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(54) WATCH CROWN

(71) We, THE UNITED STATES TIME CORPORATION, a Corporation organized under the laws of the State of Connecticut, United States of America, of Middlebury, Connecticut, United States of America, 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:—

The present invention relates to watch case constructions and more particularly to a waterproof watch crown.

The widespread acceptance of popular priced wrist watches has changed the habits of those who wear them. When the wrist watch was generally expensive and fragile, it was customary to remove it before washing one's hands or shaving. Now that wrist watches are lower in price and more rugged, they are often left on the wrist when washing. They are even sometimes, by mistake, left on when showering, bathing or swimming.

Extensive testing, in the laboratory as well as in practical use, has shown that the present so-called "water-proof" watches often fail to exclude water from the watch works. Such leakage may ruin the mechanism of the watch. Testing has shown that often this failure is not due to leakage through the watch case, but to leakage between the crown body and the watch pendant. Even when the crown is of the specially constructed "waterproof" or "deep sea" types, leakage may still occur.

The cause of these failures was difficult to ascertain. Watches were tested under water pressures of 35 pounds per square inch, the pressure often used to define the term "waterproof", and the watches did not leak. Surprisingly, some of the same watches leaked when they were tested by swimming around in a shallow pool. The leaky watches could then be emptied of water and re-tested at a pressure of 35 pounds per square inch and again would not leak.

Water-tightness is essential in a crown for a waterproof watch. However, the crown must also meet the general require-

ments for a quality watch crown, namely, that it does not wear out the case pendant when it is turned; that it is relatively easy to turn so that the watch may be wound or the hands set; that the crown itself is not readily worn out by its turning on its pendant; and that the crown may be readily replaceable on its stem without requiring the use of special tools. In addition, it is preferable that the crown should be relatively inexpensive. An inexpensive watch crown construction requires that the materials of its parts should not be costly, that the parts should be simple to manufacture, that its parts be adapted for high-speed production without sacrificing the accuracy of its parts, and that the parts may be readily assembled.

It is the objective of the present invention to provide a waterproof crown construction which prevents entry of water into a watch when the watch is worn under water, which is relatively inexpensive, and which is easily replaceable on its stem.

In accordance with the present invention there is provided a waterproof watch crown construction comprising a crown body having an internal cavity, said crown body being adapted to fit over a watch case tubular pendant, said crown body having a portion within said cavity adapted to fit within the said case pendant and to be attached to the winding stem of a watch; an annular elastic gasket within said cavity adapted to be compressed between said crown and said pendant; and an annular hard washer having an inner round hole attached at the bottom of said crown to partly cover said cavity and retain said gasket within said cavity, characterised in that when said crown body is fitted over said pendant said washer has the wall of its internal hole close to the wall of said pendant to limit sidewise motion of said crown and satisfies the relationship

$$C_R \leq \frac{I_R}{2}$$

where C_R is the clearance (calculated over radii) between the washer inner surface and the pendant outer surface and I_R is the interference (calculated

over radii) between the pendant outer surface and the gasket inner surface when the gasket is assembled in the crown body.

Further in accordance with the invention there is provided a waterproof watch crown construction comprising a crown body having an internal cavity, said crown body being adapted to fit over a watch case tubular pendant, said crown body having a portion within said cavity adapted to fit within the said case pendant and to be attached to the winding stem of a watch; an annular elastic gasket within said cavity adapted to be bent so that its inner portion extends parallel to said pendant; and an annular hard washer attached at the bottom of said crown to partly cover said cavity and retain said gasket within said cavity; wherein when said crown body is fitted over said pendant said washer has the wall of its internal hole close to the wall of said pendant to limit sidewise motion of said crown, and satisfies the relationship $C_R \leq C_{GO}$ where C_R is the clearance (calculated over radii) between the washer inner surface and the pendant outer diameter and C_{GO} is the clearance (calculated over radii) between the crown inner surface and the bent-over inner portion of the gasket.

