

SPECIFICATION

Electronic wrist watch and process of casing this watch

5 Patents CH 608 325 and 609 828 describe electronic wrist watches, the module of which is protected against external influences by a liquid which occupies the inner space of the case. The presence of a
10 liquid in the environment of the electronic module of a wrist watch is known to constitute a protection against shocks, on the one hand, and against oxidation, on the other hand. Another factor which plays a particularly important part and which tends
15 to preserve the operating qualities of an electronic watch when the time-standard of this watch is a quartz is the fact that the liquid also constitutes a protection against the gradual penetration of air into the interior of the capsule of the quartz.

20 The production of an electronic wrist watch, the module of which bathes in a liquid, poses the problem of the expansion of this liquid in case of increase of the temperature, or more exactly, at the time of a differential variation of the volume of the
25 liquid relative to the volume of the case under the effect of a temperature variation.

It is an object of the present invention to provide a new solution better adapted than the known solutions to the requirements of practice, taking into
30 account the specific conditions resulting from the thermal expansion of the liquid.

According to the present invention there is provided an electronic wrist watch with hands or with static display, comprising a case and an electronic
35 module housed in the case and bathing in a liquid, characterized in that the said liquid is, at the normal ambient temperature, at a pressure lower than the atmospheric pressure.

The invention also extends to a process of casing a
40 watch as defined above, characterized in that for putting the liquid under negative pressure in the case, the latter is cooled from a predetermined temperature to the ambient temperature while keeping it closed, the case having been entirely filled
45 beforehand with the liquid, and the case and the liquid having been raised to the said predetermined temperature.

Several embodiments of the watch according to the invention will be described below, by way of
50 example, referring to the sole figure of the appended drawing, which is a partial axial sectional view of this watch.

The watch depicted in the drawing comprises an electronic module 1. It is a module of the type having
55 a display with hands which is concerned. It therefore comprises, for example, a stepping motor (not depicted) which drives a wheel-train actuating the moving parts 2 and 3 respectively bearing a minute-hand 4 and an hour-hand 5. These hands move
60 above a dial 6 which is fixed on the module 1. The latter contains a battery (not depicted) which plays the part of a current source. Possibly, a panel may be provided for collecting solar energy. The constituting of this module is of a completely usual type. As a
65 variant, the module 1 might also be replaced by a

module of the digital-display type with liquid crystal, with luminescent diodes, with electrochromic elements, or operating according to any other system.

The case depicted in the drawing comprises a first
70 part designated by 7, which is formed by a glass 8 and a caseband 9, and a second part 10 which forms the back of the case. The caseband 9 is cemented along the periphery of the lower face of the glass 8. It is a matter of an arrangement which permits this
75 caseband to be made of a material such as synthetic stone, a ceramic, etc.

The back 10 includes a flat piece 11, preferably of metal, with a recess or groove 12 in its inner face which serves to accommodate a gasket 13 supporting a movement-holder frame 14. A maintaining ring
80 15, disposed between the glass 8 and the fillet 16 of the module 1, holds the latter in place.

Of course, the shape of the watch described is not limited to a circular shape. The watch may as well be
85 of rectangular, square, oval, rounded-side, etc. shape.

The central part of the piece 11 presents, in its inner face, a recess 17, the bottom of which is flat. Moreover, in the vicinity of the periphery of this
90 recess, a groove 18 may be contrived. At the time of the fabrication of the back, there is placed in the recess 17 a thin diaphragm 19 of plastic material which is cut out in such a way as to lie exactly flat on the bottom of the recess 17. This diaphragm is
95 cemented along its periphery on the inner face of the back. In the embodiment depicted, the gasket 13 is made in one piece with the diaphragm 19, of which it forms the outer rim.

