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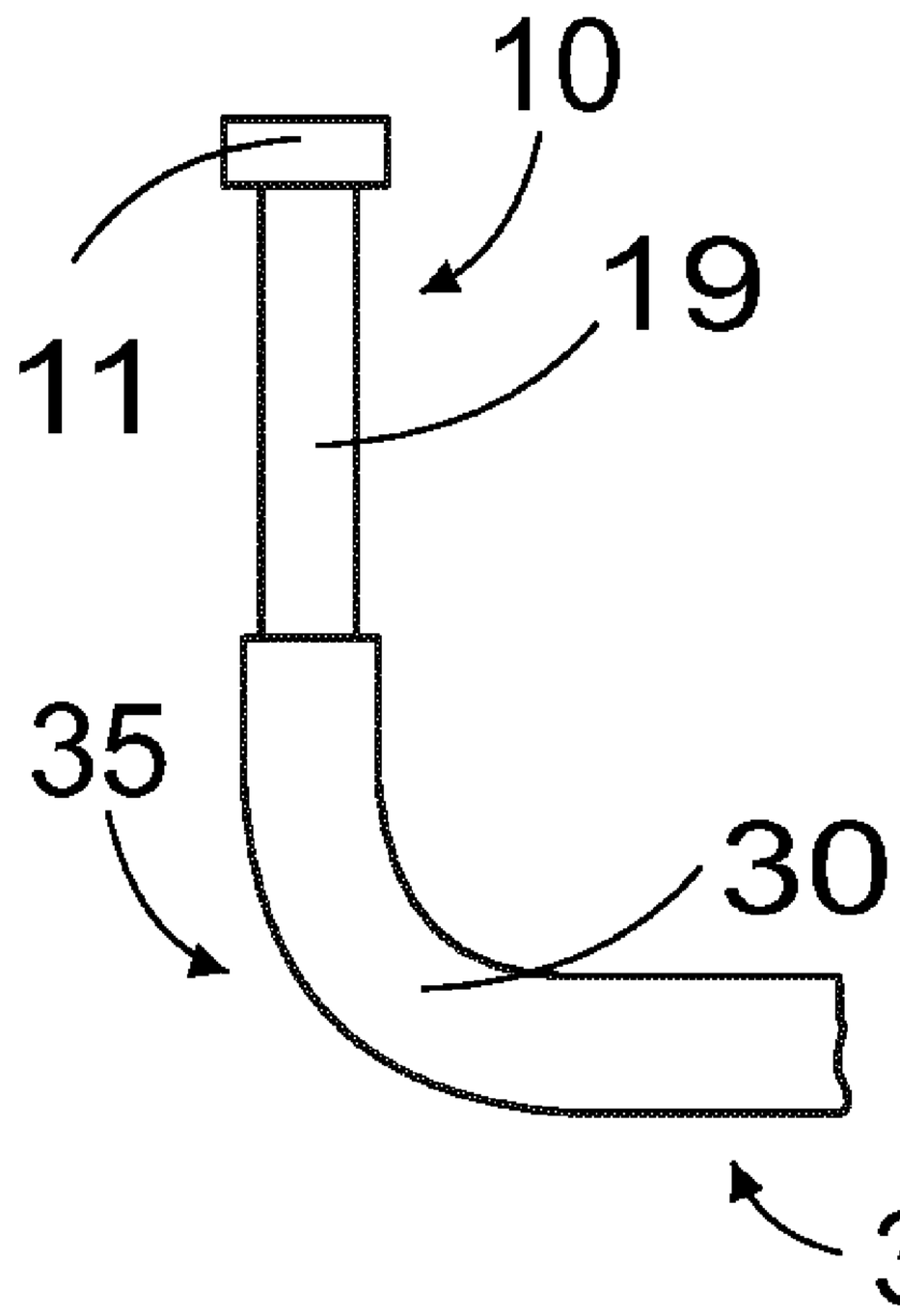
(54) **Titre : TUBE DE GUIDAGE POUR TIGE DE FORAGE PLIABLE**
(54) **Title: GUIDING TUBE FOR BENDABLE DRILL ROD**



(57) **Abrégé/Abstract:**
A guiding tube (30) for a bendable drill rod (10) for a drilling rig (1) comprises a tube-like casing forming a tubular space (41) inside the casing for holding and guiding at least a part of a drill rod that is not currently used for drilling. The guiding tube (30) comprises at least one bent portion (35), whereby a drill rod (19) positioned inside the guiding tube (30) is also bent by the bend in the guiding tube.

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(54) Title: GUIDING TUBE FOR BENDABLE DRILL ROD

(57) Abstract: A guiding tube (30) for a bendable drill rod (10) for a drilling rig (1) comprises a tube-like casing forming a tubular space (41) inside the casing for holding and guiding at least a part of a drill rod that is not currently used for drilling. The guiding tube (30) comprises at least one bent portion (35), whereby a drill rod (19) positioned inside the guiding tube (30) is also bent by the bend in the guiding tube.

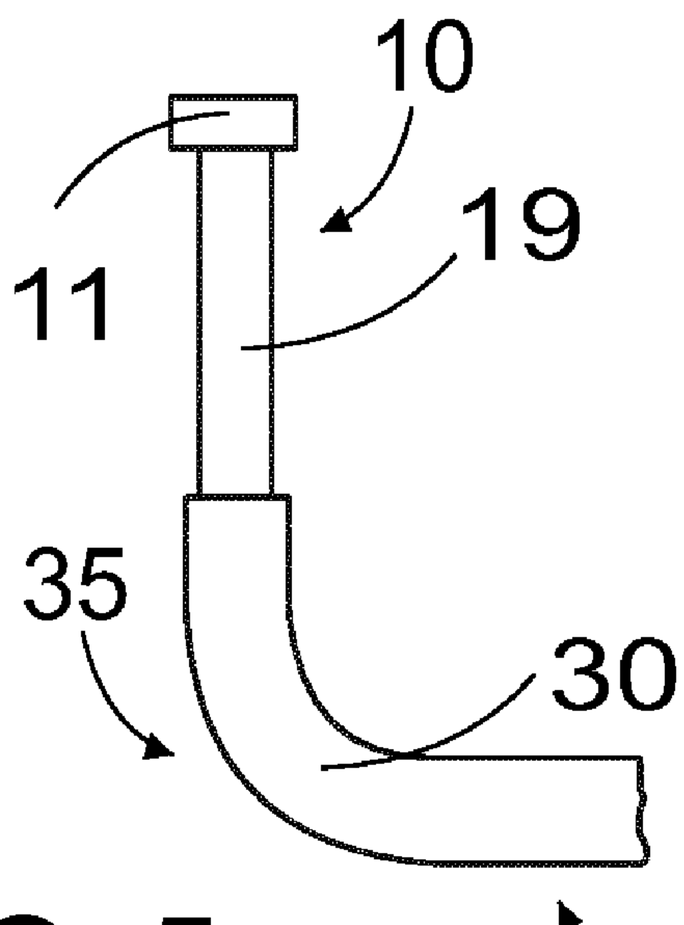

FIG. 5a

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GUIDING TUBE FOR BENDABLE DRILL ROD

BACKGROUND

The invention relates to drilling, and more particularly to a guiding tube for a bendable drill rod for drilling, to a drilling machine and a method for drilling.

Holes can be drilled in rock by means of various rock drilling machines. Drilling may be performed with a method combining percussions and rotation (percussive drilling), or drilling may be based on mere rotation without a percussive function (rotary drilling). Further, percussive drilling may be classified according to whether the percussion device is outside the drill hole or in the drill hole during the drilling. When the percussion device is outside the drill hole, the drilling is usually called top hammer drilling, wherein so-called top hammers are used, and when the percussion device is in the drill hole, the drilling is typically called down-the-hole drilling (DTH) and the drilling machine may be called a DTH drill or down-the-hole drill, for example.

