

## **Watch Component of Titanium Alloy**

The present invention concerns a watch component of titanium alloy according to the preamble of claim 1.

Among conventional materials such as gold and steel, titanium has  
5 occupied an increasingly important position in the production of watch cases for several years now. For a price appreciably less than that of gold, it offers in comparison with steel the advantage of being very well tolerated by the skin and of not giving rise to nickel allergies. Furthermore, its commercial success has been favoured by its easily identifiable mat finish which has started a  
10 craze, all the more so as this material is generally associated with watches or other products of high quality.

The invention sets off from the observation that this very particular surface appearance of titanium as generally used in watchmaking will probably not always benefit from this fashion effect. Thus, the aesthetic restrictions  
15 imposed by this material are liable not always to be accepted by a large clientele.

Attempts have already been made in the prior art to modify the appearance of watches made of titanium, e.g., by means of colouring, or by plating particular alloys of titanium on other materials. However, the plating  
20 operation adds to the cost of the components, which are, moreover, susceptible to shocks and to deep scratches.

Thus, one object of the invention is to propose watch components in titanium having an appearance different from prior art titanium components and thus capable of occupying other commercial niches.

25 This object is fulfilled according to the invention by means of a watch component made of a titanium alloy unprecedented in watchmaking.

In particular, this object is attained by resorting to a family of alloys containing at least 75% titanium, hardened by thermomechanical treatment and

having in common a mechanical strength greater than 750 MPa, preferably however close to 1000 MPa. These particular alloys have the advantage of being able to be polished on large surfaces.

Tests have already been made in the prior art with polishing watch  
5 components made of titanium. However, the titanium alloys conventionally used do not allow large parts, such as the caseband or bracelet, to be polished completely. The surface condition obtained is similar to orange peel, so that only small parts such as bezels, or small portions of larger parts, have been produced in polished solid titanium.

10 The orange peel appearance is due especially to the presence in the structure of numerous two-phase alloys, for example the phases  $\alpha$  and  $\beta$ , which are of different hardnesses and to which it is therefore difficult to give the same polishing finish. European Patent No. 0 416 929 describes a process for manufacturing a watch case made of a titanium alloy in which the already  
15 machined part is heated to a temperature above the  $\beta$  transformation point, i.e., above about 780°C, then quenched, so as to bring it into a martensitic phase. An ageing operation is then necessary before the watch case can be polished. Since this process comprises a large number of separate operations, it is consequently difficult to carry out on an industrial scale.

20 Tests have shown, however, that the grain size of the alloy plays a determining part in the quality of the polish obtained. Ordinary titanium alloys are composed of grains 150 to 200  $\mu\text{m}$  in size; thus, differences in polishing between adjacent grains are very visible.

Optimal polishing quality may therefore be obtained by refining the  
25 microstructure of the alloy, i.e., by reducing the size of the grains making up the alloy of the watch component. According to this invention, such refining is obtained by subjecting the watch component to a thermomechanical treatment.

The invention will be better understood with the aid of the examples given in the following description, no figure being necessary to illustrate them.

The present invention applies to the manufacture of any watch component, particularly the caseband, the back of the watch case, the bezel, the bracelet, and at least certain elements of the spread buckle and the clasp. The invention therefore applies to any outside part of a pocket watch or  
5 wristwatch.

According to the invention, at least one of these parts is made of a medium- or high-strength solid titanium alloy, i.e., of a titanium alloy having a mechanical strength of more than 750 MPa, but preferably close to 1000 Mpa.

These alloys have never been considered in the prior art for use in  
10 watchmaking because of unyielding prejudices, numerous watchmaking specialists believing that these materials cannot be properly machined and stamped. For that reason, titanium alloys having low mechanical strength have always been used in watchmaking. Since the mechanical properties of such alloys have been easily sufficient for watchmaking applications, there has been  
15 no incentive to use alloys supposedly much more difficult to work.

Tests carried out despite the prevalent opinion have nonetheless provided unexpected results and have shown that watch components can be produced in such alloys with modern cutting and stamping tools such as those used to machine stainless steel. Furthermore, acid engraving is likewise  
20 possible. These tests have therefore shown that those skilled in the art of machining watchmaking parts can, after a few routine manipulations, machine these new alloys by means of conventional tools despite all existing prejudices. For example, these new alloys can be machined by carefully selecting the machining tools among those currently existing and by reducing the machining  
25 speed.

