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(54) **Waterproof sealing system for underwater equipment**

(57) A system and the related method for the waterproof sealing of components for underwater equipment, comprising

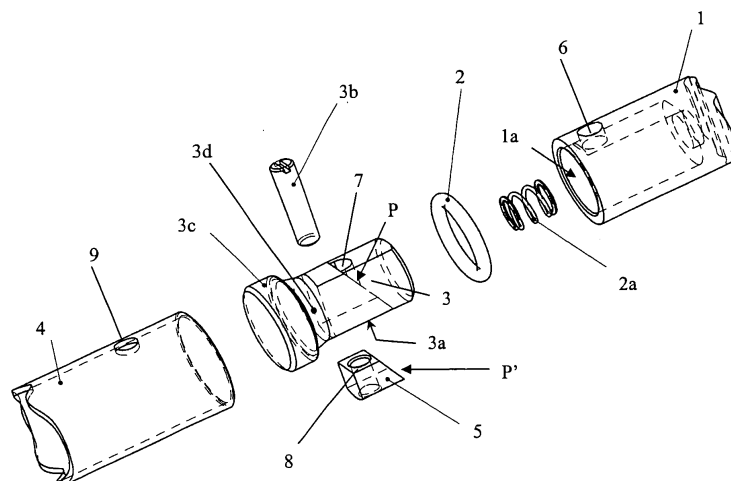
- a closure tube 1
- a waterproof seal element 2
- a closure cylinder 3
- a housing 4 of the closure cylinder 3
- a sliding peg 5

characterised in that

- the closure cylinder 3 is fitted inside with a cavity 3a that presents an inclined surface P,
- the sliding peg 5 presents a surface P' complementary to the surface P of the cavity 3a
- in the working position the surface P' of the peg 5 engages the surface P of the cavity 3a for locking in the end position.

The method includes the insertion of the waterproof seal element and of the sliding peg and finally the locking of the closure cylinder inside the housing.

Fig. 2



Description

Technical field

[0001] The present invention relates to a waterproof closure system that can be applied to underwater equipment, and the related method of use.

State-of-the-art

[0002] The use of underwater equipment necessitates the application of instruments and tools which must be fundamentally manageable and easy to use in order to minimise the required operator skills.

[0003] In this context, it is very often essential that some removable parts of the equipment used can be enclosed whilst still maintaining the waterproof seal, with the aim of reducing weight and increasing manageability. In order to achieve this effect, the solution most often used consists of sealing the parts in question by means of sealing elements such as O-rings.

[0004] These, normally of rubber or silicone, make it possible to connect together two or more detachable parts of a piece of underwater equipment, for example a gun, thus preventing water ingress and therefore enabling the maintenance in all cases of a neutral state both at the position of the grip and at the end. This considerably facilitates its use and controllability in the water thus making movements easier in all operative conditions.

[0005] However, the use that has been made until now of such sealing elements for detachable parts has always shown a considerable drawback that compromises and limits their efficiency and durability, i.e. their service life.

[0006] This is for example the case of the systems proposed in the patents WO 00/08408, US 4,019,480 and US 6,170,477 which describe certain types of underwater gun. From the description one can deduce that, normally, in order to effectively seal the connected parts, it is necessary for the O-ring to exert a certain pressure on the inner walls of the element into which it is inserted. This therefore means that the outer diameter of the ring must necessarily be greater than the inner diameter of the walls to be sealed.

[0007] Consequently, upon insertion of the O-ring under stress, there is a fretting of the ring's surface which inevitably leads to the damaging of the ring. This occurs every time that the operation is repeated and therefore compromises the durability of the O-ring, which owing to the constant and increasing damage, must therefore be replaced frequently.

[0008] This phenomenon manifests itself with even worse consequences in the case of the outer surface with which the ring comes into contact having holes or dents of various kinds, for example an aperture for the insertion of a clamping screw. In this case, the O-ring, which is made to fit inside the component and is under

the constant pressure of the surface within which it is contained, protrudes partially at the aperture and by rubbing against the edge of the hole it is inevitably damaged, thus eventually losing its integrity and sealing properties, until it splits completely.

[0009] Another drawback frequently occurring in the use of waterproof seals is the inability to adjust the state and therefore the quality of the seal.

