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- **LEANDERS, Benneth**
81181 Sandviken (SE)
- **PORTIN, Johan**
81181 Sandviken (SE)
- **ANERUD, Marcus**
81181 Sandviken (SE)
- **KOLMSKOG, Peter**
81181 Sandviken (SE)

(71) Applicant: **Sandvik Mining and Construction
Tools AB**
81181 Sandviken (SE)

(74) Representative: **Sandvik**
Sandvik Intellectual Property AB
811 81 Sandviken (SE)

(72) Inventors:
• **BLOMFELDT, Thomas**
81181 Sandviken (SE)

(54) **NICKEL BASED WEAR AND CORROSION PROTECTED DRILL COMPONENT**

(57) A drill component comprising: a longitudinal axis extending axially between a first end at an axially forward end and a second end at an axially rearward end; an external surface; and an internal surface; wherein at least

part of the external surface is coated with a first nickel-based corrosion protection layer nickel; and at least part of the first corrosion protection layer is coated with a polymer-based sealant top layer.

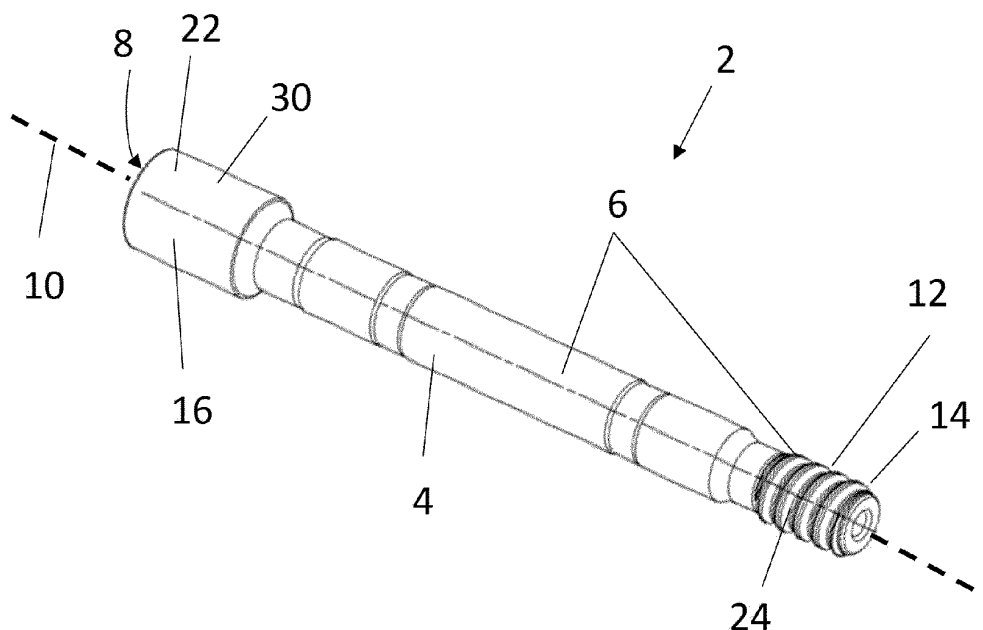


Fig. 1

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Description

Field of invention

[0001] The present invention relates to a drill component, for example a rod, tube or coupling for percussive drilling having a corrosion and / or wear protection layer.

Background

[0002] Percussion drill bits are widely used both for drilling relatively shallow bores in hard rock and for creating deep boreholes. For the latter application, drill strings are typically used in which a plurality of rods or tubes are interconnected to advance the drill bit and increase the depth of the hole. In 'top hammer drilling' a terrestrial machine is operative to transfer a combined impact and rotary drive motion to an upper end of the drill string whilst a drill bit positioned at the lower end is operative to crush the rock and form the boreholes.

[0003] Acidic water is commonly used as a flushing media in percussive drilling which leads to corrosion of the drilling components, including the drill rods, tubes, and couplings. This can lead, for example, to issues with corrosion fatigue as the mechanical strength of the material is decreased. Consequently, the service life of the drill rod, tube or coupling is reduced.

[0004] Known methods to add corrosion protection to drill components such as rods, tubes or couplings include adding a layer of phosphate which is then coated in wax. This method provides sufficient corrosion protection during transportation of the drill component but is insufficient to protect against corrosion during the drilling operation.

[0005] Therefore, the problem to be solved is how to improve the corrosion and / or wear resistance of drill components.

