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**Chabloz**

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(54) **VALVE FOR A PROSTHESIS SOCKET**

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(51) **Int. Cl.**

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| *A61F 2/60* | (2006.01) |
| *A61F 2/50* | (2006.01) |

(52) **U.S. Cl.**

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(58) **Field of Classification Search**

CPC ..... A61F 2002/748; A61F 2002/805; A61F 2002/807; A61F 2/80; F16K 7/16

See application file for complete search history.

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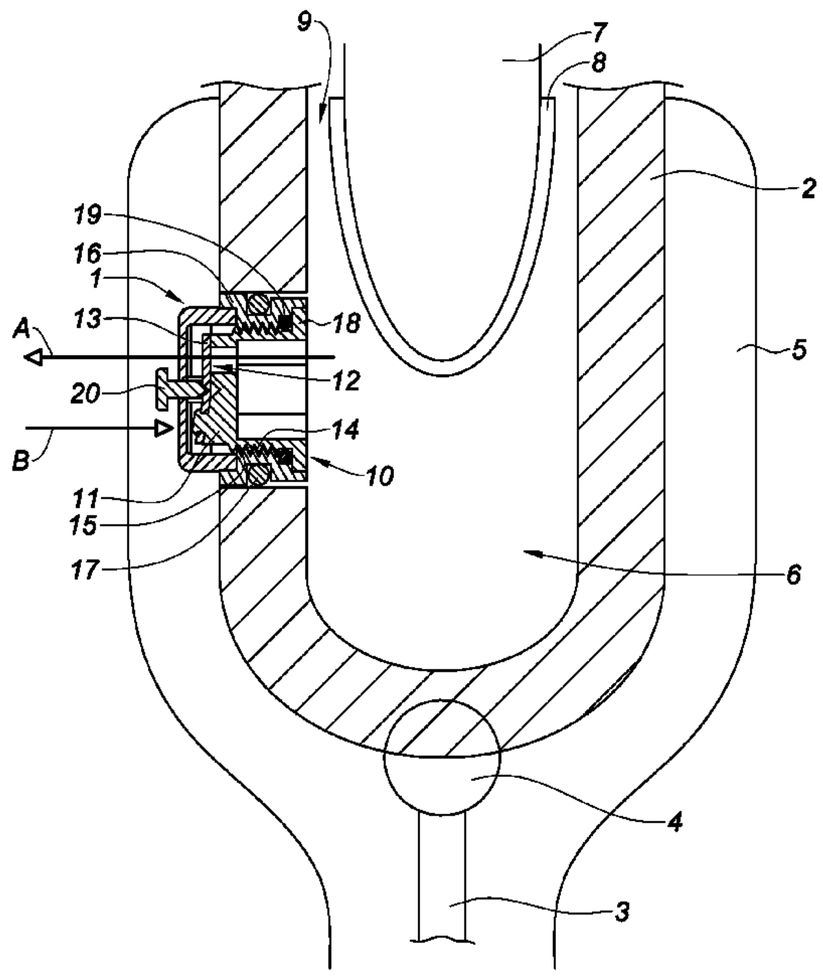
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(57) **ABSTRACT**

Valve for a prosthesis socket, the socket delineating an open cavity to receive a stump of an amputated limb and delineating a pass-through hole opening into the cavity and designed to receive the valve, the valve including a support in which a pass-through channel is formed and an element movable between an outlet position in which the element allow an air flow out of the channel in an outlet direction and a sealing position in which the element prevent any air flow inside the channel in an opposite direction to the outlet direction, the support including a thread configured to mount the support in removable manner inside the pass-through hole, and to enable disassembly of the support in an opposite direction to the outlet direction.

