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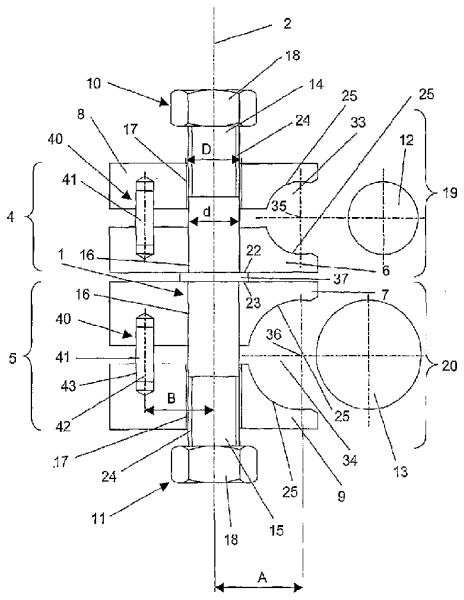
[Fortsetzung auf der nächsten Seite]

(54) Title: DOUBLE JAWS WITH AN ELASTIC CLOSING ACTION FOR DISTRACTION-COMPRESSION APPARATUS

(54) Bezeichnung: ELASTISCH SCHLIESSENDE DOPPELBACKEN ZU EXTERNEM FIXATEUR



(57) Abstract: The invention relates to a device for clamping and releasing fixing elements (12;13) in a surgical fixing or repositioning device. Said device comprises: A) a cylindrical or prismatic rod (1) with a longitudinal axis (2), a first end (14), a second end (15), a first rod segment (19) that adjoins the first end (14) and a second rod segment (20) that adjoins the second end (15); B) a first pair of clamping jaws (4) that can be displaced along the first rod segment (19) coaxially with the longitudinal axis (2); C) a second pair of clamping jaws (5) that can be displaced along the second rod segment (20) coaxially with the longitudinal axis (2); whereby; D) both pairs of clamping jaws (4;5) comprise a respective inner clamping jaw (6;7) and an outer clamping jaw (8;9) that faces the ends (14;15) and the respective clamping jaws (6;7;8;9) of each pair of clamping jaws (4;5) have opposing gripping surfaces (29;30;31;32); E) A gripping element (10;11) for clamping and releasing fixing elements (12;13) in a surgical fixing or repositioning device is mounted between two opposing gripping surfaces (29;30;31;32); and F) an elastic element (40) is located between a respective inner and outer clamping jaw (6;8;7;9), interconnecting the latter (6;8;7;9).

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Veröffentlicht:

— *mit internationalem Recherchenbericht*

— *mit geänderten Ansprüchen*

Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(57) **Zusammenfassung:** Die Vorrichtung dient zum lösbaren Festklemmen von Befestigungsmitteln (12;13) innerhalb einer chirurgischen Fixations- oder Repositionsvorrichtung. Sie umfasst: A) einen zylindrischen oder prismatischen Stab (1), welcher eine Längsachse (2), ein erstes Ende (14), ein zweites Ende (15) sowie ein endständig an das erste Ende (14) angrenzendes erstes Stabsegment (19) und ein endständig an das zweite Ende (15) angrenzendes zweites Stabsegment (20) umfasst; B) ein erstes, auf dem ersten Stabsegment (19) koaxial zur Längsachse (2) verschiebbares Klemmbackenpaar (4); C) ein zweites, auf dem zweiten Stabsegment (20) koaxial zur Längsachse (2) verschiebbares Klemmbackenpaar (5); wobei; D) die beiden Klemmbackenpaare (4;5) je eine innere Klemmbacke (6;7) und eine, gegen die Enden (14;15) gerichtete, äussere Klemmbacke (8;9) umfassen und die jeweils zwei Klemmbacken (6;7;8;9) jedes Klemmbackenpaares (4;5) gegeneinander gerichtete Spannflächen (29;30;31;32) aufweisen; E) ein Spannmittel (10;11) zum lösbaren Festklemmen von Befestigungsmitteln (12;13) einer chirurgischen Fixations- oder Repositionsvorrichtung zwischen je zwei gegeneinander gerichteten Spannflächen (29;30;31;32); und F) ein jeweils zwischen einer inneren und einer äusseren Klemmbacke (6;8;7;9) angeordnetes elastisches Mittel (40), welches die innere und äussere Klemmbacke (6,8;7,9) verbindet.

