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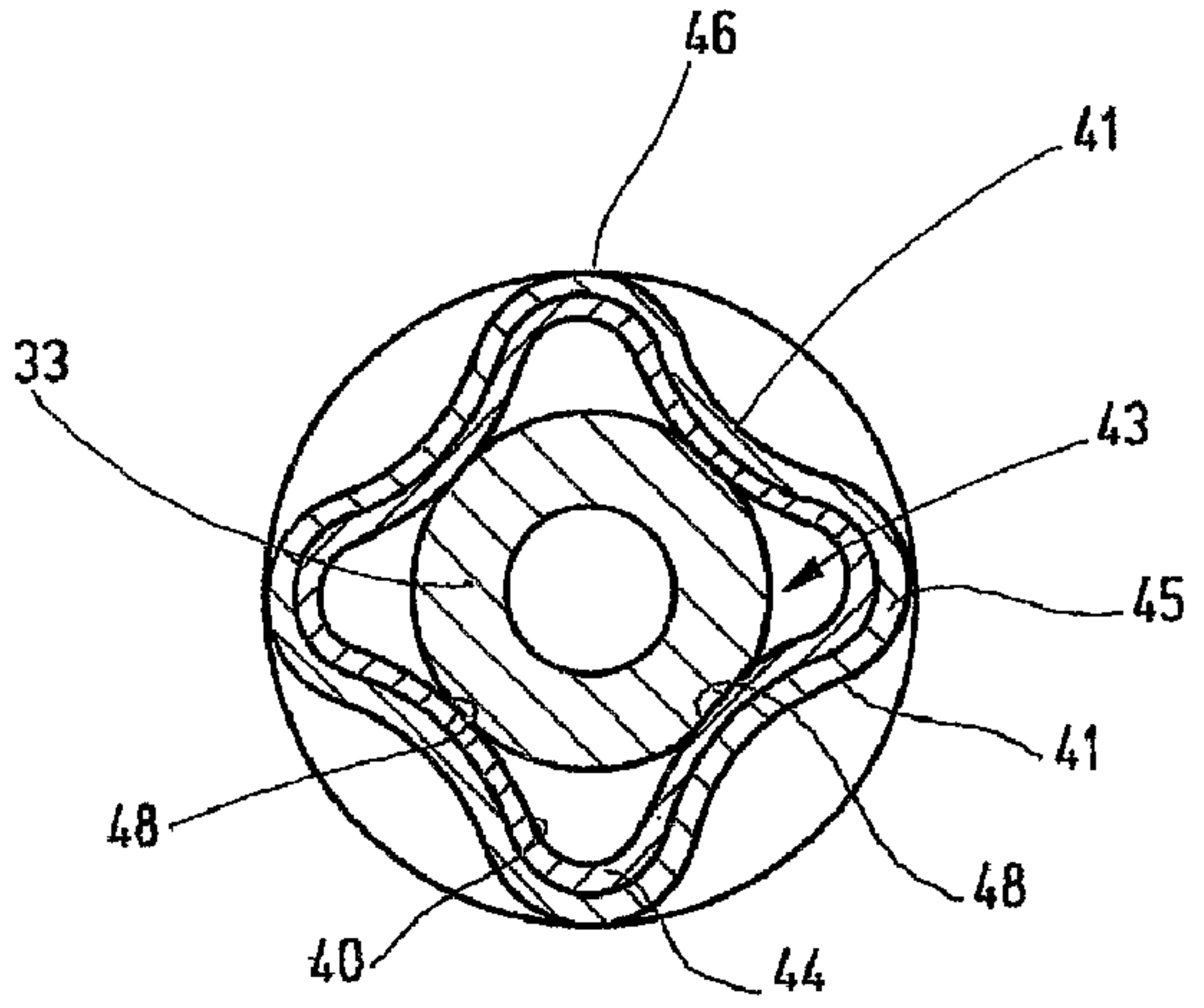
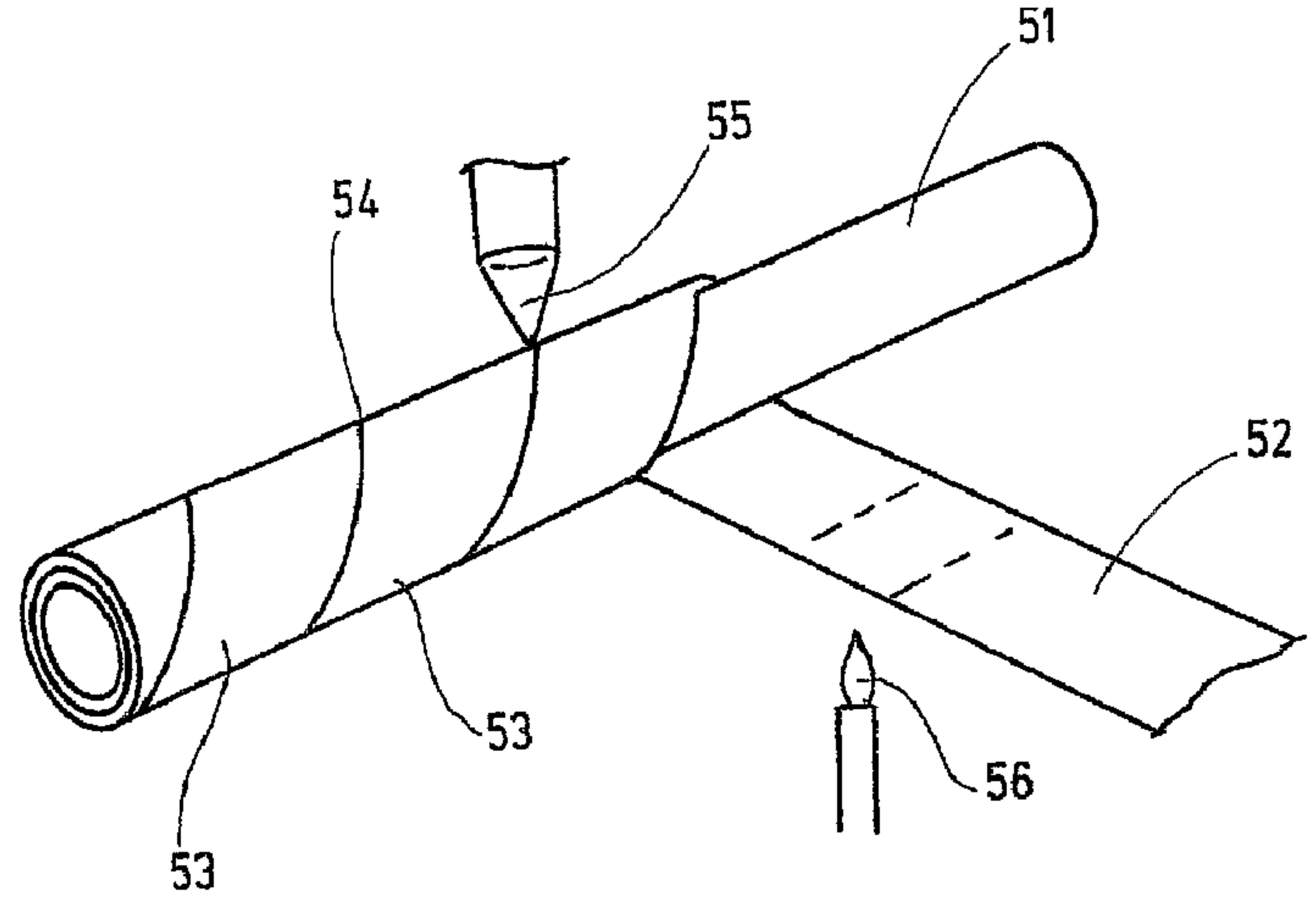
(54) **Titre :** POMPE A VIS SANS FIN EXCENTRIQUE MUNIE D'UN ROTOR RESISTANT A L'EROSION
(54) **Title:** ECCENTRIC SCREW PUMP EQUIPPED WITH EROSION-RESISTANT ROTOR





(57) **Abrégé/Abstract:**

The invention relates to an eccentric screw pump or an eccentric screw motor comprising a rotor (4) that is configured from a tubular jacket (19) with at least two layers. The outer layer (45) of the rotor jacket consists of a material that is abrasion- and/or corrosion-resistant.

