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Krekula et al.(10) **Pub. No.: US 2017/0298732 A1**(43) **Pub. Date: Oct. 19, 2017**(54) **ROCK BOLT****Publication Classification**(71) Applicant: **Northern Mining Products AB**, Luleå
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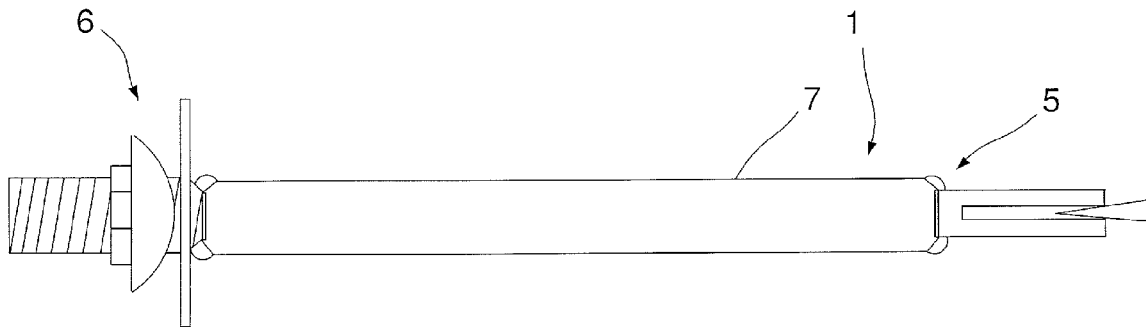
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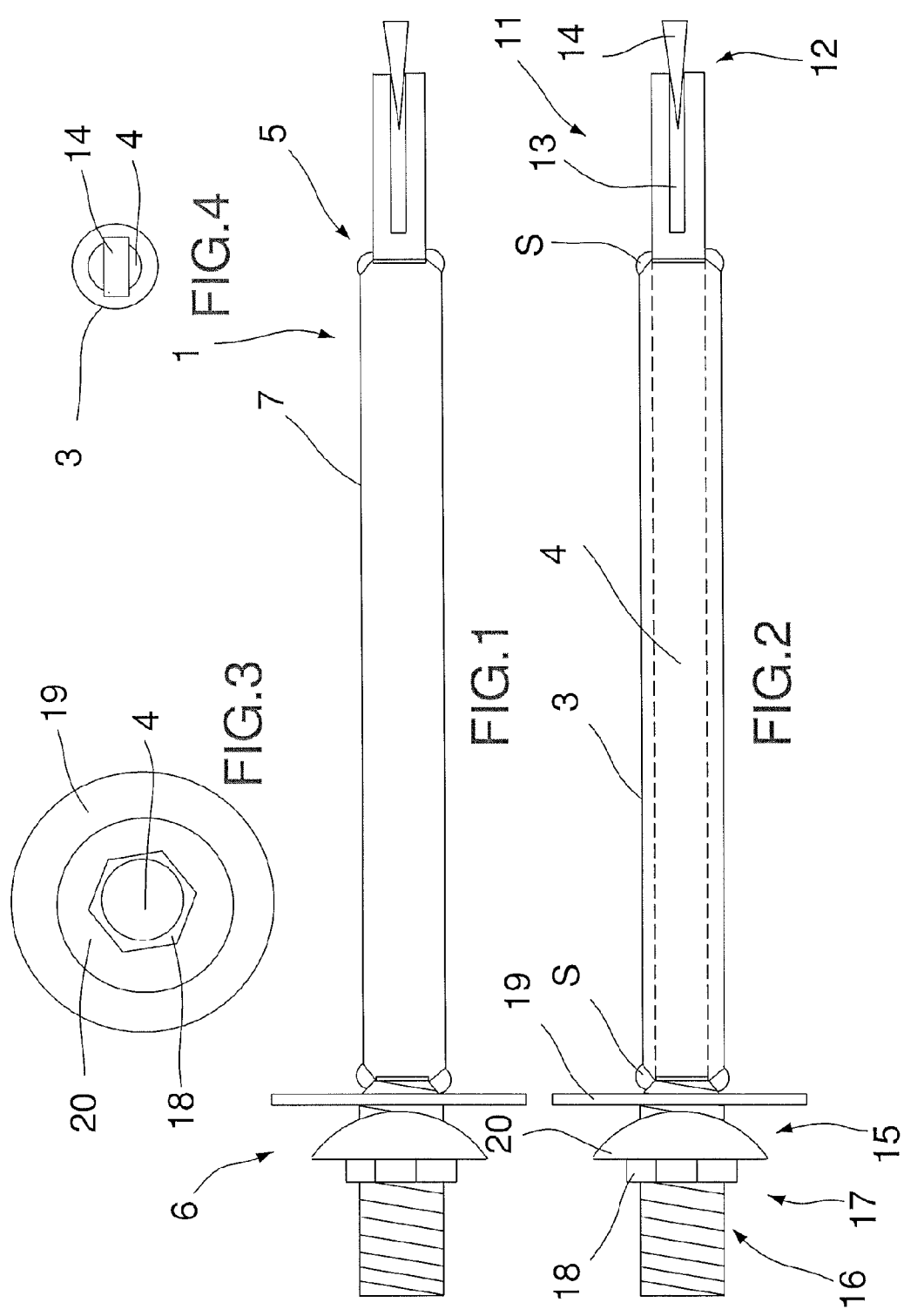