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ELASTICALLY LOCKING DOUBLE JAWS FOR AN EXTERNAL FIXATOR

The invention concerns a device for the detachable clamping of fastening elements within a surgical fixing or repositioning device.

A reference herein to a patent document or other matter which is given as prior art is not to be taken as an admission that that document or matter was, in Australia, known or that the information it contains was part of the common general knowledge as at the priority date of any of the claims.

A double jaw connection for elements of an external fixator is disclosed in DE 295 12 917 Jaquet. This hinged connector comprises a positional arrangement of two pairs of clamping jaws, that is made up from an upper outer clamping jaw and an upper inner clamping jaw as well as from a lower inner clamping jaw and a lower outer clamping jaw. The four clamping jaws are arranged on a central clamping shaft. A coil spring is inserted between the pairs of clamping jaws, i.e. between both inner clamping jaws, said coil spring causing that both inner clamping jaws are pressed apart from one another and against the outer clamping jaws. The clamping jaws are continuously held together by locking against the effect of the elastic means. Between each pair of clamping jaws grooves are provided on the clamping surfaces, said grooves forming transversely to the clamping shaft a passage each for the fastening rods or insertion connectors of the external fixator. These passages are open to the outside and enable the insertion of the fastening rods or insertion connectors into the opening of the clamping jaw of the relevant passage by exerting pressure against the effect of the elastic means. After snapping the fastening rods or insertion connectors into the passages, they will be held firmly by the action of the elastic means, before the hinged connector is definitively locked.

A disadvantage of this device is, that the coil spring is provided between the pairs of clamping jaws and due to this it is difficult to access it. Furthermore, this device does not have a constant spring force, because that depends from the position of the nut. Finally, the coil spring is subject to high fatigue.

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According to the present invention, there is provided a device for the detachable clamping of fastening elements within a surgical fixing or repositioning device, including

A) a cylindrical or prismatic rod that has a longitudinal axis, a first end, a second end, a terminal first rod segment adjoining the first end, and a terminal second rod segment adjoining the second end;

B) a first pair of clamping jaws that can be displaced on the first rod segment coaxially with the longitudinal axis;

C) a second pair of clamping jaws that can be displaced on the second rod segment coaxially with the longitudinal axis; wherein

D) the first and second pair of clamping jaws each have an inner clamping jaw and an outer clamping jaw directed towards the first and second ends of the rod, and the inner and outer clamping jaws of the first and second pairs of clamping jaws have clamping surfaces directed against one another; and

E) the device includes at least one clamping means for detachable clamping of fastening elements of a surgical fixing or repositioning device between respective pairs of clamping surfaces each directed against one another; whereby

F) an elastic means is arranged between each pair of inner and outer clamping jaws that joins the inner and outer clamping jaws,

wherein

G) the elasticity of the elastic means is provided such that, when the clamping means are loosened, rod-like fastening elements inserted between a pair of first and second clamping jaws are clamped between the clamping surfaces of the pair of clamping jaws by means of the elasticity of the elastic means.

The present invention can preferably provide a device for the detachable clamping of fastening elements, like rods, retractors, rings or bone screws, that

a) has an elastic element for each pair of clamping jaws, so that an independent manipulation of both pairs of clamping jaws is possible;

b) has fewer components than devices known to the Applicant, so that a simpler manipulation and cleaning is possible; and

c) has a constant spring force (also without nut/screw actuation).

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In a preferred embodiment the clamping jaws have bores passing through them, which are coaxial with the longitudinal axis. The purpose of these bores is to accommodate the rod in such a manner, that the clamping jaws are arranged axially displaceably on the rod. Preferably, the bore of at least one clamping jaw of each pair of clamping jaws the rod has a radial clearance, so that at least one clamping jaw of each pair of clamping jaws can be tilted from the position that is coaxial with the longitudinal axis of the rod.

This clearance can be preferably achieved by that in the axial region of the clamping jaws the rod has a diameter d and the bore of at least one clamping jaw of each pair of clamping jaws has a diameter D, and $D > d$. The $(D-d):d$ ratio can be between 0.01 and 0.10.

