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Patentanmeldung Nr. **Patent application No.** **Demande de brevet n°.**

24170760.3 / EP24170760

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For the President of the European Patent Office

Le President de l'Office européen des brevets
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Demande no:

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MECHANICAL ANCHOR FOR DOUBLE CABLE BOLTS

In Anspruch genommene Priorität(en) / Priority(Priorities) claimed / Priorité(s) revendiquée(s)
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AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR

Mechanical anchor for double cable bolts

TECHNICAL FIELD

The present invention relates to a mechanical anchor device, more specifically a mechanical anchor device for use with cable bolts in bore holes to stabilize the rock surface against collapse.

BACKGROUND

In mining and civil construction, excavations involve the removal of solid material to generate cavities, either on the ground or underground, and are generally associated with infrastructure whose purpose and use depends on the utility for which they have been designed. To keep the stability of the excavations, it is necessary to reinforce them using rock support elements. One type of reinforcement used is cable bolts. Typically, a cable bolt is installed as follows. Grout is injected into a bore hole and then the cable bolt is inserted, with the grout acting as a binding element between the cable bolt and the surrounding rock within the bore hole. When the grout has set, a steel plate is placed at the trailing end of the excavation and a barrel-wedge device is placed on the cable bolt, against the steel plate. The cable bolt is then tensioned.

A mechanical anchor device for cable bolts is disclosed in AU2006201823. The mechanical anchor device disclosed is of the type which is point anchored to the surrounding rock wall using an expansion head of the so-called mechanical anchor assembly. Typically, in the use of this device, the cable bolt is inserted into the bore hole with the mechanical anchor device placed at one end of the cable bolt. Then, a steel plate is placed at the trailing end of the excavation and a barrel-wedge device is placed on the cable bolt, against the steel plate. The cable bolt is then tensioned to provide bearing capacity. Grout can then be injected into the borehole and subsequently set. This mechanical anchor device design ensures immediate load bearing capacity when the

cable bolt has been tensioned to activate the mechanical anchor device. Then, grout can be injected after tensioning the cable bolt. A problem with the setup disclosed in AU2006201823 is that the cable bolt used, in some conditions, does not have an adequate load bearing capacity and the cable bolt may thus break. The cable bolt can thus not guarantee the safety and stability of the excavation. Using a cable bolt with a larger diameter is not feasible since they are disproportionately more expensive and are additionally less flexible and more difficult to tension.

Therefore, there is a need for improvements in mechanical anchor devices such that a higher load capacity can be achieved for cable bolts.

It is therefore an object of the present invention to present an improved mechanical anchor device with a higher load capacity.

SUMMARY

According to the present invention, the above mentioned object is achieved by means of a mechanical anchoring device for cable bolts having the features defined in claim 1.

The mechanical anchoring device for cable bolts according to the present invention comprises: an expansion head in the form of a plurality of expansion leaves, for engaging rock strata, at an axially trailing end of the mechanical anchoring device. A retention barrel located at an axially smaller distance to a leading end of the mechanical anchoring device than the distance between the expansion head and the leading end of the mechanical anchoring device. A connecting device connected to each of the expansion leaves and wherein the retention barrel comprises a first and a second through hole for receiving a cable in each of the first and second through hole.

The present inventors have realized that this configuration improves the load capacity of the cable bolt. Two cables can be used with a single mechanical anchoring device. This is a preferred solution compared to having a single cable with large diameter since large diameter cables are disproportionately

costly and difficult to tension. It is also a preferred solution compared to using two cables and having them anchored by two different mechanical anchoring devices since it is more cost efficient and having two completely different cable systems increases the risk that the cables get entangled to each other. Additionally, when using two completely different cable systems the cable of one of the systems may interfere with the anchoring of the other cable system, thus preventing adequate anchoring to the bore hole.

In the present application the leading end of the mechanical anchoring device is the part that is at the end of the bore hole, furthest from the opening of the bore hole. The trailing end of the anchoring device is the part that is closest to the opening of the bore hole. Throughout the application the expressions “leading end” and “trailing end” refer to a direction or part of a device that is closest to the end of the bore hole or closest to the opening of the bore hole, respectively.

The words “cable” and “cable bolt” both have the same meaning throughout this disclosure.

The connecting device is needed to hold the, otherwise, loosely fitted expansion leaves in position.

The expansion leaves when connected through the connecting device are collectively seen as an expansion head.

The mechanical anchoring device is positioned into the bore hole with one cable through the first through hole of the retention barrel and one cable through the second through hole of the retention barrel. Tension is then applied to the cables at the trailing end of the cables. The tensioning of the cables will move the retention barrel in a direction towards the expansion leaves and engage the inner surface of the expansion leaves to expand the expansion leaves. When the expansion leaves are expanded, they will engage the rock strata of the bore hole and will thus create an anchor point between the mechanical anchoring device and the bore hole. This is called activation of the mechanical anchoring device. Grouting the bore hole can be done before

the mechanical anchoring device is positioned and tensioned in the bore hole or, alternatively, it can be done after activation of the mechanical anchoring device.