Thus, the watch case described comprises a
100 composite portion which constitutes the back and is composed of the rigid part 10 and of the diaphragm 19 joined to the part 10 by its periphery. This diaphragm may be of an elastically deformable material or of a flexible material. Thus, in the case
105 where it is lying flat against the inner face of the part 10, a diaphragm 19 of flexible material can move away from the inner face of the back at the time the liquid is put under negative pressure, the mass of air occluded between the part 10 and the diaphragm
110 then expanding as a function of the reduction of pressure which is imposed upon the liquid.

It will now be described how casing takes place:

The module 1, equipped with the dial and the hands, is mounted inside the part 7 of the case, after
115 which the back 10, equipped with the diaphragm 19 which is laid flat in the recess 17, is placed on the periphery of the caseband 9 with interposition of the gasket 13. The corresponding seats of the two parts rest one upon the other. The whole is placed in a negative pressure chamber which contains a transparent and inert insulating liquid, e.g., glycerin, a silicone, etc. The choice of this liquid will be determined by the properties which it must present, and which result from the functions it must fulfill, as
120 will be seen below. Before the back is tightened, the chamber which contains the liquid and the watch is closed, and the interior of this chamber is put under negative pressure, by means of a vacuum pump, for example. It is easily realized that as the pressure
125 falls, the air contained in the inner spaced of the case

escapes little by little while raising the back 10 slightly, so that the liquid penetrates into the case. The pressure is reduced thus to a suitable value, which may reach, for example, 20 millibars, or about

5 15 mm Hg. Now, at this negative pressure, the air which remains contained between the diaphragm 19 and the piece 11, and the mass of which is proportioned by the volume of the groove 18, expands, so that the diaphragm 19 rises and occupies part of
10 the volume left free between the back 10 and the module 1.

By way of example, if the surface covered by the diaphragm 19 attains, for example, 200 mm² and if the total volume of the space between diaphragm
15 and back is on the order of 1 mm³, an average rising of the diaphragm 19 attaining 25/100 mm is going to correspond to a freed volume on the order of 50 mm³. Thus, the expansion of the air contained originally in the groove 18 may attain 50 times its
20 initial volume, which corresponds to a reduction in pressure of 98% and, consequently, to an absolute pressure of 20 millibars. The watch is then practically under vacuum.

The air having been entirely exhausted from the
25 inner space of the case by putting the chamber under vacuum, it then suffices to re-establish the pressure in the vacuum chamber, preferably by pressing on a valve which is generally provided for in the bottom or the glass. The liquid outside the
30 case ensures the compression of the back against the caseband 9. The screws 20 can then be locked.

A usual round back will be locked by manipulation from the outside in the chamber which is under vacuum, within the liquid. It will also be noted that
35 the part ensuring the closure will not always be the back. The glass may also play this part, as in the so-called "Vacuum" watches already known. An exhaust-valve, of the non-return valve type, may also be provided for.

40 It is realized that in case of temperature variations, the variations in volume of the liquid which fills the inner space of the case are going to cause variations of the volume enclosed by the diaphragm 19. The negative pressure therefore varies slightly. A watch
45 is obtained, the inner space of which is maintained at negative pressure but is occupied by a liquid. These conditions ensure the maximum of reliability for an electronic watch, especially for a quartz watch.

If need be, the groove 18 might be eliminated, the
50 quantity of air which remains enclosed between the back and the diaphragm 19 at the time the latter is put in place being sufficient to ensure the expansion of the deformable enclosure.

One may also go about it otherwise for effectuating the casing, avoiding the use of a device allowing
55 a high vacuum to be caused within a chamber containing the liquid. After the two parts of the case have been placed inside a chamber containing the liquid, and the air has been completely exhausted from the inside of the case, the whole of the liquid contained in the chamber may be heated, up to a temperature on the order of 60 to 80°, for example. The mass of liquid contained within the case is therefore going to undergo a thermal expansion,
60 and part of this mass is going to leave the case.