In another embodiment the rod has at least one reduction in the axial region of the clamping jaws, so that the rod has a minimum thickness b at the reductions. Further preferably, the bore of at least one clamping jaw of each pair of clamping jaws has a diameter D, while $b < D$. The at least one indentation may be executed, for example, as an annular groove.

In another embodiment indentations are formed on the clamping surfaces, said indentations lying between the opposite situated sides of the two clamping jaws belonging to one pair of clamping jaws. By virtue of these indentations grooves can be formed to accommodate the rod-shaped fastening means. The indentations can extend transversely and eccentrically to the longitudinal axis of the rod. Preferably each groove has an axis that is at right angles to the longitudinal axis of the rod and is at a distance of A from it.

In a further embodiment the elastic means are arranged on that side of the clamping jaws which, relative to the longitudinal axis, is on the side opposite to the groove. The elastic means are preferably at a distance from the longitudinal axis of the rod, while there is a distance B between the central axis of the elastic means and the longitudinal axis of the rod.

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In another embodiment the elastic means are executed as a rod-shaped element with a central axis that is parallel to the longitudinal axis of the rod.

Preferably elastic means are used, which are made from a material with a non-linear stress-deformation diagram. The elastic means can be made from a memory metal alloy, preferably from nitinol, without its clamping effect based on the memory effect. For this reason the memory metal alloy can have a transition temperature of higher than 50°, preferably higher than 80°. The transition temperature can be higher than 100°, preferably higher than 120°. Pseudoelastic materials are also preferable.

In particular the elastic means can be made from a nickel-titanium alloy, wherein 45%<Ni<55%, 45%<Ti<55% and x+y = 100%. Such a material is particularly biocompatible and highly elastic.

Apart from metallic materials the elastic means can be also made from a synthetic material, preferably from polyetheretherketone (PEEK) or carbonfibre reinforced PEEK.

In another embodiment at least one clamping means is executed as a threaded joint, whereby preferably a nut can be screwed on a rod via a thread. Instead of the nut a bolt can be screwed into a bore with an inside thread. The second

clamping means may be a head firmly joined with the rod or a second threaded joint.

In a further embodiment an annular disc is arranged between the inner clamping jaws of both pairs of clamping jaws. Depending on the embodiment the disc may be displaceable on the rod coaxially with the longitudinal axis, or be integral with the rod. By virtue of the disc, firmly joined with the rod, it can be achieved that the pairs of clamping jaws are so separated between the first and the second rod segment, that their actions will be independent.

The grooves are preferably cylindrical or prism-shaped, due to which an increased clamping effect can exerted on the rod-shaped fastening means. This is even more so when, viewed in a cross-section that is perpendicular to the axis of the groove, the grooves surround the rod-shaped fastening elements with an angle $\alpha > 180°$.

So that in the non-fixed state of the device the rod-shaped fastening elements could be snapped into the grooves transversely to the longitudinal axis of the device, the ratio *B*:*LW* between the minimum width *B* of a groove on the opening, that is perpendicular to the axis of the groove, on the lateral surfaces of the clamping jaws to the inside width *LW* of the same groove is preferably between 70% and 90%.

The invention and developments of the invention are explained in the following in detail based on the partly schematic illustrations of several embodiments.

They show in:

Fig.1 - a longitudinal section through an embodiment of the device according to the invention,

Fig.2 - a longitudinal section through another embodiment of the device according to the invention,

Fig.3a - a lateral view of the embodiment of the device according to the invention, illustrated in Fig.2, and

Fig.3b - a front view of the embodiment of the device according to the invention, illustrated in Figs.2 and 3a.

