

[54] **ELECTRONIC WATCH WITH AN ELECTRONICALLY OPERATED SOUND PRODUCER**

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[51] Int. Cl..... **G04c 21/34**

[58] Field of Search..... 58/23 BA, 38, 16, 19 R, 58/57.5

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[57] **ABSTRACT**

An electronically powered watch is disclosed which has an audible signal producing alarm system incorporated into the watch structure. The audible signal is produced by a vibrating membrane located laterally adjacent to the watch battery within the watch case. The audible signal emanates from the case by radial sound discharging openings provided through the watch case. The structure minimizes the overall height of the watch structure. Access to the battery is provided by a removable battery cover over an opening in the rear cover of the watch. The battery may be removed and a new battery installed by merely removing the battery cover without disturbing the vibrating membrane or removing the entire rear cover of the watch.

4 Claims, 10 Drawing Figures

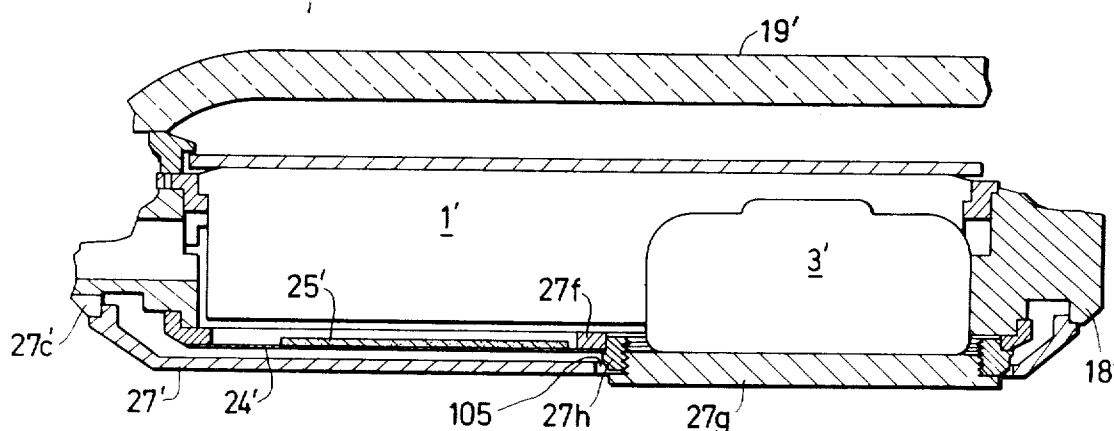


FIG. 1

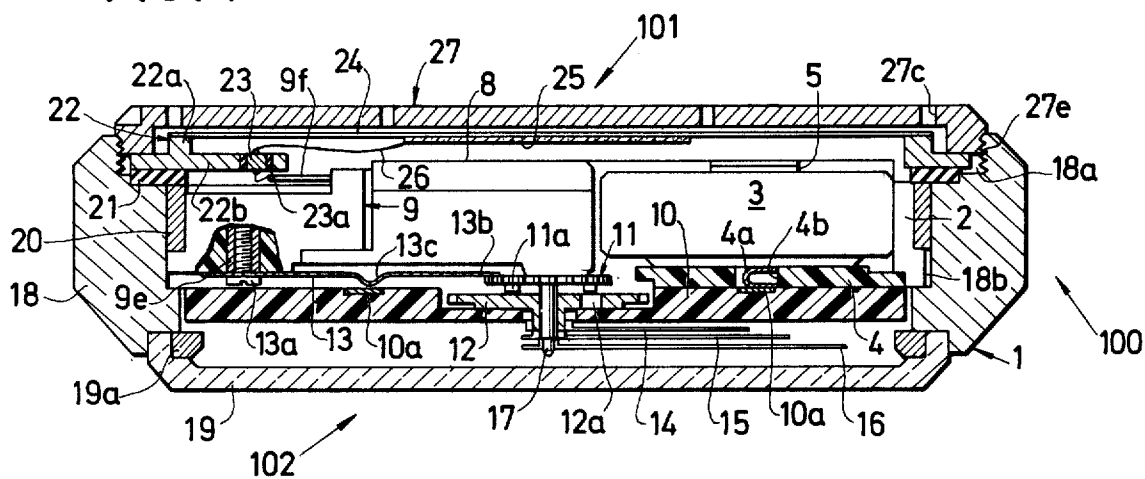


FIG. 2

