

(19)



(11)

EP 3 169 757 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

05.01.2022 Bulletin 2022/01

(51) Int Cl.:

C10M 103/06 ^(2006.01) **B24C 1/10** ^(2006.01)
C21D 7/06 ^(2006.01) **C10N 30/06** ^(2006.01)
C10N 50/08 ^(2006.01) **C10N 80/00** ^(2006.01)

(21) Application number: **14781678.9**

(86) International application number:

PCT/IT2014/000189

(22) Date of filing: **14.07.2014**

(87) International publication number:

WO 2016/009453 (21.01.2016 Gazette 2016/03)

(54) ANTI-GALLING METHOD FOR TREATING MATERIALS

VERFAHREN ZUR VERHINDERUNG VON FRESSEN ZUR BEHANDLUNG VON MATERIALIEN
PROCÉDÉ ANTI-GRIPPAGE POUR LE TRAITEMENT DE MATÉRIAUX

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(74) Representative: **Porta & Consulenti Associati
S.p.A.**

**Via Vittoria Colonna, 4
20149 Milano (IT)**

(43) Date of publication of application:

24.05.2017 Bulletin 2017/21

(56) References cited:

**EP-A1- 1 375 695 JP-A- 2005 307 903
JP-A- 2006 037 933 US-A- 5 019 182**

(73) Proprietor: **Italtractor ITM S.p.A.
40056 Valsamoggia (BO) (IT)**

- **GUIZHEN H XU ET AL: "The effect of
pre-treatment of substrate on fretting tribological
behavior of MoS₂ coatings", WEAR, vol. 255, no.
1-6, 1 August 2003 (2003-08-01), pages 246-252,
XP055171609, ISSN: 0043-1648, DOI:
10.1016/S0043-1648(03)00051-6**

(72) Inventor: **CALIA, Eustachio
75100 Matera (IT)**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 3 169 757 B1

Description

[0001] The present invention relates to an anti-galling method for treating materials.

[0002] Two mechanical bodies that slide with respect to each other during their normal operation can be subject to a phenomenon known as galling.

[0003] The term "galling" normally refers to the occurrence of locking of two or more complementary moving mechanical members due to excessive sliding friction, which causes the consequent temporary or permanent interruption of their regular operation.

[0004] Said galling can be due to various reasons, which lead to a single consequence: excessive overheating of the propulsion unit. For example, galling can be caused by lack of lubrication, by excessive stress at full power and prolonged over time (caused for example by an operating rate that is higher than the actual capability of the machine) or by incorrect play between the parts (an excessively small play between the bushing and the respective pivot, for example, can cause an interruption of the lubricating film; an excessive play does not allow correct segregation of the lubricant, if any, and can generate impacts between the components).

[0005] Between coupled components in reciprocal motion there is generally a lubricant (grease, oil or specific emulsions), although numerous mechanical couplings in which no lubricant is used are provided.

[0006] In principle, the present invention relates preferably to any pivot-bushing assembly the components of which are made of a metallic material (for example steel, aluminum and alloys of another type) with a reciprocal rotary motion.

[0007] In this type of assemblies, galling often occurs which causes machine downtime and evident damage of the pivot.

[0008] In order to obviate these drawbacks, lubricants are often interposed between the pivot and the bushing (within the play between them) and segregated therein by means of specific sealing elements.

[0009] In some cases, however, the lubricant may not be sufficient to avoid galling, especially after many hours of operation.

[0010] Accordingly, assemblies of the known type are particularly subject to galling and in order to avoid its onset periodic maintenance is provided which is aimed at checking the state of the lubricant arranged in the play between the pivot and the bushing and at restoring its ideal conditions.

[0011] Therefore, assemblies of the known type are subject to galling phenomena and, if one wishes to avoid the occurrence of this phenomenon, which would cause machine downtime, frequent and expensive periodic maintenance of the assemblies is necessary.

[0012] In order to reduce the onset of galling, it is known to resort to the execution of different types of thermal treatment on pivots made of quenched and tempered steel, at the end of which the surface of said pivot is sub-

jected to grinding.

[0013] Even after subjecting them to these treatments, the pivots remain in any case subject to the phenomenon of galling and therefore a long service life of the same cannot be ensured.