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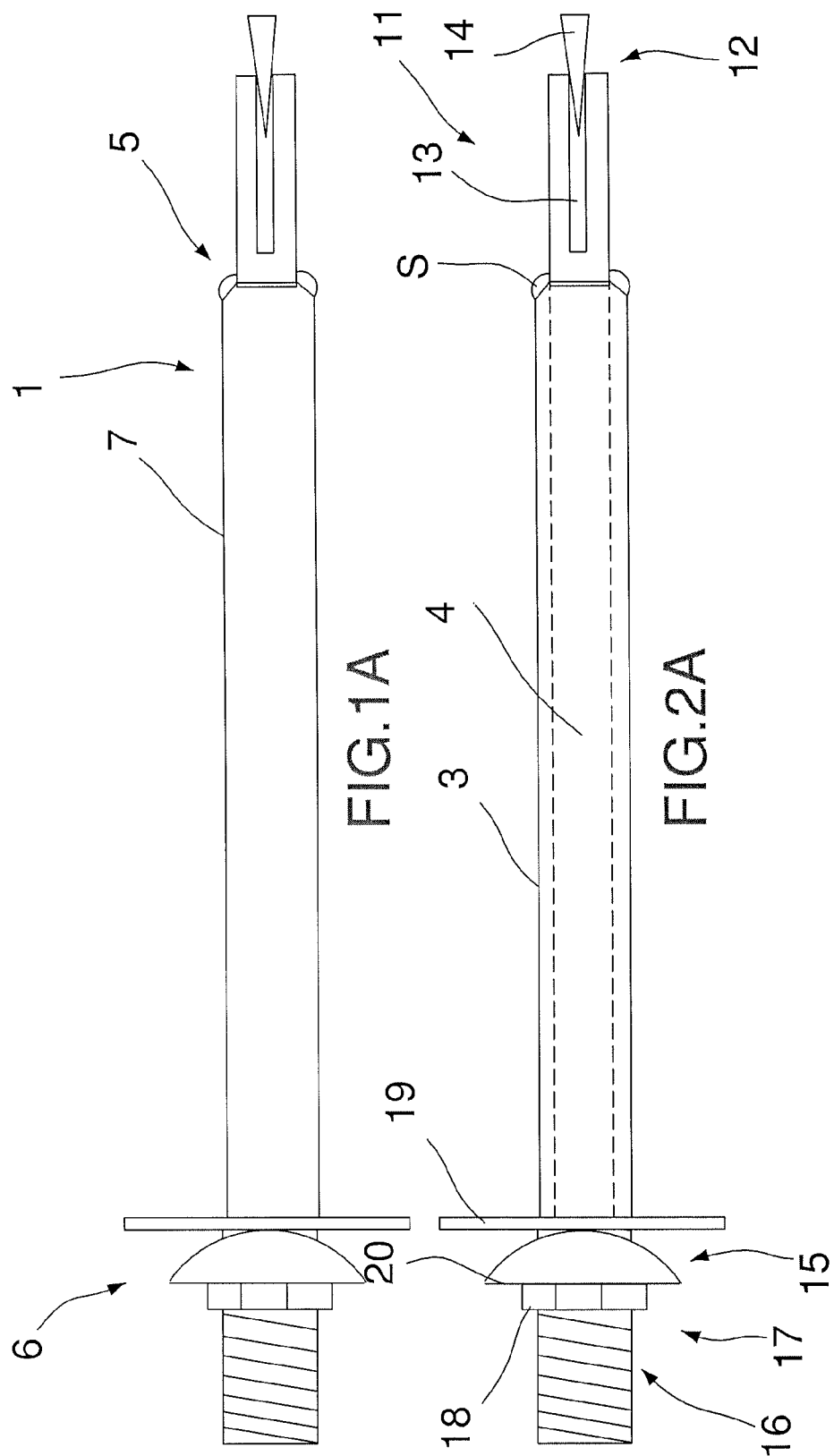
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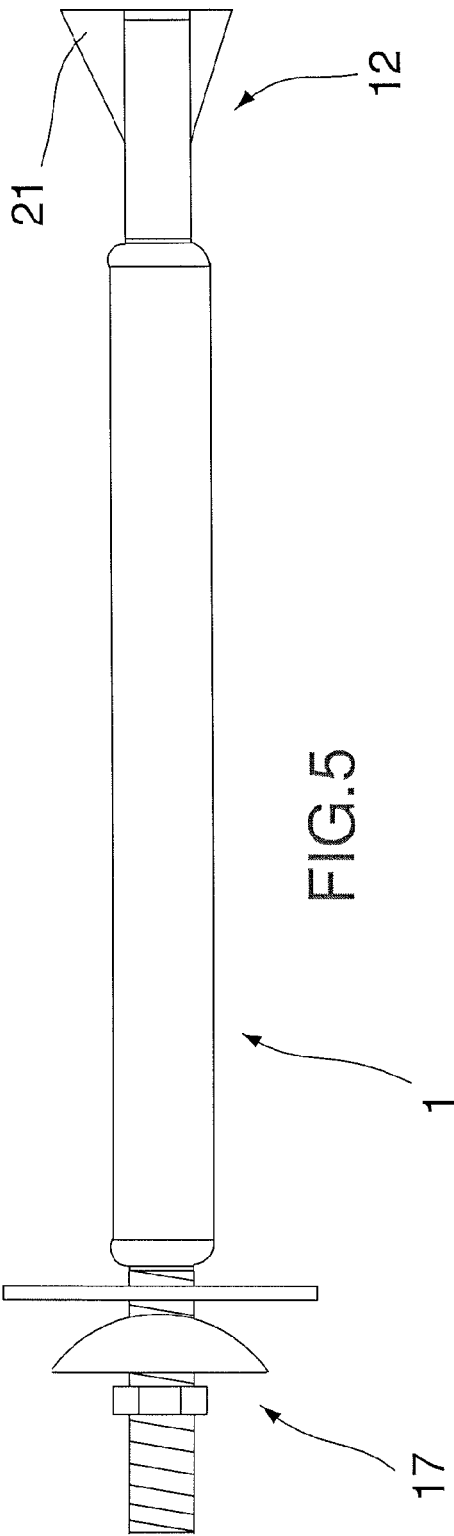
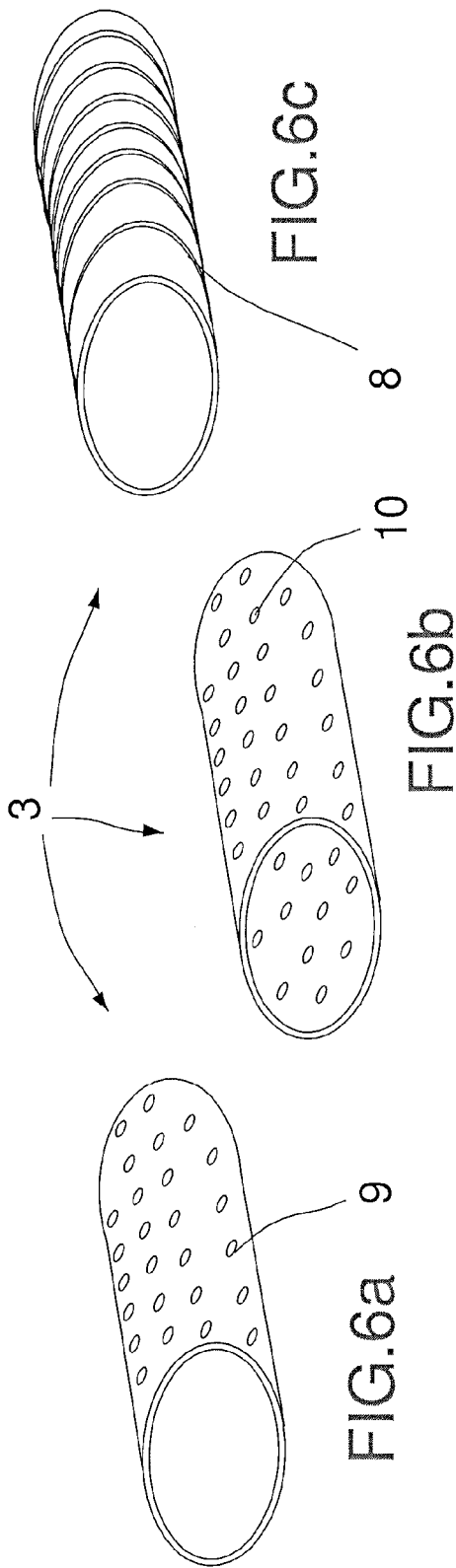
ABSTRACT

