

PATENT SPECIFICATION

(11) 1 272 183

DRAWINGS ATTACHED

- (21) Application No. 2949/70 (22) Filed 21 Jan. 1970
 (31) Convention Application No. 4910 (32) Filed 24 Jan. 1969 in
 (33) Japan (JA)
 (45) Complete Specification published 26 April 1972
 (51) International Classification G04B 37/02
 (52) Index at acceptance G3T A2C



(54) IMPROVEMENTS RELATING TO TIMEPIECES

(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 timepieces, and although it is not so restricted, it will be particularly described with reference to watches.

Conventional watches suffer from the known disadvantages that as time goes by, the watch will gain or lose time due, *inter alia*, to abrasion between and rust on the movable parts thereof. It has long been known to utilize jewelled bearings to prevent or reduce abrasion and various lubricants have been used to decrease wear due to friction. Moreover, materials of high mechanical strength have been used for fabricating those parts which are subjected to relatively great mechanical stresses and pressure in operation.

However, these expedients, while partially successful in overcoming the problems, nevertheless involve penalties in terms of cost and space. In addition, all these parts within the watch case are exposed in operation to air which contains oxygen and moisture. As a result, lubricants will gradually age and become less effective; also many metallic watch parts will in time be affected by rust. Rusty surfaces in turn will increase the abrasion between interengaging parts, and less than perfect surface finishes have a self-accelerating effect as regards abrasive wear. Also, in electric watches, in time the contact points will become unreliable because of the presence of oxygen and moisture. Moreover, the existence of the oxygen or moisture also tends to cause discoloration of the dial. In recent years, watches have come to be regarded more and more as of ornamental as well as functional value and thus discoloration of the dial will have an adverse effect on sales.

A further reason why the existence of oxygen is a serious problem is that in some modern watches so many small and precision-made parts are assembled in a small space that, for example, some parts are under a continuous operational pressure of 27 kg-mm⁻².

For all these reasons, in known watches initial accuracy cannot be maintained for a very long time. Now it has been proposed before to make so-called "vacuum watches", wherein the air is evacuated from the case as far as possible. In this way, it has been possible substantially to prevent or reduce the ageing of the lubricant, discoloration of the dial and wear due to oxidation of the rubbing parts. However, in the vacuum condition the lubricant easily evaporates and it is difficult to retain it on the parts requiring lubrication for long periods of time. Thus after a certain period of time the frictional coefficient will rise between the interengaging parts. Also, the necessity for complete air tightness makes the manufacture of the case structure more complicated.

The present invention seeks to eliminate the above defects and to provide a timepiece of high accuracy and durability.

According to the present invention, there is provided a timepiece including a sealed case containing the movement, the free volume within said case containing at least one inert gas (as hereinafter defined), the gas pressure inside said case being at least substantially atmospheric but not exceeding 1.2 kg.cm⁻², and the maximum oxygen content of said volume being 5% by volume.

Said at least one inert gas includes nitrogen, carbon dioxide, helium, neon, argon, krypton and xenon, singly or mixed together in any combination.

The timepiece may be an electric timepiece and it is preferably a watch.

Preferred embodiments of the invention will now be described with reference to the following specific Examples, in which refer-

ences will be made to the drawings. In the drawings:

Figure 1 is an enlarged perspective view adapted from a photograph of the lower pivot of the third wheel of the movement of a watch in accordance with the present invention, after the movement has been run for a year;

Figure 2 is a similar view on the same scale and showing the corresponding part of a known watch after it has run for the same period of time,

Figure 3 is an enlarged partial view adapted from a photograph of the barrel of the movement of a watch in accordance with the present invention, which movement has been driven for a long period of time,

Figure 4 is a corresponding view of a barrel of a conventional watch,

Figure 5 is a graph showing the variation of the balance amplitude and the rate of the watch with time for a watch in accordance with the present invention, and

Figure 6 is a graph corresponding to Figure 5, but showing the relationships in respect of a conventional watch.