[0014] Guizhen, H. Xu et al. / Wear 255 (2003) 246-252 discloses the effect of pre-treatment of substrate on fretting tribological behavior of MoS₂ coatings. US 5 019 182 A discloses a method of manufacturing a steel member. EP 1 375 695 A1 discloses a sliding member having a base metal and a sprayed coating formed on an external sliding surface of said base metal.

[0015] The aim of the present invention is to solve the problems described above, proposing an anti-galling method for treating materials that allows minimizing the onset of galling to the point of making it even negligible.

[0016] Within the scope of this aim, an object of the invention is to propose an anti-galling method for treating materials that makes it possible to minimize the risk of galling of a pivot intended to be turned with respect to a bushing that is mated with it.

[0017] Another object of the invention is to propose an anti-galling method for treating materials that ensures a reduction of the periodic maintenance of the mechanical couplings that comprise components subjected to said method.

[0018] Another object of the present invention is to provide an anti-galling method for treating materials that has low costs, is relatively simple to provide in practice and is safe in application.

[0019] This aim and these and other objects that will become more apparent hereinafter are achieved by an anti-galling method for treating materials, which provides for subjecting at least one of the at least two components mutually coupled with at least one degree of freedom, made of metallic material, to a first preliminary step of thermal treatments to increase surface hardness and to a second preliminary step of surface grinding, which consists in

- performing a first step of washing at least one portion of the surface of the at least one component subjected previously to the preliminary steps;
- performing a second step of shot peening said at least one portion of the surface of the at least one component previously subjected to washing;
- performing a third step of applying a layer of molybdenum disulfide on said at least one portion of the at least one component previously subjected to shot peening.

[0020] Further characteristics and advantages of the invention will become more apparent from the description of a preferred but not exclusive embodiment, of the anti-galling method for treating materials according to the invention, illustrated by way of non-limiting example in the accompanying drawing, wherein Figure 1 is a sectional front view, along a transverse plane, of a possible rotat-

able mechanical coupling provided by applying the anti-galling method according to the invention.

[0021] With particular reference to the figure, the numeral 1 generally designates a possible rotary mechanical coupling provided by applying the anti-galling method for treating materials according to the invention.

[0022] The method according to the invention can be applied to mechanical couplings between which there is at least one degree of freedom.

[0023] Said components are preferably made of metallic material: by way of example, mention is made of metallic alloys, such as steel, or metals substantially in the pure state, such as aluminum. If reference is made to components made of steel, quenched and tempered steel will generally be used.

[0024] The anti-galling method according to the invention entails subjecting at least one of the at least two components to a first preliminary step of thermal treatments to increase surface hardness and to a second preliminary step of surface grinding.

[0025] The two preliminary steps are the ones normally applied in the background art.

[0026] The method according to the invention provides for the execution of additional consecutive steps on the at least one component.

[0027] It is in fact necessary to perform a first step of washing at least one portion of the surface of the at least one component previously subjected to the preliminary steps.

[0028] It is then necessary to perform a second step of shot peening of at least one portion of the surface of the at least one component previously subjected to washing.

[0029] Finally, the process requires the execution of a third step of application of a layer of molybdenum disulfide on the at least one portion of the at least one component previously subjected to shot peening.

[0030] The first washing step also comprises a surface degreasing of the at least one portion of the surface of the at least one component previously subjected to the preliminary steps.

[0031] Degreasing consists in removing any trace of grease or dirt from the surface of the component (generally made of steel) before subjecting it to subsequent treatments (mechanical, thermal, etcetera) or to surface finishing. It is important to remove traces of grease and dirt, because the presence of organic molecules, being constituted essentially by carbon, can be dangerous: the carbon may in fact enter the matrix of the material during a thermal treatment, if performed (some mechanical treatments that generate heat also can cause the migration of the carbon contained in the grease that is present on the external surface of the part being machined), causing an aesthetic damage to the part and most of all a local degradation of its characteristics. Carbon enrichment can affect negatively the mechanical properties of the part by hardening and embrittlement, even reducing its corrosion resistance.

[0032] Degreasing can be performed with organic solvents by utilizing the chemical principle according to which "like dissolves like" or with alkaline or acid solvents in an aqueous base. In this second case, one acts on the hydrophilic part of the compound.