According to one embodiment, the connecting device comprises axial branches extending from each of the expansion leaves, along a radial outside of the retention barrel, in a direction substantially along a longitudinal axis of the mechanical anchor device towards the leading end of the mechanical anchor device. The axial branches are connected to a transverse branch, extending substantially in a direction transverse to the longitudinal axis of the mechanical anchoring device, at a position of the leading end of the mechanical anchoring device.

This configuration ensures that the expansion leaves are properly kept in place by the connecting device. Preferably the cross-section, perpendicular to the longitudinal axis of the retention barrel, of the side slots have a radius and are approximately part-circular in shape.

The longitudinal axis of the mechanical anchoring device extends in a direction substantially parallel to the bore hole when the mechanical anchoring device is attached to the cables and inserted into a bore hole.

Transverse here means that at least a part of this branch is non-parallel with the axial branches to be able to connect the axial branches. The transverse branch may, for example, be a straight part that extends perpendicular to the longitudinal axis of the mechanical anchoring device, or it can be an arched part having a radius.

According to an embodiment, the connecting device comprises an alignment hole at the transverse branch of the connecting device.

This configuration makes it possible to have the transverse branch positioned centrally, along the diameter of the bore hole, without being an obstacle when the mechanical anchoring device is positioned on the cables. Additionally, the

alignment hole aligns the cables in the bore hole and keeps them separated to avoid entanglement of the cables.

According to an embodiment, the connecting device comprises a first and a second alignment hole at the transverse branch of the connecting device.

This configuration further improves the separation of the two cables and aligns them even better compared to having a single alignment hole. Further, the placement of a cable into each of a first and second alignment hole prevents the expansion leaves from rotating around the longitudinal axis of the mechanical anchoring device.

According to an embodiment, the retention barrel comprises substantially extending side slots, one side slot for each expansion leaf, in the radial peripheral surface of the retention barrel. Each side slot being present for accommodating an axial branch of the connecting device.

This configuration ensures the position of the axial branches of the connecting device. Without this configuration the axial branches may get out of position due to interference with the rock surface in the bore hole. If the axial branches get out of position the expansion leaves may also get out of position and activation of the mechanical anchoring device may be negatively affected.

According to an embodiment, at least one of, the first and second through hole of the retention barrel widens conically at the leading end of the first or second through hole. Further, a conically, longitudinally hollow, shaped wedge is positioned in the conically widened through hole at the leading end of the retention barrel.

Longitudinally hollow means that the wedge have a through hole along the longitudinal axis of the wedge. This through hole is for insertion of a cable through the wedge. Preferably both the first and the second through hole are conically widened and a wedge is positioned in both the first and the second through hole.

This arrangement improves the connection between the mechanical anchoring device and the cables. When applying tension to the cables the wedges, and additionally the cables, will get a firm attachment to the retention barrel through the conical leading ends of the through holes in the retention barrel. Further tensioning of the cable then ensures that the retention barrel engages the expansion leaves to properly activate the mechanical anchoring device.

According to an embodiment, a spring is arranged between the leading end of the conically shaped wedge and the transverse branch of the connecting device.

With this configuration the expansion of the expansion leaves is better controlled and a more constant pressure between the expansion leaves and the rock surface of the bore hole is maintained. Preferably there is a spring arranged between each of the conically shaped wedges and the transverse branch of the connecting device, thus making it two springs in total.

According to an embodiment, the expansion leaves comprise a serrated outer surface.

This configuration ensures a firm attachment of the expansion leaves to the rock surface of the bore hole. Proper activation can thus be achieved with the mechanical anchoring device properly anchored to the bore hole.

The serrations preferably extend circumferentially around the longitudinal axis of the expansion head.

According to an embodiment, the outer radial peripheral surface of the retention barrel comprises a truncated cone at its trailing end.

According to an embodiment, the expansion head forms an inner surface formed as a truncated cone at the leading end of the expansion head.

Since the expansion head is formed by the individual expansion leaves, the surface formed is not literally a truncated cone. There will be several different

surfaces that collectively forms a truncated cone surface with longitudinal gaps in the surface between the expansion leaves.

According to an embodiment, the diameter of the truncated cone surface of the retention barrel and the diameter of the truncated cone surface of the inner surface of the expansion head are arranged so that the expansion head will be radially expanded when the mechanical anchoring device is activated to move the retention barrel towards the trailing end to engage the inside of the expansion head.