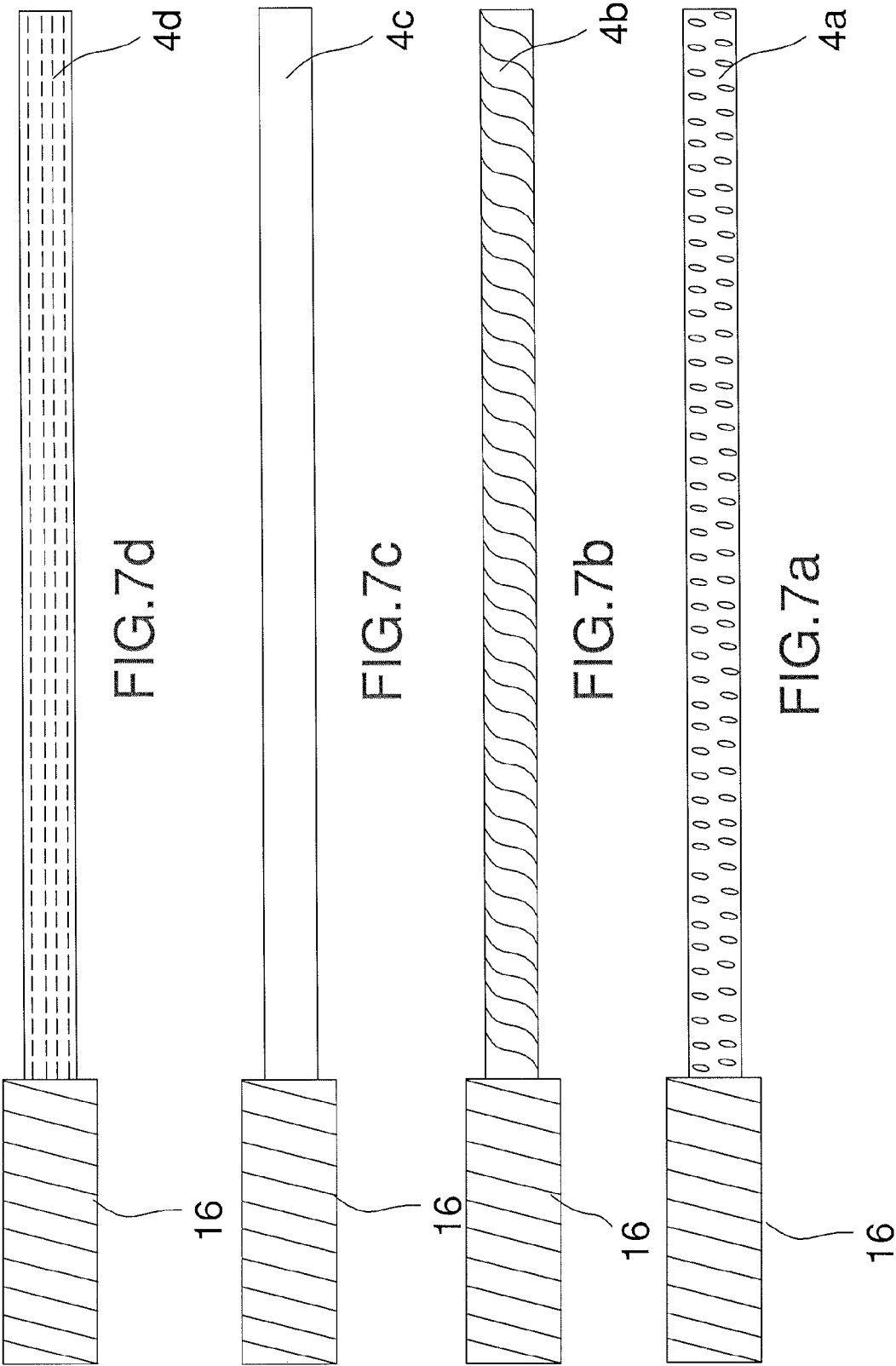
A rock bolt to be embedded in a borehole and a method of manufacturing a rock bolt, the rock bolt including an extended energy-absorbing part, the first end of the energy-absorbing part including an anchor and the second end of the energy-absorbing part including a screw joint for prestressing the rock bolt. The rock bolt includes an extended tubular part with a jacket and a first end section and a second end section, with an internal dimension that is larger than the external dimension of the energy-absorbing part and arranged in such a manner that it surrounds the energy-absorbing part.











