March 10, 1970 R. W. DENLEY ET AL 3,499,281

WATCH CROWN

Filed Feb. 29, 1968 2 Sheets-Sheet 1

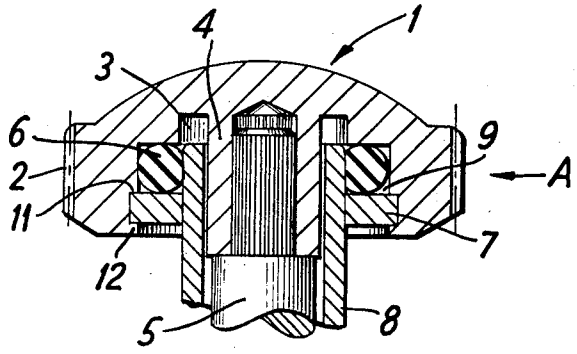

FIG. 1

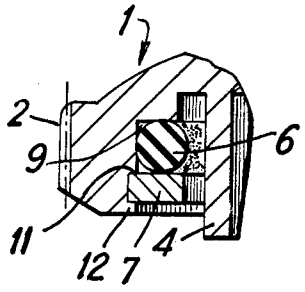

FIG. 2

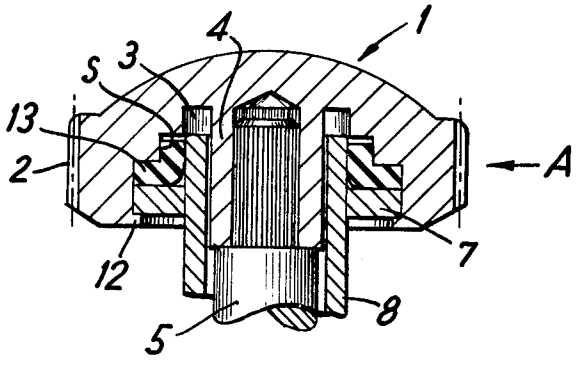

FIG. 3

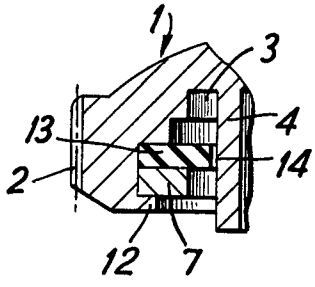

FIG. 4

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WATCH CROWN

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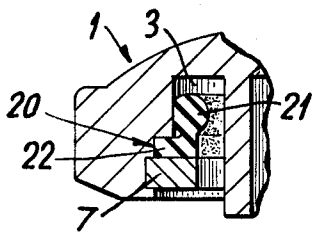

FIG. 5a

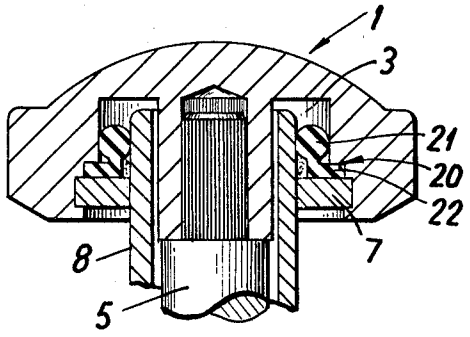

FIG. 5b

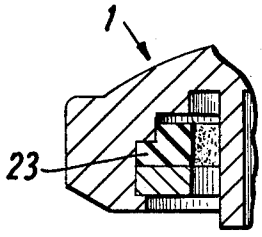

FIG. 6a

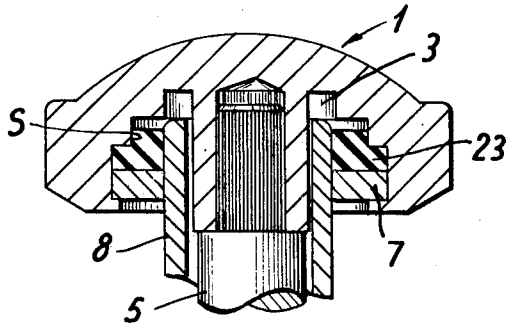

FIG. 6b

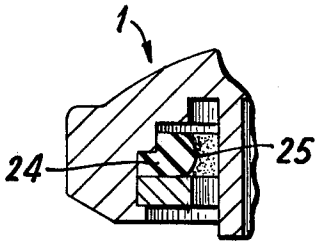

FIG. 7a

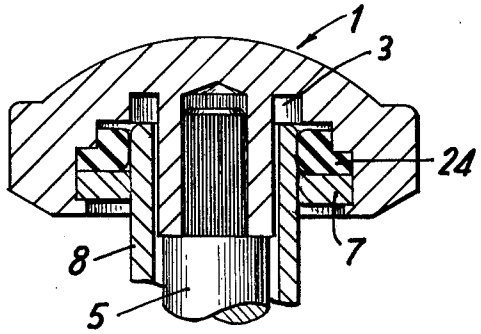

FIG. 7b

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WATCH CROWN

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Int. Cl. G04b 37/08
U.S. Cl. 58—90 13 Claims

