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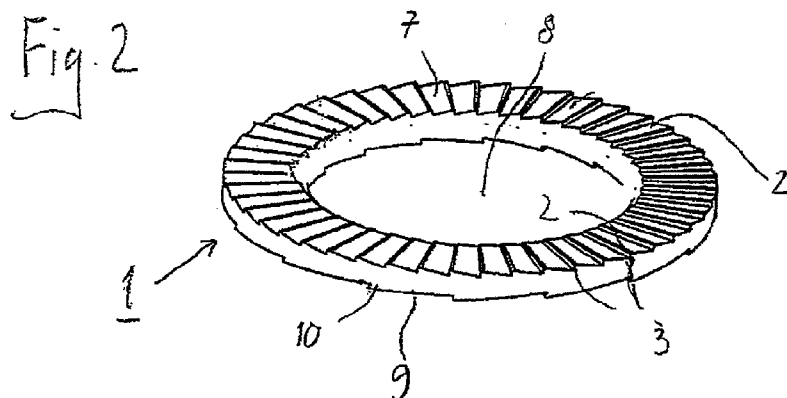
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(54) Title: A METHOD AND A PLANT FOR WASHER PRODUCTION AND A WASHER



(57) Abstract: A method for producing metallic washers (1) for locking in bolted joints, a washer having an annular configuration and on one side (9) a pattern of radially extending cams (10) and on the other side having a pattern of radially extending teeth (3), the washers on at least the side (2) having the pattern of teeth having a surface with a hardness preferably exceeding the hardness of the material to interact with the washer pattern of teeth in a locking operation. The method is especially characterized in the steps of - coating a batch of washers (1) with a corrosion resistant outer surface layer (7), the hardness of which exceeding the hardness of the material to interact with the washer pattern of teeth (3) in a locking operation. The present invention also relates to a washer and a plant.

## A METHOD AND A PLANT FOR WASHER PRODUCTION AND A WASHER

**Background**

5 Technical field

The invention relates to a process for producing a washer for locking according to the introductory portion of the accompanying claim 1.

10 The present invention further relates to a plant according to the introductory portion of the accompanying claim 24.

The present invention also relates to a washer for locking according to the introductory portion of the accompanying claim 13.

15

Prior art

Metallic washers of the kind described above are previously known. Washers of this kind are intended to be used in pairs, the sides being provided with a pattern of  
20 cams facing each other and the sides being provided with a pattern of teeth being turned outwardly and grip into a workpiece surface or a bolt head or a nut in a bolted joint. In order to obtain this, the teeth of the washers must be harder than the workpiece and the bolt head/nut, so that a penetration in the respective surface is enough to make sure that the friction in the contact between the teeth and the work-  
25 piece and bolt head/nut, respectively, exceeds the friction between the respective cam surfaces.

According to certain embodiments the metallic washers are made of steel, e.g. of stainless steel, eg acid-proof stainless steel. By cold forming of the washers the  
30 hardness increases by strain hardening. However, in this way the hardness increases to approximately the same level obtained by cold forming of bolts and nuts used in

the relevant bolted joints. Therefore the washer hardness must be increased further to secure good function.

Another known method in addition to cold forming for obtaining a hard washer surface and suitable for batchwise production is hardening in the form of heat treatment in a carbon and hydrogen atmosphere, which method provides a hard enough surface. The method, however, suffers from high costs and results in very poor stainless properties of the surface.

An object of the present invention is to provide a method for batchwise provision of metallic washers with a hard washer surface and at the same time avoiding the drawbacks of the methods previously known and commented on above.

### **Summary of the invention**

This and other objects are obtained by a method, a plant and a washer having the features according to the appended claims 1, 24 and 13, respectively.

Further advantages, discussed later, are obtained by means of what is specified in the dependent claims.

According to the invention, washers are coated with a corrosion resistant outer surface layer having a hardness exceeding the hardness of the material to interact with the washer pattern of teeth in a locking operation.

By “coating” or “coated” is intended that the corrosion resistant outer surface layer is applied on the outer surface of the washer.

### **Brief description of the drawings**

A better understanding of the present invention will be had when considering the following detailed description in conjunction with the accompanying drawings in which like details are designated with like numerals and in which

5 Fig. 1 schematically shows in cross-section one embodiment of a bolted joint using washers for locking, e.g. washers according to the present invention;

Fig. 2 shows one embodiment of a washer according to the present invention seen in a perspective view against the side having the pattern of teeth;

10

Fig. 3 shows a radial cross-section of a portion of a washer according to the present invention;

15 Fig. 4 shows a block diagram representing one embodiment of the process according to the present invention; and

Fig. 5 schematically shows one embodiment of a plant according to the present invention.