[0033] The second step of shot peening the at least one portion of the surface of the at least one component previously subjected to washing is extended to obtain, in said at least one portion, a state of residual compression with a value comprised between 200 MPa and 10000 MPa: the ideal value of residual compression that can be obtained for correct execution of the method according to the invention is approximately 1100 MPa.

[0034] Shot peening is an operation that consists in surface cold hammering by means of a violent jet of spherical shot, or of cylindrical shot obtained by cutting a wire (known as cut-wire shot).

[0035] The machines that perform this treatment, i.e., peening machines, propel the jet of rounded or cylindrical shot toward the parts to be machined by means of one or more rapidly rotating impellers, generally centrifugal ones, or by means of compressed air; in any case, the materials used for the grit can be cast iron, steel, glass and, more rarely, ceramics.

[0036] Moreover, shot peening improves the distribution of the surface tensions that has been perturbed by mechanical treatments and/or thermal treatments and attenuates the concentrations of efforts produced by notches, threads, decarburization, etcetera.

[0037] Shot peening, as regards the manners of execution, resembles sanding, while for its intended purpose it is more similar to rolling, since it acts more on plasticity than on abrasion.

[0038] It causes in fact a surface compression, since its jet induces a plastic deformation that propagates to a depth of a few tenths of a millimeter in the material being considered and technically it serves to improve the distribution of surface tensions, increasing the fatigue strength of the treated part.

[0039] This effect is due to the residual compressive tensions that it causes in the surface of the material and in the underlying layers, which are able to reduce the internal tensions when the part is subjected to stresses. The material is thus rendered more resistant to fatigue stresses.

[0040] At the end of the treatment, due to the microcavities that are generated and are mutually superimposed, one has, as a secondary effect, also a reduction in the quantity of light reflected on the material, i.e., a sort of satin finish.

[0041] The effect of shot peening depends, if the nature of the shot peened material remains constant, on the hardness and size of the shot, on the flowrate, on the velocity and angle of impingement of the stream, on the distance of the part from the projection system, on the intensity and on the coverage. Shot peening intensity, measured in Almen degrees, is evaluated by the curvature undergone, in the direction of incidence of the

stream, by one of the two faces of a laminar test piece (76 x 19 mm) obtained from C 70 UNI 7845 killed steel hardened and tempered at $44 \div 45$ HRC, the thickness "s" of which can assume three different values that correspond to shot peenings of weak intensity N, medium intensity A, and strong intensity C. The curvature, produced by the stream of shot, is measured with a quadrant comparator.

[0042] Coverage is determined by subjecting a polished test piece to a stream of shot for a time that corresponds to the associated intensity and by measuring, with a 50X magnification, the areas of all the impinged regions located within a circumference having a conventionally set diameter; coverage is defined as the ratio between the sum of the areas of the impinged regions and the area of the circle.

[0043] This second step of shot peening of the at least one portion of the surface of the at least one component subjected previously to washing is performed with S110 steel balls with a diameter comprised between 0.01 mm and 1.5 mm: preferably, balls are adopted which have a diameter equal to approximately 0.3 mm, a value for which an optimum result of the treatment in the method according to the invention has been observed.

[0044] It should also be noted that the second step of shot peening of the at least one portion of the surface of the at least one component subjected previously to washing is performed with an intensity between 4 and 40 Almen degrees referred to a type A test piece (i.e., peening of medium intensity identified by the letter A).

[0045] In this case also, it is deemed appropriate to specify that the ideal value of peening intensity, expressed in Almen degrees and referred to peening of medium intensity identified by the letter A, is approximately 6 or 8.

[0046] In any case, said second step of shot peening is performed by providing a coverage of more than 60%, although optimum results are achieved with 100% coverage of said at least one portion.

[0047] The third step of the method according to the invention, which corresponds to the application of a layer of molybdenum disulfide on the at least one portion of the at least one component, entails the provision of a layer with a thickness comprised between 1 and 50 μm .

[0048] In this case also, it is convenient to specify that ideal thicknesses of molybdenum disulfide, within the scope of the method according to the invention, are between 5 and 15 μm .

[0049] The third step of application of a layer of molybdenum disulfide on the at least one portion of the at least one component provides for the aspersion, on said portion, of an aerosol comprising molybdenum disulfide in a percentage by weight of more than 10%, inorganic resins, solvents and propellants.