The configurations of having the outer radial peripheral surface of the retention barrel comprising a truncated cone at its trailing end and the configuration of having the inner surface of the expansion head formed as a truncated cone at the leading end both improves and simplifies the expansion of the expansion head and thus the activation of the mechanical anchoring device.

According to an embodiment, the expansion leaves have slits extending substantially in a direction along the longitudinal axis of the mechanical anchoring device.

The slits are longitudinal cut-outs extending from the trailing end of the expansion leaves towards, but not up to, the leading end of the expansion leaves.

This configuration increases the deformability of the expansion leaves and makes it easier to activate the mechanical anchoring device to achieve a proper attachment to the rock surface of the bore hole.

According to an embodiment, there are exactly two, or exactly three, expansion leaves.

According to an embodiment, there are more than three expansion leaves.

Further advantages of the present invention will appear from the description following below.

LIST OF DRAWINGS

Embodiments of the invention will now be described in detail with regard to the annexed drawings, in which:

Fig. 1 is a perspective view of the mechanical anchoring device according to the invention.

Fig. 2 is a side view of the mechanical anchoring device according to the invention.

Fig. 3 is a perspective view of the retention barrel.

Fig. 4 is a perspective view of the connecting device connected to the expansion leaves.

Fig. 5 is a longitudinal cross-sectional view of the connecting device connected to the expansion leaves.

DETAILED DESCRIPTION OF EMBODIMENTS

Reference is made to Fig. 1 which shows a mechanical anchoring device 1. The mechanical anchoring device 1 is attached to two cables (preferably made of steel) and is inserted into a drilled bore hole (not shown). The mechanical anchoring device 1 has a leading end 21 and a trailing end 22. The leading end 21 of the mechanical anchoring device 1 is positioned towards the leading end of the bore hole, that is the part of the bore hole furthest from the opening of the bore hole. The trailing end 22 of the mechanical anchoring device 1 is positioned more towards a trailing end of the bore hole, that is further towards the opening of the bore hole.

An expansion head 3, made of a plurality (two in the shown embodiment) of expansion leaves 4 positioned concentrically around a longitudinal axis of the mechanical anchoring device 1, is positioned at a trailing end 22 of the mechanical anchoring device 1. The expansion leaves 4, when positioned concentrically around the longitudinal axis of the mechanical anchoring device 1, collectively forms the expansion head which has a form that resembles a cylinder.

A retention barrel 2 is positioned next to the expansion head 3 in a direction towards the leading end 21 of the mechanical anchoring device 1. The trailing end of the retention barrel 2 is partly inserted into the leading end of the expansion head 3. The retention barrel 2 comprises a first 5 and a second 6 through hole that extends parallel to the longitudinal axis of the mechanical anchoring device 1. The first 5 and second 6 through holes are for insertion of a cable through the retention barrel 2.

A connecting device 14 extends from the leading end of the expansion head, past the retention barrel 2, to a leading end 21 of the mechanical anchoring device 1. The connecting device 14 has axial branches 15 extending from the leading end of the expansion head along the radially outer surface of the retention barrel 2. The axial branches 15 are connected to respective expansion leaf 4 of the expansion head 3 by conventional means such as welding, riveting, bolting, or other fixation means. At the leading end 21 of the mechanical anchoring device 1 the axial branches 15 connects to a transverse branch 16 of the connecting device 14. The transverse branch 16 is generally perpendicular to the axial branches 15. The transverse branch 16 comprises a first 17 and a second 18 alignment hole. The alignment holes 17, 18 are circular and has a diameter suited to fit a cable in each of the alignment holes 17, 18.

Between the transverse branch 16 and the retention barrel 2, two springs 20 and two wedges 19 are positioned. The wedges 19 are conical in shape and are each partly inserted into a through hole 5, 6 of the retention barrel 2. The leading end of the first 5 and second 6 through holes of the retention barrel 2 widens conically at the exit of the through holes to accommodate the wedges 19. The wedges 19 fix the cables to the mechanical anchoring device 1. Between the wedges 19 and the transverse branch 16 springs 20 are positioned next to each wedge 19. The springs 20 are designed for being able to have a cable passing through each spring 20.

More details of the retention barrel 2 are shown in figures 2 and 3. The radially outer surface of the leading end of the retention barrel 2 has a generally cylindrical shape 7 and the trailing end has a shape generally in the form of a truncated cone 8. The truncated cone 8 achieves the effect of expanding the expansion head 3 when the retention barrel is moved towards the expansion head. The outer diameter of the trailing end of the retention barrel 2 is smaller than the inner diameter of the leading end of the expansion head 3 for the retention barrel 2 to be able to fit with the expansion head 3.