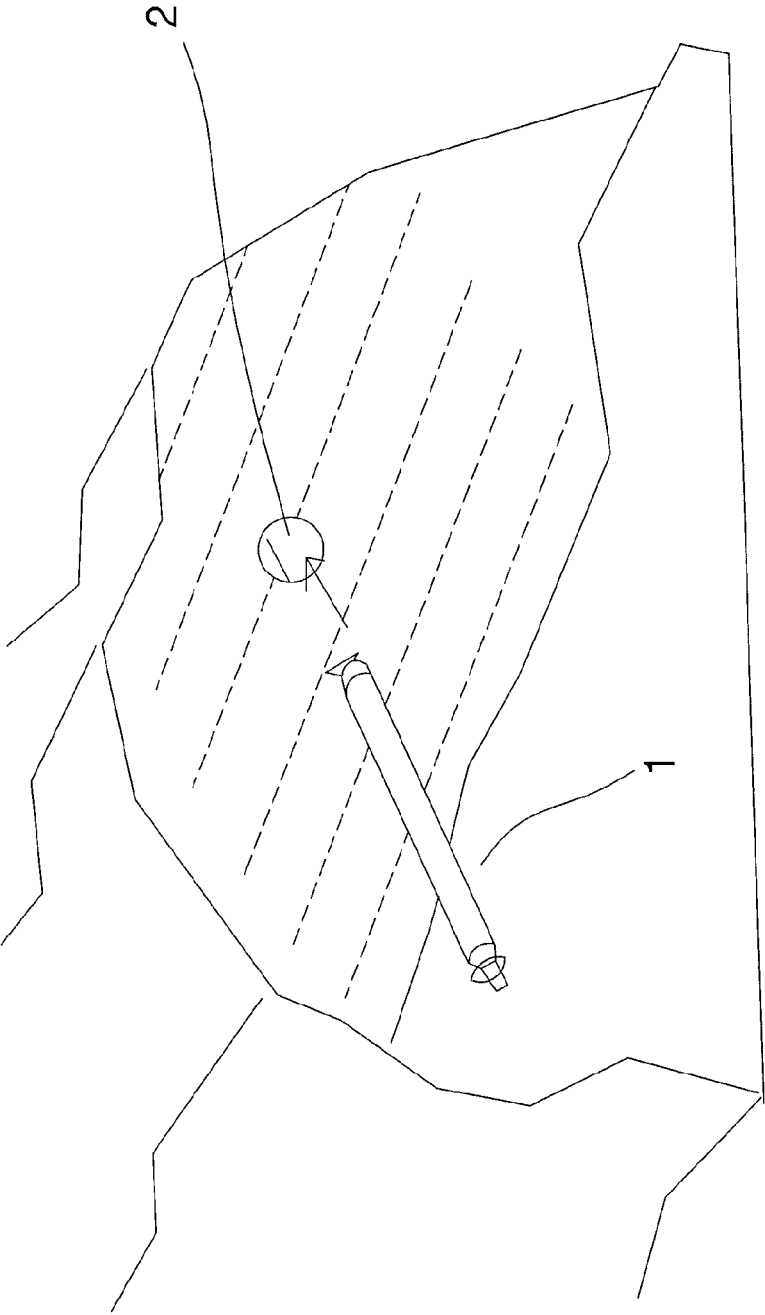


FIG. 8

ROCK BOLT

[0001] The present invention concerns a rock bolt for the absorption of forces during the reinforcement of rock chambers in mines and during similar work with rock.

BACKGROUND

[0002] Mines in the world are being constructed ever deeper in order to reach minerals. This leads to increased rock tension and an increased risk of seismic activity. As the depth increases and in regions with large deformations, reinforcement with the ability to absorb energy, known as “dynamic reinforcement”, is used.

[0003] There are principally two different types of energy-absorbing bolt. In one variant, the absorption of energy takes place through friction between the bolt and the grout or between the bolt and the borehole. The bolt glides and absorbs energy.

[0004] A second method is to deform or strain the bolt. If the degree of strain is large, the absorption of energy is also large. The larger the degree of strain, the larger the absorption of energy.

[0005] In order to achieve as large a degree of strain as possible, the disengaged length, which is the length between attachment of the bolt inside the borehole and the free end of the bolt, should be as long possible.

[0006] An embedded dynamic rock bolt normally consists of an extent with a thread with a screw joint, and one or several attachment regions along the bolt. The term “attachment region” is here used to denote one or several regions along the extent of the bolt that has been embedded in the borehole. The energy-absorbing regions along the bolt, at which the bolt can be strained, are constituted by stretches between the embedded parts that have a low friction between the grout and the bolt. A bolt with several anchors reduces the energy-absorbing ability of the bolt, since the stretch over which the bolt can be strained is reduced.