Summary of the Invention

[0006] It is an objective of the present invention to provide a means to increase the corrosion and / or wear resistance of drill components for percussive drilling. This objective is achieved by providing a drill component having a longitudinal axis, extending axially between a first end at an axially forward end and a second end at an axially rearward end; an external surface; and an internal surface; wherein at least part of the external surface is coated with a first corrosion protection layer; wherein the first corrosion protection layer is nickel-based; and at least part of the first corrosion protection layer is coated with a polymer-based sealant top layer.

[0007] Advantageously, the combination of the nickel-based corrosion protection layer with the polymer-based sealant top sealant results in fewer open cracks and flaws between the atmosphere and steel substrate and therefore improved resistance against corrosion is achieved. This coating combination provides a corrosion protective layer on the drill component thus delaying radial crack

propagation and hence delaying transversal fractures. The inclusion of the coating increases the service life of the thread, especially in mines where there is acidic water present. In addition, the coating will also increase the wear resistance of the drill component. Furthermore, this coating can be applied in a relatively simple, inexpensive manner that does not pose any major health, safety, or environmental concerns.

[0008] In one embodiment, additionally at least part of the internal surface of the drill component is coated with the first corrosion protection layer and / or the polymer-based sealant top layer. Advantageously, this provides protection against cavitation and resistance against corrosion on the inside of the drill component as well as the outside, therefore extending the lifetime of the drill component.

[0009] In one embodiment, the thickness of first corrosion protection layer is between 5 - 200 μm . Advantageously, this thickness provides the optimal balance between providing sufficient corrosion and wear protection without adding excessive costs.

[0010] In one embodiment the thickness of the polymer-based sealant top layer is between 0.1 - 10 μm . Advantageously, this provides the optimal balance between having sufficient thickness to be effective whilst not adding unnecessary cost or adding the risk that streaks are formed as the coating dries. The polymer-based sealant top layer may also penetrate into the cracks therefore providing extra adhesion and corrosion protection.

[0011] In one embodiment the first corrosion protection layer is a nickel phosphorous alloy. Advantageously, nickel phosphides provide a hard coating and therefore increased wear resistance.

[0012] In one embodiment, the phosphorus content of the nickel phosphorus alloy is 6-9 wt%. Advantageously, this phosphorus content provides increased wear without undesirable brittleness.

[0013] In one embodiment, the first corrosion protection layer and the polymer-based sealant top layer are located on all parts of the drill component. Advantageously, this provides highly comprehensive corrosion resistance. Alternatively, the first corrosion protection layer and the polymer-based sealant top layer are located only on selected parts of the drill component. Advantageously, this reduces costs.

[0014] In one embodiment the drill component is a drill rod.

[0015] In one embodiment the drill component is a drill tube.

[0016] In one embodiment the drill component is a coupling.

[0017] Another aspect of the present invention relates to a method for providing corrosion and / or wear protection on drill component as described hereinbefore or hereinafter comprising the steps of:

- depositing a first corrosion protection layer compris-

ing nickel on at least part of the external surface of the drill component;

- depositing a polymer-based sealant top layer on top of the first corrosion protection layer;
- heat treating the coated drill component.

[0018] Advantageously, this method provides a means to provide a highly effective corrosion resistance protection to the drill component, as well as providing a high wear resistant coating. This method does not pose any major health, safety, or environmental issues either.

[0019] In one embodiment the first corrosion protection layer is applied using an electroless nickel bath. Advantageously, this method is quick and less harmful to the environment compared to alternative methods of providing corrosion resistant coatings. A further benefit of this method is that it can provide a coating having a more uniform thickness with high reproducibility.

[0020] In one embodiment, the polymer-based sealant top layer is sprayed on. Advantageously, this method provides a coating having a uniform thickness.

[0021] In one embodiment the heat treatment is conducted at a temperature of between 150 - 300°C for 30 - 120 minutes. Advantageously, this temperature range provides the balance between having a high enough temperature and heating time that a hard and wear resistant surface is formed and not having too high a temperature and time that case hardened properties of the steel substrate are adversely affected.

[0022] In one embodiment the drill component is shot peened or blasted before the nickel-based corrosion protection layer is applied. Advantageously, this step provides improved adhesion of the corrosion protection layer to the surface of the drill component.

Brief description of drawings

[0023] A specific implementation of the present invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Figure 1 is a schematic drawing of a bottom contact MF rod with one male connecting component and one female connecting component.

Figure 2 is a schematic drawing of a shoulder contact MF rod with one male connecting component and one female connecting component.

Figure 3 is a schematic drawing of a tube having one male coupling section and one female coupling section.

Figure 4 is a schematic drawing of a drifter male / male rod comprising two male connecting components.