## 20 **Detailed description of preferred embodiments**

Metallic washers 1 of substantially the kind specified above are previously known and provided for e.g. bolted joints or the corresponding fastening elements for locking purposes. As schematically shown in fig.1 the sides 2 provided with a pattern of  
25 teeth 3 are turned outwardly in the pair of washers 1, the teeth being intended to grip into the bottom side 4 of the bolt head 4' or the corresponding, e.g. a nut, and a surface 5 of e.g. a workpiece 6.

30 According to preferred embodiments of the invention the washers are made of steel, e.g. stainless steel. Sometimes especially preferred are washers of acid-proof stainless steel.

According to the present invention a washer is provided with an outer surface layer 7, fig. 1, preferably intended to be harder than the material to interact with the washer pattern of teeth and, thus, into which the washer pattern of teeth is intended to grip.

According to one aspect of the present invention said surface layer 7 is made of a nickel alloy.

As shown in fig. 3 a layer 310 of electrolytically applied pure nickel is, according to one embodiment, provided under said surface layer 7 of a nickel alloy to serve as a basic coating for said outer surface layer.

According to preferred embodiments said surface layer 7 comprises a nickel / phosphorus alloy. Preferred is that said nickel / phosphorus alloy comprises about 2 – 14 % phosphorus by weight, and more specifically about 6 – 9 % phosphorus by weight, the balance being nickel and normal impurities in the nickel phosphorus alloy.

Preferably, said surface layer 7 is applied by a so-called electroless nickel plating process, preferably by a so-called barrel plating process. Such processes are known per se, the surface layer being auto-catalytically reduced onto the washers. In a barrel plating process for washers, a batch of washers are immersed in a bath in a barrel for providing the desired surface layer.

According to preferred embodiments said surface layer 7 is about 10 – 50  $\mu\text{m}$  thick.

Further, according to preferred embodiments, said surface layer 7 of the nickel / phosphorus alloy is heat treated at about 400°C for about 1 hour or at about 200 – 300°C for up to about 12 hours, preferably in an inert atmosphere and, according to one embodiment, preferably to a hardness of about 1000 HV.

According to one aspect of the present invention a method for producing washers is provided, the method thus being for batchwise production of steel washers for locking in bolted joints, a washer, fig. 2, having a flat annular configuration with a central hole 8 and on one side 9 a pattern of radially extending cams 10 and on the other side 2 having a pattern of radially extending teeth 3, the method comprising the steps of providing a hard washer surface layer, the hardness of the layer being intended to exceed the hardness of the surface material, e.g. bolt-head, nut or work-piece to interact with the washer pattern of teeth 3 in a locking operation.

In fig. 4 the steps of the method according to the present invention are illustrated.

Thus, in a first step 410 steel washers 1 are produced.

In a second step 420, which is a preferred but not always necessary step, the washers are cleaned to receive a clean surface suitable to be coated.

In a third step 430, which is also a preferred but not always necessary step, a layer 310 of pure nickel is electrolytically applied as a basic coating for said outer surface layer 7.

In a fourth step 440, a batch of washers 1 is provided with said surface layer 7. According to preferred embodiments said surface layer comprises a nickel / phosphorus alloy as described above. Also preferred is that an electroless nickel plating process is used for applying the surface layer 7, preferably performed as a barrel plating process.

In a fifth step 450, which is a preferred but not always necessary step, the surface layer 7 of said washers is heat treated at about 400°C for about 1 hour or at 200 – 300°C for up to about 12 hours, preferably in an inert atmosphere. Preferably the surface layer 7 is heat treated to about 1000 HV.

According to preferred embodiments the washers are made of stainless steel, especially preferred of acid-proof stainless steel.

- 5 According to one aspect of the present invention a plant is provided for producing washers for locking in bolted joints, the washers being of the kind discussed above, one embodiment of such a plant being shown in fig. 5.

Thus, the plant comprises means 510 for producing steel washers e.g. substantially  
10 of the kind shown in fig. 4. Preferably, the plant further comprises means 520 for cleaning washers produced and preferably means 530 for electrolytically applying a layer 310 of pure nickel on the washers as a basic coating. Further, the plant comprises means 540 for applying an outer surface layer 7 on a batch of washers, said surface layer 7 being a nickel alloy. According to preferred embodiments said layer  
15 7 consists of a nickel / phosphorus alloy and for application of said layer an electroless nickel plating process is used, preferably a barrel plating process. Further, the plant preferably comprises means 550 for heat treatment of the washers and means 560 for controlled cooling of heat treated washers.

