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(54) Device for connecting bars end-to-end

(57) A device (1) for connecting bar ends (2'), comprising a hollow body (10) having an internal cavity (12) with at least one bar insertion opening (14) and a longitudinal axis extending through the at least one insertion opening (14), and a plurality of radially-adjustable clamping elements (16), wherein the device further comprises at least one locking element (18) movably arranged inside the hollow body, the internal cavity (12) of said body comprises at least one slope (12') that is inclined relative to the longitudinal axis of said body (10), and said at least one locking element (18) each comprises an inclined face (18') that matches the profile of said at least one slope (12') and a gripping face (18'') having at least one protrusion.

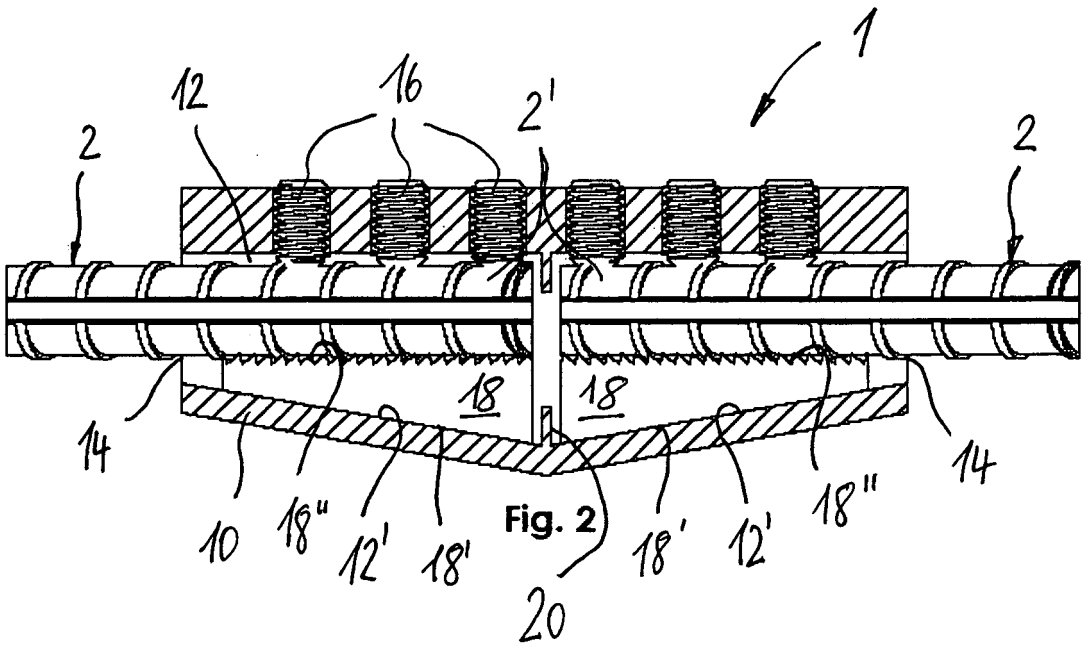

Fig. 2

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Description

BACKGROUND OF THE INVENTION

[0001] In the art of joining two bars end-to-end in order to extend their continuity, it is known to use a tubular sleeve that receives the end portion of each bar, said sleeve having radially-oriented elements that are forced into the material of the bars in order to lock them. According to one device as disclosed in EP 0 554 972, such radially-oriented elements are provided as screws and racks that are arranged longitudinally along the sleeve.

[0002] Compared to many of the existing systems to connect two bars end-to-end, such as threading or forging the bar ends, this system presents the advantage of not needing any preparation of the bar end. This means that it is not necessary to either transport the bars to a workshop where their ends can be prepared, or transport to the location of the bars the machinery needed to prepare their ends. This system was indeed developed with the aim of enabling a site assembly, with only a pneumatic or electric wrench needed to torque the screws. A site assembly is a great benefit in some industries such as the construction or the oil industry. It is also a great benefit in large countries where transport of bars is an issue, due to long distances.

[0003] However, the system disclosed in EP 0 554 972 has some drawbacks as follows. First of all, the pneumatic and electric tools that are commonly available on the market are of limited capacity, which means that it is not possible to increase the size or strength of the screws beyond a certain limit. The connection of larger or stronger bars is therefore not possible. Secondly, the effort generated by torquing the screws serves to press the racks into the sleeve as much as to press them into the bars. Less than half of the tightening effort is thus available to actually clamp the bars. Finally, its performance under a tensile load is very difficult to maintain and to control. Indeed, the effectiveness of the fitting of the sleeve onto the bar end wholly depends on the torque applied on the screws, which is the torque at which the screw heads shear off. These screws have their neck reduced so that the shearing occurs outside their threaded area. The precision of this diameter reduction, as well as the radius at the bottom of the reduction, are difficult to achieve. The stress riser at the reduction may vary from 1 to 4, depending on the radius at the bottom of the reduction, which on top of being difficult to produce accurately, is also difficult to measure and control. This variation in stress riser affects directly the torque at which the screws shear off, and consequently the performance of the system.

[0004] Moreover, the screws are calculated to shear off under a purely torsion effort. In practice however, it cannot be guaranteed that the pneumatic or electric wrench or screwdriver is perfectly aligned on the axis of the screw. Because this tool is manually held, a certain angle between its axis and that of the screw is unavoidable. Such an angle adds a flexural effort to the torsion effect, thereby reducing the torque necessary to shear off the screws, and hence reducing the system performance.

