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(54) SOLID STATE ELECTRONIC TIMEPIECE

(71) We, KABUSHIKI KAISHA SUWA SEIKOSHA, a Japanese company, of 3-4, 4-chome, Ginza, Chuo-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to solid state electronic timepieces.

According to the present invention there is provided a solid state electronic timepiece comprising: a display device, a time standard means for producing a standard time signal, electronic circuitry connected to receive the standard time signal and to produce timing signals to cause the display device to display a time indication, the display device, time standard means and electronic circuitry being mounted within a case body made of resin material, the time standard means and/or the electronic circuitry and/or the display device being completely or partially embedded within the resin material of said case body.

The timepiece may include a glass partially embedded in the case body.

The timepiece may further include a power source embedded within the case body.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:—

Figure 1 is a plan view of a conventional solid state electronic wrist watch;

Figure 2 is a cross-section of the conventional wristwatch of Figure 1;

Figure 3 is a cross-section of one embodiment of a solid state electronic timepiece according to the present invention;

Figure 4 is a cross-section of a second embodiment of a solid state electronic timepiece according to the present invention;

Figure 5 is a cross-section of a third embodiment of a solid state electronic timepiece according to the present invention;

Figure 6 is a cross-section of a fourth embodiment of a solid state electronic timepiece according to the present invention;

Figure 7 is a cross-section of a fifth embodiment of a solid state electronic timepiece according to the present invention;

Figure 8 is a cross-section of a sixth embodiment of a solid state electronic timepiece according to the present invention; and

Figure 9 is a cross-section of a seventh embodiment of a solid state electronic timepiece according to the present invention.

In Figures 3 to 9 of the accompanying drawings like parts have been designated by the same reference numerals.

Referring first to Figures 1 and 2, there is shown a conventional solid state electronic wrist watch comprising a watch case 11 on which is mounted a glass 12, the latter being retained in place on the watch case 11 by a bezel 13. A gasket 14 is disposed in contact with the watch case 11, the glass 12 and the bezel 13 to prevent water or moisture entering the interior of the wrist watch between the watch case and the glass. Electronic circuitry 16 and a display device 15, which is electrically connected to the electronic circuitry, are inserted into the watch case. A gasket 17 and a holding ring 19 are then inserted on the back of the watch case which is then closed by a back cover 18. The gasket 17 is provided to prevent water or moisture entering the interior of the wrist watch between the watch case and the back cover 18.

Because of the number of component parts of this conventional wrist watch, it takes a relatively long time to assemble and it is, therefore, difficult to manufacture it at low cost. Further, since the electronic circuitry 16 and/or the display device 15 are badly affected by moisture, it is necessary to make the wrist watch waterproof by providing the gaskets 14, 17. However, the provision of the gaskets 14, 17 increases the number of component parts of the wrist watch and this, in turn, results in some difficulty in effective quality control during manufacture. Moreover, in this conventional wrist watch, the watch case 11 is made of metal and thus the advantage of lightness in weight resulting from the use of the electronic circuitry 16 is reduced. Furthermore, the rela

tively complicated shape of the watch case 11 makes it difficult for it to be machined from metal and consequently the design of the watch case is limited. Even if the watch case is of a design which can be machined, mass-production is difficult. Furthermore, any plating applied to the watch case 11 for the prevention of rust or other corrosion must be gold or white in colour.

One embodiment of a solid state electronic timepiece, for example a wrist watch, according to the present invention is shown in cross-section in Figure 3. A time standard device 22, for example, including an oscillator, is sealed in a case body 21 made of resin material and is electrically connected to electronic circuitry 23 by means of terminals 22*a* and 22*b*. In this embodiment a power source such as, for example, a battery is not shown. The time standard device 22 produces a standard time signal which is received by the electronic circuitry to produce timing signals. In the case body 21 there is a recess 21*a* in which the electronic circuitry 23 is housed, the latter being fixed to the body by means of a projecting flange 23*a* provided on the electronic circuitry, a screw-threaded pin 24 sealed or embedded in the case body 21 and a screw 25 in engagement therewith. The timepiece may have any desired exterior shape and in the embodiment illustrated in Figure 2 has a flat 21*b* provided thereon. Therefore, in this timepiece the case body 21 together with a back cover 30, a glass 27 and a bezel 26 form the exterior surfaces of the timepiece. The glass 27 is retained in place on the case body 21 by the bezel 26, a sealing gasket 29 being disposed in contact with the body, the glass and the bezel to prevent water or moisture entering the interior of the timepiece between the body and the glass. A display device 28 is electrically connected to the electronic circuitry 23 *via* a connecting device 28*a* to receive the timing signals from the electronic circuitry so that the display device displays a time indication in a manner such as that shown in Figure 1. Between the back cover 30 and the case body 21 there is a gasket 31 and a holding ring 32. The gasket 31 is provided to prevent water or moisture entering the interior of the timepiece between the back cover 30 and the case body 21.

