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Jenni et al.

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[54] **ELECTRONIC TIMEPIECE**

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[52] **U.S. Cl.** ..... **58/23 V**; 58/23 BA; 58/23 TF; 58/50 R; 310/6

[51] **Int. Cl.** **G04b 1/00**

[58] **Field of Search** ..... 318/116; 310/6; 58/23 R, 58/23 A, 23 BA, 23 AC, 23 C, 23 D, 23 TF, 23 V, 50 R

[56] **References Cited**

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[57] **ABSTRACT**

The invention provides means for both driving the electronic mechanism of a watch from a high-voltage source, but also a liquid crystal time display. The source, which may be derived from an irradiated isotope, is connected to electrostatically drive a flat spring resonator. The pulsating current to an electrode of the resonator passes through a transformer (or capacitor) from which a pulsating d.c. is derived by rectification to supply operating current to a counter, a coder, and a crystal time display. The pulsations are also supplied without rectification to the input of the counter, the reading of which is coded to produce a time judication on the liquid crystal display means.

4 Claims, 5 Drawing Figures

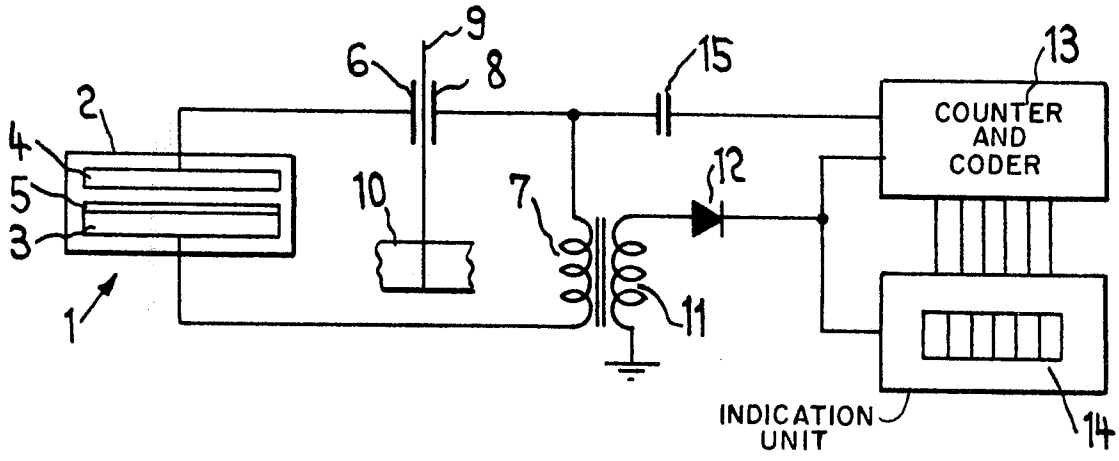


FIG. 1

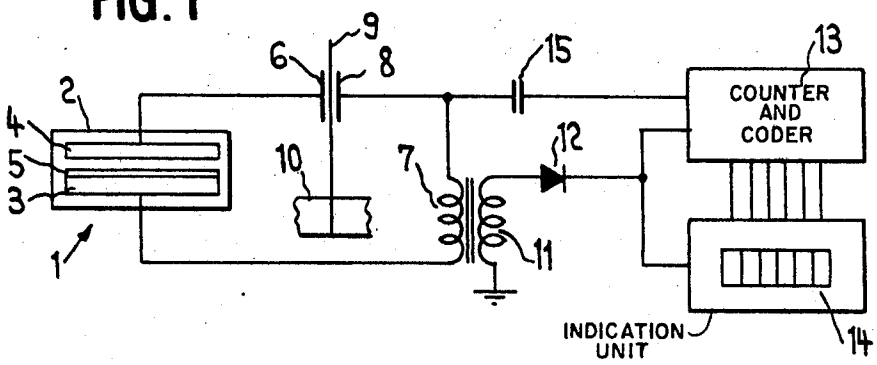


FIG. 2

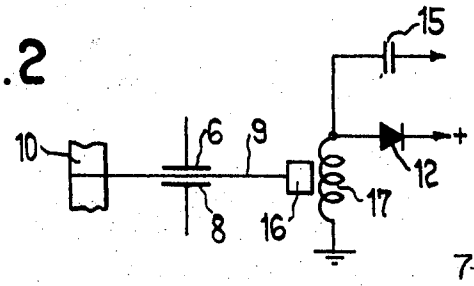


FIG. 5

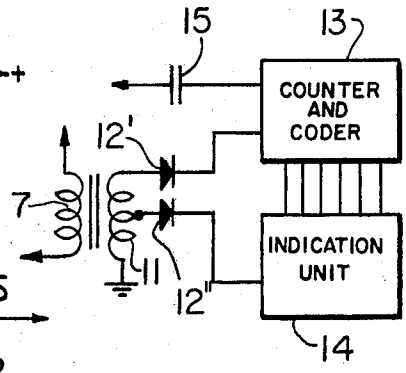


FIG. 3

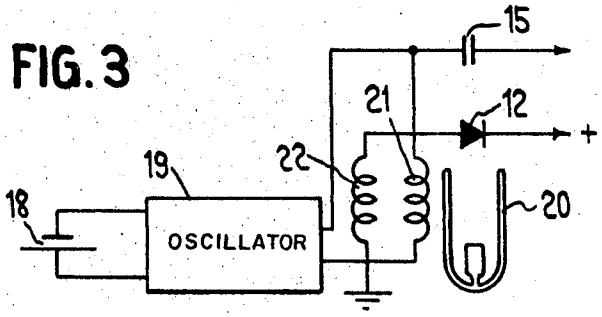
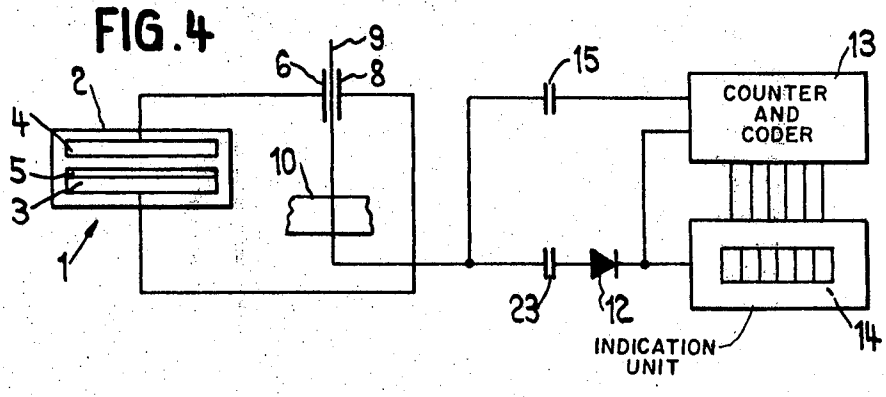


FIG. 4



ELECTRONIC TIMEPIECE

Prior Application : In Switzerland, on Mar. 13, 1973, Pat. No. 3613/73.

The present invention relates to an electronic timepiece, more particularly a watch, with electro-optical time indication and having a direct voltage source to maintain the oscillation of a resonator regulating the motion of the watch. Known watches of this kind are usually provided with a quartz oscillator the frequency of which is supplied after division to a counter. The output of the counter acts via a suitable coding circuit on conductive electrodes which produce the digital or analog electro-optical indication. For electro-optical indication liquid crystals are usually employed.

