

PATENT SPECIFICATION

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(72) Inventor HACHIRO KUSHIDA



(54) WATCH CASE

(71) We, CITIZEN WATCH COMPANY LIMITED, a Japanese Corporation, of 9—18, 1-chome, Nishishinjuku, Shinjuku-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 watch cases.

Most conventional metallic watch cases are mainly made of steel alloy, stainless steel or gold or like precious metal. Steel alloy cases are frequently coated with a precious metal, chromium or like coating for improving its anti-corrosion performance.

Stainless steel and alloy steel watch casings have initially a very beautiful metallic appearance which is gradually lost or scratched during prolonged use of the case, for instance, two or three years of practical use, on account of the relatively low hardness of the material such as H₂₀₀ or so. On the other hand, a steel alloy watch case protected by coating frequently suffers from scale-off of the coating or pinhole formation, resulting in an early corrosion of the case material.

Watch cases made of gold, platinum or like precious metal naturally have a very high price which limits their practical use.

Recently, there is a strong trend that wrist watches, especially those for gentlemen, are designed in larger sizes which has the drawback that stabilized attachment of the watch to the wearer's moving wrist is very difficult on account of its heavy weight, since the specific weight of the conventional metal watch casing amounts generally to 7.8—8.5 g/cub. centimeter.

When the watch case is made of stainless steel, for instance, its machinability and press-formability are much worse and its manufacturing process is significantly labour-consuming and costly, even when the accompanying limitation in watch case design has been neglected.

It should be noted further that conventional stainless steel or steel alloy watch cases are

limited in appearance to "white" metallic colour and cannot provide a colourful appearance which is highly favoured with modern personal accessories.

It has been recently proposed to prepare watch cases from sintered metal carbide such as tungsten or titanium carbide for attaining a superior scratch-proof property. In this advanced and improved kind of watch case, the manufacturing difficulty, heavy weight and monotone metallic appearance cannot be avoided.

An object of the present invention is to provide a relatively light weight and scratch-proof watch case.

According to the present invention there is provided a watch case comprising a plurality of separable members including a middle member, the latter comprising a base of aluminium or aluminium alloy and a skin layer of fine crystalline γ -Al₂O₃·H₂O, said layer having a coloured and at least partly polished surface.

This invention may provide a watch case, capable of being manufactured in an easy way even on a mass-production basis.

The watch case may have a rotatable ring bearing indicia, a setting crown, a bezel, a pusher button and a rear cover of which at least one is of pure aluminium or aluminium alloy with a skin layer of γ -Al₂O₃·H₂O.

The term "watch case" as used throughout this specification, includes all the at least partially exposed conventionally metallic parts including the winding stem, but excluding the non-metallic crystal or glass. The pusher button of a chronograph calendar watch is thus to be understood to be part of the case.

The thickness of the skin layer may be 5—100 microns, preferably 20—80 microns, and most preferably in the order of 50 microns. A fine crystalline γ -Al₂O₃·H₂O skin layer *per se* has a non-metallic colourful appearance of mixed grey, brown and green. The formation of such fine crystalline hard skin layer can be carried into effect by subjecting the base metal, which has been pre-

fabricated into the case component, to an anodic oxidation step in an acid bath, using preferably sulphuric acid, oxalic acid or the like, or a mixture thereof.

- 5 The colourful appearance may be further enhanced by subjecting the anodically oxidized products successively to a dyeing step and a crystal pore-filling step. A favourable mirror finish is obtained by subjecting the final
- 10 product to a polishing step.

- The hardness of the skin layer amounts generally to H_v 400—850. In practice, the skin layer consists substantially of γ -Al₂O₃ directly after completion of the anodic oxidizing step, which compound is however converted to γ -Al₂O₃·H₂O when subjected to the crystal pore-filling step, preferably by steaming for about 30—60 minutes as an example.

- 20 The specific gravity of a watch case according to this invention is generally in the order of 2.7 g/cub. centimeter which amounts only to one third that of conventionally used stainless steel. This light-weight nature of a watch case according to this invention improves substantially the desirous stabilized portableness of the watch on the wearer's wrist.

- The manufacturing labour cost of a watch case according to this invention can be reduced to 1/2—1/5 of that of the conventional stainless steel cases on an industrial mass production basis as ascertained by our practical records.

- Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:—

- Figure 1 is an axial section view of part of a watch case embodying the invention;

- 40 Figure 2 is a similar view to Figure 1, illustrating a second embodiment of the invention; and

- Figure 3 is an exploded perspective view of several constituent parts of the watch case shown in Figure 2.

- Referring now to Figure 1, the first embodiment will be described in detail hereinafter.

- In this figure, numeral 10 represents a conventional crystal preferably made of optical glass. This crystal 10 is fixedly attached to a support ring 11 by glueing, although the glued joint therebetween has been omitted from the drawing for simplicity. This support ring 11 is made of 99.8% pure aluminium or its alloy and formed with a skin surface 11' comprising substantially γ -Al₂O₃·H₂O.

- Numeral 12 represents a bezel surrounding the crystal-support ring assembly 10; 11, said bezel being made of pure aluminium or aluminium alloy and formed with a skin layer 12' of a similar nature as before.

- Numeral 13 represents the middle or main casing member which is made of pure aluminium or aluminium alloy and formed with a skin layer 13' of a similar nature as before.

This member 13 carries the crystal-support ring assembly 10; 11 and the bezel 12.

Numeral 14 represents a winding crown which is made of pure aluminium or aluminium alloy and formed with a skin surface 14' of a similar nature as before. The crown 14 is fixedly attached to the outer end of a conventional winding stem, not shown, and rotatably mounted on a conventional bearing tube 18 through a sealing ring 27, said tube being fixedly mounted in a bore 13a of said member 13.

Numeral 15 represents a rear or bottom cover which is made of pure aluminium or aluminium alloy and formed with a skin layer of a similar nature as before. This cover 15 is detachably attached to the main casing member 13 by means of a screw joint 16. For ensuring a tight or water-proof connection between two members 13 and 15, there is provided an O-ring 17. A further O-ring 19 is provided between the two members 11 and 13 for serving in the similar way.

Since the coefficient of elasticity of pure aluminium or aluminium alloy amounts generally to 7,000—7,700 kg/sq. mm. which is about 40% of that of stainless steel, certain measures must be taken for the prevention of unintentional slipping-out of constituent parts such as the crystal and the like from the watch assembly in case of an application of sudden shock which may take place when the watch is dropped on the floor, as an example. For this purpose, the crystal 10 has been glued to the support ring 11, as was referred to hereinbefore. The fixing means are not limited only thereto. Screwing, tongue-and-groove or the like connection can also be adopted when necessary.

The engagement at 20 between the bezel 12 and the middle or main casing member 13 must be carefully designed for the same reason. The engaging allowance at the connection 20 must be increased by 50—200% of the normal value as employed in the case of stainless steel watch cases. The engaging angle at the connection 20 should be increased by 50—300% above the normally employed value and in the more acute sense. The height at the same connection place 20 should be increased by 50—100% relative to the normal value.

The screw connection at 16 between the member 13 and the rear cover 15 must also be fabricated with care. The male threads as well as female threads must be rounded at their crests and valleys or bottoms although in the drawing the threads have been only schematically drawn as if they should have sharp crests and valleys. By adopting such measures, the skin layer can be formed on the whole area of the threaded region to an even thickness during the anodizingly oxidizing step. Care must be taken not to provide sharp edges on the prefabricated watch case parts, because the γ -Al₂O₃·H₂O crystals

develop in the perpendicular direction to the surface of the base material and the presence of a sharp edge or valley will result in an absence of the crystal formation and a later development of scale-off of the skin layer beginning from such non- or insufficiently anodized areas. This disadvantageous effect is rather predominant at the edge or crest and therefore the thread bottom, if necessary, may have a regular shape.

Next, referring to Figures 2 and 3, the second embodiment of the invention will be described. In these figures, for functionally identical or similar constituent parts as before, irrespective of minor difference in the specific physical configuration, the same reference numerals are employed for quicker identification and comparison, but each has added to it 100.

In these figures, 110 represents the crystal and 111 denotes the support ring therefor, both being fixedly attached by glueing or like conventional fixing means. The skin layer of the ring 111 is shown at 111'.