[0007] One disadvantage of dynamic embedded bolts arises if damage in the rock chamber reaches the region between the anchors, since in this case no counteracting forces are present to hold the rock in place.

SUMMARY OF THE INVENTION

[0008] The purpose of the present invention is to remove the problems described above by offering an embedded dynamic rock bolt of which the energy-absorbing ability is larger since the extent that can be strained being longer than it is in conventional embedded dynamic rock bolts.

[0009] This purpose is achieved through an embedded dynamic rock bolt with an energy-absorbing part that is located in a protected environment without being able to come into contact with the grout, at the same time as the energy-absorbing part is as long as possible.

DESCRIPTION OF DRAWINGS

[0010] The invention will be described below with reference to the attached drawings of which:

[0011] FIG. 1 shows a side view of a rock bolt according to the invention with an anchor with a wedge,

[0012] FIG. 1A shows an alternative embodiment of a rock bolt according to the invention,

[0013] FIG. 2 shows the rock bolt from FIG. 1 in cut-through view,

[0014] FIG. 2A shows the rock bolt from FIG. 1A in cut-through view,

[0015] FIG. 3 shows an end view of a screw joint,

[0016] FIG. 4 shows an end view of an anchor,

[0017] FIG. 5 shows the bolt from FIG. 1, where the anchor has been exchanged for a stirring arrangement,

[0018] FIG. 6a shows an external tubular part provided with lugs,

[0019] FIG. 6b shows an external tubular part with perforations,

[0020] FIG. 6c shows an external tubular part with a pattern,

[0021] FIG. 7a shows an energy-absorbing part in the form of a reinforcement member,

[0022] FIG. 7b shows an energy-absorbing part in the form of a wire,

[0023] FIG. 7c shows an energy-absorbing part in the form of a steel rod,

[0024] FIG. 7d shows an energy-absorbing part in the form of a composite material, and

[0025] FIG. 8 shows rock with a borehole for the introduction of a rock bolt.

