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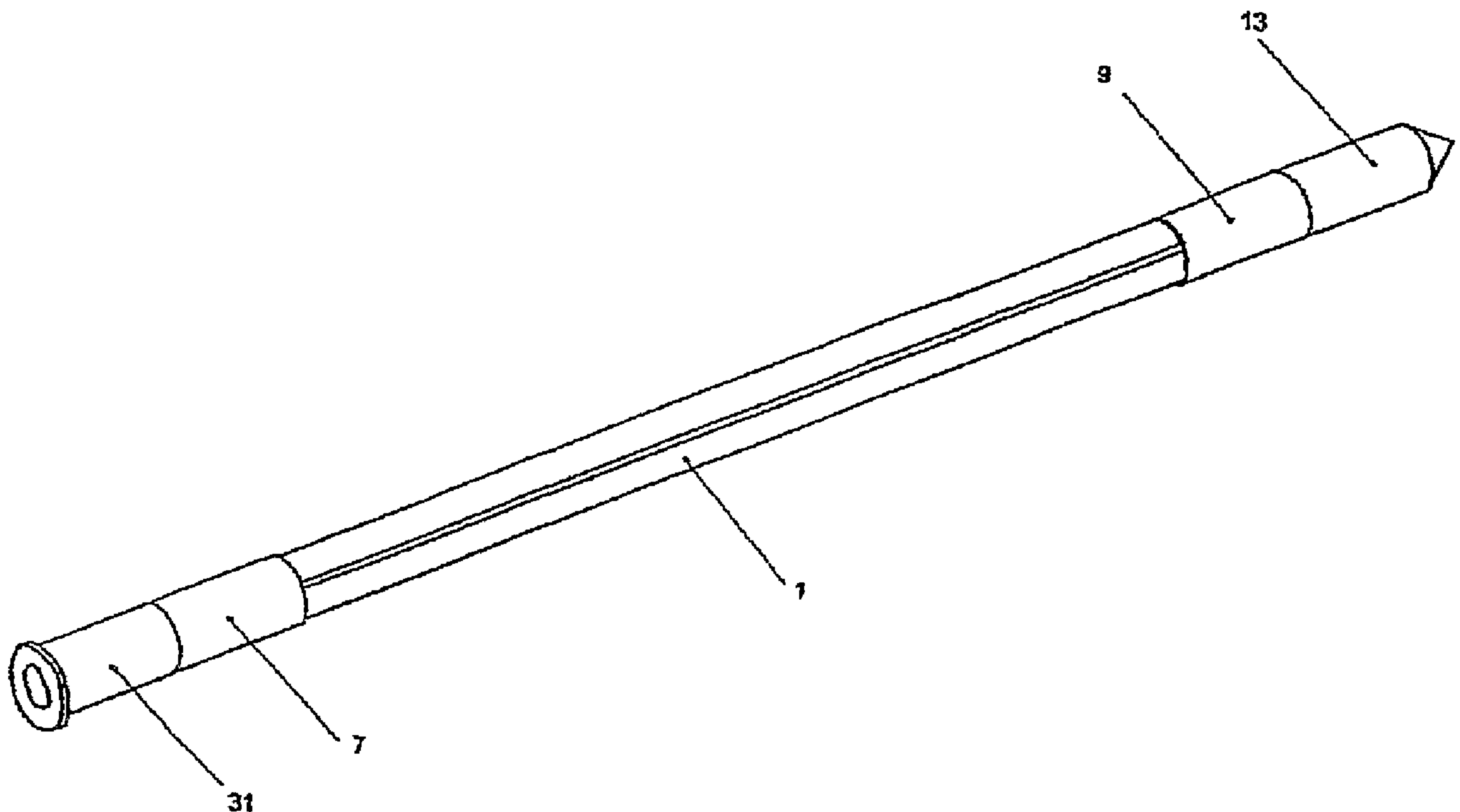
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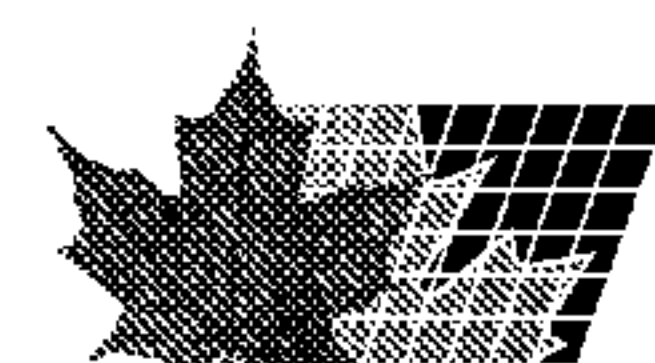
(54) Titre : PROCÉDE POUR INSTALLER DES BOULONS D'ANCRAGE ET BOULON D'ANCRAGE UTILISABLE AVEC LEDIT PROCÉDE

(54) Title: METHOD FOR INSTALLING ANCHORS AND AN ANCHOR WHICH CAN BE USED ACCORDING TO SAID METHOD



(57) Abrégé/Abstract:

The invention relates to an anchor comprising a pipe (1) which is folded in the longitudinal direction and an end piece (13) which can be opened under pressure and which is provided on the end of the anchor which is arranged inside the borehole. Said anchor is introduced into the borehole and is enlarged by using internal pressure which unfolds the pipe (1) until said pipe (1) is arranged on the friction fit and/or form fit on the borehole. Then, the pressure in the anchor is increased such that the front end (15) of the end piece (13) is separated and the hardened material is injected through the anchor into the borehole in order to fill the cavities in



(57) **Abrégé(suite)/Abstract(continued):**

the region of the end of the anchor which is arranged in the base of the borehole and in the base (ground, rock) wherein the anchor is fixed, and cavities or crevices are located in the adjacent base. A hydraulically binding material based on cement can be used, in particular, as a hardened material.

Abstract:

An anchor with a longitudinally folded pipe 1 and an end piece 13 which can be opened under pressure and which is provided at the end of the anchor lying inside the drilled hole is introduced into the drilled hole, and by applying internal pressure is expanded as the pipe 1 unfolds until the pipe 1 with frictional locking and/or positive locking engages the drilled hole, whereupon the pressure in the anchor is raised so that a forward tip 15 of the end piece 13 is separated. Then the settable mass is pressed through the anchor into the drilled hole in order to fill cavities in the area of the anchor end located at the bottom of the drilled hole and the substratum (soil, rock) in which the anchor is fixed, and cavities or cracks located in the bordering substratum. A hydraulically binding, cement-based mass can be used especially as the settable mass.

**Process for setting anchors and anchor
usable in the process**

The invention relates to a process for the setting of anchors such as ground anchors and rock anchors, with the features of the introductory part of claim 1.

The invention relates furthermore to an anchor which can be used in the process in accordance with the invention.

US 4,459,067 A discloses a process of the initially named type.

In this known process an anchor (rock bolt or rock anchor) which has a longitudinally inwardly folded pipe is placed in a drilled hole and expanded by increasing the pressure within the folded pipe, so that the outside surface of the pipe comes to rest against the inside surface of the drilled hole and thus fixes the anchor in the drilled hole.

In the known rock anchor, the front end of the pipe is closed and the back end of the pipe, therefore the end which is adjacent to the opening of the drilled hole (the outer end of the drilled hole) is connected to a hose or pipe via which the pressurized fluid (especially water) can be introduced into the interior of the pipe for expanding it.

It is a disadvantage of the known process and rock anchor that the latter is fixed in the drilled hole exclusively by friction and positive locking, but that the beneficial side effects of an injection anchor, such as solidification of the soil or rock surrounding the drilled hole, are not provided.

The object of the invention is to provide a process of the initially mentioned type and an anchor which can be used in this process which does not have the described disadvantages, and allows for the quick achievement of a permanently reliable retention of the anchor.

This object is achieved with respect to the process with the features of the main process claim, and with respect to the anchor, with the features of the independent claim directed to the anchor.