A particular difficulty encountered in such electronic wathces is that a relatively high voltage is required for the electro-optical indication, which voltage considerably exceeds the voltages of conventional batteries for use in watches. Therefore it was necessary to provide a direct current transformer assembly. This, however, entailed considerable disadvantages because such a voltage transformer assembly requires considerable space and has only a moderate efficiency. Again, a separate oscillator to feed the primary winding of the transformer assembly had to be provided.

It is an object of the present invention to provide an electronic timepiece of the aforesaid kind which effects a saving in components and space. According to the present invention, there is provided an electronic timepiece such as a watch, having an electro-optical time indicating means and a direct voltage source to maintain the oscillation of a resonator regulating the movement of the timepiece, wherein electric signals vary synchronously with the resonator oscillation are employed both as an input signal to the electro-optical indication means and to produce the operating voltage for it.

The invention is particularly suitable when the timepiece, which will now be referred to as a watch, is fitted with an isotope voltage source which generates a relatively high voltage between 300 and 1000 volts. This voltage is too high to operate the electro-optical indication, which requires a voltage of 10 to 20 volts, and it is also excessive for operating a frequency divider, a counter and a coding circuit. The high voltage, however, is suitable to operate an electrostatically operated drive of a resonator vibrating between two electrodes connected to the source of voltage and kept oscillating by change in charge. The current or voltage changes occurring in time with the resonator oscillation are used to produce a suitable operating voltage for the electro-optical indication and the control circuits therefor.

The invention will be described in detail below by way of some embodiments shown schematically in the accompanying drawings, in which:

FIG. 1 shows a first embodiment,

FIG. 2 shows a part of an alternative embodiment,

FIG. 3 shows a part of a further embodiment and,

FIG. 4 shows a further embodiment,

FIG. 5 shows a part of a modification of the device of FIG. 1.

The watch shown in FIG. 1 has an isotope voltage source 1. This voltage source shown schematically is of known type and has in a housing 2 an anode 3 and a cathode 4. The anode 3 is coated with a radioactive

preparation 5, which contains a beta irradiator such as tritium. The electrons emitted by the preparation 5 reach the cathode 4 and charge it negatively, whilst the anode 3 is charged positively.