The embodiment illustrated in Fig.1 comprises a rod 1 with a longitudinal axis 2 and having two rod segments 19, 20, as well as a pair of clamping jaws 4, 5 which can be axially displaced on each rod segment 19, 20. Each pair of clamping jaws 4, 5 comprises an inner clamping jaw 6, 7 and an outer clamping jaw 8, 9. The clamping jaws 6, 7, 8, 9 have bores 16, 17 which are coaxial with the longitudinal axis and each pair can be axially displaced on one of the rod segments 19, 20. The inner clamping jaws 6, 7 abut against the end faces 22, 23, which are perpendicular to the longitudinal axis 2, of an annular disc 37, firmly arranged between the rod segments 19, 20. The outer clamping jaws 8, 9 can be pressed against the inner clamping jaws 6, 7 by clamping means 10, 11. The clamping means 10, 11 are nuts 18, which can be screwed onto both rod segments 19, 20 via threads 24 provided at their ends. Both clamping jaws 6, 8 of the first pair 4 of clamping jaws as well as both clamping jaws 7,9 of the second pair 5 of clamping jaws have clamping surfaces 29, 30, 31, 32, which oppose one another and are at right angles to the longitudinal axis 2. Between each pair of the clamping surfaces 29, 30, 31, 32 belonging to one of the pair 4, 5 of clamping jaws a rod-shaped fastening means 12, 13 can be pushed in at right angles to the longitudinal axis 2 and locked between an inner and outer clamping jaw 6, 7, 8, 9 each by tightening the clamping means 10, 11.

Furthermore, on each two opposing clamping surface 29, 30, 31, 32 indentations 25 are provided. The indentations 25 extend perpendicularly to the longitudinal axis 2 and are at a distance from it. The cross-section of the indentations 25 is circular in this case, but can also have a triangular shape. Between two clamping jaws 6, 7, 8, 9 of each pair 4, 5 of clamping jaws the indentations 25 form grooves 33, 34, which are open towards the lateral surfaces 28 of the clamping jaws 6, 7,8, 9 and have groove axes 35, 36 perpendicularly to the longitudinal axis 2 and at a distance from it.

As is shown in Fig.2, the cross-sections, which are perpendicular to the groove axes 35, 36, have the shape of a unilaterally flattened circular surface for both grooves 33, 34, while the inside width *LW* of each groove 33, 34 is greater than the width *B* of the opening on the lateral surfaces of the jaws 6, 7, 8, 9, situated perpendicularly to the relevant groove axis 35, 36 of the corresponding groove 33, 34.

By virtue of this construction the rod-shaped fastening means 12, 13, once pushed into the grooves 33, 34 transversely to the longitudinal axis 2, will be secured against slipping out from the grooves 33, 34 in a transverse direction to the longitudinal axis 2.

Furthermore, each pair 4, 5 of clamping jaw comprises elastic means 40, by which both clamping jaws 6, 7, 8, 9, belonging to one pair 4, 5 of the clamping jaws, are kept at a certain axial distance from one another. The distance between two clamping jaws 6, 7, 8, 9, belonging to one pair 4, 5 of the clamping jaws, is so dimensioned, that a rod-shaped fastening means 12, 13 can be pushed in by hand between the adjoining clamping surfaces 29, 30, 31, 32 of each pair 4, 5 of the clamping jaws, transversely to the longitudinal axis 2. The rod-shaped fastening means 12, 13, pushed in in this manner while the clamping means 10, 11 are slackened, are then so firmly clamped between the clamping surfaces 29, 30, 31, 32 by virtue of the elastic means 40, that they can be still displaced by hand parallel to their central axes 26, 27.

As elastic means 40 two nitinol rods 41 are inserted at a distance from the rod 1 between two clamping jaws 6, 7,8, 9 of each pair 4, 5 of clamping jaws. The nitinol rods 41 have central axes 42 and are pressed into bores 43. To introduce the rod-shaped fastening means 12, 13 into the grooves 33, 34, two clamping jaws 6, 7, 8, 9 of the relevant pair 4, 5 of clamping jaws are forced apart on those sides which are provided with indentations 25, so that the two clamping jaws 6, 7, 8, 9 of each pair 4, 5 of clamping jaws are pressed against one another on that side which has the elastic means 40 and the nitinol rods 41 are elastically deformed. So that the two clamping jaws 6, 7, 8, 9 of each pair 4, 5 of clamping

jaws could carry out the spreading movement, each outer clamping jaw 8, 9 has bores 17, which are coaxial with the longitudinal axis 2 and their diameter *D* is greater than the diameter *d* of the rod 1 in this axial region.