Preferred and advantageous embodiments of the invention are the subject matter of the dependent claims.

An anchor set according to the process of the invention sticks securely and permanently since it rests securely against the inside surface of the drilled hole, not only because the wall of the expanded pipe of the anchor provides a positive locking and friction by deforming into gaps, crevices and/or areas with softer material, but also has the advantage that the rock or soil into to which the anchor is inserted is solidified in the area of the deepest end of the drilled hole by the added settable mass, so that any gaps or cracks present deep in the drilled hole are filled with the mass.

The anchor as claimed in the invention is a development of known friction pipe anchors, as are known for example from the aforementioned US 4,459,067 A and which are also called "Swellex". In the anchor in accordance with the invention, force transferred into the substratum takes place both by means of friction and also by means of a mechanical (positive locking-type) connection to the substratum.

The anchor in accordance with the invention also has the advantage that the anchor can also

be used as an injection lance for soil improvement. Soil improvement at certain depths or starting from a certain depth is especially important where the soil layers overlying the open surface or the rock layers ahead in tunneling would be negatively affected by the compaction pressure, such that under certain circumstances the entire stability of the structure could be endangered.

Within the framework of the invention, anchor mortar, Portland cement and other cements with small enough grain sizes, but also synthetic resins and other injection material can fundamentally be used as the settable mass (injection material).

The settable mass used in the process in accordance with the invention can also be a hydraulically setting mass such as grout (essentially a mixture of water, cement and optionally fine aggregate such as fly ash, for example) or a mortar (essentially a mixture of water, cement and aggregate with small grain size). In this case the process in accordance with the invention further has the advantage that the interior of the anchor is protected against corrosion by the hardened mass.

The settable mass can also be plastics which are added for example in molten liquid form and which solidify by cooling or harden after placement by chemical reaction.

In general words the procedure used in the process in accordance with the invention can be described as follows:

A drilled hole of the length and diameter required for respectively used product (anchor) is produced. The expandable anchor is placed in this drilled hole. The anchor is then connected to a pump, especially by way of an adaptor, filled with water and pressurized until the profile of the anchor unfolds and the pipe rests snugly against the drilled hole wall. Subsequently, the profile

expands such that irregularities in the drilled hole diameter are filled in. In crevices or cavities, the profile expands up to its largest possible diameter, whereby relative to the limited expansion in a regular drilled hole a mechanical (positive locking-type) anchoring is also created. After this is achieved, the pressure is further increased until the tip, especially in the area of a groove provided for this purpose, opens and is separated at the bottom of the drilled hole. At this point the adapter used previously, via which the water was introduced, is replaced by an injection adapter and the injection material is delivered into the ground through the separated tip of the anchor. The grouting material (injection material) is also introduced under pressure, whereby the pressure is absorbed, because of friction and mechanical anchor-substratum bonding of the anchor which is dimensioned accordingly, such that the anchor is not pressed out of the drilled hole in the manner of a piston.

The anchor which can be used in the process in accordance with the invention on its front end, which means the end with which it is introduced into the drilled hole, has an end piece which is attached, for example, to a sleeve provided there and connected to the pipe, the end piece opening at a pressure which is higher than the pressure applied during expansion of the pipe for placement against the inside of the drilled hole, so that a settable mass can be pressed through the pipe and the then open end piece and into the drilled hole.

The anchor in accordance with the invention can bear on its end which lies in the drilled hole an anchor plate which is supported on the soil or rock side on the outer end sleeve of the anchor.

Anchors as claimed in the invention can also be combined with injection drill anchors. This has the advantage that the anchor as claimed in the invention ensures prompt loadability and the

injection anchor ensures long-term loadability.

Other details, features and advantages of the invention will become apparent from the following description with reference to the attached drawings.

Figure 1 schematically shows in an oblique view a rock anchor, Figure 2 shows the pipe of the rock anchor in cross-section in the middle region, Figure 3 shows the pipe of the rock anchor in cross-section in the region of one of its ends, Figure 4 shows the end piece on the front end of the rock anchor in a first embodiment, Figure 5 schematically shows the pipe of a rock anchor expanded to make contact with the inside surface of the drilled hole, Figure 6 shows the end piece of the rock anchor in a second embodiment, Figure 7 shows an adapter receiving piece provided at the rear end of the rock anchor adjacent the open end of the drilled hole, Figure 8 shows an adapter for the introduction of a pressure medium for expansion of the rock anchor pipe, Figure 9 shows an adapter for the introduction of the settable mass into the drilled hole, Figure 10 shows an anchor partially in a section, and Figure 11 shows another embodiment of an anchor partially in cross-section.

Although the invention is described in the following primarily using the example of rock anchors as also shown in the drawings, it should be stressed that the invention can be used fundamentally for all types of anchors, predominantly those of the initially named type, therefore also for use in soils and similar soft substratum.

The rock anchor shown in Figure 1 has a pipe 1 which has in its middle area the cross sectional shape shown in in Figure 2. The pipe 1 therefore has a longitudinal, inwardly directed fold 3, whereby the part of the wall of the pipe 1 folded inward in the middle area (Figure 2) appears

somewhat omega-shaped, whereas in the area of the ends of the pipe 1 the lengthwise fold 3 folded to the inside has two wall parts 5 which run essentially parallel to one another (Figure 3).

The ends of the pipe 1 which as mentioned have the cross sectional shape shown in Figure 3 are connected to sleeves 7 and 9 placed over these ends. In particular, the sleeves 7, 9 are connected to the ends of the pipes 1 by welds 11.

An end piece 13 is connected to the inner end of the pipe 1, especially to the sleeve 9 connected to this end of the pipe 1.

The end piece 13 is closed, but made such that at a certain pressure (a pressure higher than the pressure required for expanding the pipe 1) it opens and clears access to the interior of the end piece 13 or the pipe 1. Possible embodiments for end pieces 13 are shown in Figures 4 and 6 as well as 10 and 11.

In the embodiment shown in Figure 4 the end piece 13 has a tapered end 15 which is connected to the tubular part of the end piece 13 by a groove 17, therefore a weakening point. When a certain pressure is reached within the pipe 1, the wall of the end piece 13 breaks in the area of the groove 17 so that the end of the pipe 1 connected to the sleeve 9, for example by a weld 10, is open.

In the embodiment shown in Figure 6, the end piece 13 is made as a pipe with a free end 19 which is provided with an internal thread. A plug 21 is screwed into the internal thread so that the end piece 13 of the embodiment shown in Figure 6 is initially closed. When a certain internal pressure is reached in the pipe 1 or in the sleeve 9, the plug 21 is pressed out of the end 19 of the end piece 13 which is made as a plug holder, so that in this embodiment the interior of the pipe 1 is connected to the vicinity, therefore to the interior of the drilled hole.

An adapter receiving piece 31 is connected via the sleeve 7 to the other end of the pipe 1 which is shown in Figure 7 and which is opposite the inner end of the pipe 1 with the sleeve 7 and the end piece 13. For example, the adapter receiving piece 31 is connected to the sleeve 7 by a weld 33. The adapter receiving piece 31 is located in the area of the open end of the drilled hole in which the rock anchor is to be fixed. The adapter receiving piece 31 can be equipped with a check valve 34 which opens into the pipe 1 only in the flow direction and thus prevents the pressurized fluid and settable mass from emerging from the rock anchor.

Either [sic] the adapter 35 shown in Figure 8 for feeding the pressurized fluid, especially water, into the interior of the pipe 1 can be connected to the adapter receiving piece 31. Alternatively the adapter 37 which is shown in Figure 9 and which is used for forcing in the settable mass, especially hydraulically binding mass, such as grout or mortar, can be placed on the adapter receiving piece 31.

The adapter 37 from Figure 9 can be equipped with a quick-release coupling 38 so that a hose coming from a pump which delivers the settable mass can be quickly connected.

