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Lockable quick coupling

The invention relates to a lockable quick coupling for releasably connecting a tube to an implantable device.

Implantable devices are typically medical devices, such as blood pumps, implanted in a patient's body to be connected to a liquid-conveying tube. In the case of a blood pump, one end of the tube is typically connected to an artery and the other end to the blood pump. Hereby, there is the difficulty that on connecting the tube with the implanted device the connection between tube and artery could be damaged by the resulting forces.

US 7,273,446 B2 discloses a blood pump which operates anticyclically in relation to the pulsation of the heart. In such a counterpulsatile, CPD ("counter pulsation device") blood pump, the blood-conveying tube is tightly sutured with the subclavian and the pump implanted in the right pacemaker pocket in the chest area of the patient. The pump sucks the amount of blood ejected from the heart during systole, thus reducing the force applied by the heart muscle. After closing the aortic valve, the CPD pumps the previously absorbed amount of blood into the artery during diastole. When implanting a CPD, the pump is connected to the tube sutured to the subclavian. In doing so, the tube transmits torsional and other forces to the suture connection with the subclavia. Connecting the tube and pump must therefore be performed with great care so as not to damage the suture connection on the subclavia. In addition, the connection must be air-free and without visible transition edges.

US 4,433,973 A and US 5,456,676 A describe catheter couplings each with two attachment pieces, which are rotatable against each other in the locked state.

The invention has for its object to facilitate the connection of a tube with an implantable device.

The solution according to the invention is defined by the features of claim 1. According to this, a lockable quick coupling for releasably connecting a tube to an implantable device is proposed. The quick coupling has a first attachment piece

connectable to the tube and a second attachment piece connectable to the device. The two attachment pieces are releasably lockable together and in the locked state rotatable against each other.

The two attachment pieces can be easily connected to each other, for example, after the device has been implanted in the patient and the tube has been sutured to an artery of the patient. When connecting both attachment pieces, less force than previously needs to be applied. In the case of a CPD, less force is exerted on the tube and the danger of damage to the suture connection with the subclavia is reduced. In particular, the connection between the first attachment piece and the tube can already be made before delivery of the quick coupling, so that the operator only needs to connect the two attachment pieces to each other, in order to connect the tube to the device. In that the two attachment pieces in the locked state are rotatable against each other, the risk of torsion of the tube on connecting to the device is reduced, or can at least be corrected immediately after the connection has been made. The quick coupling also allows a particularly compact construction with little additional diameter, a small wall thickness and a short form. Considering the limited space available during implantation, the small size of the quick coupling is of particular importance for connecting the tube to the device. In particular, the tube (graft) can be introduced with a radius to the pump.

Preferably, at the attachment pieces are formed matching annular contact surfaces, each enclosing a passage through the attachment piece, so that by locking the attachment pieces together the contact surfaces are pressed together and automatically make a sealing connection. In particular, in the case of a counterpulsatile blood pump, due to the high pressures involved in conveying the blood, a well-sealed connection is important. In this case, it is advantageous if a radially outer peripheral region of each contact surface recedes relative to a sealing inner contact region by an angle α of a few degrees and in particular of less than one degree. As a result, the contact surfaces in the locked state touch only in the inner contact region, so that in the inner, adjacent to the passage contact area, the surface pressure is increased, and the sealing effect improved. In that the highest surface pressure is achieved in the area of the blood-conducting passage, this eliminates the need for a separate sealing element, for example in the form of a sealing ring.

Preferably, the one first attachment piece, particularly the first attachment piece connectable to the tube, is enclosed by a union nut, which is lockable with the other second attachment piece, particularly the second attachment piece connectable with the device, in such a manner that a cavity is formed between the other attachment piece and the union nut. In this cavity is held, the one first attachment piece which is in particular connectable with the tube, wherein the union nut is designed for locking with the other attachment piece. The one attachment piece enclosed by the union nut is connected by the union nut to the second attachment piece, and can be turned as desired in the cavity in relation to the other attachment piece.

