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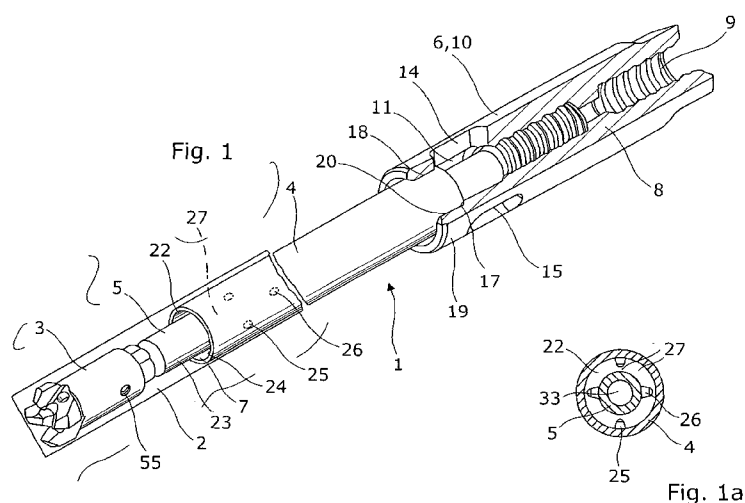
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(54) Title: DRILLING DEVICE FOR PERCUSSION OR ROTARY PERCUSSION DRILLING HAVING A COUPLING SLEEVE



(57) Abstract: For the purpose of producing boreholes (2) in the combined drilling and setting process, a tube spile (4), which subsequently remains in the borehole (2), is driven into the latter via a coupling sleeve (6). Said coupling sleeve (6) is constructed as a combined thrusting, striking and ejecting adapter (10), and therefore ensures both the propulsion of the tube spile and the transmission of the power of the drilling machine to the drill rod (5) and thereby the drill bit (3). Said drill bit (3) is secured on the drill rod (5), or rather its front end (37), via an axial fixing system (55) against unintended detachment.

**DRILLING DEVICE FOR PERCUSSION OR ROTARY PERCUSSION
DRILLING HAVING A COUPLING SLEEVE**

[008] The invention relates to a device for the process for the combined drilling of a
5 borehole and setting of a tube spile or a tubular anchor that remain in the borehole
produced and that serve for advance rock stabilisation, for example in tunnel
construction.

[009] When producing a borehole, above all in loose areas of rock, and subsequently
securing an anchorage in the borehole, it is known practice, from WO 98/21439 and
10 WO 98/58132, to introduce a casing tube into the borehole in such a way, while
producing the latter for example by means of a percussion or rotary percussion drilling
machine, that after completing the borehole, part of the drill bit, together with the drill
rod, can be removed from the borehole while the casing tube itself remains in the
latter. A hardenable material such as mortar or a multi-component adhesive is then
15 introduced into the said casing tube so that the latter, together with the hardenable
material, can serve as an anchor in the borehole.

[0010] From EP 1 381 756 B2, it is known practice to use a casing tube which has a
continuous, or at least largely continuous, longitudinal slot and which is introduced
with pre-tensioning so that, after termination of the drilling operations and the
20 removal of the drill rod while leaving the drill bit in the borehole, said casing tube
produces a certain stabilisation of the rock as a result of expansion. In this instance,
the casing tube and the drill bit or the tip of the drill rod are connected to one another
in such a way that it is possible to draw the casing tube into the borehole as well in
the course of the drilling operation. Because of the longitudinal slot, the cuttings
25 released during the production of the borehole are initially not discharged from the
latter at one point in a predetermined manner, with the result that they can be
collected and removed only with difficulty. In the most unfavourable circumstance,
they become clogged around the casing tube in the area of the jacket, so that the
mortar or consolidating material cannot be introduced later in this area. For this
30 reason, this "expanding anchor" cannot, as a rule, be used in conjunction with a
coupling sleeve that fulfils a number of functions. In addition, in the case of a tube
spile which is closed on all sides, the cuttings can only escape during drilling if a slot
between the coupling sleeve and the tube spile is briefly left during percussion
drilling. For this reason, this system merely functions only with a slotted tube spile.

Finally, deliberate detachment of the drill bit after the termination of the drilling operations is difficult or impossible, because said drill bit has become too tightly fixed on the corresponding end of the drill rod cone. Finally, it is difficult to drive the casing tube in as well when producing the borehole.

- 5 [0011] The underlying object of the invention is therefore to make operations using the combined drilling and setting process with tube spiles that remain in the borehole more effective, more reliable and more economical.

[0012] This object is achieved, according to the invention, through the fact that the coupling sleeve is constructed as a combined thrusting, striking and ejecting adapter
10 which has, at the borehole end, an annular space which is connected to the tube, which is closed on all sides, of the tube spile and is provided, for its part, with radial transverse apertures passing through the wall of the sleeve, and is also constructed so as to have a thrusting and striking face for the tube spile at its front end. In particular, according to the invention, there is provided a device for use in drilling and securing a
15 borehole for advance rock stabilisation wherein said device comprises:

- a drill rod carrying a preferably detachable drill bit,
- a tube spile having a continuous tube to receive said drill rod, and
- a coupling sleeve for connecting said drill rod to a hammer drill;

wherein the coupling sleeve is a combined thrusting, striking and ejecting adapter
20 having a wall which adaptor at its borehole end forms an annular space around the drill rod, which annular space is connected to the tube wherein the annular space is provided with one or more radial transverse apertures which pass through the wall

[0013] For one thing, a coupling sleeve of this kind ensures, first of all, that the cuttings occurring when the borehole is produced are removed in a reliable and
25 predetermined manner and leave the drilling apparatus at a point where they do not cause any problems or can be conducted onwards in a predetermined manner. In addition, the coupling sleeve, or the corresponding adapter, has a thrusting and striking face via which the tube spile can be driven into the borehole with it smoothly and in a manner conducive to progress in the drilling operation. Finally, the coupling
30 sleeve has, in a manner which is known *per se*, suitable faces via which the impacts emanating from the rotary hammer drill are transmitted smoothly to the drill rod, so that smooth drilling-out of the boreholes by the rotation of the drill rod and drill bit can be ensured. At the same time, the coupling sleeve or adapter is equipped with

guiding faces which ensure that the tube spile, which can also be described as the "casing tube" in spite of the absence of the or any longitudinal slot, is introduced into the borehole in a manner axially parallel to the drill rod. This is possible because the tube spile obtains its "drive" via the coupling sleeve. To enable this, the coupling sleeve may be arranged so that the tube spile is capable of being pushed suitably far into or onto said coupling sleeve.

[0014] According to one expedient construction of the invention, provision may be made for the coupling sleeve to be constructed so as to have a guide for the tube spile. In one embodiment, the tube spile can be pushed into the coupling sleeve to a suitable point at which the shoulders or the stop via which the impacts are transmitted from the coupling sleeve to the tube spile are present. However, the present invention goes further, in that the intention is to provide predetermined guidance for the tube spile on or in the coupling sleeve. Guidance and particularly precise guidance of the tube spile in any situation is thus possible.

[0015] In one embodiment of the invention, the coupling sleeve may have a cylindrical or combined cylindrical/conical guide on the outside that permits sufficiently free axial movement, particularly of the tube spile on the coupling sleeve. The coupling sleeve, or an end of the sleeve, may thus be constructed so as to be capable of being introduced into or onto the tube spile; the length of the sleeve that engages with the tube spile being preselected in accordance with the practicalities such as how the device according to the invention is to be used. An advantage of matching the said (borehole) end of the coupling sleeve on the one hand, and the receiving end of the tube spile on the other, is that the impacts are transmitted in a precise manner and the tube spile is guided in a predetermined manner when producing the borehole.

[0016] Further optimisation is possible, according to the invention, as the coupling sleeve may have a cylindrical or combined cylindrical/conical guide on the inside. An advantage of such a construction is that sufficiently free axial movement is possible, the said cylindrical/conical guide working in a reliable manner because of the engagement of the coupling sleeve and the tube spile.