Abstract

An eccentric screw pump or an eccentric screw motor has a rotor formed from at least a tubular jacket with at least two layers. The outer layer of the jacket consists of a material that is abrasion-resistant and/or corrosion-resistant.

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Eccentric Screw Pump Equipped with Erosion-Resistant Rotor

A rotor for an eccentric screw pump or eccentric screw motor produced by cold deformation is known from DE 198 52 380 A1.

The pump or motor has a stator with a continuous helical opening over which the rotor rolls during displacement operation. The stator constitutes a cylindrical tube provided with an elastomeric cladding. The elastomeric cladding itself represents the wall of the passage opening and acts as a seal relative to the stator.

The stator* consists of a core element and a shell formed around it. Starting from a cylindrical tube, the shell is deformed to the helical configuration. The originally cylindrical tube acquires not only the helical configuration, which is required for the rotor, but the tube is also firmly connected to the core element in this way. In the final state, the thread valleys of the shell of the stator have a tight firmly friction fit with the core element. To improve the driving effect between the core element and the shell of the stator, the support element can also be provided with longitudinal ribs.

The known rotor can be produced cost-effectively in very large numbers. Lengths of up to 6 meters can easily be reached without requiring final machining of the surface of the stator. The surface of the rotor is very smooth and sufficiently stable in dimension.

The core element present in the shell prevents uncoiling of the rotor when exposed to pressure, which would lead to a pitch error between the stator and rotor and corresponding leaks as a result.

The steel material thus far used for the known rotor is not strong enough for a number of applications with respect to the wear that occurs, and is also not sufficiently corrosion-resistant for some applications. In other words the known rotor is not characterized by sufficient erosion resistance. Erosion is understood to mean not only wear by corrosion, but also ablation by sliding abrasion of the transported material on the surface.

It is also known from the prior art to provide the stator with a shell that also has a helical configuration similar to the helical configuration of the passage opening. The elastomeric cladding, which again serves as sealing material, has an almost constant wall thickness in these cases. With such a stator larger pressures can be produced, or larger torques in the case of an eccentric screw motor.

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* [Editor's note: This paragraph and the next seem to be describing the rotor, but more often than not refer to it as the stator.]

With this as the point of departure, the task of the invention is to devise an eccentric screw pump or an eccentric screw motor in which the rotor is characterized by better erosion resistance.

This task is solved according to the invention with the eccentric screw motor or eccentric screw pump with the features of Claim 1.

Another task of the invention is to devise a method to produce a rotor having greater erosion resistance.

The method is characterized by the features of Claim 23.

The rotor in the eccentric screw pump according to the invention or eccentric screw motor according to the invention is designed like a sandwich. It consists of a radially inner layer and a radially outer layer, the radially outer layer being especially adapted to the higher erosion resistance. It can be more abrasion-resistant or more corrosion-resistant or both than the radially inner layer.

Since more corrosion-resistant materials with larger wall thicknesses are in some circumstances more difficult to deform and are much more expensive than the radially inner layer, the radially inner layer can primarily be chosen from a standpoint of strength and cost, so that the use of a very thin radially outer layer becomes possible.

The very homogeneous structure of the rotor can be achieved if the inner tube is a seamless tube. Inhomogeneities, which otherwise occur during welding, are avoided on this account. Such inhomogeneities could continue outward as shape defects. However, it is also possible to use a wound tube as the inner tube. The tube is preferably laser-welded at the helical butt joint. The coil should run opposite the coil of the outer layer.

The inner layer or the inner tube consists of an easily deformable steel that is readily suited to transfer the recurrent forces and can be cold-worked in the usual manner.

The outer layer can consist of an attached tube. This solution, however, is only suitable for rotors with a shorter design length. In rotors with a larger design length, it is advantageous for the outer layer to be formed from a wrapped metal band.

The metal band is wrapped with butt joints so that the individual windings abut each other without a gap. A particularly good arrangement is achieved if the helically running joint where the windings abut is welded before cold deformation. Welding is preferably done with a laser.

Stainless steels V2A, V4A steel or other abrasion-resistant steels are considered as outer material. Since these have a very much higher specific weight than normal steel, the two-layer design also means a weight saving in comparison with a rotor made only of stainless steel. This plays a role in rotors with a length up to 6 meters.

The strength of the rotor can be improved if it has a core element. The rotor can be molded around the core element so that good connection with the core element is produced. The core element prevents uncoiling of the rotor under load at great lengths. In addition, additional torque can be introduced over the length of the rotor by means of the core element. The essentially rotationally symmetric and nonhelical core is better suited for this purpose.

The core element can be tubular or solid.

In addition, the intermediate space between the tube or shell of the rotor and the core element is either left open or filled with a mass.

In the method according to the invention a cylindrical tube is prepared first. The tube is enclosed with a metal layer so that a double-walled structure is obtained. The double-walled structure, which is still cylindrical, is then helically deformed.

Covering of the cylindrical tube with the outer layer is very simple, and can also be executed simply because of the simple geometric shape of the already prepared tube.

Because the outer layer need only be applied with a limited thickness since the stability of the rotor is produced under some circumstances primarily by the inner tube, materials that could no longer be deformed while cold at greater wall thicknesses can also be used for the outer layer.

A seamless tube is advantageously used in the method according to the invention.

The seamless tube advantageously has a bright metallic surface so that connection of the outer layer with the tube by cold deformation is not hampered by oxide residues.

The outer metal layer in the simplest case consists of a metal band wrapped around the tube. To increase the tension the metal band can be heated before winding immediately ahead of the contact site. Subsequent cooling ensures a shrinkage process that holds the metal band particularly tightly on the surface of the tube.

The butt joint between the adjacent windings is advantageously welded in order to prevent penetration of particles.

The obtained double-walled structure is cold deformed. During the deformation process the outer layer is bonded at least point-like to the inner tube, as is also the case during lamination. The connection is particular durable on this account, and is also not opened by alternating temperatures.

According to the method of the invention a core element can be inserted before deformation of the coated tube.

Modifications of the invention are also objects of the dependent claims. Studying of the embodiment will also make it clear that a number of modifications are possible.

An embodiment of the object of the invention is shown in the drawings. In the drawings:

Figure 1 shows an eccentric screw pump in an oblique view, partially cut away,

Figure 2 shows a longitudinal section through the stator of the eccentric screw pump according to the invention,

Figure 3 shows a longitudinal section through the rotor of the eccentric screw pump according to the invention,

Figure 4 shows a cross section through the rotor according to Figure 3 and

Figure 5 shows the method according to the invention for production of the rotor of the eccentric screw pump or eccentric screw motor according to Figure 1, with symbolization of the process steps.

Figure 1 shows in a schematized, oblique view an eccentric screw pump 1 according to the invention. A pump head 2, stator 3 in which a rotor 4, shown broken off in Figure 2, rotates, as well as connection head 5 are parts of the eccentric screw pump 1.

The pump head 2 has an essentially cylindrical housing 6, which is provided on one end with a closure cover 7, through which a drive shaft 8 is guided outward in sealed fashion. A connector 9 discharges radially into housing 6, which ends in a fastening flange 11. As is common in eccentric screw pumps the coupling piece for torque-proof coupling of drive shaft 8, which is connected to a drive motor (not shown), to rotor 4 is situated inside housing 6.