A spring may be provided in the cavity for exerting a force from the union nut on the one attachment piece towards the other attachment piece. In the locked state, the attachment piece enclosed by the union nut is pressed by the spring against the other attachment piece in the axial direction, while a rotation of both attachment pieces relative to each other is made possible. To get an evenly distributed pressure on the contact surfaces pressed against each other in the locked state, the spring is preferably a wave spring, which in the compressed, locked state exerts a maximum pressure. The danger of tilting the two attachment pieces is reduced and the sealing effect distributed evenly over the circumference.

The first attachment piece connectable to the tube preferably has a collar with a sharp end edge onto which the tube is pushed. The sharp end edge allows a nearly stepless transition between tube and attachment piece in order to reduce the risk of blood agglomeration. The collar is provided on its exterior with a step which secures the pushed-on tube, in the manner of a barbed hook, against slipping off the attachment piece. The connection between the sharp-edged first attachment piece and the tube can already be prepared, before delivery of the quick coupling, with the necessary care, and be sealed to reduce the risk of injury to the surgeon and that of gap formation on making the connection.

Preferably, a bayonet lock is provided for locking between the union nut and second attachment piece, wherein the union nut may have a guard ring covering the bayonet lock

to reduce the risk of injury to the surgeon on making a connection, or reduce penetration of glove material. With the bayonet lock the connection can be made easily and detachably by pushing together and then twisting the two pieces against each other, wherein when closing the bayonet lock the rotational movement is not transmitted to the tube, and thus not to a possible suture with a blood vessel of the patient. Preferably, the two attachment pieces, the union nut and the implantable spring are made of titanium to produce a stable and lightweight quick coupling that will not be corroded by blood. The protective ring is preferably made of a high-friction transparent plastic, so that the surgeon can grasp the ring well even with surgical gloves and turn it for locking.

In the following, an exemplary embodiment will be explained in more detail with reference to figures.

Shown are:

Figure 1 A longitudinal section through the quick coupling according to the invention, with a connected tube.

Figure 2 A side view of a first attachment piece according to the exemplary embodiment.

Figure 3 A side view of a second attachment piece according to the exemplary embodiment.

Figure 4 A longitudinal section of area IV in Figure 3.

Figure 5 A perspective view of a union nut according to the exemplary embodiment.

The quick coupling 10 consists of the first attachment piece 14 connectable with the tube 12, the second attachment piece 16 connectable with the implantable device, the union nut 18, the spring 20 and the protective ring 23.

Figure 1 shows the first attachment piece 14 with the tube 12 slid on. For this purpose, the first attachment piece 14 has a protruding, cylindrical collar 22, whose circumferential end edge 24 tapers, so that in the transition region between the collar 22 and tube 12 no edge clearly projecting into the tube lumen is formed at which blood could agglomerate. On the exterior the collar 22 is provided with a peripheral step 26 which forms a projection in the direction of the second extension piece 16 and slopes obliquely towards the end edge 24. In this way, the tube 12, which is thermally shrunk on the collar 22, is secured against slipping by the step 26 in the manner of a barbed hook. A nitinol coil 13 encloses the tube 12 proximally and distally from the end edge 24 and prevents an expansion of the tube 12, which could cause the tube 12 to slip off the first attachment piece 14 and damage the tube 12 by abrasion at the sharp end edge 24. The nitinol coil 13 is covered on the proximal attachment piece 14 with a durable and biocompatible plastic adhesive (epoxy) 17. The abutting edge 11 of the tube 12 is thereby completely encapsulated to the attachment piece 14 and secured against expansion.

At the distal end of the nitinol coil 13, the last coil of the nitinol coil 13 is guided back over the nitinol coil 13 to the penultimate coil of nitinol coil 13. The two coils of the nitinol coil 13 are guided there in parallel over a short distance and laser-welded on the upper and lower side. Subsequently, the entire area of the distal end of the nitinol coil 13 is encapsulated over two coils with durable and biocompatible plastic adhesive (epoxy) 19. A pointed end of the nitinol coil 13 is thus prevented and perforation or puncture of the tube 12 avoided.

The tube 12 is glued to the attachment piece 14 with a durable adhesive and the end edge 24 is covered with a durable and biocompatible plastic adhesive (epoxy) 15 to completely eliminate the edge 24 as regards blood.