[0017] It has been explained that there is an annular space in the coupling sleeve which has an advantage that it enables cuttings to be discharged in the area of the coupling sleeve via the transverse apertures. In use, an annular duct may be formed

between the drill rod and the tube spile. The tube spile is closed according to the invention in that it lacks a longitudinal slot and preferably lacks any aperture from which cuttings may exit. As a result cuttings, particularly in their entirety, may be guided as far as the coupling sleeve; a further result of this is that the space between
5 the tube spile and the wall of the borehole remains largely free from cuttings so that consolidating material, mortar or two-component adhesive can be reliably introduced later. In order to improve all this throughout the drilling operation, the invention makes provision for the annular space in the coupling sleeve to be designed so as to form an extension of the annular duct existing between the inner wall of the tube spile
10 and the outer wall of the drill rod, its cross-section and/or size being geometrically similar, identical or approximately identical, for example approximately identical in size. Thereby the chance of backflow is reduced or is more particularly impossible. A problem with backflow is that it has a risk of the cuttings drying out, becoming clogged within the annular duct and then leading to obstructions. Thus one of the
15 advantages the invention is that smooth removal of the cuttings is ensured. What is also advantageous about this is the fact that the flushing water or flushing fluid is forced as far as the deepest point of the borehole via the inner duct in the drill rod, so as to then flow in a predetermined manner into the annular duct and then, through the latter, out into the coupling sleeve.

20 [0018] According to the foregoing description, the cuttings are guided out of the annular duct and into the annular space and, from there, into the transverse apertures. Taking this direction of flow into consideration, provision may be made, in one embodiment of the invention, for the transverse apertures in the wall of the sleeve to be constructed as elongated holes. These elongated holes then ensure that the
25 incoming mixture of water and cuttings is able to "flow out" of the coupling sleeve without causing harm and/or an obstruction.

[0019] In the case of greater borehole depths, it may be expedient, according to a further embodiment of the invention, for the inner wall of the tube spile and/or the outer wall of the drill rod to be associated or provided with guiding elements,
30 preferably at certain or individual points wherein a sufficiently large residual cross-section is left between the guiding elements to form the annular duct. Optionally these guiding elements may be arranged over the length of the drill rod or of the tube spile, if a particularly long borehole length is needed. Otherwise it is generally sufficient to provide a ring of individual guiding elements at or near the end of the

drill rod and/or of the tube spile in the direction of the deepest point of the borehole. Under these circumstances, the teaching according to the invention ensures that a backflow of the mixture of cuttings and water cannot occur in this case either, since it is stated that a sufficiently large residual cross-section must be left in any case.

5 [0020] According to another embodiment of the invention, there may be provided a plurality of additional guiding elements in the form of longitudinal ribs and axial longitudinal grooves which are arranged so as to be distributed, at a distance particularly from each other, over the duct cross-section. This can take place in the area of the coupling sleeve in order to improve the guidance of the tube spile at that
10 point or, optionally, at the borehole end of the tube spile and/or drill rod as well.

[0021] If these additional guiding elements are constructed in the coupling sleeve, the invention additionally makes provision for the longitudinal grooves to be constructed so as to be prolonged beyond the thrusting and striking face and to produce the radial transverse apertures at that point. The thrusting and striking face thus lies in the area
15 of the cuttings guide, the "keeping-clean" of said thrusting and striking faces being promoted as a result of interruption by the longitudinal grooves. The thrusting and striking face is thus interrupted, in a sense, by these longitudinal grooves, so that it is cleaned again and again, so to speak, by the mixture of water and cuttings flowing through.

20 [0022] The introduction of the coupling sleeve into the tube spile is facilitated, and at the same time satisfactory guidance of the cuttings ensured, through the fact that the outer edge, that reaches into the annular duct, of the guide on the inside has chamfers that promote the flow of cuttings. Said flow of cuttings therefore does not flow in front of a fairly large edge, but is conveyed smoothly onwards over this transition by
25 the chamfers.

[0023] In various drilling applications, including in the offsetting of tube spiles in drilling technology, a successful approach is to mount the drill bit on a cylindrical or slightly conical polygon or polygonally shaped surface. The polygon in question may be a trigonal or multiple polygon. Preferred embodiments are a hexagonal or trigonal
30 polygon. The faces of the polygon, whether they are rounded edges of the polygon or not, may ensure the necessary transmission of the torque from the drill rod to the mounted drill bit. For the drilling operation, no separate securing of the drill bit is necessary during the pure drilling phase and under normal circumstances, since said

drill bit is kept in contact with the rock and the drill rod by the pressure-applying force during the drilling operation. When locating the starting point for the borehole, however, the drill bit can strike against lining elements, such as lattice arch girders for example, and be easily stripped off the drill rod in the process. Also, a mounted drill
5 bit can be "shot" off the polygon of the drill rod, that is to say thrown off very rapidly, by the flushing pressure of the flushing medium if the flushing operation is inadvertently switched on too early. In addition, problems can occur in the case of modern tunnel-drilling rigs which have a so-called "automatic anti-jamming system for drills". This system conveys the hammer drill, and with it the tool string (coupling
10 sleeve, drill rod and drill bit), back, counter to the axial direction of drilling, when the sensors report a risk of jamming of the drill. This risk is present if elevated torque occurs in the course of the drilling operation, something which happens quite frequently. When travelling back, however, an unsecured drill bit is stripped off the drill rod or thrown off by the flushing pressure. When the drill rod travels forwards
15 again, it usually no longer encounters the drill bit that has fallen off, and the drilling operation has to be terminated for the borehole in question. The result is a lost borehole, a drill bit that is also lost, and lost working time. In order to avoid this series of problems, and thereby also to achieve more effective, reliable and economic operation when producing combined drilling and setting boreholes, according to a
20 further embodiment of the invention there is provision for the drill bit to have or form an internally located multiple polygon or internal polygonal aperture which have a transverse bore, and the front end of the drill rod having or forming a corresponding externally located multiple polygon or a corresponding externally-formed polygonal shape which have a clearance, and for a fixing element that can be sheared off to be
25 arranged in a form-locking and/or force-locking manner in the cavity thus formed, in particular by the transverse bore. What is achieved by way of this construction is a reliable axial connection between the drill bit and the drill rod, which connection can be severed in a predetermined manner, so that the chance of the problems described occurring is reduced; in particular, what is ensured in this way is that, in the case of
30 drilling operations of this kind, the drill bit is reliably seated on the front of the drill rod and remains there until this connection between the drill rod and the drill bit is terminated in a predetermined manner.

[0024] According to a further embodiment of the invention, provision is made for the fixing element to be constructed, in terms of its shape and the properties of its
35 material, so as to have a retaining force of at least 5 N and at most 800 N, preferably

from 10 to 200 N. Depending upon the threat to the drilling operations, a lower or upper limit should be adhered to, this adaptation to the prevailing circumstances being possible without any problems because of the construction of the aforesaid fixing element that can be sheared off or destroyed. The fixing element is slipped in through the transverse bore as far as the clearance, so that it is then also possible, when the necessary shearing-off operation occurs, to achieve or preset a plane which promotes the predetermined shearing-off of the fixing element, or allows said plane to be precisely set. In any case, it is possible, in this way, to ensure that inadvertent shearing-off or detachment cannot occur, with the result that a complete drilling outfit is always available for the scheduled drilling operations.

[0025] Optimisation of the "connection" between the drill bit and drill rod can be achieved if the clearance has the shape of a transverse groove, preferably a continuous or interrupted rounded annular groove or a bore, while the transverse bore is constructed as a cylindrical or conical radial bore. As a result of this, it is easier to achieve the predetermined degree of security when mounting the drill bit, without it being absolutely necessary for the transverse bore and clearance to be exactly coincident. Simpler assembly is achieved in this way.

[0026] One expedient construction of the fixing element makes provision for the latter to be a clip, preferably a plastic clip, of resilient design, which is pushed or knocked into a radial bore in the drill bit or consists of plastically deformable plastic or soft metal, preferably in the form of bars or wires. Such a clip can be easily fitted and brought into the securing position, so that assembly as a whole is also facilitated thereby. As a result of shaping it as bars or wires, the fixing element can also be very easily introduced and kept in the position which it is to assume during the drilling operations. On completion of these and on the predetermined detachment of the drill bit, this plastic or the soft metal can be deformed or sheared off in such a way that the temporary connection between the drill bit and the drill rod can be reliably severed.

[0027] Another possible construction for the fixing element is one in which said fixing element is constructed so as to consist of fluid or gel-like or foam-like material which can be injected or forced in. Such a fixing element can be satisfactorily introduced into the bore or clearance, and possibly fastened or cured at that point, so as to then reliably release the drill bit when it is necessary to sever the connection between the latter and the drill rod.