The bezel and its skin layer are shown at 112 and 112', respectively.

The middle or main casing member and its skin layer are shown at 113 and 113', respectively. The winding crown and its skin surface are shown at 114 and 114', respectively. The middle member 113 is formed similarly with a lateral opening for reception of a bearing tube 118 to be described. Numerals 115 and 115'; 116; 117; 118; 119 and 120 have respectively the same meaning as before. The mutual design and arrangements of these parts are also substantially similar to before.

Numeral 21 represents a manually rotatable ring which is most clearly seen from Figure 3. This ring bears an indicating mark 21a and a time-indicating scale 21b. This ring is rotatably mounted on a ring groove 113b on a horizontal plane when seen in Figure 2. An open ring wire spring 22 is inserted between the middle 113 and the ring 21 so as to prevent unintentional disengagement of the latter, and at the same time, to provide a certain frictional resistance to the rotatable ring 21.

This ring 21 is formed with a hard skin layer 21' the nature and characteristics of which are just the same as before and provided for the same purpose.

For obtaining a more effective sealing between the crystal-support ring assembly 110; 111 and the middle 113, a further sealing ring 129 is additionally provided to the O-ring 119. It will be easily seen that all the constituting parts shown in Figure 3 may be assembled together, so as to provide a watch case with a crystal as shown in Figure 2.

As described briefly hereinbefore, the presence of sharp edges on the exposed surface of the watch case assembly must be avoided as far as possible for increasing the scale-off

resistance of the hard skin layer. A sharp edge, if formed on a part of the case by moulding, pressing, machining, grinding or any other metallurgical or mechanical process must be rounded with a radius amounting preferably to 200—500 microns. This rounding or chamfering operation should be carried into effect in advance of the anodizing step. The minimum thickness of any part of the case is preferably 800—1,000 microns in consideration of the more unfavourable mechanical strength of the pure aluminium or aluminium alloy employed for the manufacture of the watch case as compared with that of stainless steel conventionally used.

An exemplary method of manufacture of the watch case according to the invention and several performance tests are as follows:—

Example

A 6 mm. thick sheet of anticorrosive aluminium alloy, Class 1, J.I.S. (Japanese Industrial Standards) was prefabricated by pressing, cutting and grinding to the middle having the shape as shown at 13. There was no necessity for annealing in any way; on the contrary to the correspondingly shaped stainless steel watch case in which, at least four to seven annealing steps were necessary at 1,100°C or so. In this way, the manufacturing labour cost was reduced to about a half that for the conventional prefabrication method.

In a similar way, the bezel, the winding crown and the rear cover shown in Figure 1 were prefabricated.

Next, these case parts were dipped in a 7% aqueous caustic soda solution, at 60°C, for about 1—2 minutes for degreasing.

Then, these parts were subjected to an anodizing oxidation process under the following conditions:

Bath composition:

10%—sulphuric acid with the addition of 2—3% each of oxalic acid and glycerin

Treating temperature:

from minus 3°C to plus 10°C

Treating period:

40 minutes

Current density:

2 amperes/cm²

Thickness of skin layer:

30—50 microns

These parts are used without further treatment or after glazing by polishing with diamond powder.

As an alternative, the parts were coloured using a dyeing bath process in advance of performing the final polishing. Dye stuff was used in the ratio of 5—20 g. per 1,000 cc.

of pure water. The bath temperature was 60°C and the treating period was 5—10 minutes.

- 5 In most cases, in advance of the dyeing step, the parts were preferably subjected to a weak acid treatment step using, for instance, a 2.5%-acetic acid bath for about 1—2 minutes for improving the activation. This step promoted the conversion of $\gamma\text{-Al}_2\text{O}_3$ to
- 10 $\gamma\text{-Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$.

- Finally, the products were subjected to a steaming step or a hot-water treating step. In the latter case, the products were dipped in a hot pure water bath, kept at 90°—100°C, for
- 15 30 minutes, so as to seal-off the crystal pores, and to complete the conversion to $\gamma\text{-Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$.

- Details of dyestuffs and corresponding colour tones are given below.

- 20 The dyestuffs employed may be those conventionally used in the art.

- For obtaining a deep black colour effect, a dyeing solution of 1 litre water containing 10—20 g. of ammonium molybdate and 5—
- 25 10 g. of NH_4Cl , temperature 80°C.

