

[54] WATCH WITH AN ELECTRONIC BUZZER  
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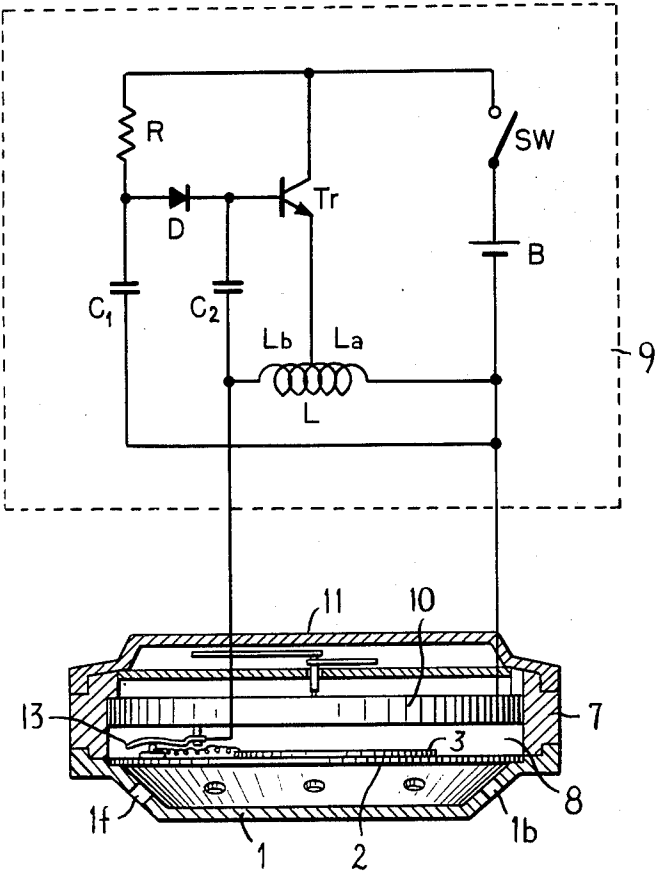
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[58] Field of Search..... 58/38, 57.5

[56] References Cited  
UNITED STATES PATENTS  
3,341,841 9/1967 Stampfli..... 58/38 X  
3,733,804 5/1973 Diersbock..... 58/38

3,577,876 5/1971 Spadini ..... 58/57.5  
3,638,418 2/1972 Spadini ..... 58/57.5  
Primary Examiner—George H. Miller, Jr.  
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[57] ABSTRACT  
A watch with an electronic buzzer which comprises a double-constructed back cover including an inner back cover on which a piezoelectric element is mounted to produce a mechanical buzz sound when a voltage is applied thereto and an outer back cover provided with a plurality of small holes for enhancing transmission of the buzz. A driving circuit for actuating or energizing the piezoelectric element is disposed in the watch case releasably from the back cover and the piezoelectric element. This construction enables the watch to be made small in size and assures the watertightness of the watch.