The end of the housing 6 remote from cover 7 is provided with a tightening flange 12 whose diameter is greater than the diameter of the essentially cylindrical housing 6. The tightening flange 12 contains a stepped hole 13 that is aligned with the internal space of housing 6. A contact shoulder not visible, is formed in the stepped hole, against which one end of stator 3 is pressed.

Connection head 5 has a tightening flange 14 cooperating with tightening flange 12, which also contains a stepped hole in which the other end of the stator 3 is inserted. A discharge line 15 is aligned with the stepped hole.

Between the tightening flanges 12 and 14 the stator 3 is firmly tightened in sealed fashion by means of a total of four tie bolts 16. In order to accommodate the total of four tie bolts 16, the two tightening flanges 12 and 14 are each provided with four aligned holes 17 that lie on a circular are larger than the outside diameter of housing 6 or tube 15. The rod-like tie bolts 16 are passed through these holes 17. Nuts 18 are threaded onto the tie bolt 16 on the side facing away from the opposite tightening flange 12 and 14, by means of which the two tightening flanges 12 and 14 are tightened to each other.

As shown in Figure 2, the stator 3 consists of a tubular shell 19 with constant wall thickness, surrounding an inner space 20. The shell 19 consists of steel, steel alloy, light metal or a light metal alloy. It is shaped so that its inside wall 21 acquires the outer configuration of a multiple start screw. Its outside 22 has a similar matching shape with a diameter greater than the diameter of the inner space of shell 19 according to the wall thickness of shell 19.

The shell 19 terminates at end surfaces 23 and 24 which are oriented at right angles with reference to its longitudinal axis 25. The longitudinal axis 25 is the axis of inner space 20.

In the simplest case, the internal space 20 has the shape of a two-start screw. The cross section enclosed by the outer surface 22, viewed at right angles to the longitudinal axis 25, also has the shape of an oval, similar to a racetrack. In order to adapt the geometry to the stepped hole 13, a closure or reducing ring 26 is seated on the shell 19 on each end. As an alternative, the ends can also be formed as cylindrical tubes. The closure ring 26 contains a passage opening 27, which coincides with the course of the outer surface 22 over the longitudinal extent of the closure ring 26. In other words, the closure ring 26 act in the broadest sense as a nut, which is screwed onto the thread defined by the shell 19. The length of the thread corresponds to the thickness of the closure ring 26.

Radially outward the closure ring 26 is bounded by a cylindrical surface 28, which transitions axially into a flat surface 29 that faces away from shell 19.

On the inner side 21 shell 19 is provided over its entire length with a continuous cladding 32. The cladding 32 consists of an elastically flexible, preferably elastomeric material, for example, natural rubber or a synthetic material, and has roughly the same wall thickness at each location.

As is apparent in Figure 3, the rotor 4 consists of a core element 33, a rotor jacket 34, and a coupling head 35.

The core element 33 in the depicted embodiment is a thick-walled steel tube with an at least originally cylindrical outer peripheral surface 36 and a continuous cylindrical internal space 37.

The core element 33 is configured straight and therefore tubular because the internal space makes no noticeable contribution to the strength, but merely increases the weight. It can also be solid, however.

On its right end in Figure 3 the core element 33 is provided with a threaded end 38. On the opposite end the core element 33 contains a threaded hole 39.

The jacket 34 of rotor 4 is also a tube with an inner wall 40 and an outside surface 41. The outside surface 41 forms a thread that continues over the entire axial length of jacket 34. It begins at 42 and ends at 43. The number of threads of the thread formed by outer surface 41 is one fewer than the number of threads in the passage opening 20 in stator 3.

As is apparent from the cross section in Figure 4, the rotor 4 in the depicted embodiment has a four-start thread, i.e., a total of four strips run helically along jacket 34. Since the passage opening 20 accordingly has five starts, the five-start threads in the passage opening 20 are formed with a total of five helically extending strips made of elastomeric material.

The cross section through the rotor 4 is shown in Figure 4. The rotor jacket 34 is two-layered and consists of an inner layer 44 and an outer layer 45 situated on it. The inner layer 44 consists of an originally cylindrical steel tube with good deformability and strength suitable for the applications.

The outer layer 45, on the other hand, consists of an erosion-resistant material, which is a material that is little worn or ground off by the medium being pumped and/or chemically attacked by the medium being pumped. Appropriate material is, for example, stainless steel like V2A or V4A. The wall thickness of the inner layer 44 is between 1 mm and 5 mm, while the wall thickness of the outer layer 45 can also lie between 1 mm and 5 mm. Production of this rotor 4 is explained further below by means of Figure 5.

The jacket 34, as already mentioned, is tubular, for which reason the inner surface 40 follows the outer surface 41 at constant spacing.

Because of the screw-like deformation of jacket 34, its outer surface 41, viewed in the longitudinal direction, forms thread crests 46 or thread valleys 47 in alternation. As a result of the multiple starts, the thread valleys 47 and the thread crests 46 appear not only in the longitudinal direction, but, as shown in the cross section of Figure 4, also in each sectional plane in the circumferential direction.

The dimensions of the cylindrical straight tube from which the jacket 34 is cold-deformed are chosen so that after final deformation to the helical configuration, the jacket 34 at least touches the outside peripheral surface 36 of core element 33 with its inside peripheral surface 40 in the region of the thread valleys 47 (with reference to the outer contour).

During correspondingly stronger deformations it is also possible to slightly deform the outer peripheral surface 36 of core element 33 so that its outer peripheral surface 36 acquires shallow grooves 48 that follow the contour of the thread valleys 47. If deformation is continued in this way, then not only a frictional but also a form-fit connection results between jacket 34 and core element 33 in the region of the thread valleys 47 that curve toward the interior of jacket 34 with the core element 33. Moreover, because of deformation, cold welding between jacket 34 and core element 33 can even occur at the contact sites.

As mentioned, since the semifinished product from which the jacket 34 is produced is a cylindrical tube whose diameter is greater than the outside diameter of core element 33, intermediate spaces 49 are formed running helically between the core element 33 and the jacket 34. The number of helical screw intermediate spaces 49 is equal to the number of thread crests 46, which are apparent in the cross section of the rotor 4 in the circumferential direction. Depending on the application, these intermediate spaces 49 can either be left empty or filled with a mass. This mass, for example, can be a synthetic resin or synthetic resin filled with light metal powder.

The method of production of the rotor 4 consisting of layers 44 and 45 is shown highly schematized in Figures 5 to 7.

A bright drawn, seamless steel tube 51 with a suitable wall thickness and an appropriate length of several meters is initially prepared. The steel tube 51 is wrapped on the outside with a metal band 52, which later forms the outer layer 45. The metal band 52 is a band made of appropriate stainless steel or another steel. The band 42, as is apparent in Figure 6, is wrapped like a single-thread screw onto the outside of steel tube 51. Windings 53 lying next to each other are then formed, which are separated from each other by a helical butt joint 54. Wrapping of the metal band 52 occurs so that the butt joint 54 is as closed as possible.

Butt joint 54 is welded, during winding or in a separate step, by means of a laser beam 55 and filler material in order to achieve a smooth, homogeneous cylindrical surface. Other welding methods are also possible. Welding can be carried out in order to join the band 52 to the support tube 51 with a substance-to substance bond in the vicinity of butt joint 54.

Immediately before the metal band 52 is placed on tube 51 it is heated, for example, by a gas flame 56 or inductively. This achieves a situation in which the metal band 52, after wrapping onto tube 51 and cooling, produces significant pressure in the circumferential direction.

After the band 52 has been wrapped over the entire length of tube 51 and butt joint 54 is also welded over the entire length, the core element 33 is inserted according to Figure 7. The structure is then brought to the desired helical shape by cold deformation, for example by rolling with a number of rolls, only one of which is indicated as 57.

During rolling, the metal band 52 is bonded very intimately with the outside surface of the underlying steel tube 51.