Figs.2, 3a and 3b illustrate an embodiment, that differs from the embodiment illustrated in Fig.1 by the following:

a) only the first clamping means 10 is executed as a threaded joint with a nut 18 that can be screwed on the first end 14 of the rod 1 via a thread 24, whereas the second clamping means 11 comprises a firm head 60 on the second end 15 of the rod 1. Consequently, the outer clamping jaw 9 of the second pair 5 of clamping jaws is resting axially on the head 60;

b) no disc 37 (Fig.1) is provided between the inner clamping jaws 6, 7 of the two pairs 4, 5 of clamping jaws; and

c) the possibility of spreading the outer clamping jaws 8, 9 of each pair 4, 5 of clamping jaws during the insertion of the rod-shaped fastening means 12, 13 is achieved by a reduction 50 on the rod 1 in the shape of an annular groove in the axial region of the respective clamping jaws 8, 9. The diameter *d* of the reduction 50 is smaller than the diameter *D* of the bores 17 in the outer clamping jaws 8, 9.

By tightening the first clamping means 10 both pairs 4, 5 of clamping jaws can be pressed against the head 60 and the rod-shaped fastening elements 12, 13, placed between the clamping jaws 6, 7, 8, 9 of each pair 4, 5 of clamping jaws, can be firmly clamped in the grooves 33, 34.

Furthermore, the rod-shaped fastening element 12 is shifted transversely to the longitudinal axis 2 into the groove 33 so far, that both clamping jaws 6, 8, adjoining the groove 33, are spread at a maximum spread angle ß of approx. 2°-3°.

Throughout the description and claims of this specification the word "comprise" and variations of that word, such as "comprises" and "comprising", are not intended to exclude other additives or components or integers.

The invention described herein is susceptible to variations, modifications and/or additions other than those specifically described and it is to be understood that the invention includes all such variations, modifications and/or additions which fall within the spirit and scope of the above description.

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THE CLAIMS DEFINING THE PRESENT INVENTION ARE AS FOLLOWS:

1. A device for the detachable clamping of fastening elements within a surgical fixing or repositioning device, including

A) a cylindrical or prismatic rod that has a longitudinal axis, a first end, a second end, a terminal first rod segment adjoining the first end, and a terminal second rod segment adjoining the second end;

B) a first pair of clamping jaws that can be displaced on the first rod segment coaxially with the longitudinal axis;

C) a second pair of clamping jaws that can be displaced on the second rod segment coaxially with the longitudinal axis; wherein

D) the first and second pair of clamping jaws each have an inner clamping jaw and an outer clamping jaw directed towards the first and second ends of the rod, and the inner and outer clamping jaws of the first and second pairs of clamping jaws have clamping surfaces directed against one another; and

E) the device includes at least one clamping means for detachable clamping of fastening elements of a surgical fixing or repositioning device between respective pairs of clamping surfaces each directed against one another; whereby

F) an elastic means is arranged between each pair of inner and outer clamping jaws that joins the inner and outer clamping jaws,

wherein

G) the elasticity of the elastic means is provided such that, when the clamping means are loosened, rod-like fastening elements inserted between a pair of first and second clamping jaws are clamped between the clamping surfaces of the pair of clamping jaws by means of the elasticity of the elastic means.

2. A device according to claim 1, wherein the inner and outer clamping jaws have bores passing through them which are coaxial with the longitudinal axis of the cylindrical or prismatic rod for axially displaceable accommodation of the rod, while the rod has a radial clearance in the bore of at least one inner or outer clamping jaw of each pair of first and second clamping jaws.

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3. A device according to claim 2, wherein the rod has a diameter *d* in an axial region of the inner and outer clamping jaws and the bore of at least one inner or outer clamping jaw of each pair of first and second clamping jaws has a diameter *D*, and the radial clearance is due to the fact that $D > d$.

4. A device according to claim 2, wherein the rod has at least one diametrical reduction in an axial region of the inner and outer clamping jaws, so that the rod has a diameter *b* at the at least one diametrical reduction, and the bore of at least one inner or outer clamping jaw of each pair of first and second clamping jaws has a diameter *D*, and wherein the radial clearance is due to the fact that $b < D$.

5. A device according to any one of claims 1 to 4, wherein the clamping surfaces of the inner and outer clamping jaws have indentations that form, between an inner clamping jaw and an outer clamping jaw of each of the respective pairs of first and second clamping jaws, a groove that passes through transversely and eccentrically to the longitudinal axis of the cylindrical or prismatic rod for the purpose of accommodating a rod-like fastening element.