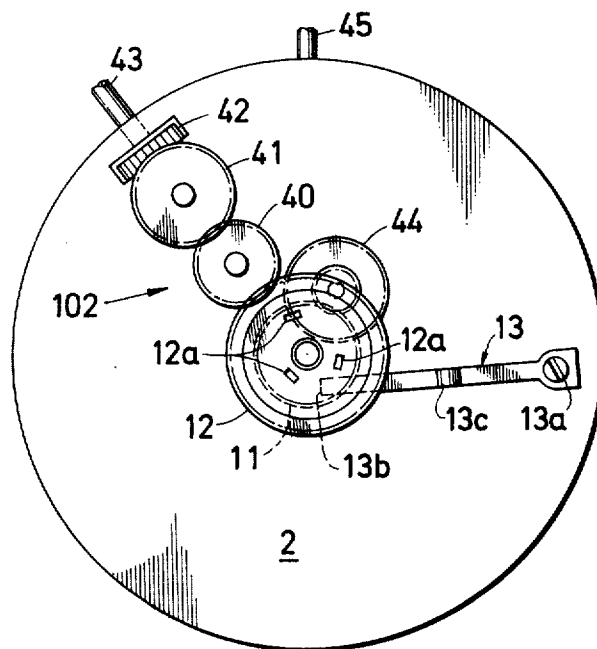


FIG. 3

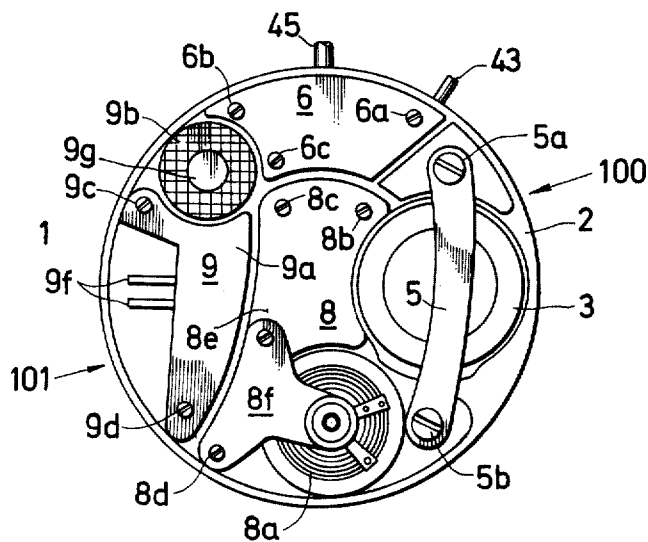


FIG. 4

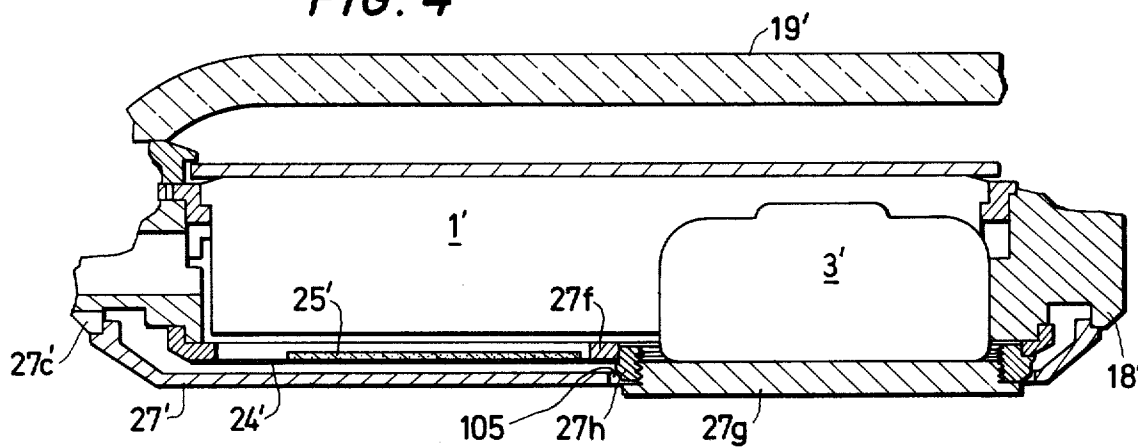


FIG. 5

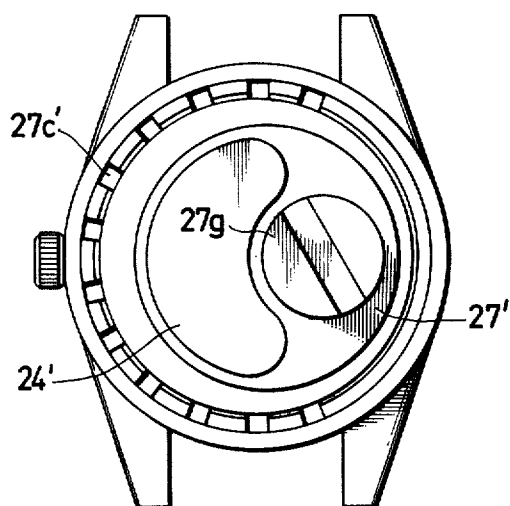


FIG. 7

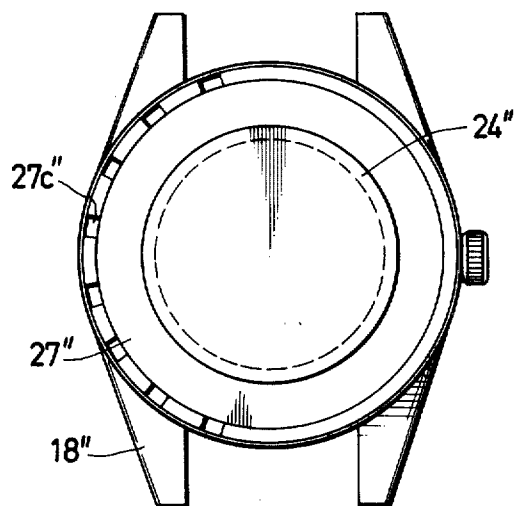


FIG. 6

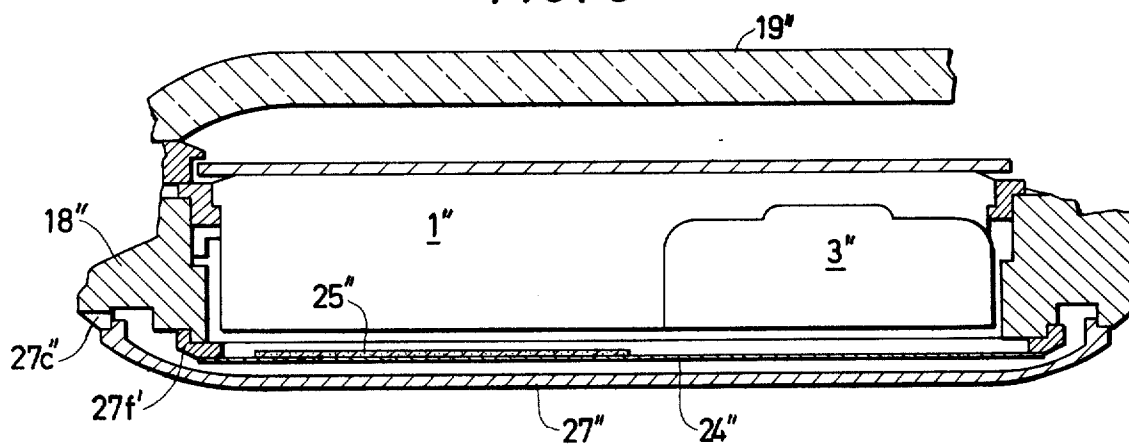


FIG. 8

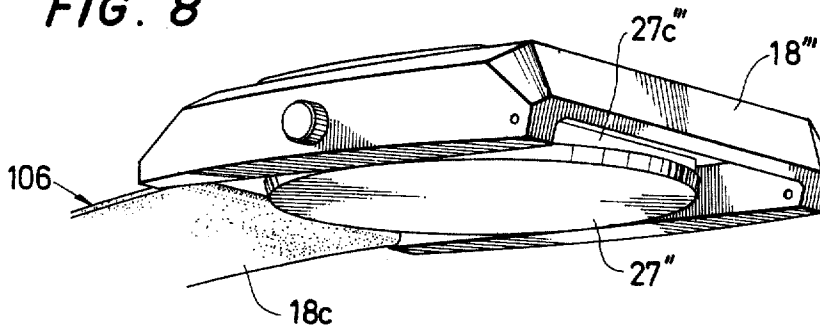


FIG. 9

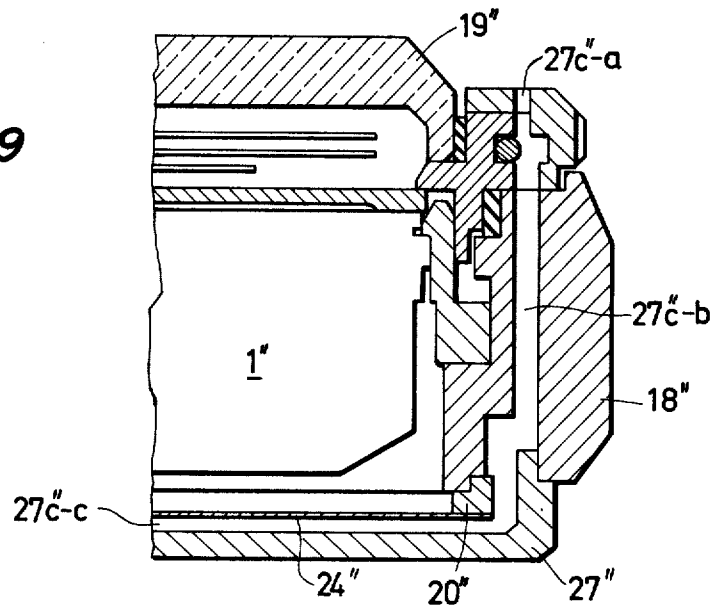
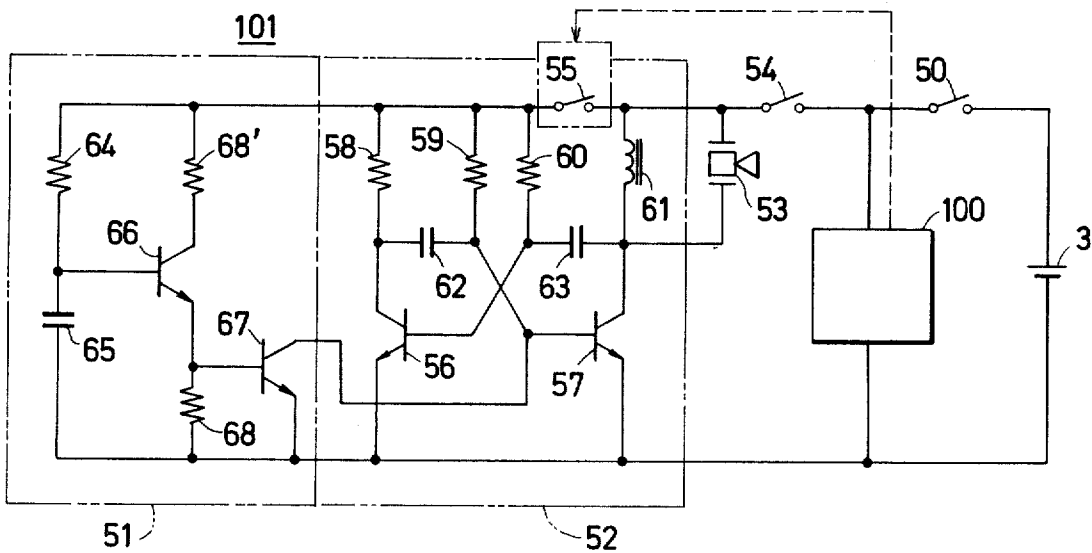


FIG. 10



ELECTRONIC WATCH WITH AN ELECTRONICALLY OPERATED SOUND PRODUCER

BACKGROUND OF THE INVENTION

This invention relates to improvements in and relating to electronic watches fitted with an electronic sonic sound generator.

It is known to those skilled in the art that the watch movement and the sound generator are both electronically driven and energized from one and same battery. It was, however, very difficult to limit the contacting period of a switch which on-off-controls the sound generator and thus, the latter may operate, upon once started, for an excessively long time until the user becomes aware thereof and stops intentionally the operation. With such unintentionally longer operation of the sound generator acting as an alarm, the amount of energy consumption will amount disadvantageous to a considerable value.