After the process step according to Figure 6 is concluded, the metal band 52 forms a second outer tube on the metal steel tube 51, which is seated firmly and with circumferential tension in a friction fit with the outside peripheral surface of tube 51. The two tubes, mainly the tube formed by wrapping and the seamless inner steel tube, are already so firmly joined to each other after wrapping that they can no longer be separated from each other.

The subsequent rolling process according to Figure 7 ensures more intimate bonding, which at least to a certain degree is similar to plating with a metal layer.

By rolling, which leads to stretching of a metal piece, the outer tube produced by wrapping is surprisingly not separated from the tube 51 situated beneath it. Instead, both are deformed together into the desired helical shape, intimate bonding with the core element 33 being produced at the same time.

Instead of just one metal band, several metal bands can also be wound like a multi-thread screw. In addition, the winding process can be repeated in order to produce several layers, one on the other.

The invention has been explained relative to an eccentric screw pump. For one skilled in the art, however, it is immediately recognized that the invention is in no way restricted to eccentric screw pumps. Instead, rotors for eccentric screw motors or mud motors can also be produced following the method of the invention according to Figures 5 to 7. As a result, a displacement machine is obtained which contains a very resistant rotor.

An eccentric screw pump or an eccentric screw motor has a rotor formed from one at least two-layer tubular jacket. The outer layer of the jacket consists of material that is abrasion-resistant and/or corrosion-resistant.

Claims

1. Eccentric screw pump or eccentric screw motor (1),

with a stator (3), which contains a continuous stator bore (20) having a helical configuration,

with a helical rotor (4), adapted to the stator bore (20), which has a helical deformed tube (34) that consists of an inner layer (44) and at least one outer layer (45) that are deformed together to the helical configuration, in which the outer layer (45) consists of a material that differs from the material of the inner layer (44) and

with a coupling head (35) connected in a torque proof manner with rotor (4).

2. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the material of the outer layer (45) is more abrasion-resistant and/or corrosion-resistant than the material of the inner layer (44).

3. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the inner layer (44) consists of a seamless tube (51).

4. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the inner layer (44) is made of a steel.

5. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the outer layer (45) consists of at least one metal band (52).

6. Eccentric screw pump or eccentric screw motor according to Claim 5, characterized by the fact that the at least one metal band (52) of the outer layer (45) is helically wrapped onto the inner layer (44).

7. Eccentric screw pump or eccentric screw motor according to Claim 6, characterized by the fact that the butt joints (54) between adjacent windings (53) of at least one wrapped metal band (52) are welded.

8. Eccentric screw pump or eccentric screw motor according to Claim 7, characterized by the fact that the butt joints (54) are laser welded.

9. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the material of the outer layer (45) is formed from a corrosion-resistant and/or highly abrasion-resistant steel.

10. Eccentric screw pump or eccentric screw motor according to Claim 9, characterized by the fact that the steel was chosen from the materials V2A, V4A.

11. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the rotor (4) contains a core element (33) bonded frictionally and/or in shape-mated fashion to tube (34).

12. Eccentric screw pump or eccentric screw motor according to Claim 11, characterized by the fact that the tube (34) is bonded in form-fitting fashion to core element (33) in the region of thread valleys (47) by virtue of the fact that the core element (33) is pressed in only in the region of the thread valleys (47) of tube (34) to form at least one helical shallow groove (48).

13. Eccentric screw pump or eccentric screw motor according to Claim 11, characterized by the fact that at least one helical intermediate space (49) is contained between the core element (33) and tube (34).

14. Eccentric screw pump or eccentric screw motor according to Claim 11, characterized by the fact that the core element (33) is tubular.

15. Eccentric screw pump or eccentric screw motor according to Claim 11, characterized by the fact that the core element (33) is solid.

16. Eccentric screw pump or eccentric screw motor according to Claim 13, characterized by the fact that the at least one helical intermediate space (49) is filled with a mass.

17. Eccentric screw pump or eccentric screw motor according to Claim 13, characterized by the fact that the at least one helical intermediate space (49) is empty.

18. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the stator (3) has a wall (32) formed by an elastomeric mass.

19. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the stator (3) is formed from a jacket (19) with an elastomeric cladding (32).

20. Eccentric screw pump or eccentric screw motor according to Claim 19, characterized by the fact that the elastomeric mass has an essentially constant wall thickness over a large part of the extent of stator (3).

21. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the jacket (19) has a helical configuration similar to the stator bore (20).

22. Eccentric screw pump or eccentric screw motor according to Claim 1, characterized by the fact that the jacket (19) has a cylindrical configuration and the cladding (32) has a cylindrical outer peripheral surface.

23. Method for production of a rotor in an eccentric screw pump or eccentric screw motor with a stator (3) containing a continuous stator bore (20) that has a helical configuration, in which the process includes the steps:

a cylindrical tube (51) is prepared, the tube (51) is enclosed with a metal layer (52) so that a double-walled structure (51, 52) is produced, the double-walled structure (51, 52) is deformed to the helical configuration of the rotor (4).

24. Method according to Claim 23, characterized by the fact that cylindrical tube (51) is a seamless tube.

25. Method according to Claim 24, characterized by the fact that cylindrical tube (51) has a bright metallic outer peripheral surface.

26. Method according to Claim 23, characterized by the fact that the metal layer is formed from at least one metal band (52).

27. Method according to Claim 26, characterized by the fact that the metal band (52) is wrapped on the inner tube (51) so that the windings (53) essentially abut each other without a gap.

28. Method according to Claim 23, characterized by the fact that the butt joint (54) between adjacent wrapping (53) is welded.

29. Method according to Claim 23, characterized by the fact that the metal band (52) is continuous heated before winding onto tube (51).

30. Method according to Claim 23, characterized by the fact that the double-walled structure (51, 52) is cold-deformed.

31. Method according to Claim 30, characterized by the fact that before cold deformation a core element (33) is inserted into the double-walled structure (51, 52).

32. Method according to Claim 31, characterized by the fact that the core element (33) has a longitudinal rib.

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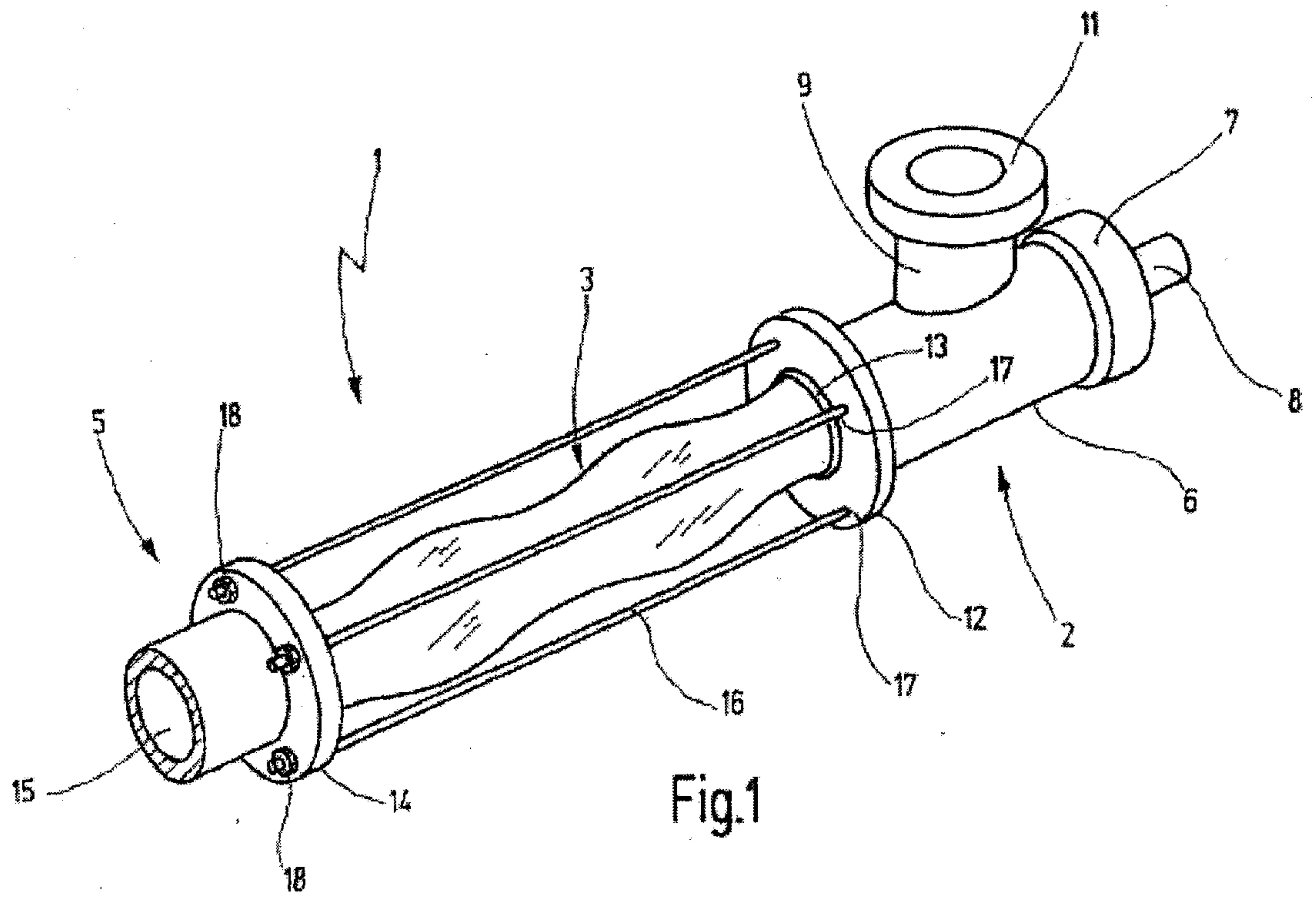
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Fig.1