- 20 According to another aspect of the present invention the outer surface layer provided on a batch of steel washers is applied by means of a physical vapor deposition, PVD, process, said outer surface layer being made of at least one of the compounds titanium nitride, TiN, titanium carbonitride, TiCN, chromium nitride, CrN, and titanium aluminium nitride, TiAlN.

25

An outer surface layer of this kind provides both the desired hardness and the desired stainless properties for the washer pattern of teeth side of the batch of washers. The layer thickness is preferably about 0,5 – 50  $\mu\text{m}$ .

According to this aspect of the present invention a method according to the present invention comprises the steps corresponding to the previously described steps 410, 420 and 430, the step 430 being the step comprising the PVD process.

5 Further, according to this aspect of the present invention, a plant according to the present invention comprises means corresponding substantially to the previously described means 510, 520 and 540, means 540 comprising means for providing the PVD process for providing the outer surface layer for a batch of washers.

10 The washer as well as the method and the function of the plant according to the present invention should to a considerable and necessary extent have been made clear by the description given above.

Thus, the present invention makes it possible to produce metallic washers having an  
15 outer surface layer, which provides a hardness for, inter alia, the pattern of teeth side of the washers, this hardness exceeding, if desired, the hardness of the material into which the teeth are intended to grip, such as a bolt head or a nut.

The nickel / phosphorus alloy layer has an amorphous or to a certain degree  
20 amorphous structure and provides the desired hardness as well excellent stainless and acid-proof properties.

Said alloy is also extremely suitable for batchwise application, e.g. in a barrel plating process, which provides a low cost production.

25

Said alloy may also be heat treated to a desired hardness.

Further, a nickel alloy according to the invention also provides excellent stainless properties according to, inter alia, the amorphous structure.

30

Embodiments specifying cleaning and embodiments specifying the provision of an electrolytically applied basic coating of pure nickel provides a good connection of the outer surface layer.

5 The present invention using PVD process provides a washer outer face having the desired hardness and also the desired corrosion resistance properties. Normally a cleaning operation should be performed as part of the PVD process aspect of the invention.

10 Above the present invention has been described in association with examples and preferred embodiments.

Of course, further embodiments as well as minor additions and changes may be imagined without departing from the basic inventive idea.

15

Thus, the present invention is also applicable for so-called friction locking washers.

Thus, the present invention should not be considered limited to the embodiments shown but may be varied within the scope of the accompanying claims.

20

## CLAIMS

1. A method for producing metallic washers for locking in bolted joints, a washer having an annular configuration and on one side a pattern of radially extending  
5 cams and on the other side having a pattern of radially extending teeth, the washers on at least the side having the pattern of teeth having a surface with a hardness preferably exceeding the hardness of the material to interact with the washer pattern of teeth in a locking operation, **characterized by**
  - 10 - coating a batch of washers (1) with a corrosion resistant outer surface layer (7), the hardness of which exceeding the hardness of the material (6) to interact with the washer pattern of teeth (3) in a locking operation.
2. A method according to claim 1, **wherein** said outer washer surface layer is a  
15 layer of a nickel alloy.
3. A method according to claim 1 or 2, **wherein** said outer washer surface layer is a nickel / phosphorus alloy.
- 20 4. A method according to claim 3, **wherein** said outer washer surface layer is a nickel / phosphorus alloy comprising about 2 – 14 % phosphorus by weight, preferably about 6 – 9 % phosphorus by weight.
5. A method according to claim 2, 3 or 4, **wherein** said outer washer surface layer  
25 is applied by a so-called electroless nickel plating process, preferably by so-called barrel plating.
6. A method according to anyone of claims 2 – 5, **characterized in** the steps of  
30 - cleaning the washer surface in a cleaning operation (440); and then, preferably,

- applying electrolytically a layer (310) of pure nickel before providing said outer washer surface layer (7) of said nickel alloy.

5 7. A method according to anyone of claims 1 – 6, **characterized in** the step of

- applying an outer washer surface layer (7) having a thickness of about 10 – 50  $\mu\text{m}$ .

10 8. A method according to anyone of claims 4 – 7, **characterized in** the step of

- heat treating said outer washer surface layer of said washers at about 400°C for about 1 hour or at 200 – 300°C for up to about 12 hours.

15 9. A method according to claim 8, **wherein** said outer washer surface layer is heat treated to a hardness of about 1000 HV.