The radially outer surface of the retention barrel 2 has side slots 9. One side slot 9 for each axial branch 15 of the connecting device 14. The side slots 9 are generally partly circular in a cross-section transverse the longitudinal axis of the retention barrel 2. Each side slot 9 accommodates an axial branch 15 of the connecting device 14 to ensure that the connecting device 14 is properly positioned without moving around.

More details of the expansion head 3 are shown in figures 4 and 5. The expansion leaves 4 of the expansion head 3 have a serrated outer surface 10. The serrations extend circumferentially around the longitudinal axis of the expansion head 3. The serrations are generally saw tooth shaped in a longitudinal cross section of the expansion head 3 and the sharp end of the saw tooths are directed towards the trailing end of the expansion head 3 to grip to the rock surface of the bore hole when the mechanical anchoring device 1 is being activated and a tension load is applied in a direction towards the trailing end of the bore hole.

The expansion leaves 4 further comprises axially extending slits 13. The slits 13 extend from the trailing end of the expansion leaves 4 towards, but not reaching, the leading end of the expansion leaves 4. The slits 13 weaken each expansion leaf 4 and makes it easier to deform and expand the expansion head 3.

The trailing end of the expansion head has an inner surface that is generally cylindrical 11 and an inner surface at the leading end that is generally formed as a truncated cone 12. The truncated cone part 12 of the expansion head 3 fits with the truncated cone part 8 of the retention barrel 2.

The axial length of both the expansion head 3 and the truncated cone part 8 of the retention barrel 2 is customized and varied, depending on the characteristics of the rock that is surrounding the bore hole, to achieve as firm grip between the mechanical anchor device 1 and the bore hole as possible.

Activation of the mechanical anchoring device will now be described. After a hole has been drilled in the rock, two steel cables are inserted into the bore hole. The steel cables are, at the time of insertion into the bore hole, attached to a mechanical anchoring device, one steel cable through each of the through holes 5, 6 of the retention barrel 2. A steel plate is then positioned against the rock surface at the exit of the bore hole. The steel cables are then tensioned using, for example, a hydraulic jack for tensioning cables. During tensioning the retention barrel 2 will engage the expansion head 3 to expand the expansion leaves 4 in a radial direction, thus anchoring the expansion leaves to the walls of the bore hole. The mechanical anchoring device will thus immediately after tensioning be able to resist immediate loading from falling rocks. Thereafter grout can be inserted into the bore hole to further stabilize the excavation. Alternatively, the grouting is performed before the mechanical anchoring device is positioned in the bore hole.

LIST OF REFERENCE NUMERALS

(1) Mechanical anchoring device for cable bolts
(2) Retention barrel
(3) Expansion head
(4) Expansion leaf
(5) First through hole of the retention barrel
(6) Second through hole of the retention barrel

(7) Cylindrical part of the retention barrel

(8) Truncated cone part of the retention barrel

(9) Side slot in retention barrel

(10) Serrated outer surface of expansion head

(11) Cylindrical inner surface of expansion head

(12) Truncated cone part of inner surface of expansion head

(13) Slit in expansion leaf

(14) Connecting device

(15) Axial branch of connecting device

(16) Transverse branch of connecting device

(17) First alignment hole

(18) Second alignment hole

(19) Wedge

(20) Spring

(21) Leading end of mechanical anchoring device

(22) Trailing end of mechanical anchoring device

CLAIMS

1. A mechanical anchoring device (1) for cable bolts, comprising:
an expansion head (3) in the form of a plurality of expansion leaves (4), for engaging rock strata, at an axially trailing end (22) of the mechanical anchoring device (1);
a retention barrel (2) located at an axially smaller distance to a leading end (21) of the mechanical anchoring device (1) than the distance between the expansion head (3) and the leading end (21) of the mechanical anchoring device (1);
a connecting device (14) connected to each of the expansion leaves (4);
and wherein the retention barrel (2) comprises a first (5) and a second (6) through hole for receiving a cable in each of the first (5) and second (6) through hole.

2. A mechanical anchoring device according to claim 1, **characterized in** that the connecting device (14) further comprises axial branches (15) extending from each of the expansion leaves (4), along a radial outside of the retention barrel (2), in a direction substantially along a longitudinal axis of the mechanical anchor device (1) towards the leading end (21) of the mechanical anchor device (1) and wherein the axial branches (15) are connected to a transverse branch (16), extending substantially in a direction transverse to the longitudinal axis of the mechanical anchoring device (1), at a position of the leading end of the mechanical anchoring device (1).

3. A mechanical anchoring device according to any of claims 1 or 2, **characterized in** that the connecting device (14) further comprises an alignment hole (17, 18) at the transverse branch (16) of the connecting device (14).

4. A mechanical anchoring device according to claims 1 or 2, **characterized in** that the connecting device (14) comprises a first (17) and a second (18) alignment hole at the transverse branch of the connecting device (14).