[0005] Also known is a device as disclosed in US 5,909,980 and US 6,202,282 that works essentially in the same way as the one previously cited, but has replaced the gripping effect of the racks by the friction effect of the bar against the internal surface of the sleeve. Because friction is not as efficient as gripping in transmitting effort, it compensates by using a longer length and a larger number of screws. Being so closely related to the first product cited, it doesn't bring any additional benefit, but suffers from the additional drawback of bulkiness.

[0006] Also known is a device as disclosed in EP 1 482 187 that also works essentially in the same way as the ones previously cited, but provides two rows of screws and uses an internal thread rather than racks to produce the gripping effect inside the sleeve. Being so closely related to the two products cited above, it doesn't bring any additional benefit, but suffers from the additional drawback that the angle between the two rows of screws requires extra free space for its installation.

SUMMARY OF THE INVENTION

[0007] It is an object of the present invention to provide a device for connecting bar ends that upholds the benefit of site assembly, but brings new benefits in term of reliability, safety to the structure, and load bearing performance.

[0008] This object is achieved by a device for connecting bar ends according to claim 1. Preferred embodiments of the invention are defined in the dependent claims.

[0009] These goals are achieved by a hollow casing or body whose internal cavity presents slopes, or surfaces that are at a certain angle relative to the axis of the bars to be connected.

[0010] According to the present invention, the device for connecting bar ends further comprises at least one locking element movably arranged inside the hollow body, and the internal cavity of said body comprises at least one slope, that is inclined relative to the longitudinal axis of said body, while said at least one locking element each comprises an inclined face that matches the profile of said at least one slope, and a gripping face having at least one protrusion. With this structure, the device according to the present invention allows to achieve a "self-locking effect" in which the clamping/gripping force of the device increases with increased loading of the bar(s) to be connected. As a result, the device according to the invention achieves a high loading bearing performance on an improved safety and reliability level. Moreover, thanks to a reduced bulkiness, it provides improved safety not only to the installer but also to the people working around him on an industrial or construction site.

[0011] Even though the device may be adapted to re-

ceive on bar only, for instance if on part of the device is welded to a structure, it is preferred that the hollow body has at least two insertion openings and that the internal cavity of said body comprises at least two slopes, that are inclined relative to the longitudinal axis of said body, these inclinations being in opposite directions. As a result, plural bars can be reliably connected in a self-locking manner.

[0012] The shape of the slopes and inclined faces is not particularly limited in the present invention, as long as cooperating slopes and inclined faces are matching to each other. They may be flat or curved, for example.

[0013] In order to achieve an optimum gripping force and an easy and reliable operation of the device, it is preferred according to the present invention that the gripping surface is generally parallel to the longitudinal axis of said body. The material of the gripping surface is chosen and its teeth are shaped to suitably bite into the material of the bars to be connected.

[0014] According to a further development of the present invention, the cross-section area of the internal cavity of said hollow body is not regular but increases from a minimum at the extremity towards a maximum at the middle and then decreases back to a minimum at the other extremity. Alternatively, the cross-section area of the internal cavity may also decrease from a maximum at the extremity towards a minimum at the middle and then increase back to a maximum at the other extremity.

[0015] The shape and type of the radially-adjustable clamping elements is not specifically limited in the present invention. In many cases, these will be screws which may have pointed or flat ends, depending on the material of the bars to be connected. They may have standard necks or neck reductions designed to shear under a certain torque. Further, there may be provided one or more rows of screws.

[0016] In order to achieve a proper and easy positioning of the bars/bar ends to be connected, it is preferred that stop means are provided in the internal cavity of the body.

[0017] In order to increase the variability of the device, it is preferred that said locking elements are of different radial thickness in order to accommodate bars of different sizes.

[0018] The locking elements may in the present invention act as "passive" locking elements which develop a "self-locking effect" only after an increase load has been brought on the bars to be connected. However, in order to reduce possible slip or deformation, it is preferred that the device according to the present invention further comprises pushing means for pushing said locking elements from outside of said body. In this way, the locking elements may be prestressed and/or the rish can be reduced during fastening the radially-adjustable clamping elements that the at least one locking element(s) slides away.

[0019] According to a further development of the present invention, at least one internal phase of said body comprises ribs or grooves. This will improve the bond and anchoring of the device when it is cast inside another material such as in concrete, for example.

[0020] Further, in order to increase the durability of the device according to the present invention, it is preferred that a corrosion-protection or binding substance is poured or injected inside said body.