In order to satisfy the above demands, a large capacity battery must be fitted at a certain place outside the watch casing, such as on the watch band. Or alternatively, in the case of a self-contained battery, of a relatively small capacity, the replacement thereof must be carried out in a short time period, for instance, once per month.

When an electromagnetically operating buzzer is used as the sound generator, a considerably large space for housing the buzzer must be provided within the watch casing, thereby further limiting the capacity of the drive battery. A further drawback encountered in this case, stray fluxes are issued from the electromagnetic buzzer which affects upon the operation of the electronic watch movement in the adverse direction against maintaining the precision of time-keeping motion thereof to a considerable degree. Provision of magnetic shielding means is rather difficult from the limited space conditions.

In place of electromagnetic buzzer, piezoelectric one has been used in the art. In this case, also, a limitation of the operational period thereof to 10 minutes or lesser is highly difficult and ineffective consumption of battery energy is again accompanied.

In order to generate efficient alarm sounds with minimum possible energy consumption in use of the piezoelectric buzzer, it is preferable to design the vibrating membrane to have a broader surface area and a smaller thickness as possible. With such design of the vibrating membrane, the bearing performance to a concentrated load will become inferior.

SUMMARY OF THE INVENTION

The main object of the present invention is to provide an electronic watch fitted with an electronically operated alarm device, with minimum overall current consumption.

This and further objects of the invention will appear from the following detailed description of the invention to be set forth by reference to the accompanying drawings illustrative of a preferred main embodiment of the invention, with addition of several partial modifications thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is an axial section of the electronic watch fitted with an electronic alarm, in its preferred embodiment.