At the distal end opposite to the end edge 24, the first attachment piece 14 has a contact surface 30 for making contact with the second attachment piece 16. The contact surface 30 is annular and encloses a passage 32 of the cylindrical lumen passing through the two attachment pieces 14, 16. The contact surface 30 is bounded on the outside by a distally and outwardly projecting cylindrical retaining edge 34. The inner diameter of the retaining edge 34 is slightly larger than the outer diameter at the proximal end of the

second end piece 16, so that the retaining edge 34 can be pushed onto the second attachment piece 16 and engages around the proximal end of the second attachment piece 16.

The proximal end of the second attachment piece 16 has an annular contact surface 36 surrounding the passage 32 on the outside. The two contact surfaces 30 and 36 are designed to fit one another, wherein an outer peripheral region 38 of each contact surface 30, 36, as shown in Figure 4, recedes at an angle α relative to an inner contact region 40 in such a way that the contact surfaces 30, 36, shown in the state of being pressed against each other in Figure 1, only contact each other in the inner contact region 40, and in the outer peripheral region 38 are spaced from each other. As a result, the surface pressure in the inner contact region 40 is relatively high and a uniform circumferential seal is created on the basis of a press fit, without an additional sealing element, such as, for example, a sealing ring, being needed. The two attachment pieces 14 and 16 are radially adapted in the region 37 via a clearance, so that both parts are easy to join, with the maximum radial offset being minimal. Accordingly, there is no abutting edge for blood, on which blood components can accumulate. The band of clearance in region 37 is short and provided at both ends with precisely adjusted radii 41/39, so that the attachment pieces 16 and 14 can be tilted against each other for venting. For this purpose, the band serves as a contact edge, thus simplifying joining. Thus, liquid can be applied from above in the resulting slot/gap, while the parts can be joined without the inclusion of air.

The first extension piece 14 is enclosed outside by the union nut 18. The proximal right end of the union nut 18 shown in Figure 1 has an inner diameter which is smaller than the outer diameter of the retaining edge 34. As a result, a cavity 42 is created for the spring 20 between the union nut 18 and the first extension piece 14. The union nut 18 can be pushed completely over the first attachment piece 14 in the proximal direction and is held in the distal direction by the retaining edge 34. Between the retaining edge 34 and the proximal region with a reduced inner diameter of the union nut 18, the spring 20 is compressed on moving the union nut 18 in a distal – left in Figure 1 – direction and exerts a spring pressure on the union nut 18 in the proximal direction in relation to the first attachment piece 14. The spring 20 is a wave spring for generating a uniformly distributed spring pressure over the circumference.

The union nut 18 is, as shown in Figure 5, provided at its distal, in Figure 5 left end, with three circumferentially distributed hook-shaped elongated holes 44 of a bayonet lock. The hook holes 44 each engage with a corresponding button 46 radially projecting from the second attachment piece 16 so that the bayonet lock is closable from the elongated holes 44 and the buttons 46 by a plug-and-turn movement of the union nut 18 relative to the second attachment piece 16, and the union nut 18 locks to the second attachment piece 16. In the locked state shown in Figure 1, the spring 20 presses the first attachment piece 14 against the second attachment piece 16, wherein the inner contact regions 40 of the contact surfaces 30, 36 have a sealing press fit.

The union nut 18 is surrounded in the region of the hook-shaped elongated holes 44 by a protective ring 23, not shown in Figure 5, made of transparent plastic, which, as shown in Figure 1, covers the bayonet lock on the outside. This prevents a surgeon's operation glove from getting jammed in the bayonet lock on locking the quick coupling 10. In addition, the plastic ring provides a non-slip grip even with surgical gloves. The ring 28 shown in Figure 1 (preferably made of silicon) serves as a retaining ring for the union nut 18, so that it cannot slip away in the direction of the suture prior to the joining process.

In the exemplary embodiment, the implantable device to be connected to the tube 12 is a counterpulsatile blood pump (CPD) not shown in the figures. The tube 12 is an arterial graft, the proximal end of which opposite to the quick coupling 10 is sutured tightly to an artery ascending from the heart, typically the subclavian, so that arterial blood flows through the tube 12. Hereby, the quick coupling makes it possible to initially establish the suture between the tube 12 and the subclavian during surgery, and then easily connect the end of the tube 12 opposite to the subclavian with the blood pump, without the risky tensile, compressive or torsional forces being thereby exerted on the suture between tube 12 and subclavia. The two attachment pieces 14, 16, the spring and the union nut 18 are made of titanium and the tube 12 is made of a relatively elastic and flexible material (e.g. EPTFE).