The adapters 35 and 37 can be provided with an outside thread 39 which can be screwed into the internal thread 41 of the adapter receiving piece 31.

Components such as for example eye bolts (DIN 580) can be attached to the adapter receiving piece 31, after the rock anchor has been fixed in a drilled hole, as is described above.

To fix the described rock anchor in a drilled hole, the procedure is as follows:

First of all, the rock anchor is inserted with its end piece 13 first into a previously prepared drilled hole. As soon as this has taken place, a pressurized fluid (for example, water with a pressure

of roughly 100 - 500 bar) is fed into the interior of the pipe 1 via the adapter 35 which is attached to the adapter receiving piece 31 by screwing it in. Under the action of the pressure prevailing within the pipe 1, the pipe 1 expands as its lengthwise fold 3 is opened so that it is pressed with its outside surface tightly against the inside surface of the drilled hole (Figure 5). As soon as this has happened, the adapter 35 can be removed from the adapter receiving piece 31 by unscrewing and replaced by the adapter 37 (Figure 9) whereby this adapter 37 is screwed into the adapter receiving piece 31. At this point the settable mass, especially grout or mortar, which is delivered from a corresponding pump under pressure is forced in through the adapter 37 (Figure 9). The pressure in the settable mass is thereby higher than the previously prevailing pressure during expansion of the pipe 1 so that the end piece 13 opens, by either (Figure 4) the tip 15 being separated from the end piece 13 by breaking the wall in the area of the groove 17 or (Figure 6) by the plug 21 being forced out of the plug holder 19. As soon as this has happened, first the fluid which has been used to expand the pipe 1, especially water, and then the settable mass emerge from the pipe 1 via the sleeve 9 and the end piece 13 into the drilled hole. The settable, especially hydraulically binding mass now fills the space 8 remaining after expansion of the pipe 1 between the remainder of the fold 3 and the inside surface of the drilled hole (Figure 5). In addition, the settable mass penetrates into the cracks or fractures which proceed from the front end of the drilled hole and thus solidifies the material (rock, stone, or the like) into which the rock anchor has been set, mainly in the area which surrounds the drilled hole bottom.

In one modified procedure, one proceeds such that first a pressure is produced with the fluid fed via the adapter 35 from Figure 8 which is sufficient for expanding the pipe 1 as its fold 3 opens,

so that the pipe 1 with its outer surface rests against the drilled hole (Figure 5), whereupon the pressure in the fluid is then raised so that the end piece 13 opens and only then is the adapter 35 from Figure 8 replaced by the adapter 37 from Figure 9.

In addition, the described procedure offers the advantage that the interior of the rock anchor which consists especially of steel is protected against corrosion. In the case in where a hydraulically binding mass based on cement is used, an alkaline environment is additionally ensured, which is advantageous.

With the procedure as claimed in the invention and the use of the rock anchor as claimed in the invention in combination with injection drill anchors (so-called "hybrid anchors") the advantages of rock anchors which can be expanded using internal pressure (quick strength and solid seating) are combined with the advantages of injection drill anchors fixed by a settable, for example hydraulically binding mass, since the settable mass fills possible free spaces in the area of the drilled hole between the outside of the injection drill anchor and also penetrates into cracks or gaps which proceed from the drilled hole, and thus compacts the rock, the soil or quite generally the substratum around the drilled hole.

In the embodiment shown in Figure 10, the anchor again consists of a profiled pipe 1 and the two sleeves 7 and 9 provided at its ends. The sleeves 7 and 9 are connected to the profiled pipe 1 of the anchor by pressure and welding. An end piece 31 is welded to the sleeve 7 in the embodiment shown in Figure 10, and the adapters shown in Figures 8 and 9 can be selectively screwed into the end piece 31. For this purpose, the end piece 31 has an inside thread via which the coupling piece shown in Figure 8 for expanding the profiled pipe 1 can be screwed in. Water is

injected under pressure via this coupling in order to expand the profiled pipe 1 and then to blow off the tip of the anchor.

The injection adapter as shown in Figure 9 with the anchor can be connected (screwed onto) the end piece 31 after the coupling as shown in Figure 8 has been removed.

On the front end of the anchor, via the sleeve 9 the end piece 13 is connected to the tip 15 by a weld 10. An outwardly open groove 14 is provided in the wall of the end piece 13 in the vicinity of the base of the tip 15. Material fracturing is then induced by way of this groove 14 after the expansion pressure is exceeded whereby the tip 15 is subsequently blown off so that the mass binding the substratum can then be injected through the anchor.

In the embodiment shown in Figure 11, the anchor again has the profiled pipe 1, the sleeves 7 and 9 which are attached to the ends of the profiled pipe 1 by pressing and/or welding and the end piece 31 which is connected (welded) to the sleeve 7. A coupling piece 54 which is provided with an outside thread is connected to the front sleeve 9 via a weld 55. Via this coupling piece 54 a coupling piece 53 which is provided with an inside thread is screwed, to which the weld, the end piece 13 with the tip 15 is connected [sic]. In the embodiment shown in Figure 11, the groove 17 on the base of the tip 15 is open toward the inside of the end piece 13.

The tip 15 in contrast to the embodiment shown in the drawings can be made with different angles. End pieces 13 with an arched front end (bomb-shaped) or with a flat front end can also be used.

In summary, one exemplary embodiment of the invention can be described as follows:

An anchor with a longitudinally folded pipe 1 and with an end piece 13 which can be

opened under pressure and which is provided on the end of the anchor lying inside the drilled hole is introduced into the drilled hole, and by applying internal pressure is expanded as the pipe 1 unfolds until the pipe 1 with frictional locking and/or positive locking engages the drilled hole, whereupon the pressure in the anchor is raised so that the forward tip 15 of the end piece 13 is separated. Then the settable mass is pressed through the anchor into the drilled hole in order to fill cavities in the area of the anchor end located at the bottom of the drilled hole and the substratum (soil, rock) in which the anchor is fixed, and cavities or cracks located in the bordering substratum. A hydraulically binding, cement-based mass can be used especially as the settable mass.

Claims:

1. Process for setting anchors with a pipe (1) which has been longitudinally folded at least once, the pipe (1) being expanded by using internal pressure, after it has been pushed into a drilled hole, characterized in that after expanding the pipe (1) the internal pressure is raised until an end piece (13) provided on the inner end of the anchor opens and releases a connection between the interior of the pipe (1) of the anchor and the drilled hole and that then the settable mass is pressed through the pipe (1), that the settable mass fills empty spaces (8) between the front end of the pipe (1) and the drilled hole, gaps and cracks proceeding from the drilled hole and that finally the settable mass is allowed to harden.

2. Process as claimed in claim 1, wherein a hydraulically binding mass is used as the settable mass.

3. Process as claimed in claim 2, wherein a cement-based hydraulically binding mass is used as the settable mass.

4. Process as claimed in claim 1, wherein a plastic is used as the settable mass.

5. Process as claimed in claim 4, wherein a plastic which hardens by a chemical reaction is used.

6. Process as claimed in claim 5, wherein an epoxy resin is used.

7. Process as claimed in claim 4, wherein a plastic which is injected in molten form is used as the settable mass.

8. Process as claimed in one of claims 1 to 7, wherein to expand the pipe (1) a fluid,

especially water under a pressure of 100-500 bar, is fed into the pipe (1) of the anchor.

9. Process as claimed in claim 8, wherein the pressure in the fluid added to expand the pipe (1) is increased after expansion of the pipe (1) in order to open the end piece (13).

10. Process as claimed in one of claims 1 to 9, wherein the end piece (13) is opened by a rupture in the area of a predetermined breaking point (groove 17).

11. Process as claimed in one of claims 1 to 9, wherein the end piece (13) is opened by pressing out the sealing plug (21).

12. Anchor for use in the process defined in one of claims 1 to 11 having a pipe (1) which has at least one lengthwise fold (3), characterized in that on the back end of the pipe (1) to be inserted first into a drilled hole an initially closed end piece (13) is provided, and that the end piece (13) can be opened under the action of the pressure prevailing in the pipe (1).