FIG. 2 is a plan view of several parts employed when seen from inside of the watch towards a time-display dial, and on a slightly reduced scale.

FIG. 3 is a plan view of several main working parts of the watch and on a further reduced scale.

FIG. 4 is an axial section of the watch, showing certain modification from the foregoing main embodiment.

FIG. 5 is an inverted plan view of the watch shown in FIG. 4 and at a reduced scale wherein the rear cover has been removed from position for clear display of inner working parts.

FIG. 6 is an axial section of a further modification from the main embodiment.

FIG. 7 is a similar view to FIG. 5, showing a further modification.

FIG. 8 is a perspective view of a still further modification.

FIG. 9 is a part of an axial section of the electronic watch, showing a still further modification.

FIG. 10 is a wiring diagram of electronic parts contained in the main embodiment.

DETAILED DESCRIPTION OF THE INVENTION

In the following a preferred embodiment of the present invention will be described in detail by reference to the accompanying drawings.

Numeral 1 represents a watch movement in its entirety which includes a conventional pillar plate 2 to which a conventional battery unit 3, preferably a mercury battery, is detachably attached, said battery serving as an exclusive power source means of the watch movement 1. The battery unit 3 is fixedly mounted through an insulating board 4 on the plate 2.

Numeral 5 represents an elongated pressure spring which is fixedly attached at its both ends by means of set screws 5a and 5b to the plate 2, thereby the battery unit 3 being elastically pressed against the board 4 from upper.

Numeral 6 represents a conventional time-keeping drive circuit block constituent of the whole electronic watch assembly, generally shown at 100, all the constituent parts of said block being moulded into a resin block as conventionally. This block 6 is adapted as conventionally for driving electromagnetically a drive balance wheel 8a and fixedly, yet detachably mounted on the plate 2 by means of set screws 6a, 6b and 6c. Further, the circuit block 6 is electrically connected by suitable leads, not shown, with battery 3 and plate 2, although not shown by virtue of very popularity.

Numeral 8 represents a conventional time-keeping gear train block, only schematically by the outline of its occupying space in the watch movement, said gear train being operatively connected with said drive balance wheel 8a, for being driven thereby as conventionally, although not specifically shown.

The gear train block 8 is arranged between bridge means 8e; 8f and the plate 2, said bridge means being fixedly attached by several set screws 8b, 8c and 8d to the plate 2. Thus, these circuit block 6 and gear train block 8 are included in the electronic watch assembly 100.

Numeral 9 represents an electronic circuit for a sound generator 101, including transistors, condensers

and resistors, as will be described later by reference to FIG. 10. These circuit elements are moulded into a block 9a. The circuit comprises further a coil 9b wound on a ferrite core 9g, so as to minimize stray fluxes emanating therefrom.

Coil 9b is electrically connected with a piezoelectric or magnetostrictive element, thereby the output voltage from the block 9a being adapted for use at the element 25. The circuit block 9 is detachably attached to the plate 2 by means of set screws 9c and 9d.

Numerals 10 represents a conventional time-display dial, made of an insulating material and carrying concentrically and fixedly a conductive ring 10a on the inner surface of the dial. When necessary, this ring 10a formed by the print circuit technique.

The battery support 4 is centrally bored at 4b and a resilient contact 4a kept in conducting relationship with said ring 10a is housed in the bore 4b. Numeral 11 represents a conventional cannon wheel which mounts in turn rotatably conventional unlocking wheel 12.

Numerals 13 represents unlocking wheel arbor spring the root end of which is fixed to a terminal 9e of the circuit block 9 by means of a set screw 13a, while the free end 13b of the spring 13 is kept in pressure engagement with cannon wheel 11, thereby urging the latter towards below when seen in FIG. 1. The spring 13 is formed substantially at its central portion of its whole length, integrally with a rounded projection 14 kept in pressure contact with the conductive ring 10a.

Three projections 11a are formed on the cannon wheel 11 at mutually different radial lengths, while three perforations 12a are formed through the cannon wheel 12 in correspondence to said three projections 11a.

Numerals 40, 41 and 42 are gear wheels meshing one after another in succession, which constitute in combination an intermediate transmission gear train constituting part of an alarm presetting device 102. Gear 40 meshes with unlocking wheel 12, while gear 41 meshes with a gear 42 which is fixedly attached to unlocking wheel arbor or stem 43 which can be manually operable. Numeral 45 represents a regular winding and time-setting stem.

To the unlocking wheel 12, a conventional unlocking or alarm-presetting hand 14 is fixedly attached as conventionally.