3 Claims, 5 Drawing Figures



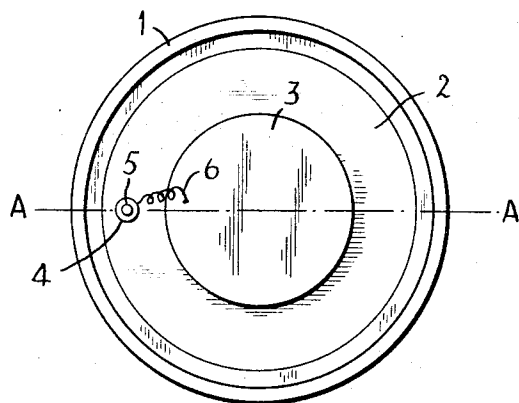


FIG. 1

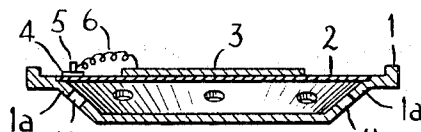


FIG. 2

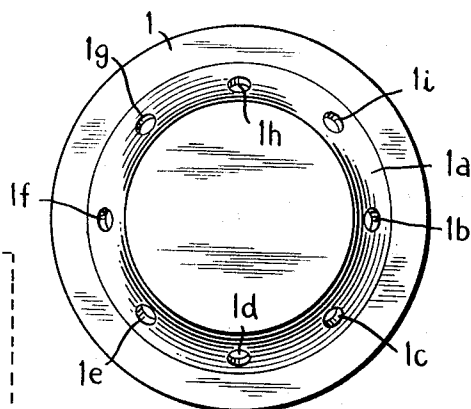


FIG. 3

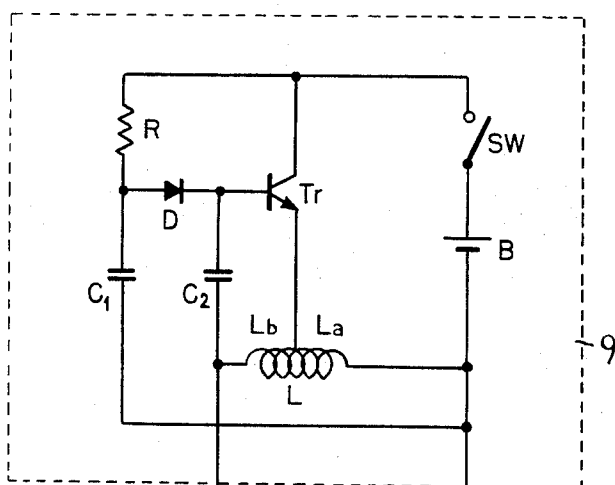


FIG. 4

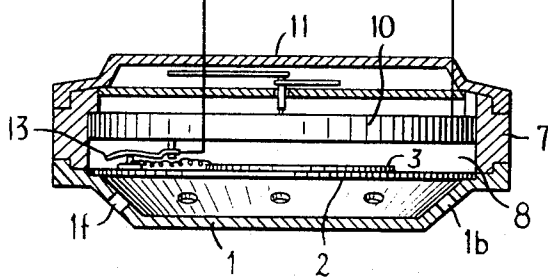
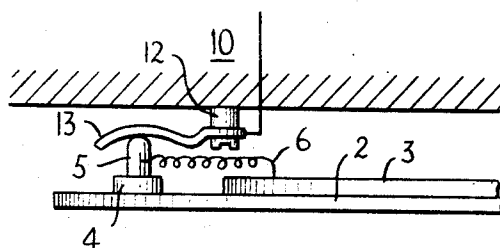


FIG. 5



## WATCH WITH AN ELECTRONIC BUZZER

## BACKGROUND OF THE INVENTION

This invention relates generally to watches, and more particularly to a watch with an electronic buzzer wherein a piezoelectric element functions as a vibrating means employed to produce a buzz sound.

## DESCRIPTION OF PRIOR ART

Conventional buzzers for a watch have been constructed with a vibrating member such as a hammer, electromagnetically driven, hits against a glass or back cover of a watch. However, a buzzer of this type requires a certain large space for the strokes of the vibrator, and requires another space for locating an electromagnet for driving the vibrating member. Therefore, in using a buzzer of the above-mentioned type in a watch, many problems arise: the watch becomes too large in size; it is difficult to adjust the distance between the glass or back cover and a hammer positioned in a narrow space after all the works of the watch have been assembled; and it is impossible to obtain a full sound effect of the vibrator because the watch case is constructed water-tight.

## SUMMARY OF THE INVENTION

An object of the present invention is to provide a watch with an electronic buzzer in which a piezoelectric element serves as a vibrating element and is employed to eliminate mechanically driven members and a driving electromagnet thereby allowing construction of a watch of small size.

Another object of the present invention is to provide a watch with an electronic buzzer from which a full sound effect is obtained and watertightness is assured by employing a double-constructed back cover comprising an inner back cover and an outer back cover provided with one or a plurality of sound emission or sound escape openings.