[0050] It is preferable to adopt aerosols in which the molybdenum disulfide percentage is higher than 20% in order to obtain better results and a more efficient and stable layer on the treated portion of the component.

[0051] The combination of the steps indicated and provided by the method according to the invention is particularly effective, since surface cleaning defines ideal conditions for the adhesion of the molybdenum disulfide layer.

[0052] At the same time, the shot peening step generates on the outer surface of the component a plurality of contiguous micro-concavities.

[0053] This surface irregularity facilitates the adhesion of the molybdenum disulfide, ensuring that deposits of even higher thickness are produced locally which increase its structural strength.

[0054] Furthermore, it is evident that with respect to a same smooth surface, the surface affected by a plurality of contiguous concavities without discontinuity has a larger area, thus extending the regions of contact between the molybdenum disulfide and the surface itself: the toughness of the adhesion of the molybdenum disulfide is directly proportional to the area of the surface that is coated and therefore an irregular surface produces a higher stability of the stratification.

[0055] Finally, the residual tension produced by the shot peening step ensures higher rigidity of the surface of the component.

[0056] A component that is less subject to deformations is certainly more suitable to be subjected subsequently to the deposition of a layer of rigid material, since deformations might cause layer separations.

[0057] The combination of the steps entails therefore an overlap of the indicated effects and also a synergistic combination thereof which ensures a strength of the layer of molybdenum disulfide and also an effectiveness of the mechanical coupling that is surprising in terms of durability and mechanical performance.

[0058] It should be noted that the method according to the invention also provides for the optional execution of an additional auxiliary step of removing material in the other of the two mutually coupled components, in order to increase play between them.

[0059] The removal of material, in this case, occurs at at least one region of the other component that does not face and is proximate to the at least one portion subjected to the first to third steps.

[0060] The removal of material makes it possible to ensure that sliding between the two (or more) components occurs exclusively at the portions subjected to the method: the other parts in fact are separated by considerable play, which is obtained with the further removal of material provided in the auxiliary step cited earlier.

[0061] Moreover, the increase in plays makes it possible to contain a larger quantity of lubricant (oil or grease) within said plays. The lubricant is segregated within the free space (play) that is present between the components by means of respective sealing elements of the traditional type, for which the provision of any specific description is not deemed necessary (since they are known).

[0062] According to a particular application of the method according to the invention, which makes it pos-

sible to simply and immediately identify its numerous advantages and considerable potentials, a first component is constituted by a pivot 2 and a second component is constituted by a bushing 3.

[0063] The pivot 2, in the configuration for use, is inserted rotatably within the bushing 3 and defines a sliding of its at least one portion 4, subjected to the first to third steps, on corresponding areas of the internal surface of the bushing 3.

[0064] In turn, the bushing 3 is machined with removal of material on a part of its internal surface in order to define a region 5 of the cavity formed by it that has a larger diameter.

[0065] In this manner it is possible to identify a play 6 (which can also have considerable dimensions) between the pivot 2 and said region 5 of the bushing 3.

[0066] Within the play 6, a predefined quantity of lubricant can be segregated which facilitates the mutual rotations of the pivot 2 and the bushing 3.

[0067] The accompanying figure, in particular, refers to a possible coupling of links of a chain that are mutually articulated.

[0068] Analyzing specifically the constructive solution given by way of example, the links 7 and 8 of the chain in this case are keyed on the bushing 3 with a predefined interference.

[0069] Likewise, two other chain links 9 and 10, opposite the ones that are integral with the bushing 3, are keyed, again by adopting a predefined interference, on the pivot 2.

[0070] In practice, according to the configuration defined previously, the assembly of the pivot 2 and of the links 9 and 10 constitutes a first joint part and the assembly of the bushing 3 and of the links 7 and 8 constitutes a second joint part.

[0071] The two joint parts constitute the mechanical coupling, which can be particularly efficient if the portions 4 of the pivot 2 that are intended to slide on the internal surface of the bushing 3 have been subjected to the method according to the invention.

[0072] Finally, it is specified that in order to ensure the necessary segregation of the lubricant in the play 6 defined between the pivot 2 and the region with larger diameter of the cavity inside the bushing 3, sealing elements 11 and 12 are used between the pivot 2 and the bushing 3.