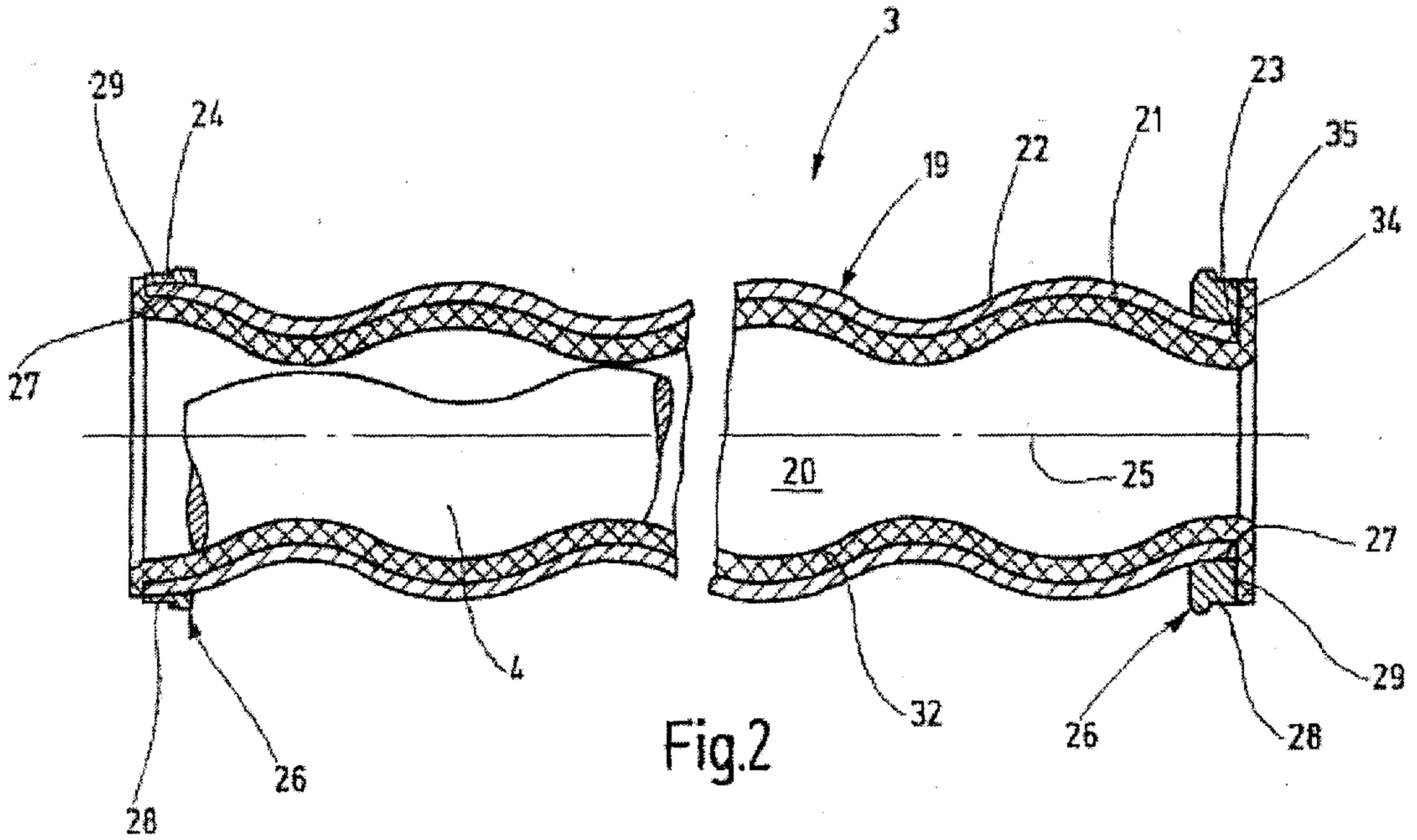
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Fig.2