- For obtaining a blackish red colour effect, a dyeing solution of 1 litre water containing 15 g. of potassium sulphate 0.3 g of potassium bichromate and 1 g. of alizarin, temperature 80—90°C.
- 30

- For obtaining a blackish-blue colour effect, a dyeing solution of 1 litre water containing 5 g. of potassium ferrocyanide and 5 g. of ferric chloride, temperature 70—80°C.
- 35

- Organic dyestuffs may also be used.
- For obtaining a mirror finish effect, powdery alpha- Al203 (No. 1,000—3,000) or diamond powder is coated on a rotatable Sn- or Pb-disc and the finishing operation is performed with the part wet. Finished watch cases have excellent surface finish like volcanic glass, ruby or sapphire, as the case may be depending upon the kind of dyeing step.
- 40

- Several tests were carried out.
- 45 For carrying-out a wear test, 20 watch cases prepared as described and having a skin layer 30 microns thick, together with 2 litre of water, were loaded in a rotatable drum having an effective inside volume 15 litre and the charged drum was rotated for 48 hours. Results were such that the initial mirror finish glaze was completely maintained; no scratch appeared, and the colour effect was not changed in any way.
- 50

- 55 Comparative tests were performed on stainless steel cases in which case the mirror finish was completely lost, many scratches appeared on the surface, original sharp edges were considerably rounded, and decorative appearance was damaged substantially.
- 60

Impact test.

A knife edge (hardness h_v 600) made of SK4 (JIS) tool steel was attached to the working tip of a hammer operable to have

an impact energy of 3 kg-cm and fitted on an impact testing machine was brought in impact contact with a watch case made as described and placed on the table of said machine. This impact test corresponded to the case being dropped from a height of 5.5 metres on a hard floor. A recess having a depth of 1—2 mm was formed, but not scale-off of the skin layer was observed, thus showing a satisfactorily good tightness between the skin and the base material.

65 70 75

In a comparative test on a stainless steel-made case, a slightly deeper recess (having a depth of 1.5—2 mm) was observed.

Hardness Test.

Tests were made of hardness using a load of 200 g. and hardness values of 450, 550, 400 and 490 were measured. With the use of a load of 5 g. the surface hardness was measured as 800, 780 and 850.

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Comparative tests on stainless steel cases showed hardness values of 190, 250, 213 and 218.

85

Atmospheric exposure tests.

Watch cases prepared as described were exposed to the atmosphere for six months, no colour fade was observed, except those coloured green which showed a slight fading. Initial mirror finish was practically preserved and no corrosion was seen.

90

In a comparative test on stainless steel cases, pitting was observed and an appreciable loss of the initial polish was seen.

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Salt water jet exposure tests.

10 cases were tested with jets of 5% NaCl solution at 35°C; the test period was 240 hours.

100

After a lapse of 100 hours, slight pitting was observed at edges. However, no progress of the pitting was encountered. Even after a lapse 240 hours, the initial mirror finish glaze was substantially preserved.

105

In a comparative test on stainless steel cases, red rust was observed even after a lapse of 50 hours. The rust developed gradually and after 240 hours, all the surfaces were covered with rust.

110

Artificial sweat dip tests.

Dip solution was a 50% methanol/water solution containing per 1,000 cc thereof, NaCl 10 g, urea 1 g, 85% lactic acid 4 cc and aqueous ammonia solution 0.2 cc, bath temperature was 20—25°C. dipping period extended for 30 days, and the test watches were 10 in number.

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Initial mirror finish was preserved even after ten days dip and only one of them showed slight pitting.

120

In a comparative test on stainless steel cases, no alteration was observed even after a lapse of 10 days.

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In some circumstances, the case may be of the one piece style which comprises the middle member and the bottom or rear cover as one piece.

or aluminium alloy and a skin layer of fine crystalline $\gamma\text{-Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$, said layer having a coloured and at least partly polished surface.

10

2. A watch case substantially as hereinbefore described with reference to the accompanying drawings.

5 WHAT WE CLAIM IS:—

1. A watch case comprising a plurality of separable members including a middle member, the latter comprising a base of aluminium

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