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[54] DRIVING ARRANGEMENT FOR LIQUID CRYSTAL DISPLAY IN TIMEPIECES

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[58] **Field of Search** ..... 58/23 R, 23 A, 23 BA, 58/23 TF, 50 R, 50 A; 340/167, 168 R, 309.4; 350/160 LC

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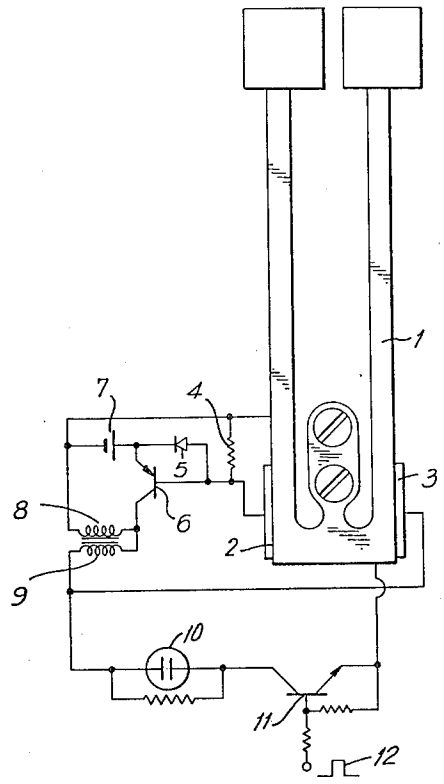
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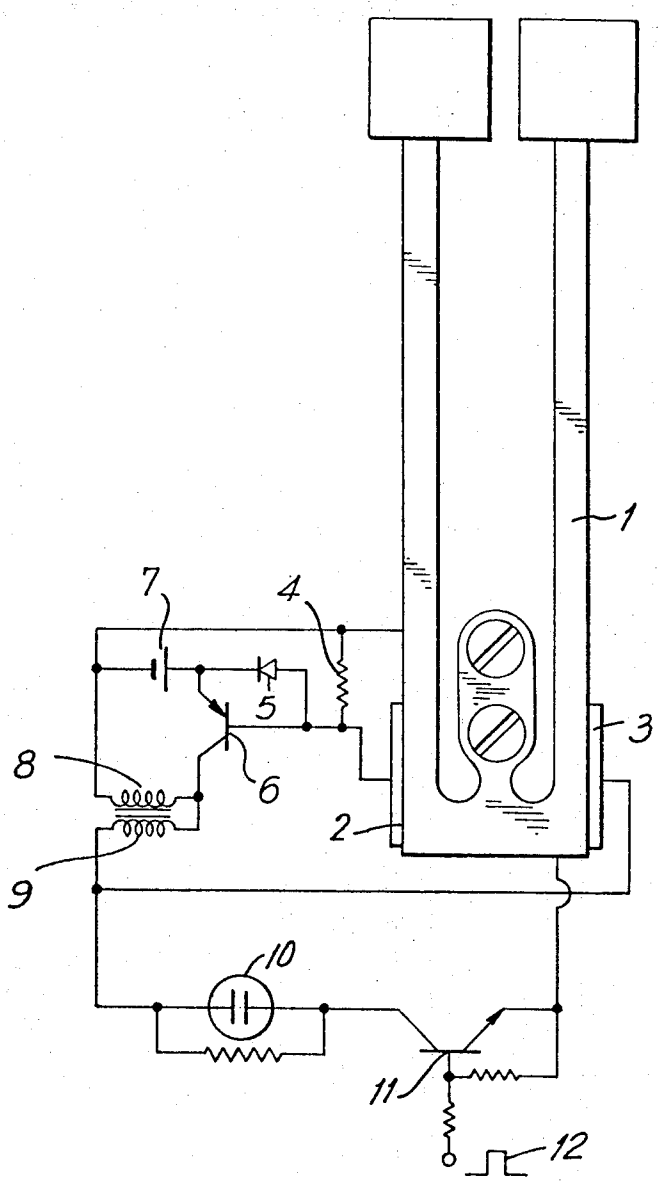
[57] **ABSTRACT**

A driving arrangement for liquid crystal displays for timepieces wherein the relatively low voltage of a battery is stepped up in response to the oscillating frequency of the time standard oscillator for application to the liquid crystal displays. Where said time standard vibrator is a piezo-electrically driven tuning fork type vibrator, the driving signal for said vibrator is also obtained from the secondary of the step-up transformer.

4 Claims, 1 Drawing Figure



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DRIVING ARRANGEMENT FOR LIQUID CRYSTAL DISPLAY IN TIMEPIECES

BACKGROUND OF THE INVENTION

This invention relates to timepieces provided with liquid crystal displays. The voltage for actuating such liquid crystal displays in timepieces is about 20–40 volts, a value much greater than the voltage of the battery customarily incorporated in such timepieces, especially where such timepieces are watches. The battery incorporated in watches is usually of the button-type having a voltage of about 1.3–1.5 volts, the limited space in a watch preventing the use of several batteries. By providing means for boosting the voltage of the battery, liquid crystal displays may be incorporated in such timepieces.