Numerals 44 represents a conventional minute wheel which is kept in meshing with a known cannon pinion 17 having a minute hand 16 fixedly attached thereto and with cannon wheel 11 having an hour hand 15 fixedly attached thereto. In this way, cannon wheel 11 performs a complete revolution per 12 hours.

By manual rotation of the unlocking stem 43 for pre-setting a certain alarm time, motion is transmitted therefrom through intermediate gear train 42, 41 and 40 to unlocking wheel 12 to the position corresponding to the desired alarm time point. With rotation of the cannon wheel 11 through the action of time-keeping gear train 8 and at arrival of the preset time point, the projections 11a on cannon wheel 11 will be brought into registration with the openings 12a of unlocking wheel 12, thereby the former wheel 11 being urged to move axially downwards in FIG. 1 under the action of unlocking spring 13. In this way, curved downward projection 13c of unlocking spring 13 is brought into pressure contact with conductive ring 10a. Thus, alarm pre-

setting device 102 comprises aforementioned several parts 12, 13, 40, 41, 42 and 43.

Numerals 18 represents a case band which defines mainly a large inside space 18b housing all the working parts of the watch-and-alarm device. A crystal glass cover 19 is attached to the case band by means of a tension ring 19a for defining the lower limit of the space 18b in FIG. 1. Numeral 20 represents a middle frame fixedly attached to the case band, although the fixing means have been omitted from the drawing on account of its very popularity.

Numerals 21 represents a water-proof sealing ring arranged between members 20 and 22 under pressure. The member 22 constitutes a support ring having an upwardly projecting cylindrical projection 22a onto which the outer marginal ring area of a vibrator membrane 24 is fixedly attached by glueing or the like attaching means. The support ring 22 is formed with an inwardly projecting tongue 22b which is fitted with two separated insulator sleeves 23a, each of the latter holding therein a conductive pin 23. In FIG. 1, only one set of pin-and-sleeve unit 23; 23a is shown.

Onto the backside of the membrane 24, a piezoelectric or magnetostrictive element 25 is fixedly attached by glueing or the like conventional attaching means. Although only one is shown in FIG. 1, two leads 26 extend from the both electrodes of the element 25 to the conductive pins 23, respectively.

Circuit block 9 has two spring terminals 9f. When the block 9 and its support ring 22 are assembled together and arranged in position, these spring terminals 9f are kept in contact with said conductive pins 23, respectively.

Numerals 27 represents a rear cover, having a number of sounds-delivery perforations 27c for discharge of sounds generated by the vibratory membrane 24 when energized in the manner to be described. Rear cover 27 is formed with male threads 27e on its outer peripheral surface and kept in screw engagement with corresponding female threads 18a on case band 18, so as to maintain several related members 20, 21 and 22 in position.

In FIG. 4, a slight modification of the foregoing embodiment is shown. This modification aims at easier exchange of the battery.

In FIG. 4, 3'; 24'; 25' and 27f represent a battery; vibratory membrane; piezoelectric element and middle frame, respectively, which perform similar respective functions of the corresponding members in the foregoing embodiment. The battery 3' is attached detachably to the watch movement 1' only schematically shown.

The membrane 24' is attached sealingly and tightly at its peripheral area to the middle frame 27f, as before. The piezoelectric element 25' is attached fixedly to the membrane 24' as before. Thus, the combination of these members 24'; 25' acts as an electro-mechanical converter for sound generation, when fed with electrical signals from the electronic sound generator drive circuit 101 to be described, thereby the membrane 24' being brought into oscillation at an audio frequency. The resulted audible sound will be discharged through a discharge opening or openings 27c' formed between the case band 18' and rear cover 27' into open atmosphere. The rear cover is attached to the case band in such a manner that it is spacially separated from membrane 24' and middle frame 27f.

A female threaded ring 27h is fixedly attached to middle frame 27f by pressure fit or the like means, and extends into an opening 105 perforated through rear cover 27'. A battery cover 27g is driven threadably with the female ring 27h through said opening 105 for positively holding the battery 3' in position relative to the watch movement 1'. Therefore, by dismounting the cover 27g from position, the battery 3' can be exchanged without opening the rear cover 27'.

In this modification, the membrane 24' takes a non-circular and irregular shape as shown in its plan configuration in FIG. 5, for avoiding otherwise caused troubles as met in the battery exchange job. By adopting such modified arrangement and configuration of the membrane 24', the structural density of the watch can be further improved without substantial loss of the effective area of the membrane.

By adopting the eccentric arrangement of the membrane 24' as shown in FIG. 5 for avoiding interference with the battery and its cover, the alarm unit can represent a directional performance in combination with the directionally arranged sounddissipating opening or openings 27c'.