[0010] In fact, when the sealing element is introduced inside the component to be sealed it is not possible to have any control over the level of pressure it exerts on the walls containing it; therefore, a variation of the inner pressure of the instrument or a deformation of the same, occurrences arising frequently underwater, can cause a deterioration of the seal of the sealing element, without the operator being able to take quick corrective action.

[0011] Consequently, there could be an ingress of water into the sealed cavity therefore weighing down the equipment and resulting in the deterioration of operating conditions.

Object of the invention

[0012] Based on all that has been described previously, the object of the present invention is therefore the development of a system and the related method of use, which makes it possible to use waterproof seal elements for underwater equipment without them being damaged and without their sealing characteristics deteriorating.

[0013] Another object of the present invention is that of developing a fast and reliable sealing system that makes it possible to easily adjust the quality of the closure of the sealing element used at any time.

[0014] This problem is solved by a closure system according to claim 1 comprising the following parts:

- a closure tube 1
- a waterproof seal element 2
- a closure cylinder 3
- a housing 4 of the closure cylinder 3
- a sliding peg 5

[0015] Such a system is characterised by the combination of the following elements:

- the closure cylinder 3 is fitted inside with a cavity 3a that presents an inclined surface P,
- the sliding peg 5 presents a surface P' complementary to the surface P
- in use the surface P' of the peg 5 engages the surface P of the cavity 3a for locking in the end position.

Detailed description of the invention

[0016] The understanding of the present invention will be simplified by reference to the drawings, which in any case must not be considered as the only possible embodiments of the object claimed herein but rather as

non-limiting auxiliary exemplifications.

[0017] As illustrated in Fig. 1, in order to obtain the waterproof sealing of two components of an underwater equipment, which correspond herein to the tube 1 and to the housing 4, the sealing element 2, in this specific case a rubber or silicone O-ring, is provided on the closure cylinder 3, making it slide up to the truncated cone-sectioned neck 3d of the cylinder 3. At this point one inserts the cylinder 3 into the closure tube 1 and the entire assembly into the housing 4, until the apertures 6, 7, and 9, with which the parts 1, 3 and 4 are respectively fitted, align.

[0018] In this phase, the sealing element is not yet under pressure and the parts 1 and 4 are therefore not yet tightly fitted.

[0019] Moreover, as the locking surface indicated as 3c possesses a diameter greater than or equal to the outer diameter of the waterproof seal element 2, the latter does not exert any pressure on the inner surface of the housing 4 and can therefore be introduced inside it without any stress. The protection supplied by the cylindrical part of which the surface 3c is a component, thus prevents the fretting of the ring 2 on both the outer surface of the housing 4 and the edge of the aperture 9.

[0020] The waterproof closure phase occurs at this point as a consequence of the sliding of an inclined surface P of the cavity 3a on the complementary inclined surface P' of the peg 5. This sliding is created by gradually inserting the peg 5 inside coaxial apertures 9, 6 and 7. By means of its progressive insertion, the peg 5 enters the cavity 3a causing the sliding of the inclined surface P' of the former on the inclined surface P of the latter.

[0021] The sliding is counteracted by a force element 2a, which in the figures is realised by a spring, housed within the tube 1, and having one end in contact with the rear surface of the closure cylinder 3.

[0022] The locking and sealing operation provides that, by the insertion of the peg 5, the sealing element 2 is pushed by the edge of the tube 1, which has the same diameter as the surface 3c, along the inclined surface of the neck 3d. The diameter of this truncated cone-sectioned neck 3d increases in the direction of the fixing surface 3c, and the result is therefore a homogeneous and radial expansion of the ring 2 during the advance towards the surface 3c. When it comes in contact with the surface 3c it is compressed between the latter and the edge of the closure tube 1, which thus results in a firm fit, providing a waterproof seal with the housing 4 as illustrated in fig. 1 a.

[0023] By means of this system and the related method of use it is therefore possible to obtain a waterproof seal of the parts of the underwater equipment in question without affecting the integrity of the sealing element. This reaches its final form and compression, thus exerting the required pressure on the inner walls of the housing, only upon arriving at its operating position in the final phase of assembly.

[0024] Evidently this does not merely represent a simple, efficient and fast method of waterproof sealing, but also offers the advantage of reducing the costs connected with the frequent replacement of the sealing elements, by minimising their wear and therefore prolonging their life and usage.

[0025] Moreover, should the seal provided by the sealing ring 2 be broken, it is possible to directly adjust the peg 5 in order to immediately improve the efficiency of the seal, without it being necessary to interrupt the operation in progress and have to, for example, return to the surface in order to dismantle the equipment and remove the water that has leaked inside.

