March 5, 1963 J. A. HULTQUIST 3,079,748

ILLUMINATED ELECTRONIC TIME PIECE

Filed June 27, 1960

Fig. 1

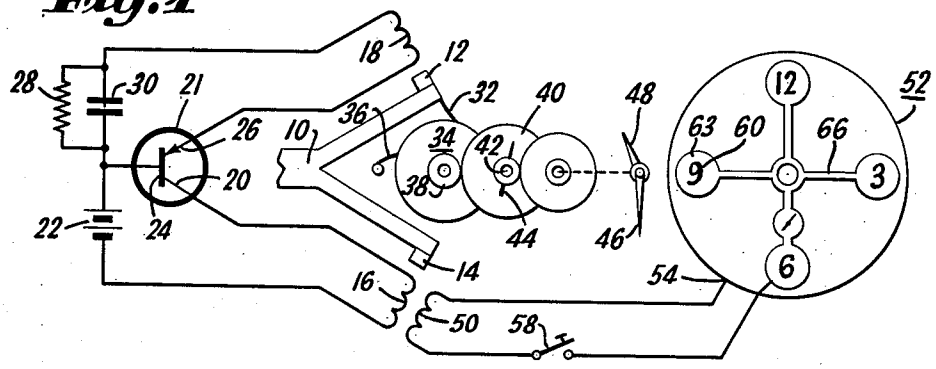


Fig. 4

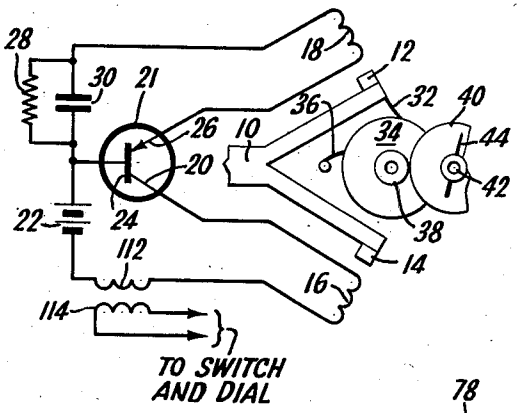


Fig. 5

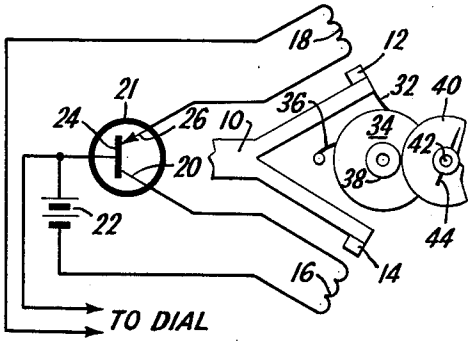


Fig. 2

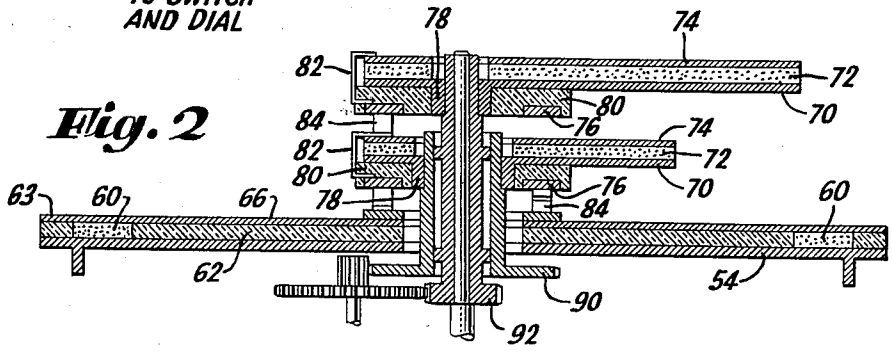
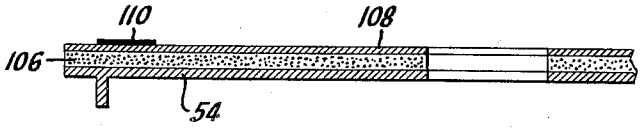


Fig. 3



INVENTOR
J. ALBERT HULTQUIST
BY J. Albert Hultquist
ATTORNEY

United States Patent Office

3,079,748

Patented Mar. 5, 1963

3,079,748

ILLUMINATED ELECTRONIC TIME PIECE

J. Albert Hultquist, Scarsdale, N.Y., assignor to Sylvania Electric Products Inc., a corporation of Delaware

Filed June 27, 1960, Ser. No. 38,836
5 Claims. (Cl. 58—50)

The present invention relates to portable time pieces such as traveling clocks, pocket watches and wrist watches and, more particularly, to an arrangement for facilitating the reading of time at night, particularly when no external source of illumination is available.