During this operation, care will be taken to exert between the two parts of the case a regulated force tending to keep the case closed, while permitting the evacuation of the surplus liquid under the effect of
70 the expansion. For that purpose, the two parts of the case may be placed one upon the other, and provision may be made for causing a weight or a spring to act upon the part situated above. Once the entirety of the liquid in which the case and the
75 module are bathing has been brought to the required temperature, it will suffice to allow cooling. The presence of the weight or of the spring which compresses the two parts of the case one against the other will prevent the liquid from re-entering the
80 case, so that upon cooling, the negative pressure required will be set up spontaneously. The exhaustion of the air out of the case may also be ensured before the heating of the enclosure without using a vacuum pump. Thus, the case containing the module
85 can be filled with the liquid by immersing the case in a fluid-tight chamber containing a mass of the liquid. The liquid presents a free level above which a residual mass of air is present. After the chamber has been closed, a fuel is caused to burn
90 within this mass of air in order to bind the oxygen from the air, according to the principle described in the patent CH 533 832.

Other embodiments are also possible. A part which is deformable under stress, instead of being
95 constituted by the diaphragm 19 and the rigid piece 11, might also be constituted by a usual back and a small bag made of plastic material placed freely or fixed by any means between the back and the module. This bag would contain a small mass of air or another gas. In other designs, provision might be
100 made, for example, for a variable volume capsule constituted by a rigid tube, e.g., a tube in the shape of a circle segment, one end of which would be closed, whereas the other end would be open. A movable plug, e.g., a drop of mercury or a part of a solid material, would separate within this tube the zone constituting the variable volume capsule occupied by a small mass of gas and the outer portion communicating with the inner space of the case and
105 consequently occupied by the liquid which fills the case. A metallic back or a part constituting the glass, slightly deformable under the effect of the pressure, might also constitute a part deformable under stress, which maintains the negative pressure in the case.

115 In all these embodiments, the two casing processes described above are applicable.

If the battery is housed within the module 1, the change of battery necessitates the opening of the case, so that it is then necessary to re-establish the vacuum and, if need be, to replace the liquid lost at
120 each change of battery. As has been seen above, however, this operation is extremely simple to effect.

However, it has been found that it was advantageous to keep the battery in contact with the protective liquid. Indeed, the losses due to the influence of the ambient atmosphere are then reduced. As a result, the watch described ensures a longer running time of the battery than what has
125 been known until now. Now, batteries are already

presently known which can ensure a running autonomy on the order of 6 to 7 years, so that, practically, any battery replacement can be dispensed with.

The properties which the liquid must present are principally the following: it must be transparent, insulating, chemically inert, of low volatility. Different liquids which meet these conditions are known, besides the silicones and glycerin, already mentioned.

On the other hand, if there is reason for allowing easy and frequent changes of batteries, it may likewise be provided for to place the battery in a housing separated from the inner space of the case, only this inner space being occupied by the liquid, whereas a separate cover gives access to the battery.

Finally, the realization described lends itself more particularly to designs in which the elements of the case are solid and rigid elements, i.e., elements of synthetic stone, of ceramics, of metal and/or of glass, or of sintered metallic or other compositions. Indeed, the great hardness of such materials is known to be accompanied by a very high resistance to deformation, so that the effect of the atmospheric pressure being exerted on the case does not entail practically any deformation.

CLAIMS

1. Electronic wrist watch with hands or with static display, comprising a case and an electronic module housed in the case and bathing in a liquid, characterized in that the said liquid is, at the normal ambient temperature, at a pressure lower than the atmospheric pressure.

2. Wrist watch according to Claim 1, wherein said case comprises at least two different parts and removable securing means securing said two parts to one another, characterized in that one of the said parts is lined internally with a deformable diaphragm connected fluid-tightly by its periphery to the said case part.

3. Wrist watch according to Claim 2, characterized in that the said diaphragm is initially laid flat against an inner face of the said case part, and in that the latter presents at least one recess so as to contrive a small mass of air occluded between it and the diaphragm, this small mass of air expanding at the time of putting the liquid under negative pressure.