5. A mechanical anchoring device according to any of the previous claims, **characterized in** that the retention barrel (2) further comprises substantially axially extending side slots (9), one side slot (9) for each expansion leaf (4), in the radial peripheral surface of the retention barrel (2), each for accommodating an axial branch (15) of the connecting device (14).

6. A mechanical anchoring device according to any of the previous claims, **characterized in** that, at least one of, the first (5) and second (6) through hole of the retention barrel (2) widens conically at the leading end of the first (5) or second (6) through hole and in that a conically shaped, longitudinally hollow, wedge (19) with axially extending through hole is positioned in the conically widened through hole (5, 6) at the leading end of the retention barrel (2).

7. A mechanical anchoring device according to claim 6, **characterized in** that a spring (20) is arranged between the leading end of the conically shaped wedge (19) and the transverse branch (16) of the connecting device (14).

8. A mechanical anchoring device according to any of the previous claims, **characterized in** that the expansion leaves (4) comprise a serrated outer surface (10).

9. A mechanical anchoring device according to any of the previous claims, **characterized in** that the outer radial peripheral surface of the retention barrel (2) comprises a truncated cone (8) at its trailing end.

10. A mechanical anchoring device according to any of the previous claims, **characterized in** that the expansion head (3) forms an inner surface formed as a truncated cone (12) at the leading end of the expansion head (3).

11. A mechanical anchoring device according to claims 8 and 9, **characterized in** that the diameter of the truncated cone surface (8) of the retention barrel (2) and the diameter of the truncated cone surface (12) of the inner surface of the expansion head (3) are arranged so that the expansion head (3) will be radially expanded when the mechanical anchoring device (1) is activated to move the retention barrel (2) towards the trailing end of the mechanical anchoring device (1) to engage the inside of the expansion head (3).

12. A mechanical anchoring device according to any of the previous claims, **characterized in** that the expansion leaves (4) have slits (13) extending substantially in a direction along the longitudinal axis of the mechanical anchor device (1).

13. A mechanical anchoring device according to any of the previous claims, **characterized in** that there are exactly two, or exactly three, expansion leaves (4).

14. A mechanical anchoring device according to any of claims 1 to 12, **characterized in** that there are more than three expansion leaves (4).

ABSTRACT

A mechanical anchoring device 1 for cable bolts comprising: an expansion head 3 in the form of a plurality of expansion leaves 4, for engaging rock strata, at an axially trailing end 22 of the mechanical anchoring device 1, a retention barrel 2 located at an axially smaller distance to a leading end 21 of the mechanical anchoring device 1 than the distance between the expansion head 3 and the leading end 21 of the mechanical anchoring device 1, a connecting device 14 connected to each of the expansion leaves 4, and wherein the retention barrel 2 comprises a first 5 and a second 6 through hole for receiving a cable in each of the first 5 and second 6 through hole.

(Publication figure: Fig. 1)