Heretofore, it usually has been possible to read the time indicated by a portable time piece at night without an external source of illumination only if the time piece was equippd with the so-called "radium" dial. In this form of construction a mixture of fluorescent material such as willemite with a small amount of radium or other radio active material to excite the fluorescent material is applied to the hands and chapters of the time piece. The glow of the fluorescent material was thus easily visible to the dark adapted eye.

However, in recent years there has been an ever increasing concern as to possible health hazards to the user because of the presence of radio active materials in such close proximity to his person for a major portion of every day. It thus becomes desirable to avoid both actual hazard and reputed hazard while still providing the undoubted convenience of being able to read the time in the dark.

Within the past few years, the so-called electronic time pieces have become available. Usually these employ a mechanically resonant element such as a tuning fork or balance wheel electromechanically driven from a battery and mechanically coupled to a reducing gear train which drives the watch hands.

One particular form of electronic time piece utilizes a tuning fork operating at 360 cycles per second coupled to a transistor in a self oscillatory circuit and to a small battery, all combined within a case about the size of the usual wrist watch. The tuning fork mechanically operates a pawl coupled to a ratchet wheel. The ratchet wheel has 360 teeth in its periphery and therefore turns at 1 revolution per second. A 60 to 1 gear reduction train drives the second hand at 1 revolution per minute and further conventional gear reduction trains drive the hour and minute hands at respectively 2 revolutions per day and 1 revolution per hour.

In accordance with the principles of my present invention, a watch as aforesaid is provided with an electroluminescent dial or with electroluminescent chapters or characters and hands on a dark dial, energized by the 360 cycle current derived from the driving circuit for the tuning fork to make the dial and hands visible in the dark.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing in which FIGURE 1 illustrates diagrammatically an embodiment of the present invention while FIGURE 2 illustrates in greatly enlarged transverse cross-section a dial suitable for use in my invention; FIGURE 3 illustrates a modified form of dial shown in FIGURE 2; FIGURE 4 illustrates a modification of the circuit shown in FIGURE 1; while FIGURE 5 is a schematic showing of still a further modification of the circuit arrangement of FIGURE 1.

In FIGURE 1 I have shown a tuning fork 10 having permanently magnetized pole pieces 12 and 14 at the ends of the legs of the tuning fork. In inductive relationship to magnet 14 is driving coil 16 and similarly arranged with respect to magnet 12 is feedback winding 18. Driving coil 16 is connected in a circuit running from collector

20 of transistor 21 through driving coil 16 to battery 22 and thence to base 24 of transistor 21. Pick-up coil 18 is connected in a series circuit running from emitter 26 through pick-up coil 18, resistor 28 by-passed by capacitor 30, and thence to base 24. Coils 16 and 18 are so phased as to maintain oscillation of the mechanically resonant tuning fork 10, preferably at a frequency of 360 cycles. The tuning fork is so constructed as to be insensitive to variations in temperature, so that the time keeping ability of the watch is not affected by variations in ambient conditions. A light pawl 32 connected to one of the legs of tuning fork 10 engages ratchet teeth on driving wheel 34 one tooth at a time for each vibration of tuning fork 10. A light click pawl 36 bearing against the ratchet teeth on wheel 34 is provided to assure that the wheel 34 is not dragged backwards by the friction of pawl finger 32 in its reverse motion. If wheel 34 has 360 teeth and the tuning fork operates at 360 cycles per second, wheel 34 makes 1 revolution per second. A simple 60:1 gear reduction, as by means of pinion 38 mounted concentrically with wheel 34 and gear wheel 40, drives shaft 42 at 1 revolution per minute and hand 44 therefore constitutes the second hand of the watch.

The further gear reduction train diagrammatically indicated drives minute hand 46 at 1 revolution per hour and hour hand 48 at 2 revolutions per day, as is conventional in watch practice.