[0073] Chains of the type shown in the accompanying figure are used universally in earth-moving machines and in many other industrial processes.

[0074] The method according to the invention can be applied in any case to a considerable number of other mechanical couplings and joints which, due to the mechanical tensions applied and/or to the speed and frequency of the mutual movements, are normally subject to galling.

[0075] Advantageously, the present invention solves the problems described earlier, proposing an anti-galling method for treating materials that allows minimizing the

onset of galling to the point of even rendering it negligible.

[0076] This result is achieved by the synergistic effect of the residual state of compression induced by the shot peening step and by the presence of a layer of molybdenum disulfide.

[0077] Usefully, the anti-galling method according to the invention allows minimizing the risk of galling of a pivot 2 intended to be turned with respect to a bushing 3 that is mated therewith, thus being particularly effective in the case of rotary couplings.

[0078] Efficiently, the anti-galling method according to the invention ensures a reduction in periodic maintenance of the mechanical couplings comprising components subjected to said method.

[0079] In fact, the reduced onset of the galling phenomenon and the presence of a greater play 6 (with respect to couplings of the traditional type) ensures a drastic reduction of the number of required maintenance interventions.

[0080] Favorably, the anti-galling method according to the invention can be performed with substantially low costs, is relatively simple to provide in practice and is safe in application.

[0081] The materials used, as well as the dimensions, may be any according to the requirements and the state of the art.

[0082] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. An anti-galling method for treating materials, which provides for subjecting at least one of the at least two components mutually coupled with at least one degree of freedom, made of metallic material, to a first preliminary step of thermal treatments to increase surface hardness and to a second preliminary step of surface grinding, which consists in

- performing a first step of washing at least one portion of the surface of the at least one component subjected previously to the preliminary steps, said first washing step also comprising surface degreasing of the at least one portion of the surface of the at least one component subjected previously to the preliminary steps;
- performing a second step of shot peening said at least one portion of the surface of the at least one component previously subjected to washing;
- performing a third step of applying a layer of molybdenum disulfide to said at least one por-

tion of the at least one component previously subjected to shot peening; said third step of application of a layer of molybdenum disulfide on said at least one portion of the at least one component providing for the aspersion, on said at least one portion, of an aerosol comprising molybdenum disulfide in a percentage by weight of more than 10%, inorganic resins, solvents and propellants.

2. The anti-galling method according to claim 1, **characterized in that** said second step of shot peening said at least one portion of the surface of the at least one component previously subjected to washing is prolonged until a state of residual compression with a value comprised between 200 MPa and 10000 MPa is obtained in said at least one portion.
3. The anti-galling method according to claim 1, **characterized in that** said second step of shot peening said at least one portion of the surface of the at least one component previously subjected to washing is performed with S110 steel balls with a diameter comprised between 0.01 mm and 1.5 mm.
4. The anti-galling method according to claim 1, **characterized in that** said second step of shot peening said at least one portion of the surface of the at least one component previously subjected to washing is performed with an intensity whose value is comprised between 4 and 20 Almen degrees referred to a type A test piece.
5. The anti-galling method according to claim 1, **characterized in that** said second step of shot peening said at least one portion of the surface of the at least one component previously subjected to washing is performed with a coverage of more than 60% of said at least one portion.
6. The anti-galling method according to claim 1, **characterized in that** said third step of application of a layer of molybdenum disulfide on said at least one portion of the least one component provides for the creation of a layer with a thickness comprised between 1 and 50 μm .
7. The anti-galling method according to claim 1, **characterized in that** it comprises an auxiliary step of removing material in the other one of the two mutually coupled components to increase the play between them, said removal of material taking place in at least one region of said other component that does not face and lie proximate to said at least one portion subjected to the first to third steps.
8. The anti-galling method according to claim 1, **characterized in that** a first component is a pivot (2) and

a second component is a bushing (3), said pivot (2), in the configuration for use, being inserted rotatably within said bushing (3) and defining a sliding of its at least one portion (4), subjected to the first to third steps, on corresponding areas of the internal surface of said bushing (3).