**6 Claims, 5 Drawing Sheets**



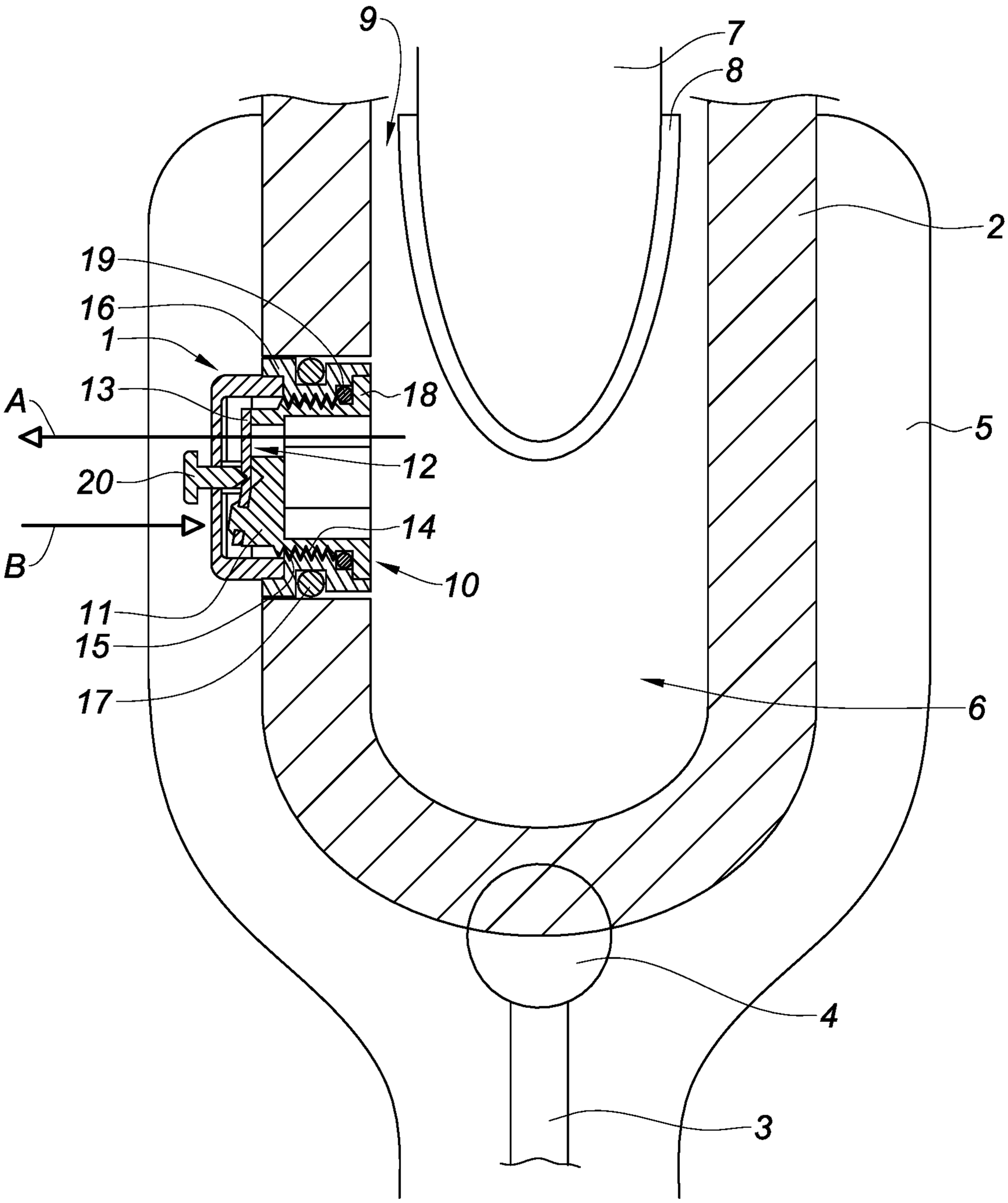



Fig. 1

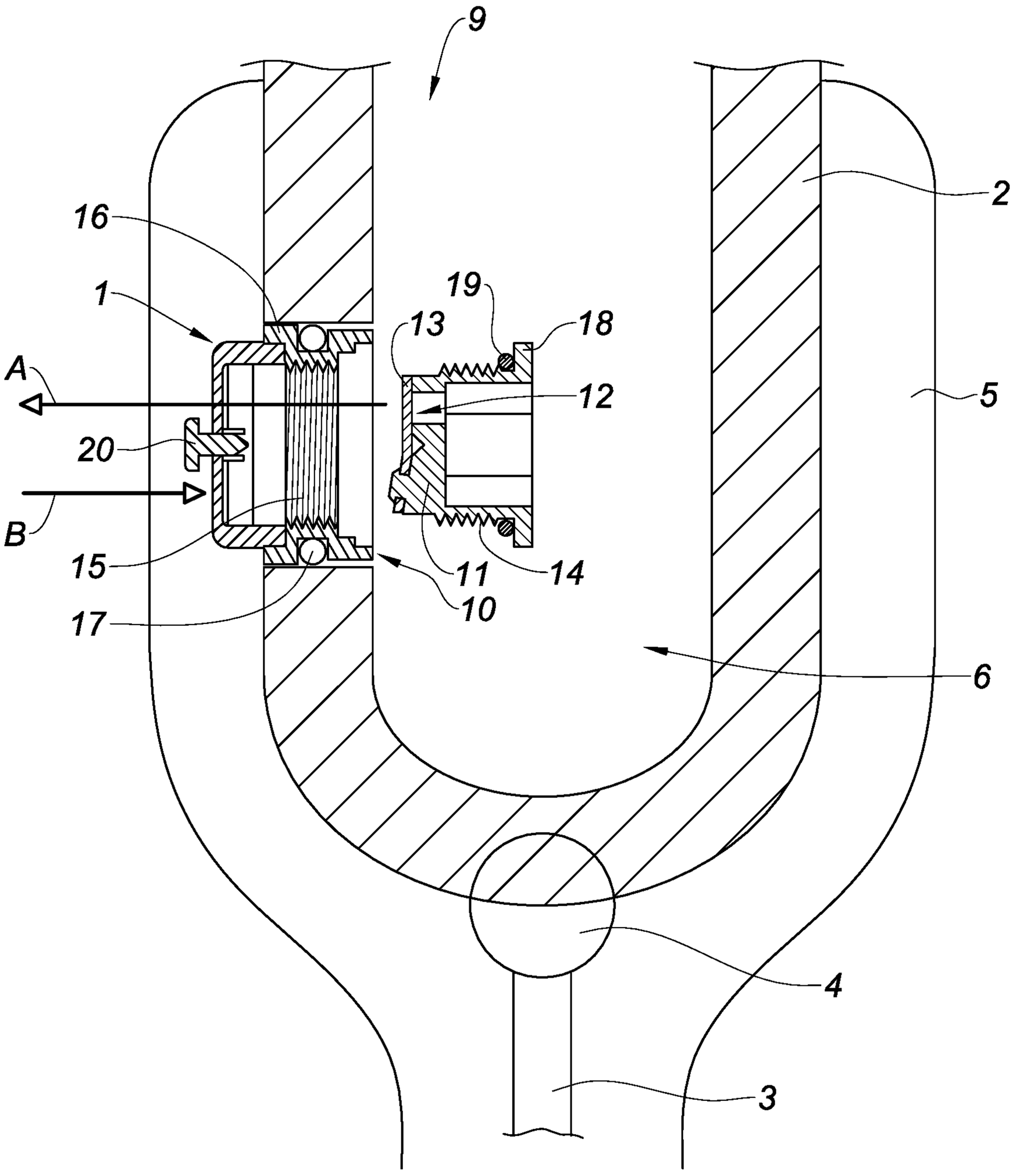



*Fig. 2*

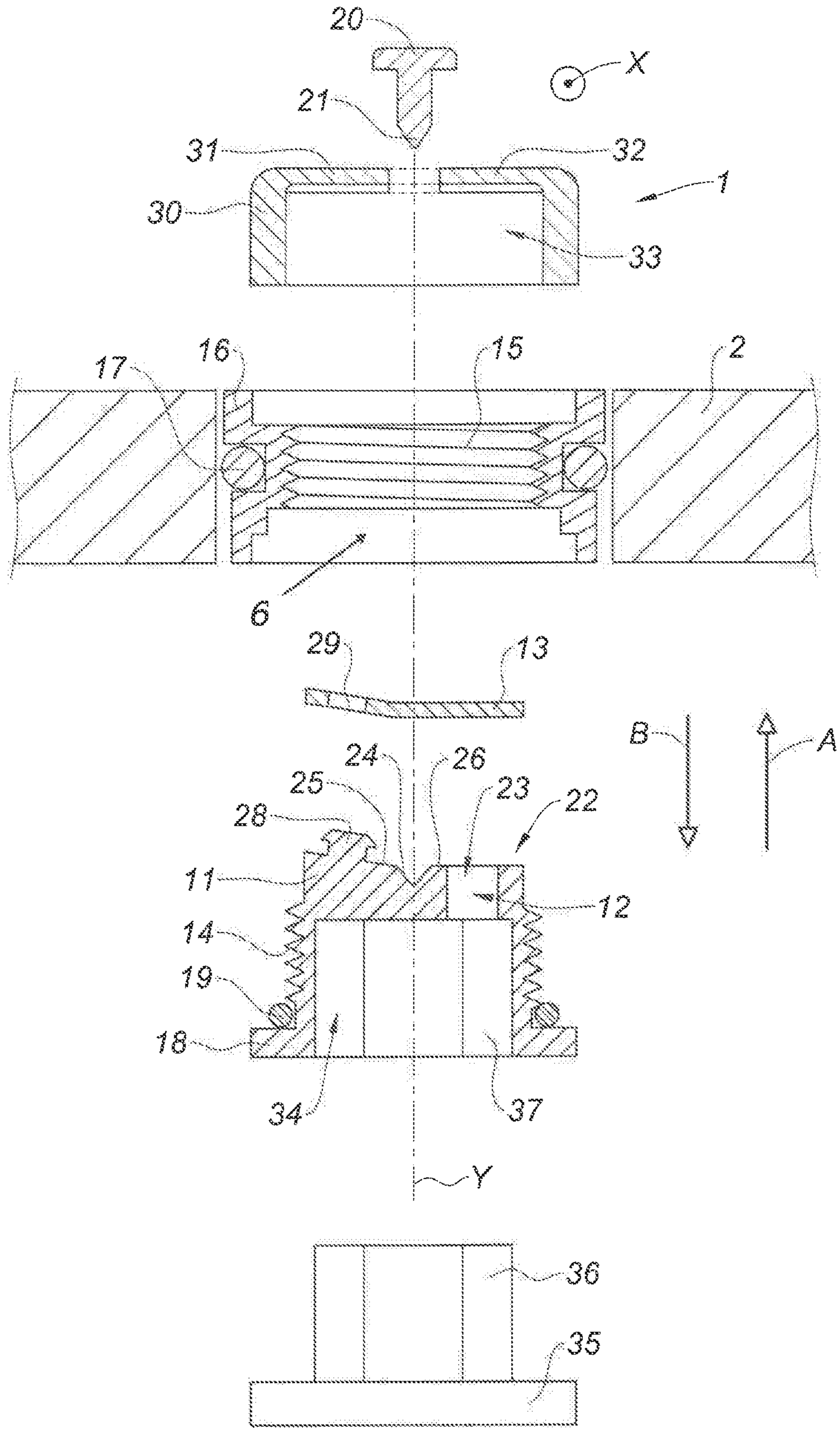

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Fig. 3

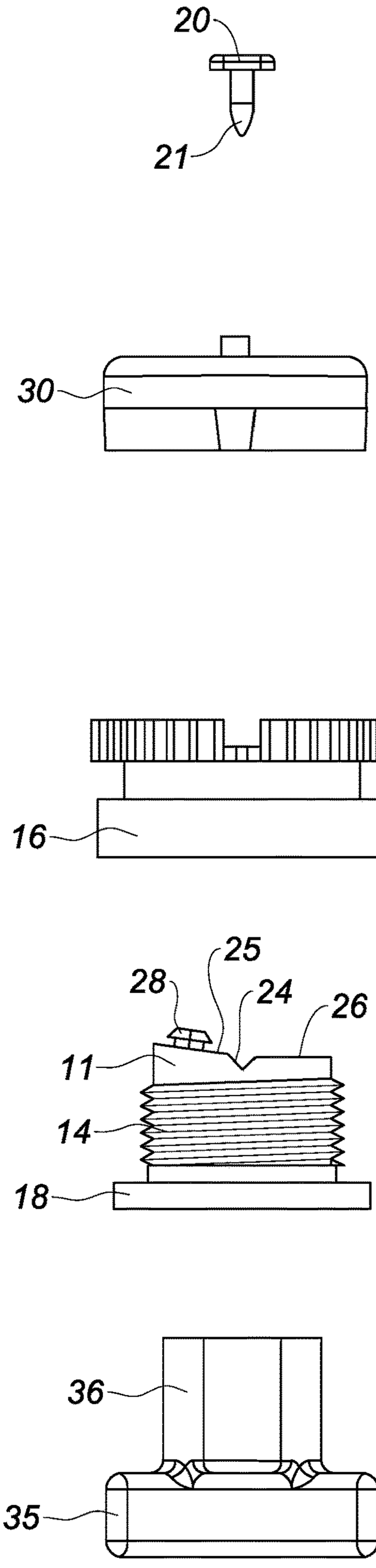

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Fig. 4

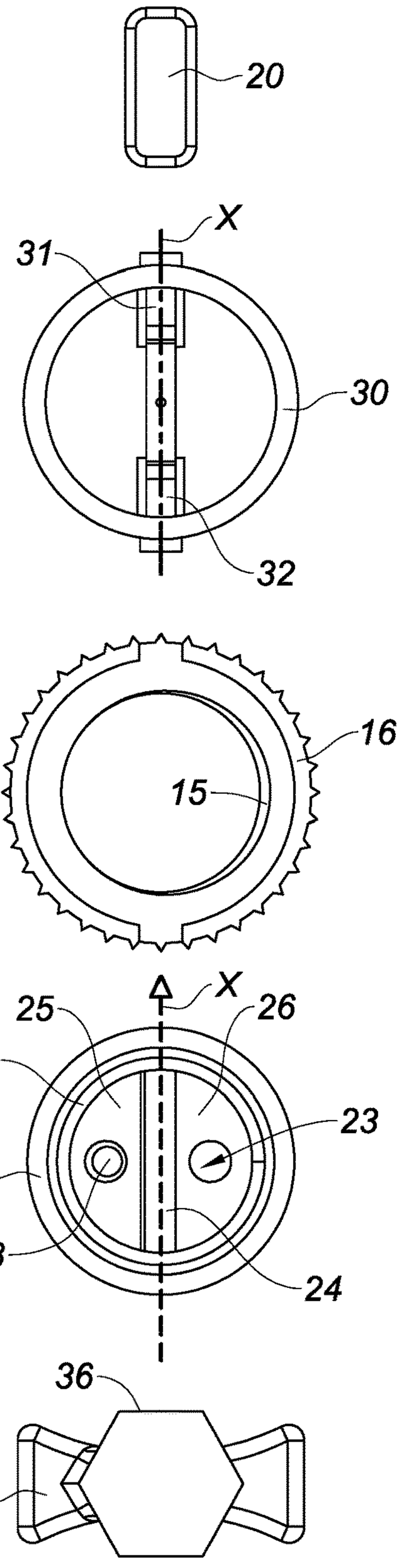

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Fig. 5

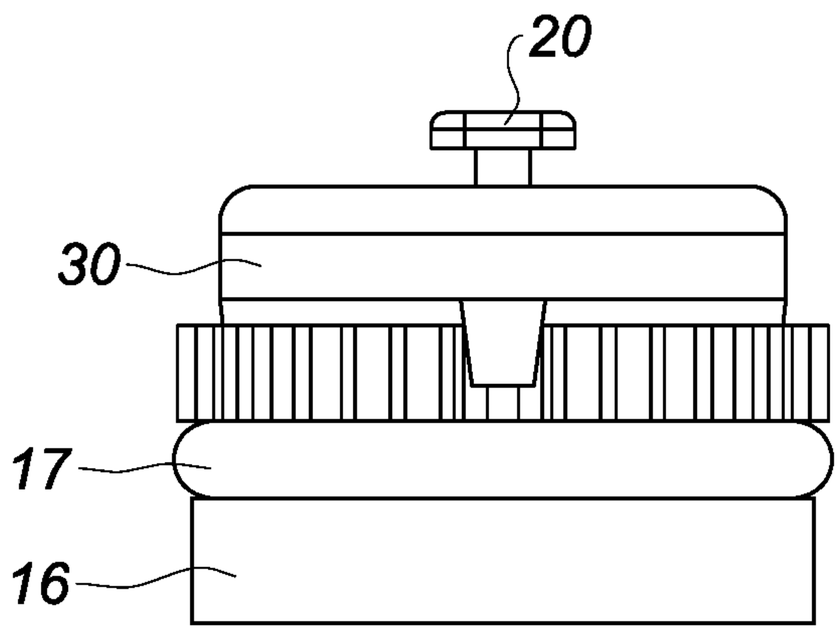



Fig. 6

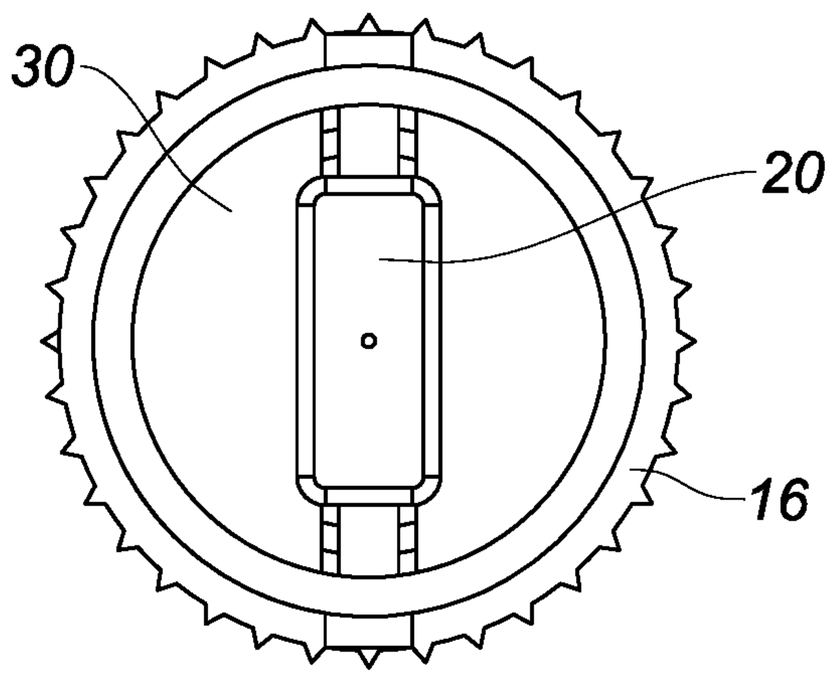



Fig. 7

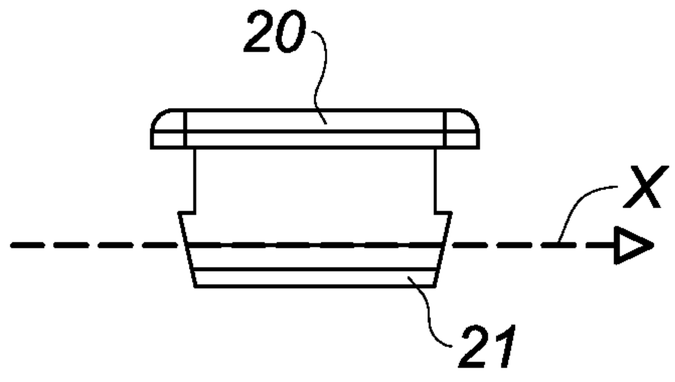



Fig. 8

# VALVE FOR A PROSTHESIS SOCKET

## BACKGROUND OF THE INVENTION

The invention relates to valves for a prosthesis socket, and more particularly to lower limb prostheses.

## STATE OF THE ART

Prostheses designed to replace a missing part of an amputated limb, such as an arm or leg, are currently used. The prostheses comprise a socket, i.e. an engagement shell, on which a prosthetic limb is fixed. The socket delineates an open cavity to receive the stump of the amputated limb. Furthermore, in order to keep the socket secured to the stump, the residual air situated between the socket and the