[0021] According to a further aspect, the present invention provides a method of connecting bars using the device as described above. Further details on the method of connecting bar ends according to the present invention will be apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Fig. 1	schematically shows a perspective view of a device for connecting bar ends according to a first embodiment of the present invention;
Fig. 2	schematically shows a cross-section view of the embodiment shown in Fig. 1;
Fig. 3	schematically shows a cross-section view of a variant of the first embodiment where a corrosion-protection or binding substance has been injected inside the body;
FIG. 4	schematically shows a perspective view of a device for connecting bar ends according to a second embodiment of the present invention;
FIG. 5	schematically shows a perspective view of a device for connecting bar ends according to a third embodiment of the present invention;
FIG. 6	schematically shows a cross-section view of the device for connecting bar ends according to a further embodiment of the present invention;
FIG. 7a to 7f	schematically show various designs of locking elements;
FIG. 8	schematically shows a cross-section view of a device for connecting bar ends according to a fourth embodiment of the present invention adapted to connect bars of different diameters;
FIG. 9	schematically shows a cross-section view of a device for connecting bar ends according to a fifth embodiment of the

present invention provided with pushing means;

FIG. 10 schematically shows a cross-section view of a device for connecting bar ends according to a sixth embodiment of the present invention, also provided with pushing means;

FIG. 11 schematically shows a cross-section view of a device for connecting bar ends according to a seventh embodiment of the present invention adapted to receive mainly compressive forces;

FIG. 12 schematically shows a cross-section view of a device for connecting bar ends according to a seventh embodiment of the present invention adapted to receive both tensile and compressive forces.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0023] Preferred embodiments of the invention are discussed in the following with reference to the enclosed drawings.

[0024] A device 1 for connecting the ends 2' of a bar according to a first embodiment of the present invention is schematically shown in a perspective view in Fig. 1 as well as in a cross-section view in Fig. 2. The device is adapted for connecting bar ends of rebars and the like as they are used in construction, for instance in reinforced concrete structures but may also be used for other bars.

[0025] The device 1 comprises a hollow body 10 having an internal cavity 12 which, in the present embodiment, comprises two insertion openings 14 through which a longitudinal axis extends. The direction of extension of the longitudinal axis coincides with the direction of extension of the bars 2 to be connected (Fig. 2). Further, the device 1 comprises a plurality of clamping screws 16 which are fitted into threaded holes formed in the hollow body 10. The screws may have a reduced neck so as to produce a defined failure. As can be seen in Fig. 2, the screws 16 are adapted to press on the bars 2 inserted into the hollow body 10.

[0026] Further, the device 1 comprises two locking elements 18 which are movably arranged inside the internal cavity 12 of the hollow body 10. Specifically, the internal cavity 12 of the body 10 comprises two slopes 12' which are inclined relative to the longitudinal axis of the body 10, and the locking elements 18 each comprise a inclined face 18' which matches the profile of the corresponding slope 12' and is in contact therewith. In addition, each locking element 18 has a gripping face 18" having a plurality of rack teeth. The gripping face 18" is adapted to grip and fix the respective bar 2 together with the screws 16. Therefore, it is preferred that the gripping faces 18" are generally parallel to the longitudinal axis of the bars 2/body 10.

[0027] As can be seen in Fig. 2, the device 1 further comprises stop means 20, for example in the form of stop or separation walls. As shown in Fig. 6, this stop or separation wall 20 may also fully separate the internal cavity 12 in two parts.

[0028] For applications where the connection needs to grip or bond with an external surrounding material, for example in concrete construction, ribs or grooves 24 may be provided on the external surface of said body 10.

[0029] The connection is achieved by inserting the ends 2' of bars 2 until they hit the wall 20. The screws 16 are then tightened either until a given torque, or until their heads shear off, thereby forcing the ends 2' of bars 2 against the gripping face 18" of the locking elements 18, and locking themselves into the surface material of said bars 2.

[0030] The bars 2 are then put in use and sustain a tensile load. This tensile load tends to pull both bars apart, along with the locking elements 18 thanks to the gripping achieved on their gripping faces 18" . When the locking elements 18 move apart by sliding over the slopes 12', they force their grip 18" further into the material of the bars 2. Thus, the resistance of the device increases with the load applied on the bars.

[0031] Fig. 3 relates to a second embodiment for applications where it is necessary to fill up said cavity 12 with a corrosion-protection or binding substance, end caps 26 may be provided to close the spaces at each extremity of the connection, and a hole 28 may be provided in said body 10, through which said substance may be poured or injected.

[0032] Figs. 4 and 5 show that the external shape of the hollow body 10 may be widely varied within the present invention. Further, the device 1 may comprise one row or also plural rows of screws 16, as shown in FIG. 5.

[0033] Also the shape of the locking elements 18 is not specifically limited in the present invention. Various examples of suitable locking elements 18 are shown in FIGS. 7A to 7G. For instance, the inclined face 18' may be flat or curved just like the gripping face 18" . Of course, further designs are possible.

[0034] Fig. 8 shows an embodiment which is adapted to connecting bars 2 having different diameters. For this purpose, the locking elements 18 have a different radial thickness. Specifically, in Fig. 8, the locking element 18 on the left handside is adapted to grip a bar 2 having a smaller diameter and, therefore, itself has a smaller radial thickness than the locking element 18 on the right handside.

[0035] Figs. 9 and 10 show a sixth and seventh embodiment, respectively, with additional pushing means 22 for pushing the locking elements 18 against the ends 2' of bars 2 prior to the tightening of screws 16. This feature is illustrated in Fig. 9 with a cam 23 that is rotated around its axis. In Fig. 10 the pushing means 22 com-

prises a central screw 25 that pushes on the rear faces of the locking elements 18.

[0036] Fig. 11 schematically shows an eighth embodiment of the present invention for cases where the connection must withstand not tensile, but mainly compression efforts.

In this embodiment, the slopes 12' are diverging towards the insertion openings 14. Under a compression effort, the locking elements 18 are moving towards the center of the body, thereby securing the clamping of the bars 2.