SUMMARY OF THE INVENTION

Generally speaking, in accordance with the invention, a timepiece is provided including liquid crystal display means, a battery, time standard vibrator means, and step-up transformer means. First circuit means are provided for alternately connecting said battery to the primary of said step-up transformer means in response to the oscillation frequency of said time standard vibrator means while second circuit means is provided connecting said liquid crystal display means to the secondary of said step-up transformer means and for selectively actuating said liquid crystal display means to provide time indication.

Said time standard vibrators may include a piezo-electrically driven tuning fork type vibrator means having a piezo-electric driving element and a piez-electric detecting element, said first circuit means detecting said time standard vibrator means frequency at said piezo-electric detecting element. Said piezo-electric driving element may be connected to said secondary of said step-up transformer means.

Accordingly, it is an object of this invention to provide a time-piece wherein a relatively low voltage battery may drive a liquid crystal display device.

A further object of the invention is to provide a timepiece wherein the liquid crystal display device is driven by a relatively low voltage battery and a piezo-electrically driven tuning fork type vibrator.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification and drawing.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWING

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawing, in which:

The FIGURE is a circuit diagram depicting one embodiment of the arrangement according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The driving arrangement for liquid crystal displays for timepieces according to the invention is depicted in the FIGURE, wherein a tuning fork type vibrator **1** is provided as a time standard. Said vibrator is provided with a detecting piezo-electric element **2** for detecting the vibration thereof and a driving piezo-electric element **3** for exciting the vibration thereof. A transistor **7** is provided connected at its base to detecting piezo-electric element **2.** Diode **5** is connected between the emitter and base of transistor **6** for bias adjustment while a base leak resistor **4** is provided connected to the base of said transistor.

A direct current source **7** is connected in series with the primary coil **8** of a step-up transformer and the emitter-collector path of transistor **6.** The secondary coil **9** of said transformer is connected between the collector of said transistor and a liquid crystal display element **10.** Driving piezo-electric element **3** is connected to the terminal of secondary coil **9** to which said liquid crystal display element is connected.

A switching transistor **11** is connected with its emitter-collector path in series with liquid crystal display element **10.**

When the tuning fork type vibrator **1** oscillates, a voltage is produced in detecting piezo-electric element **2** and an alternating current is applied to the base of transistor **6.** This current is amplified by transistor **6** to produce a voltage at both ends of primary coil **8,** which voltage is stepped up by the transformer to produce a higher voltage at secondary coil **9.** This higher voltage is applied to driving piezo-electric element **3** for driving the tuning-fork type vibrator **1** and for sustaining such vibrations.

The high frequency output of the tuning fork vibrator **1** is divided into time signals in the usual manner, such time signals being representative of seconds, minutes and hours, as desired. Liquid crystal element **10** depicted in the drawing is representative of a matrix of such elements providing a digitial time indication when suitable combinations thereof are actuated. At the instant that the liquid crystal display element **10** depicted in the drawing is to be actuated, a time signal **12** produced by a matrix circuit (not shown) from the output signal of the time standard vibrator, is applied to the base of transistor **11** to render said transistor conductive so that the stepped up voltage is supplied to the liquid crystal display element. Each of the liquid crystal display elements of the display matrix would be provided with a separate switching transistor, the required combination of such display elements for the display of present time being simultaneously actuated in response to such time signals.

The arrangement according to the invention permits the driving of liquid crystal display elements by means of a D.C. electric source of low voltage such as a mercury battery of 1.3 volts or a silver battery of 1.5 volts. Further, the arrangement according to the invention permits the provision of a compact structure suitable for watches wherein space is limited. In such constructions, it is most convenient to use a tuning fork type vibrator which is of small size and produces a relatively low frequency, so as to permit the direct use of the frequency of the vibrator for stepping up the voltage of the electric source. However, the arrangement according to the invention is not limited to a metallic tuning fork, but may also be applied to a quartz crystal vibrator.

The connection between driving piezo-electric element **3** and the secondary coil **9** of the transformer provides a driving voltage of a value suitable for driving the

piezo-electrically driven tuning fork type vibrator. Such vibrators require a voltage of about 20 volts for proper driving. The arrangement according to the invention provides this voltage while permitting reduction in the area occupied by the transformer which is fairly large, thereby resulting in a cost savings.

It will thus be seen that the objects set forth above, and those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. A timepiece comprising liquid crystal display means; time standard vibrator means; D.C. voltage source means; step-up transformer means having a primary and a secondary; first circuit means operatively coupling said D.C. voltage source means and said step-up transformer means primary and being coupled to said vibrator means for alternately connecting said D.C. voltage source means to said step-up transformer means in response to the frequency of oscillation of said time standard vibrator; and second circuit means operatively connecting said liquid crystal display means to said step-up transformer means secondary and for the selective actuation of said liquid crystal display means for time indication.

2. A timepiece as recited in claim **1,** wherein said time standard vibrator is a piezo-electrically driven tuning fork type vibrator means having a detecting piezo-electric element and a driving piezo-electric element, said first circuit means being connected to said vibrator means at said detecting piezo-electric element.

3. A timepiece as recited in claim **2,** wherein said driving piezo-electric element and said liquid crystal display means are connected together to said step-up transformer means secondary.

4. A timepiece as recited in claim **2,** wherein said first circuit means includes a transistor means connected with its emitter-collector path in series with said D.C. voltage source means and said step-up transformer means primary, the base of said transistor being connected to said detecting piezo-electric element.

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