Both these drill types may comprise one or more drill rods, which may also be called drilling tubes, to guide a drill bit to the hole and to supply at least the rotation provided by a rotation unit to the drill bit. Especially in tunnels of very low height, such as low profile and extra low profile mines, the height of the tunnel typically limits the length of the drill rods. This causes problems especially when the hole to be drilled is deeper than the height of the tunnel, which is often the case especially in these low profile and extra low profile mines.

Some applications are known, where this problem has been attended by using manual extension rods, that is several drill rods, or similar, that are joined or coupled together one at a time. In some applications, these types of elements may be arranged around a hose. However, a problem with these solutions is that they slow down the process considerably, as the drilling work has to be stopped to add a new element. The manual work to be done by an operator, which is typically needed in these applications, causes many kinds of problems, including occupational safety hazards, especially when working in tunnels of low and extra low profile mines, for example. Publication US 2012/155813 discloses a composite coiled tube stored on a reel and an injector assembly to guide the coiled composite tube into a well bore.

BRIEF DESCRIPTION

The object of the invention is to provide a new and improved guiding tube for a bendable drill rod, drilling machine and method for drilling a hole.

The invention is based on the idea of providing a bent guiding tube for receiving at least a part of a bendable drill rod, more particularly at least a part of a bendable drill rod at the end of the drill rod that is not inserted in the drill hole. The outer end of the bendable drill rod can thus be inserted into the guiding tube for storage and extracted for drilling. As the drill rod is flexible in the direction transverse to the longitudinal direction of the drill rod, the bent guiding tube also guides the drill rod to a bent formation for storage and/or for being fed to the drill hole.

An advantage of the solution is that a single piece continuous drill rod that is formed to be flexible and rigid at the same time can be stored in a bent guiding tube, whereby the guiding tube also guides the drill rod to a similar bent formation for storage of a part of the drill rod that is not currently positioned inside the drill hole. Whereas the bendable drill rod enables both substantially continuous drilling without manual work phases by an operator joining or coupling extension rod and drilling of holes considerably deeper than the height of the tunnel and in practice of any depth up to the drill rod length or even beyond by connecting several such drill rods to one another, the guiding tube enables storing this drill rod in a practical way saving space, protecting the drill rod from external dirt and external impacts and/or delivering the drill rod to the place of drilling in an easier manner and storing it in the drilling machine and maintaining it while not in use.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following the invention will be described in greater detail by means of preferred embodiments with reference to the attached [accompanying] drawings, in which

Figure 1 shows a drilling unit;

Figures 2a and 2b illustrate a part of a drill rod;

Figure 3 illustrates an example of a shape of a corrugated cut;

Figure 4 shows a rock drilling rig;

Figure 5a and 5b illustrate a drill rod arranged in a guiding tube;

Figure 6 illustrates a guiding tube according to the current solution;

Figure 7 shows further a rock drilling rig,

Figures 8a and 8b show some guiding tube geometries, and

Figure 9 illustrates schematically a method for storing a bendable drill rod.

DETAILED DESCRIPTION

Figure 1 shows a drilling unit 4 comprising drilling equipment 9 provided with a percussion device 13. A rotation unit 7 may be supported to a carriage 8, or alternatively the rotation unit may comprise sliding parts or the like support members with which it is movably supported to the feed beam 5. The rotation unit 7 may be provided with drilling equipment 9 which may comprise one drill rod (or drilling tube) 10, or several drill rods / drilling tubes 10 connected to each other, and a drill bit 11 at the outermost end of the drilling equipment. The percussion device 13 is provided at an opposite end of the drilling equipment 9 and, thus, the drill rod 10 in relation to the rotation unit 7. During the drilling, the down-the-hole drill 13 is in the drill hole and the drill bit 11 may be connected directly to the down-the-hole drill 13. When the drill hole 12 has been drilled to a desired depth, the drilling equipment 9 can be pulled by means of the feed device 6 out of the drill hole 12 in return direction C.

Figures 1 is shown as an example of a drilling unit, wherein drill rods are used for drilling a hole, and the current solution is by no means limited to that particular embodiment. Instead, the guiding tube and drill rod described in this description, as well as a drilling machine comprising such a guiding tube, are applicable to substantially all types of drilling wherein conventional drill rods have been used. Some embodiments may, for instance, not comprise a rotation unit and the drill rod may not be rotated during drilling. The current solution is especially well suited for drilling in circumstances, where space is somehow limited, like in tunnels for limited height, such as in low profile mines comprising a height in the range of 1.6 to 2.2 m, for example, or in extra low profile mines comprising a height of 0.6 to 1.1 m, for example, or in drilling rigs of limited size and so on. Some embodiments in this description are explained in connection with a tunnel due to these special benefits related to tunnels, such as underground tunnels, but it is clear for a skilled person that these embodiments are suitable for other drilling circumstances as well, such as drilling in open mines. Similarly, at least some of the embodiments may be suitable for other types of drilling in addition to rock drilling.

A bendable drill rod 10 is thus suitable for use in different types of

drilling rigs. The bendable drill rod shown in Figures 2a and 2b, for example, is especially suitable for drilling, where the drill rod 10 is rotated, in other words the drill rod 10 is rotatably connectable to a drilling rig 1. Figures 2a and 2b illustrate a part of one example of such a drill rod 10. Figure 2a shows a detail of a drill rod 10 from a side and Figure 2b in a direction of the cut A-A shown in Figure 2a. The drill rod 10 may comprise a tube 19 and at least one corrugated cut 20 extending through the wall of the tube 19 in a transverse direction G, in other words in a direction transverse to the longitudinal axis D of the drill tube 19 extending at each point substantially radially through the tube wall from the outside of the tube to the inside of the tube. In Figure 2b two examples of this transverse direction G are shown, but, naturally, the transverse direction varies at different points of the tube 19 wall and surface.

Each corrugated cut 20 may have a substantially spiral baseline 21 extending in a circulating manner around the tube 19 in the lengthwise direction E of the tube 19 from the direction of a first end 22 of the drill rod to a direction of a second end 23 of the drill rod. The lengthwise direction is, thus, a direction of the longitudinal axis D of the drill rod or a direction substantially parallel to the longitudinal axis D of the drill rod. The actual ends 22 and 23 are not shown in Figure 2a, as it only shows a section of the drill rod 10 and the tube 19 the drill rod comprises. The baseline 21 is explained in more detail in connection with Figure 3, but the baseline 21 is not a physical part of the cut, but provides a spiral-like path on both sides of which the corrugated cut 20 extend in a corrugated manner. This, too, is explained in more detail in connection with Figure 3.

According to an embodiment, the drill rod 10 may comprise one such corrugated cut 20 extending in the lengthwise direction E substantially from a vicinity of a first end 22 of the drill rod to a vicinity of a second end 23 of the drill rod 10, which second end 23 is an opposite end to the first end 22. According to another embodiment, the drill rod 10 may comprise two or more of such corrugated cuts 20. These corrugated cuts 20 may be arranged subsequently, in other words one after another, in the lengthwise direction E of the drill rod 10 and/or they may be arranged at least partly parallel to one another. Embodiments where the corrugated cut(s) 20 extend substantially continuously along substantially the whole length of the drill rod 10 and, thus, the tube 19 provide the additional benefit that the drill rod may be formed to be very flexible such that it can be easily arranged, for instance, in a coiled formation during

storage and/or use for the part that is not currently used for drilling.

According to an embodiment, an uncut portion 24 of a drill rod 10 may be left between two corrugated cuts 20 arranged subsequently. According to a further embodiment, an uncut portion 24 may be, in addition or instead of an uncut portion 24 between two subsequent corrugated cuts 20, provided at one or both ends 22, 23 of the drill rod 10. These alternatives may be beneficial considering the machining of the drill rod 10, for example, and they may provide sufficient flexibility for certain applications. Naturally, the length of such an uncut portion 24 should not exceed the height of the tunnel, where the drill rod is to be used.

According to an embodiment, the tube 19 comprises steel material. Preferably, the steel material comprises stainless steel. According to an embodiment, the tube 19 is formed as a single, unitary piece. Thus, the drill rod 10 may also be formed as a substantially single, unitary piece. This makes the structure of the tube 19 and the drill rod 10 simple to manufacture, store and transport and no connection elements, such as connector objects or threads, are needed. The absence of connection elements also means that such means are not lost, worn down are damaged during transportation, storing and use. Naturally, such connections also do not need to be tightened.