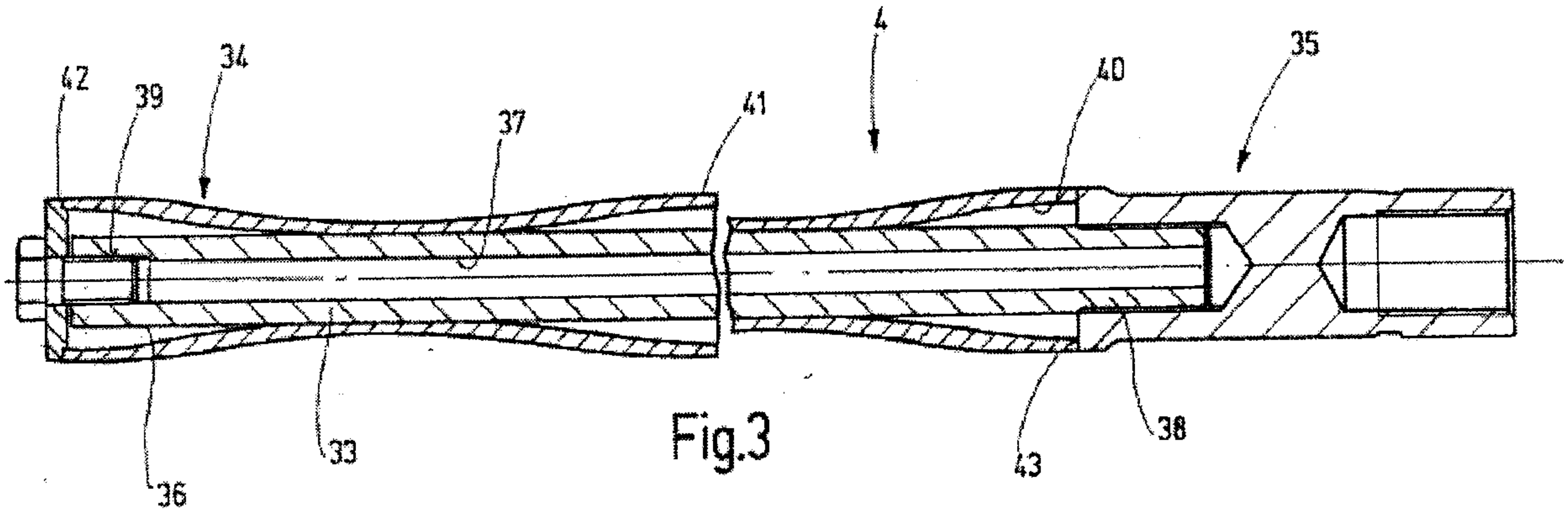


Fig.3

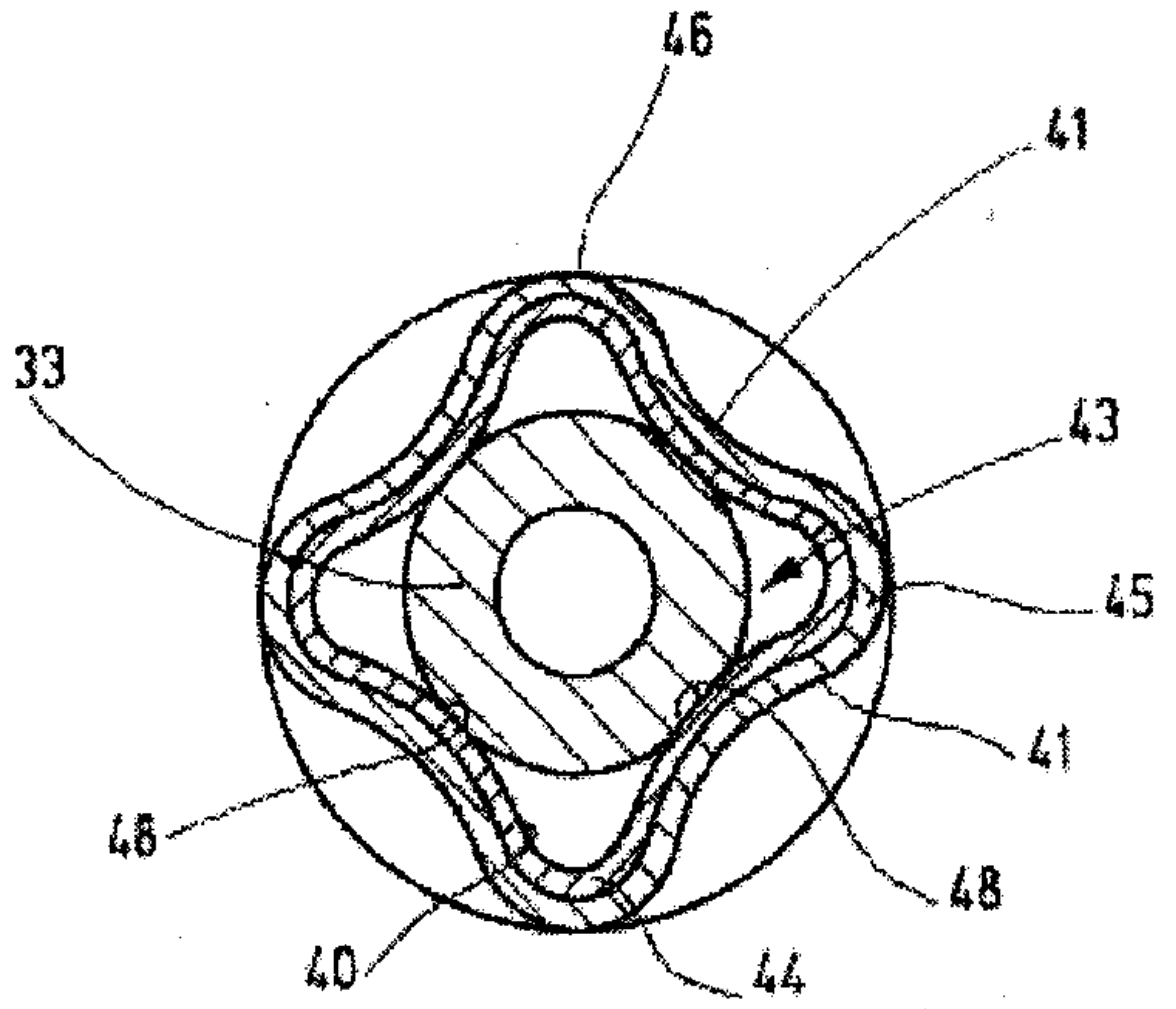


Fig.4

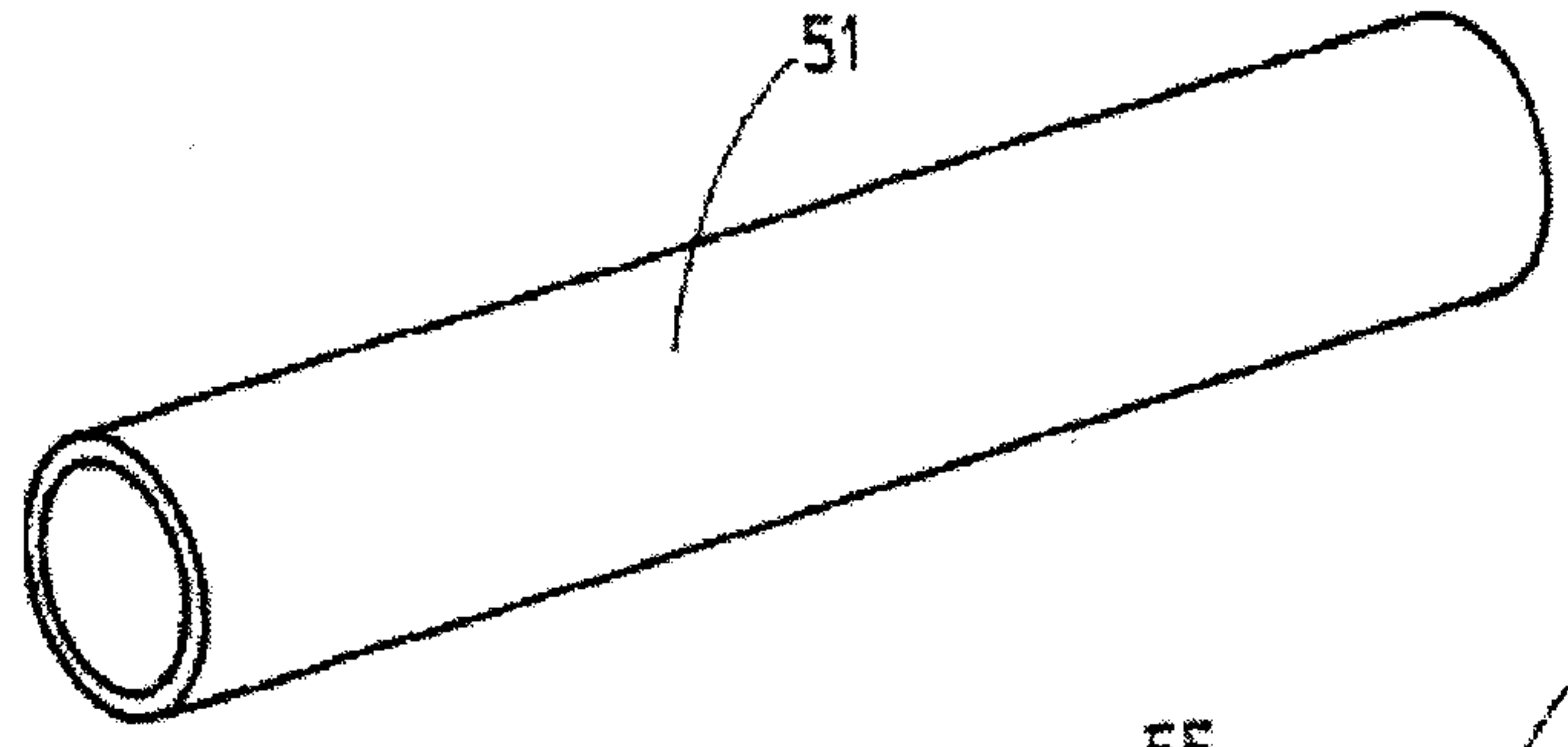