The cathode 4 is directly connected to an electrode 6 of an oscillation capacitor, whilst the anode 3 is connected to the second plate 8 of the oscillation capacitor via the primary winding 7 of a transformer. Between the plates 6 and 8 there is a resilient flat spring 9, one end of which is clamped in a holder 10. The flat spring 9 is tuned to a suitable natural frequency and oscillates when in operation between the plates 6 and 8. The oscillation is maintained by reversal of charge on the spring 9 during its contact with one or the other of the electrodes.

The transformer has a secondary winding 11 which is connected in series with a rectifier 12. Hence a pulsating direct voltage is produced which is supplied to a counter 13 and an electro-optical indication unit 14 as operating voltage. One plate 8 of the oscillation capacitor is connected via a capacitor 15 to the counting input of the counter 13. The counter 13, besides the actual counting circuit, also contains a coding circuit which via connecting leads transmits the necessary time indicating signals to the indication unit 14, which is formed as an electro-optical digital indicator of known kind employing a liquid crystal medium.

During operation a pulsating current flows through the primary coil 7 of the transformer to the electrode 8 of the oscillation capacitor, so that surges of suitable voltage are induced in the secondary coil 11 which are rectified by the rectifier 12 and supplied as operating current to the units 13 and 14. At the same time an alternating voltage of the frequency of the plate spring 9, which may be 50 Hz, is transmitted to the input of the counter 13. Both the counter 13 and the indication unit 14 may be operated from a pulsating direct current. If necessary, however, a filter may be provided to smooth the rectified current pulses.

FIG. 2 shows an alternative embodiment in which corresponding parts are numbered similarly to FIG. 1. In this case a permanent magnet 16 is secured to the end of the flat oscillating spring 9 and caused to oscillate in the region of a coil 17. Hence an alternating voltage is induced in this coil which is rectified by the rectifier 12 and supplied to the circuits 13 and 14 as an operating supply. At the same time the alternating voltage induced in the coil 17 is supplied via the capacitor 15 to the input of the counter 13.

FIG. 3 shows a further alternative embodiment. In this case a direct current source 18 of low voltage, for example, a single dry battery, is provided, which supplies a conventional oscillator circuit 19 to maintain the oscillation of a tuning fork 20 via a coupling coil 21. Coupled to the coupling coil 21 is a further coil 22 which via a rectifier 12 supplies the operating current for the circuits 13 and 14. The alternating voltage occurring at the coil 21 is supplied via the capacitor 15 to the input of the counter 13.

FIG. 4 shows a further embodiment with an isotope voltage source in accordance with FIG. 1, with similar parts numbered as in FIG. 1. As already explained by way of FIG. 1, the charge on the flat oscillating spring 9 is continually reversed, the operating potential being similar to that of the source in FIG. 1. The flat spring 9 is connected to the rectifier 12 via a capacitor 23, which rectifier supplies the operating for the parts 13

and **14.** The alternating voltage occurring on the flat spring **9** is also transmitted via the capacitor **15** to the input of the counter **13.**

Further alternative embodiments are possible. In these alternatives cases, two different operating voltages, one for the electro-optical indication unit **14** and another to drive the counter **13,** are provided. In the embodiments of FIGS. **1** to **3** two rectifiers **12'** and **12''** may be provided which are connected to different tapping points of the coils **11, 17** and **22** respectively, whilst in the embodiment shown in FIG. **4** two differently dimensioned rectifier circuits may be provided, so that one operating voltage may be smoothed, whilst the other operating voltage may pulsate.

We claim:

1. An electronic timepiece such as a watch comprising liquid-crystal time indicating means, a single isotope direct voltage source, a mechanical resonator regulating the timekeeping function of said timepiece, an electrostatic driving system for said resonator, a driving circuit interconnecting said driving system with said voltage source, said resonator generating electric signals which are synchronous with the resonator oscillation, voltage transducing means having its input connected to said driving circuit, a counting and coding circuit connected at a control input to said driving circuit and at an output to said indicating means, the output of said transducing means being connected to supply operating potential to a power input of said counting and coding circuit and to said indicating means for energizing them, energy from said signals being employed both as a control input signal to said counting and coding circuit and as an operating voltage for said counting and coding circuit and for said indicating means.

2. A timepiece as recited in claim **1,** wherein said transducing means is a transformer the primary winding of which is connected into said driving circuit whilst the secondary winding of said transformer is connected to and supplies operating current for said indicating means and for said coding circuit via a rectifier.

3. A timepiece as recited in claim **1** wherein said indication means is operated from a pulsating direct voltage derived from said transducer.

4. A timepiece as recited in claim **1,** wherein said transducing means has two power outputs for power of different characteristics, one of said outputs being connected to said indicating means and the other of said outputs being connected to said counting and coding circuit.

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