The connection between first attachment piece 14 and tube 12 can already be made with the required care in advance in the laboratory, so that by means of an

appropriate sealing the sharp end edge 24 does not constitute any risk for the surgeon or the tube 12 when making the connection. In this case, the connection between the tube 12 and the first extension piece 14 can be produced under the purview of the quality control of the manufacturer independently of the surgeon. The surgeon only needs to lock the bayonet lock during implantation without having any influence on the seal tightness of the connection.

Patentkrav

1. Låsbar hurtigkobling (10) til aftagelig forbindelse af en slange (12) med et implanterbart apparat, med et med slangen (12) forbindeligt første forlængerstykke (14) og et med apparatet forbindeligt andet forlængerstykke (16), hvor forlængerstykkerne (14, 16) hver omslutter et gennemløb (32) gennem forlængerstykket (14, 16), og hvor forlængerstykkerne (14, 16) har med hinanden matchende ringformede kontaktflader (30, 36) og er drejelige i forhold til hinanden i låst tilstand, **kendetegnet ved, at** et radialt udvendigt omkredsområde (38) af hver kontaktflade (30, 36) er trukket tilbage i en vinkel (α) i forhold til et tætnende indvendigt kontaktområde (40), idet vinklen (a) er mindre end 1°.

2. Hurtigkobling (10) ifølge krav 1, **kendetegnet ved, at** de to forlængerstykker (14, 16) er tilpasset radialt i et område (37) via en løbepasning.

3. Hurtigkobling (10) ifølge krav 2, **kendetegnet ved, at** løbepasningens bånd i området (37) er dimensioneret til at være så kort og på begge ender har radier (39, 41) tilpasset på en sådan måde, at forlængerstykkerne (14, 16) kan vippes i forhold til hinanden for at ventilere.

4. Hurtigkobling (10) ifølge et af kravene 1 til 3, **kendetegnet ved, at** hurtigkoblingen (10) har en, omsluttende det ene forlængerstykke (14), omløbermøtrik (18), som er låsbar med det andet forlængerstykke (16), således at der mellem omløbermøtrikken (18) og det andet forlængerstykke (16) er dannet et hulrum (42), i hvilket det ene forlængerstykke (14) er fastholdt.

5. Hurtigkobling (10) ifølge krav 4, **kendetegnet ved, at** der i hulrummet (42) er tilvejebragt en fjeder (20) til at udøve en kraft fra omløbermøtrikken (18) til det ene forlængerstykke (14) i retning af det andet forlængerstykke (16).

6. Hurtigkobling (10) ifølge krav 5, **kendetegnet ved, at** fjederen (20) er en bølgefjeder.

7. Hurtigkobling (10) ifølge et af kravene 1 til 6, **kendetegnet ved, at** det første forlængerstykke (14) til slangen (12) har en cylindrisk krave (22) med en skarp endekant (24) og med et trin (26), der som en modhage sikrer slangen (12) mod at glide af.

8. Hurtigkobling (10) ifølge et af kravene 1 til 7, **kendetegnet ved, at** låsningen er udformet via en bajonetlås (44, 46).

9. Hurtigkobling (10) ifølge krav 8, **kendetegnet ved, at** hurtigkoblingen (10) har en beskyttelsesring (23) dækkende bajonetlåsen (44, 46).

10. Hurtigkobling (10) ifølge et af kravene 1 til 9, **kendetegnet ved, at** de to forlængerstykker (14, 16) er fremstillet af titan, og alle andre elementer af hurtigkoblingen (10) er fremstillet af titan.

11. Hurtigkobling (10) ifølge et af kravene 1 til 10, **kendetegnet ved, at** kontaktfladen (30) af et forlængerstykke (14) er begrænset af en cylindrisk fastholdelseskant (34) stikkende frem i retning af det andet forlængerstykke og udad, idet en indre diameter af fastholdelseskanten (34) er lidt større end den ydre diameter ved enden af det andet forlængerstykke (16), således at fastholdelseskanten (34) kan skubbes på det andet forlængerstykke (16) og griber fat om enden af det andet forlængerstykke (16).