Patentansprüche

1. Verfahren zur Verhinderung von Fressen zur Behandlung von Materialien, das vorsieht, dass mindestens eines der mindestens zwei mit mindestens einem Freiheitsgrad miteinander gekoppelten Bauteile aus metallischem Material einem ersten vorbereitenden Schritt von Wärmebehandlungen zur Erhöhung der Oberflächenhärte und einem zweiten vorbereitenden Schritt des Oberflächenschleifens unterzogen wird, der besteht in
 - Durchführen eines ersten Schritts des Waschens mindestens eines Abschnitts der Oberfläche des mindestens einen Bauteils, das zuvor den vorbereitenden Schritten unterzogen wurde, wobei der erste Schritt des Waschens auch das Entfetten der Oberfläche des mindestens einen Abschnitts der Oberfläche des mindestens einen Bauteils umfasst, das zuvor den vorbereitenden Schritten unterzogen wurde;
 - Durchführen eines zweiten Schritts des Kugelstrahlens des mindestens einen Abschnitts der Oberfläche des mindestens einen Bauteils, das zuvor dem Waschen unterzogen wurde;
 - Durchführen eines dritten Schritts des Aufbringens einer Schicht aus Molybdändisulfid auf den mindestens einen Abschnitt des mindestens einen Bauteils, das zuvor dem Kugelstrahlen unterzogen wurde; wobei der dritte Schritt des Aufbringens einer Schicht aus Molybdändisulfid auf den mindestens einen Abschnitt des mindestens einen Bauteils das Aufsprühen eines Aerosols auf den mindestens einen Abschnitt vorsieht, das Molybdändisulfid in einem Gewichtsprozentanteil von mehr als 10 %, anorganische Harze, Lösungsmittel und Treibmittel umfasst.
2. Verfahren zur Verhinderung von Fressen nach Anspruch 1, **dadurch gekennzeichnet, dass** der zweite Schritt des Kugelstrahlens des mindestens einen Abschnitts der Oberfläche des mindestens einen Bauteils, das zuvor dem Waschen unterzogen wurde, verlängert wird, bis ein Zustand der Restkompression mit einem Wert zwischen 200 MPa und 10000 MPa in dem mindestens einen Abschnitt erreicht wird.
3. Verfahren zur Verhinderung von Fressen nach Anspruch 1, **dadurch gekennzeichnet, dass** der zwei-

te Schritt des Kugelstrahlens des mindestens einen Abschnitts der Oberfläche des mindestens einen Bauteils, das zuvor dem Waschen unterzogen wurde, mit S110-Stahlkugeln mit einem Durchmesser zwischen 0,01 mm und 1,5 mm durchgeführt wird.

4. Verfahren zur Verhinderung von Fressen nach Anspruch 1, **dadurch gekennzeichnet, dass** der zweite Schritt des Kugelstrahlens des mindestens einen Abschnitts der Oberfläche des mindestens einen Bauteils, das zuvor dem Waschen unterzogen wurde, mit einer Intensität durchgeführt wird, deren Wert zwischen 4 und 20 Almen-Grad liegt, bezogen auf ein Prüfstück vom Typ A.
5. Verfahren zur Verhinderung von Fressen nach Anspruch 1, **dadurch gekennzeichnet, dass** der zweite Schritt des Kugelstrahlens des mindestens einen Abschnitts der Oberfläche des mindestens einen Bauteils, das zuvor dem Waschen unterzogen wurde, mit einer Bedeckung von mehr als 60 % des mindestens einen Abschnitts durchgeführt wird.
6. Verfahren zur Verhinderung von Fressen nach Anspruch 1, **dadurch gekennzeichnet, dass** der dritte Schritt des Auftragens einer Schicht aus Molybdändisulfid auf den mindestens einen Abschnitt des mindestens einen Bauteils für die Erzeugung einer Schicht mit einer Dicke zwischen 1 und 50 µm sorgt.
7. Verfahren zur Verhinderung von Fressen nach Anspruch 1, **dadurch gekennzeichnet, dass** es einen zusätzlichen Schritt des Abtragens von Material in dem anderen der beiden miteinander gekoppelten Bauteile umfasst, um das Spiel zwischen ihnen zu vergrößern, wobei das Abtragen von Material in mindestens einem Bereich des anderen Bauteils erfolgt, der dem mindestens einen Abschnitt, der den ersten bis dritten Schritten unterzogen wurde, nicht zugewandt ist und in der Nähe davon liegt.
8. Verfahren zur Verhinderung von Fressen nach Anspruch 1, **dadurch gekennzeichnet, dass** ein erstes Bauteil ein Drehzapfen (2) und ein zweites Bauteil eine Buchse (3) ist, wobei der Drehzapfen (2) in der Gebrauchskonfiguration drehbar in die Buchse (3) eingesetzt ist und ein Gleiten seines mindestens einen Abschnitts (4), der den ersten bis dritten Schritten unterzogen wurde, auf entsprechenden Bereichen der Innenfläche der Buchse (3) definiert.