Fig.5

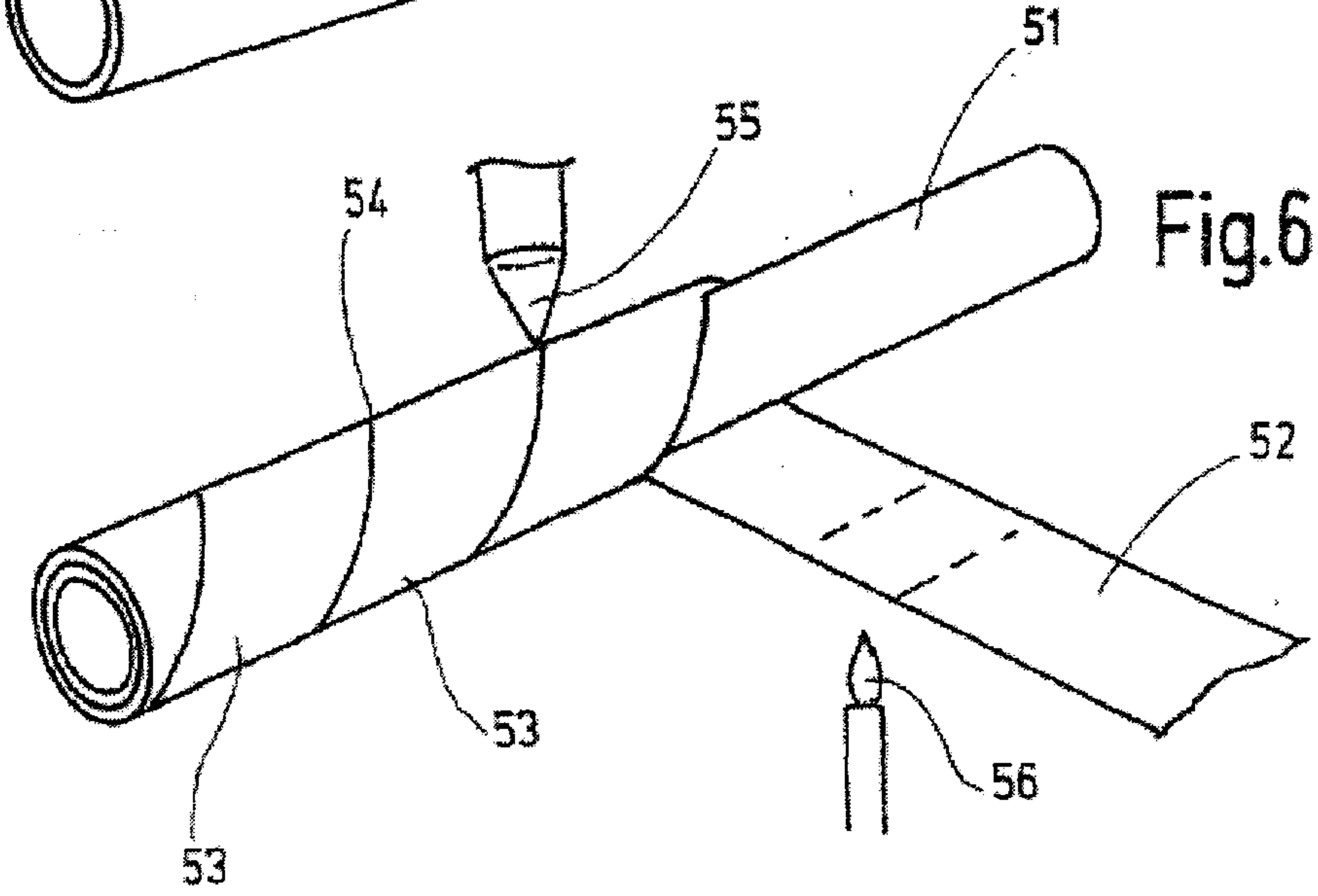


Fig.6

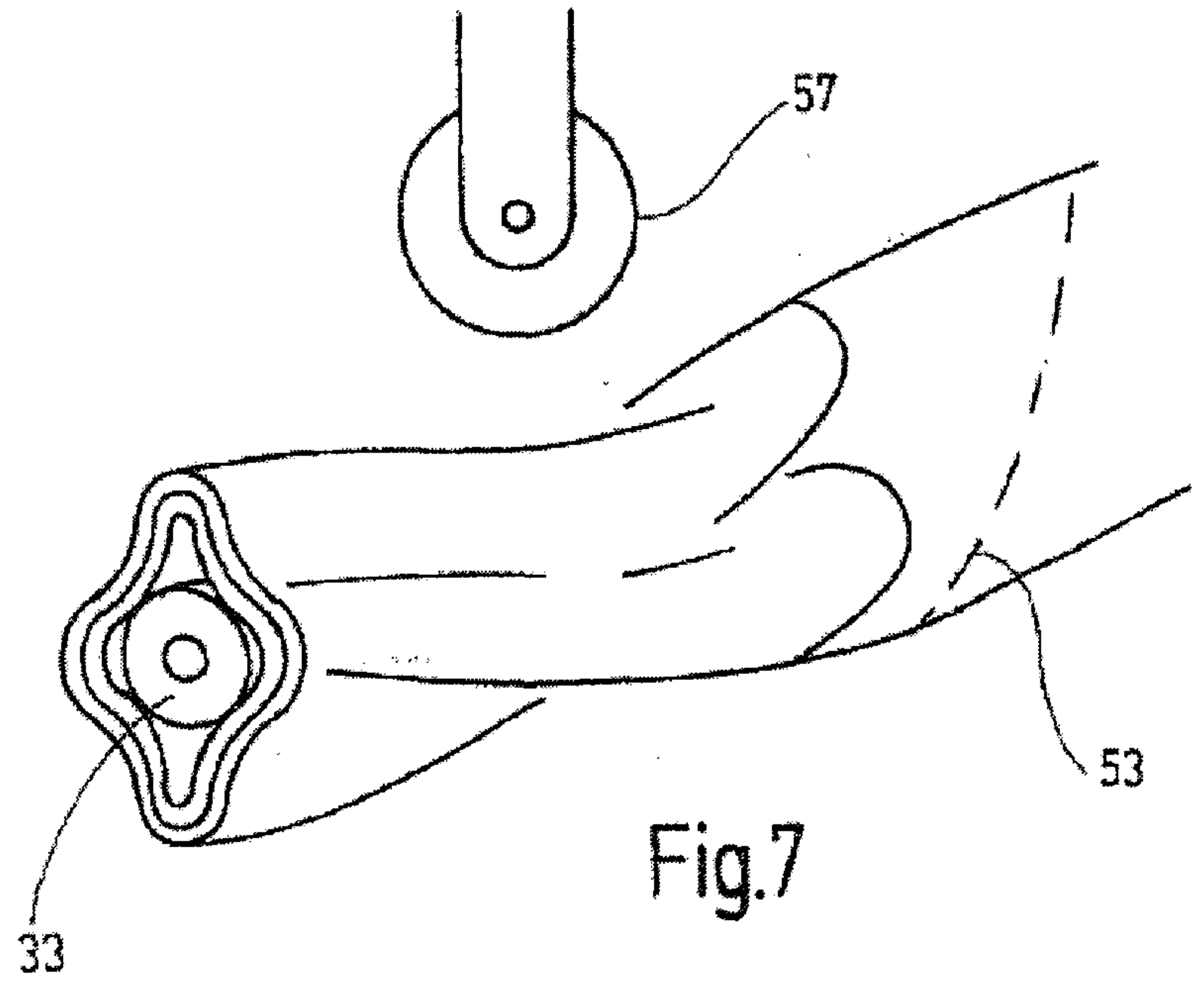
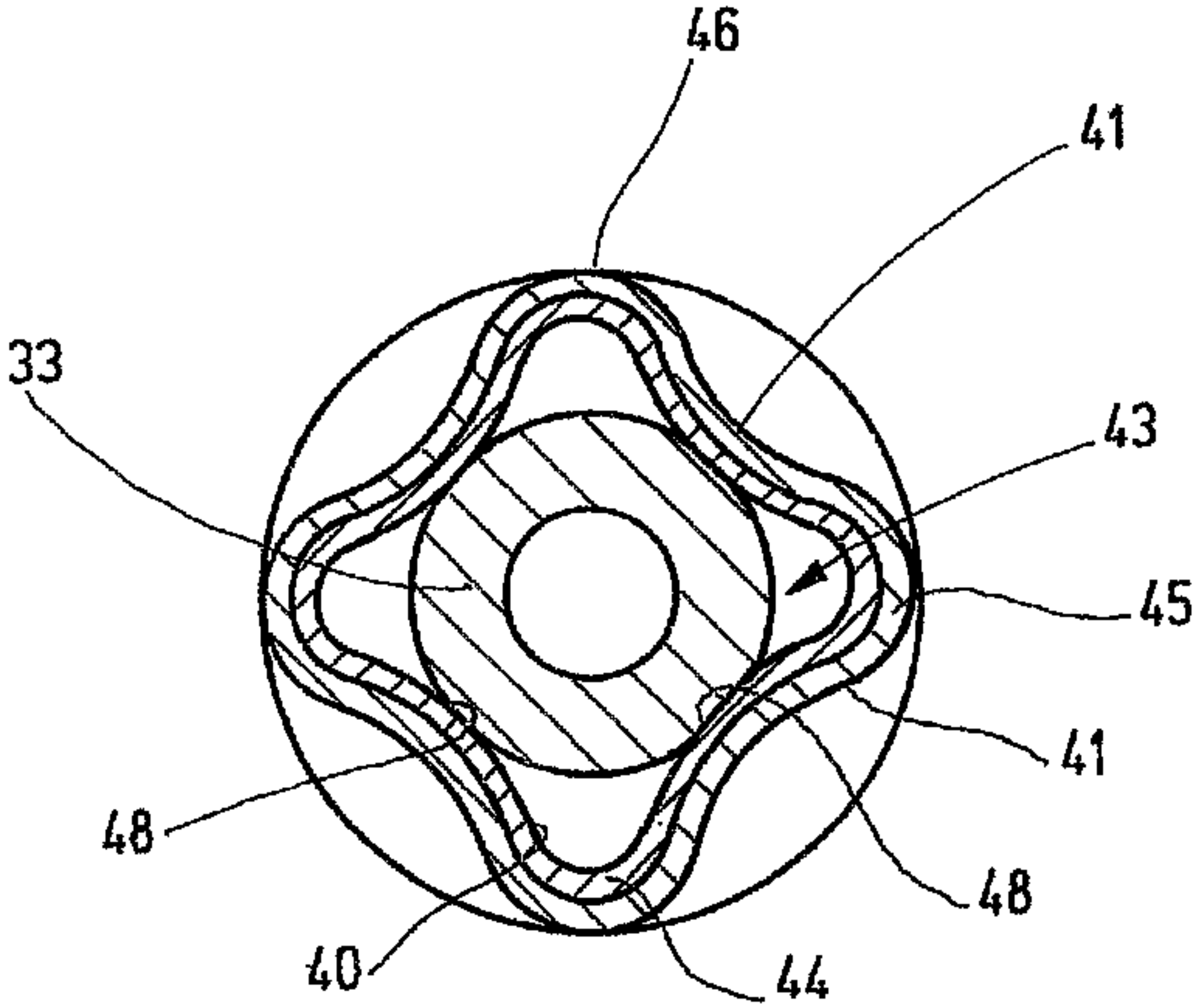