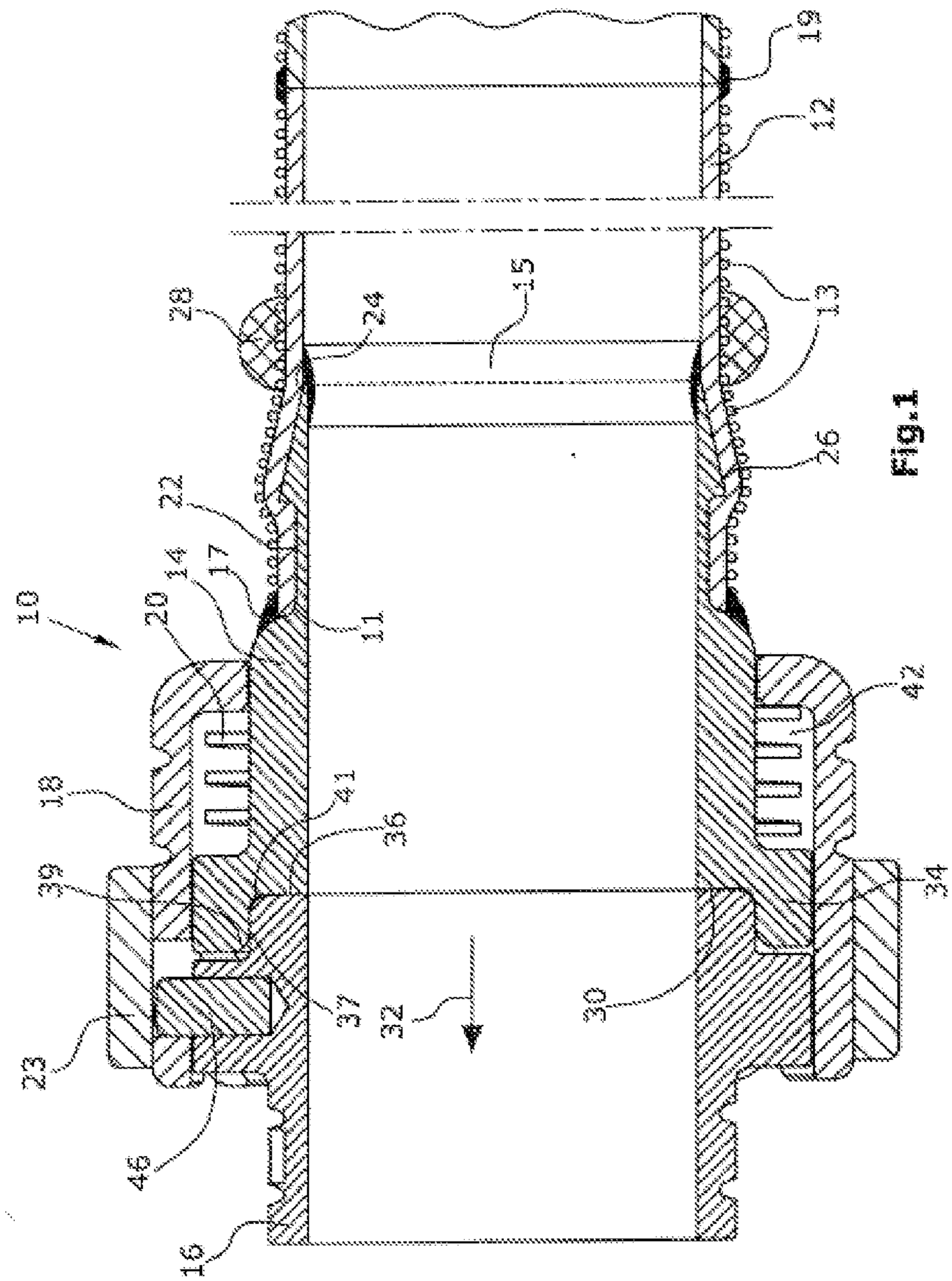

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Fig.1