In a further modification not shown, the membrane 24', when desired, may take the form of a concentric ring.

Still a further modification is shown only schematically in FIG. 6, in which the directional sound discharge performance is again realized.

In this modification, 1'' represents a watch movement; 3'' a battery; 18'' a case band; 24'' a vibratory membrane; 25'' a piezoelectric element; 27f' a middle frame. The relative arrangement can be easily seen from FIGS. 6 and 7 by consultation with the foregoing description of the main embodiment shown in FIGS. 1 - 3.

By adopting this modification, an efficient waterproofness can be guaranteed for the watch movement 1''.

When the number of the sound dissipating openings 27c' or 27c'' is reduced one and this sole opening is arranged to direct in the direction of nine o'clock, the directional performance will be highly shaped and accentuated. Since the watch wearer carries his watch or his left hand, this directional arrangement would be rather convenient for the wearer. In the arrangement shown, eight openings 27c'' are provided so as to cover an angular range from 7 - 11 o'clock.

In FIG. 8, a still further modification is shown in which sound dissipation opening are united at 27c''' into one which opens towards one end of a watch band 106, said end being in opposition to the other end 18c and positioned in close proximity to a side projection 18''' of the case band. The sole sound dissipation opening 27c''' is substantially hidden by the side projection 18''' and the corresponding end, not shown, of the watch band 106. Thus, the ornamental design of the watch is not adversely affected in spite of the advantageous directional alarm sound dissipation performance thus obtained. Rear cover of the watch is shown also with 27'' as before.

In a still further modification shown in FIG. 9, the alarm sound dissipation is directed towards the upper or crystal side of the watch. The crystal is shown at 19'' in FIGS. 6 and 9, while it is shown at 19' in FIG. 4.

As shown, one or more sound dissipation openings 27c''-a open to the open atmosphere in close proximity

of the outer periphery of the crystal 19'', said opening 27c''-a leading through a passage duct 27c''-b provided axially through the case band 18'' to a resonance space 27c''-c formed between the vibratory membrane 24'' and the rear watch cover 27''.

In the following, the electronic drive circuit 101 will be described by reference to FIG. 10.

The electronic watch assembly per se, shown at 100, is connected through a main switch 50 to the battery 3 for being fed with voltage therefrom.

51 represents an alarm time presetter circuit, while 52 shows an alarm oscillator circuit and 53 represents a buzzer. The sound generator 101 comprises these constituents 51, 52 and 53, and is electrically connected to the same battery 3 in parallel to the circuit 100. Thus, the both circuits 100 and 101 are powered from the one and same battery 3.

54 represents an alarm stop switch; 55 an unlocking or alarm start switch which is closable upon controlled by the device 100 preset beforehand to a certain preselected time point when it arrives.

In the foregoing embodiment shown in FIGS. 1 - 3, the alarm start switch 55 is on-off controlled by the on-off operation of the unlocking spring 13 relative to the conductive strip ring 10a.

Alarm oscillator circuit 52 comprises basically an astable multivibrator.

This circuit 52 includes NPN transistors 56; 57, three resistors 58 - 60, voltage-elevating coil 61 and condensers 62; 63 which are connected mutually as shown.

The circuit 51 comprises resistor 64, condenser 65, transistor 66, resistors 68; 68' and further transistor 67 which are connected mutually as shown. This timer circuit 51 operates with the time constant which is determined by the combination of resistor 64 and condenser. The output side of this timer circuit or more specifically the collector electrode of transistor 67 is connected to the base electrode of either transistor 56 or 57 of the next stage circuit 52, for control of the alarming period.

In the present embodiment, the member 3 is a mercury battery of 1.3 volts. Resistor 64 is of 1 Mohm; condenser 65 is of 1 μ F. The alarm operation period of the circuit 51 can be set to about 1 - 2 seconds as an example.

The operation of the embodiment is as follows:

When main switch 50 is closed by manipulation of a manually operable member such as that shown at 45 from outside, the electronic watch assembly 100 is caused to start as is known commonly, for initiating the stepping motion.

When the watch bearer desires to deliver audio alarm signal at a predetermined time point, the unlocking wheel 12 is preset thereto by manipulation of unlocking stem 43, as was referred to hereinbefore. In this way, switch 54 is kept at its closed state.

When the predetermined time point arrives, switch 55 is caused to close. By the closure of this switch, the device 101 is caused to operate instantly and the membrane 24 is brought into its vibrating state, thereby alarm sounds being dissipated.

In the conventional watch alarm, the alarm operation will be caused to continue so far as the alarm switch is kept in its closed state, if not the alarm stop switch 54 is manually opened by the user.