In the embodiment of the invention illustrated in FIGURE 1, I have provided a secondary coil 50 in inductive relationship to driving coil 16 and having such turns ratio with regard to coil 16 as to provide a sufficient voltage to energize the electroluminescent dial 52 of the watch. One connection of coil 50 runs directly to metal base plate 54 of dial 52 while the other end of coil 50 is directly connected to a transparent conductive coating 63 over the face of dial 52. If desired, a switch 58 may be provided in circuit with coil 50 to de-energize the electroluminescent dial when no illumination is desired.

In the form of watch dial shown in transverse cross-section in FIGURE 2, the metal backing plate 54 of the dial has the chapters or numerals 60 of the dial printed thereon with a mixture of an electroluminescent phosphor in a glass "frit." The glass "frit" preferably has a high dielectric constant. Portions of dial plate 54 which are not occupied by the numerals 60 are coated with an insulating layer 62. Insulating layer 62 may conveniently be formed of a thin layer of glass "frit" or enamel with no phosphor embedded in it and preferably of as low a dielectric constant as possible. The use of a low dielectric constant glass for insulation between the dial plate 54 and the transparent conductive coating 63 reduces idle or "dead" capacity, thus minimizing the capacitive loading on the oscillator circuit. Over at least each of the numerals 60 and over a narrow ring-like area around central aperture 64 is laid down a thin transparent conductive coating 63. If the coating 63 does not cover the entire dial face, all of the individual transparent conductive coating spots are connected together by narrow transparent coating strips 66. Alternating current produced in coil 50 establishes a varying electric field across the embedded phosphor forming each of the numbers and excites the phosphor to luminescence whereby the numbers are caused to glow so that they may readily be distinguished in the darkness.

In order to read the positions of at least the hour and minute hands with respect to the numbers, said hands are each made of a thin, metal strip 70 coated on the face with a dielectric layer 72 containing electroluminescent phosphor with a thin transparent conductive coating 74 overall. A thin, conductive washer or slip ring 76 coaxial with the mounting hub 78 for each of the hands is secured to the back surface of the hand with an insulating washer

80 intervening and having a conductive connection 82 to the transparent conductive coating on the face of the hand. A thin circular leaf spring 84 secured to the conductive coating 60 on the watch dial, by means of a conductive adhesive or solder, bears against conductive washer 76 on the back of the hour hand and completes an energizing circuit for the electroluminescent hour hand. Another spring 84 is conductively secured to the transparent conductive coating 74 on the face of the hour hand to bear against a slip ring 76 on the minute hand. The return side of the circuit is, for both hands, completed through conductive connection of the hands to the shaft on which hour wheel 90 and cannon pinion 92 are individually mounted.

The modified dial shown in enlarged fragmentary cross-section in FIGURE 3 utilizes a continuous electroluminescent layer 106 covering the entire face surface of dial plate 54. As in the previous embodiment the electroluminescent layer is preferably composed of a mixture of glass frit and phosphor fired on the surface of the dial plate. Under some circumstances however it may be desirable to utilize an organic plastic dielectric rather than a glass frit.

The electroluminescent layer 106 is coated with a continuous transparent conductive layer 108 having opaque numerals printed on the surface, one being indicated at 110. While the hands are not shown in this view, they are the usual opaque hands as used on conventional time pieces. Since the entire face glows when coil 50 is connected from plate 54 to coating 108, the numerals and hands stand out dark against the lighted background making the time piece easily read in darkness. With this modification particularly, it is desirable to arrange switch 58 to be normally open and only to close it when it is desired to read the time. The comparatively large glowing area may be disturbing if it is continuously energized. Furthermore, the load on the oscillator circuit will be larger thus increasing the battery drain. However, momentary energization of the dial is satisfactory even if the load is sufficient to cause the oscillator to be overloaded since such periods will be brief enough and usually infrequent enough that they will not seriously affect the time keeping qualities of the watch.

Where there is sufficient space within the watch case and it is desired to convert a non-illuminated electric watch to an illuminated one, the modified circuit shown in FIGURE 4 may be used. In this figure, parts similar to those in FIGURE 1 bear the same reference numerals and will not again be described. The modifications include a transformer having its primary winding 112 in series between driving coil 16 and battery 22 with secondary winding 114 connected to switch 58 and dial 52 as indicated by the legend. This modification also provides for more freedom in design of the step-up ratio between the alternating current in the oscillator circuit and that utilized to illuminate the dial.