It has then been found that by subjecting these alloys to a thermomechanical treatment, it is possible to reduce considerably the size of the  $\alpha$  and  $\beta$  grains of the alloy and thus to obtain a material capable of being polished to give the parts a brilliant mirror finish. Such a polish is unusual in

watchmaking for titanium watches. The advantageous properties of this material, especially its anti-allergic properties, may thus be extended to watch lines for which the use of another metal would have been preferred for aesthetic reasons.

- 5                   The thermomechanical treatment preferably consists of an operation of heating the alloy to a temperature below the  $\beta$  transformation point ( $780^{\circ}\text{C}$ ) during a deformation operation of the initial part. Preferably, the thermomechanical treatment consists of stamping the heated part at a temperature of between  $600$  and  $750^{\circ}\text{C}$ , but preferably between  $600$  and
- 10    $700^{\circ}\text{C}$ . Tests have shown that effective refining of the microstructure of the alloy is obtained when it is simultaneously subjected to pressure or to a significant deformation and heated to a temperature slightly below the  $\beta$  transformation point. Various mechanisms, e.g., dynamic recrystallization, may be used for refining the microstructure. Grain sizes of less than  $5$  microns, on
- 15   the order of  $1\text{ }\mu\text{m}$ , may be obtained through a judicious choice of the heating temperature and the deformation pressure applied.

The alloys used may also be electrolytically oxidised and anodised to obtain different colour effects.

- Hardening and stamping of the part are therefore carried out in a
- 20   single operation; no subsequent heating, quenching, or ageing operation is necessary. Hence this process is particularly advantageous to implement as compared with prior art processes.

The family of medium- and high-strength titanium alloys suitable for such polishing includes especially:

- 25                   binary alloys:       Ti 8Mn
- ternary alloys:   Ti 6Al 4V,
- Ti 7Al 4Mo

quaternary alloys: Ti 8Al 1Mo 1V,

Ti 10V 2Fe 3Al

Ti 6Al 6V 2Sn

Ti 4Al 3Mo 1V

5 Ti 10V 2Fe 3Al

Alloys composed of five or more elements: Ti 6Al 2Sn 4Zr 6Mo

Ti 5Al 2Sn 4Zr 4Mo 4Cr

Ti 6Al 2Sn 2Zr 2Mo 2Cr

Ti 15V 3Cr 3Al 3Sn

10 (the numbers indicating percent by weight in the composition).

In general, these are two-phase  $\alpha$  +  $\beta$  titanium alloys offering an optimum compromise between ductility and mechanical strength. However, almost monophase  $\alpha$  alloys or alloys of  $\beta$  structure are not excluded. These two-phase alloys can be refined and hardened by suitable thermomechanical  
15 treatments.

In the titanium alloys, the aluminium has the property of stabilising the  $\alpha$  phase, stable at temperatures of up to 880°C. The vanadium stabilises the  $\beta$  phase, which is normally stable at temperatures above 880°C. Tests have shown that the alloy Ti 6Al 4V proves optimal for the manufacture of a  
20 mirror-polished titanium watchmaking part. The composition of this alloy may vary as follows (composition in percent by weight):

aluminium 5.5 to 6.75, vanadium 3.5 to 4.5, nitrogen 0.05 maximum, carbon 0.1 maximum, hydrogen 0.015 maximum, iron 0.4 maximum, oxygen 0.2 maximum, various elements 0.1 maximum each, total 0.5 maximum, the  
25 remainder being titanium.

Advantageously, the caseband, back, bezel, spread buckle, clasp, and/or bracelet of a watch are made of one of these alloys. It is nevertheless also possible to combine the use of these alloys for certain elements, or for

certain parts of certain elements, with other materials for other elements. In particular, it is possible to combine the use of titanium having medium or high mechanical strength for certain components, especially for parts which are visible when the watch is worn, with titanium having low mechanical strength for  
5 less visible parts, e.g., for the spread buckle, which will then not be polished.