It has been found that previous crowns permitted leakage because their gaskets were unsealed or unseated by sidewise pressures on the crown. Such sidewise pressures are prevented from affecting the sealing of the crown of the present invention because of its hard, preferably metal washer. The internal diameter of the washer is specified in accordance with a certain formula. The thickness, i.e., the axial dimension, of the washer is not critical. The crown cannot wobble or turn away from its axis as its central internal portion is firmly attached to the winding stem of the watch. The gasket, preferably of rubber, may be for example, round (an "O" ring), square or "D" shaped, or tube shaped.

Further details and advantages of the invention will be apparent from the following detailed description of preferred embodiments thereof given by way of example, reference being had to the accompanying drawings, in which:—

Fig. 1 is a side vertical sectional view of a first embodiment of the present invention in which the crown is in place on the case pendant;

Fig. 2 is a portion, in a side vertical sectional view, of the embodiment of Fig. 1 prior to assembly of the crown onto the case pendant;

Fig. 3 is a side sectional view of a second embodiment of the present invention with the crown assembled on the case pendant;

Fig. 4 is a portion, in a side sectional vertical view, of the crown of the embodi-

ment of Fig. 3 prior to assembly of the crown onto the case pendant; and

Figs. 5a, 5b, 6a, 6b, 7a and 7b are side vertical sectional views of other embodiments of the present invention, of which Figs. 5a, 6a and 7a are partial sectional views before the crown is assembled on the case pendant, and Figs. 5b, 6b and 7b are full sectional views with the crown assembled on the case pendant.

The waterproof crown construction shown in Fig. 1 includes a crown body 1. The crown body, preferably constructed of brass or stainless steel, has external teeth 2 to enable the fingers to grip the crown for turning. The crown is turned when the hands of the watch are set in either a mechanical or electric watch, and when the watch is wound in a mechanical watch. The crown body has a tubular cavity 3 forming a centre tubular pedestal 4. The tubular pedestal 4 may have internal screw threads which are screwed onto the external screw threads of the winding stem 5, or it may be held onto the winding stem by an interference fit or by other means. The winding stem 5 is connected to gears which in a mechanical watch in one position, usually toward the case body, winds the mainspring. In its other position, usually pulled out from the case body, the crown sets the hands. In an electric watch the crown usually is pulled out from the case body to set the hands.

The cavity 3 of the crown body 1 fits over the case pendant 8. The case pendant 8 is a tubular neck which is integral with a portion of the watch case, usually the bezel. The winding stem 5 is rotatable within the fixed tubular case pendant 8. The cavity 3 has an enlarged lower portion 9. Lower portion 9 is adapted for the insertion of the crown members utilized to prevent leakage of water. Without such leakage-preventive members, water would leak from outside of the crown, between the crown body and the case pendant, over the top of the pendant, through the internal opening of the case pendant, and into the watch.

An elastic gasket 6 is positioned in cavity 3 within lower portion 9 of the crown. This gasket 6, in the embodiment of Fig. 1, is originally an "O" ring which is circular in cross-section prior to the insertion of the case pendant within the cavity 3 of the crown body 1. Preferably, the "O" ring is made of rubber. The rubber preferably is of a type which is resistant to salt water and may be artificial rubber. The "O" ring is sufficiently large so that it is compressed and distorted when the crown is positioned over the case pendant. The "O" ring, as long as it retains its seal with the case pendant and the crown body, prevents

water from seeping between the crown body and the case pendant.

A hard, preferably metal washer 7 is staked or otherwise fastened, for example, by adhesive, within a ledge portion 11 of the crown body 1. The staking may produce a holding lip 12 of the crown body 1. The metal washer 7 has sufficient compressive strength to prevent sidewise motion of the crown body 1 under sidewise thrusts, such as is shown by arrow A. In addition, it prevents sidewise motion of the crown body 1 under those thrusts having sidewise components similar to the motion in the direction of arrow A. The metal washer 7 is also used to retain the "O" ring gasket 6 within the crown body. The metal washer 7, at its internal diameter, is extended as far as the case pendant in accordance with the below-specified formula. The washer 7 is utilized to prevent sidewise thrust. It has been found that, although there may be some wear due to the turning and axial thrust movements of the washer 7 on the pendant, there is not sufficient wear to injure the case pendant; preferably the washer 7 is an oil impregnated sintered metal washer.