stump is expelled through a pass-through hole arranged in the socket. More particularly, a valve is housed in the pass-through hole to prevent air from getting into the cavity and to allow air to be expelled to the outside of the cavity. Such a valve is of the check valve, or one-way valve, type as it only enables an air flow in one direction in normal operation.

French Patent applications FR2903294 and FR2903295 can be cited for example which disclose a cap for a prosthesis, movable between a sealed position and a released position of a pass-through hole arranged in the prosthesis. The cap is equipped with a valve for performing air outlet from the cavity of the prosthesis and for preventing air from entering the cavity. The valve comprises a flexible element provided with an opening which is normally closed and which opens under the effect of a deformation of the flexible element caused by an air thrust originating from the cavity of the prosthesis.

French Patent application FR2994381 can also be cited which discloses a cap with an automatic check valve for a socket in the form of a negative pressure prosthesis shell comprising a fixing base equipped with a tubular end-part designed to be assembled to an aperture of the socket, and provided with a support element of the valve performing air outlet from the socket and preventing air from entering the socket. The support element is movable by pivoting to occupy a separated position where the valve is located away from the aperture, and the base is equipped with a securing nose of the support element. The valve is further clip-fastened onto the top part of the support element.

However these valve caps are not suitable for all types of prostheses. The prostheses can in fact be covered by a foam aesthetic covering and a covering stocking made from cloth, silicone, or polyurethane. Furthermore, the valves which have just been described are very sensitive to dust which prevents them from operating correctly. It is therefore necessary to clean the valves regularly, and the covering stocking and aesthetic covering then have to be removed to access the valves.

Patent documents US2015/0265433, FR1088509, WO2014/035561, U.S. Pat. Nos. 4,595,172, and 6,613,096 can be cited which disclose valves for a prosthesis socket for which the aesthetic covering has to be removed to clean the valve.

## OBJECT OF THE INVENTION

The object of the invention consists in remedying these shortcomings, and more particularly in providing a valve that is easy to maintain and that guarantees that the junction between the socket and the stump of the amputated limb is kept secure.



Another object of the invention consists in providing a prosthesis socket equipped with one such valve.

According to one feature of the invention, a valve for a prosthesis socket is proposed, the socket delineating an open cavity to receive a stump of an amputated limb and delineating a pass-through hole opening into the cavity and designed to receive the valve.

The valve comprises a support in which a pass-through channel is formed, and an element mounted movable between an outlet position in which the element allows an air flow out of the channel in an outlet direction only and a sealing position in which the element prevents any air flow inside the channel in an opposite direction to the outlet direction.

The support comprises a fixing means configured to mount the support in removable manner inside the pass-through hole.

The fixing means is configured to enable disassembly of the support in the opposite direction to the outlet direction.