13. Anchor as defined in claim 12, wherein sleeves (7, 9) which are tightly connected to the pipe (1) are provided at the ends of the pipe (1).

14. Anchor as defined in claim 13, wherein the end piece (13) is connected to the sleeve (9) which is provided on the inner end of the pipe (1) of the anchor.

15. Anchor as defined in one of claims 12 to 14, wherein the end piece (13) on its closed end (15) has a predetermined breaking point (groove 17).

16. Anchor as defined in claim 15, wherein the end of the end piece (13) which is outside the predetermined breaking point (groove 17) has a tip (15).

17. Anchor as defined in one of claims 12 to 16, wherein the end piece (13) has a plug (21) which is inserted into its outer end (19).

18. Anchor as defined in claim 17, wherein the plug (21) is inserted, especially screwed, in the area of the internally threaded end (19) of the end piece (13).

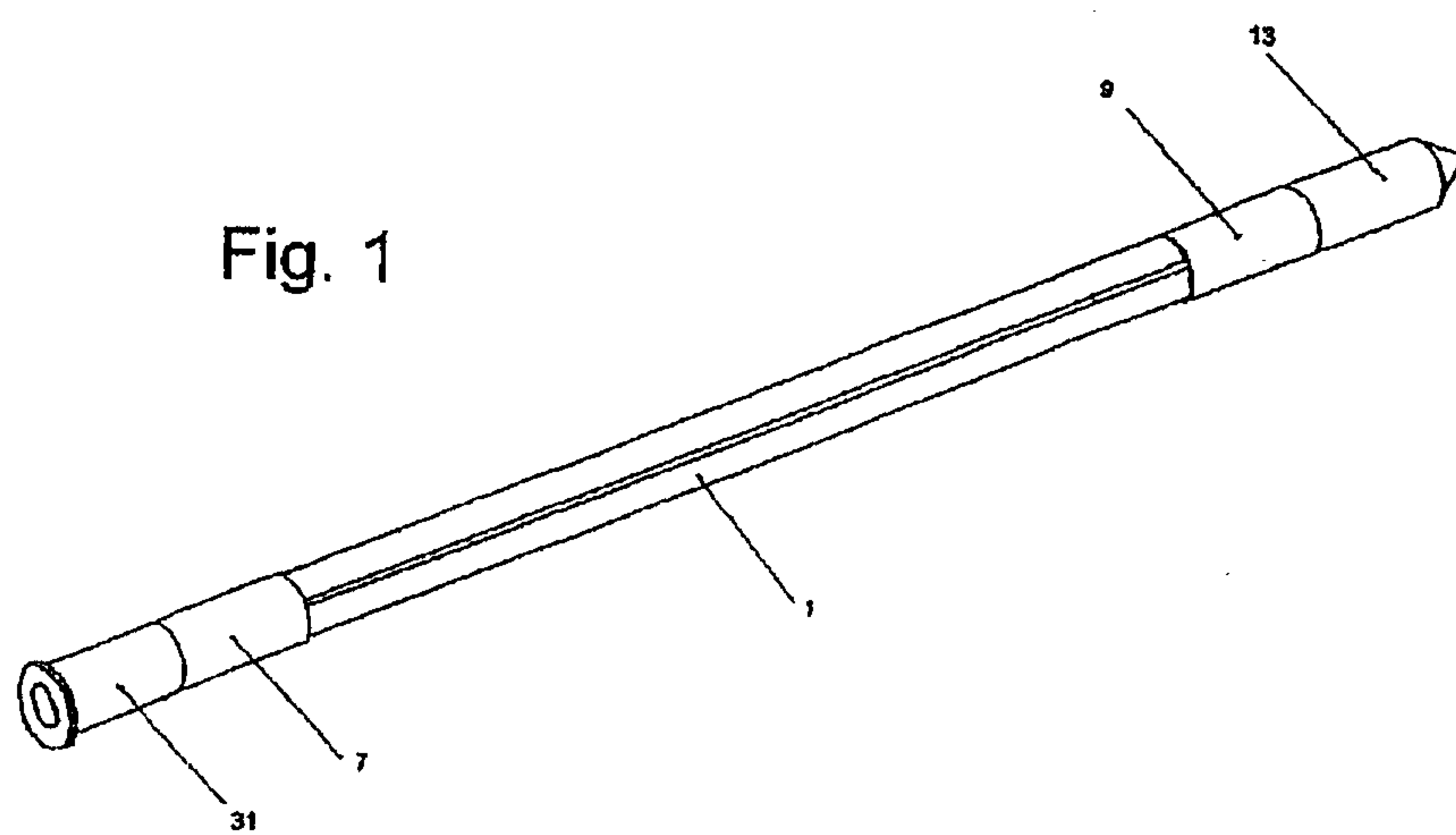
19. Anchor as defined in one of claims 12 to 18, wherein the end piece (13) is a pipe which is connected to the inner sleeve (9) of the anchor.

20. Anchor as defined in one of claims 12 to 19, wherein on the outer end of the pipe (1) of the anchor opposite the end piece (13) there is an adapter receiving piece (31) in which alternately an adapter (35) for feeding pressurized fluid and an adapter (37) for feeding the settable, especially hydraulically binding mass, can be fixed.