15 Description of the drawings

[0026] The drawings relate to possible embodiments of the present invention and illustrate:

- 20 Fig. 1: sectional view of the elements constituting the present system,
- Fig. 1 a: sectional view of the complete sealing system,
- Fig. 2: first variant of the system,
- 25 Fig. 3: sectional view of the first variant,
- Fig. 4: sectional view of the first variant with assembly completed,
- Fig. 5: variant of the elements 1 and 3 of the system.

30 **[0027]** A closure tube 1 has inside, as illustrated in fig. 1, a seat for a spring 2a and an aperture 6 for the peg 5. The sealing element is an O-ring that is positioned on the truncated cone-sectioned neck 3d of the closure cylinder 3. This neck has an increasing diameter in the direction of the fixing surface 3c.

35 **[0028]** The cylinder 3 is fitted with a cavity 3a into which the sliding peg 5 is inserted. The gradual introduction of the peg 5 makes it possible to adjust the sliding of the inclined surface P' of the peg 5 on the complementary inclined surface P of the cavity 3a. Fixing occurs, as illustrated in fig. 1 a, inside the housing 4 fitted with an aperture 9 for the insertion of the peg 5.

40 **[0029]** The figures from 2 to 4 illustrate a second possible embodiment of the system under consideration. In this alternative the peg 5 is fitted inside with an aperture 8 coaxial with the aperture 7 of the cylinder 3. A locking pin 3b is gradually inserted into this aperture making it possible to adjust the sliding of the inclined surface of the peg 5 on the complementary surface of the aperture 3a until the locking of the sealing element 2 between the surface 3c and the tube 1.

45 **[0030]** Figures 3 and 4 respectively offer a sectional view of this system before and after locking, with the afore-mentioned components indicated.

50 **[0031]** In particular, fig. 4 illustrates the system in the locked position: by means of the gradual tightening of the element 3b the peg 5 is completely inserted into the

cavity 3a and consequently the O-ring is compressed between the surface 3c and the edge of the closure tube 1. The position is stabilised by the compressed spring 2a.

[0032] Figure 5 illustrates a possible variant of the embodiment of the cylinder 3 and of the closure tube 1. In the case illustrated, the truncated cone-sectioned neck rather than being on the cylinder - as in fig. 1 - is on the edge of the tube 1 at the mouth 1a, and is indicated as element 3e.

[0033] Also, in this embodiment the outermost diameter of the edge of the tube corresponds to the diameter of the blockage surface 3c.

[0034] In correspondence with the sliding of the surfaces P and P', the sealing element 2 will be pushed by the surface 3c on the neck 3e of the tube 1, with a consequential gradual and radial expansion of the diameter of the ring 2, until it reaches the vertical wall of the edge of the tube 1, where the sealing element 2 is compressed in order to obtain a waterproof seal.