[0037] Fig. 12 schematically shows an ninth embodiment of the present invention for the cases where the connection must withstand alternate tensile and compression efforts. In this embodiment, a total of four locking elements 18a, 18b are provided, namely two locking elements 18a, 18b per bar 2. Further, the locking elements 18a, 18b of each bar have their respective slopes 18' inclined in opposite directions. Thus, under a tensile effort, the locking elements 18a are moving towards the extremities of the body, thereby securing the clamping of the bars. Under a compression effort, the locking elements 18b are moving towards the centre of the body, thereby securing the clamping of the bars.

[0038] The connection of the bars 2 is achieved by inserting the device 1 over the end 2' of a first bar 2, said bar end 2 being received by the cavity 12 between the locking element 18 and the screws 16. A second bar 2 is then inserted into the other side of the device 1. The device can now be oriented in the radial direction deemed most suitable either for access purpose or for space optimisation. The pushing means 22 may then be used to reduce the clearance between the bars 2 and the device 1. The screws 16 are finally torqued so that they press the bar 2 against the locking elements 18 and themselves penetrate into the surface of the bars 2.

[0039] When the bars 2 are pulled by application of a tensile load, the initial resistance comes from the gripping effect between the screws 16 and the locking elements 18. As the load increases, the locking elements 18 move along the slopes 12' of the body 10, and further lock the bar ends 2' inside the cavity, thereby greatly improving the tensile performance: the stronger the pull on the bars, the stronger the lock.

Claims

1. A device (1) for connecting bar ends (2'), comprising

a hollow body (10) having an internal cavity (12) with at least one bar insertion opening (14) and a longitudinal axis extending through the at least one insertion opening (14), and

a plurality of radially-adjustable clamping elements (16),

characterised in that

the device further comprises at least one locking element (18) movably arranged inside the hollow body,

the internal cavity (12) of said body comprises at least one slope (12') that is inclined relative to the longitudinal axis of said body (10), and

said at least one locking element (18) each comprises an inclined face (18') that matches the profile of said at least one slope (12') and a gripping face (18") having at least one protrusion.

2. The device according to claim 1, **characterised in that** the internal cavity (12) of said body comprises at least two slopes (12') that are inclined relative to the longitudinal axis of said body (10), these inclinations being in opposite directions.

3. The device according to claim 1 or 2, **characterised in that** the gripping face (18") is generally parallel to the longitudinal axis of said body (10).

4. The device according to any of the preceding claims, **characterised in that** the cross-section area of the internal cavity (12) of said hollow body (10) is not regular, but increases from a minimum at the extremity towards a maximum at the middle and then decreases back to a minimum at the other extremity, or decreases from a maximum at the extremity towards a minimum at the middle and then increases back to a maximum at the other extremity.

5. The device according to any of the preceding claims, **characterised in that** said radially-adjustable clamping elements (16) comprise a location of preferential failure.

6. The device according to any of the preceding claims, **characterised in that** stop means (20) are provided in the internal cavity of said body.

7. The device according to any of claims 2 to 6, **characterised in that** said locking elements (18) are of different radial thicknesses in order to accommodate bars of different sizes.

8. The device according to any of the preceding claims, **characterised in that** said it further comprises pushing means (22) for pushing said locking elements (18) from outside of said body.

9. The device according to any of the preceding claims, **characterised in that** said locking elements (18) have their thicker end chamfered in order to reduce their maximum height.

10. The device according to any of the preceding claims, **characterised in that** at least one external face of said body (10) comprises ribs (24) or grooves.

11. The device according to any of.the preceding claims,

characterised in that a corrosion-protection or binding substance is poured or injected inside said body (10).