4. Wrist watch according to Claim 1, characterized in that a small bag made of flexible material is disposed between the back of the case and the lower face of the module, and in that this small bag contains a small mass of air or of another gas which expands at the time of putting the liquid under negative pressure.

5. Wrist watch according to Claim 1, characterized in that the case contains a tubular rigid element containing a small mass of air or of another gas, closed at one end, and in which is accommodated a plug of a solid or liquid material capable of moving toward the open end under the effect of the expansion of the gas.

6. Wrist watch according to any one of the claims 1 to 5, characterized in that the parts of the case are

constituted or rigid elements of metal, of synthetic stone, of ceramics, and/or of glass.

7. Process of casing a watch according to Claim 1, characterized in that for putting the liquid under negative pressure in the case, the latter is cooled from a predetermined temperature to the ambient temperature while keeping it closed, the case having been entirely filled beforehand with the liquid, and the case and the liquid having been raised to the said predetermined temperature.

8. Process according to Claim 7, characterized in that, for filling the case containing the module with the liquid, the case containing the module is immersed in a mass of liquid in a fluid-tight chamber, the liquid presenting a free level above which a residual mass of air is present, then, after the chamber has been closed, a fuel is caused to burn within this mass of air.

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16

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The properties which the liquid must present are

- 5 principally the following: it must be transparent, insulating, chemically inert, of low volatility. Different liquids which meet these conditions are known, besides the silicones and glycerin, already mentioned.
- 10 On the other hand, if there is reason for allowing easy and frequent changes of batteries, it may likewise be provided for to place the battery in a housing separated from the inner space of the case, only this inner space being occupied by the liquid,
- 15 whereas a separate cover gives access to the battery.
- Finally, the realization described lends itself more particularly to designs in which the elements of the case are solid and rigid elements, i.e., elements of synthetic stone, of ceramics, of metal and/or of
- 20 glass, or of sintered metallic or other compositions. Indeed, the great hardness of such materials is known to be accompanied by a very high resistance to deformation, so that the effect of the atmospheric pressure being exerted on the case does not entail
- 25 practically any deformation.

CLAIMS

- 30 1. Electronic wrist watch with hands or with static display, comprising a case and an electronic module housed in the case and bathing in a liquid, characterized in that the said liquid is, at the normal ambient temperature, at a pressure lower than the atmospheric pressure.
- 35 2. Wrist watch according to Claim 1, wherein said case comprises at least two different parts and removable securing means securing said two parts to one another, characterized in that one of the said parts is lined internally with a deformable di-
- 40 aaphragm connected fluid-tightly by its periphery to the said case part.
3. Wrist watch according to Claim 2, characterized in that the said diaphragm is initially laid flat against an inner face of the said case part, and in that
- 45 the latter presents at least one recess so as to contrive a small mass of air occluded between it and the diaphragm, this small mass of air expanding at the time of putting the liquid under negative pressure.
- 50 4. Wrist watch according to Claim 1, characterized in that a small bag made of flexible material is disposed between the back of the case and the lower face of the module, and in that this small bag contains a small mass of air or of another gas which
- 55 expands at the time of putting the liquid under negative pressure.
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- 60 closed at one end, and in which is accommodated a plug of a solid or liquid material capable of moving toward the open end under the effect of the expansion of the gas.
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- 65 1 to 5, characterized in that the parts of the case are

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- 70 negative pressure in the case, the latter is cooled from a predetermined temperature to the ambient temperature while keeping it closed, the case having been entirely filled beforehand with the liquid, and the case and the liquid having been raised to the said
- 75 predetermined temperature.
8. Process according to Claim 7, characterized in that, for filling the case containing the module with the liquid, the case containing the module is immersed in a mass of liquid in a fluid-tight chamber,
- 80 the liquid presenting a free level above which a residual mass of air is present, then, after the chamber has been closed, a fuel is caused to burn within this mass of air.

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