If the timepiece is rectangular in plan, the bezel 26 may also be made of resin material so that its water-tightness with the body is more effective and its appearance, having regard to the body, is more harmonious. As the back cover 30 may be in direct contact with the user of the timepiece, in the case where the latter is a wrist watch, it is preferably made from an anti-corrosive resin material or metal. The electronic circuitry 23 may include conventional correcting means (not shown) for correcting the time indication displayed by the display device 28 and also an operating switch or switches (also not shown).

In place of the pin 24 and the screw 25, the electronic circuitry may be fixed to the case body 21 by melting some of the resin material of the latter. Alternatively, a hole may be provided in a flange of the case body and a pin passed through the hole to retain the electronic circuitry in position within the case body.

In this embodiment, the time standard device 22 is embedded in the resin material of the case body, so that it is unaffected by moisture and means for fixing the time standard device to the case body are, therefore, unnecessary. Furthermore, not only is the electronic circuitry 23 mounted on the body 21, the latter has a surface 21*d* which engages the bezel 26 to maintain it in position, and screw-threads 21*c* onto which the back cover 30 is screwed to maintain it in position.

In addition, the electronic circuitry 23 can be removed relatively easily for repair or replacement by merely undoing the screw 25. Furthermore, as there is no metallic watch case, the weight of the timepiece may be minimised so that the timepiece is relatively light in weight. As the body can be made in a conventional injection molding machine, it can have any desired shape. The case body 21 can also have any colour by making it from a resin material of the desired colour. Indeed, the case body 21 may have a multicoloured design by making it using a conventional multicolour injection molding machine. The timepiece illustrated in Figure 3 may, therefore, be mass produced in a variety of designs.

A second embodiment of a solid state electronic timepiece, for example a wrist watch, according to the present invention is shown in Figure 4. In this embodiment, the electronic circuitry 23 is embedded in the resin material of the case body 21. The electronic circuitry 23 is electrically connected to a battery 42 by a positive terminal 43*a* and a negative terminal 43*b*. The time standard device 22 is fixed to the body by means of a fixing plate 44 and a screw 45. As the electronic circuitry 23 is particularly susceptible to moisture, in this embodiment the electronic circuitry is protected against contact with moisture so that a relatively more stable and highly accurate timepiece can be obtained.

A third embodiment of a solid state electronic timepiece, for example a wrist watch according to the present invention, is shown in Figure 5. In this embodiment, the display device 28 is partially embedded in the body 21 and the electronic circuitry 23 in-

cluding the time standard device (not shown) is detachably fixed to the case body 21 by means of screws 54, 55 and pins 56, 57 respectively which are partially embedded in the case body. Existing display devices are comparatively short-lived, so that they need to be exchanged fairly frequently. In this embodiment, the case body 21 and the display device 28 can be replaced as a whole merely by undoing the screws 54, 55, removing the electronic circuitry 23, and further removing the bezel 26 and the glass 27. It is, therefore, possible to replace the case body 21 and the display device if the latter has failed or, if the display device is still functioning, it is possible to rework the exterior of the case body 21 so that it looks new in appearance. It is also possible to exchange the case body 21 with one of another shape or design to suit the taste of the user.

In the embodiment shown in Figure 5 the time standard device 22 and the battery 42 are not shown.