Revendications

1. Procédé d'anti-grippage pour le traitement de matériaux, qui prévoit de soumettre au moins l'un des au moins deux composants mutuellement couplés selon au moins un degré de liberté, réalisés en un ma-

tériau métallique, à une première étape préliminaire de traitements thermiques pour augmenter la dureté de surface et à une seconde étape préliminaire de meulage de surface, qui consiste à

- effectuer une première étape de lavage d'au moins une partie de la surface de l'au moins un composant soumis précédemment aux étapes préliminaires, ladite première étape de lavage comprenant également un dégraissage de surface de l'au moins une partie de la surface de l'au moins un composant soumis précédemment aux étapes préliminaires ;
- effectuer une deuxième étape de grenaillage de ladite au moins une partie de la surface de l'au moins un composant précédemment soumis au lavage ;
- effectuer une troisième étape d'application d'une couche de disulfure de molybdène sur ladite au moins une partie de l'au moins un composant précédemment soumis à un grenaillage ; ladite troisième étape d'application d'une couche de disulfure de molybdène sur ladite au moins une partie de l'au moins un composant prévoyant l'aspersion, sur ladite au moins une partie, d'un aérosol comprenant du disulfure de molybdène selon un pourcentage en poids de plus de 10 %, des résines inorganiques, des solvants et des propulseurs.

2. Procédé d'anti-grippage selon la revendication 1, **caractérisé en ce que** ladite deuxième étape de grenaillage de ladite au moins une partie de la surface de l'au moins un composant précédemment soumis à un lavage est prolongée jusqu'à ce qu'un état de compression résiduelle avec une valeur comprise entre 200 MPa et 10000 MPa soit obtenu dans ladite au moins une partie.
3. Procédé d'anti-grippage selon la revendication 1, **caractérisé en ce que** ladite deuxième étape de grenaillage de ladite au moins une partie de la surface de l'au moins un composant précédemment soumis à un lavage est effectuée avec des billes d'acier S110 d'un diamètre compris entre 0,01 mm et 1,5 mm.
4. Procédé d'anti-grippage selon la revendication 1, **caractérisé en ce que** ladite deuxième étape de grenaillage de ladite au moins une partie de la surface de l'au moins un composant précédemment soumis à un lavage est effectuée avec une intensité dont la valeur est comprise entre 4 et 20 degrés Almen par rapport à une éprouvette de type A.
5. Procédé d'anti-grippage selon la revendication 1, **caractérisé en ce que** ladite deuxième étape de grenaillage de ladite au moins une partie de la sur-

face de l'au moins un composant précédemment soumis à un lavage est effectuée avec une couverture de plus de 60 % de ladite au moins une partie.

6. Procédé anti-grippage selon la revendication 1, **caractérisé en ce que** ladite troisième étape d'application d'une couche de disulfure de molybdène sur ladite au moins une partie de l'au moins un composant permet la création d'une couche avec une épaisseur comprise entre 1 μm et 50 μm . 5
10

7. Procédé anti-grippage selon la revendication 1, **caractérisé en ce qu'il** comprend une étape auxiliaire d'enlèvement de matière dans l'autre des deux composants mutuellement couplés pour augmenter le jeu entre eux, ledit enlèvement de matière ayant lieu dans au moins une région dudit autre composant qui ne fait pas face et ne se trouve pas à proximité de ladite au moins une partie soumise aux première à troisième étapes. 15
20

8. Procédé anti-grippage selon la revendication 1, **caractérisé en ce qu'un** premier composant est un pivot (2) et un second composant est une douille (3), ledit pivot (2), dans la configuration d'utilisation, étant inséré de manière rotative dans ladite douille (3) et définissant un glissement de son au moins une partie (4), soumise aux première à troisième étapes, sur des zones correspondantes de la surface interne de ladite douille (3). 25
30