[0028] Finally, it is also possible to construct the fixing element as an elastic, ring-shaped element which is constructed so as to be insertable in a ring-shaped groove section of the multiple polygon of the drill rod and a ring-shaped groove section on the inner wall of the drill bit. When the drill bit is pushed on, this ring-shaped fixing element is pushed into the groove sections and ensures that the two parts, that is to say the drill rod and the drill bit, remain connected while this is necessary or scheduled from the point of view of drilling technology.

[0029] It is particularly expedient if the fixing element is an annular element consisting of elastic material, preferably of plastic or rubber, which is inserted in an annular groove in the drill rod, and the inner face which lies above it is of planar construction. In this way, the annular element is deformed and practically pressed flat on insertion in such a way that a very satisfactory force-locking connection can be achieved between the drill bit and the multiple polygon or drill rod.

[0030] In this case, it is particularly expedient if the annular groove in the edges of the multiple polygon is constructed so as to receive the annular element as a whole and is constructed, on the flat lateral faces, so as to be entirely flat or not at all flat. The placing or forming of the annular element into the edges that are kept solid at the edges ensures that the annular element, which is virtually "fixed" at a plurality of points, is also drawn, with them, into the scheduled position in a reliable manner on insertion so as to then produce the desired force-locking connection. The result is the deformation of the annular element in the area of the flat lateral faces, under which circumstances, however, the entrainment of the annular element is reliably achieved as a result of its being fixed in the annular groove.

[0031] In this case, it is particularly expedient to design the annular groove so as to taper towards the lateral face, starting from the edges, since the "entrainment" of the annular element is then safeguarded still more satisfactorily, especially as the "length" of the squeezing zone for said annular element can be precisely preset by the length or special construction of the annular groove. Under these circumstances, this is progressive, with the result that, at any rate after the insertion of the multiple polygon in the drill bit receptacle, the annular element is located precisely in the braking position which reliably prevents unintended pulling-off of the drill bit.

[0032] The annular element is squeezed or deformed in a particularly uniform manner if the inner face of the drill bit receptacle is slightly roughened. Since the multiple

5 polygon, that is to say, therefore, the end piece of the tube spile or of the drill rod, is compressed in any case by pressure when the borehole is produced, the annular element thus always achieves the optimum position of force-locking connection, as a result of which the pulling-off or pushing-off of the drill bit is achieved in any case when the drill rod is pulled back, but not, on the other hand, an unintended severing of the connection between the drill bit and the drill rod.

[0033] Another form of embodiment makes provision for the coupling sleeve to have, at the end associated with the tube spile, a thrusting and striking face which is interrupted a number of times, and thereby to have an outer rim which is interrupted
10 by the transverse apertures. In this way, the tube spile can obtain the necessary striking power at this point without having to be introduced excessively far into the coupling sleeve or into the combined thrusting, striking and ejecting adapter. The corresponding thrusting and striking faces are constructed virtually directly on the outer rim or at the end of the coupling sleeve and grip the tube spile at this point and
15 pass on the impacts which emanate from the drilling machine. The cuttings can be removed without any difficulty via the interruptions or the transverse bores.

[0034] Even with such a construction of the coupling sleeve or its end, a certain amount of guidance is possible because there is constructed at the outer rim, starting from the thrusting and striking faces, a narrow guiding and centring face for the tube
20 spile, which face is interrupted by the transverse apertures, two to four transverse bores being provided in a manner distributed over the periphery of the coupling sleeve, thus producing four thrusting and striking faces at this point too. This has the advantage that, even in the case of this construction, the cuttings are reliably discharged at the appropriate end of the coupling sleeve, from which point they can be
25 removed reliably and without impairing the operation. Under these circumstances, the corresponding guiding and centring face is operative in any case and cannot hinder the efflux, because the transverse apertures interrupt, at this point, the outer rim with the corresponding guiding and centring faces. Nevertheless, this is still sufficient for a suitable operation, even if with a reduced guiding function for the tube spile. Even in
30 these embodiments, regardless of how many transverse bores are provided, there is still an adequate thrusting and striking face.

[0035] Both in the embodiment described earlier and in the form of embodiment with the restricted guiding function, it is advantageous if four transverse bores are provided

in a manner distributed over the periphery of the coupling sleeve and, accordingly also, four thrusting and striking faces in the form of embodiment last described. As is shown later on in the drawings, both the transverse bores and the remaining thrusting and striking faces may be of identical dimensions.

5 [0036] The invention is distinguished, in particular, by the fact that, for the process for the combined drilling and setting of tube spiles which remain in the borehole produced, a solution is provided, with respect to the coupling sleeve and the connection between the drill rod and the drill bit, which ensures that the assembly process as a whole is very effective, very reliable and also, as a result of avoiding
10 downtimes, very economical. As a result of being constructed as a combined thrusting, striking and ejecting adapter, there is imparted to the coupling sleeve shaping which brings considerable advantages, on the one hand, in the drilling process and also, in addition, in the necessary assembling operation. The cuttings can be removed within the drill rod in a predetermined manner such that they do not impair
15 either the drilling operations or the drilling operatives. The latter are also safeguarded in their work through the fact that the drill bit remains at the drill rod, or rather on the latter, as long as is intended. Only after termination of the drilling operations is the connection between the drill bit and the drill rod severed in a predetermined manner, so that said drill rod can be withdrawn from the tube spile without the drill bit. Said
20 tube spile is then additionally fixed in the borehole by the introduction of consolidating material or two-component adhesive, if this is desired and necessary because of the geological operations.

[0037] Further details and advantages of the invention emerge from the following description of the appertaining drawings, in which a preferred exemplified
25 embodiment is represented, together with the details and individual parts necessary for the purpose, and in which:

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| | Figure 1 | shows a drilling device without a drilling machine in a perspective view, partly in section; |
| | Figure 1a | shows a cross-section in the area in which the tube spile and the drill rod overlap; |
| 30 | Figure 2 | shows a coupling sleeve with an internally located guide; |
| | Figure 3 | shows a coupling sleeve with an externally located guide; |

- Figure 4** shows the coupling sleeve according to Figure 3, in the area of transition to the drill rod/tube pile;
- Figure 5** shows an axial securing system in front of the connection of the tube pile and drill rod;
- 5 **Figure 6** shows the connection shown in Figure 5, after the drill bit has been mounted;
- Figure 7** shows a first embodiment of the axial securing system;
- Figure 8** shows a second embodiment of the axial securing system;
- Figure 9** shows a third embodiment of the axial securing system;
- 10 **Figure 10** shows a further embodiment of the said axial securing system;
- Figure 11** shows a drilling device with a cut-open coupling sleeve and restricted guidance;
- Figure 12** shows the cut-open coupling sleeve according to Figure 11, reproduced on an enlarged scale;
- 15 **Figure 13** shows a cut-open end piece of the drill bit, that is to say, virtually, the drill bit receptacle with the multiple polygon of the drill rod introduced; and
- Figure 14** shows a simplified reproduction of a multiple polygon with an annular groove and annular element.
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[0038] In the drilling device 1 shown in Figure 1, the borehole 2 which is to be produced or which has been produced is indicated only in outline. The drill bit 3, which is mounted on the drill rod 5 and is secured via an axial fixing system 55, can be seen in the area of the deepest point of the borehole. The drill rod 5 is surrounded by the tubular tube pile 4, the latter being, in this instance, a closed tube which is guided right into the coupling sleeve 6 in a manner covering the drill rod 5. The tube pile 4 is additionally provided with the reference numeral 7 in order to make it clear that it is, in this instance, a closed tube, under which circumstances the annular duct 22 between the outer wall 23 of the drill rod 5 and the inner wall 24 of the tube pile 4 receives the cuttings, which are not represented here, and the water, in order to then feed them into the annular space 11 of the coupling sleeve 6 which is constructed as a combined thrusting, striking and ejecting adapter 10. This annular space 11 is equipped with transverse apertures 14, 15 in the wall 8 of the sleeve, so that the mixture of water and cuttings is able to pass out at this point.

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[0039] At this end, the coupling sleeve 6 has an internal thread 12 which is designed to correspond with the external thread on the drill rod 5.

[0040] The connection 9 to the hammer drill is provided, in this case also in the form of a corresponding internal thread, at the opposite end of the coupling sleeve 6.