A fourth embodiment of a solid state electronic timepiece, for example a wrist watch, according to the present invention, is shown in Figure 6. In this embodiment, the time standard device 22 and the electronic circuitry 23 are both embedded in the resin material of the case body 21, but not the display device 28 and the battery 42. Therefore, the display device 28 and the battery 42, both of which have a relatively short life, can be easily removed for repair or be replaced, so that the timepiece can be assembled or repaired fairly easily. On the other hand, the electronic circuitry 23 and the time standard device 22, which rarely need replacement, are embedded in the resin material of the case body 21 to reduce or prevent them being affected by moisture. Thus this timepiece is of relatively great stability.

A fifth embodiment of a solid state electronic timepiece, for example a wrist watch, according to the present invention is shown in Figure 7. In this embodiment, the display device 28 and the glass 27 are partially embedded in the resin material of the case body 21. As with the solid state electronic timepiece illustrated in Figure 5, if the screws 54, 55 are undone, the electronic circuitry 23 may be removed so that the display device, which has a relatively short-life can be replaced when it fails together with the case body in which it is embedded. If the glass 27 becomes cracked or otherwise damaged or if the case body 21 is damaged, they too may be replaced in a similar manner. The time standard device is not shown in Figure 7.

A sixth embodiment of a solid state electronic timepiece, for example a wrist watch, according to the present invention is shown in Figure 8. This embodiment is similar to the solid state electronic time piece of Figure 6 except that the display portion 28 and the glass 27 are partially embedded in the resin material of the case body 21 and no bezel is provided. In this embodiment, the battery 42 can be replaced relatively easily upon removal of the back cover 30. It is not uncommon for a battery to leak and this is apt to cause trouble. However, in this timepiece any fluid leaking from the battery 42 will accumulate in a space 42*a* around the battery and so will not affect operation of the other component parts of the timepiece. Furthermore, although the electrical connection between the electronic circuitry 23 and the display device 28 is usually effected by a relatively large number of terminals, in this embodiment, however, the electronic circuitry 23 and the display device 28 can be directly connected electrically so that the number of component parts is further reduced and the timepiece has relatively good reliability. The time standard device is not shown in Figure 8.

Finally, a seventh embodiment of a solid state electronic timepiece, for example a wrist watch, according to the present invention is shown in Figure 9. In this embodiment, the electronic circuitry 23, the glass 27 and the display device 28 are embedded at least partially in the resin material of the case body 21. Accordingly, the timepiece is complete protected against the ingress of moisture. If any defect occurs in any of the component parts, or if the battery expires, the user can immediately exchange the timepiece at a watch store with another one. Further, owing to the reduction in the number of component parts as well as in the reduction in assembly time, the manufacturing costs may be reduced to an extent that a user may well buy a new timepiece, instead of exchanging the non-functioning timepiece. This is in line with the present trend of discarding a timepiece after it has been used for a long period. The time standard device is not shown in Figure 9.

The solid state electronic timepieces described above represent a break from conventional timepieces and show that solid state electronic timepieces having no mechanical moving parts and that satisfy all requirements of performance, price as well as design, may be manufactured.

In some, if not all, of the embodiments of the present invention described above, the back cover 30 may, if desired, be sealed by resin material to the case body 21.

The case body 21 may be made from a plastics resin or a silicon resin both of which have superior injection molding characteristics and superior electrical insulating characteristics. In order to improve

the strength or hardness of the resin material, it is preferable to use a resin material to which a strengthening or hardening agent is applied. Other materials, such as jewels, shells, resins, minerals, etc. may be included in the resin material for appearance or strength and the whole or part of these other materials may be visible on the exterior of the timepiece to give a particular design effect.

WHAT WE CLAIM IS:—

1. A solid state electronic timepiece comprising: a display device, a time standard means for producing a standard time signal, electronic circuitry connected to receive the standard time signal and to produce timing signals to cause the display device to display a time indication, the display device, time standard means and electronic circuitry being mounted within a case body made of resin material, the time standard means and/or the electronic circuitry and/or the display device being completely or partially embedded within the resin material of said case body.

2. A time piece as claimed in claim 1 including a glass partially embedded in the case body.

3. A timepiece as claimed in claim 2 including a power source embedded within the case body.

4. A solid state electronic timepiece substantially as herein described with reference to and as shown in any one of Figures 3 to 9 of the accompanying drawings.

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