35

40

45

50

55

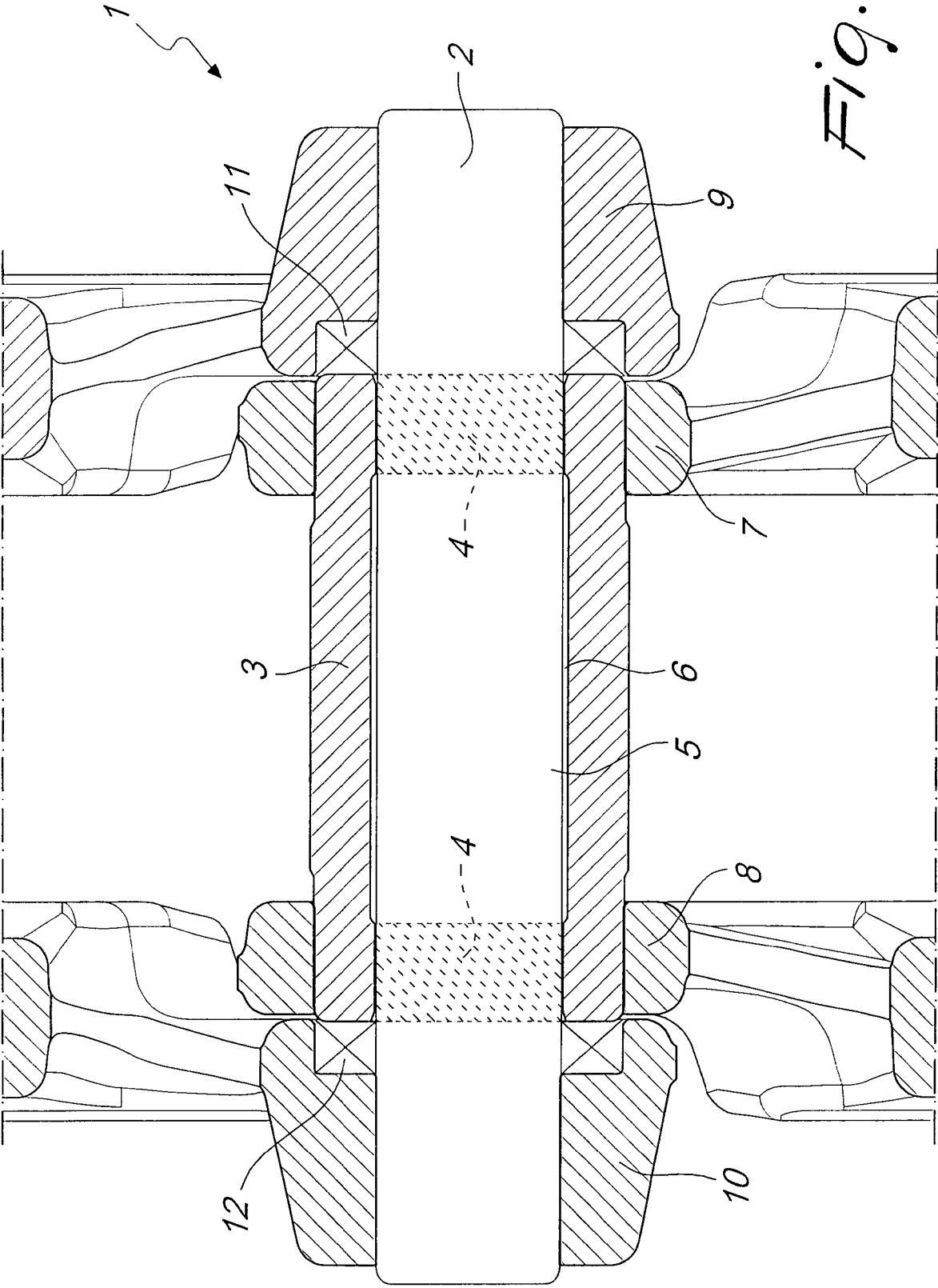


Fig. 1

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 5019182 A [0014]
- EP 1375695 A1 [0014]

Non-patent literature cited in the description

- GUIZHEN, H. XU et al. *Wear*, 2003, vol. 255, 246-252
[0014]