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[54] **SEALED EVACUATED AND PRESSURIZED WATCH CASES**

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[51] **Int. Cl.** **G01l 19/12**

[58] **Field of Search** ..... 116/65, 70; 58/90 R, 50 R; 73/49.3, 406

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[57] **ABSTRACT**

A device for indicating the maintenance of a given vacuum or over-pressure in a sealed watch case comprises a hollow piston slidably mounted in a bore of a support member, one end of said bore communicating with a primary enclosure of the case and the other end of said bore being fluidtightly sealed off from said primary enclosure by means including a watch glass. A bistable metallic membrane is disposed within said hollow interior of the piston so as to define and fluidtightly separate two compartments, one of which contains a gas and the other of which includes an opening communicating the hollow interior with an outer face of said piston adjacent to said other end of the bore, said other compartment containing an opaque liquid, for example a brightly colored oil. The membrane is movable between two positions according to whether the pressure in the primary enclosure is above or below a limiting value, a first position in which the volume of said other compartment is such that no liquid is located between said outer face of the piston and said glass whereby said piston is visible through said glass, and a second position in which the volume of said other compartment is such that a quantity of liquid is disposed between said outer face of the piston and said glass whereby said piston is concealed.

6 Claims, 2 Drawing Figures

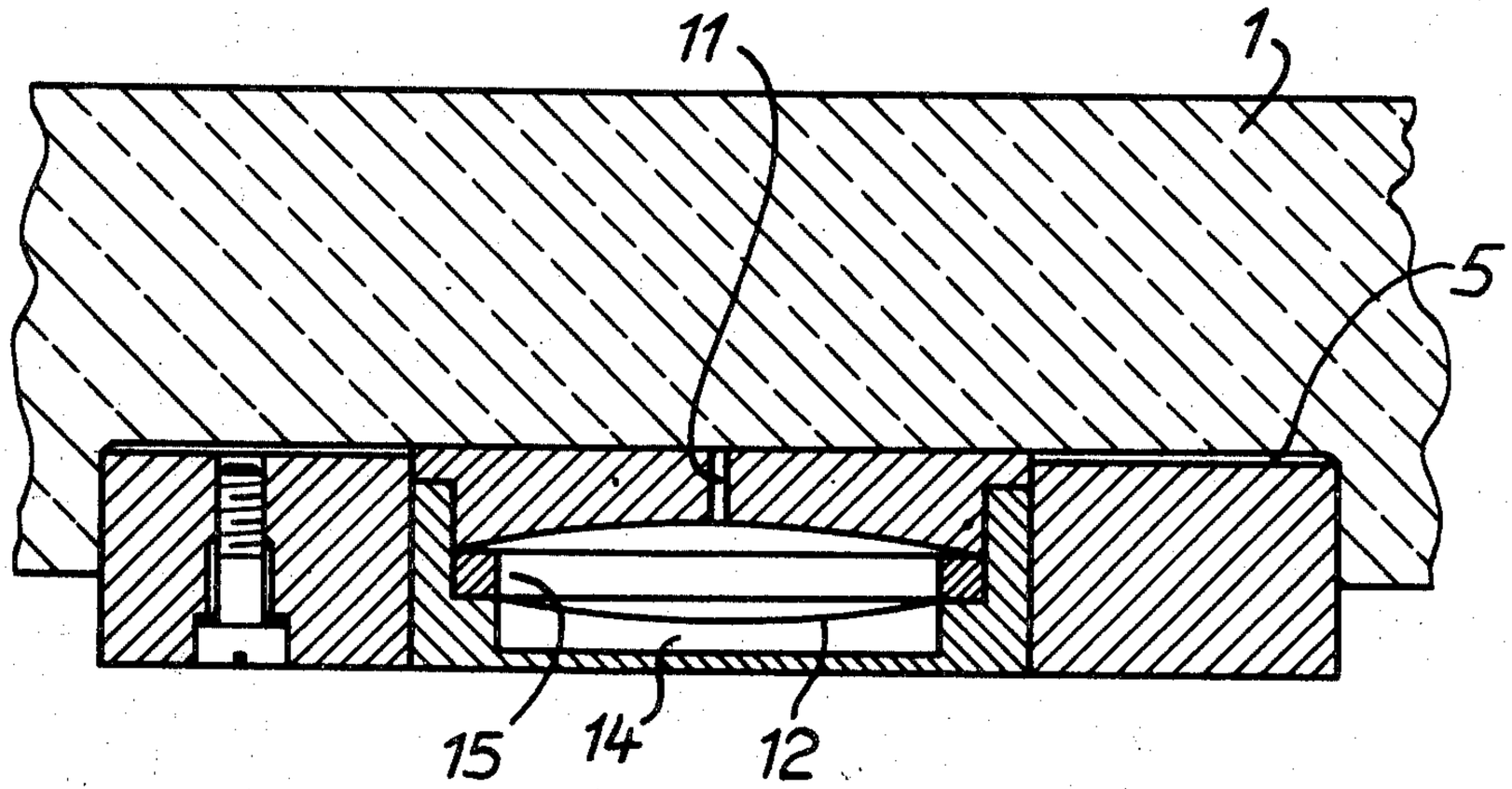
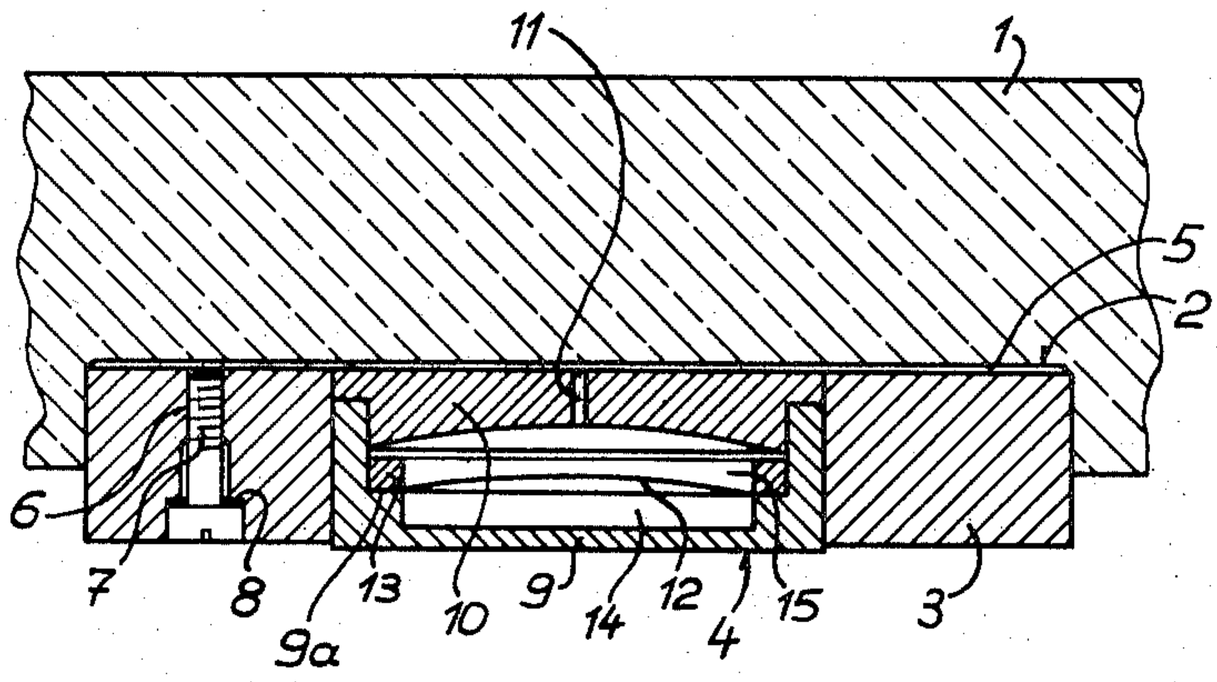


