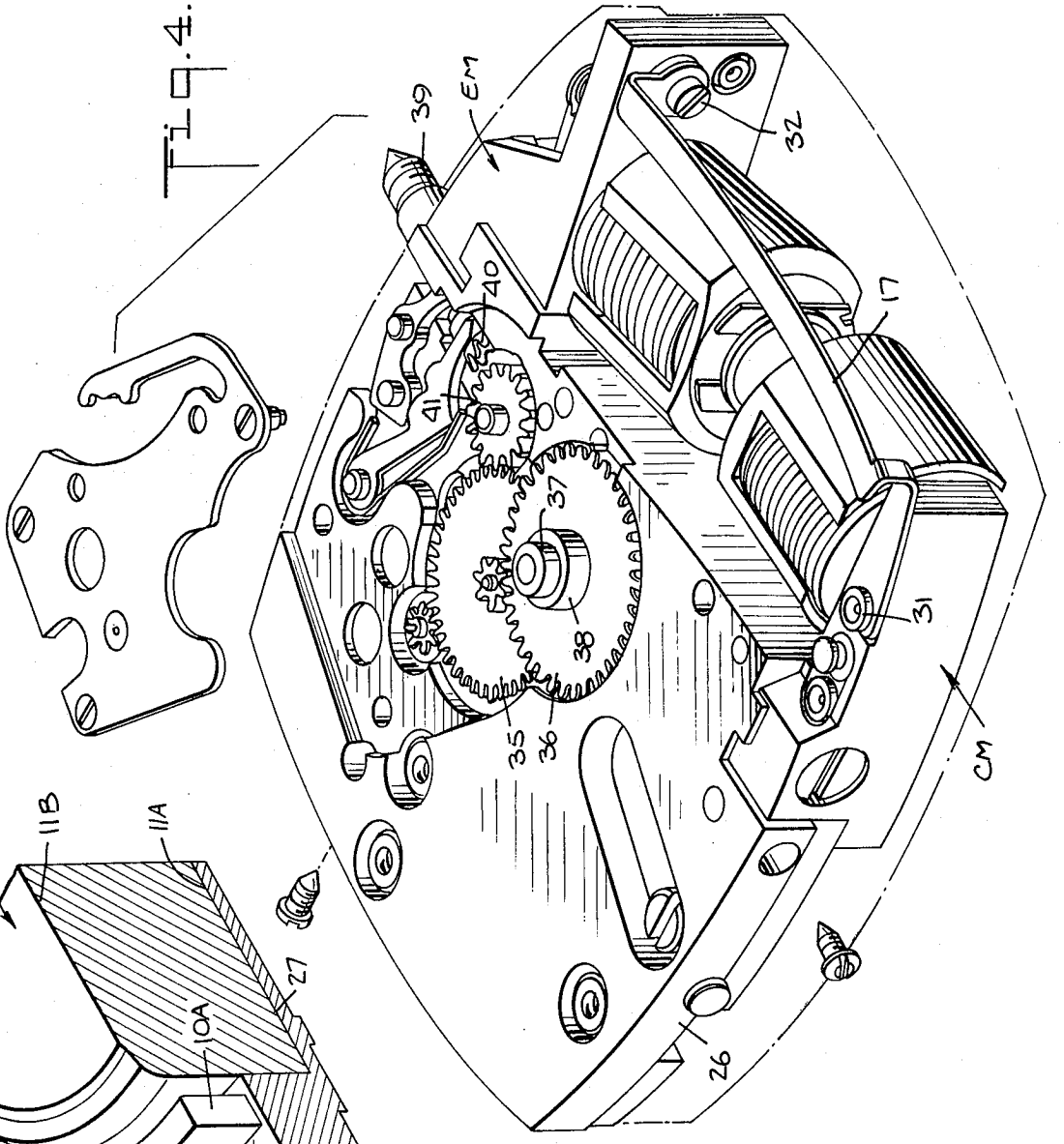
Fig. 4.