12. A method of connecting bar ends (2') with the device according to any of the preceding claims.

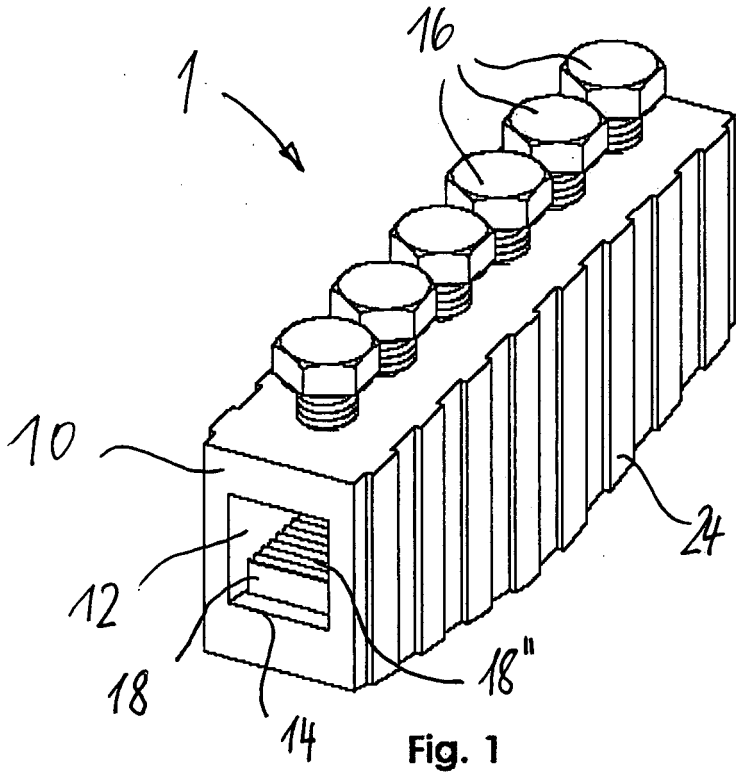

Fig. 1

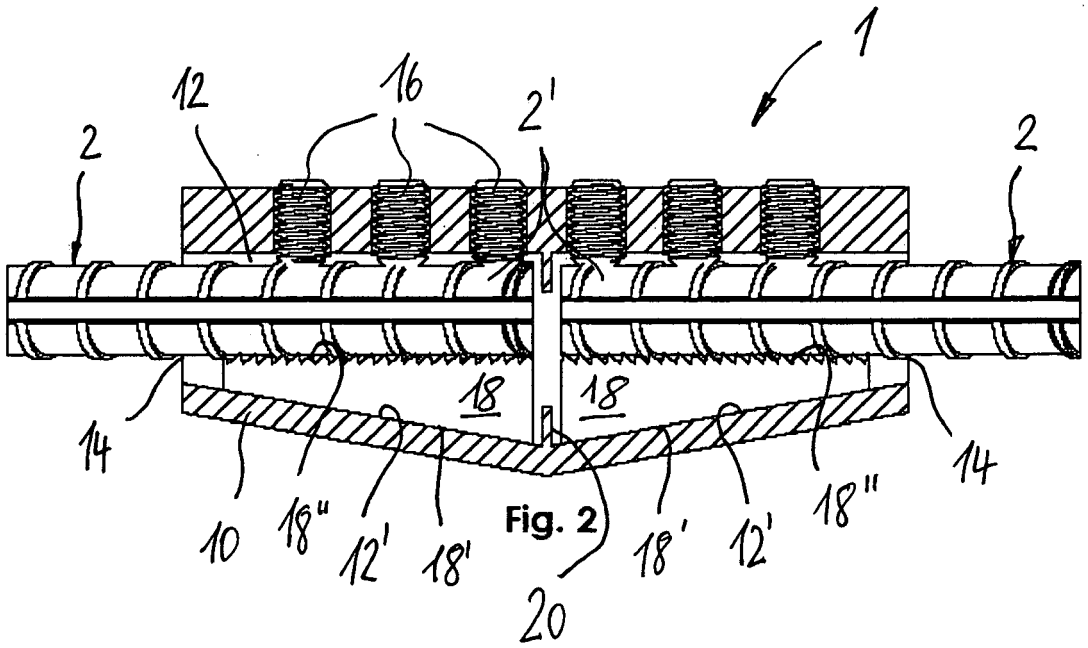

Fig. 2

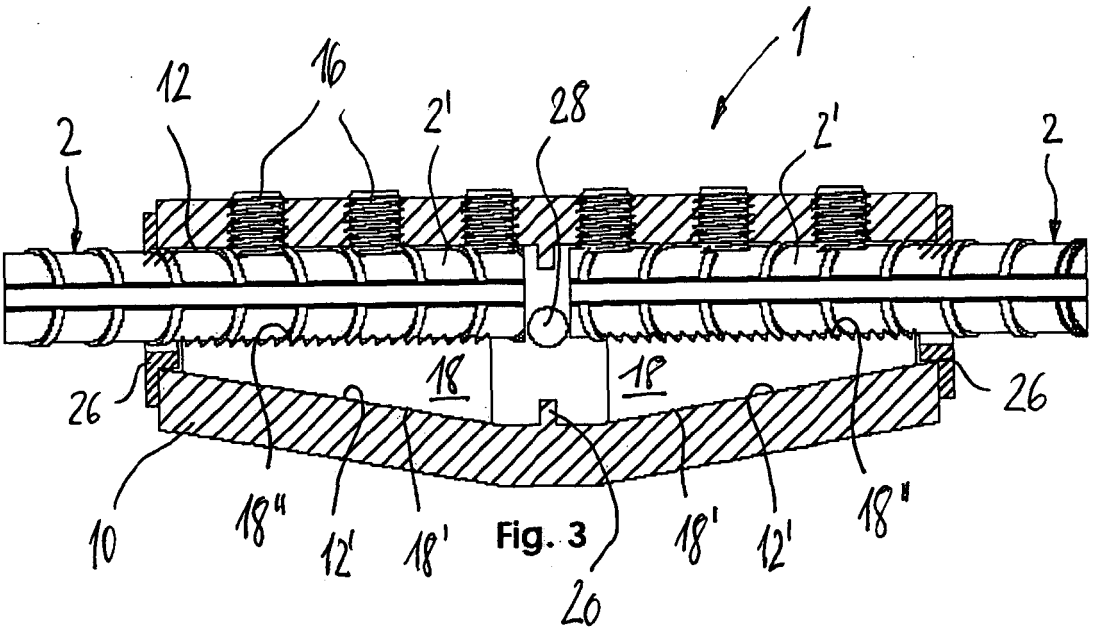

Fig. 3

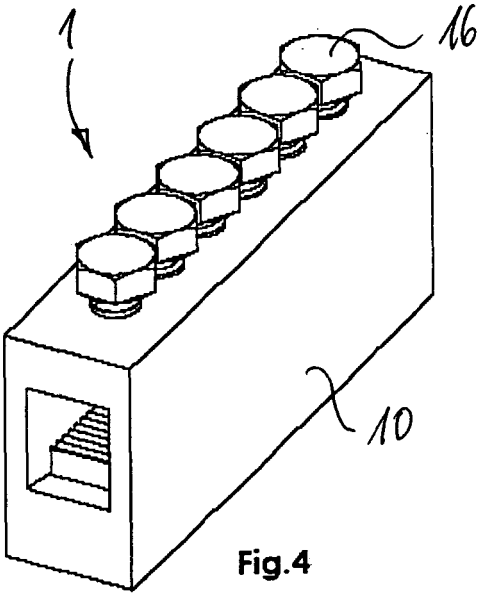

Fig.4

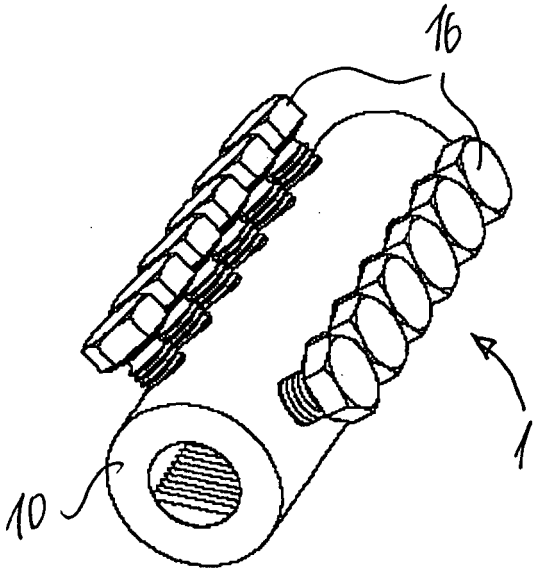