## Claims

1. Method of manufacturing a watch component made of a solid titanium alloy, comprising the steps of
  - 5       hardening an alloy containing at least 75% titanium and having a mechanical strength greater than 750 MPa during a thermomechanical treatment step, and
  - polishing visible outside surfaces of the component.
- 10       2. Method of manufacturing a watch component according to the preceding claim, characterised in that said thermomechanical treatment is obtained by heating the alloy below the  $\beta$  transformation point during an operation of deformation of the initial part.
- 15       3. Method of manufacturing a watch component according to one of the preceding claims, characterised in that said thermomechanical treatment is obtained by heating the alloy to a temperature of between 600 and 750°C during stamping of the watch component.
- 20       4. Method of manufacturing a watch component according to one of the preceding claims, characterised in that the heating time, the heating temperature, and the pressure exerted are so optimised as to obtain a grain size of the alloy of less than 5  $\mu\text{m}$ .
5. Method of manufacturing a watch component according to one of the preceding claims, characterised in that it comprises no quenching step.
- 25       6. Method of manufacturing a watch component according to one of the preceding claims, characterised in that said alloy is of the two-phase  $\alpha + \beta$  type.

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7. Method of manufacturing a watch component according to one of the preceding claims, characterised in that said alloy has the following composition (composition in percent by weight):

aluminium 5.5 to 6.75, vanadium 3.5 to 4.5, nitrogen 0.05 maximum,  
5 carbon 0.1 maximum, hydrogen 0.015 maximum, iron 0.4 maximum, oxygen 0.2 maximum, various elements 0.1 maximum each, total 0.5 maximum, the remainder being titanium.

8. Watch component made of a solid alloy containing at least 75% titanium, characterised in that said alloy is hardened during a thermomechanical treatment step, has a mechanical strength greater than 750 MPa, and at  
10 least the visible outside surfaces of the component are polished.

9. Watch component according to the preceding claim, characterised in that the grain size of the alloy is less than 5  $\mu\text{m}$ .

10. Watch component according to one of the claims 8 or 9, characterised  
15 in that said alloy is of the two-phase  $\alpha + \beta$  type.

11. Watch component according to the preceding claim, characterised in that said alloy has the following composition (composition in percent by weight):

aluminium 5.5 to 6.75, vanadium 3.5 to 4.5, nitrogen 0.05 maximum,  
20 carbon 0.1 maximum, hydrogen 0.015 maximum, iron 0.4 maximum, oxygen 0.2 maximum, various elements 0.1 maximum each, total 0.5 maximum, the remainder being titanium.

12. Watch component according to one of the preceding claims, characterised in that it is constituted by a caseband of which only the visible outside  
25 surfaces are polished.

13. Watch component according to one of the claims 8 to 12, characterised in that it is constituted by a bezel the visible outside surfaces of which are polished.

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14. Watch component according to one of the claims 8 to 12, characterised in that it is constituted by a bracelet, at least the visible outside surfaces of which are polished.

15. Watch comprising at least a caseband according to claim 12 and a  
5 bracelet according to claim 14.

16. Watch according to the preceding claim, characterised in that it further comprises at least one other piece of titanium or of titanium alloy with a mechanical strength less than that of the caseband.

17. Watch according to the preceding claim, characterised in that at  
10 least one element of the spread buckle is made of titanium or of titanium alloy with a mechanical strength less than that of the caseband.

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**Abstract**

Watch component made of the following alloy (composition in percent by weight):

5           aluminium 5.5 to 6.75, vanadium 3.5 to 4.5, nitrogen 0.05 maximum, carbon 0.1 maximum, hydrogen 0.015 maximum, iron 0.4 maximum, oxygen 0.2 maximum, various elements 0.1 maximum each, total 0.5 maximum, the remainder being titanium.

10           This alloy allows the watch component to be machined and polished with conventional tools and to be given a brilliant mirror appearance.



## Claims

1. Method of manufacturing a watch component made of a solid titanium alloy, comprising the steps of
  - 5       hardening an alloy containing at least 75% titanium and having a mechanical strength greater than 750 MPa during a thermomechanical treatment step, and
  - polishing visible outside surfaces of the component.
- 10       2. Method of manufacturing a watch component according to the preceding claim, characterised in that said thermomechanical treatment is obtained by heating the alloy below the  $\beta$  transformation point during an operation of deformation of the initial part.
- 15       3. Method of manufacturing a watch component according to one of the preceding claims, characterised in that said thermomechanical treatment is obtained by heating the alloy to a temperature of between 600 and 750°C during stamping of the watch component.
- 20       4. Method of manufacturing a watch component according to one of the preceding claims, characterised in that the heating time, the heating temperature, and the pressure exerted are so optimised as to obtain a grain size of the alloy of less than 5  $\mu\text{m}$ .
5. Method of manufacturing a watch component according to one of the preceding claims, characterised in that it comprises no quenching step.
- 25       6. Method of manufacturing a watch component according to one of the preceding claims, characterised in that said alloy is of the two-phase  $\alpha + \beta$

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type.