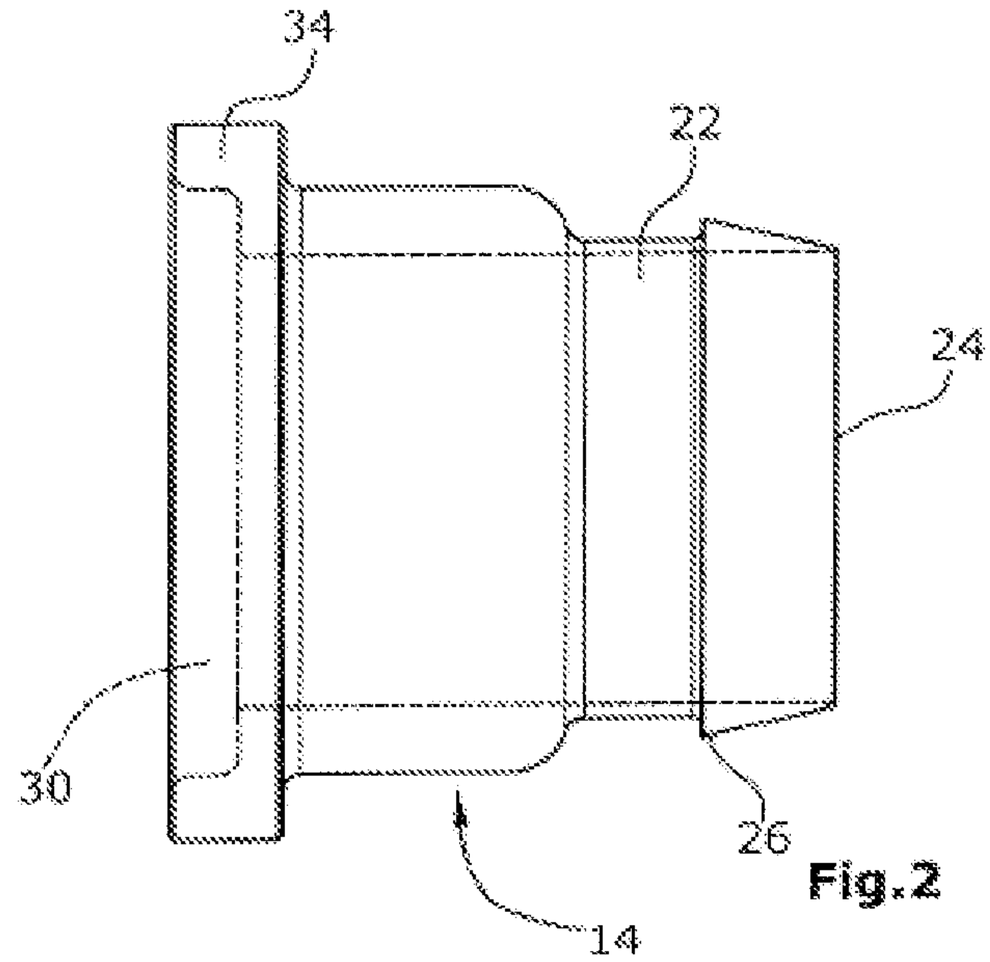


Fig.2

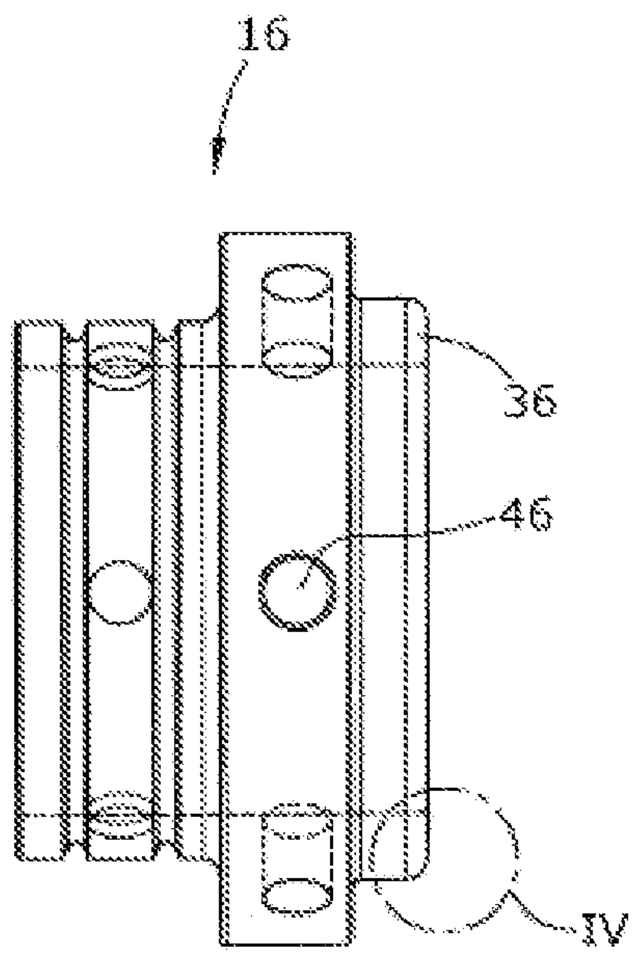


Fig.3