According to another embodiment, the tube length is at least 2.5 meters, and more preferably at least 3 meters long. The length of the tube 19 and, thus, the drill rod 10 is measured in the lengthwise direction E of the drill rod 10. With a single, unitary piece, such as a metal tube 19, of a length of at least 2.5 meters, on which the corrugated cut 20 is provided, a drill rod 10 may be achieved that may be used to drill holes 12 deeper that the height of the tunnel or other drilling environment also in low profile and extra low profile mines, as the bendable drill rod may be used in environments lower that the length of the drill rod 10, the drill rod 10 may be stored in a very compact manner and the tube 19 of the drill rod 10 is rigid enough to transmit torque, at least in a substantially rotational direction H of the drill rod 10, and thrust, at least in a substantially lengthwise E direction of the drill rod 10, needed for drilling. While in use and under the torque and thrust, such a tube 19 is also rigid enough in a transverse direction G of the drill rod 10 to transmit the torque and thrust. With rotational direction H of the drill a direction directed around the longitudinal axis D of the drill rod, or in other words around a lengthwise direction E of the drill rod, is meant. By using a single, unitary piece to form the tube

19 and/or the drill rod 10, also the bending and rigidness properties are more evenly distributed over the length of the drill rod 10 that in solutions where several shorter, stiff drill rods are joined or coupled together to provide the length needed for drilling the hole.

Figure 3 illustrates an example of a shape of such a corrugated cut 20. Each corrugated cut 20 may, thus, be arranged to deviate from its baseline 21 on both sides of the baseline 21 forming a cut of a substantially corrugated shape. The baseline 21 is not a physical part of the corrugated cut 20, but a virtual line on both sides of which the corrugated cut extends at each portion of the drill rod 10. The corrugated cut 20 may comprise curved portions of one or several radiuses. The corrugated cut 20 may also comprise straight portions connecting the curved portions. In different embodiments, the straight portions may be substantially parallel to the direction of the baseline 21, substantially perpendicular to the direction of the baseline 21 and/or arranged at an angle with respect to the baseline 21. This corrugated cut 20 may then spiral along the tube 19. In other words, the corrugated cut 20 may circulate around the drill rod 10, more particularly around the longitudinal axis D of the drill rod 10 and, thus, the tube 19, and extending through the wall of the tube 19 in a spiral-like manner and extending from the direction of a first end 22 of the drill rod towards a second end 23 of the drill rod that is opposite to the first end 22 of the drill rod in the lengthwise direction E of the drill rod. By providing such a corrugated cut 20 on a rigid drill rod 10, the drill rod 10 may be made at the same time flexible, such that bending of the drill rod 10 is enabled in a transverse direction of the drill rod 10, and rigid, such that transmitting torque and thrust needed for drilling is enabled. The bending radius of the tube 19 is preferable less than 1 m, and more preferably under 0,5 m. This enables bending the drill rod 10 also at low drilling spaces and achieving an optimal amount of uninterrupted drilling at any circumstances using as much of the available drilling height as possible. It also enables storing the drill rod 10 in a compact space when it or part of it is not in use, in a bent or coiled formation, for example.

According to an embodiment, the shape of the corrugated cut 20 is of a teardrop-like shape. With teardrop-like shape a shape is meant, wherein the end 25 of each corrugation, in other words the widest part of a continuous teardrop-like shape defined by the corrugated cut 20, is wider in the direction of the baseline 21 than width of the base 26 formed by the shortest distance between two adjacent corrugations. At the same time, the base 26 is also the

narrowest part of the continuous teardrop-like shape defined by the corrugated cut on the opposite side of the baseline 21 compared to the side of the baseline where the end 25 of the corrugation, that is the widest part, is formed.

According to an embodiment, a first distance 27 between two adjacent corrugations in the direction of the baseline 21 and measured from the corresponding point of each corrugation is in the range of 1 to 10 mm. According to another embodiment, the width of the end 25 of each corrugation and/or the base 26 of each corrugation is in the range of 1 to 10 mm. According to a further embodiment, a second distance between the base line 21 and the widest part of the teardrop-like shape, in other words the end 25 of the corrugation, in a direction perpendicular to the direction of the baseline 21 is in the range of 1 to 10 mm. This helps to achieve a drill rod 10 flexible enough to enable bending it in a transverse direction G of the drill rod and at the same time rigid enough to enable transmitting torque and thrust needed for drilling while using the drill rod.

According to an embodiment, a third distance 29 between two adjacent turns, in other words the pitch between the turns, of the baseline 21 in the lengthwise direction E of the tube is smaller than or substantially equal to 50 mm. The third distance 29 should preferably be substantially equal to or greater than the sum of the height of the corrugation, in other words the greatest distance between the points of one corrugation in the direction perpendicular to the baseline 21, and the thickness of the tube 19 wall. This helps to achieve a drill rod 10 that is flexible enough to enable bending it in a transverse direction of the drill rod and at the same time rigid enough to enable transmitting torque and thrust needed for drilling.

According to an embodiment, the corrugated cut may be formed by laser cutting and/or high pressure water jet cutting.

Figure 4 shows a rock drilling rig 1 that may comprise a movable carrier 2 provided with a drilling boom 3. This particular type of a rock drilling rig 1 is especially suitable for tunnels and other drilling spaces of limited height, such as low profile mines. Similarly, the rock drilling rig of Figure 7 may comprise similar parts and features, but due to the different structure it may be especially well suited for extra low profile mines.

The boom 3 is provided with a rock drilling unit 4 comprising a feed beam 5, a feed device 6 and a rotation unit 7. The rotation unit 7 may be supported to a carriage 8, or alternatively the rotation unit may comprise sliding

parts or the like support members with which it is movably supported to the feed beam 5. The rotation unit 7 may be provided with drilling equipment 9 which may comprise one or more drill rods (or drilling tubes) 10 connected to each other, and a drill bit 11 at the outermost end of the drilling equipment. The rotation unit 7 may be arranged to slide on the feed device 6 by a feed cylinder 32. The rotation unit 7 may comprise a rotation chuck 33 that may grip tightly to the drill rod 10 when the rotating unit 7 starts rotating and the feed device 6 starts pushing the drill rod into the hole 12, such that the torque and the thrust are transmitted to the drill rod 10 and further to the drill bit 11. The rock drilling rig 1 and/or a drilling unit may further comprise a rod retainer 34 that keeps the drill rod 10 in place when the rotation chuck 33 is returned to the original position and a new drilling sequence is started.

A drilling rig 1 may comprise several drilling units 4 comprising at least one feed device 6, rotation unit 7 comprising a rotation chuck 33 and/or a down-the-hole drill (DTG drill). According to an alternative embodiment, the drilling rig 1 may not comprise a rotation unit, but the drilling may be carried out without rotating the drill rod 10.

A guiding tube 30 may be provided comprising a tube-like casing forming a tubular space 41 inside the casing for holding and guiding at least a part of a drill rod that is not currently used for drilling, wherein the guiding tube 30 may comprise at least one bent portion 35, whereby a drill rod 10 position inside the guiding tube 30 is also bent by the bend in the guiding tube 30. Thus, the tubular inner space 41 of the casing serves as a storage space for at least a part of the drill rod 10. For the drill rod 10 to fit inside the guiding tube the inner diameter of the guiding tube 30 is larger than the outer diameter of the drill rod 10. According to an embodiment, the drill rod 10 may be arranged rotatably inside the guiding tube 30.