7. Method of manufacturing a watch component according to one of the preceding claims, characterised in that said alloy has the following composition (composition in percent by weight):

5           aluminium 5.5 to 6.75, vanadium 3.5 to 4.5, nitrogen 0.05 maximum, carbon 0.1 maximum, hydrogen 0.015 maximum, iron 0.4 maximum, oxygen 0.2 maximum, various elements 0.1 maximum each, total 0.5 maximum, the remainder being titanium.

8. Method of manufacturing a watch component made of a solid titanium  
10 alloy according to any one of the claims 1 to 6, characterised in that it consists

- on the one hand, in the selection of an alloy having the following composition (composition in percent by weight) aluminium 5.5 to 6.75, vanadium 3.5 to 4.5, nitrogen 0.05 maximum, hydrogen 0.015 maximum, oxygen 0.2 maximum, various elements 0.1 maximum each, total 0.5 maximum,  
15 the remainder being titanium, *<sic.>*

-on the other hand, in the hardening of this alloy during a step of thermomechanical treatment.

9. Watch component made of a solid alloy containing at least 75% titanium, characterised in that said alloy is hardened during a thermomechanical treatment step, has a mechanical strength greater than 750 MPa, and at  
20 least the visible outside surfaces of the component are polished.

10. Watch component according to the preceding claim, characterised in that the grain size of the alloy is less than 5  $\mu\text{m}$ .

11. Watch component according to one of the claims 9 or 10, character-

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ised in that said alloy is of the two-phase  $\alpha + \beta$  type.

12. Watch component according to the preceding claim, characterised in that said alloy has the following composition (composition in percent by weight):

5           aluminium 5.5 to 6.75, vanadium 3.5 to 4.5, nitrogen 0.05 maximum, carbon 0.1 maximum, hydrogen 0.015 maximum, iron 0.4 maximum, oxygen 0.2 maximum, various elements 0.1 maximum each, total 0.5 maximum, the remainder being titanium.

13. Watch component according to one of the preceding claims, characterised in that it is constituted by a caseband of which only the visible outside surfaces are polished.

14. Watch component according to one of the claims 9 to 13, characterised in that it is constituted by a bezel the visible outside surfaces of which are polished.

15           15. Watch component according to one of the claims 9 to 13, characterised in that it is constituted by a bracelet, at least the visible outside surfaces of which are polished.

16. Watch comprising at least a caseband according to claim 13 and a bracelet according to claim 15.

20           17. Watch according to the preceding claim, characterised in that it further comprises at least one other piece of titanium or of titanium alloy with a mechanical strength less than that of the caseband.

18. Watch according to the preceding claim, characterised in that at least one element of the spread buckle is made of titanium or of titanium alloy  
25 with a mechanical strength less than that of the caseband.

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7. Method of manufacturing a watch component according to one of the preceding claims, characterised in that said alloy has the following composition (composition in percent by weight):

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maximum, various elements 0.1 maximum each, total 0.5 maximum, the remain-  
der being titanium.

8. Method of manufacturing a watch component made of a solid titanium  
10 alloy according to any one of the claims 1 to 6, characterised in that it consists

- on the one hand, in the selection of an alloy having the following  
composition (composition in percent by weight) aluminium 5.5 to 6.75,  
vanadium 3.5 to 4.5, nitrogen 0.05 maximum, carbon 0.1 maximum, hydrogen  
0.015 maximum, iron 0.4 maximum, oxygen 0.2 maximum, various elements 0.1  
15 maximum each, total 0.5 maximum, the remainder being titanium,

-on the other hand, in the hardening of this alloy during a step of  
thermomechanical treatment.

9. Watch component made of a solid alloy containing at least 75%  
titanium, characterised in that said alloy is hardened during a thermomechani-  
20 cal treatment step, has a mechanical strength greater than 750 MPa, and at  
least the visible outside surfaces of the component are polished.

10. Watch component according to the preceding claim, characterised  
in that the grain size of the alloy is less than 5  $\mu\text{m}$ .

11. Watch component according to one of the claims 9 or 10, character-