EXAMPLE 1

Air in a watch case was displaced by completely dried high-purity nitrogen gas sealed in at a pressure of 1 kg-cm^{-2} , the back case of the watch being substantially waterproof and air-tight. For the purpose of comparison, this watch and the conventional watch were run for one year, after which they were disassembled and examined.

As a result of these examinations, see Figures 1 and 2, it was found that the pivot of the watch of the present invention shows no rust or abrasion, while the conventional watch pivot shows abrasion to a marked degree.

It is well-known that as abrasion progresses due to the adhesion of the rubbing surfaces, the fine powder produced thereby will be sprayed around and will react with the oxygen in the air. As a result, refractory metallic oxide particles will be formed which will act as abrasives further to increase the abrasion effect. Thus the difference between the two watches above mentioned will become larger as time goes by.

It will be noted that in known watches the lower pivot of the third wheel receives a radially directed pressure which may be as high as 27 kg-mm^{-2} so that a small amount of abrasion such as a few microns will in fact amount to a fatal defect as regards precision of the watch.

EXAMPLE 2

A pair of watches were run for twelve months, left for one month and each part was examined, one of the watches being in accordance with this invention and including high-purity argon gas sealed in at a pressure

of 1.2 kg-cm^{-2} , and a conventional watch. The results of the examination are shown in Figures 3 and 4 which are respective microscopic views, enlarged to the same scale, of the inner surface of the barrel which in operation rubs against the barrel arbor of the watch movement. This barrel is made of brass.

While the barrel of the watch in accordance with the present invention shows substantially no trace of abrasion, the barrel of the conventional watch quite clearly shows effects of abrasion and has a rough surface. The barrel of the watch according to the present invention maintains its initial brightness, but the conventional watch is discoloured and has substantially lost its brightness, although this is not discernible from the illustration.

In addition, in the conventional watch small pits can be detected on such metal parts as the crown wheel and escape wheel pinion at a microscope magnification of $\times 40$. After observation, it has been found that these pits are generated or formed during the last month of the test period.

Although the pressure given above is 1.2 kg-cm^{-2} , the precise value of the pressure is not relevant to the broadest formulation of the present invention, although it is desirable to keep this pressure nearly equal to the atmospheric pressure to reduce sealing problems. Certainly, if one aims at maintaining good accuracy for five years or longer, it is desirable to keep the internal pressure closely similar to atmospheric pressure.

EXAMPLE 3

A watch in accordance with the present invention included a mixture of nitrogen and helium in the proportion of 90% to 10% by volume, sealed in at a pressure of 1 kg-cm^{-2} . This watch and a conventional watch were run for twelve months and the change in the amplitude of the balance and the rate with time were studied. The results are illustrated graphically in Figures 5 and 6, respectively. From the graphs, it will be understood that the watch of the present invention exhibited a smaller variation in amplitude and a much stabler rate, whereby initial accuracy is maintained for a long time. In contrast, as can be seen from Figure 6, as time goes by, in the conventional watch the amplitude fluctuation and damping increase and so the rate gradually changes.

EXAMPLE 4

Batches of fifty waterproof and air-tight watches were run for a period of twelve months, with the daily rate variation being examined. Each batch of fifty watches had a gas or a mixture of gases sealed therein, as shown in the Table below, with the sealing pressure being 1 kg-cm^{-2} , and the watches were maintained at a temperature of 20°C .

The Table shows, for each gas or mixture of gases, the mean value, in the batch of fifty watches, of the difference (in seconds) between the maximum and minimum daily rates, the

said mean value being measured daily and, for the purposes of the Table, averaged over the period of twelve months.