10. A method according to claim 1, **characterized in** the step of

20 -applying said outer surface layer (7) being made of at least one of the compounds titanium nitride, TiN, titanium carbonitride, TiCN, chromium nitride, CrN, and titanium aluminium nitride, TiAlN by a physical vapor deposition process.

25 11. A method according to claim 10, **wherein** said outer surface layer has a thickness of about 0,5 – 50  $\mu\text{m}$ .

12. A method according to anyone of claims 1 – 11, **characterized in** the step of

30 - providing said washers as washers of steel, e.g. stainless steel, preferably acid-proof stainless steel.

13. A metallic washer for locking in bolted joints, the washer having a flat annular configuration with a central hole and on one side having a pattern of radially extending cams and on the other side having a pattern of radially extending teeth, the washer on at least the side having a pattern of teeth having a surface with a hardness at least corresponding to the hardness of the material to interact with the washer in a locking operation, **characterized in** that the washer (1) is coated with a corrosion resistant outer surface layer (7), the hardness of which exceeding the hardness of the material (6) to interact with the washer pattern of teeth (3) in a locking operation.

14. A washer according to claim 13, **wherein** said outer washer surface layer is a layer of a nickel alloy.

15. A washer according to claim 13 or 14, **wherein** a basic coating layer (310) of electrolytically applied pure nickel is provided under said surface layer (7) of a nickel alloy.

16. A washer according to claim 13, 14 or 15, **wherein** said surface layer (7) comprises a nickel / phosphorus alloy.

17. A washer according to claim 16, **wherein** said nickel / phosphorus alloy comprises about 2 – 14 % phosphorus by weight, preferably about 6 – 9 % phosphorus by weight.

18. A washer according to anyone of claims 14 – 17, **wherein** said outer washer surface layer is applied by a so-called electroless nickel plating process, preferably by a so-called barrel plating process.

19. A washer according to anyone of claims 13 – 18, **wherein** said surface layer is about 10 – 50  $\mu\text{m}$  thick.

20. A washer according to anyone of claims 14 – 16, **wherein** said surface layer is heat treated at about 400°C for about 1 hour or at 200 – 300°C for up to about 12 hours, preferably in an inert atmosphere and preferably to a hardness of about 1000 HV.

21. A washer according to anyone of claims 13 – 20, **wherein** said metallic washers being made of steel, e.g. stainless steel, preferably an acid-proof stainless steel.

22. A washer according to claim 13, **wherein** said washer outer surface layer is applied by a physical vapor deposition, PVD, process, said layer being made of at least one of the compounds titanium nitride, TiN, titanium carbonitride, TiCN, chromium nitride, CrN, and titanium aluminium nitride, TiAlN.

23. A washer according to claim 22, **wherein** said surface layer is about 0,5 – 50 µm thick.

24. A plant for producing metallic washers for locking in bolted joints, a washer having a flat annular configuration with a central hole and on one side having a pattern of radially extending cams and on the other side having a pattern of radially extending teeth, comprising means for producing the washers and for providing the washers with an increased surface hardness, **characterized in** means (510) for producing steel washers (1) and means (540) for batchwise coating of said washers with a corrosion resistant outer surface layer (7) having a hardness exceeding the hardness of the material to interact with the washer pattern of teeth (3) in a locking operation.

25. A plant according to claim 24, **wherein** said means for batchwise coating provides a surface layer comprising a nickel / phosphorus alloy comprising about 2 – 14 % phosphorus, preferably 6 – 9 % phosphorus.

26. A plant according to claim 24, **wherein** said means for batchwise coating are arranged for applying a washer outer surface layer comprising at least one of the compounds titanium nitride, TiN, titanium carbonitride, TiCN, chromium nitride, CrN, and titanium aluminium nitride, TiAlN by a physical vapor deposition, PVD, process.

27. A plant according to anyone of claims 24 – 26, **wherein said** washers are made of steel, e.g. stainless steel, preferably acid-proof stainless steel.