6. A device according to claim 5, wherein each groove has a groove axis that extends perpendicularly to the longitudinal axis of the cylindrical or prismatic rod and is at a distance from the longitudinal axis of the cylindrical or prismatic rod.

7. A device according to claim 5 or 6, wherein the elastic means are arranged on a side of the inner and outer clamping jaws which, relative to the longitudinal axis of the cylindrical or prismatic rod, is opposite to the grooves.

8. A device according to any one of claims 1 to 7, wherein the elastic means is a rod-shaped element that is substantially parallel with the longitudinal axis of the cylindrical or prismatic rod.

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9. A device according to any one of claims 1 to 8, wherein the elastic means is made from a material with a non-linear stress-deformation diagram.

10. A device according to any one of claims 1 to 9, wherein the elastic means is made from a memory metal alloy.

11. A device according to claim 10, wherein the memory metal alloy is nitinol.

12. A device according to any one of claims 1 to 11, wherein the elastic means is made from a nickel-titanium alloy, wherein 45%<Ni<55% and 45%<Ti<55% such that Ni + Ti = 100%.

13. A device according to any one of claims 10 to 12, wherein the memory metal alloy has a transition temperature of higher than 50°C.

14. A device according to claim 13, wherein the transition temperature is higher than 80°C.

15. A device according to claim 13 or 14, wherein the transition temperature is higher than 100°C.

16. A device according to any one of claims 13 to 15, wherein the transition temperature is higher than 120°C.

17. A device according to any one of claims 1 to 9, wherein the elastic means is made from a synthetic material.

18. A device according to claim 17, wherein the synthetic material is PEEK.

19. A device according to claim 17 or 18, wherein the synthetic material is carbonfibre-reinforced PEEK.

20. A device according to any one of claims 1 to 19, wherein at least one clamping means includes a screw connection.

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21. A device according to claim 20, wherein the screw connection includes an outer thread on the rod as well as a nut that can be screwed on the outer thread.

22. A device according to claim 20, wherein an annular disc is arranged between the two pairs of first and second clamping jaws.

23. A device according to claim 22, wherein the disc can be coaxially displaced on the rod.

24. A device according to claim 22, wherein the disc is arranged integrally with the rod and between the first rod segment and the second rod segment.

25. A device according to any one of claims 5 to 7, or any one of claims 8 to 24 when dependent on claim 5, wherein the grooves are prism-shaped.

26. A device according to any one of claims 6 to 7, or any one of claims 8 to 25 when dependent on claim 6, wherein each groove has an inside width *LW* and, on an opening that is perpendicular to a respective groove axis, a width *B* between the inner and outer clamping jaws which adjoin, and the ratio *B*:*LW* is between 70% and 90%.

27. A device according to any one of claims 1 to 26, wherein the elastic means is made from a pseudoelastic material.

28. A device according to any one of claims 1 to 27, wherein the ratio (*D*-*d*):*d* is between 0.01 and 0.10.

29. A device according to any one of the embodiments substantially as herein described and illustrated.

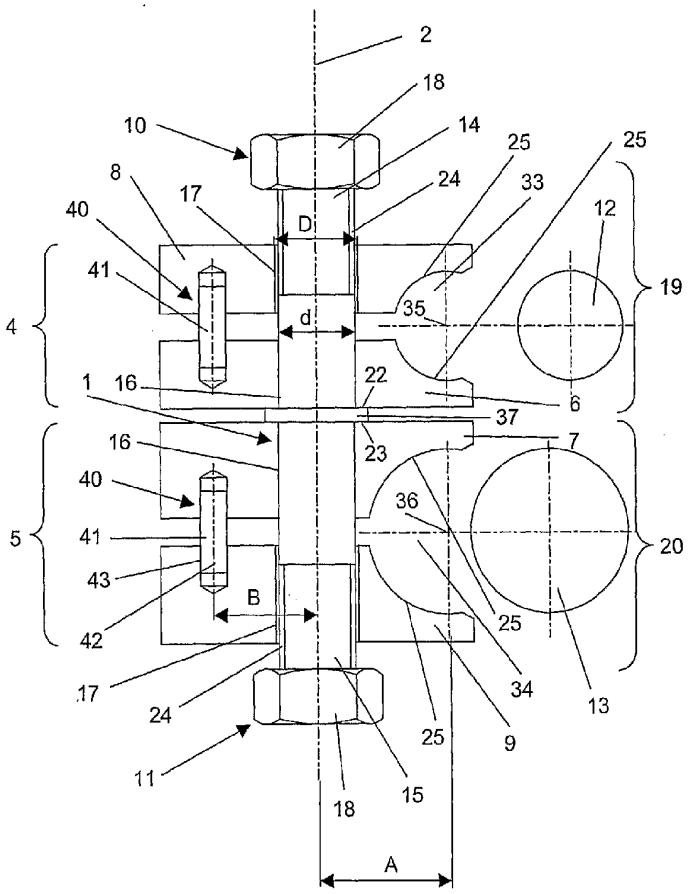
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Fig. 1