Such a bent guiding tube does not only enable providing a space-efficient way of storing the part of the bendable drill rod 10 that is not currently in use, it also provides a simple and robust structure for protecting the drill rod against any dirt and/or external impact from the mining environment and allowing the drill rod to rotate inside the guiding tube 30 without a need for any additional bearings or the like to enable rotation of the part of the drill rod not currently used for drilling. The most space-efficient storage formation for the drill rod 10 may vary in different embodiments and, thus, the formation of the guiding tube 30 may be selected based on the mining environment of the embodi-

ment. For example, the dimensions of the mining tunnels and the mining machines/drilling rigs vary and, therefore, also the most space saving position and formation of the guiding tube 30 varies. The guiding tube 30 also ensures that no flush, lubrication or any other such substance is spread from the drill rod 10 to the mining environment.

The bent portion 35 of the guiding tube 30 may comprise any type of a portion where the longitudinal axis 37 of the guiding tube 30 is bent. The bent portion 35 may comprise a single bend; two or more bends arranged one after another; a continuous bending formation, such as a coil; and/or any combination thereof. The guiding tube 30 may also comprise, besides the bent portion 35, at least one straight portion 36. The guiding tube 30 may further comprise any combination of one or more bent portions 35 and substantially straight portions 36.

Figure 5a illustrates a detail of a bent guiding tube 30 and a tube 19 of a drill rod 10 arranged within the guiding tube 30 seen from a side. Figure 5b illustrates a cross-section of the bent guiding tube 30 and a hose 31 arranged inside a tube 19 of the drill rod 10 and the guiding tube 30. According to a further embodiment, the bent guiding tube 30 may be arranged to hold a part of the drill rod 10 that is not currently at use in an at least partly bent formation. According to an embodiment, the at least partly bent formation may comprise a coiled formation.

According to an embodiment, the guiding tube 30 is arranged to be fixed, meaning that the guiding tube 30 is rigid enough to force a bendable drill rod 10 to bend in transverse direction of the drill rod at least at one point of the drill rod 10. Therefore, the guiding tube 30 may comprise a material that can provide sufficient rigidity. According to an embodiment, the guiding tube 30 may comprise a corrosion resistant material to withstand the lubrication and cleaning of the drill rod 10, the guiding tube and/or other parts of the arrangement. According to an embodiment, the guiding tube 30 may comprise a material that has good heat transfer properties to improve the cooling of the arrangement. According to a further embodiment, the guiding tube 30 may comprise stainless steel, as stainless steel can provide sufficient rigidity, corrosion resistance and heat transfer properties.

According to an embodiment, a drilling machine, such as a drilling unit 4 of Figure 1 or a drilling rig 1 of Figure 4 or Figure 7, may comprise one or several such guiding tubes 30. A drilling machine may further comprise a drill

rod 10 described in connection with the drill rod embodiments and corresponding figures or formed as a combination thereof. Such a drilling machine 1 may further comprise a hose 31 for air or water provided inside the drill rod 10. In such an embodiment, the drill rod 10 and the hose 31 may be preferably arranged to rotate together, as wear down of the hose 31 can be greatly reduced in this manner.

Figure 6 illustrates a guiding tube 30 according to the current solution. The guiding tube 30 comprises a bent portion 35 and a straight portion 36. A bendable drill rod 10 may be arranged at least partly within the tubular space defined by the guiding tube 30.

A hose 31 for air or water may be provided inside the drill rod 10 and, thus, inside the guiding tube 30. According to an embodiment, a hose reel 38 may be provided for the part of the hose 31 that is not currently that is not currently placed inside the drill rod 10 at the rear end of the guiding tube 30 opposite to the end through which the drill rod 10 may be fed for drilling, through the rotating unit 7 and the rotation chuck 33 in the embodiment of Figure 7, for example. In embodiments, where the drill rod 10 and the hose 31 are rotated, a rotary connection 39 may be provided between the hose 31 and the hose reel 38. The rotary connection 39 may comprise a substantially liquid tight rotary connection known as such.

Some further examples of the geometries of some guiding tubes are shown in Figures 8a and 8b. These are shown as illustrative examples only and the guiding tube may, thus, comprise one or more bent portions 35 and, in some embodiments, also one or more substantially straight portions 36. The bent guiding tube 30 may only comprise one bent portion 35 and straight portion(s), such as in the detail of Figure 5a. The bent guiding tube may also comprise a coiled formation, in other words a formation of continuous rings arranged one above the other in a spaced manner, wherein the continuous rings may have a substantially regular size and spacing, such as in the Figures 6 and 7. Depending on the embodiment, the coiled formation may be formed around horizontal or vertical axis or any axis suitable for the purpose. According to an embodiment, the bent guiding tube 30 may comprise a combination of bent portions 35 and straight portions 36 forming a corrugated formation, as in Figure 8a. According to a further embodiment, the bent guiding tube may comprise a geometry that mainly consists of straight portions 36, but comprises one or several bent portions 35.

The bending radius 40 of the guiding tube 30 is preferably greater than the minimum bending radius of the drill rod 10. Thereby the guiding tube 30 does not tend to bend the drill rod 10 more than its flexibility permits without any kind of damage or additional wear for the drill rod 10.

According to an embodiment, a drill rod described in connection with the drill rod embodiments and/or Figures 3 and 4 and/or a drilling machine comprising such a drill rod may be used in a method for drilling a hole. According to an embodiment, the method may comprise driving the drill rod by a rotation chuck on a linear zone.

According to an embodiment, the method may comprise rolling up the drill rod in a guiding tube 30 upstream from the rotation chuck 33. In other words, the guiding tube 30 may comprise a bent portion 35, inside which a part of the drill rod 10 that is not currently in use, may be stored in a bent position. According to a further embodiment, the guiding tube 30 may comprise at least a portion of a coiled shape and, thus, at least a portion of the part of the drilling rod 10 not currently in use for drilling the hole 12 may be arranged within the guiding tube 30, thus coiling the drill rod 10 as well. This coiling of the drill rod 10 is enabled by at least one corrugated cut 20 provided on the drill rod 10 as explained in connection with the different embodiments related to the drill rod 10.

According to an embodiment, the method may comprise translating the drill rod 10 and the rotation chuck up and down by a feed cylinder to rotate the drill rod 10 and to feed it into the hole 12. Thus, a length of the drill rod substantially up to a height of the tunnel may be used at a time without interruptions to drill a hole or, in other words, a portion of the hole 12 that equals substantially in depth to the length of the drill rod 10 used at a time and to the height of the tunnel.

A method for drilling holes in drilling spaces of limited height using a drill rod described in connection with the drill rod embodiments and/or corresponding figures and/or a drilling machine comprising such a drill rod, may comprise using at least one drill rod comprising a length that is larger than the height available in the drilling space, bending said at least one drill rod in a transverse direction, and drilling a hole using the drill rod in a substantially upward or downward direction.

According to an embodiment of a method for drilling a hole using a drill rod described in connection with the drill rod embodiments and/or corre-

sponding figures and/or a drilling machine comprising such a drill rod, the method may comprise, in addition to or instead of the steps described above, drilling in a step-wise manner a maximum length allowed by a tunnel height or other predefined limit at a time; using a rod retainer 34 to keep the drill rod in place while rotation unit is returned to a feed start position; releasing the rod retainer once the rotation chuck jaws are clamped again at the feed start position to start feeding the drill rod and to continue drilling; and repeating the step-wise drilling until a planned depth of the hole has been reached.

Figure 9 illustrates schematically a method for storing a bendable drill rod, at least a part of a bendable drill rod that is not currently in use is stored 91 in a bent guiding tube. According to an embodiment, at least a part of the bendable drill rod that is not currently used for drilling is inserted 92 into a bent guiding tube for storage, when extracting the drill rod from a hole; and at least a part of the bendable drill rod is extracted 93 from the bent guiding tube for drilling, when drilling deeper into the hole.

This solution is particularly beneficial, when the depth of the hole to be drilled excesses the height available for mining. A bent guiding tube 30 enables feeding of the bendable drill rod 10 in mines with a lower profile and/or a space-saving way to store at least a part of such a drill rod that is not currently used for drilling. However, the solution may be used in other kind of circumstances as well at it may still provide benefits related to storing and transportation, for example.

All the ranges disclosed in this description also include the upper and lower limit values, where applicable.