5 [0041] Figure 1a shows a cross-section through the drill rod 5 and tube spile 4, in which it becomes clear that an internal bore 33 is provided in the drill rod 5 for feeding in the cooling fluid. An annular duct 22 is constructed between the drill rod 5 with its outer wall 23 and the tube spile 4 with its inner wall 24. Indicated in outline,
10 particularly in the end area, are guiding elements 25, 26 which can be fitted either on the inner wall 24 or the outer wall 23 in order to secure, at this point, smooth guidance of the tube spile 4 in relation to the drill rod 5. These guiding elements 25, 26 are so arranged and constructed that an adequate residual cross-section for the annular duct 22 is left.

[0042] Figures 2 and 3 are comparable, the key faces 50 merely being positioned at
15 different positions and the end of the coupling sleeve 6 being viewed towards the borehole. What is shown in figure 2 is that the tube spile 4, which cannot be seen here, can be introduced into the coupling sleeve 6, a lead-in cone 21 being provided for that purpose. The enveloping guide 18 is formed by the suitably constructed inner side 20 of the bore in the coupling sleeve 6, while the outer side 19 has little to do
20 with the enveloping guide 18. Also visible are the transverse apertures 14, 15 as well as the thrusting and striking face 17, the function of which is to ensure that the corresponding striking force is transmitted from the coupling sleeve 6 to the tube spile 4. The same striking force is then also passed on via the striking face 16, namely from the coupling sleeve 6 to the drill rod 5. Constructed between the two internal
25 threads 12 and 49 in the form of the slip-in thread for the hammer is a central flushing bore 13. The latter ensures the clear conformation for the striking face 16. The striking face on the chamber side, via which the striking forces are transmitted from the hammer drill to the coupling sleeve 6, is designated by 48. The thread on the end of the drill rod 5 in figure 4 is indicated by 51.

30 [0043] In Figure 3, parts which are the same are provided with the same reference numerals, the illustrated insertion guide being provided with the reference numeral 18' here in order to make it clear that it varies, compared with the representation in figure 2. It can be seen that, in this case, the corresponding end of the coupling sleeve 6 is

of tongue-like construction in a sense, in order to permit insertion into the tube spile 4. Supplementing this, figure 4 shows how it looks when this connection is produced. A supporting edge, which is intended to ensure precise introduction and then positioning between the coupling sleeve 6 and the tube spile 4, is designated by 34.

- 5 [0044] The transverse bores 14, 15 in the wall 8 of the sleeve are prolonged in the direction of the insertion guide 18', namely in the form of a longitudinal rib 28 and an axial longitudinal groove 29. The outer edge 30 of the corresponding insertion guide 18' has chamfers 31, 32 in order to ensure or promote smooth guidance of the mixture of water and cuttings.
- 10 [0045] Reference has already been made earlier to figure 4. The latter reproduces the connection between the tube spile 4 and the coupling sleeve 6, in particular the thread 51. Also visible is one of the transverse bores 14, it becoming evident that the latter is clear, while the longitudinal rib 28 and axial longitudinal groove 29, which are not visible, are located inside the tube spile 4.
- 15 [0046] The other figures, 5 to 10, show the connection between the drill bit 3 and the drill rod 5. Figure 5 shows a drill bit 3 before it is pushed onto the drill rod 5. For this purpose, the drill bit 3 has a multiple polygon 35, while the front end 37 of the drill rod 5 has a corresponding multiple polygon 38. The latter is equipped with a clearance 39, while the drill bit 3 has a transverse bore 36. A fixing element 40,
- 20 which is additionally represented in Figures 7 to 9, is pushed into this transverse bore 36. The whole arrangement is designated as the axial fixing system 55, which ensures that the drill bit 3, once it has been pushed onto the drill rod 5, cannot be inadvertently pushed off it again. This is possible only with an appropriate expenditure of force, for which reason the fixing element 40 should have a retaining
- 25 force of 10 to 200 N.

- [0047] According to figure 7, this axial fixing system 55 is designed as an elastically resilient snap-in element, in figure 8 as a plastically deformable element and, in figure 9 as an in-situ spray-in element made of hardenable gel, foam or the like. Finally, figure 10 shows an embodiment for such an axial fixing system 55, in which an
- 30 internally located radial bore 42 is provided in the drill bit 3, namely in the form of a ring-shaped groove section 44, while a ring-shaped groove section 43 is provided in the front end 37 of the drill rod 5. A ring-shaped fixing element 40''' is located in both of them. The inner wall of the drill bit 3 is provided with the reference numeral

45, the ring-shaped groove section 44 being arranged at this point. The water infeed in the front end 37 of the drill rod 5 is indicated by 53, the said water infeed 53 being continued within the drill bit 3.

[0048] Figure 11 shows a drilling device 1 in which work is carried out using a
5 simplified guide 18 for the tube spile 4. Said tube spile 4 is represented in part, in the same way as in figure 1, the front end making it clear that this is a closed tube 7 which is being used as the tube spile 4. The drill rod, which is detachably connected to the drill bit 3 via the fixing element 40, is designated by 5. The transverse bores, through
10 sleeve 6, are denoted by 14, 15. The striking rim or striking end of the tube spile 4 is designated by 63. The said striking rim 63 is supported on the thrusting and striking faces 17 and 60, 60', 60'' respectively, which denote the outer rim 62 of the coupling sleeve 6. Starting from the outer rim 62, a total of four transverse bores 14, 14', 15
15 are provided in a manner distributed over the periphery of the coupling sleeve 6, so that cuttings are also able to pass out at this point within a predetermined area, without it being necessary for a gap between the striking rim 63 of the tube spile 4 and the corresponding end 61 of the coupling sleeve 6 to be brought about beforehand.

[0049] Figure 12 illustrates the special construction of the end 61 of the coupling sleeve 6 and also the construction of the corresponding transverse bores 14, 14', 15.
20 These transverse bores 14, 14', 15 interrupt the thrusting and striking faces 60, 60', 60'' and also the narrow guiding and centring faces 18''. Limited, but still adequate, guidance of the tube spile 4 by way of the coupling sleeve 6 is possible via the said narrow guiding and centring faces 18''.

[0050] Figure 13 shows a form of embodiment similar to the representation in figure
25 10, except that, in this instance, the drill bit 3 is reproduced partly in section, namely in the area of the drill bit receptacle 71. In the lower area, there can be seen the annular groove 65 in which the annular element 67 is inserted without it being possible for the latter to be subjected to load, i.e. therefore to be squeezed, by the inner face 70 of the drill bit receptacle 71. When the multiple polygon 38 is pushed
30 into the multiple polygon 35, the latter is fixed in such a way that it reaches its working position in any case, without slipping out of place excessively on the surface or the lateral faces 68, 69. The annular element 67 is reproduced in its deformed shape by 67', this being the situation on one of the lateral faces 68 or 69.

[0051] This is illustrated by figure 14, which shows that the annular groove 65 is constructed in a tapering manner, viewed across the lateral faces 68, 69, resulting in the production, in the central area, of the main zone 72 where it is possible, in any case, for the deformation of the annular element 67 that results in the necessary force-locking connection to arise. In the edges 66, 66', on the other hand, the annular element is also drawn into the working position in any case, as has already been mentioned.

[0052] The drill bit 3, or the inner faces 70 of the drill bit receptacle 71, is/are smooth, that is to say, no groove, even just the tapering annular groove 65, is realised at this point. The inner face 70 of the drill bit receptacle 71 may be slightly roughened, in order to guarantee a precise and permanent fit of the annular element 67. In the area of the lateral faces 68, 69, particularly of the main squeezing zone 72, the elastic O-ring or annular element 67 is squeezed radially when the drill bit 3 is pushed onto the multiple polygon 38, as a result of which a radial normal force is brought about between the O-ring or annular element 67 and the inner face 70 of the drill bit receptacle 71. This results, in conjunction with the high coefficient of friction between the rubber of the annular element 67 and the steel of the drill bit 3, in a major frictional force which effectively counteracts the unintended pulling-off of the drill bit 3.

[0053] All the features mentioned, including those that can be inferred from the drawings alone, are regarded, both in isolation and in combination, as essential to the invention.