A watch with an electronic buzzer according to the present invention comprises a watch case accommodating a watch movement. A back cover is mounted on the case and vibrating means are mounted on the back cover. The vibrating means is a piezoelectric element. A driving circuit actuates the vibrating means to produce a buzz sound at a predetermined time. The driving circuit is disposed releasably from the back cover and the vibrating means, and means for connecting the vibrating means to the driving circuit.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a back cover of a watch with an electronic buzzer according to the present invention;

FIG. 2 is a cross-section view taken on section line 2—2 of FIG. 1;

FIG. 3 is a back side elevation view of a watch according to the invention;

FIG. 4 is a schematic sectional view and a circuit diagram of an overall construction of a watch with an electronic buzzer according to the present invention; and

FIG. 5 is an enlarged fragmentary view of a part of FIG. 4 illustrating means for connecting vibrating means to a driving circuit.

Other objects and advantages will appear from the following description of an example of the invention,

and the novel features will be particularly pointed out in the appended claims.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 to 3, there is shown an embodiment of a back cover of a watch case comprising a dished outer back cover 1 on an inclined or dished surface portion 1a on which are provided a plurality of small openings 1b to 1i spaced angularly equally and an inner back cover 2, the marginal peripheral portion of which is secured to the outer cover 2. A piezoelectric element 3 is attached to a central portion of the inner cover 2 with an electrically conductive adhesive. The piezoelectric element 3 has on its back or top surface electrodes; one of which is electrically connected, through the inner back cover 2 and the outer back cover 1, to a frame plate 10 and the other of which is also connected through a lead conductor 6 to a terminal pin 5 mounted on a seating means 4 which is electrically insulated from the inner cover 2 and, therefore, from the outer cover 2 and the frame plate 10 (See FIG. 5).

FIG. 4 is an overall construction view with a circuit diagram illustrating the embodiment of the electric buzzer according to the present invention. A circuit 9 for sounding a buzzer is disposed in an internal space of the watch case defined by the inner surface of the inner back cover 2 and the frame plate 10, and a case band 7 mounted on the outer back cover 1. A watch crystal or glass 11 is mounted on the case band 7 in a fluid-tight condition.

When the back cover is mounted on the watch case band 7, the end of the terminal pin 5, as shown in FIG. 5, is held in contact with an electrically conductive terminal spring 13 secured to an insulating member 12 which is in turn mounted on a back surface of the frame plate 10. It will be, therefore, understood that the piezoelectric element 3 is connected to the circuit 9 through the lead wire 6, the pin 5, and the spring 13, on the one hand, and through the inner cover 2, the watch case band 7 and the frame plate 10 (serving as ground), on the other hand.

The circuit 9 for energizing the buzzer comprises a transistor Tr the collector of which is connected in series to a switch SW actuated in response to a timer mechanism (not shown) and a battery B having, for example, a voltage value of 1.5. The negative terminal of the battery is grounded to the plate 10. On the other hand, a diode D is connected to a base of the transistor, and a resistor R is connected between the input terminal of the diode and the collector of the transistor. A capacitor C<sub>1</sub> is connected between the input terminal of the diode and ground. Thus, the diode D, resistor R and capacitor C<sub>1</sub> constitute a time constant circuit. Another capacitor C<sub>2</sub> is connected to the base of transistor Tr and to the spring 13. To one terminal of the capacitor C<sub>2</sub> is connected a coil L which is divided into two portions La and Lb. The emitter of the transistor Tr is connected to the centertap of the coil L. Moreover, the capacitor C<sub>2</sub> is connected through the spring 13, the terminal pin 5 and the lead wire 6 to one electrode of the piezoelectric element 5. Thus it will be understood that the piezoelectric element 3 is connected across the coil L.