DESCRIPTION OF EMBODIMENTS

[0026] FIG. 1 shows a rock bolt 1 according to the invention intended to be embedded in a borehole 2 in rock. The rock bolt 1 comprises an extended external tubular part 3 and an internal extended energy-absorbing part 4. In one preferred embodiment, the external part 3 has been given a length that is somewhat less than the length of the energy-absorbing part 4. The external tubular part 3 has a first end 5 and a second end 6, and a magnitude that allows the energy-absorbing part 4 to be surrounded by the external part 3. It is an advantage if the external part 3 has circular cross-section in the form of a circularly symmetrical metal tube, but it should be realised that also other forms and materials are possible. Square, elliptical or rectangular tubes, of metal, plastic or composite material can, for example, be used. Also other forms of the external tubular part 3 can be used.

[0027] The jacket 7 of the external tubular part 3 is, as is shown in FIGS. 6a-6c, arranged with a friction-increasing structure, for example in the form of a pattern 8. The jacket 7 may be arranged with lugs 9, in the same manner as the lugs on a commonly occurring reinforcement member. The jacket 7 also may be arranged with perforations 10, or with various combinations of pattern, lugs and perforations. The purpose of the friction-increasing structure is to give a better attachment surface in the concrete into which the bolt 1 has been embedded. If the jacket 7 is provided with perforations 10, the concrete is given the possibility to grip onto the tubular part 3 without the concrete running into the tubular part and making contact with the energy-absorbing part 4.

[0028] The internal energy-absorbing part 4 demonstrates a length that exceeds the length of the external tubular part 3. In one preferred embodiment, the energy-absorbing part 4 comprises a reinforcement member 4a, but it can in other embodiments comprise a wire 4b, a rod 4c or an extended member of a composite material 4d, as shown in FIGS. 7a-7d. One end 11 of the internal energy-absorbing part 4, the end that is intended to be located at the bottom of the borehole 2 when the rock bolt 1 has been mounted, is arranged with an anchor 12 in the form of a slot 13 with a wedge 14. The slot 13 is placed in the end 11 of the

energy-absorbing part 4 in such a manner that the end has a division to a certain extent. A wedge 14 is located in the slot 13. When the bolt 1 is introduced into the borehole 2 and reaches the bottom of the borehole, the bolt 1 is pressed or beaten against the bottom of the borehole such that the wedge 14 is pressed into the slot 13. When the wedge 14 is pressed into the slot 13, the parts on the two sides of the slot are pressed outwards against the walls of the borehole and attach in this manner the end 11 of the rock bolt in the borehole 2.

[0029] The second end 15 of the energy-absorbing part 4 is provided with a threaded section 16 that extends a certain distance into the energy-absorbing part 4. The threaded section 16 is intended to be located outside of the borehole when the bolt 1 has been introduced into the hole 2, and has a diameter that is equal to or greater than the external dimension of the outer part, as shown in FIGS. 1 and 2. The purpose of this is to avoid any weakening of the internal energy-absorbing part caused by the thread. A screw joint 17 in the form of a nut 18, a washer 19 and a force distributor in the form of a half sphere 20 is mounted at the threaded section 16. When the rock bolt 1 is mounted and embedded in the borehole 2, it is prestressed by the screw joint 17. The task of the half sphere 20 is to direct the force from the rock against the washer 19 and the nut 18. It should be realised that, when the internal energy-absorbing part 4 comprises a wire 4b or a composite material 4d, the threaded section 16 and the anchor 12 are attached to the energy-absorbing part 4c or 4d through welding, gluing or in another manner permanent attached.