FIG. 1



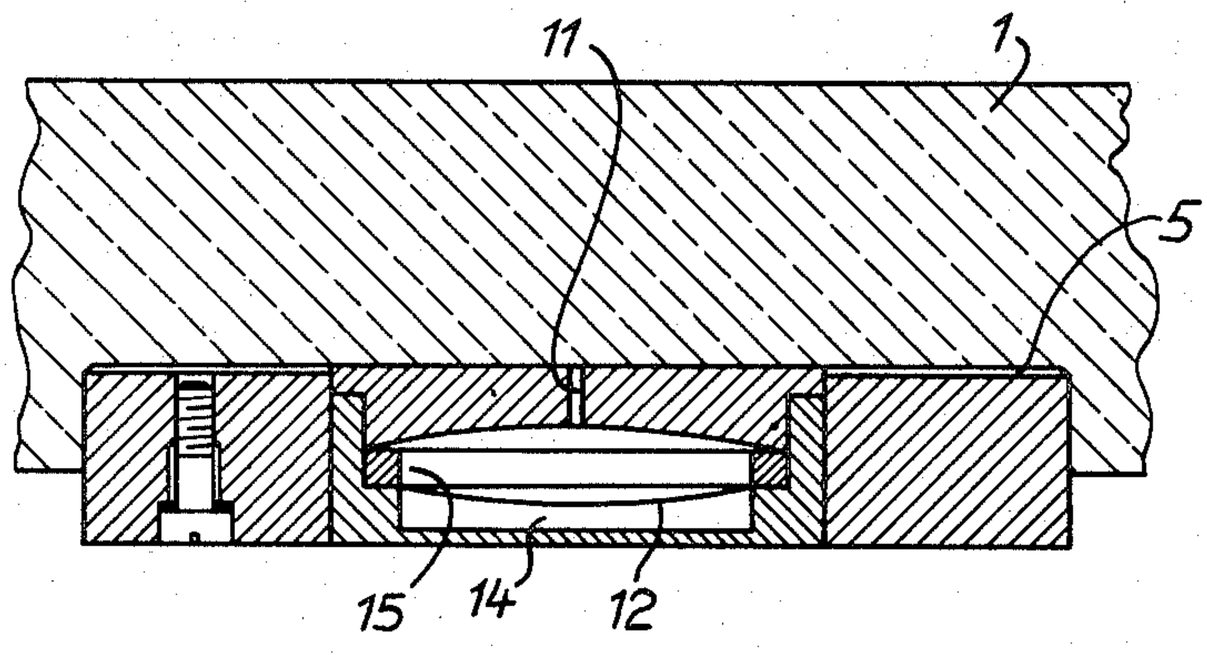


FIG. 2

SEALED EVACUATED AND PRESSURIZED WATCH CASES

The invention relates to sealed evacuated and pressurized watch cases.

It has already been proposed to evacuate certain watch-cases to eliminate the air resistance of the balance, and to pressurize divers' watch cases to render penetration of water into the case more difficult.

It has also been proposed to incorporate in such watches a device for indicating the vacuum or overpressure prevailing inside the case, and adapted to warn the user of a leak.

One of the proposed arrangements consists of a manometer formed of two circular elastomeric membranes stuck together edge to edge at atmospheric pressure and taking the shape of a sphere when the case is evacuated; this sphere acts on a lever compressing a spring, the other end of the lever serving as an indicating member.

A simpler known arrangement consists of a piston movable behind a glass, and the end of which is visible to a greater or lesser degree through an eyepiece according to the position of the piston.

Another known arrangement employs an elastomeric membrane of dished shape and having two stable states which are respectively concave and convex in a manner to enable a direct "all-or-nothing" observation of the state of pressure in the watch. In one embodiment of this arrangement, observation of the displacement of the membrane is obtained by means of an auxiliary membrane which comes to stick against a glass, producing an optical effect due to elimination of the reflexion by the rear face of the glass at the location where contact takes place.

The use of elastomeric membranes gives excellent results in the laboratory when the pressure is modified instantaneously or at least rapidly. However, in practice, the pressure varies only very slowly and, because of the permeability of the membrane, as soon as a disequilibrium of the pressure on either side of the membrane appears, diffusion occurs. For example, in the case of observation by means of a membrane which must be applied against a glass in the event of breakdown of a vacuum in the case, in the event of a slow leak the membrane will remain in its initial state and will not come to be applied against the glass. For an abrupt increase in the pressure, the effect of application of the membrane against the glass will be seen, provided that the initial pressure is sufficiently low, but because of diffusion through the membrane an equilibrium will be re-established on the two sides of the membrane which will peel off from the glass causing the indication to disappear after a certain time.