Figure 5 is a schematic drawing of a hexagonal rod

having a threaded connection.

Figure 6 is a schematic drawing of a rod having a taper fit connection.

Figure 7 is a schematic drawing of a coupling.

Figure 8 is schematic drawing of the corrosion protection layer.

Detailed description

[0024] Figure 1 shows a drill component 2 for percussive drilling, comprising a hollow elongate main length section 4 having a longitudinal axis 10 extending axially between a first end 12 at an axially forward end 14 and a second end 16 at an axially rearward end 22 of the drill component 2. The first end 12 could comprise a male connecting component 24 or a female connecting component 30. The second end 16 could comprise a male connecting component 24 or a female connecting component 30. The drill component 2 may contain one male connecting component 24 and one female connecting component 30 or two males connecting components 24 or two female connecting components 30. The drill component 2 has an external surface 6 and an internal surface 8.

[0025] The drill component 2 could for example be a bottom contact MF rod, as shown in figure 1, wherein the first end 12 comprises a male connecting component 24 and the second end 16 comprises a female connecting component 30.

[0026] Figure 2 shows that optionally the drill component 2 may comprise a radially projecting shoulder 26 that axially separates the main length section 4 and the male connecting means 24. The shoulder 26 comprises a peripheral surface 28 that has a greater outer diameter than the outer diameter of the main length section 4. Figure 2 shows a shoulder contact MF rod.

[0027] Figure 3 shows that alternatively the drill component 2 could for example be a tube comprising one male connecting component 24 and one female connecting component 30. Optionally, the tube may also comprise a shoulder.

[0028] Figure 4 shows that alternatively the drill component 2 could for example be a drifter rod having two male connecting components 24.

[0029] Figure 5 shows that alternatively the drill component 2 could for example be a hexagonal rod.

[0030] Figures 1-5 all show examples where the male connecting components 24 and the female connecting components 30 are threaded.

[0031] Figure 6 shows that alternatively the drill component 2 could have connecting components that are conical and therefore form a taper fit connection. The taper fit connection could be employed on any other rod or tube geometry.

[0032] Figure 7 show that alternatively the drill compo-

nent 2 is a coupling.

[0033] This invention could also apply to any other type of drill rod, tube or coupling with any combination of geometry and connection form.

[0034] Figure 8 shows that at least a part of the external surface 6 of the drill component 2 is coated with a first corrosion protection layer 18 wherein the first corrosion protection layer 18 is nickel-based. At least part of the first corrosion protection layer 18 is coated with a polymer-based sealant top layer 20. Areas of the external surface 6 of the drill component 2 that are not coated with the first corrosion protection layer 18 may also be coated with the polymer-based sealant top layer 20. Part or all of the first corrosion protection layer 18 could be coated with the polymer-based sealant top layer 20.

[0035] "Nickel-based" means that the major component on the first corrosion protection layer 18, in both mass % and atomic %, is nickel, for example >50% nickel, for example >70% nickel, for example >80% nickel, for example >90% nickel.

[0036] "Polymer-based" means that the major component of the sealant top layer 20, in both mass % and atomic %, is polymer, for example >50% polymer, for example >70% polymer, for example >80% polymer, for example >90% polymer.

[0037] In some embodiments, at least part of the internal surface 8 of the drill component 2 may also be coated with the first corrosion protection layer 18 and / or the polymer-based sealant top layer 20. At least part or all of the internal surface 8 may be coated with only first corrosion protection layer 18. At least part or all of the internal surface 8 may be coated with only the polymer-based sealant top layer 20. At least part or all of the internal surface 8 may be coated with both the first corrosion protection layer 18 and the polymer-based sealant top layer 20. Any combination of these options is possible.

[0038] In one embodiment the thickness of first corrosion protection layer 18 is between 5-200 μm , more preferably between 7-100 μm , even more preferably between 10-50 μm .

[0039] In one embodiment the thickness of the polymer-based sealant top layer 20 is between 0.1 - 10 μm , preferably between 0.1 - 5 μm .

[0040] The first corrosion protection layer 18 could be nickel alloyed with sulphur, phosphorus, boron, or any other suitable element. Preferably, the first corrosion protection layer 18 is a nickel phosphorous alloy. Preferably, the phosphorus content of the nickel phosphorous alloy is 6-9 wt%.

[0041] For example, the polymer could be a Teflon or a fluorinated polymer (e.g., Polytetrafluoroethylene (PTFE)) or a non-fluorinated crystalline polymer (e.g., Polyether ether ketone (PEEK)) or a high-density polymer (e.g., Ultra-high-molecular-weight polyethylene (UHMWPE)).