A valve is thus provided the element to be maintained of which may be extracted via the cavity of the socket. Maintenance of the valve is therefore facilitated as the aesthetic covering which envelops the socket does not have to be removed in order to be able to access the valve.

The valve can comprise a base configured to be mounted inside the pass-through hole and comprising a tapped hollow body, the fixing means comprising a thread cooperating with the thread of the body of the base.

The support can comprise a stop to prevent disassembly of the support in the outlet direction.

The valve can comprise an actuator configured to immobilize the element in the outlet position in order to allow an air flow out of the channel in the outlet direction and an air flow inside the channel in the opposite direction to the outlet direction.

The actuator can comprise a termination, and the support comprises a surface in which an opening of the channel and a longitudinal slot situated facing the terminal are formed, the longitudinal slot enabling a deformable part of the element to be received to move the element away from the opening of the channel.

The surface of the support can comprise two flat areas situated on each side of the longitudinal slot, the two flat areas being inclined with respect to one another.

The valve can comprise a cap having a deformable tab on which the actuator is mounted, the tab enabling movement of the actuator for the termination to press on the element.

The support can comprise a housing, the valve comprising a removable piece configured to cooperate with the housing in order to disassemble the support in the opposite direction to the outlet direction.

According to another feature, a prosthesis socket is proposed delineating an open cavity for receiving a stump of an amputated limb and delineating a pass-through hole in the cavity, the socket comprising a valve as defined in the foregoing mounted inside the pass-through hole.

## BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages and features will become more clearly apparent from the following description of particular embodiments of the invention given for non-restrictive example purposes only and represented in the appended drawings, in which:

FIG. **1** schematically illustrates a cross-sectional view of an embodiment of a valve mounted on a prosthesis socket according to the invention;

FIG. **2** schematically illustrates a cross-sectional view of the valve of FIG. **1** the support of which has been dismantled;

FIG. **3** schematically illustrates an exploded cross-sectional view of another embodiment of the different parts of a valve;

FIG. **4** schematically illustrates perspective side views of certain parts of FIG. **3**;

FIG. **5** schematically illustrates perspective top views of the parts of FIG. **4**;

FIG. **6** schematically illustrates a perspective side view of the valve of FIG. **3** the parts of which are mounted;

FIG. **7** schematically illustrates a perspective top view of the valve of FIG. **6**; and

FIG. **8** schematically illustrates another perspective side view of a valve actuator.

## DETAILED DESCRIPTION

In FIG. **1**, a valve **1** for a prosthesis socket **2** has been represented. The prosthesis comprises a prosthetic limb **3**, for example a replacement leg or forearm, fixed to a distal end of the socket **2** by an articulated link **4**, such as a pivot joint. The prosthesis can also comprise an aesthetic covering **5** made from foam, cloth, silicone, or polyurethane, partially or totally covering the socket **2**. The socket **2** delineates an open cavity **6** to receive a stump **7** of an amputated limb. The stump **7** of the amputated limb can be enveloped by a sleeve **8** of complementary external shape to the cavity **6** of the socket **2** to facilitate engagement of the stump **7** inside the cavity **6**. An opening **9** of the cavity **6** is situated at the level of the proximal end of the socket **2**. A pass-through hole **10** is further formed in the thickness of the socket **2**. The pass-through hole **10** opens into the cavity **6** and is shaped so as to receive the valve **1**.

The valve **1** is particularly suitable for a tibial prosthesis socket **2**. The valve **1** enables a vacuum to be created between the socket **2** and stump **7**, which maintains their junction. Preferentially, the valve **1** is a check valve, also called one-way valve, i.e. in normal operation, the valve **1** only lets air flow in a first direction A, in particular from the inside of the cavity **6** to the outside of the cavity **6**, and prevents any air inlet inside the cavity **6** in a second direction B opposite the first direction A. The first direction A is also called "outlet direction", and the second direction B is called "disassembly direction" B. In order to keep the socket **2** secured to the stump **7**, the residual air contained in the cavity **6** is expelled through the valve **1** to the outside of the cavity **6**, in the first direction A. When the valve **1** is one-way, it prevents the outside air from entering the cavity **6**, and a vacuum is then created between the stump **7** and socket **2** to keep them secured to one another. Advantageously, to guarantee the airtightness between the stump **7** and socket **2**, a sealing part can be placed at the proximal end of the socket **2**. For example, the sealing part can be a lip seal fixed to the socket **2**, or to the sleeve **8** covering the stump **7**, or be an elastic sheath enveloping the socket **2** and sleeve **7** at the level of the opening **9** of the cavity **6**.

The valve **1** comprises a support **11** in which a channel **12** is formed, and an element **13** for closing the channel **12**. The channel **12** is pass-through to make the inside of the cavity communicate with the outside. When the valve **1** is mounted in the pass-through hole **10**, the pass-through channel **12** opens into the cavity **6** to enable the residual air situated between the socket **2** and stump **7** to be expelled. The element **13** of the valve **1** is movable between an outlet position in which the element **13** allows an air flow out of the pass-through channel **12** in the outlet direction A, and a sealing position, as illustrated in FIG. **1**, in which the element **13** prevents any air flow inside the pass-through channel **12** in the disassembly direction B. The element **13** of the valve **1** is preferentially elastically deformable. In this case, the element **13** deforms in order to occupy the outlet position when the pressure of the air contained in the pass-through channel **12** is higher than the pressure of the outside air, and to revert to the sealing position when the pressure of the air contained in the pass-through channel **12** is lower than the pressure of the outside air. The element **13** can be mounted movable on the support **11**. Preferentially, the element **13** comprises a first part mounted fixed on the support **11** and a second part movable with respect to the support **11**. The element **13** can further be elastically deformable. For example, the element **13** can be an elastic membrane.