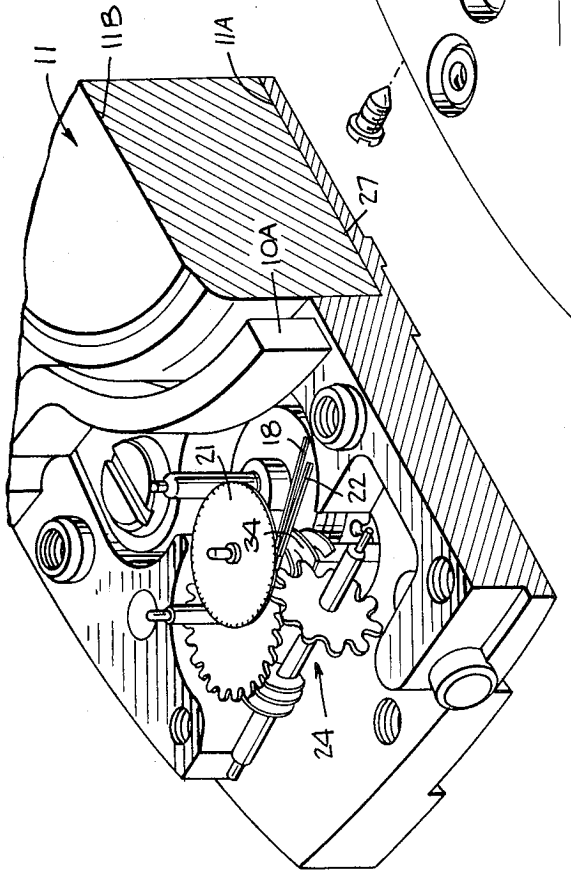


Fig. 5.

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MINIATURIZED BATTERY-OPERATED TUNING-FORK TIMEPIECE

RELATED APPLICATION

This application is related to commonly assigned copending application of Dale R. Koehler, Ser. No. 45,326, filed June 11, 1970, now U.S. Pat. No. 3,622,819 and entitled ELECTROMAGNETIC TRANSDUCER.

BACKGROUND OF THE INVENTION

This invention relates generally to battery-operated electronic timepieces, and more particularly to a miniaturized electronic watch including a tuning-fork resonator whose vibrations are converted into rotary motion for operating dial pointers, the resonator being sustained in vibration by a battery-energized electronic drive circuit.

In electronic timepieces of the type disclosed in U.S. Pat. Nos. Re. 26,322 and 2,971,323, a battery-energized transistor drive circuit acts through an electrodynamic transducer to sustain the vibratory motion of a tuning fork. This motion is transferred by a pawl and ratchet mechanism to a rotary movement including a gear train for turning the dial pointers or hands.

In tuning-fork electronic watches of the type heretofore known, the structural arrangement or layout had been such as to preclude a reduction in the diameter and thickness of the watch movement to a degree making it possible to house the movement within a lady's watch case. Though such watches have been manufactured in relatively large models having masculine appeal, it has not heretofore been feasible to miniaturize the dimensions to a point rendering the watch acceptable to ladies.

One important obstacle standing in the way of miniaturization is the power cell for the electronic drive circuit. This single-cell battery, which is round and button-like, occupies a relatively large portion of the useful volume of a watch movement. In movements of the type heretofore known, the cell and tuning fork are placed side by side; hence the size of the movement must be sufficient to accommodate both the cell and fork. In order to reduce this requirement, it has been the practice to bow the tines inwardly and to fit the cell within the concave area formed by one of the tines, but this expedient effects only a slight saving in space.

SUMMARY OF THE INVENTION

In view of the foregoing, it is the main object of this invention to provide a tuning-fork timepiece movement which is highly compact and therefore suitable for ladies'-model watches as well as other forms of miniature timepieces.

More specifically, it is an object of the invention to provide a timepiece movement of the above type in which the battery cell is disposed between the tines of the tuning fork to conserve space without in any way impairing the efficiency of the movement.

Also an object of the invention is to provide a movement of the above type in which the tines of the fork carry the magnetic elements of electrodynamic transducers, the elements cooperating with stationary coils projecting from plastic modules, one of which modules incorporates the components of the electronic drive circuit, thereby effecting further space economies.

Briefly stated, these objects are attained in a miniaturized movement including a tuning!-fork resonator whose vibrations are converted into rotary motion for operating the hands of the timepiece, the fork being mounted on the rear side of a pillar plate. The fork is constituted by a pair of tines having a bow-legged formation to define a circular zone which is occupied by the battery cell for energizing the electronic drive circuit, the cell being seated in a well formed in the pillar plate.