[0042] It should be understood that the external surface 6 includes the external surfaces of the main length

section 4, the male connecting components 24 and the female connecting components 30. It should be understood that the internal surface 8 includes the internal surfaces of main length section 4, the male connecting components 24 and the female connecting components 30. External surfaces are considered to be any area on the outside of the drill component 2. Internal surfaces are considered to be any area on the inside of the drill component 2.

[0043] The present application further relates to a method for providing corrosion protection on a drill component 2 comprising the steps of:

- a) depositing a first corrosion protection layer 18 comprising nickel on at least part of the external surface 6 of the drill component 2;
- b) depositing a polymer-based sealant top layer 20 on top of the first corrosion protection layer 18;
- c) heat treating the coated drill component 2.

[0044] In one embodiment, the first corrosion protection layer 18 is applied using an electroless nickel bath. The nickel or nickel-based alloy adheres to the substrate, the substrate being the metal of the drill component. In electroless nickel plating the object reacts to the plating bath chemistry, creating a uniform and smooth, layer with very little surface porosity. The even deposition makes it an ideal choice for complex, non-line of sight, geometries and often eliminates the need for grinding after plating. Alternatively, the first corrosion protection layer could be applied via electroplating or any other suitable method.

[0045] In one embodiment, the polymer-based sealant top layer 20 is sprayed on. Alternatively, the polymer-based sealant top layer 20 could be applied through dipping or any other suitable method.

[0046] The purpose of the heating step is to enable the formation of Ni-P intermetallic phases, improve the adhesion to the substrate and to cure the polymer-based sealant top layer. Typically, the heat treatment is conducted in furnace.

[0047] In one embodiment the heat treatment is conducted at a temperature of between 150 - 300°C, preferably between 225 - 260°C. In one embodiment the heat treatment is conducted for between 30 - 120 minutes, preferably between 45 - 75 minutes.

[0048] The same method can be used to apply the first corrosion protection layer 18 and / or the polymer-based sealant top layer 20 to the internal surface 8 of the drill component 2.

[0049] In one embodiment, the surface of the drill component 2 is shot peened or blasted before the nickel-based corrosion protection layer 18 is applied.

[0050] The drill component as described hereinbefore or hereinafter could be part of a drill string and / or a drill rig arrangement.

Claims**1.** A drill component (2) comprising:

a longitudinal axis (10) extending axially between a first end (12) at an axially forward end (14) and a second end (16) at an axially rearward end (22);
 an external surface (6); and
 an internal surface (8);

component (2) according to any of claims 1-10 comprising the steps of:

- depositing a first corrosion protection layer (18) comprising nickel on at least part of the external surface (6) of the drill component (2);
- depositing a polymer-based sealant top layer (20) on top of the first corrosion protection layer (18);
- heat treating the coated drill component (2).

characterized in that:

at least part of the external surface (6) is coated with a first corrosion protection layer (18); wherein the first corrosion protection layer (18) is nickel-based; and
 at least part of the first corrosion protection layer (18) is coated with a polymer-based sealant top layer (20).

12. The method according to claim 11 wherein the first corrosion protection layer (18) is applied using an electroless nickel bath.

13. The method according to claim 11 or 12 wherein the polymer-based sealant top layer (20) is sprayed on.

14. The method according to any of claims 11-13 wherein the heat treatment is conducted at a temperature of between 150 - 300°C for 30 - 120 minutes.

15. The method according to any of claims 11-14 wherein the surface of the drill component (2) is shot peened or blasted before the nickel-based corrosion protection layer (18) is applied.

2. The drill component (2) according to claim 1 wherein additionally at least part of the internal surface (8) is coated with the first corrosion protection layer (18) and / or the polymer-based sealant top layer (20).

3. The drill component (2) according to claim 1 or claim 2 wherein the thickness of first corrosion protection layer (18) is between 5 - 200 µm.

4. The drill component (2) according to any of the previous claims wherein the thickness of the polymer-based sealant top layer (20) is between 0.1 - 10 µm.

5. The drill component (2) according to any of the previous claims wherein the first corrosion protection layer (18) is a nickel phosphorous alloy.

6. The drill component (2) according to claim 5 wherein the phosphorus content of the nickel phosphorus alloy is 6-9 wt%.

7. The drill component (2) according to any of the previous claims wherein the first corrosion protection layer (18) and the polymer-based sealant top layer (20) are located on all parts of the drill component (2).