The support **11** also comprises a fixing means **14** configured to mount the support **11** inside the pass-through hole **10** in removable manner. More particularly, the fixing means **14** is configured to allow disassembly of the support **11** in the direction B opposite to outlet direction A. It is thus possible to dismantle the element **13** and its support **11** inside the cavity **6**. A valve **1** whose support **11** and element **13** are dismantled in the disassembly direction B and are located inside the cavity **6** has been illustrated in FIG. **2**. The aesthetic covering **5** then does not have to be disassembled to remove the element **13** from the socket **2**. Such a valve **1** facilitates regular maintenance or repair. Furthermore, fixing means **14** enables the support **11** to be mounted in the outlet direction A. In other words, the support **11** is assembled to the socket **2** via the inside of the cavity **6**, i.e. by inserting the support **11** and element **13** inside the cavity **6**. This furthermore facilitates mounting thereof on a prosthesis previously equipped with an aesthetic covering **5**, as the aesthetic covering **5** does not have to be removed to assemble the support **11** and element **13** to the socket **2**.

For example, the fixing means **14** is configured to cooperate with a receiving means **15** to mount the support **11** in the pass-through hole **10**. The receiving means **15** can be situated in the thickness of the socket **2**. The support **11** can thus be mounted directly on the socket **2**. Advantageously, the valve **1** can comprise a base **16** configured to be mounted in the pass-through hole **10** and to receive the support **11**. The base **16** can be screw-fastened, welded, stuck, or crimped in the thickness of the socket **2**. An O-ring **17** can be provided housed in an aperture provided on the outer surface of the base **16**. The O-ring **17** guarantees the airtightness between the socket **2** and base **16**. The base **16** comprises a hollow body. Furthermore, the base **16** comprises the receiving means **15** to mount the support **11** inside the hollow body of the base **16**. When the base **16** is fixed to the pass-through hole **10**, it prevents the support **11** from accidentally coming out when the stump **7** is removed from the cavity **6**. For example, the fixing means **14** comprises an external thread and the receiving means **15** comprises an internal thread. The fixing means **14** can comprise securing notches and the receiving means **15** comprises housings designed to receive the securing notches.

Advantageously, the support **11** can comprise a stop **18** to prevent disassembly of the support **11** in the outlet direction A. The stop **18** can comprise a collar salient from the body of the support **11**. The collar **18** is situated at a proximal end opposite to the distal end of the support **11** where the

element **13** is located. The support **11** can also comprise an opening provided on its outer surface to receive an additional O-ring **19**. The additional O-ring **19** guarantees the airtightness between the support **11** and base **16**.

The valve **1** can further comprise an actuator **20** configured to immobilize the element **13** in the outlet position in order to allow both air flow out of the pass-through channel **12** in the outlet direction A and air flow inside the pass-through channel **12** in the disassembly direction B. When the element **13** is immobilized in the outlet position, an air inlet is allowed inside the cavity **6**, which disunites the socket **2** and sleeve **7** so that the user can remove the prosthesis. It is also said that the actuator **20** unlocks the valve **1**. Indeed, in normal operation, the valve **1** is said to be locked, and the element **13** is free to occupy the sealing position or the outlet position. The element **13** moves from one position to the other according to the pressure difference between the inside and outside of the cavity **6**. On the contrary, it is noted that the valve **1** is unlocked when the element **13** is kept in the outlet position, and in this case air can flow in both directions A, B between the inside and outside of the cavity **6**.

In FIG. **2**, the valve **1** described in FIG. **1** has been represented, the support **11** of which is removed from the base **16**, i.e. removed from the socket **2**. In FIGS. **4** and **5**, the valve **1** has been represented with its parts disassembled, and in FIGS. **6** and **7**, the valve **1** has been represented with its parts assembled.

In FIG. **3**, an exploded view of the different parts of the valve **1** has been represented. Preferably, the actuator **20** comprises a termination **21** and the support **11** comprises a surface **22** in which an opening **23** of the pass-through channel **12** and a slot **24** are formed. The surface **22** is situated at the distal end of the support **11**. The slot **24** preferably has a complementary shape to that of the termination of the actuator **20** to receive a deformed part of the element **13**. For example, the termination **21** of the actuator **20** extends along a longitudinal axis X, perpendicular to the sheet plane of FIG. **3**. In FIG. **8**, another view of the actuator **20** has been represented in which the longitudinal axis X is in the plane of FIG. **8**. The termination **21** can have a V-shape to provide an end in the shape of a tip. The longitudinal slot **24** also extends along an axis parallel to the longitudinal axis X of the termination **21**. The slot **24** can also have a V-shape complementary to that of the termination **21**. In particular, the longitudinal slot **24** is situated facing the termination **21**. When the actuator **20** occupies an initial position, as illustrated in FIG. **1**, the valve **1** is locked. When the user presses the actuator **20**, the latter translates along an axis Y parallel to a longitudinal axis of the pass-through channel **12**. When translation takes place, the actuator **20** presses the element **13** against the surface **22** of the support **11**, in particular at the level of the longitudinal slot **24**. In this way, a deformable part of the element **13** is inserted into the slot **24**, which raises the element **13** and moves the latter away from the opening **23** of the pass-through channel **12**. At the end of translation, the actuator **20** occupies the second position in which the element **13** occupies the outlet position. The element **13** can then be kept in the outlet position by maintaining the pressure of the actuator **20** against the element **13**. When the element **13** is immobilized in the outlet position, air can flow from the cavity **6** to the outside, through the pass-through channel **12**, and in the opposite direction, i.e. from the outside to the inside of the cavity **6**. When the user releases the pressure on the actuator **20**, the latter reverts to its initial position and the element **13** reverts to its sealing position. The element **13** reverts to its position on account of its elasticity.