The clearance between the metal washer 7 inner diameter (I.D.) and the case pendant 8 outer diameter (O.D.) to prevent unsealing of the gasket when the crown is subjected to sidewise travel due to side thrusts is defined by the following terms:

C_R is the clearance (calculated over radii) between washer and pendant;
 W_{ID} is washer I.D. when assembled to crown body;
 P_{OD} is pendant O.D.;
 I_R is the interference (calculated over radii) between pendant and gasket;
 G_{ID} is gasket I.D. when assembled in the crown body and before being positioned around the pendant;

Where:

$$C_R = \frac{W_{ID} - P_{OD}}{2} \text{ and } I_R = \frac{P_{OD} - G_{ID}}{2}$$

It has been determined by testing that unsealing of the gasket will not occur when the clearance, C_R , limits the sidewise travel of the crown to a value equal to 50% of I_R or values less than 50% of I_R . Consequently, the critical dimension of the washer I.D. is given by the following

$$\text{Formula I: } C_R \leq \frac{I_R}{2}$$

The embodiment shown in Fig. 3 is similar in most of its parts to the embodiment of Fig. 1, and the parts labelled with the

same numerals perform the same function in the described embodiment.

In the crown of Fig. 3 the rubber gasket 13 is in the form of a flat annular ring, i.e., it is shaped like a flat washer, prior to insertion of the case pendant within its hole. The hole 14 within the gasket 13 is slightly smaller than the outer diameter of the case pendant 8. When the case pendant is forced up through this hole, it bends the inside portion of gasket 13 upward so that it lies parallel to the pendant. The gasket 13 may be held firmly, or be loose, between the inside wall of the cavity and the case pendant.

The structure of the crown and the size of metal washer 7 of Fig. 3 does not follow the above-recited Formula I. Due to the shape of its gasket 13 the size of the metal washer 7 using the flat type of gasket is determined by the following Formula II, set forth below.

The following terms are defined for use in Formula II:

CR_{ID} is the crown I.D. (inner diameter) at surface S (see Figure 3), which surface is the inner wall of the crown against which the gasket is urged by the pendant;
 FG_T is the flat gasket thickness;
 P_{OD} is the pendant O.D. (outer diameter);
 C_{GC} is the clearance (calculated over radii) between the bent-over inner portion of the gasket and the crown (when the crown is in its assembled state with the pendant in position);
 W_{ID} is the washer I.D. when assembled to crown body;
 C_R is the clearance (calculated over radii) between the washer and pendant;

where

$$C_R = \frac{W_{ID} - P_{OD}}{2} \text{ and } C_{GC} = \frac{CR_{ID} - (P_{OD} + 2FG_T)}{2}$$

Formula II is: $C_R \leq C_{GC}$, where C_R is in the range 0.00050 to 0.0030 inches.

The gasket 13 of Figs. 3 and 4 is flat and may be moulded or stamped in the form of a flat washer.

The embodiments of Figs. 5, 6 and 7 differ from the previous embodiments in the shape of their gaskets. The gasket 20 of Figs. 5a and 5b is formed, preferably moulded, so that its upper annular free portion 21 is rounded, i.e., has a round cross-section. Its lower annular flat ring portion 22 is held clamped between the washer and the crown body (see Fig. 5a). The gasket

23 of Figs. 6a and 6b is formed, also moulded, so that its upper portion is of sufficient thickness so that its one side touches the pendant and its other side touches the inner wall S of the upper section of the crown cavity. The gasket 24 of the embodiment of Figs. 7a and 7b is formed similarly to the gasket 21 of Fig. 6 except that its inner portion 25 is curved, presenting a rounded gasket portion to the pendant.