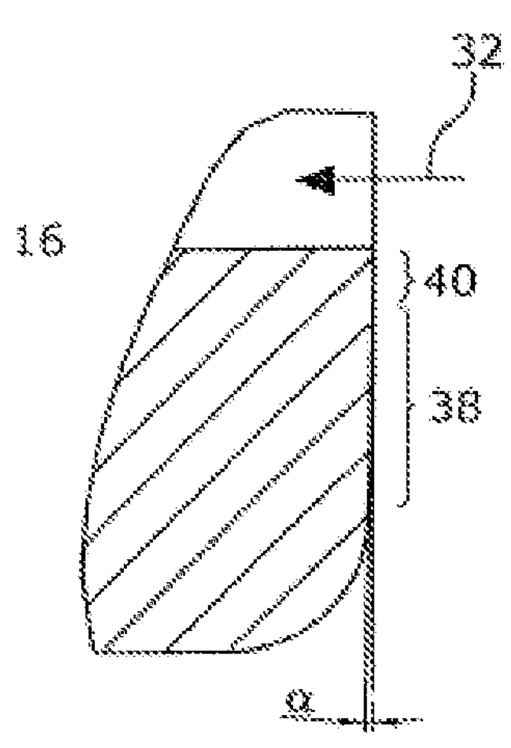


Fig.4

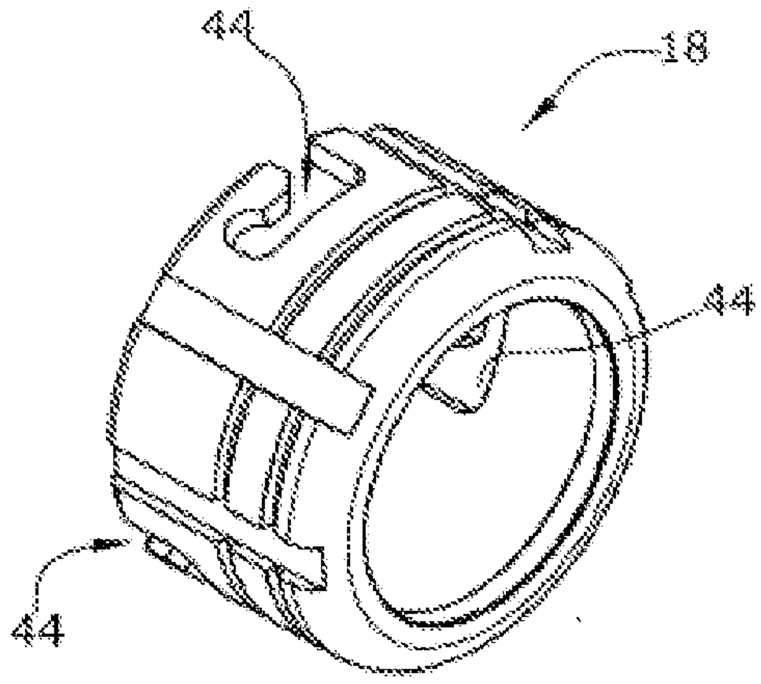


Fig.5