It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

CLAIMS

1. A guiding tube for a bendable drill rod for a drilling rig, the guiding tube comprising a tube-like casing forming a tubular space inside the casing for holding and guiding at least a part of the bendable drill rod when an end of the drill rod is outside a drill hole and the guiding tube comprising at least one bent portion, whereby the drill rod positioned inside the guiding tube is also bent by the bend in the guiding tube.

2. A guiding tube according to claim 1, wherein the bent portion comprises a single bend in the guiding tube.

3. A guiding tube according to claim 1, wherein the bent portion comprises two or more bends arranged one after another or a continuous bending formation.

4. A guiding tube according to any one of claims 1 to 3, wherein the bent portion comprises at least one straight portion.

5. A guiding tube according to any one of claims 1 to 4, wherein the guiding tube comprises a coiled formation.

6. A guiding tube according to any one of claims 1 to 4, wherein the guiding tube comprises a corrugated formation.

7. A drilling arrangement comprising a guiding tube according to any one of claims 1 to 6 and the bendable drill rod at least a part of which is arranged within the tubular space defined by the guiding tube.

8. A drilling arrangement according to claim 7, wherein the drilling arrangement further comprises a hose for air or water provided inside the drill rod.

9. A drilling arrangement according to claim 7 or 8, wherein the bending radius of the drill rod is less than 1 meter and the length of the drill rod is at least 2.5 meters.

10. A drilling arrangement according to any one of claims 7 to 9, wherein the drill rod comprises a tube comprising at least one corrugated cut extending through a wall of the tube in a transverse direction, wherein said at

least one corrugated cut has a substantially spiral baseline extending in a circulating manner around the tube in the lengthwise direction of the drill rod from the direction of a first end of the drill rod to a direction of a second end of the drill rod and said at least one corrugated cut is arranged to deviate from its baseline on both sides of the baseline forming a cut of a substantially corrugated shape spiralling along the tube, such that at least part of the drill rod is flexible to enable bending in a transverse direction of the drill rod and the drill rod is rigid to enable transmitting torque and thrust needed for drilling.

11. A drilling arrangement according to any one of the claims 7 to 10, wherein the tube is formed as a single, unitary piece.

12. A drilling machine comprising a drilling unit or a drilling rig and at least one drilling arrangement according to any one of claims 7 to 11.

13. A method for storing a bendable drill rod, comprising

storing at least a part of the bendable drill rod at the end of the drill rod when the end of the drill rod is outside a drill hole in a bent guiding tube, whereby the drill rod positioned inside the guiding tube is also bent by the bend in the guiding tube.

14. A method according to claim 13, wherein the method further comprises

inserting at least a part of the bendable drill rod into a bent guiding tube for storage, when extracting the drill rod from the drill hole; and

extracting at least the part of the bendable drill rod from the bent guiding tube for drilling, when drilling into the drill hole.