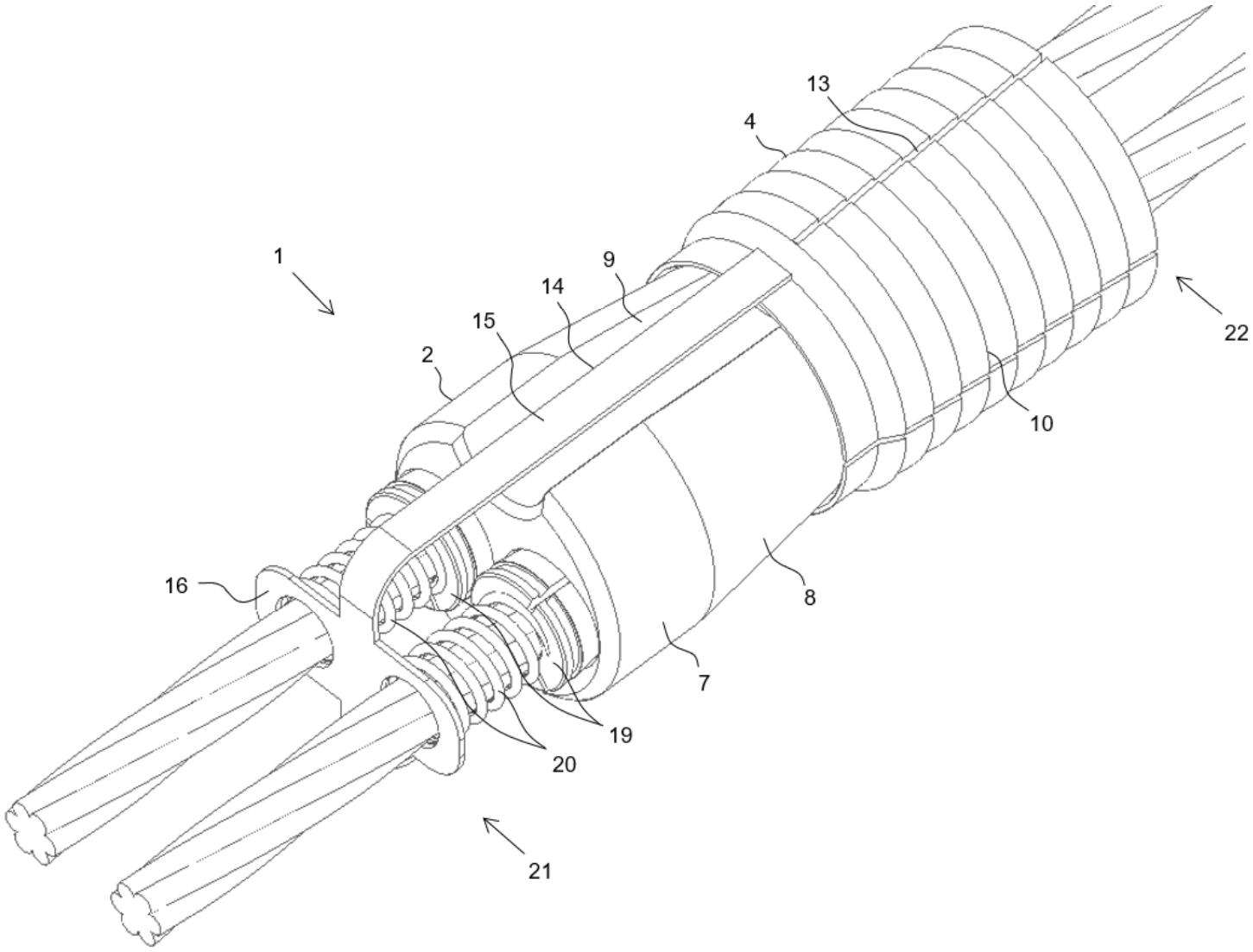

FIG. 1

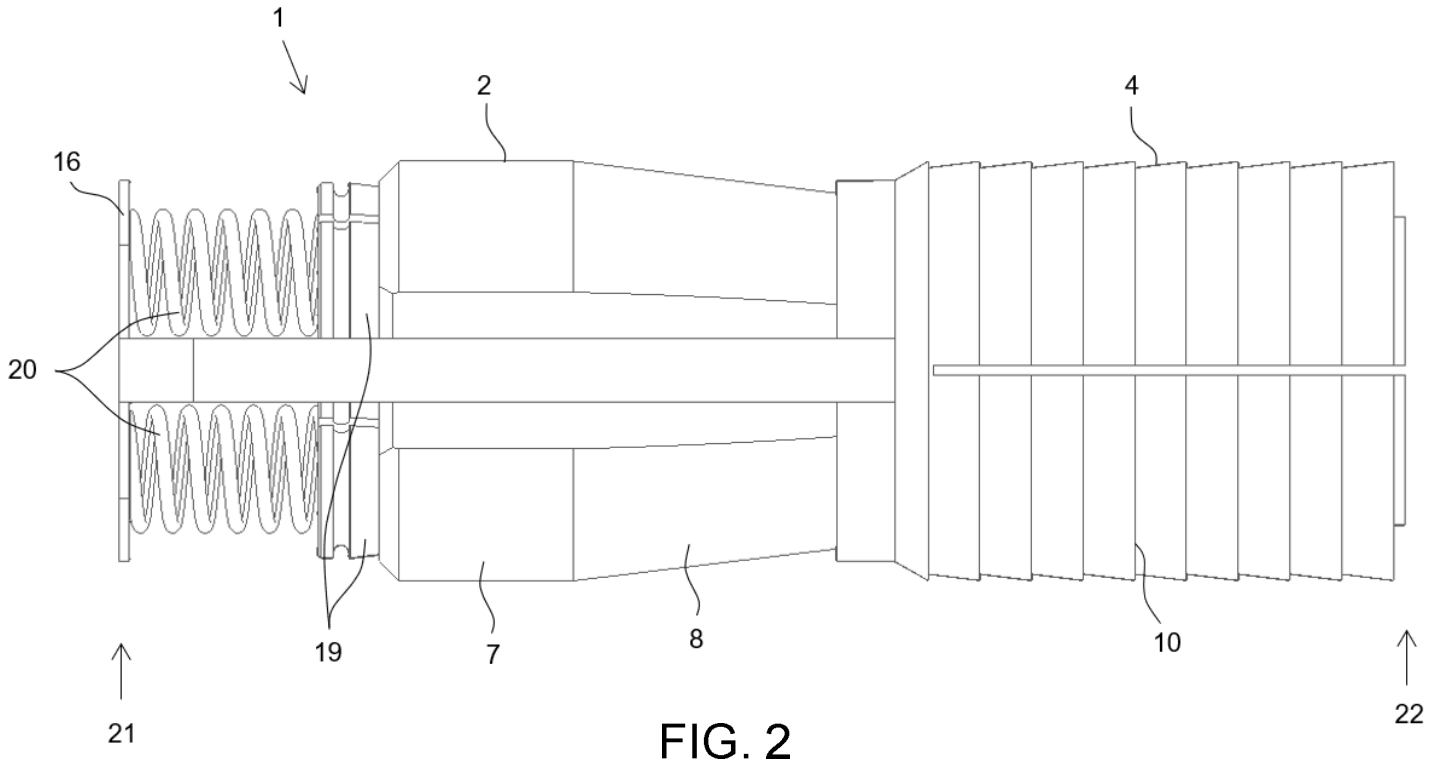