An aim of the present invention is to obviate the above-mentioned faults of indicating devices including membranes in organic material.

According to the invention there is provided a sealed watch-case including a primary enclosure which is under vacuum or under pressure, and a device for indicating the maintenance of a given vacuum or overpressure in said primary enclosure, said device comprising a hollow piston slidably mounted in a bore of a support member, one end of said bore communicating with said primary enclosure and the other end of said bore being fluidtightly sealed off from said primary enclosure by means including a transparency covering

said other end of the bore, said piston including an opening communicating the hollow interior of said piston with an outer face of said piston adjacent to said other end of the bore, at least one bistable metallic membrane disposed within said hollow interior of the piston, means including said at least one membrane for defining and fluidtightly separating two compartments in said hollow interior of the piston, one of said compartments containing a gas, and the other of said compartments including said opening and containing an opaque liquid, said at least one membrane being movable between two positions according to whether the pressure in said primary enclosure is above or below a limiting value, a first position in which the volume of said other compartment is such that no or substantially no liquid is located between said outer face of the piston and said transparency whereby said piston is visible through said transparency, and a second position in which the volume of said other compartment is such that a quantity of liquid is located between said outer face of the piston and said transparency whereby said piston is concealed.

The accompanying drawings show, by way of example, an embodiment of the invention. In the drawings:

FIG. 1 is an axial cross-section through an indicating device in a position corresponding to vacuum in the primary enclosure of a watch-case; and,

FIG. 2 is a similar view showing the device after disappearance of the vacuum.

The indicating device shown is fixed in a cylindrical recess 2 machined in the central part of a transparency in the form of a watchglass 1 of mineral glass. In this recess 2 is secured a polished metal ring 3, for example by means of an epoxy glue such as Araldite (registered Trade Mark). The ring 3 has a central bore serving as cylinder for a piston 4, this central bore being reamed to a tolerance of 0.02mm. The inner end face of ring 3 is spaced apart from the bottom face of recess 2 by from 0.1 to 0.2mm so as to leave a cavity 5. The ring 3 also has a tapped through bore 6 able to receive a screw 7 closing bore 6 in fluid-tight manner by means of an O-ring 8 compressed between the head of screw 7 and a shoulder of bore 6.

The piston 4 is formed by a cup 9 into which is fitted a polished metal cover 10 pierced at its center with a bore 11 of small diameter, for example 0.2 to 0.4mm, which communicates with the interior of the hollow piston, this bore 11 leading out into the face of cover 10 adjacent to glass 1.

The hollow interior of the piston is divided into two compartments 14, 15, fluid-tightly separated from one another by a metal membrane 12 held between a shoulder 9*a* of the cup 9 and a metal ring 13. The parts of piston 4 are assembled in fluid-tight manner, for example by means of an epoxy glue. The metallic membrane 12, preferably of bronze, has a thickness of the order of 0.025 mm and is slightly dished in a manner to have, in operation of the device, two stable states, namely the states shown in FIGS. 1 and 2 respectively. The compartment 14 enclosed by membrane 12 and cup 9 contains air at atmospheric pressure; this is achieved by fixing the membrane 12 in normal atmospheric pressure conditions, with the membrane 12 in its dished "rest" position shown in FIG. 2. The position of membrane 12 shown in FIG. 1 is quasi-stable in as much as that in order to remain in this position a pressure differential

must be applied to the opposed faces of the membrane. The compartment **15**, bore **11** and cavity **5** are filled with an oil which has a low vapour pressure, is chemically very stable, has a low coefficient of thermal expansion and a low viscosity, for example an oil sold on the market under the name Dow Corning 704, a type used in diffusion pumps. This oil is brightly coloured, for example by means of a small quantity of "Macrolexblau" dye of Bayer, which rapidly dissolves in organic solvents and gives the oil a bright blue colour which is stable in daylight. A thin layer of this oil suffices to conceal the shiny metallic surfaces of the ring **3** and cover **10** of piston **4**.