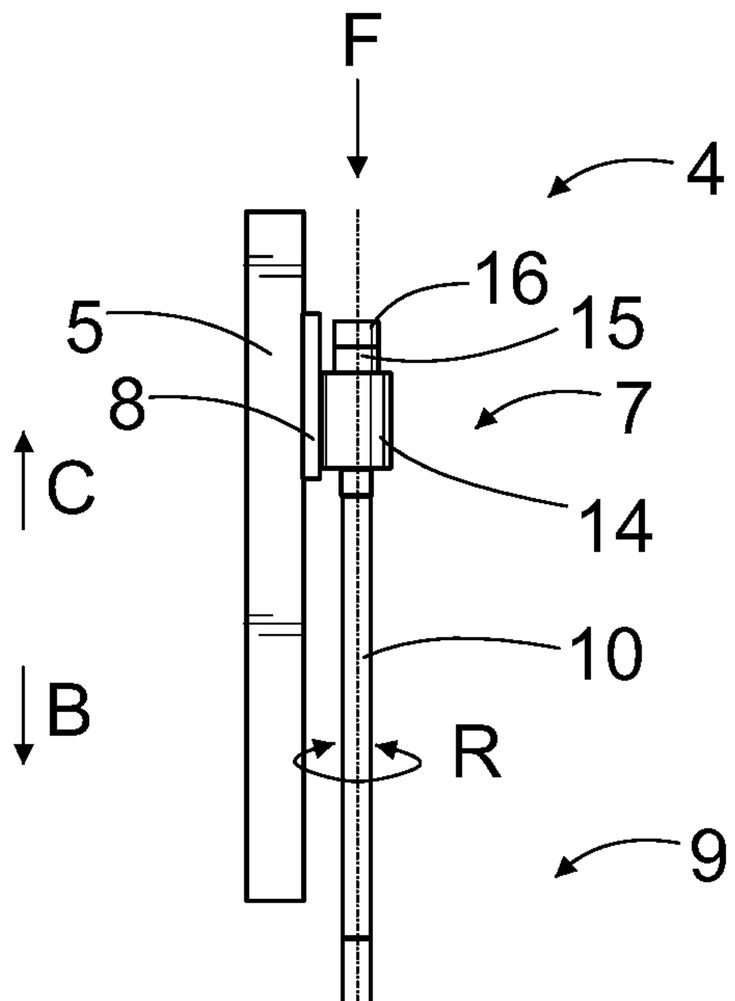


FIG. 1

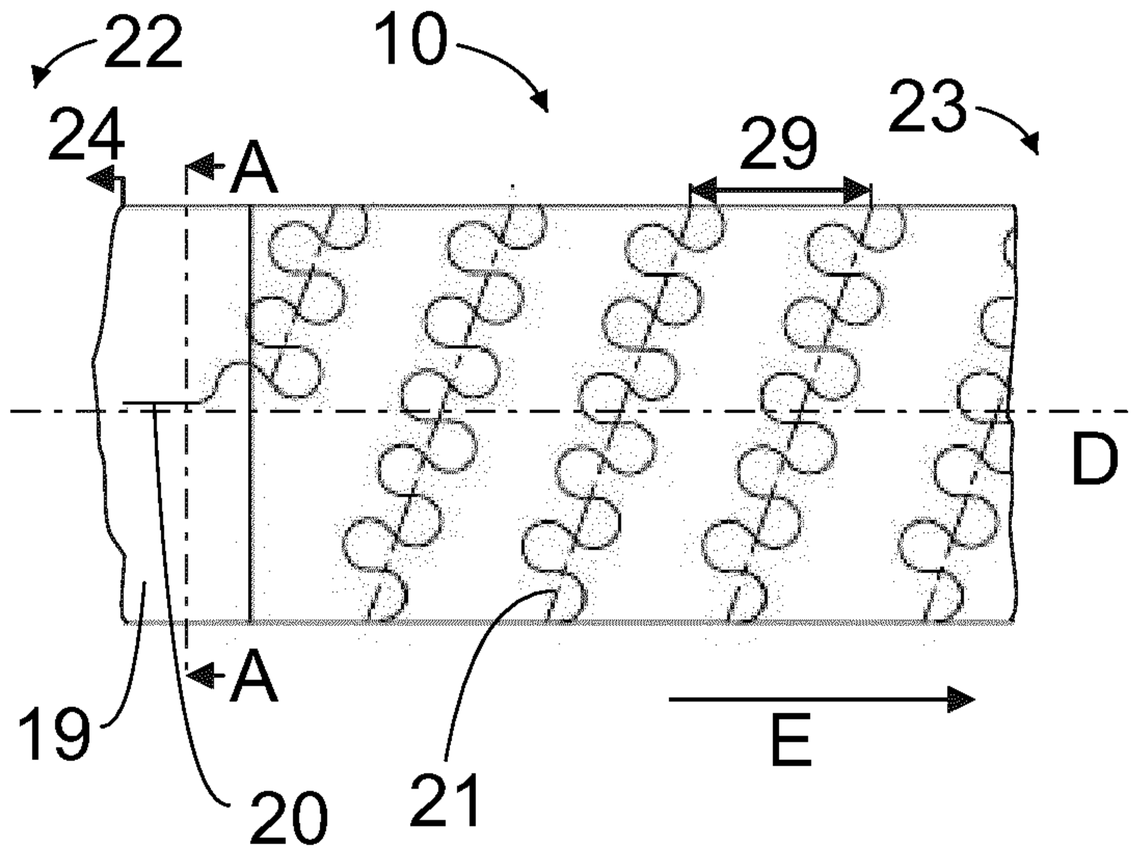


FIG. 2a

FIG. 2b

FIG. 3

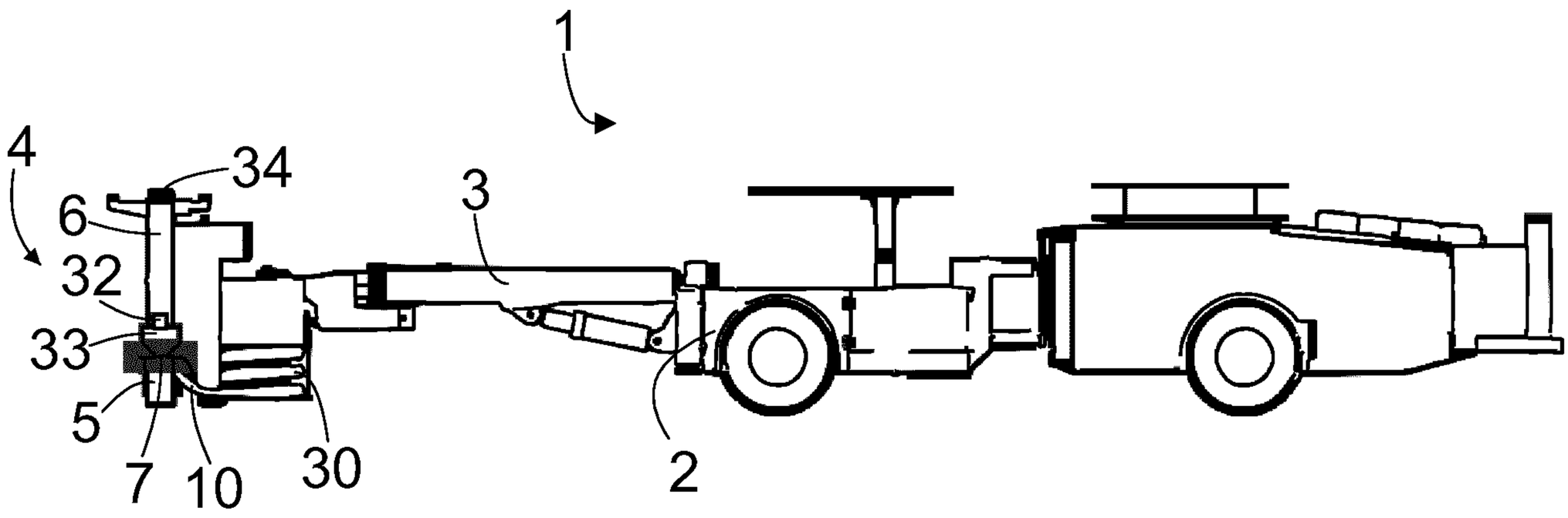


FIG. 4

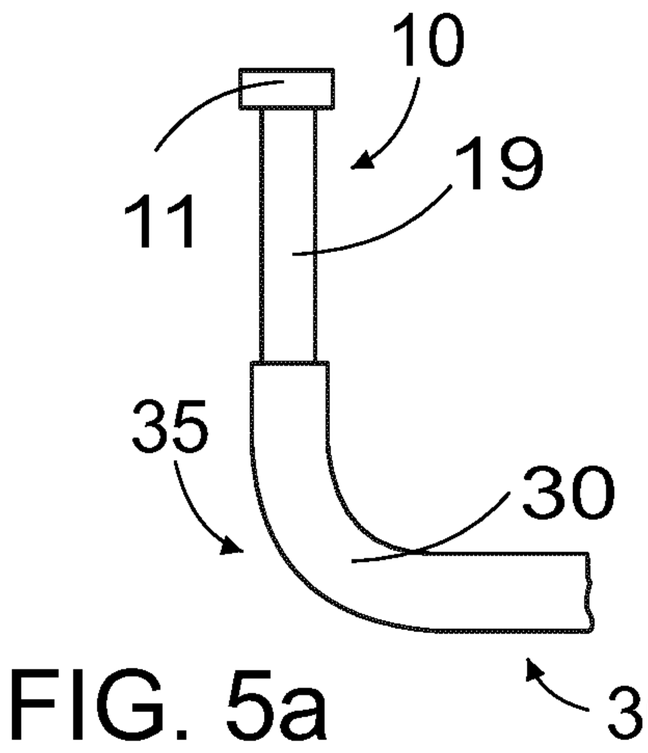