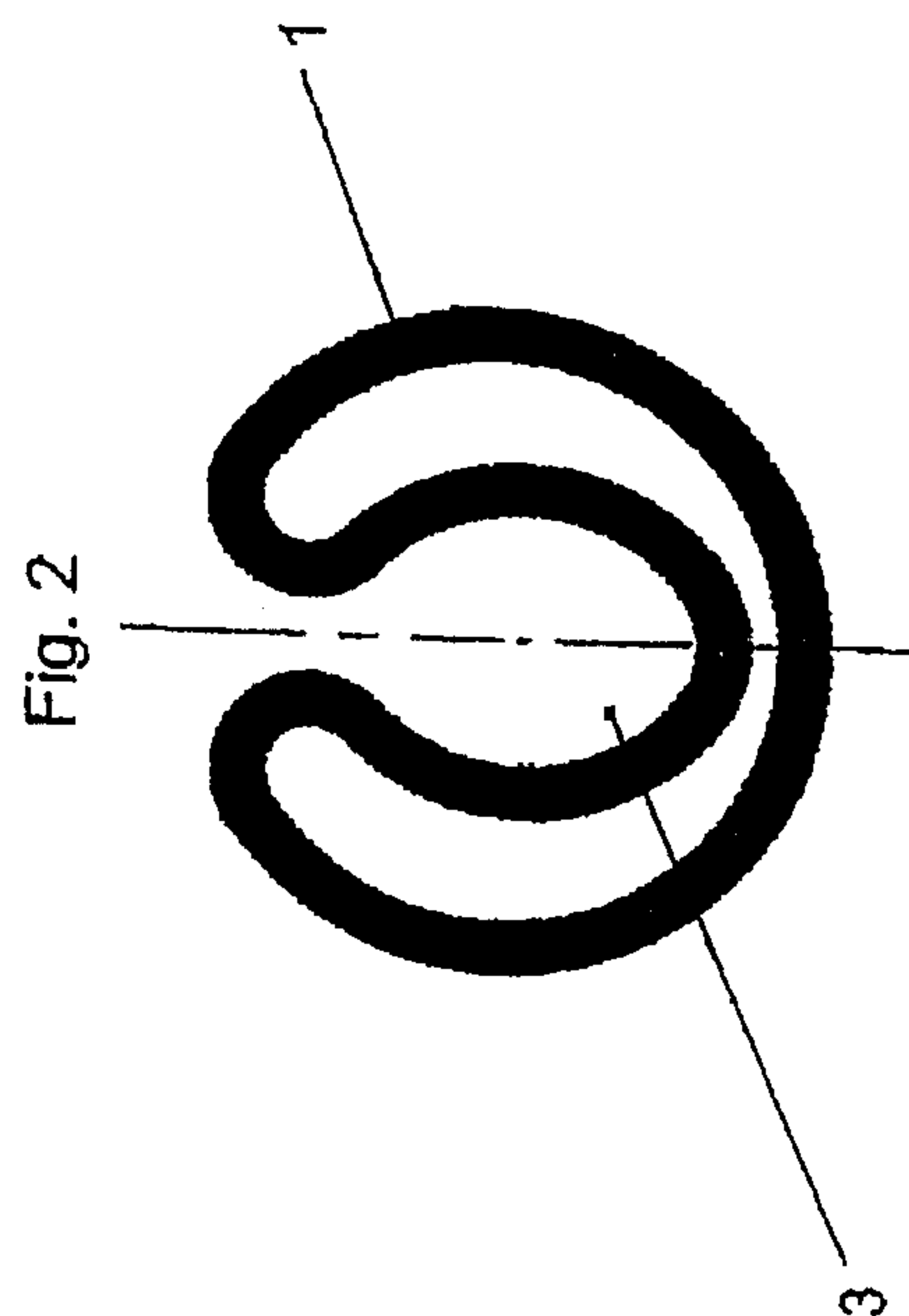
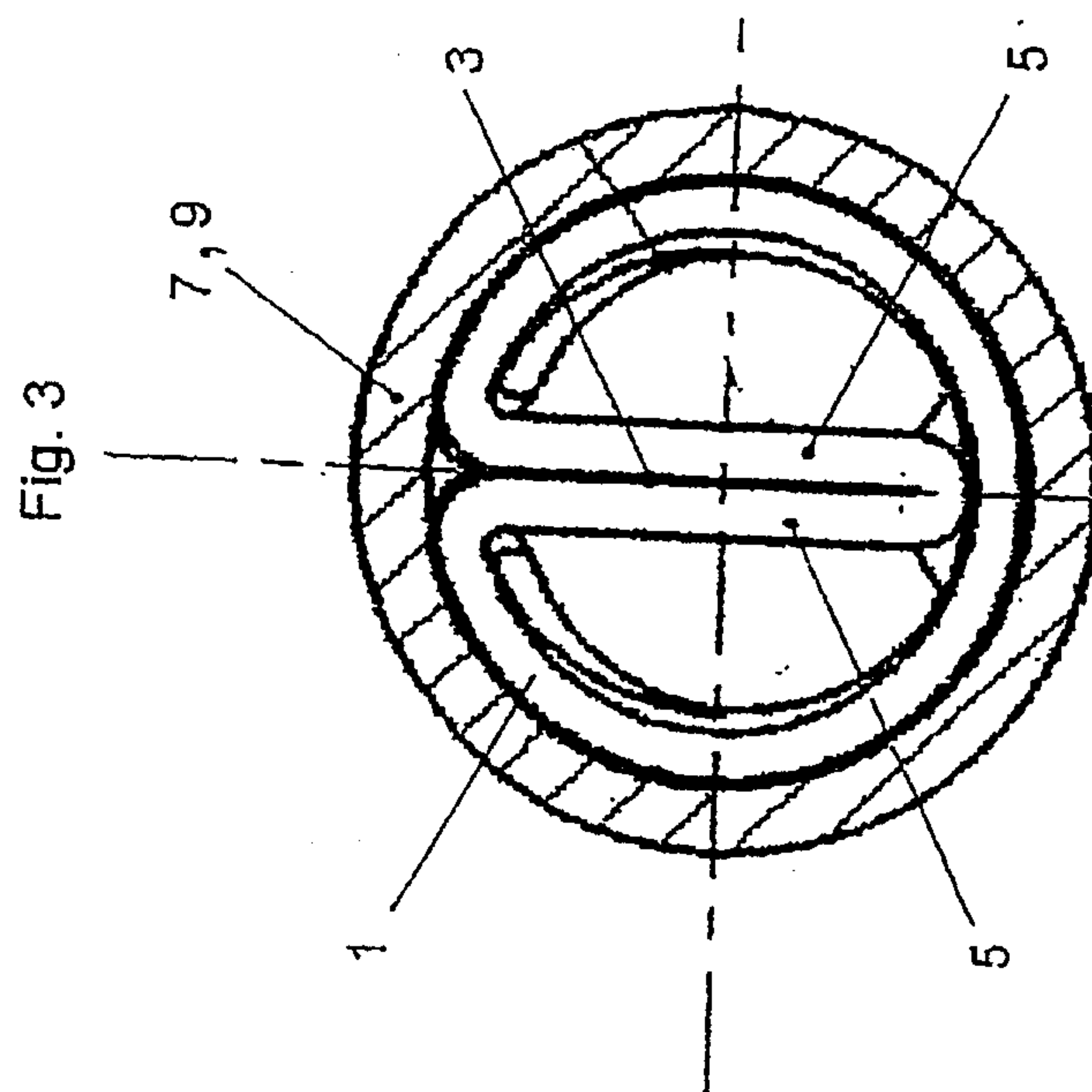
21. Anchor as defined in claim 20, wherein the adapter receiving piece (31) bears an inside thread (41) and wherein the adapter (35, 37) with an outside thread (39) can be screwed