Fig.7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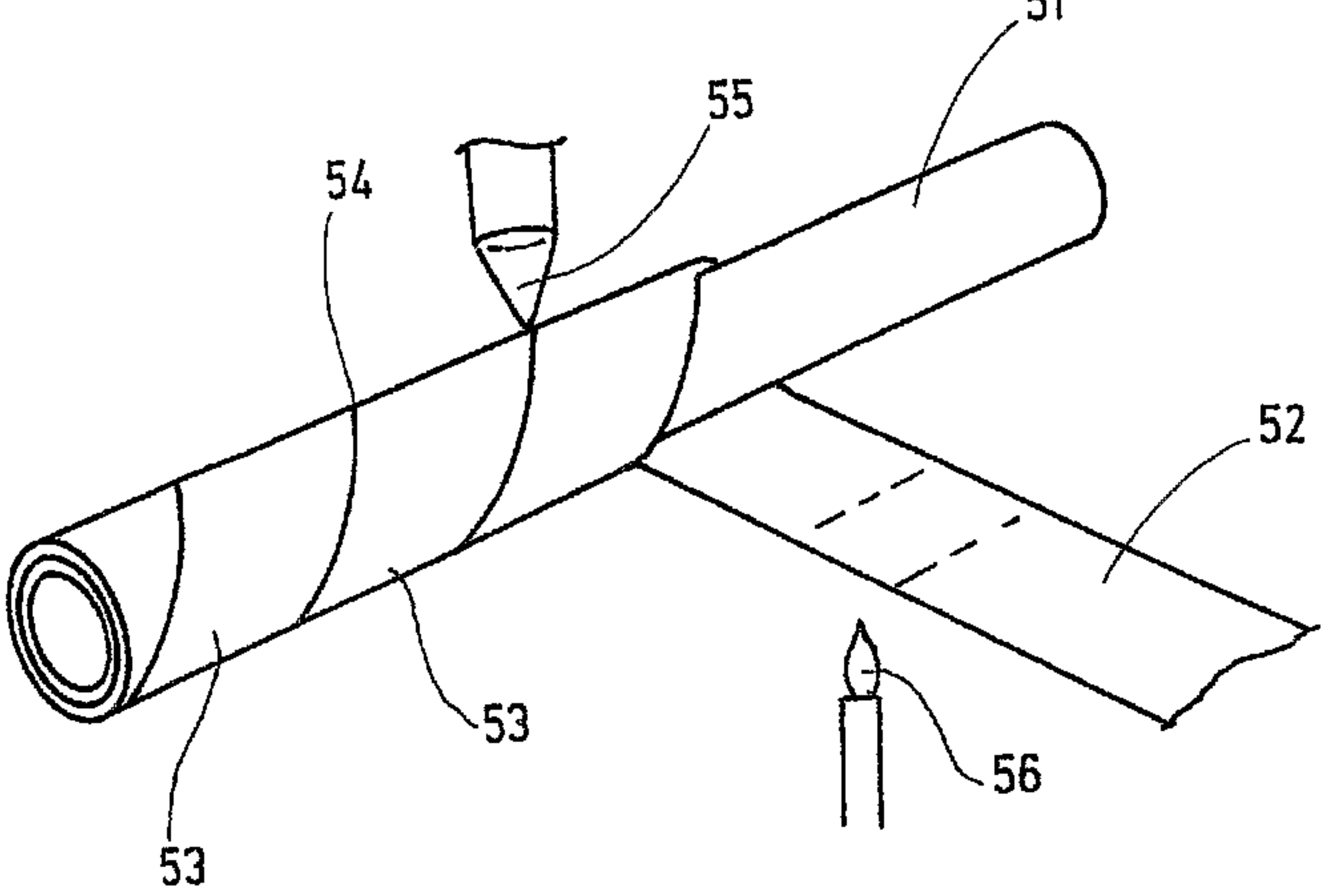
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