[0054] The invention will now be defined with reference to the following statements:

[0055] Statement 1 is directed to a device for the process for the combined drilling and setting of tube spiles (4) or tubular anchors that remain in the borehole (2) produced and that serve for advance rock stabilisation, for example in tunnel construction, said device having a drill rod (5) carrying the detachable drill bit (3), the tube pile (4) encasing said drill rod (5) and a coupling sleeve (6) via which said drill rod (5) is to be connected to the shank of the hammer drill, characterised in that the coupling sleeve (6) is constructed as a combined thrusting, striking and ejecting adapter (10) which has, at the borehole end, an annular space (11) which is connected to the tube (7), which is closed on all sides, of the tube pile (4) and is provided, for its part, with radial transverse apertures (14, 15) passing through the wall (8) of the

sleeve, and is also constructed so as to have a thrusting and striking face (17) for the tube spile (4) at its front end.

[0056] Statement 2 is directed to a device according to statement 1, characterised in that the coupling sleeve (6) is constructed so as to have a guide (18) for the tube spile (4).

[0057] Statement 3 is directed to a device according to statement 2, characterised in that the coupling sleeve (6) has a cylindrical or combined cylindrical/conical guide (18) on the outside (19) that permits sufficient free axial movement.

[0058] Statement 4 is directed to a device according to statement 2, characterised in that the coupling sleeve (6) has a cylindrical or combined cylindrical/conical guide (18') on the inside (20).

[0059] Statement 5 is directed to a device according to statement 1, characterised in that the annular space (11) in the coupling sleeve (6) is designed so as to form the extension of the annular duct (22) existing between the inner wall (24) of the tube spile (4) and the outer wall (23) of the drill rod (5), its cross-section being geometrically similar, identical or approximately identical and also approximately identical in size.

[0060] Statement 6 is directed to a device according to statement 1, characterised in that the transverse apertures (14, 15) in the wall (8) of the sleeve are constructed as elongated holes.

[0061] Statement 7 is directed to a device according to any one of statements 1 to 6, characterised in that guiding elements (25, 26) are associated, preferably at certain points and leaving a sufficiently large residual cross-section (27) for the annular duct (22), with the inner wall (24) of the tube spile (4) and/or the outer wall (23) of the drill rod (5).

[0062] Statement 8 is directed to a device according to statement 7, characterised in that there are provided a plurality of guiding elements (25, 26) in the form of longitudinal ribs (28) and axial longitudinal grooves (29) which are arranged so as to be distributed, at a distance, over the duct cross-section.

[0063] Statement 9 is directed to a device according to statement 8, characterised in that the longitudinal grooves (29) are constructed so as to be prolonged beyond the thrusting and striking face (17) and to produce the radial transverse apertures (14, 15) at that point.

- 5 [0064] Statement 10 is directed to a device according to any one of statements 1 to 9, characterised in that the outer edge (30), that reaches into the annular duct (22), of the guide (18') on the inside has chamfers (31, 32) that promote the flow of cuttings.

[0065] Statement 11 is directed to a device according to any one of statements 1 to 10, characterised in that the drill bit (3) having an internally located multiple polygon
10 (35) has a transverse bore (36), and the front end (37) of the drill rod (5) having a corresponding externally located multiple polygon (38) has a clearance (39), and that a fixing element (40) that can be sheared off is arranged, in a form-locking and/or force-locking manner, in the cavity thus formed.

[0066] Statement 12 is directed to a device according to statement 11, characterised in
15 that the fixing element (40) is constructed, in terms of its shape and the properties of its material, so as to have a retaining force of at least 5 N and at most 800 N, preferably 10 to 200 N.

[0067] Statement 13 is directed to a device according to statement 11, characterised in that the clearance (39) has the shape of a transverse groove, preferably a continuous or
20 interrupted rounded annular groove or a bore, while the transverse bore (36) is constructed as a cylindrical or conical radial bore.

[0068] Statement 14 is directed to a device according to statement 11, characterised in that the fixing element (40) is a clip, preferably a plastic clip, of resilient design, which is pushed or knocked into a radial bore (42) in the drill bit (3) or consists of
25 plastically deformable plastic or soft metal, preferably in the form of bars or wires.

[0069] Statement 15 is directed to a device according to statement 11, characterised in that the fixing element (40) is constructed so as to consist of fluid or gel-like or foam-like material which can be injected or forced in.

[0070] Statement 16 is directed to a device according to any one of statements 1 to 15, characterised in that the fixing element (40) is constructed as an elastic, ring-shaped
30 element and is constructed so as to be insertable in a ring-shaped groove section (43)

of the multiple polygon (38) of the drill rod (5) and a ring-shaped groove section (44) on the inner wall (45) of the drill bit (3).

[0071] Statement 17 is directed to a device according to any one of statements 1 to 16, characterised in that the fixing element (40) is an annular element (67) consisting of
5 elastic material, preferably of plastic or rubber, which is inserted in an annular groove (65) in the drill rod (5), and the inner face (70), which lies above it, of the drill bit (3) is of planar construction.

[0072] Statement 18 is directed to a device according to statement 17, characterised in that the annular groove (65) in the edges (66) of the multiple polygon (38) is
10 constructed so as to receive the annular element (67) as a whole and is constructed, on the flat lateral faces (68, 69), so as to be entirely flat or not at all flat.

[0073] Statement 19 is directed to a device according to statement 17, characterised in that the annular groove (65) is designed so as to taper towards the lateral face (68, 69), starting from the edges (66).

15 [0074] Statement 20 is directed to a device according to any one of statements 1 to 19, characterised in that the inner face (70) of the drill bit receptacle (71) is roughened.

[0075] Statement 21 is directed to a device according to statement 2, characterised in that the coupling sleeve (6) has, at the end (61) associated with the tube spile (4), a
20 thrusting and striking face (17, 60) which is interrupted a number of times, and thereby has an outer rim (62) which is interrupted by the transverse apertures (14, 15).

[0076] Statement 22 is directed to a device according to statement 21, characterised in that there is constructed at the outer rim (62), starting from the thrusting and striking
faces (60), a narrow guiding and centring face (18") for the tube spile (4), which face is interrupted by the transverse apertures (14, 15), two to four transverse bores (14,
25 15) being provided in a manner distributed over the periphery of the coupling sleeve (6).

CLAIMS

1. Device for use in drilling and securing a borehole for advance rock stabilisation wherein said device comprises:
 - a drill rod (5) carrying a preferably detachable drill bit (3),
 - 5 a tube pile (4) having a closed tube (7) to receive said drill rod (5), and
 - a coupling sleeve (6) for connecting said drill rod to a hammer drill;wherein the coupling sleeve is a combined thrusting, striking and ejecting adapter (10) having a wall (8) which adaptor at its borehole end forms an annular space (11) around the drill rod which annular space is connected to the tube (7) wherein the
10 annular space is provided with one or more radial transverse apertures (14, 15) which pass through the wall.
2. Device according to claim 1, wherein the adaptor is constructed at its borehole end so as to have a thrusting and striking face (17) for the tube pile (4).
- 15 3. Device according to claim 2, wherein the coupling sleeve is constructed so as to have a guide (18,18') for the tube pile.
4. Device according to claim 3, wherein the coupling sleeve has a cylindrical or
20 combined cylindrical/conical enveloping guide (18) on an outside surface (19) that permits sufficient free axial movement.
5. Device according to claim 3, wherein the coupling sleeve has a cylindrical or combined cylindrical/conical insertion guide (18') on an inside surface (20).
- 25 6. Device according to any one of the preceding claims, wherein an annular duct (22) is formed between an inner wall (24) of the tube pile (4) and an outer wall (23) of the drill rod (5); preferably the annular duct (22) is constructed so as to form an extension of the annular space (11) in the coupling sleeve (6); preferably the annular
30 duct (22) has a cross-section which is similar, identical or approximately identical in geometric shape and/or size.
7. Device according to any one of the preceding claims, wherein the transverse apertures in the wall of the sleeve are constructed as elongated holes.

8. Device according to one of the preceding claims, wherein the inner wall of the tube spile and/or the outer wall of the drill rod are provided with one or more guiding elements (25, 26); preferably the guiding elements are provided at individual points; preferably the guiding elements leave a sufficiently large residual cross-section (27)
5 for the annular duct (22).

9. Device according to claim 4, wherein the insertion guide is in the form of one or more longitudinal ribs (28) and axial longitudinal grooves (29) which are arranged so as to be spaced evenly over the duct cross-section; preferably the longitudinal
10 grooves (29) are constructed so as to be prolonged beyond the thrusting and striking face (17) and to produce the radial transverse apertures (14, 15) at that point; preferably the insertion guide has an outer edge (30) that reaches into the annular duct wherein the outer edge has chamfers (31, 32) that promote the flow of cuttings.