into the adapter receiving piece (31).

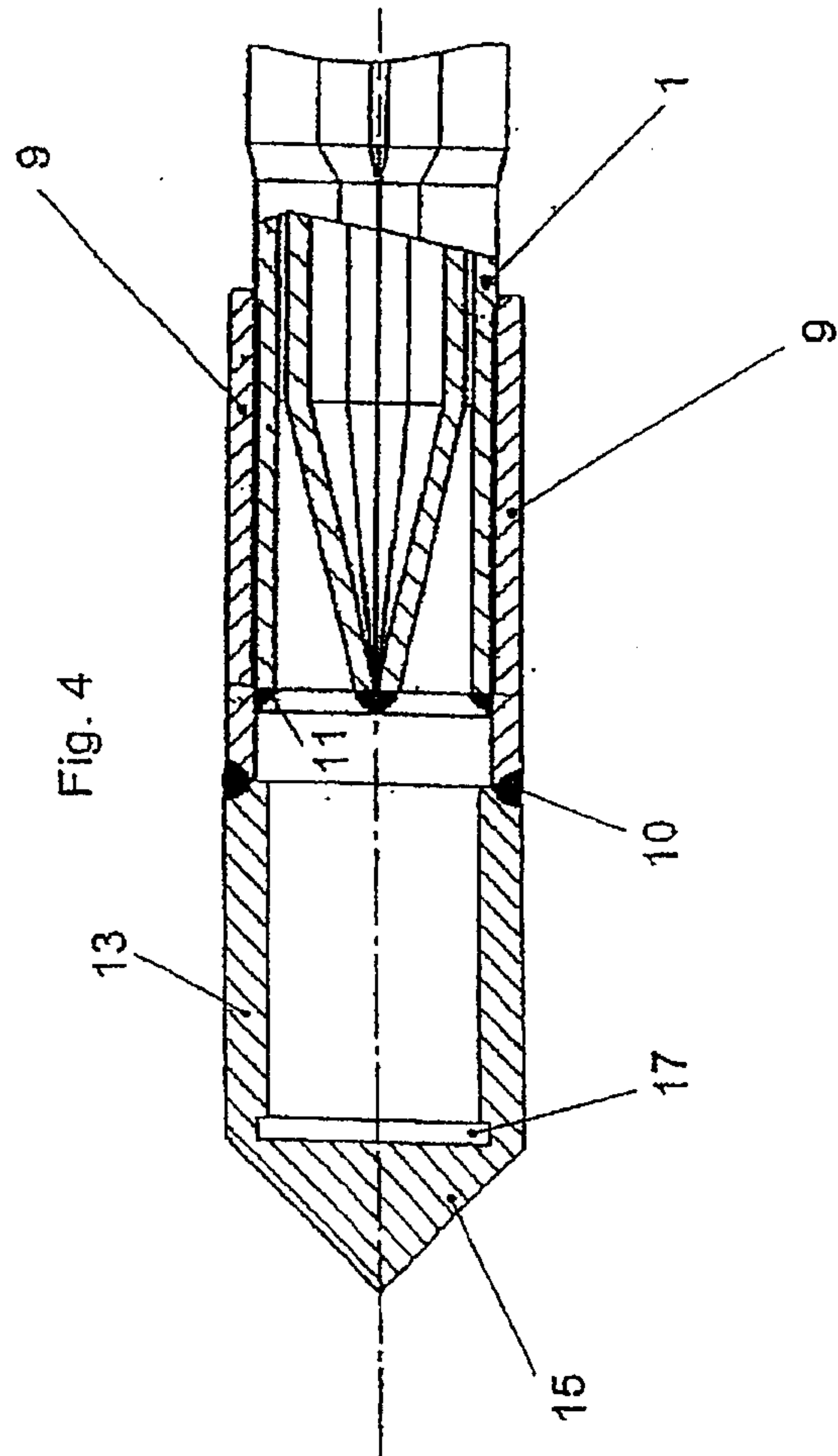
22. Anchor as claimed in claim 20 or 21, wherein the adapter (37) for feeding the settable mass bears a quick coupling (38) for connecting a delivery hose for the settable mass.