FIG. 2

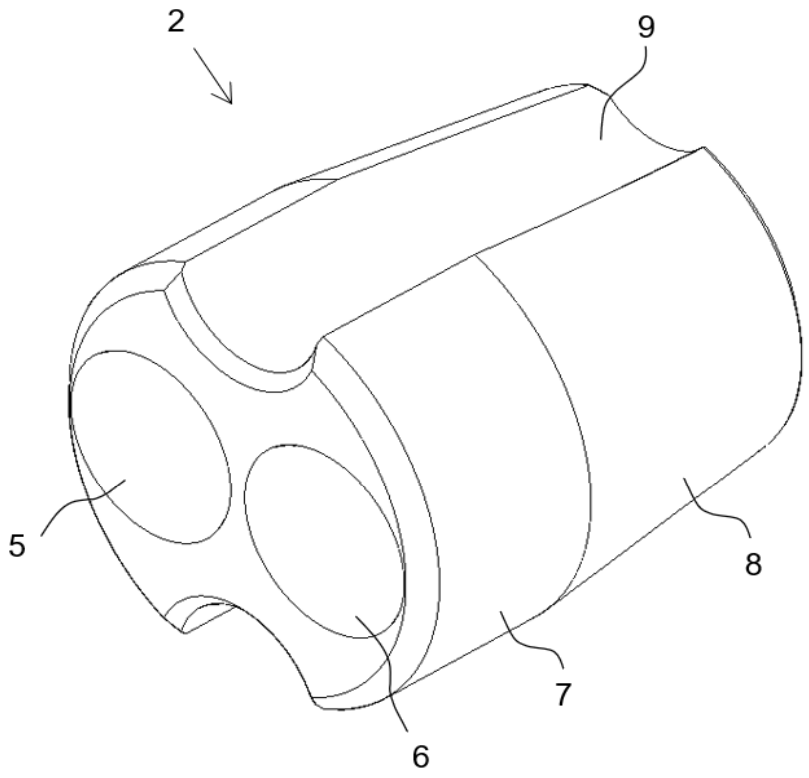

FIG. 3