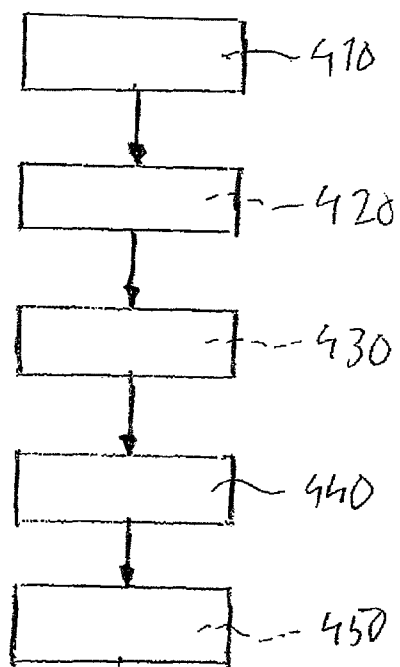


Fig. 4

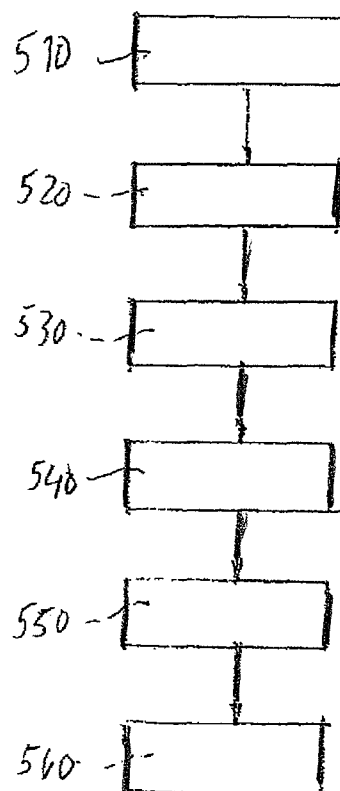


Fig. 5

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE2011/050463

## A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B21D, F16B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                     | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | US 3417802 A (OLDENKOTT CARL O), 24 December 1968 (1968-12-24); column 2, line 1 - line 4; column 2, line 28 - line 51; column 3, line 12 - line 27; column 5, line 8 - line 28; figures 1, 8, 9<br>-- | 1, 13                 |
| A         | US 5011351 A (TERRY SYDNEY L), 30 April 1991 (1991-04-30); column 4, line 8 - line 11<br>--                                                                                                            | 1-23                  |
| A         | WO 2007142599 A1 (NORD LOCK AB ET AL), 13 December 2007 (2007-12-13); page 5, line 27 - page 6, line 3; claims 1, 14<br>--                                                                             | 1-23                  |



Further documents are listed in the continuation of Box C.



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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                 | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | US 3257674 A (ERNST JORDAN), 28 June 1966 (1966-06-28); column 1, line 60 - line 68; figures 1-3<br>--                                                             | 1-23                  |
| A         | GB 514923 A (JOHN ALBERT CHAPPUIS), 21 November 1939 (1939-11-21); column 4, line 19 - line 28; figures 1-3<br>--                                                  | 1-23                  |
| A         | WO 2004033139 A2 (TERRY SYDNEY L), 22 April 2004 (2004-04-22); page 9, line 3 - line 6; figures<br>--                                                              | 13-23                 |
| A         | JP 2007302971 A (JAPAN POWER FASTENING CO LTD), 22 November 2007 (2007-11-22); (abstract) Retrieved from: PAJ database; Original document: abstract<br>--<br>----- | 1-23                  |

**Continuation of:** second sheet

**International Patent Classification (IPC)**

**B21D 53/22** (2006.01)

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Information on patent family members

International application No.  
**PCT/SE2011/050463**

|    |               |            |      |                 |            |
|----|---------------|------------|------|-----------------|------------|
| US | 3417802 A     | 24/12/1968 | NONE |                 |            |
| US | 5011351 A     | 30/04/1991 | NONE |                 |            |
| WO | 2007142599 A1 | 13/12/2007 | CN   | 101460662 A     | 17/06/2009 |
|    |               |            | DE   | 202007019121 U1 | 30/09/2010 |
|    |               |            | EP   | 2032739 A1      | 11/03/2009 |
|    |               |            | KR   | 20090023370 A   | 04/03/2009 |
|    |               |            | SE   | 0601268 L       | 09/12/2007 |
|    |               |            | SE   | 531379 C2       | 17/03/2009 |
|    |               |            | US   | 20100239389 A1  | 23/09/2010 |
| US | 3257674 A     | 28/06/1966 | CH   | 435867 A        | 15/05/1967 |
|    |               |            | NL   | 300144 A        | -          |
| GB | 514923 A      | 21/11/1939 | CH   | 246430 A        | 31/12/1946 |
|    |               |            | CH   | 246429 A        | 31/12/1946 |
|    |               |            | CH   | 204565 A        | 15/05/1939 |
| WO | 2004033139 A2 | 22/04/2004 | AU   | 2003284058 A8   | 04/05/2004 |
| JP | 2007302971 A  | 22/11/2007 | NONE |                 |            |