FIG. 5a

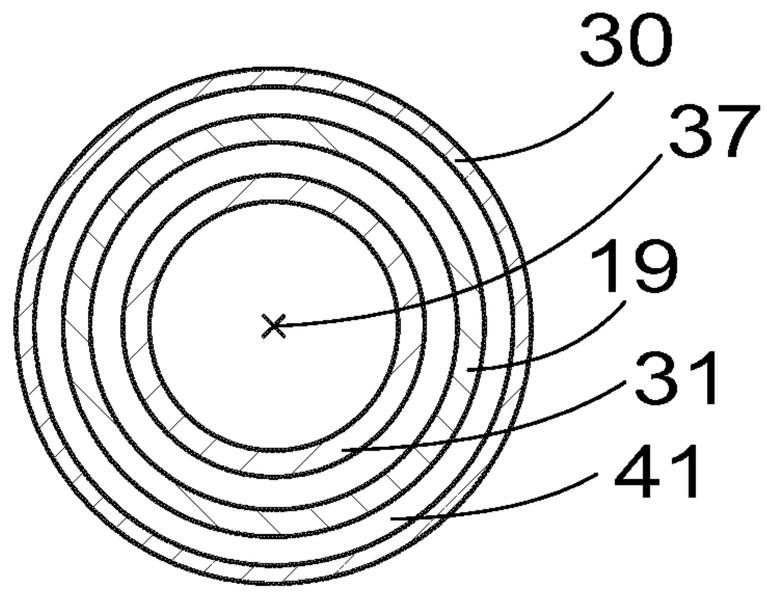


FIG. 5b

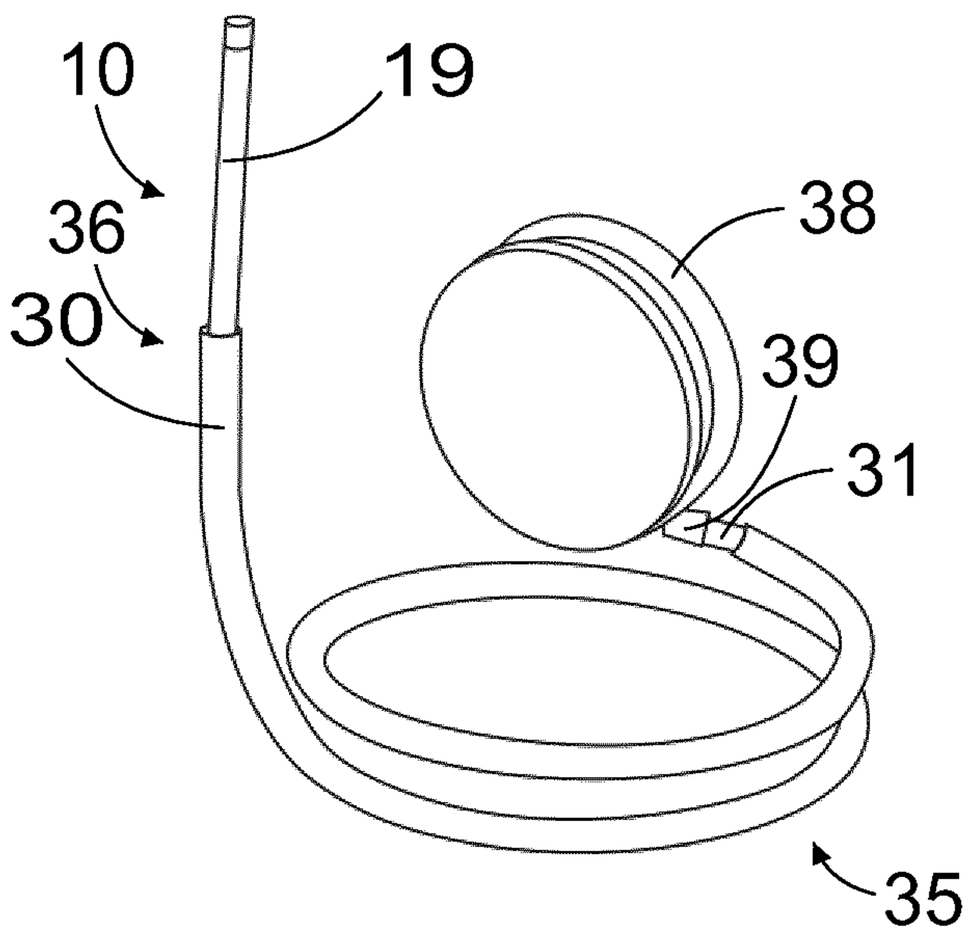


FIG. 6

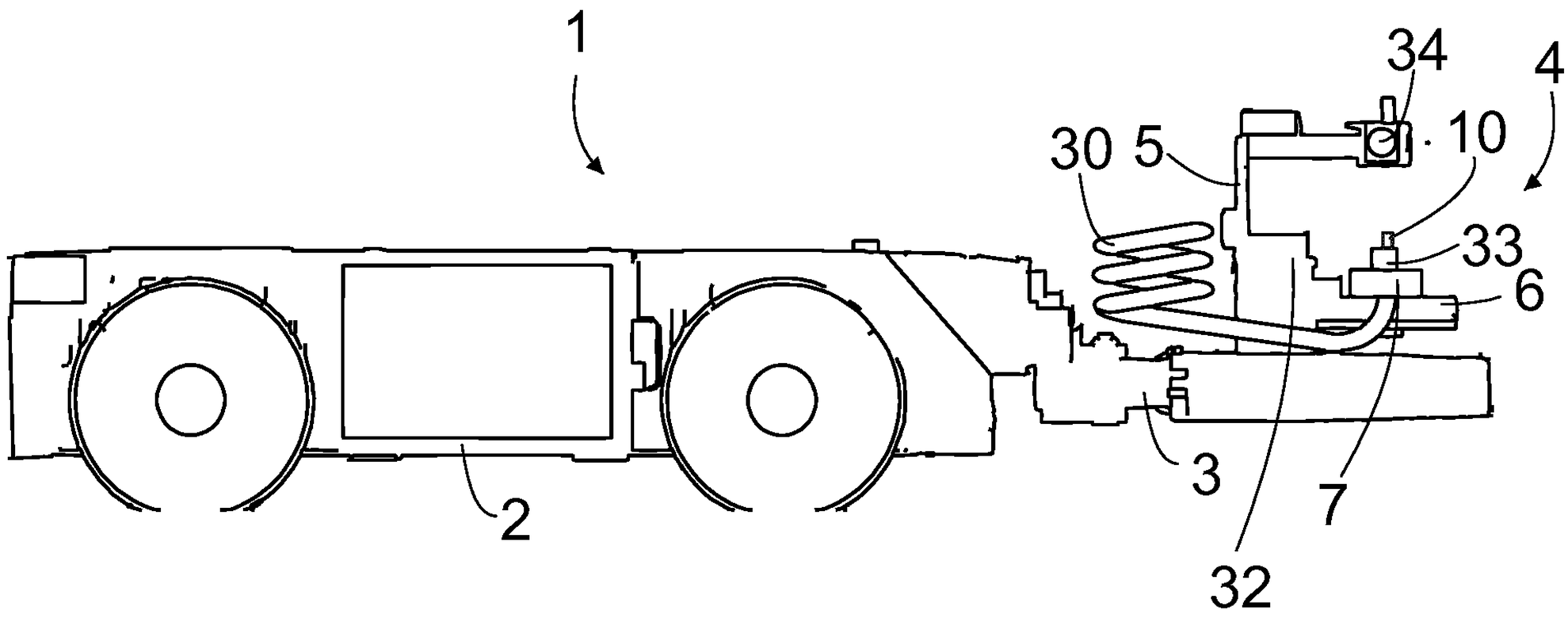


FIG. 7

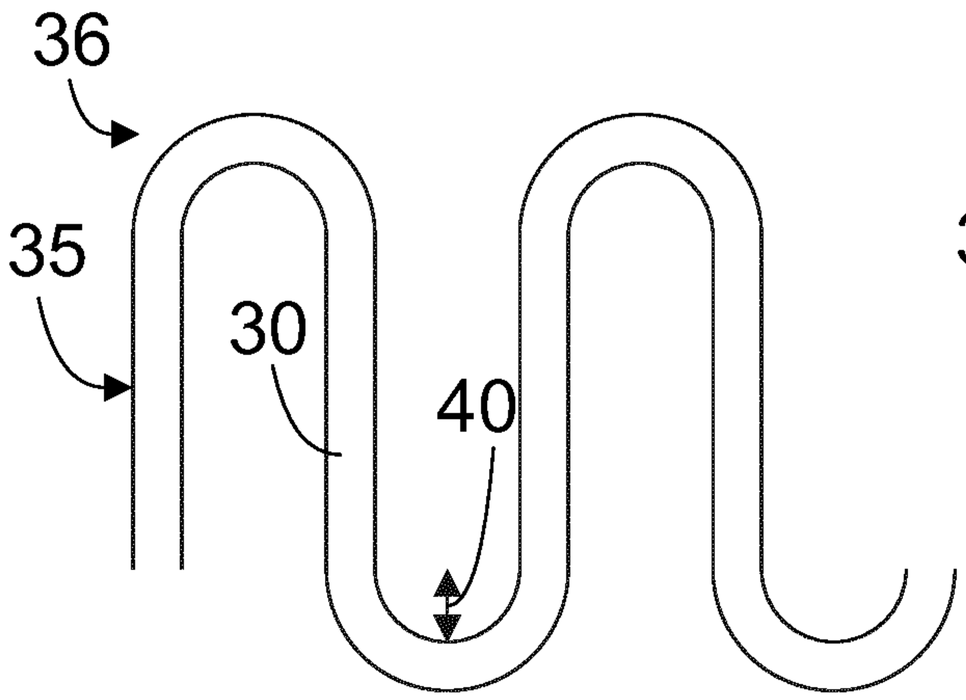