In order to facilitate deformation of the element **13** so that it occupies the outlet position, the surface **22** of the support **11** can comprise two flat areas **25**, **26** situated on each side of the longitudinal slot **24**. The two flat areas **25**, **26** can be inclined with respect to one another. Furthermore, the element **13** can have a curved shape which coincides with the two inclined flat areas **25**, **26**. The support **11** can comprise a spigot **28** which is inserted in an aperture **29** provided in the element **13**. The spigot **28** enables a part of the element **13** to be kept fixed to keep the element **13** secured to the support **11**, the other part of the element **13** being deformable to occupy the outlet and sealing positions.

Advantageously, the valve **1** comprises a cap **30** having at least one deformable tab **31**, **32** on which the actuator **20** is mounted. The deformable tabs allow movement of the actuator **20** in translation along the axis Y to press the actuator **20** against the element **13**. For example, the tabs are elastic and the actuator **20** reverts to its initial position on account of the elasticity of the tabs **31**, **32**. According to another advantage, the cap **31** delineates a chamber **33**. The chamber **33** is situated at one end of the valve **1** so that the element **13** is situated between the chamber **33** and support **11**. The chamber **33** enables the element **13** to occupy the outlet position. The chamber **33** in fact forms a clearance volume to receive the element **13**. Furthermore, a pass-through hole is formed in the wall of the cap **30**. The pass-through hole is situated on the surface of the cap **30** where the tabs **31**, **32** are located. The pass-through hole opens into the chamber **33** to allow the outside air to enter the chamber **33**, and inversely so that the air from the chamber **33** can flow to the outside.

When the user wants to remove the stump **7** from the socket **2**, after the vacuum has been created between the socket **2** and stump **7**, the user presses the actuator **20**, the element **13** is immobilized in the outlet position, and the outside air is inserted inside the cavity **6**. This air inserted inside the cavity **6** disunites the stump **7** and socket **2**, and the stump **7** can be removed. For example, the aesthetic covering **5** can be porous to air. In this way, when it is required to create the vacuum between the socket **2** and stump **7**, the aesthetic covering **5** allows the residual air situated between the socket **2** and stump **7** to escape the outside. Furthermore, when it is required to remove the stump **7** from the socket **2**, the aesthetic covering **5** enables the outside air to be inserted inside the cavity **6**. As a variant, an air outlet channel can be provided situated in the thickness of the aesthetic covering **5** and connecting the chamber **33** with the outside. In particular, the outlet channel connects the pass-through hole of the cap **30** with the outside. Advantageously, the aesthetic covering **5** is flexible to allow the user to press the actuator **20**, from the outside, by pressing the aesthetic covering **5**.

The support **11** can also comprise a housing **34** designed to receive a removable piece **35**. The piece **35** is inserted in the housing **34**, and cooperates with the housing **34** to disassemble the support **11** in the disassembly direction B. For example, the piece **35** can comprise several faces **36** and the housing **34** comprises complementary faces **37** to be able to make the support **11** rotate around the axis Y, thereby disassembling the support **11** from the valve **1**.

The invention claimed is:

**1**. A valve for a prosthesis socket, the socket delineating an open cavity to receive a stump of an amputated limb and delineating a pass-through hole opening into the cavity and designed to receive the valve, the valve comprising:

a support in which a pass-through channel is formed,

an element mounted movable between an outlet position in which the element allows an air flow out of the channel in an outlet direction only and a sealing position in which the element prevents any air flow inside the channel in an opposite direction to the outlet direction,

a base configured to be mounted inside the pass-through hole and comprising a hollow body and a receiving means,

the support comprising a fixing means configured to cooperate with the receiving means to mount the support in removable manner inside the pass-through hole,

the fixing means being configured to enable disassembly of the support in the opposite direction to the outlet direction, and

an actuator configured to immobilize the element in the outlet position in order to allow an air flow out of the channel in the outlet direction and an air flow inside the channel in the opposite direction to the outlet direction,

the actuator comprising an end, and the support comprises a surface in which an opening of the channel and a longitudinal slot situated facing the end are formed, the longitudinal slot enabling a deformable part of the element to be received to move the element away from the opening of the channel.

**2**. The valve according to claim **1**, wherein the support comprises a stop to prevent disassembly of the support in the outlet direction.

**3**. The valve according to claim **1**, wherein the surface of the support comprises two flat areas situated on each side of the longitudinal slot, the two flat areas being inclined with respect to one another.

**4**. The valve according to claim **1**, comprising a cap having a deformable tab on which the actuator is mounted, the tab enabling movement of the actuator for the end to press on the element.

**5**. The valve according to claim **1**, wherein the support comprises a housing, the valve comprising a removable piece configured to cooperate with the housing in order to disassemble the support in the opposite direction to the outlet direction.

**6**. A prosthesis socket delineating an open cavity for receiving a stump of an amputated limb and delineating a pass-through hole in the cavity, the socket comprising a valve according to claim **1** mounted inside the pass-through hole.

* * * * *