15 10. Device according to one of the preceding claims, wherein the drill bit (3) forms an internal polygonal aperture (35) and the front end (37) of the drill rod (5) has a corresponding externally-formed polygonal shape (38) which has a clearance (39); preferably the clearance (39) is in the form of a transverse groove or bore, preferably a continuous or interrupted rounded annular groove or a bore.

20

11. Device according to claim 10, wherein the drill bit has a transverse bore (36) and wherein a removable fixing element (40) may be arranged in the cavity thus formed by the transverse bore; preferably the transverse bore (36) is constructed as a cylindrical or conical radial bore; preferably the removable fixing element is a form-
25 locking and/or force-locking element; preferably the fixing element has a retaining force of from 5 to 800 N, preferably from 10 to 200 N; preferably the fixing element is a clip, preferably a plastic clip, of resilient design, which is pushed or knocked into a radial bore (42) in the drill bit (3) or consists of plastically deformable plastic or soft metal, preferably in the form of bars or wires; preferably the fixing element is
30 constructed so as to consist of a fluid or gel-like or foam-like material which can be injected or forced in.

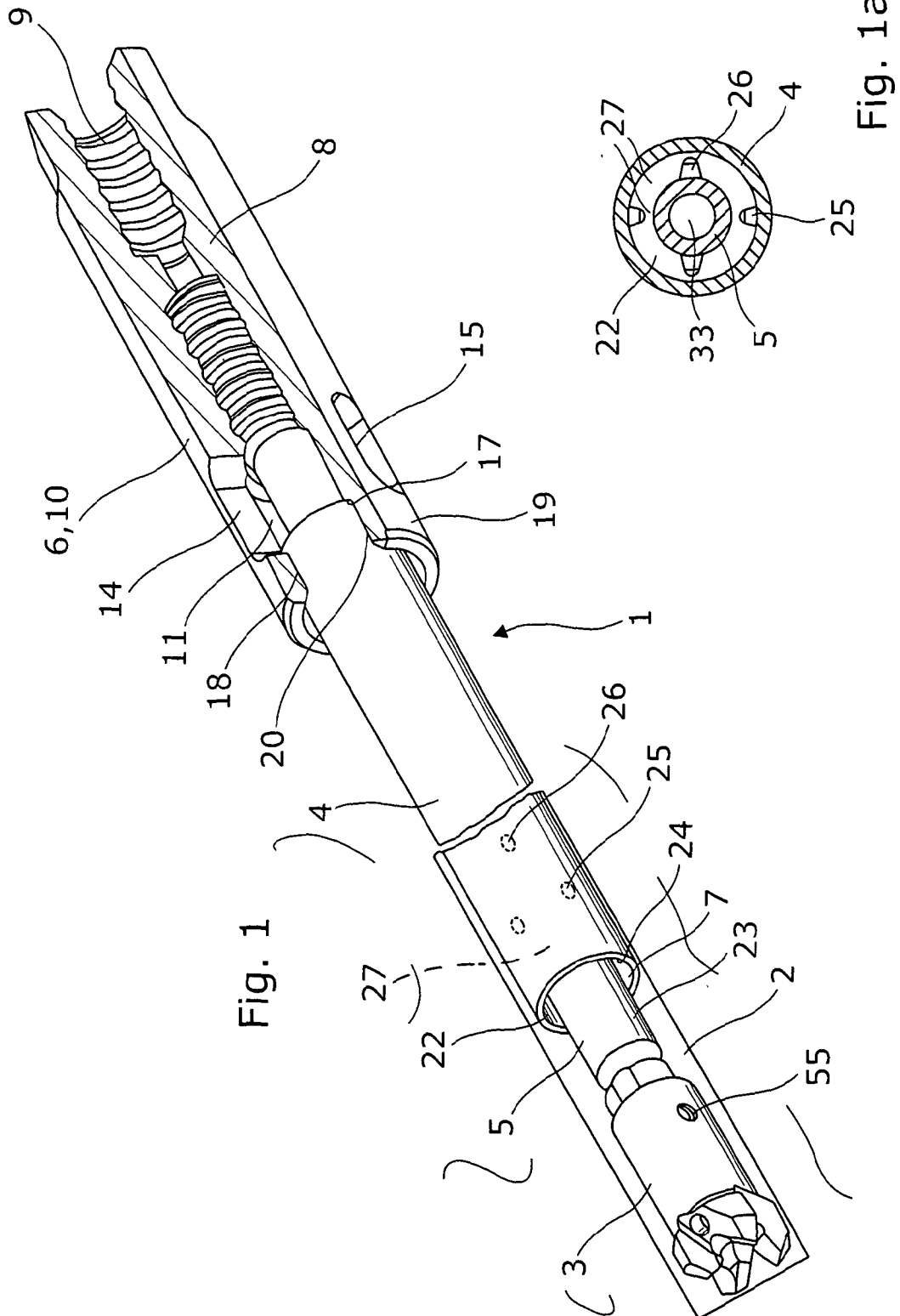
12. Device according to one of the preceding claims, wherein the externally-formed polygonal shape of the drill rod has a ring-shaped groove section (43) and/or
35 the internal polygonal aperture of the drill bit has a ring-shaped groove section (44) on

its inner wall (45) and wherein the annular fixing element (40,67) is constructed as an elastic element to be insertable in either or both of the ring-shaped groove sections; preferably the annular fixing element consists of elastic material, preferably of plastic or rubber, which is inserted in an annular groove (43,65) in the drill rod (5);
5 preferably the inner face (70) of the drill bit (3) is of planar construction; preferably the annular groove is on the edge (66) of the externally-formed polygonal shape of the drill rod; preferably the annular groove is constructed so as to receive the annular fixing element as a whole and wherein the externally-formed polygonal shape of the drill rod has faces (68, 69) arranged laterally to the annular groove which lateral faces
10 are constructed so as to be entirely flat or not at all flat; preferably the annular groove (65) is arranged so as to taper towards the lateral faces (68, 69), starting from the edges (66).

13. Device according to one of claims 10 to 12, wherein the inner face (70) of the
15 internal polygonal aperture is roughened.

14. Device according to claim 2, wherein the coupling sleeve (6) has at the borehole end (61) a toothed outer rim (62) such that an interrupted thrusting and striking face (17, 60) is formed whereby the transverse apertures are formed when the
20 tube spile abuts the outer rim.

15. Device according to claim 14, wherein there is constructed at the outer rim (62), starting from the thrusting and striking faces (60), a narrow guiding and centring face (18") for the tube spile (4), which face is interrupted by the transverse apertures
25 (14, 15), two to four transverse bores (14, 15) being provided in a manner distributed over the periphery of the coupling sleeve (6).



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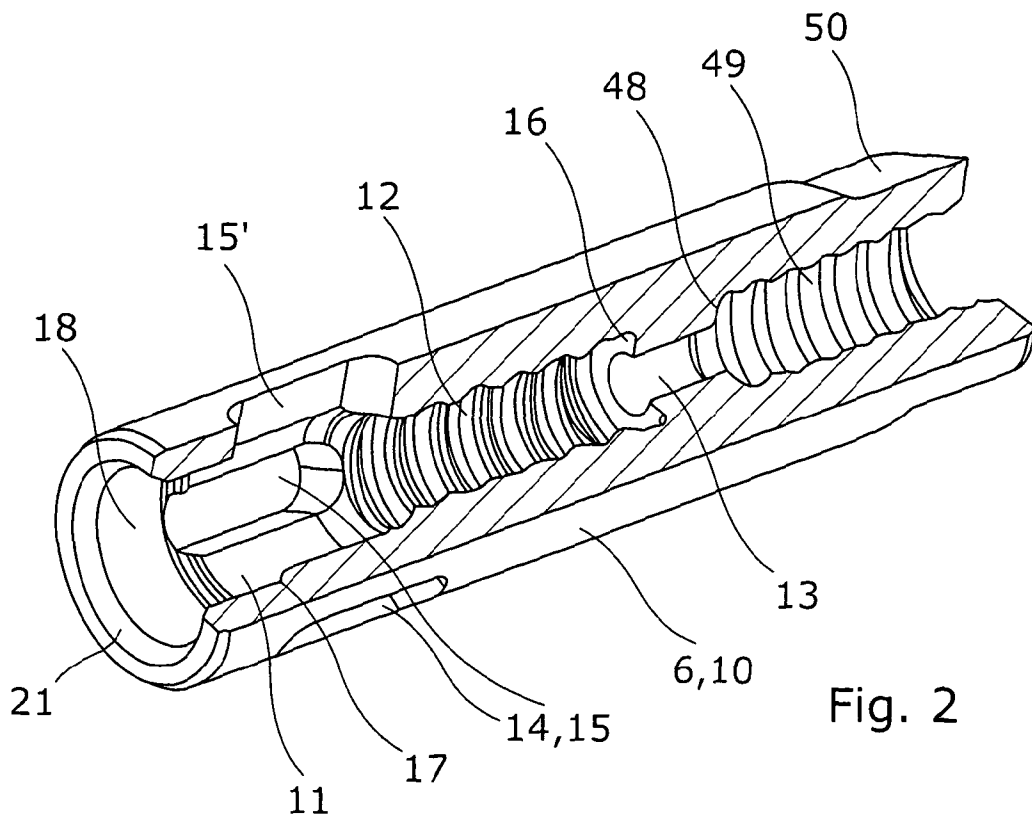