OUTLINE OF THE DRAWING

For a better understanding of the miniaturized, battery-operated tuning-fork timepiece of the present invention, reference is made to the following detailed description to be read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic representation of the electrical and mechanical components of a miniaturized watch movement in accordance with the invention;

FIG. 2 is an isometric view of a preferred embodiment of said movement as seen from the rear of the pillar plate;

FIG. 3 shows a portion of the movement, partly in section, the cover of the housing for the timing train being removed to reveal the gears thereof; and

FIG. 4 is an isometric view of the same movement as seen from the front or dial side of the pillar plate.

DESCRIPTION OF THE INVENTION

Referring now to FIG. 1, the electrical and mechanical components of a miniaturized watch movement in accordance with the invention are illustrated schematically. The movement includes a tuning fork generally designated by numeral 10, having two tines 10A and 10B and a re-entrant mounting stem 10C which is secured to the pillar plate of the movement.

Tines 10A and 10B have a bow-legged formation to define a circular zone, within which is installed a replaceable, single-cell battery 11. Battery 11 is round and button-like and is concentrically disposed within the zone, the narrow annular spacing between the periphery of the battery and the tines being sufficient to permit the tines to vibrate freely.

Secured to the free ends of the tines 10A and 10B are magnetic elements 12A and 12B, preferably of the type disclosed in the above-identified copending application. These elements coact with a stationary drive coil 13 and a stationary sensing coil 14 to provide electrodynamic transducers. In practice, the drive coil may be formed by two series-connected sections, one of which is wound adjacent sensing coil 14.

Associated with the transducers is a plastic module EM within which is encapsulated the electronic drive circuit whose components are transistor 15 and a resistance-capacitance network 16. The base B of the transistor is connected through network 16 to one end of sensing coil 14 whose other end is connected through a lead 17 to one end of drive coil 13. The other end of drive coil 13 is connected by conductor S to one terminal of battery 11, whose other terminal is connected to the emitter E of the transistor 15. The connection between emitter E and the other battery terminal is effected through the pillar plate of the movement.

The manner in which the battery-energized electronic drive circuit contained in module EM acts to sustain the fork in vibration is described in the above-identified prior patents and will therefore not be repeated. The concern of the present invention is not with the electronic circuit but with a movement layout which is calculated to make optimum use of the available space.

The vibratory action of tuning fork 10 is converted into rotary motion by means of an indexing finger 18 extending from a post 19 mounted on a bracket 20 attached to tine 10A, the finger engaging the ratchet teeth of an index wheel 21. Reverse motion of the wheel is prevented by a pawl 22 extending from a post 23 mounted on the pillar plate. Index wheel 21 is operatively coupled to a timing gear train, generally designated by numeral 24, which in turn operates the dial train 25 of the movement for rotating the hands of the timepiece, the gear ratios being such as to convert the vibrations of the fork, which occur at a rate determined by the resonance characteristics thereof (i.e., 440 Hz), into rotary motion, causing the hour and minute hands to indicate time correctly.

Referring now to FIGS. 2, 3 and 4, showing the actual movement, it will be seen that the movement block is designed to have a tonneau shape, whose profile is outlined by the dashed lines. Tuning fork 10 is mounted on the rear side of a

pillar plate **26**, stem **10C** being screwed thereto. As best seen in FIG. **3**, battery **11** is received in a circular recess of well **27** formed in the circular zone whose boundaries are defined by the bow-legged tines **10A** and **10B**.

Interposed between magnetic elements **12A** and **12B** and the periphery of the battery is a shock bridge **28** having ears **28A** and **28B** overlying tines **10A** and **10B** and serving to limit vertical movement thereof as a result of shock forces. Tines **10A** and **10B** are provided with bores **10A'** and **10B'** within which are disposed pins (not shown) anchored on the pillar plate and serving to prevent excessive deflection of the tines in the oscillation plane of the fork.

Because battery cell **11** is positioned within the zone defined by the tines of the fork, the overall space in the horizontal plane occupied on the pillar plate by the fork and cell is no greater than that occupied by the fork alone. Battery cell **11** has two terminals **11A** and **11B** on the opposing faces thereof, the bottom terminal **11A** resting on the bed of well **27** and thereby making electrical contact with pillar plate **26**. The top terminal **11B** of the cell, which is elevated relative to the tines of the fork, is engaged by conductor S which bridges over the tines of the fork.