The further modification shown in FIGURE 5 substitutes the capacitance of the electroluminescent lamp for the condenser 30 of FIGURE 1. The capacitance of the lamp is purposely made lossy enough to substitute also for the resistance of resistor 28 of FIGURE 1. In this modification, of course, the dial must be energized at all times since the dial is then an essential element of the oscillator circuit for driving timing fork 10 so switch 58 is omitted.

While I have shown and particularly described several modifications of my invention, it should be understood that my invention is not limited thereto but modifications within the scope of the appended claims may be made.

I claim:

1. A portable electronic time piece including a mechanically resonant element, a dial and hands, a gear drive coupled to said resonant element and to said hands whereby said hands are driven, an electrical circuit for driving said resonant element from a battery contained within said time piece, means for deriving an alternating current from said circuit, said means comprising a transformer having a low voltage primary winding in said circuit and a high voltage secondary winding, said dial including an electroluminescent lamp energized from the high voltage secondary winding of said transformer.

2. A portable electronic time piece including a mechanically resonant element, a dial and hands, a gear drive coupled to said resonant element and to said hands whereby said hands are driven, an electrical circuit for driving said resonant element from a battery contained within said time piece, means for deriving an alternating current from said circuit, said means comprising a transformer having a low voltage primary winding in said circuit and a high voltage secondary winding, said dial comprising a conductive back plate at least partially covered with a layer including an electroluminescent phosphor suspended in a dielectric solid and a transparent conductive film over said layer and connections from said high voltage secondary winding to said plate and said film.

3. A portable electronic time piece including a mechanically resonant element, a dial and hands, a gear drive coupled to said resonant element and to said hands whereby said hands are driven, an electrical circuit for driving said resonant element from a battery contained within said time piece, means for deriving an alternating current from said circuit, said means comprising a transformer having a low voltage primary winding in said circuit and a high voltage secondary winding, said dial comprising a conductive back plate at least partially covered with a layer including an electroluminescent phosphor suspended in a transparent dielectric solid and a transparent conductive film over said layer and connections from said high voltage secondary winding to said plate and said film, said hands comprising conductive base portions coated with an electroluminescent phosphor suspended in a solid dielectric and each having a transparent conductive film thereover, an electrical connection from each of said supports to said plate and an electrical connection from each of the transparent conductive films on said hands to said conductive film on said dial.

4. A portable electronic time piece including a mechanically resonant element, a dial and hands, a gear drive coupled to said resonant element and to said hands whereby said hands are driven, an electrical circuit for driving said resonant element from a battery contained within said time piece, means for deriving an alternating current from said circuit, said means comprising a transformer having a low voltage primary winding in said circuit and a high voltage secondary winding, said dial having its chapters formed of an electroluminescent phosphor suspended in a transparent dielectric solid on a conductive base plate, the areas between said chapters being coated with a dielectric film, a transparent conductive film over at least said chapters and connections from said high voltage secondary winding to said base plate and said conductive film.

5. A portable electronic time piece including a mechanically resonant element, a dial and hands, a gear drive coupled to said resonant element and to said hands whereby said hands are driven, an electrical circuit for driving said resonant element from a battery contained within said time piece, means for deriving an alternating current from said circuit, said dial having its chapters formed of an electroluminescent phosphor suspended in a transparent dielectric solid on a conductive base plate, a transparent conductive film over each of said chapters, strips of conductive coating connecting each of the conductive films over said chapters, connections from said conductive base plate and said conductive coating to said means, said hands comprising conductive base portions coated with an electroluminescent phosphor suspended in a solid dielectric and each having a transparent conductive film thereover, an electrical connection from each

of said supports to said plate and an electrical connection from each of the transparent conductive films on said hands to said conductive film on said dial.

References Cited in the file of this patent

UNITED STATES PATENTS

2,680,813	Doyle	June 8, 1954
2,922,912	Miller	Jan. 26, 1960
2,945,145	Neugass	July 12, 1960
2,960,817	Hetzel	Nov. 22, 1960
3,003,305	Goldman	Oct. 10, 1961

FOREIGN PATENTS

761,609	Great Britain	Nov. 14, 1956

OTHER REFERENCES

"Electroluminescence," E. C. Payne et al., Illuminating Engineering, November 1950, pages 688–693.

"Now The Atomic Wrist Watch," John Pfeiffer, The N.Y. Times Magazine, Sept. 2, 1956, page 23.

"Electroluminescence and Its Applications," J. N. Bowfel, Journal I.E.E., August 1957.

RCA TN No. 111, Princeton, N.J., April 1, 1958, one page.