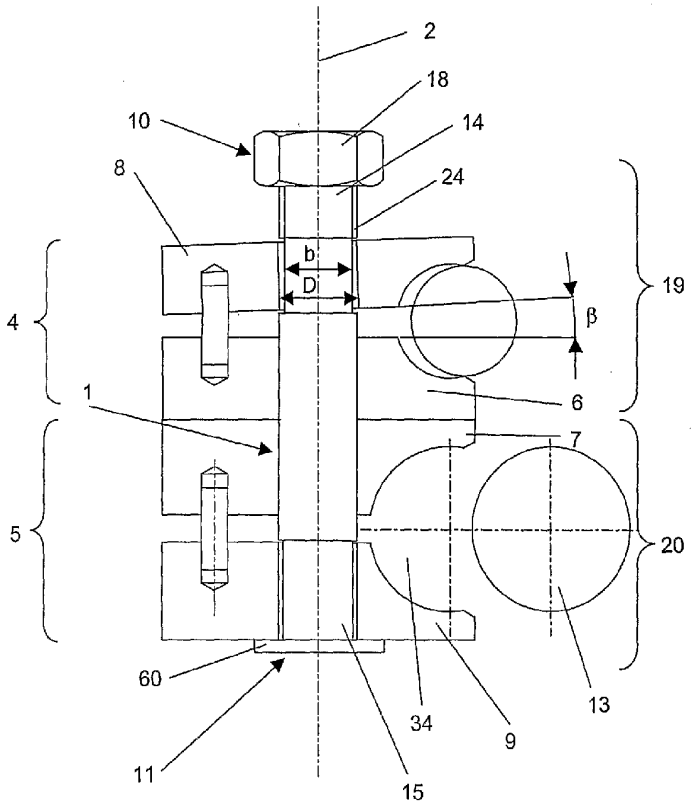

Fig. 2

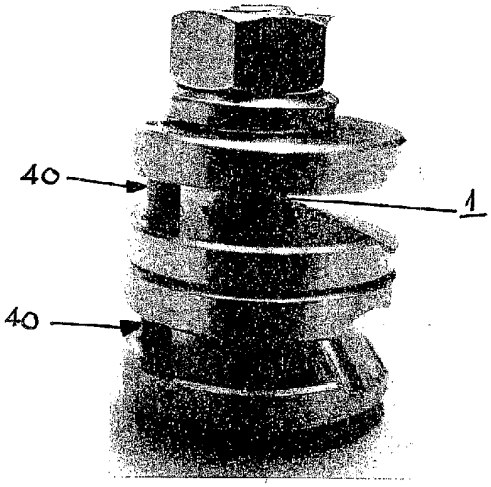

FIG.3a

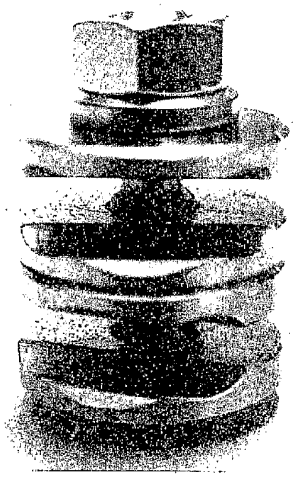

FIG.3b