FIG. 8a

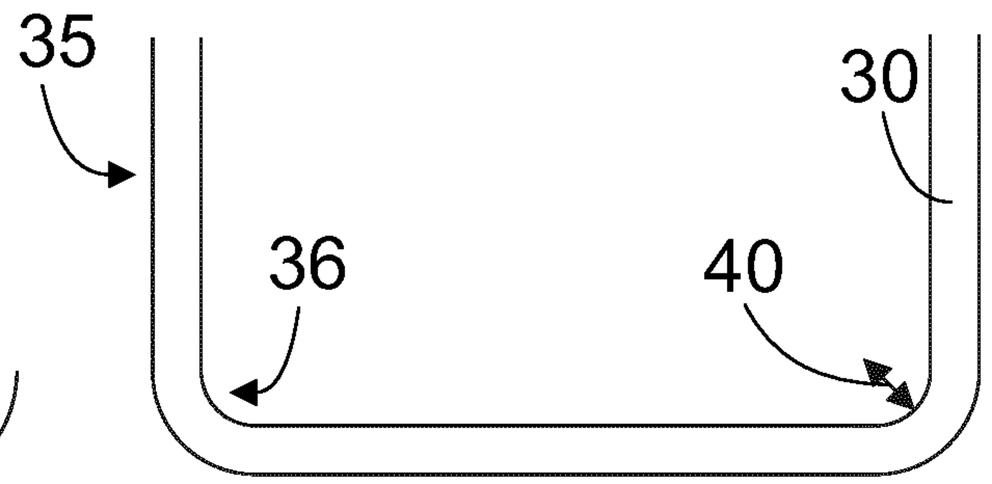


FIG. 8b

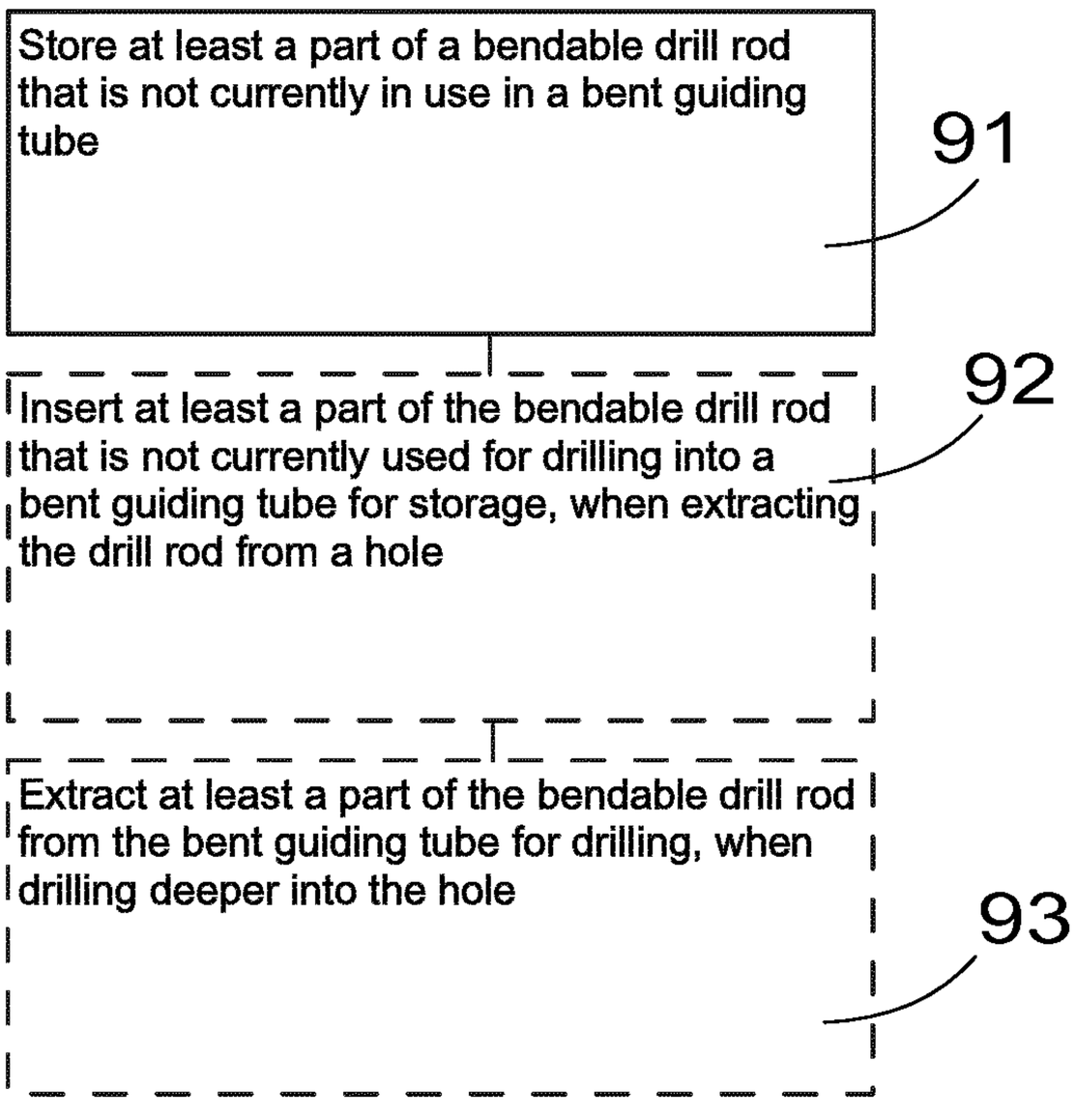
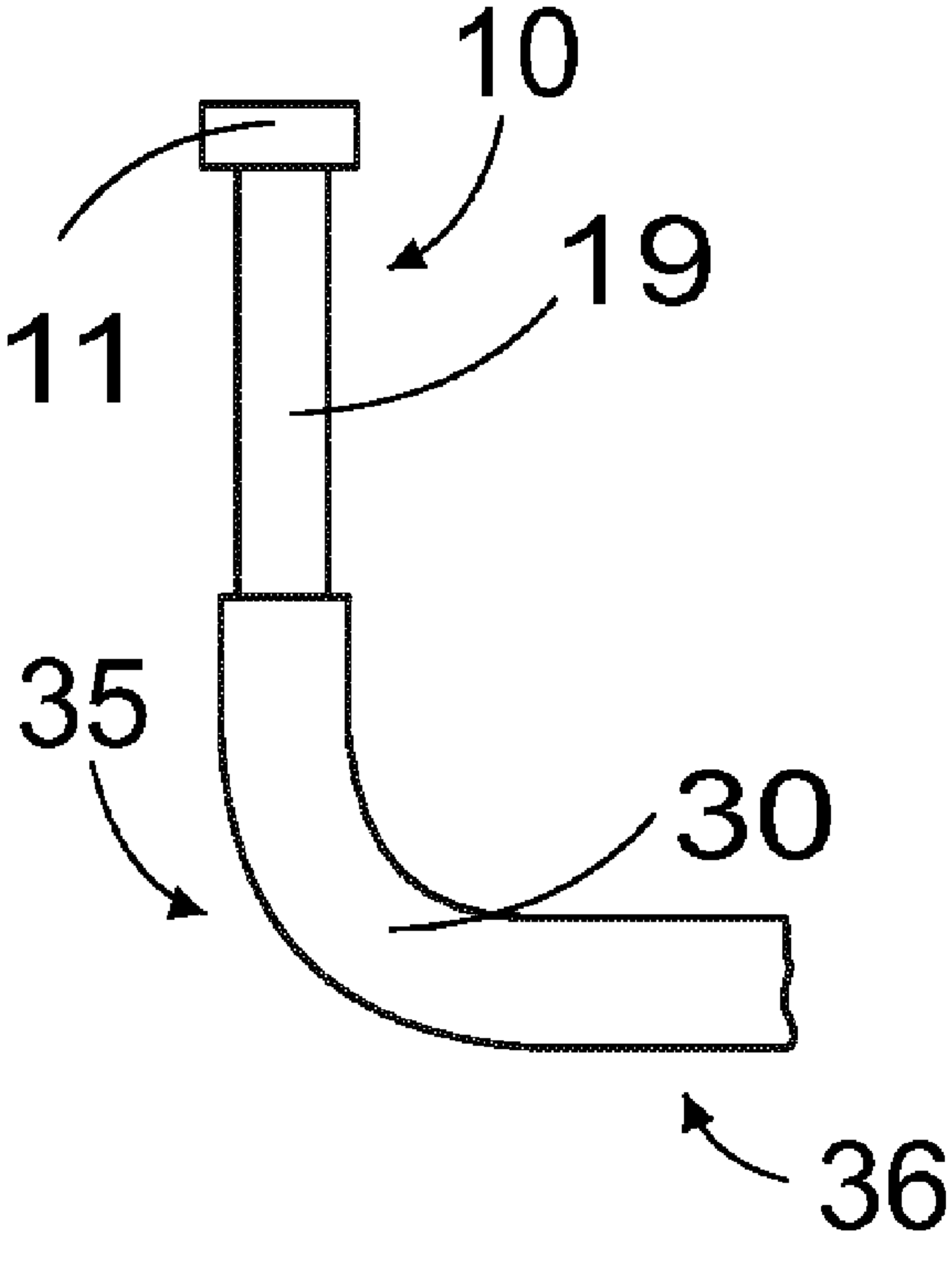


FIG. 9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