The piston **4** is placed in the following manner: gas is firstly carefully removed from said oil under vacuum in a recipient; then the piston **4** is immersed therein with its bore **11** upwards and, since the assembly is evacuated, the metallic membrane **12** moves into the position of FIG. **1**; then, atmospheric pressure is reestablished so that the oil entirely fills the compartment **15** and bore **11** of the piston, the membrane moving back to its FIG. **2** position. The recess **2**, equipped with the ring **3**, is also partly filled with oil, with the glass **1** turned so that recess **2** faces upwards. The piston **4** is then removed from the oil bath and placed in its cylinder, with the bore **11** downwards. After having fully pushed piston **4** to the position of FIG. **2** in which the end face of cover **10** is applied against the bottom of recess **2** so that there is no oil between these parts, the screw **7** in inserted in bore **6** and screwed in. The oil penetrates between the cylinder and piston **4**, ensuring lubrication thereof.

In this initial state, the device displays a blue ring surrounding a whitish metallic zone formed by the piston. As the primary enclosure of the watch-case is evacuated, the device remains in this initial state until a limiting pressure value determined by the elastic constants of membrane **12** is reached. When the pressure in the primary enclosure passes below this limiting value, membrane **12** "switches" to the FIG. **1** position, and an observer sees an uniform blue disc aburptly appear. The point of "switching" of membrane **12** can be calculated from the modulus of elasticity of the material used and the dimensions of the membrane.

In order to obtain an uniform thickness of oil over the entire bottom face of recess **2**, the depth of cavity **5** is made equal to the displacement of piston **4** upon "switching." This displacement can be easily calculated, at least approximatively, since the difference of the volume of either of compartments **14** and **15** for the two stable positions of the membrane **12** is approximately the sum of two segments of a sphere.

As a variation, it is possible to provide a fluid-tight metallic cpasule suspended freely in the oil filling the piston; this capsule can be formed of two circular membranes in bronze welded together by their edges.

In both examples, when, as a result of a leak, the pressure inside the primary enclosure of the watch-case reaches about 0.1 atmosphere for example, the membrane **12** "switches" into its initial position (FIG. **2**) causing the oil between the piston cover **10** and the face of recess **2** to return inside the compartment **15** of the piston **14** while enabling the piston **4** to move

towards the glass **1**, thereby allowing the metallic surface of cover **10** to appear.

By means of the same or a similar device it is possible to control the maintenance of an over-pressure inside a watch-case. In this example, the space **5** could be eliminated in a manner such that in the over-pressure position the device displays an entirely metallic disc, whereas a central coloured disc appears when the pressure inside the primary enclosure of the case falls below a certain limit.

The transparency closing the device need not necessarily be the watch-glass but could be a special glass for the device which may, for example, be mounted in the dial.

What is claimed is:

1. A sealed watch case including a primary enclosure which is under vacuum or under pressure, and a device for indicating the maintenance of a given vacuum or over-pressure in said primary enclosure, said device comprising a hollow piston slidably mounted in a bore of a support member, one end of said bore communicating with said primary enclosure and the other end of said bore being fluidtightly sealed off from said primary enclosure by means including a transparency covering said other end of the bore, said piston including an opening communicating the hollow interior of said piston with an outer face of said piston adjacent to said other end of the bore, at least one bistable metallic membrane disposed within said hollow interior of the piston, means including said at least one membrane for defining and fluidtightly separating two compartments in said hollow interior of the piston, one of said compartments containing a gas, and the other of said compartments including said opening and containing an opaque liquid; said at least one membrane being movable between two positions according to whether the pressure in said primary enclosure is above or below a limiting value, a first position in which the volume of said other compartment is such that substantially no liquid is located between said outer face of the piston and said transparency whereby said piston is visible through said transparency, and a second position in which the volume of said other compartment is such that a quantity of liquid is disposed between said outer face of the piston and said transparency whereby said piston is concealed.

2. A watch case according to claim **1**, in which the piston houses a single metallic membrane fixed by its edges to the piston.

3. A watch case according to claim **1**, in which said one compartment is defined by two metallc membranes joined by their edges and forming a capsule freely floating in liquid within the hollow interior of the piston.

4. A watch case according to claim **1**, in which said support member is formed by a metallic ring secured in a recess in said transparency with a front face of the ring spaced apart from said recess to form a cavity therebetween, said cavity being filled with liquid.

5. A watch case according to claim **1**, in which said transparency is a watch glass.

6. A watch case according to claim **1**, in which said opaque liquid is a coloured oil.

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