23. Anchor as claimed in one of claims 19 to 22, wherein there is a check valve (34) in the adapter receiving piece (31).

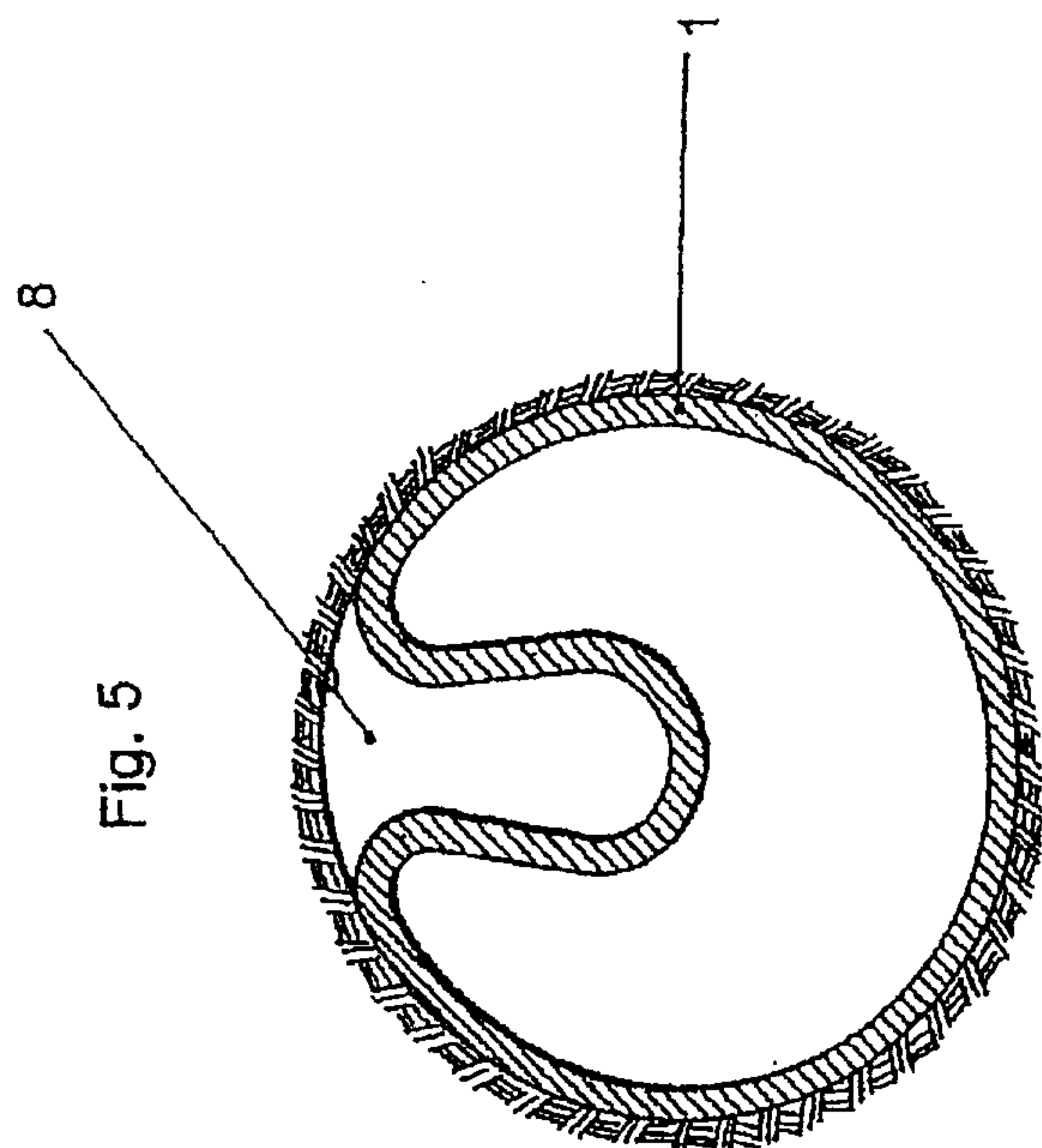


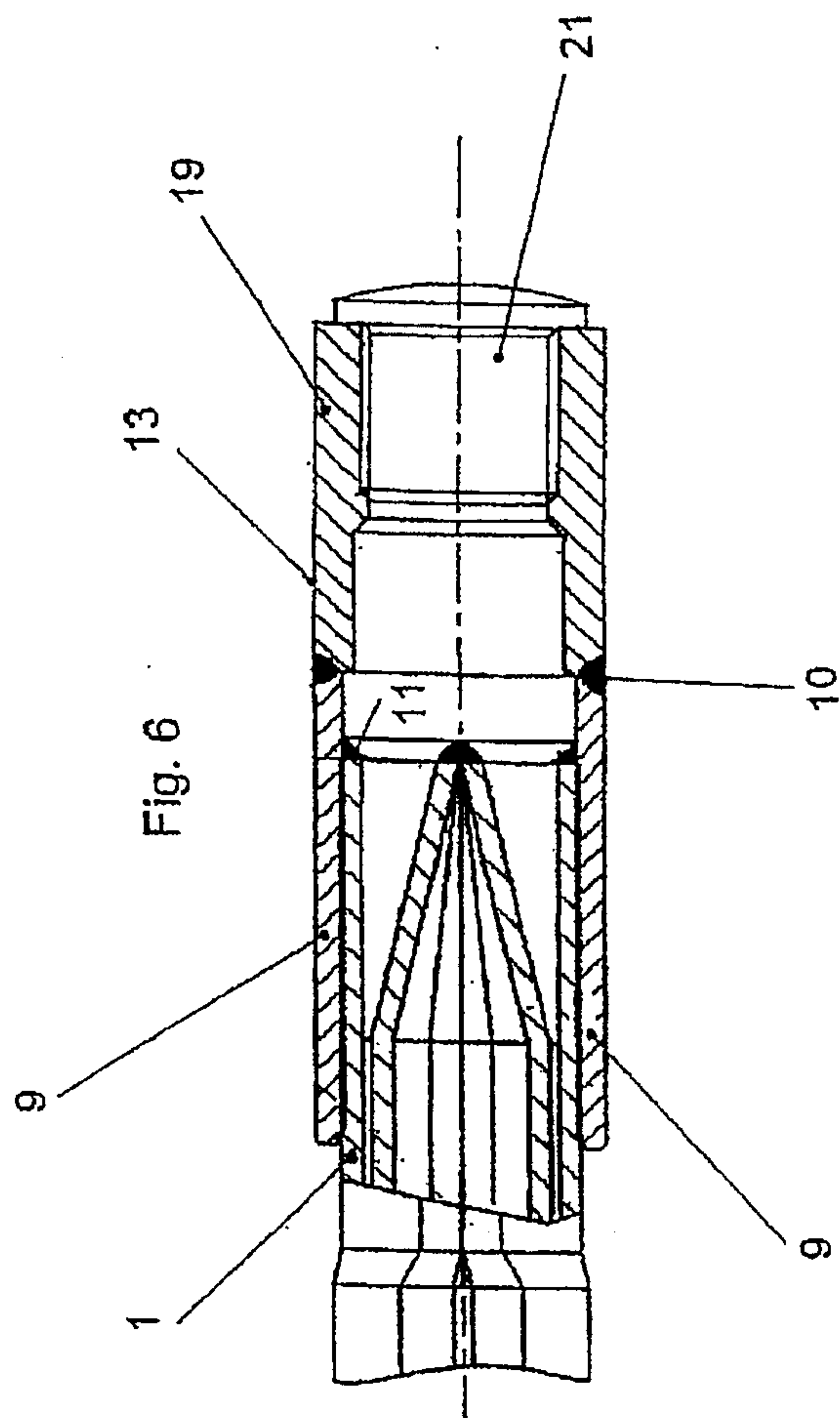
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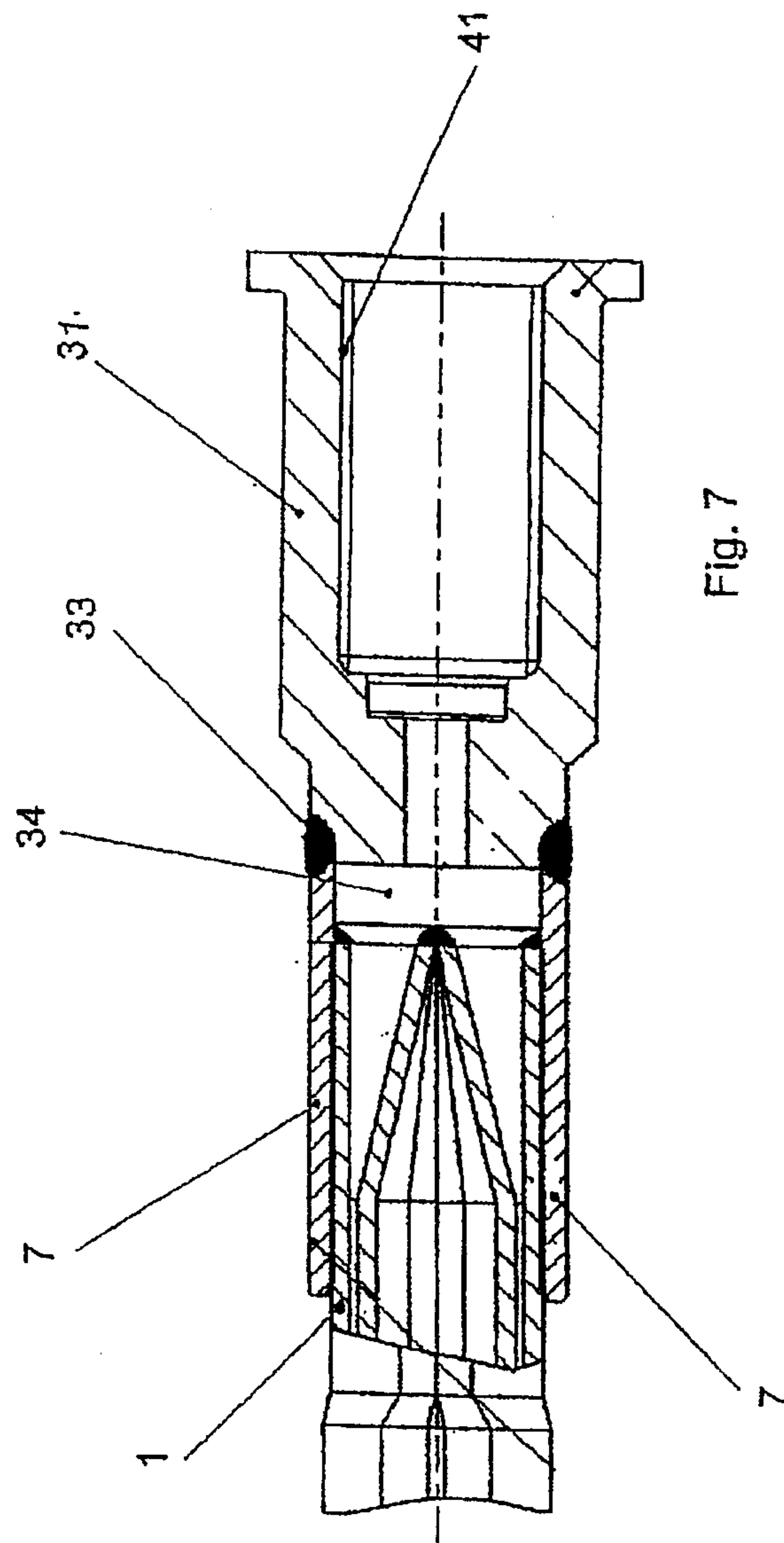