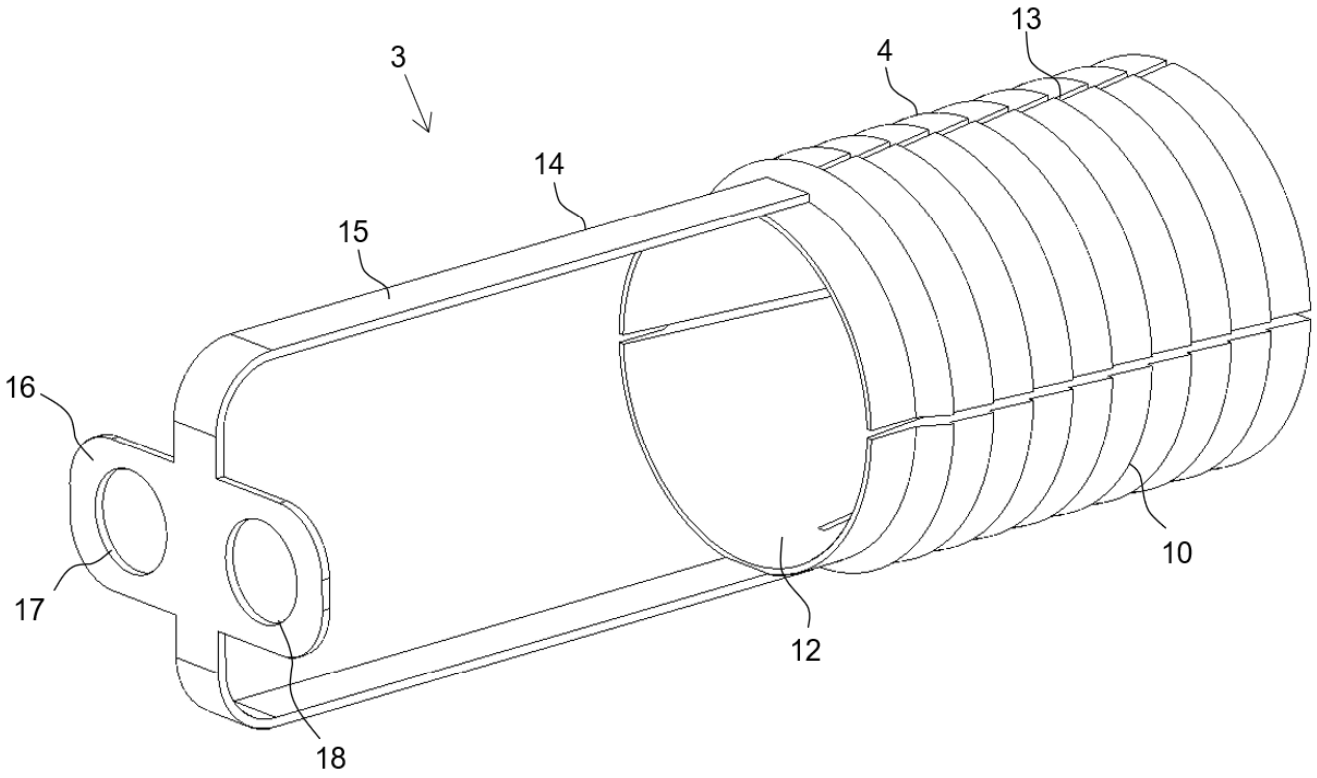

FIG. 4

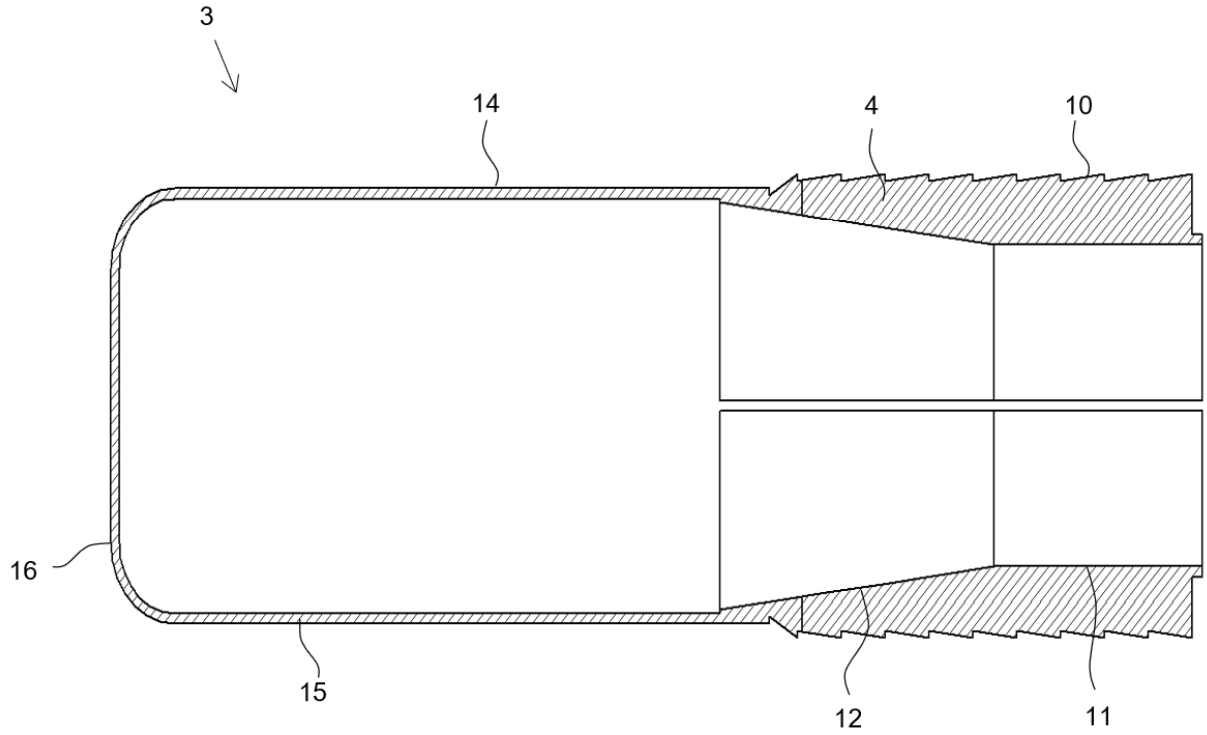

FIG. 5