8. The drill component (2) according to any of claim 1-7 wherein the drill component (2) is a drill rod.

9. The drill component (2) according to any of claim 1-7 wherein the drill component (2) is a drill tube.

10. The drill component (2) according to any of claim 1-7 wherein the drill component (2) is a coupling.

11. A method for providing corrosion protection on a drill

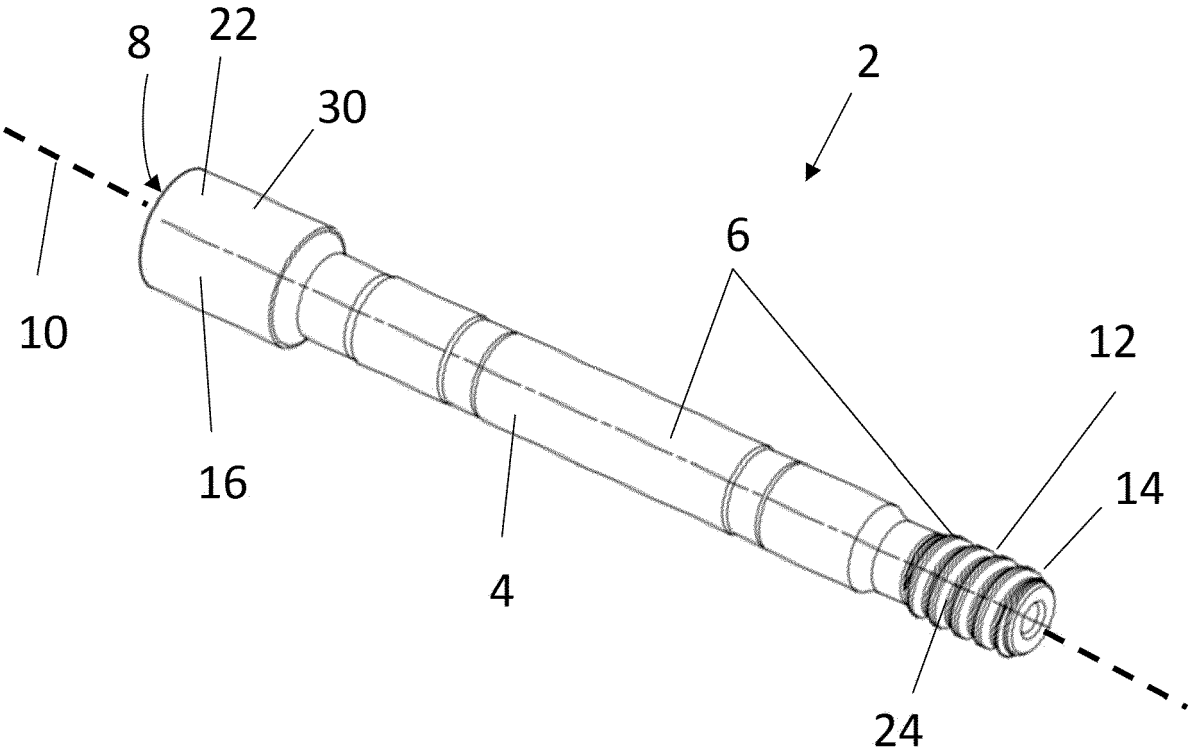


Fig. 1

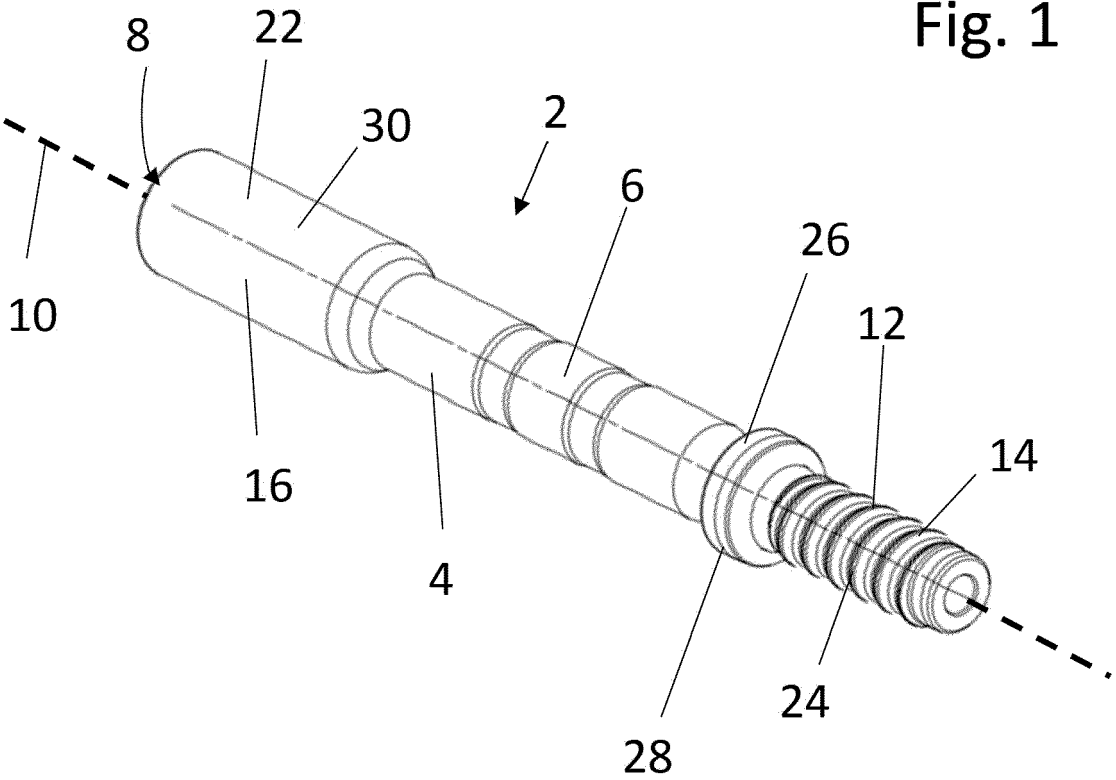
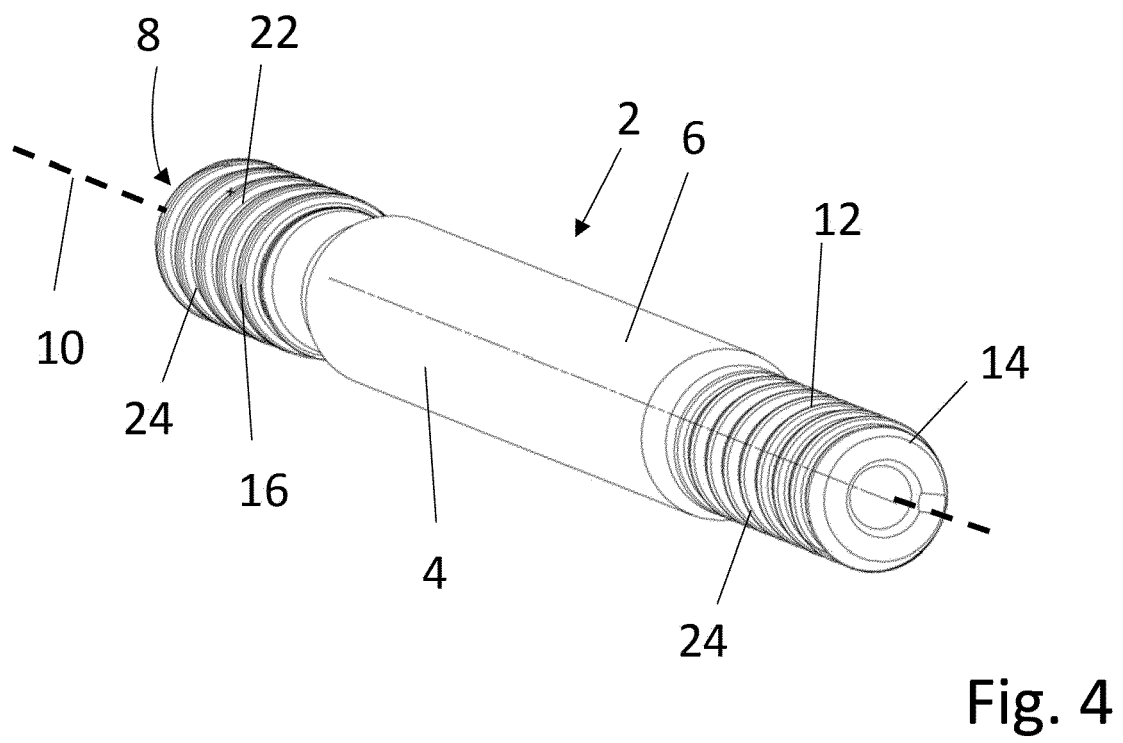
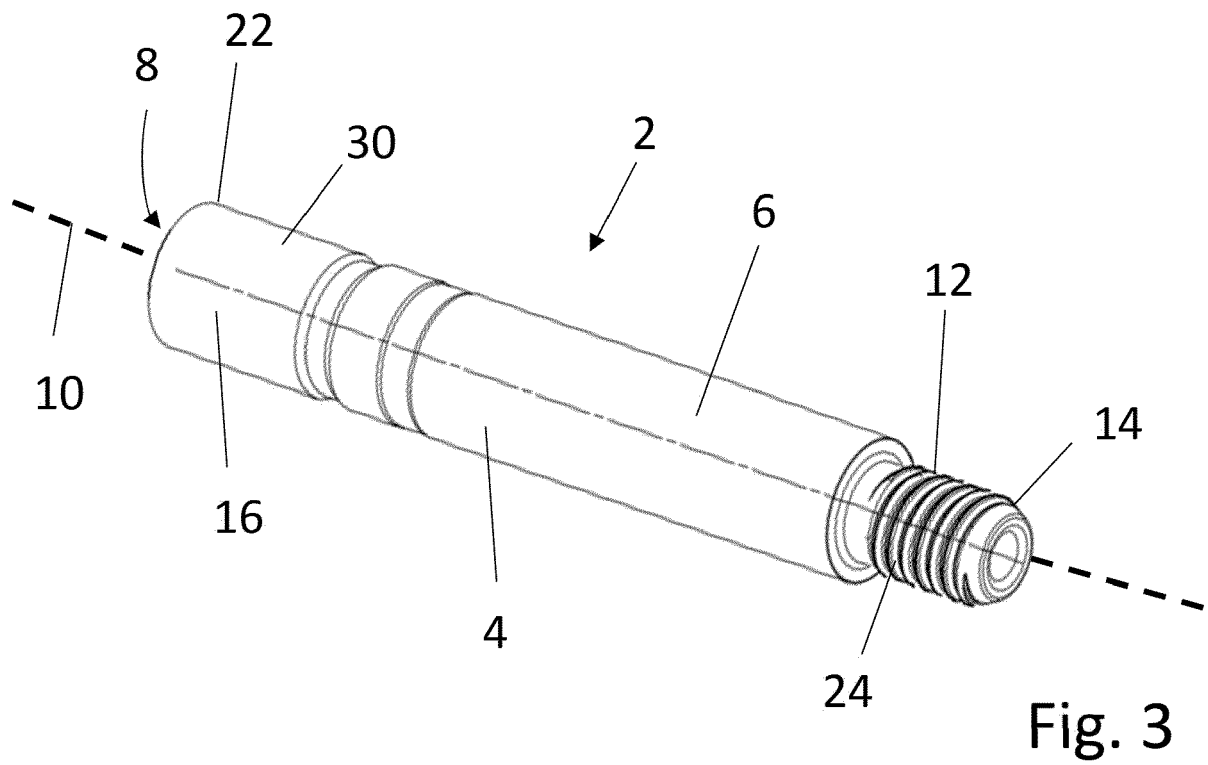