TABLE

Type of gas and its percentage	(Max. daily rate — Min. daily rate) mean value. (seconds)
Air (conventional type watch)	7.8
O ₂	9.2
He	5.2
N ₂	4.9
A	5.0
Ne	4.9
Kr	5.2
Xe	5.1
CO ₂	5.4
N ₂ 90% + He 10% (by volume)	5.0
N ₂ 99% + O ₂ 1% (by volume)	5.5
A 99% + O ₂ 1% (by volume)	5.4
N ₂ 50% + A 50% (by volume)	4.8

From the Table it is evident that watches including air, that is to say conventional watches, and watches including atmospheric or greater proportions of oxygen are substantially unstable as regards their accuracy, whereas watches including up to a maximum of 5% by volume of oxygen and the remainder one or more inert gases maintain stable accuracy. However, best results were obtained when the sealed-in gas was a pure inert gas.

It will of course be appreciated that, if so desired, a mixture of inert gases could be sealed together.

EXAMPLE 5

Two electric watches incorporating balances were compared, one, in accordance with the present invention, including a mixture of nitrogen and argon in the ratio 80% to 20% by volume and sealed in at the pressure of 1 kg-cm⁻², and a conventional watch. The watches were tested on a high speed tester continuously for five years, whereafter the electric contact point of each watch was

checked. The contact point of the balance of the watch in accordance with the present invention maintained its initial bright surface, while the contact point of the conventional watch exhibited discoloration and abrasion.

Since it is normally impossible to lubricate the balance contact point, this part presents many problems in durability and stability. As is well-known, the state of the contact point has a close relation with the regularity of the cycle of the balance, and thus the effect of the present invention is substantially to enhance the possibility of maintaining high accuracy of the watch.

As will be appreciated, the preferred embodiments of this invention provide a time-piece in which lubricating oil will not be aged by oxidization, abrasion will be substantially eliminated as regards oxidization wear, and metallic parts will not become rusty. Moreover, the present invention renders it unnecessary to adopt complicated sealing structures. The present invention is applicable to various types of watches, such as electric

watches, using balances, tuning fork watches, tuning piece watches, quartz crystal watches as well as mechanical watches using balances.

- 5 The term "inert gas" as used in this description and claims should be interpreted broadly as including not only the so-called noble gases such as Ne, Kr, A, Xe and Rn, but also N and CO₂ gas, and generally any gas that will not form compounds with the usual materials employed in the fabrication of timepieces under normal temperatures and pressures likely to be encountered by said timepieces.

10 WHAT WE CLAIM IS:—

- 15 1. A timepiece including a sealed case containing the movement, the free volume within said case containing at least one inert gas (as hereinbefore defined), the gas pressure inside said case being at least substantially atmospheric but not exceeding 1.2 kg.cm⁻²,

and the maximum oxygen content of said volume being 5% by volume. 20

2. A timepiece as claimed in claim 1 wherein said at least one inert gas includes nitrogen, carbon dioxide, helium, neon, argon, krypton and xenon, singly or mixed together in any combination. 25

3. A timepiece as claimed in any preceding claim wherein the timepiece is an electric timepiece.

4. A timepiece as claimed in any preceding claim wherein the timepiece is a watch. 30

5. A timepiece as claimed in claim 1 substantially as hereinbefore described.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1972.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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WHAT WE CLAIM IS:—

- 15 1. A timepiece including a sealed case containing the movement, the free volume within said case containing at least one inert gas (as hereinbefore defined), the gas pressure inside said case being at least substantially atmospheric but not exceeding 1.2 kg.cm⁻²,

and the maximum oxygen content of said 20 volume being 5% by volume.

2. A timepiece as claimed in claim 1 wherein said at least one inert gas includes nitrogen, carbon dioxide, helium, neon, argon, krypton and xenon, singly or mixed together in any 25 combination.

3. A timepiece as claimed in any preceding claim wherein the timepiece is an electric timepiece.

4. A timepiece as claimed in any preceding 30 claim wherein the timepiece is a watch.

5. A timepiece as claimed in claim 1 substantially as hereinbefore described.

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