Fig. 2

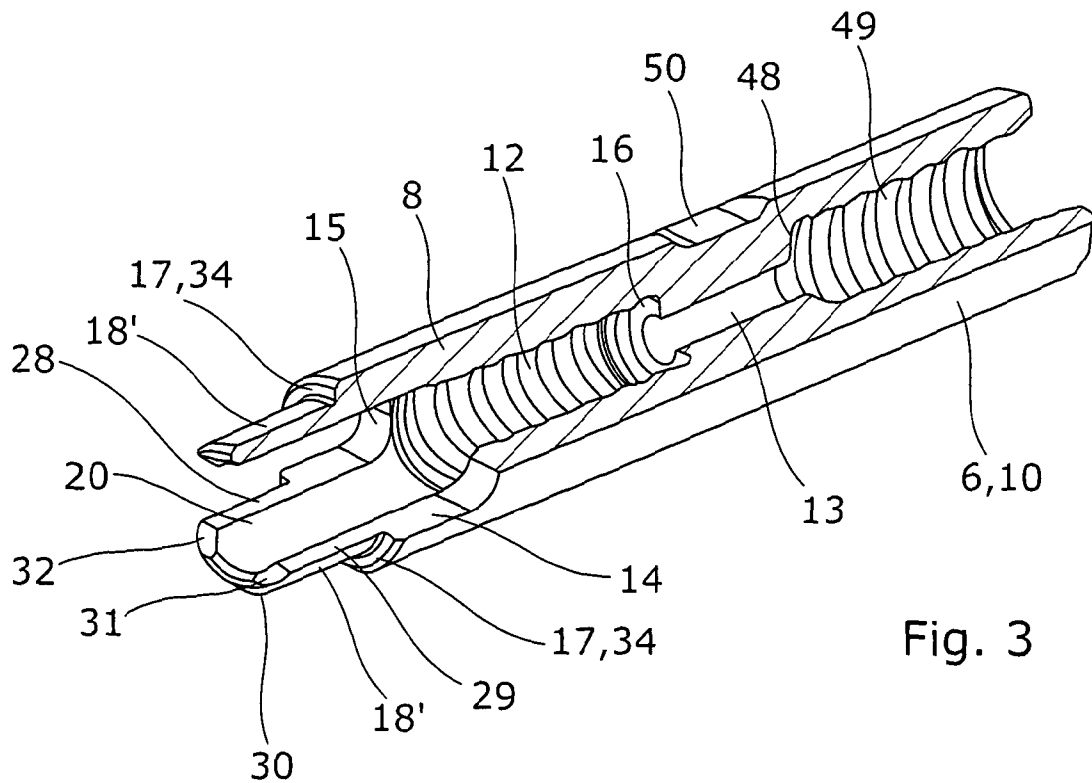


Fig. 3

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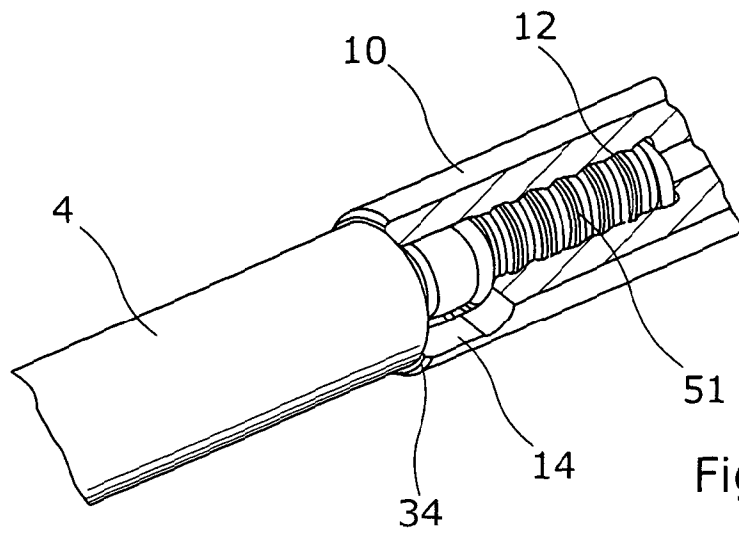