Claims

1. A system for the waterproof seal of components for underwater equipment, comprising
 - a closure tube (1)
 - a waterproof seal element (2)
 - a closure cylinder (3)
 - a housing (4) of the closure cylinder (3)
 - a sliding peg (5)
 wherein
 - the closure cylinder (3) is fitted inside with a cavity (3a) that presents an inclined surface P,
 - the sliding peg (5) presents a surface P' complementary to the surface P of the cavity (3a)
 - in the working position the surface P' of the peg (5) engages the surface P of the cavity (3a) for locking in the end position.
2. The system according to claim 1, wherein the closure cylinder (3) presents a locking surface (3c) of the waterproof seal element (2).
3. The system according to claims 1 and 2, wherein the diameter of the locking surface (3c) and of the outer edge of the closure tube (1) is greater than or equal to the external diameter of the waterproof seal element (2).
4. The system according to claims from 1 to 3, wherein the diameter of the locking surface (3c) and the diameter of the outer edge of the closure tube (1) are equal.
5. The system according to claims from 1 to 4, wherein the closure cylinder (3) presents in correspondence with the locking surface (3c) a truncated cone-sectioned neck (3d) whose diameter increases in the direction of the surface (3c).
6. The system according to claims from 1 to 4, wherein the edge of the closure tube (1) presents, in correspondence with the entry mouth (1 a) of the cylinder (3), a truncated cone-sectioned neck (3e) whose diameter diminishes in the direction of such a mouth (1 a).
7. The system according to claims from 1 to 6, wherein the sliding peg (5) fixes the tube (1) to the housing (4) thus locking the inclined surface P on the complementary surface P'.
8. The system according to claims from 1 to 6, wherein the peg (5) is fixed to the closure tube (1), to the cavity (3a) and to the housing (4) by a gradual locking element (3b).
9. The system according to claim 8, wherein the gradual locking element (3b) is inserted into apertures coaxial with one another, 6, 7, 8 and 9 of the tube (1), cylinder (3), peg (5) and housing (4) respectively.
10. The system according to claims from 1 to 9, wherein the waterproof seal element (2) is an O-ring.
11. The system according to claims from 1 to 10, wherein the waterproof seal element (2) is made of rubber or silicone.
12. The system according to claims from 1 to 11, wherein the closure cylinder (3) is in contact with a force element (2a), such as a spring, housed inside the closure tube (1).
13. A method for the waterproof closure of components for underwater equipment comprising the following phases:
 - Insertion of a waterproof seal element (2) on the surface of a closure cylinder (3),
 - Gradual insertion of a sliding peg (5) inside a cavity (3a) of the closure cylinder (3),
 - Locking of the closure cylinder (3) inside a housing (4) by the sliding of an inclined surface (P) of the cavity (3a) on the complementary surface (P') of the sliding peg (5).
14. The method according to claim 13, wherein by the gradual insertion of the peg (5), the sealing element (2) slides up a truncated cone-sectioned neck (3d or 3e) pushed by the edge of the closure tube (1)

and/or by a locking surface (3c) on the cylinder (3).

15. The method according to claims 13 e 14, wherein the sealing element (2) is gradually compressed between the locking surface (3c) and the edge of the closure tube (1). 5

16. The method according to claims from 13 to 15, wherein the gradual sliding of the surface (P) of the cavity (3a) on the surface (P') of the sliding peg (5) is counteracted by a force element (2a). 10