The closing period of switch 55 is highly difficult to shorten it less than 10 minutes, provided that the on-off

operation is controlled by a gear wheel which performs a complete revolution per 12 hours, and indeed, with a positive and reliable conductingly switching operation.

When a current of 5 mA necessary to operate the buzzer 53 at least for 10 minutes and if the alarm operation takes place twice per day, the monthly current consumption will amount to 50 mAH is worst case. Since the mercury battery as used for electronic watch has only a capacity of 150 - 200 mAH, it will be consumed up within 3 - 4 months, when assuming the watch drive energy per month amounts monthly to 7 mAH. In comparison with the above conventional alarm watch arrangement, the battery exchange period can be extended to nearly two years with use of the above disclosed inventive arrangement and by use of a battery of 200 mAH capacity.

When alarm stop switch is closed, condenser 63 is charged positively when seen from the side of coil 61. When the predetermined time point arrive, unlocking switch 55 is closed and transistor 57 turns initially to "on," because the resistor 60 has a larger resistance value than that of the resistor 59 and on account of the above mentioned charging condition at 63. In this way, a drive current for the operation of buzzer 53. The base-emitter voltage at transistor 56 will be increased, depending upon the time constant as determined by the combination of both elements 60 and 63. At the same time, condenser 62 is charged positively when seen from the side of resistor 58.

With the transistor 56 turned on, the base-emitter voltage at 57 drops suddenly, and finally becoming off.

Under these conditions, the base-emitter electrode at 57 will rise up gradually, depending upon the time constant as determined by the combination of both elements 59 and 62.

At this stage, condenser 63 is charged positively when seen from the coil 61.

With the transistor 57 turned on, the base-emitter electrode at 56 will suddenly be caused to drop and finally becomes "off."

By repeating the above operation, current will flow through the coil 61 each time when the transistor 57 turns on, thereby oscillation being performed at about 5 kHz.

Buzzer 53 will continue to operate on account of this oscillation.

On the other hand, when the switch 55 is closed, the transistors 66 and 67 are off at first, while condenser 65 is gradually charged up and the base voltage 66 will gradually rise up until it turns on. This period amounts generally to about 1 - 2 seconds as was referred to hereinabove. Therefore, transistor 67 will become on.

Then, current will flow through resistor 59, the base end of transistor 57 and the collector-emitter passage of transistor 67 and thus, the base voltage at 57 will drop and the transistor 57 will be always off. Thus, the buzzer 53 will stop its alarming operation. In this way, the above state will continue until the unlocking switch 55 is again opened.

Under these conditions, dark current will flow through transistors 67, 66 and 56. However, this dark current, 0.1 mA or so, is very small in comparison with the operation current, say 5 mA, flowable through coil 61 and transistor 57.

It will easily occur to any person skilled in the art, that the drive balance wheel can be replaced by a tuning fork, quartz oscillator or the like equivalent oscillator means.

The embodiments of the invention in which an exclusive property or privilege is claimed are as follows:

1. In an electronically powered watch having a watch casing, a dial attached to one side of said casing, an electronically powered watch movement located within said casing and connected to indicating means on the external side of said dial to indicate the time, an electronic alarm oscillator circuit located within said housing, an alarm switch coupled to said oscillator circuit and controlled by said indicating means, means actuable from externally of the watch casing to adjust the time of closing of said alarm switch, and a battery electrically connected to the watch movement and the alarm oscillator circuit, the improvements comprising:

- a. a middle frame attached to a side of said casing opposite said dial, said middle frame having a plurality of openings therethrough, one of said openings surrounding said battery;
- b. an irregular shape vibratory membrane attached to said middle frame so as to cover the unoccupied opening in said frame, said irregular shape vibratory membrane being located laterally adjacent to said battery;
- c. means attached to said vibratory membrane and electrically connected to said electronic alarm oscillator circuit so as to cause said membrane to vibrate and emit an audible sound upon an electric input from said alarm oscillator circuit;
- d. a rear cover attached to said case adjacent to said vibratory membrane and spaced therefrom, said rear cover having an opening therethrough coaxially with said battery to enable the removal of said battery therethrough, the junction of said case and said rear cover defining at least one radial discharge opening to allow passage of the audible sound therethrough; and
- e. a battery cover removably attached to said rear cover to close said opening therethrough.

2. The improved electronically powered watch of claim 1 wherein said means to oscillate said irregular shape vibratory membrane comprises a piezoelectric oscillator.

3. The improved electronically powered watch of claim 1 wherein said means to oscillate said irregular shape vibratory membrane comprises an electrostrictive oscillator.

4. The improved electronically powered watch of claim 1 wherein said irregular shape vibratory membrane is sealingly attached to said middle frame to prevent the passage of dust and moisture into said case.

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