Fig.5

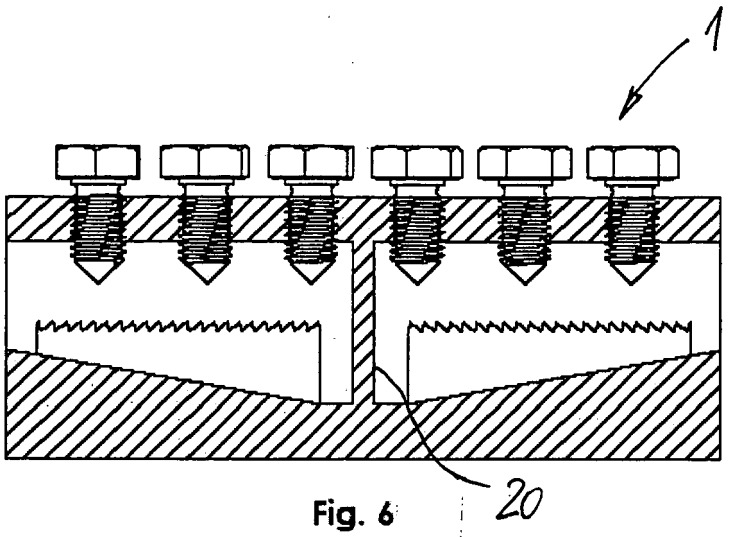

Fig. 6

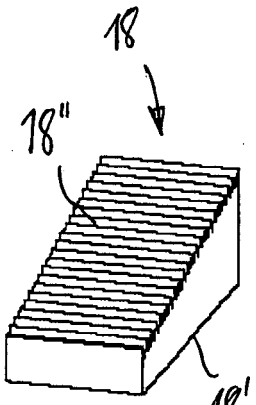

Fig. 7a

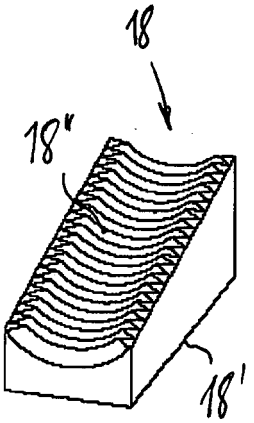

Fig. 7b

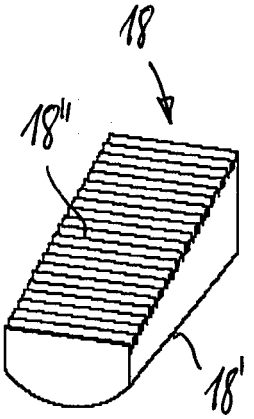

Fig. 7c

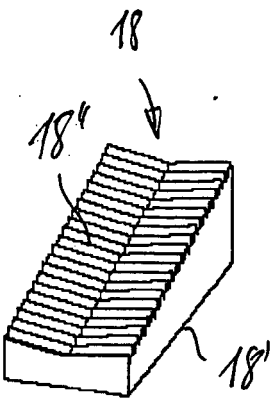

Fig. 7d

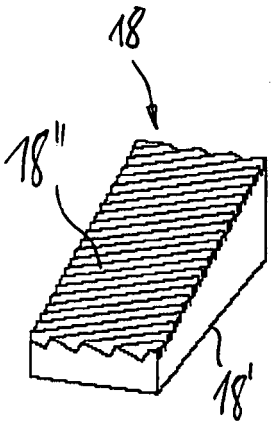

Fig. 7e

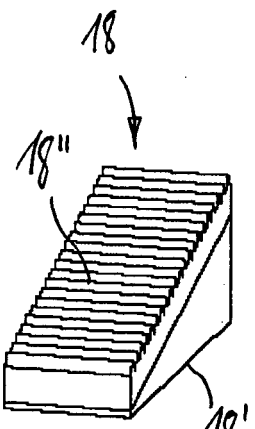