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Fig. 1

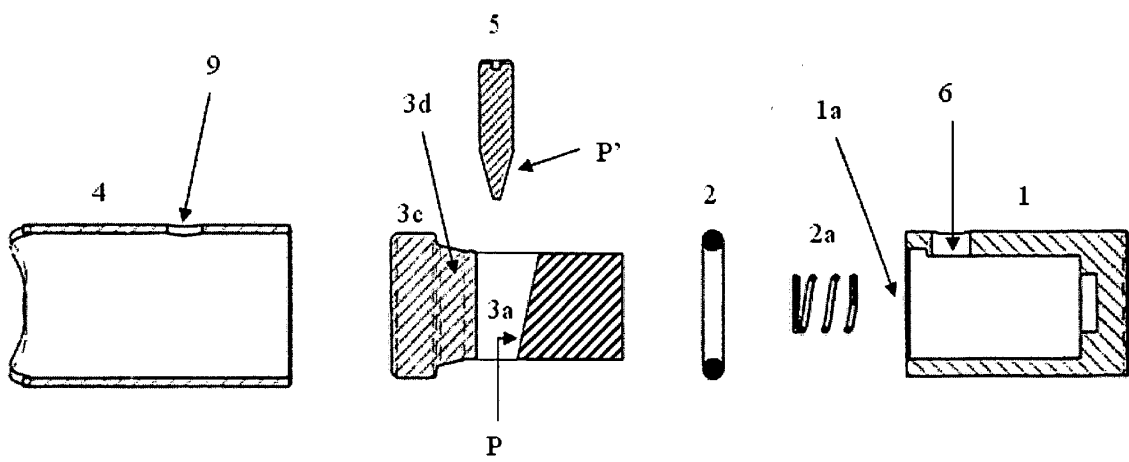


Fig. 1a

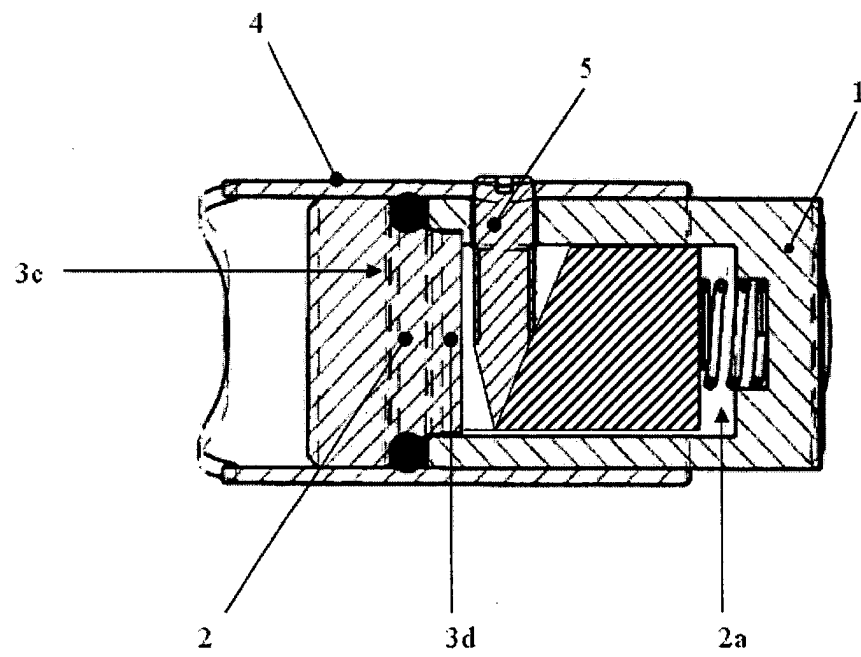


Fig. 2

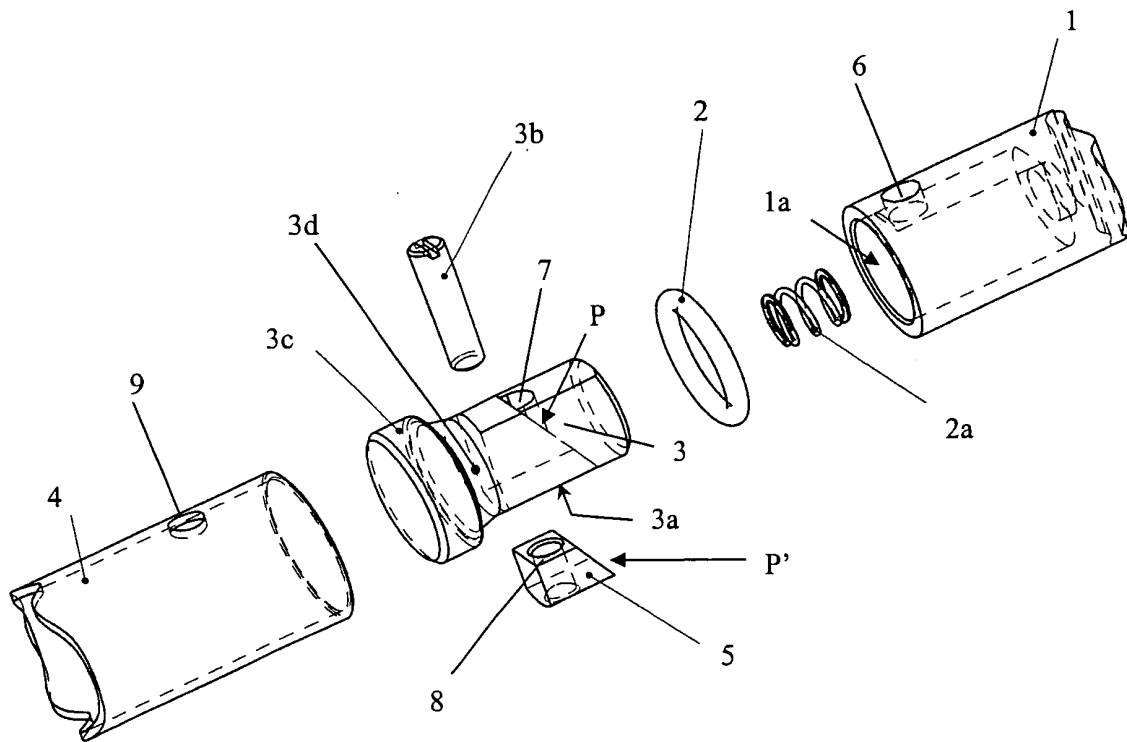


Fig. 3

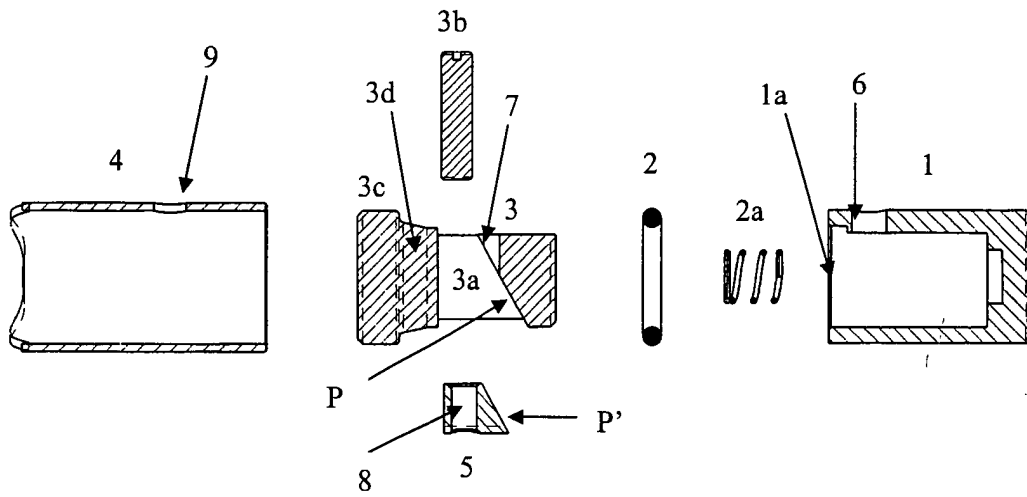


Fig. 4

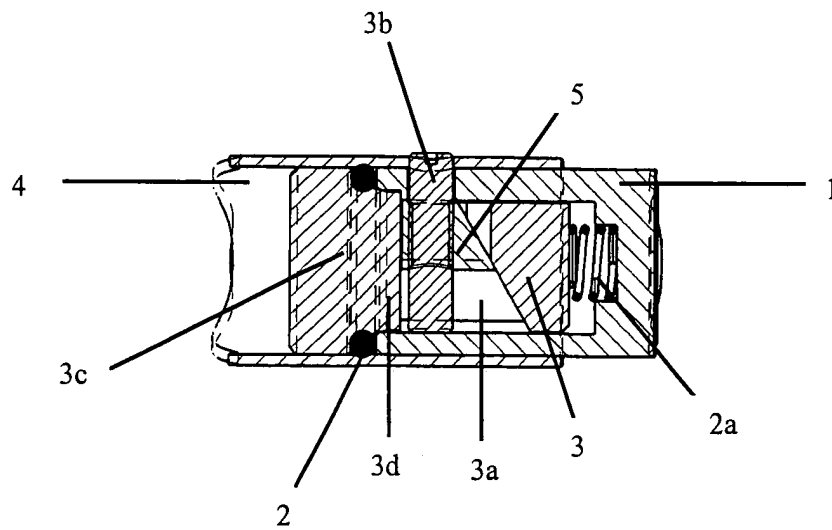
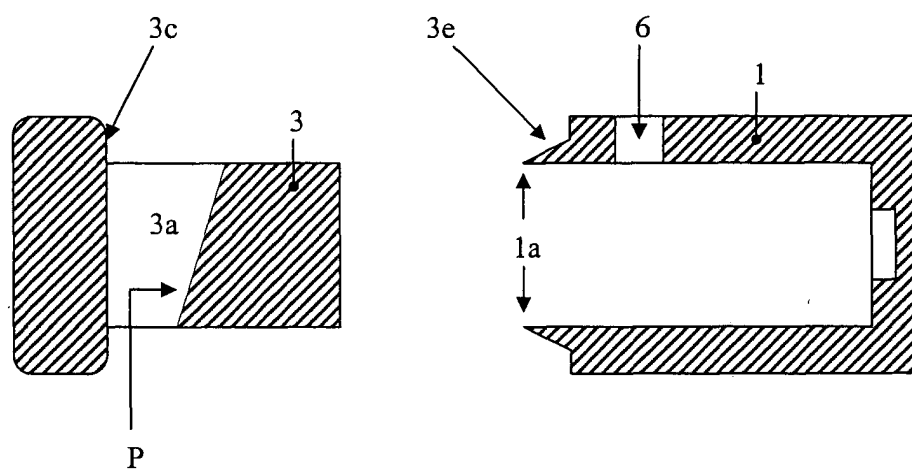


Fig. 5





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 02 1305

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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 18 November 2003	Examiner Moya, E
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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