The embodiments of Figs. 5, 6 and 7 possess certain advantages compared to other types of watch crown constructions. A good seal is obtained between the washer, which may readily be produced with a smooth highly finished surface, and the gasket. A good seal is also obtained between the pendant and the crown body as each gasket may be moulded so that the moulding flash does not occur on the surface of the gasket touching the pendant.

The crowns of Figs. 5, 6 and 7 provide a firm holding of the gasket in the crown body as the metal washer clamps the outer lower portion of the gasket. The curved surfaces, in the gaskets of the embodiments of Figs. 5 and 7, provide an "O" ring type of seal having comparatively low torque. At the same time the gaskets in the embodiments of Figs. 5 and 7 are firmly gripped between the washer and the crown body, unlike an "O" ring gasket. The sealing and low torque is particularly effective in the embodiment of Figs. 5a, 5b, which uses a top annular portion having a round cross-section, because its cross-section is similar to an "O" ring gasket.

The constructions of Figs. 5, 6 and 7 use the critical relationships of Formula I, above, as to their washers, which Formula I also applies to the embodiments of Figs. 1 and 2.

As a specific example, crowns were constructed according to Fig. 3 and Formula II and having an internal diameter of 0.100 inches at its upper cavity section (surface S). The flat gasket had a thickness of 0.009 inches and an internal diameter of 0.061 inches (all dimensions prior to insertion into the cavity), the gasket being inserted into the crown's cavity. The case pendant had an external diameter of 0.080 and the washer had an internal diameter of 0.082. These crowns did not leak when tested under water at atmospheric pressure and at a pressure of 35 lbs. per square inch, with side pressure applied to the crown.

WHAT WE CLAIM IS.—

1. A waterproof watch crown construction comprising a crown body having an internal cavity, said crown body being adapted to fit over a watch case tubular pendant, said crown body having a portion

within said cavity adapted to fit within the said case pendant and to be attached to the winding stem of a watch; an annular elastic gasket within said cavity adapted to be compressed between said crown and said pendant; and an annular hard washer having an inner round hole attached at the bottom of said crown to partly cover said cavity and retain said gasket within said cavity, characterised in that when said crown body is fitted over said pendant said washer has the wall of its internal hole close to the wall of said pendant to limit sidewise motion of said crown and satisfies

the relationship $C_R \leq \frac{I_R}{2}$, where C_R is the

clearance (calculated over radii) between the washer inner surface and the pendant outer surface and I_R is the interference (calculated over radii) between the pendant outer surface and the gasket inner surface when the gasket is assembled in the crown body.

2. A watch crown construction as claimed in claim 1 wherein the gasket is an "O" ring which is substantially circular in cross-section prior to its compression.

3. A watch crown construction as claimed in claim 1 wherein the gasket is a ring which is substantially 'D' shaped in cross-section prior to its compression.

4. A waterproof watch crown construction comprising a crown body having an internal cavity, said crown body being adapted to fit over a watch case tubular pendant, said crown body having a portion within said cavity adapted to fit within the said case pendant and to be attached to the winding stem of a watch; an annular elastic gasket within said cavity adapted to be bent so that the inner portion extends parallel to said pendant; and an annular hard washer attached at the bottom of said crown to partly cover said cavity and retain said gasket within said cavity; wherein when said crown body is fitted over said pendant said washer has the wall of its internal hole close to the wall of said pendant to limit sidewise motion of said crown, and satisfies the relationship $C_R \leq C_{GO}$ where C_R is the clearance (calculated over radii) between the washer inner surface and the pendant outer surface and C_{GO} is the clearance (calculated over radii) between the crown inner surface and the bent-over inner portion of the gasket.

5. A watch crown construction as claimed in any one of the preceding claims, wherein a staked lip on the crown retains the washer in place.