Fig. 4

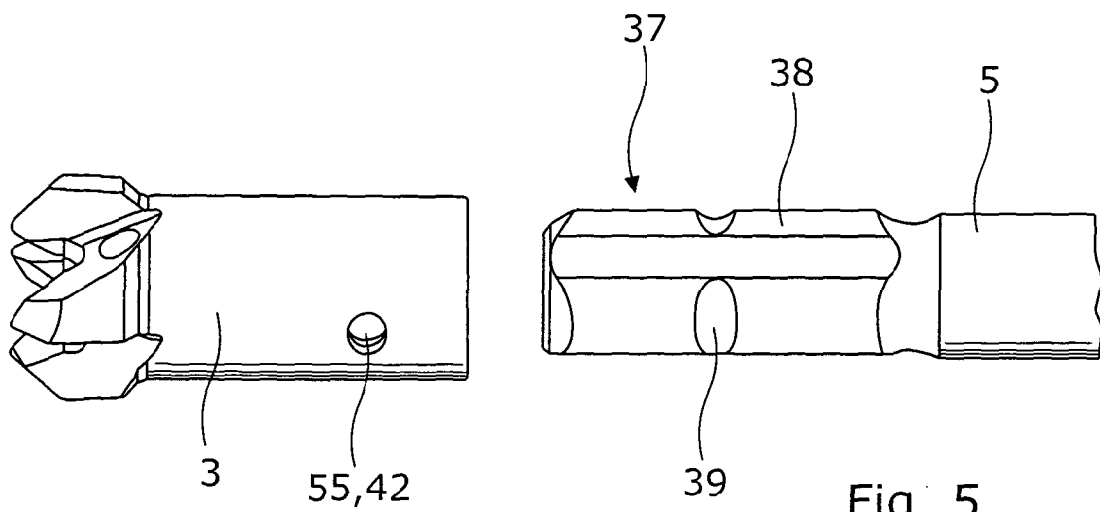


Fig. 5

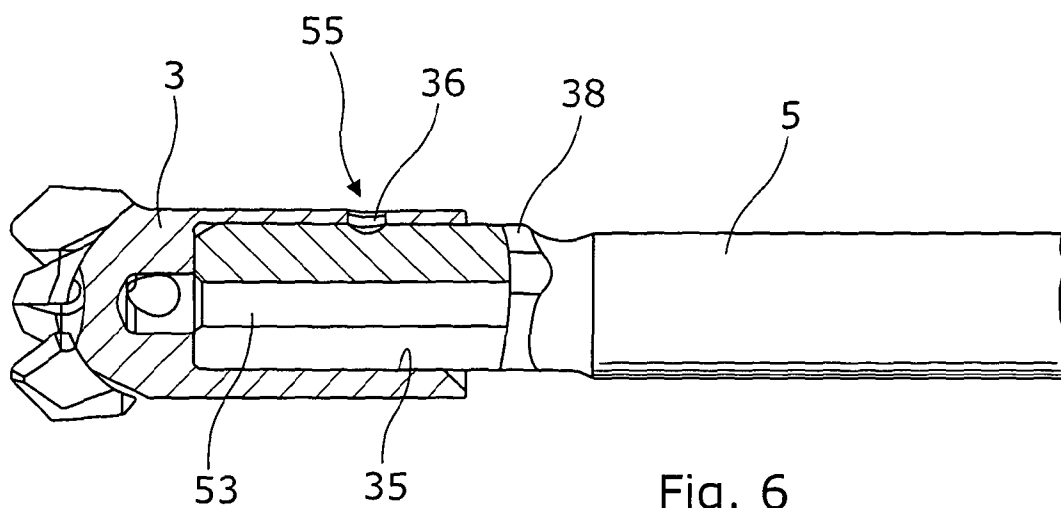
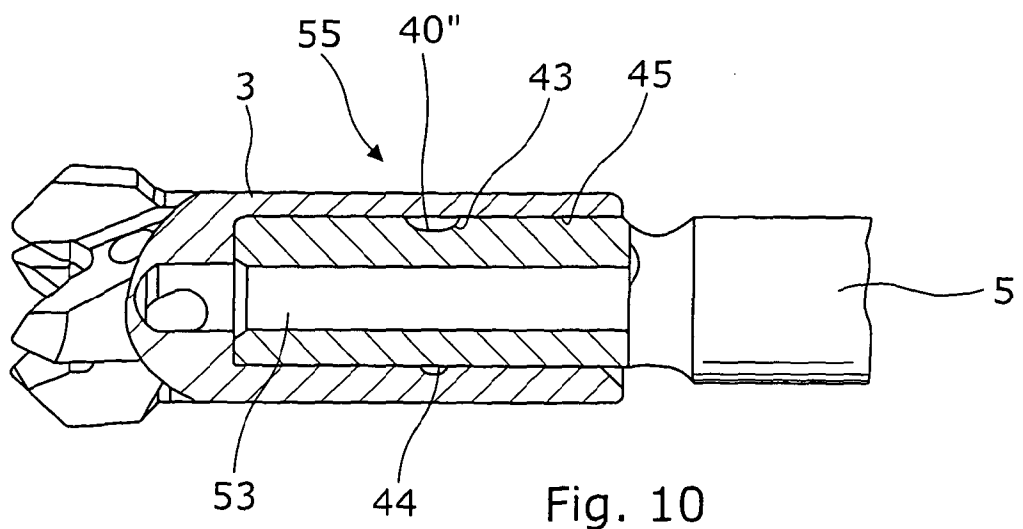
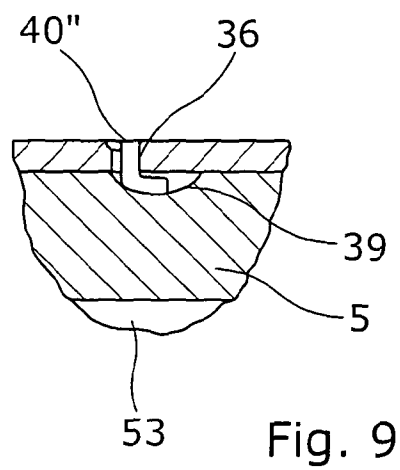
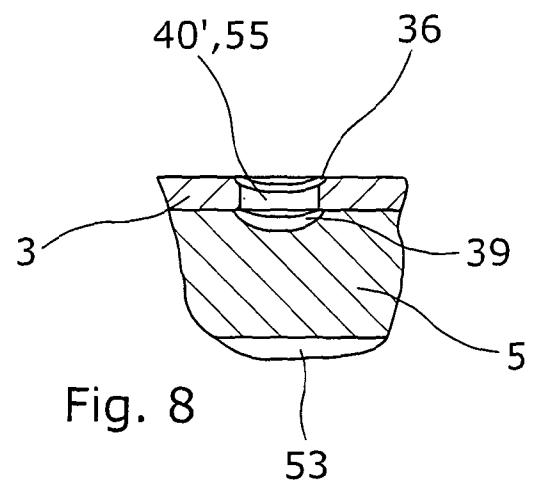
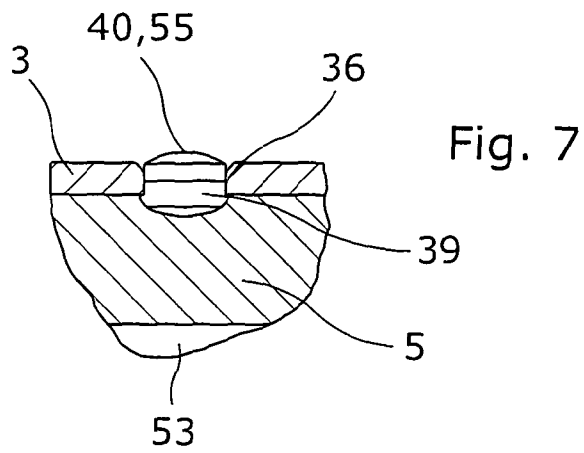
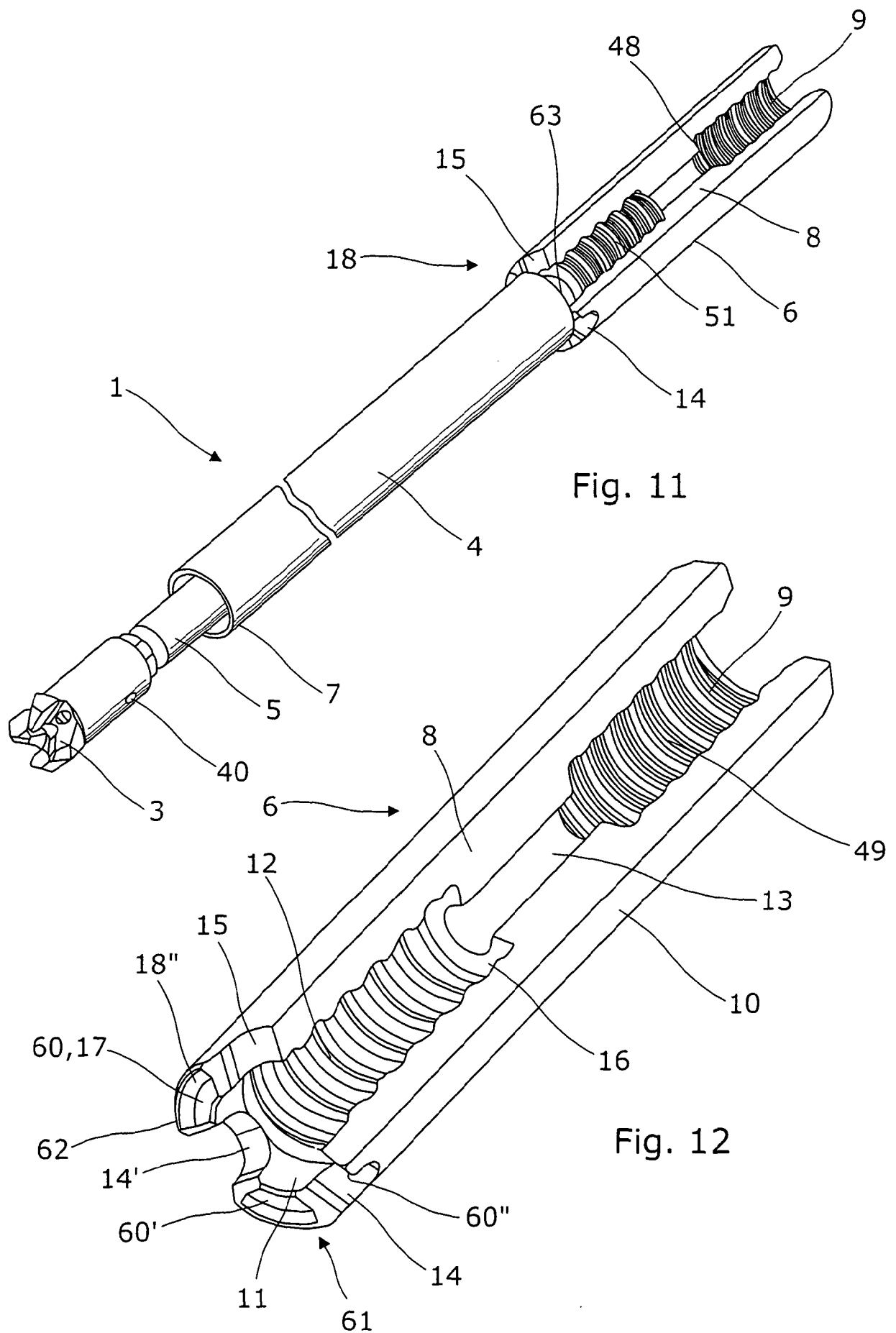


Fig. 6

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