Conductor S in the form of a flexible metallic strap formed of phosphor bronze, stainless steel or other conductive material, and is provided with resilient fingers S_a and S_b to ensure good electrical contact with the cell and also to hold the cell in place. One end of strap S is pivotally mounted on an insulated post **29**, the other end having a hook formation adapted to latch onto the circular groove of a terminal **30** connected to drill coil **13**, as shown in FIG. **1**. Terminal **30** is mounted on a plastic module CM from which drive coil **13** projects. Thus, to replace the battery, one has merely to unlatch strap S and to swing it away from the battery, thereby making it possible to remove the battery from the well and to insert a fresh battery.

Sensing coil **14** is mounted on and projects from module EM which is mounted on the pillar plate. As pointed out previously, module EM incorporates all of the necessary electrical components of the drive circuit other than the battery, the connections from coil **14** to these components being included in module EM. As will be evident from FIG. **1**, drive coil **13** requires a connection to battery **11** by way of conductor strap S as well as a connection by way of lead **17** to sensing coil **14**. Drive coil module CM includes a terminal **30**, for connection to conductor strap S, and as best seen in FIG. **4**, a terminal **31** for connection to conductor **17** leading to terminal **32** on the electronic module EM which includes the connection to sensing coil **14**.

Thus each of the modules may be readily installed or replaced, thereby facilitating assembly or disassembly without the need for soldering or unsoldering wires. The only connection which is made after the modules are mounted in place is that of lead **17** which takes the form of a rigid metallic strip whose extremities have bores to receive the threaded posts of terminals **31** and **32**. Lead **17** serves a dual function, for it provides the only necessary electrical connection between the modules and also acts as a structural strut to maintain the position of the modules which extend from the pillar plate.

The vibratory action of the fork is converted to rotary motion by index finger **18** which engages the teeth of index wheel **21**. This wheel drives the timing gear train generally designated by numeral **24**, which is contained in a housing **33** formed on the rear side of the pillar plate adjacent module EM. Index wheel **21** is keyed to a shaft bearing a screw gear **34** which in turn transmits motion to the other gears in the timing train.

As best seen in FIG. **4**, the dial train, generally designated by numeral **25**, is mounted on the front or dial side of the pillar plate and includes a minute wheel **35** and an hour wheel **36**. The hour hand (not shown) is mounted on tube **37**, which is concentric with cannon **38** from which the minute hand (not shown) extends. The movement is set in the usual way by means of a stem **39** which engages the minute wheel via a clutch **40** and a pinion **41**. Because the dial train is disposed on the dial side of the pillar plate in an area partially overlying the tuning fork and battery combination, this too makes possible a more compact arrangement.

While there has been shown a preferred embodiment of the miniaturized, battery-operated tuning-fork timepiece of the present invention, it will be understood that many changes and modifications may be made therein without departing from the essential spirit of the invention.

I claim:

1. An electronic timepiece movement comprising:
   - A. a pillar plate,
   - B. a tuning fork mounted on one side of the plate, said fork being constituted by a pair of tines having a bow-legged formation to define a circular zone whose periphery is demarcated by the pair of tines, the tines of said fork being spaced inwardly from the opposing edges of the pillar plate to define two module zones,
   - C. an electronic drive circuit coupled to transducers associated with said fork to sustain said fork in vibration, said transducers being constituted by magnetic elements attached to said tines and stationary drive and sensing coils associated with said elements, said coils being supported on respective modules occupying said two module zones and secured to said pillar plate,
   - D. a battery cell for energizing said circuit, said cell having a round, button-like shape and being seated in a well formed in said pillar plate concentrically within said zone, the diameter of said cell being slightly smaller than that of said zone whereby said tines are free to vibrate, the available space in said zone being otherwise fully utilized, and
   - E. means to convert the vibratory motion of said fork into rotary motion for operating the hands of said timepiece.

2. A movement as set forth in claim 1, wherein the components of said electronic circuit are encapsulated in one of said modules.

3. A movement as set forth in claim 2, further including a resilient conductive strap engaging the top terminal of said cell and bridging over the tines of the fork, the strap being connected to a terminal on the other of said modules for connection to the associated coil.

4. A movement as set forth in claim 1, wherein said means to convert the motion of the fork includes a timing train disposed on said one side of the plate, which train is operatively coupled to a dial train disposed on the opposite side thereof.

5. A movement as set forth in claim 1, wherein a connection is made between said modules by means of a rigid metallic strip which also acts as a stabilizing strut to maintain the position of said modules on said pillar plate.

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