ABSTRACT OF THE DISCLOSURE

A watch is wound or set, or both, by a crown having external teeth. The crown is constructed with a cavity that fits over a tubular case pendant. The crown is waterproof in that it prevents leakage between the crown body and the pendant. The crown construction includes a gasket positioned between the internal wall of the cavity of the crown and the case pendant. The crown also includes a washer which rotates on the base pendant. The washer, which is fastened to the bottom of the crown, closing its cavity, also retains the gasket in position. The inside diameter of the washer is accurately made to a specified formula to prevent sidewise motion of the crown relative to the pendant.

The present invention relates to horology 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 frigile, 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 "waterproof" 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 pressure 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 would 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 requirements for a quality watch crown, namely, that it does not wear out the case pendant (tubular neck) 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, a crown is provided having an internal cavity which fits over its case pendant (the tubular neck portion of the case). The crown has an internal central portion which attaches the crown to the winding stem of the watch. The winding stem rotates within the case pendant when the crown is turned. An elastic gasket, preferably of rubber, is tightly wedged between the crown and the pendant to provide sealing. The gasket may be, for example, round (an O ring), square or D shaped, or tube shaped. A metal washer is fastened on the bottom of the crown to retain the gasket and the ring in postion and to prevent sidewise motion of the crown.

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 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.

Other objectives will be apparent from the detailed description of the preferred embodiment given below, taken in conjunction with 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 is in place on 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 embodiment of FIG. 3 prior to assembly of the crown onto the case pendant; and

FIGS. 5*a*, 5*b*, 6*a*, 6*b*, 7*a* and 7*b* are side vertical sectional views of other embodiments of the present invention. FIGS. 5*a*, 6*a* and 7*a* are partial sectional views before the crown is assembled on the case pendant, and FIGS. 5*b*, 6*b* and 7*b* 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 center tubular pedestal (center body) **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.

A 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 the 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 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 the 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.

The clearance between the metal washer **7** I.D. (inner diameter) and the case pendant **8** O.D. (outer diameter) 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 I.D. and pendant O.D.;
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 O.D. and gasket I.D.;
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 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 labeled 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 basket **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. 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 flat gasket and the crown I.D. (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 I.D. and pendant O.D.

The Formula II is:

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

The gasket **13** of FIGS. 3 and 4 is flat and may be molded 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 molded, 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 molded, 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 molded so that the molding 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 inch at its upper cavity section (surface S). The flat gasket had a thickness of 0.009 inch and an

internal diameter of 0.061 inch (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 is claimed is:

1. A waterproof watch crown 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; wherein said washer has the wall of its internal hole close to the wall of said pendant to prevent sidewise motion of said crown, and wherein

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

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

2. A watch crown as in claim **1** wherein the washer is an oil impregnated sintered metal.

3. A watch crown as in claim **1** wherein the washer is of metal and staked in place within the crown.

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

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

6. A watch crown as in claim **1** wherein a staked lip on the crown retains the washer in place.

7. A watch crown as in claim **1** wherein the washer is attached to the crown by an adhesive.

8. A waterproof watch crown 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 clamped between said washer and said crown body and compressed between said crown and 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 said washer has the wall of its internal hole close to the wall of said pendant to prevent sidewise motion of said crown, and wherein $C_R \leq C_{GC}$ where C_R is the clearance (calculated over radii) between the washer inner diameter and the pendant outer diameter and C_{GC} is the clearance (calculated over radii) between the crown inner diameter and the thickness of the gasket.

9. A watch crown as in claim **8** wherein the washer is an oil impregnated sintered metal.

10. A watch crown as in claim **8** wherein the washer is of metal and staked in place within the crown.

11. A watch crown as in claim **8** wherein the gasket is in the form of a flat annular ring prior to its compression.

12. A watch crown as in claim **8** wherein a staked lip on the crown retains the washer in place.

13. A watch crown as in claim **8** wherein the washer is attached to the crown by an adhesive.

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58—63