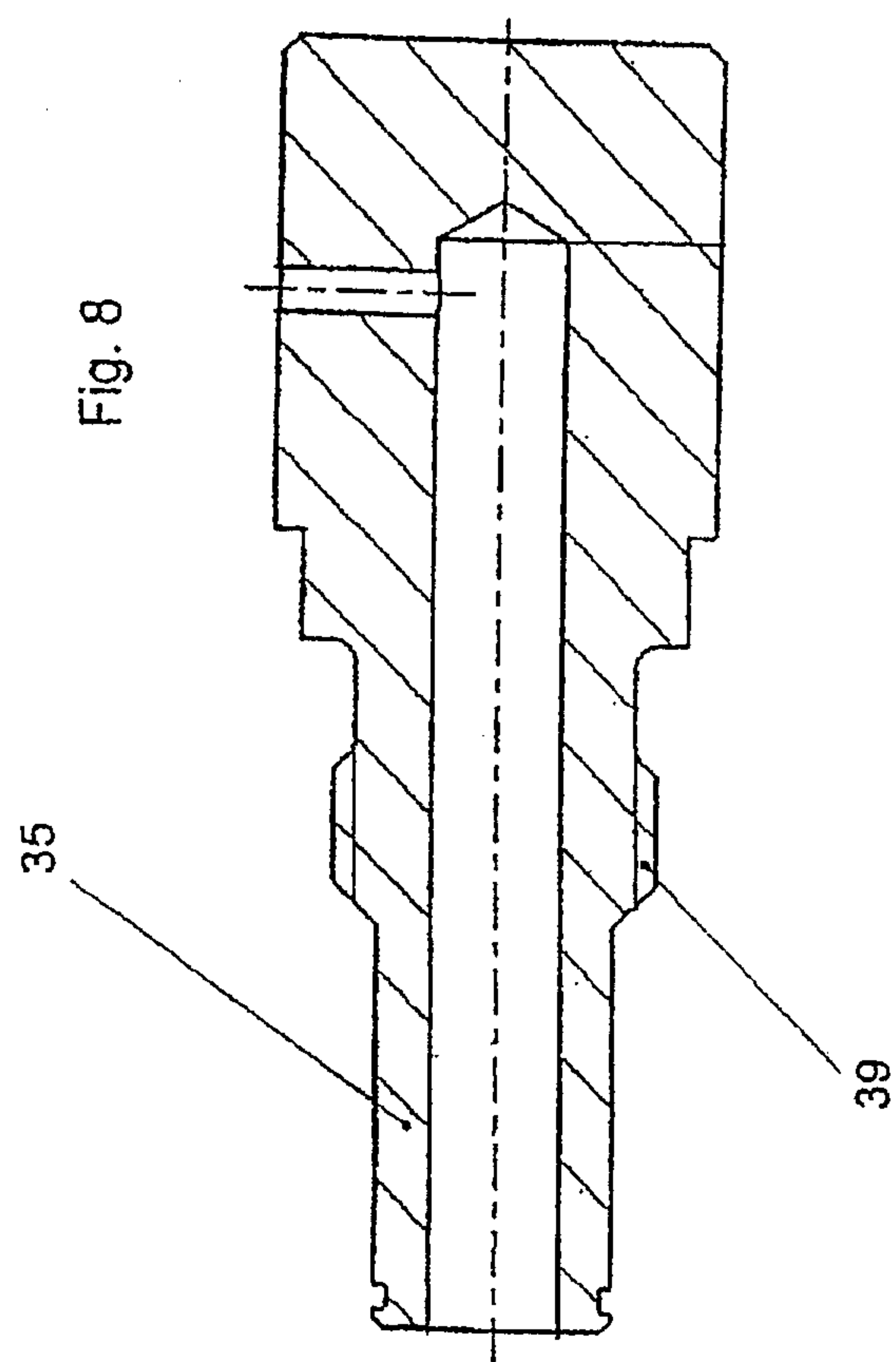
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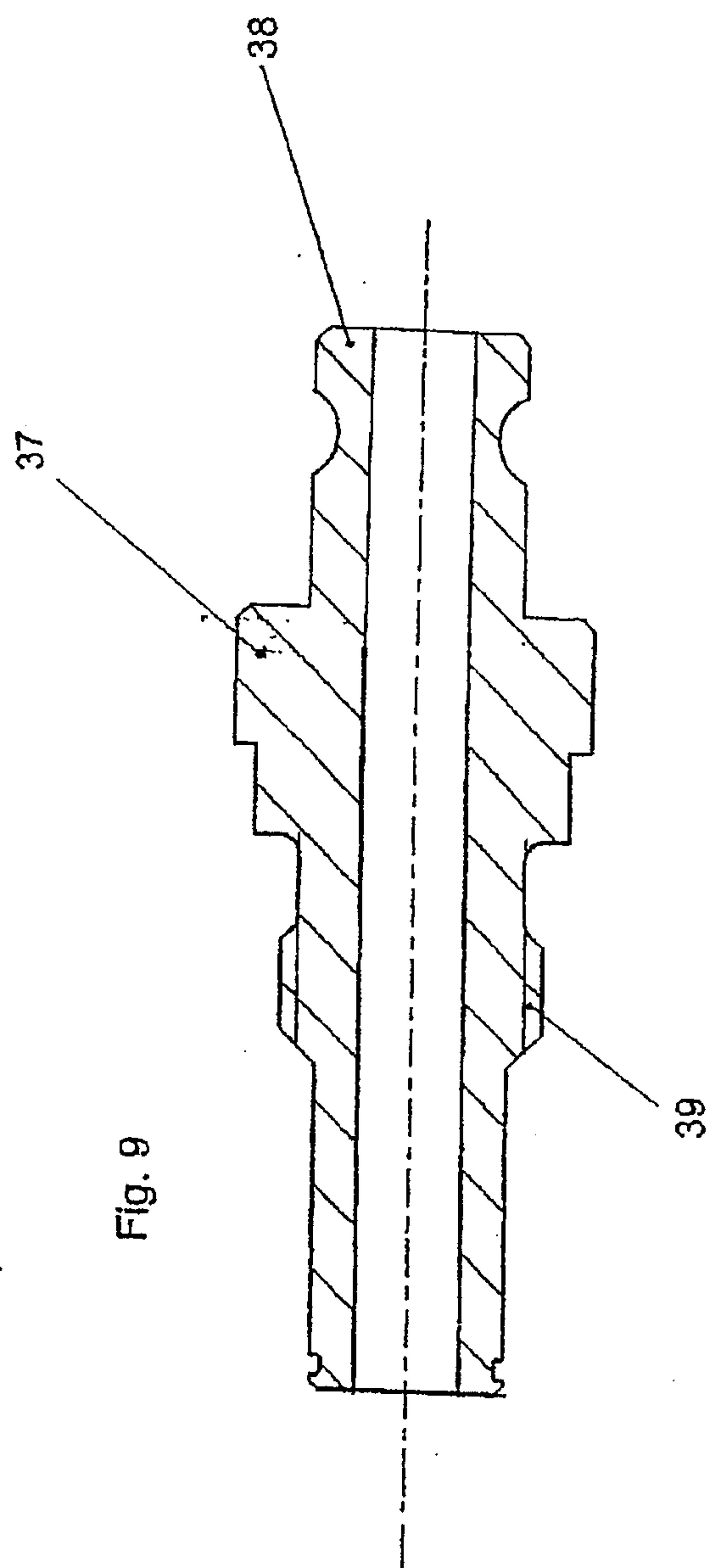






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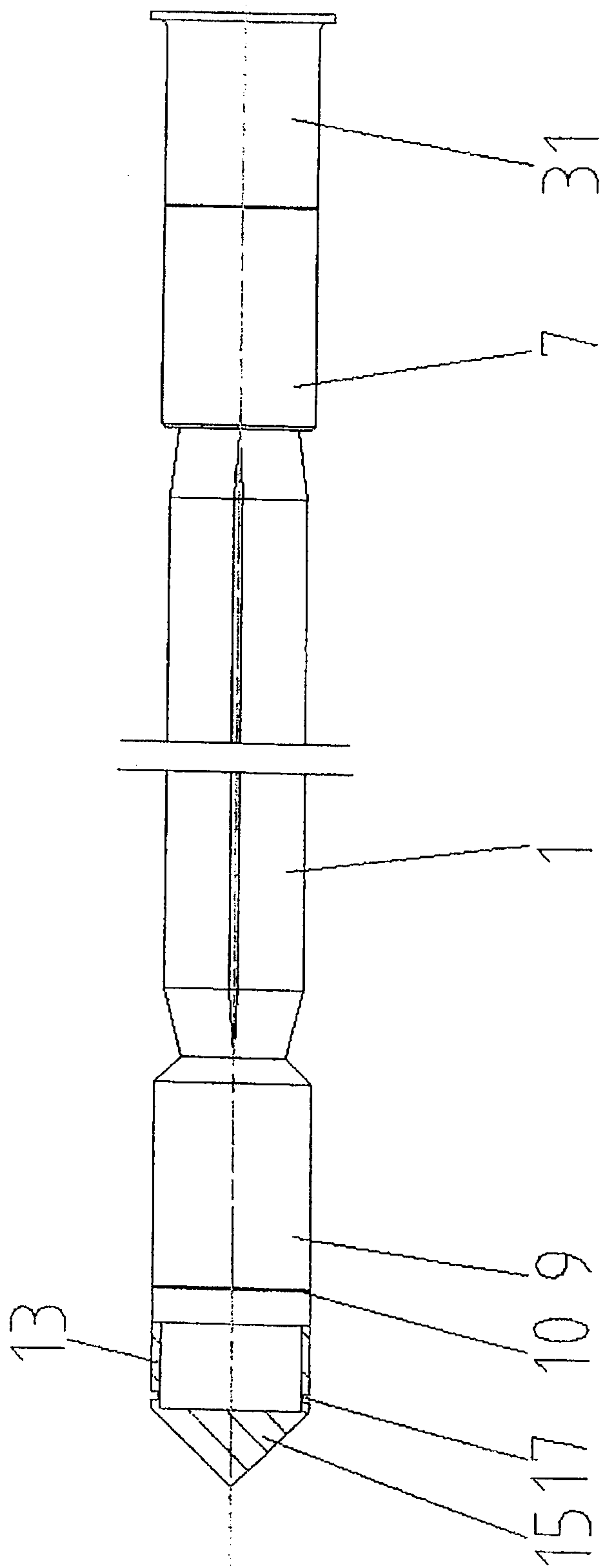


Fig. 10

Fig.11