With this arrangement, the capacitor C<sub>1</sub> is charged with a current flowing from the battery B through a re-

sistor R when the switch SW is closed at the predetermined time associated with the timer mechanism. The charging time thereof is determined by the time constant of the capacitor  $C_1$  and the resistor R. When the voltage across the capacitor exceeds a predetermined value; for instance 0.6V when a silicon diode is employed, the voltage is applied to the base of the transistor  $T_r$  to bias the transistor  $T_r$ , whereby the current flows from the collector. Since the coil L is divided into two parts  $L_a$  and  $L_b$  and connected to the emitter, the current change in the collector circuit causes a voltage change in the coil  $L_a$ . Thus an induced voltage is produced in the coil  $L_b$  and then fed back through the capacitor  $C_2$  to the base of the transistor. Therefore, the circuit begins to oscillate with the resonance frequency determined by the coil L and the capacitor  $C_2$ .

The oscillation continues until the complete discharge of the condenser  $C_1$  is finished. When the discharge is completed, the transistor is turned off to stop the oscillation. When the capacitor  $C_1$  is charged again, the circuit begins to oscillate in the same way as mentioned above, so that intermittent oscillation occurs with the repeated charge and discharge of the capacitor  $C_1$ . The piezoelectric element 3 connected across the coil L vibrates intermittently in response to the oscillation of the circuit. In order to obtain the maximum sound effect, the oscillatory frequency of the circuit should conform to the resonance frequency of the piezoelectric element.

The driving circuit employed in the invention brings about many advantages as follows: the consumption of the electric power is low due to the use of the transistor-switching circuit; the maximum sound effect of the vibrator may be obtained with small consumption of electric power because the vibrating means is resonant with the oscillating frequency of the circuit; the life of the circuit is substantially permanent because the circuit is contactless except for the switch actuated by the timing mechanism; no re-adjustment of the frequency is required, so that maintenance is easy and without trouble; and it is particularly suitable for use in portable apparatus, such as a watch the inner space of which is extremely limited.

On the other hand, the watch with the electric buzzer according to the present invention has many advantages as follows: the watertightness of the watch case is positively assured by the inner back cover of the double-constructed back cover; case band and glass; the sound effect of the buzzer is readily heard because the vibrating sound of the piezoelectric element is transmitted through the angularly spaced openings provided

on the outer back cover; the piezoelectric element employed as the vibrating means has no mechanical portions and therefore requires no readjustment and difficult adjustment for the frequency; the piezoelectric element is thin in form so that it is particularly suitable for use in a small watch; and the back cover of the watch case is easily assembled or disassembled because the piezoelectric element adhesively fixed to the inner back cover is electrically connected to the vibrating circuit by means of the terminal pin provided on the inner back case and the terminal spring provided on the watch movement.

What I claim and desire to secure by letters patent is:

1. A watch with an electronic buzzer comprising, a watch case for accommodating a watch movement, a back cover mounted on said housing, vibratable means capable of producing a mechanical sound when a voltage is applied thereto and mounted on said back cover, a driving circuit for actuating said vibratable means to produce a mechanical buzz sound at a predetermined time, means connecting said driving circuit releasably to said back cover and said vibratable means, means for connecting said vibratable means to said driving circuit, said driving circuit comprising a power source, a transistor having a collector connected in series with said power source and a timing switch; a time-constant circuit including a first capacitor and a resistor connected in parallel with said transistor; and an oscillating circuit including a second capacitor connected to a base of said transistor and a coil having one end connected to said second capacitor and the other end connected to said power source, said coil having a center-tapped portion to which an emitter of said transistor is connected, and means connecting said vibratable means across said coil.

2. A watch with an electronic buzzer comprising, a watch case for accommodating a watch movement, a back cover mounted on said watch case, a piezoelectric element capable of producing a mechanical sound when a voltage is applied thereto mounted on said back cover, a driving circuit for actuating said piezoelectric element to produce a mechanical buzz sound at a predetermined time, means connecting said driving circuit releasably to said back cover and said piezoelectric element, and additional means for connecting said piezoelectric element to said driving circuit.

3. A watch with an electronic buzzer according to claim 2, wherein said back cover comprises an inner back cover and an outer cover, and said piezoelectric element is mounted on said inner cover.

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