6. A watch crown construction as claimed in any one of the preceding claims, wherein the washer is of metal and staked in place within the crown.

23 of Figs. 6a and 6b is formed, also moulded, so that its upper portion is of sufficient thickness so that its one side touches the pendant and its other side touches the inner wall S of the upper section of the crown cavity. The gasket 24 of the embodiment of Figs. 7a and 7b is formed similarly to the gasket 21 of Fig. 6 except that its inner portion 25 is curved, presenting a rounded gasket portion to the pendant.

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The constructions of Figs. 5, 6 and 7 use the critical relationships of Formula I, above, as to their washers, which Formula I also applies to the embodiments of Figs. 1 and 2.

As a specific example, crowns were constructed according to Fig. 3 and Formula II and having an internal diameter of 0.100 inches at its upper cavity section (surface S). The flat gasket had a thickness of 0.009 inches and an internal diameter of 0.061 inches (all dimensions prior to insertion into the cavity), the gasket being inserted into the crown's cavity. The case pendant had an external diameter of 0.080 and the washer had an internal diameter of 0.082. These crowns did not leak when tested under water at atmospheric pressure and at a pressure of 35 lbs. per square inch, with side pressure applied to the crown.

WHAT WE CLAIM IS.—

1. A waterproof watch crown construction comprising a crown body having an internal cavity, said crown body being adapted to fit over a watch case tubular pendant, said crown body having a portion

within said cavity adapted to fit within the said case pendant and to be attached to the winding stem of a watch; an annular elastic gasket within said cavity adapted to be compressed between said crown and said pendant; and an annular hard washer having an inner round hole attached at the bottom of said crown to partly cover said cavity and retain said gasket within said cavity, characterised in that when said crown body is fitted over said pendant said washer has the wall of its internal hole close to the wall of said pendant to limit sidewise motion of said crown and satisfies

the relationship $C_R \leq \frac{I_R}{2}$, where C_R is the

clearance (calculated over radii) between the washer inner surface and the pendant outer surface and I_R is the interference (calculated over radii) between the pendant outer surface and the gasket inner surface when the gasket is assembled in the crown body.

2. A watch crown construction as claimed in claim 1 wherein the gasket is an 'O' ring which is substantially circular in cross-section prior to its compression.

3. A watch crown construction as claimed in claim 1 wherein the gasket is a ring which is substantially 'D' shaped in cross-section prior to its compression.

4. A waterproof watch crown construction comprising a crown body having an internal cavity, said crown body being adapted to fit over a watch case tubular pendant, said crown body having a portion within said cavity adapted to fit within the said case pendant and to be attached to the winding stem of a watch; an annular elastic gasket within said cavity adapted to be bent so that the inner portion extends parallel to said pendant; and an annular hard washer attached at the bottom of said crown to partly cover said cavity and retain said gasket within said cavity; wherein when said crown body is fitted over said pendant said washer has the wall of its internal hole close to the wall of said pendant to limit sidewise motion of said crown, and satisfies the relationship $C_R \leq C_{GO}$ where C_R is the clearance (calculated over radii) between the washer inner surface and the pendant outer surface and C_{GO} is the clearance (calculated over radii) between the crown inner surface and the bent-over inner portion of the gasket.

5. A watch crown construction as claimed in any one of the preceding claims, wherein a staked lip on the crown retains the washer in place.

6. A watch crown construction as claimed in any one of the preceding claims, wherein the washer is of metal and staked in place within the crown.



7. A watch crown construction as claimed in any one of claims 1 to 5, wherein the washer is attached to the crown by an adhesive.
- 5 8. A watch crown construction as claimed in any one of the preceding claims, wherein the washer is an oil impregnated sintered metal.
- 10 9. A waterproof watch crown construction substantially as hereinbefore described with reference to Figures 1 and 2, Figures 3 and 4, Figures 5a and 5b, Figures 6a and 6b or Figures 7a and 7b of the accompanying drawings.

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