Fig. 2



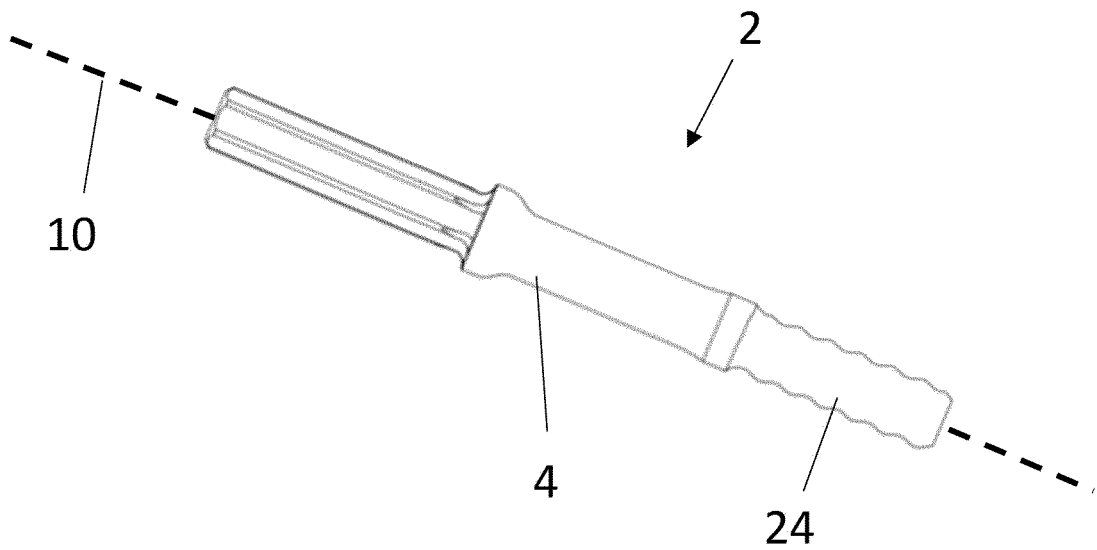


Fig. 5

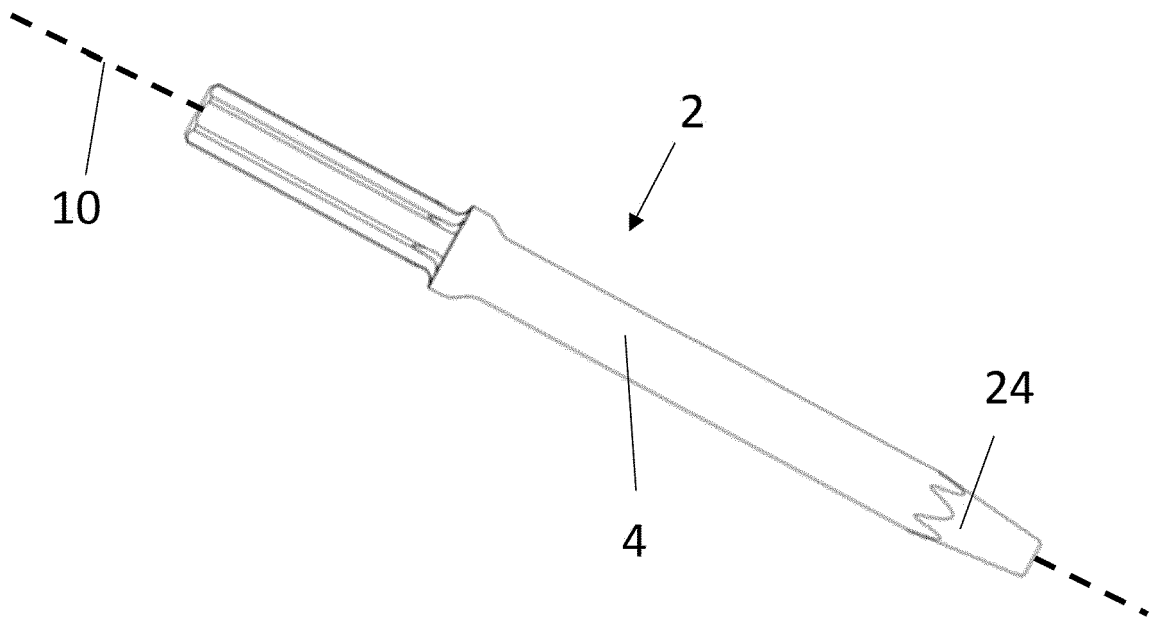


Fig. 6

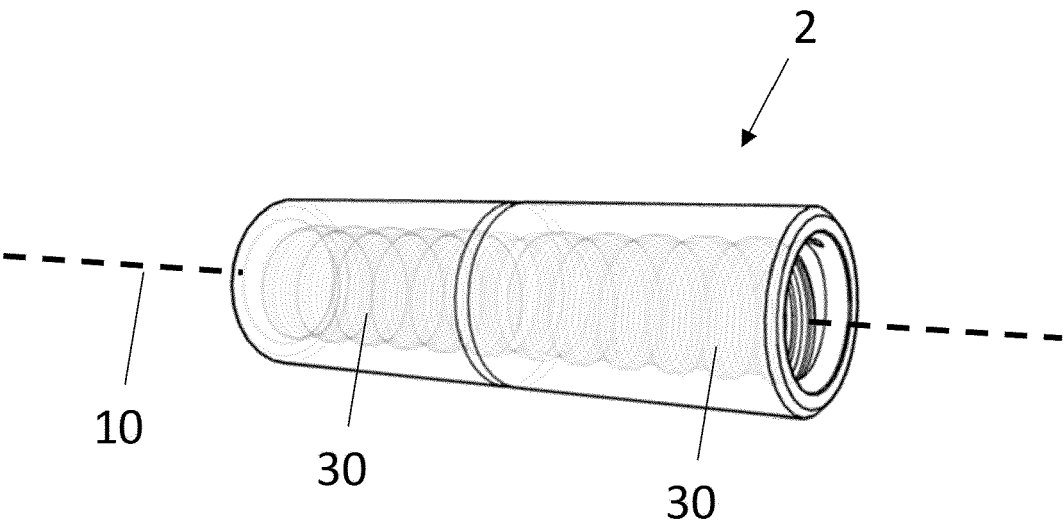


Fig. 7



Fig. 8



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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		1 February 2024	Altamura, Alessandra
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