Fig. 7f

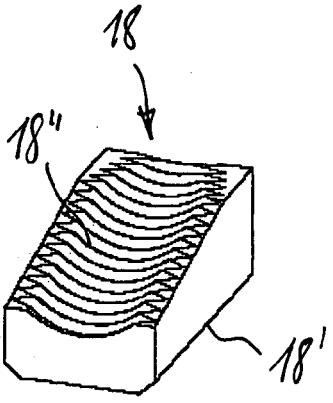

Fig. 7g

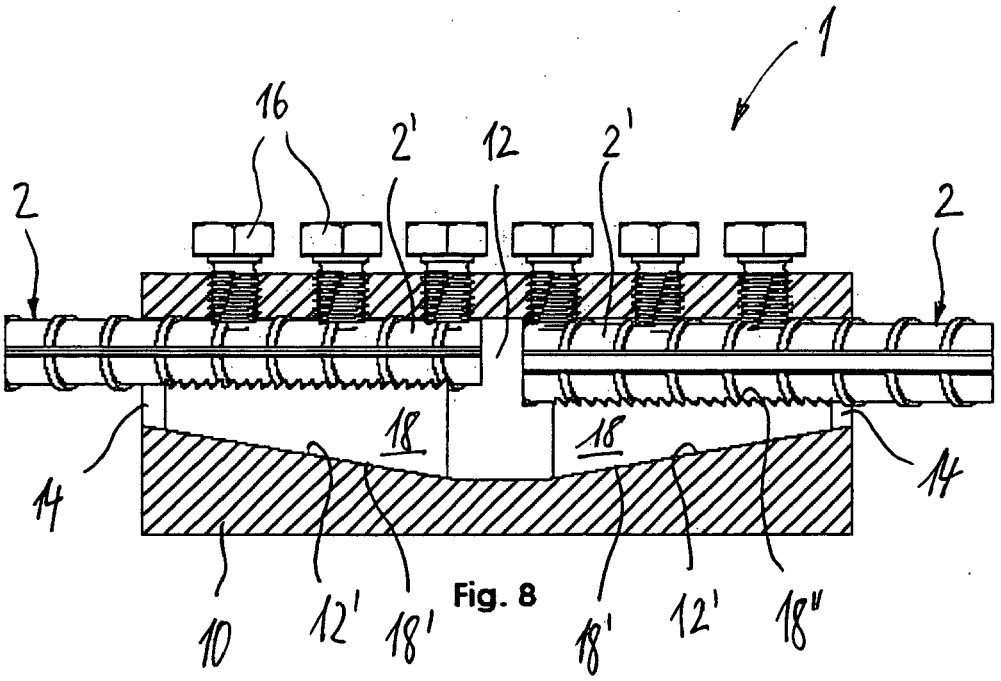

Fig. 8

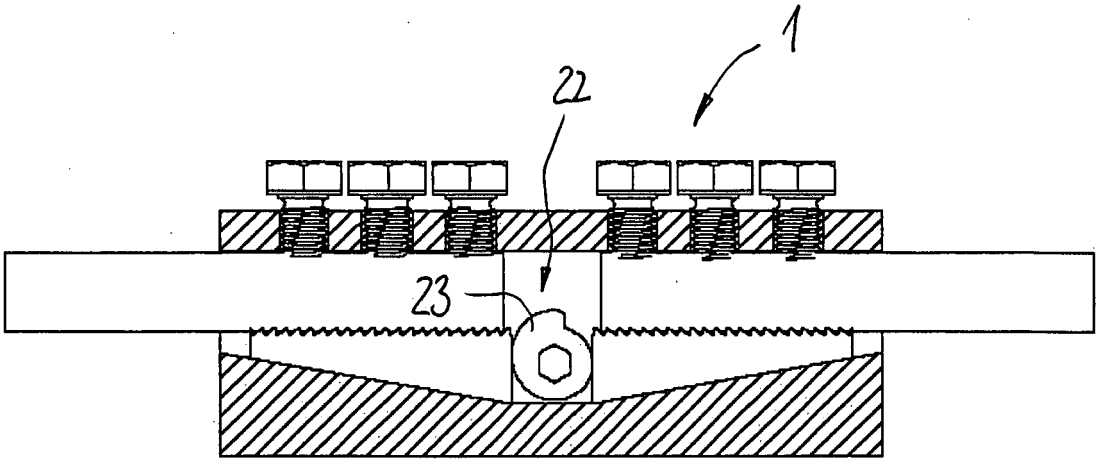

Fig. 9

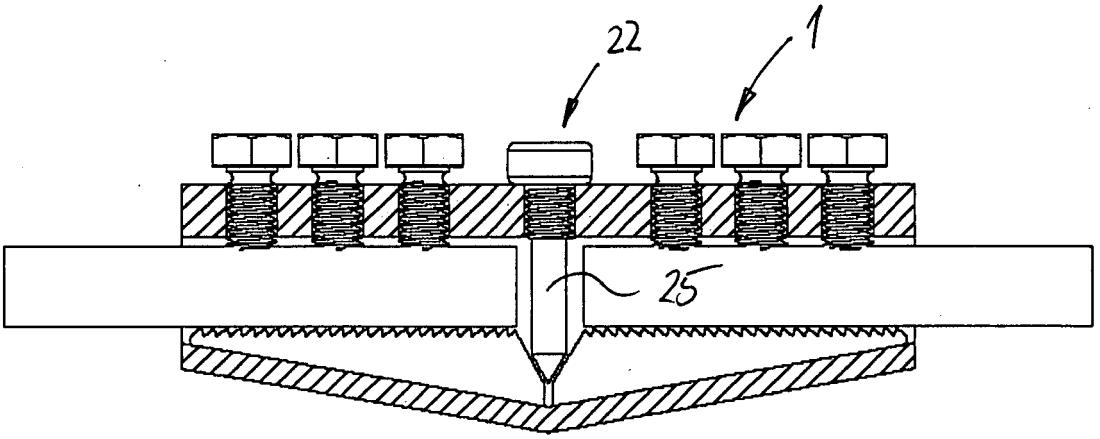

Fig. 10

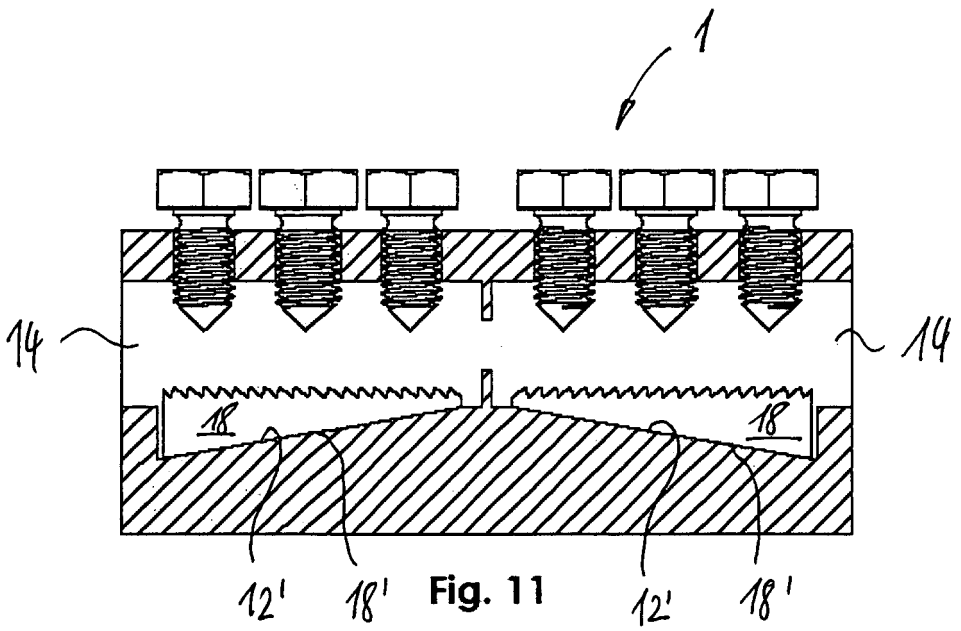

Fig. 11

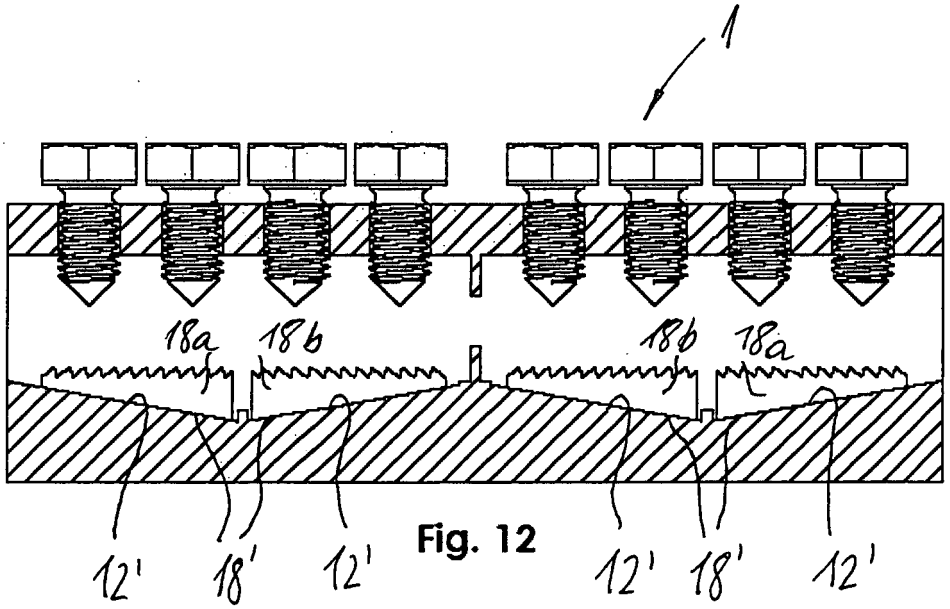

Fig. 12

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 01 8851

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 February 2007	Righetti, Roberto

CATEGORY OF CITED DOCUMENTS

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3

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 01 8851

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