[0030] The internal energy-absorbing part 4 is introduced into, placed inside, the external tubular part 3. One end 5 of the external tubular part 3 is attached at the internal energy-absorbing part 4 in association with the anchor 12. The second end 6 of the tubular part 3 is attached in close association with the screw joint 17, in direct association with the end of the threaded section 16. According to one preferred embodiment, the ends 5, 6 of the external tubular part 3 are attached by means of welding with fully welded joints S. It should, however, be realised that another type of fastening can be used, such as gluing or other permanent fastening. Gluing is particularly appropriate when other material than steel is used for the energy-absorbing part 4 and/or the external tubular part 3.

[0031] In another embodiment, only the end 5 of the tubular part is attached through welding with fully welded joints to the internal energy-absorbing part in association with the anchor 12. The length of the tubular part 3 is adapted such that its second end 6 comes into contact with the washer 19 and makes contact with it when the rock bolt is prestressed.

[0032] The preferred rock bolt is mounted in the following manner as shown in FIG. 8: a fixing material such as concrete is introduced into the borehole 2 when it has been drilled in the rock. The rock bolt 1 is subsequently introduced into the hole with the anchor 12 entering the borehole first. When the rock bolt 1 reaches the bottom, the bolt is pressed or beaten against the bottom of the borehole such that the anchor becomes attached and the bolt is fixed. When the concrete has hardened, the screw joint 17 is mounted on the part of the threaded part 16 that protrudes from the borehole 2, and is tightened such that the energy-absorbing part 4 is prestressed.

[0033] If resin is used instead of concrete, the bolt 2 is provided with an anchor in the form of a stirring arrangement 21 formed by a blade or disk having the form of a paddle, instead of the wedge. When the bolt is to be mounted, the resin is introduced into the borehole, after which the bolt is introduced into the borehole and rotated such that the resin is mixed by the stirring arrangement 21. The resin hardens rapidly, which is why the screw joint 17 can be mounted and prestressed in direct association with the insertion of the bolt 1 into the hole 2.

[0034] Due to the fact that the external tubular part 3 surrounds and encloses the energy-absorbing part 4, the energy-absorbing part 4 is not subject to corrosion or other influences that can weaken the bolt 1. This gives a lifetime that is longer than that of other types of embedded rock bolt. In addition, the rock bolt 1 is given a maximum extent over which the bolt can be bent, since the energy-absorbing part 4 does not come into contact with the embedding material. This gives the advantage that the rock bolt can be bent more extensively and in this way can absorb larger forces than those absorbed by other types of embedded rock bolt.

[0035] The rock bolt is manufactured in the following manner:

[0036] a length and a diameter of the hole 2 in the rock are determined,

[0037] an extended energy-absorbing part 4 is arranged,

[0038] an extended tubular part 3 is arranged,

[0039] the energy-absorbing part 4 is adapted inside of the tubular part 3,

[0040] one end 5 of the tubular part 3 is permanently attached in association with a first end section 11 of the energy-absorbing part 4.

[0041] A final step in the manufacture comprises

[0042] the second end 6 of the tubular part 3 being permanently attached in association with a second end section 15 of the energy-absorbing part 4.

[0043] According to a second embodiment described above, the final step in the manufacture comprises

[0044] a screw joint 17 with a washer 19 being arranged at a second end section 16 of the energy-absorbing part, and the second end 6 of the tubular part 3 coming into contact with the washer.

[0045] The internal dimension of the external tubular part 3, i.e. its internal diameter in the case in which it comprises a circular pipe, exceeds the external dimension or the diameter of the energy-absorbing part 4. The dimensions may be so adapted that the energy-absorbing part 4 must be pressed into the external tubular part 3, but it should be realised that it is an advantage if the external tubular part 3 has an internal dimension that is large enough to allow the internal energy-absorbing part 4 to move or be displaced freely relative to the tubular part 3 before the fastening, by, for example, welding or gluing. If the internal dimension of the external tubular part 3 is sufficiently large relative to the dimension of the internal energy-absorbing part 4, the advantage is achieved that the risk that grout comes into contact with the energy-absorbing part is minimised.

[0046] The present invention is not limited to what has been described above and shown in the drawings: it can be changed and modified in several different ways within the scope of the innovative concept defined by the attached patent claims.

1. A rock bolt to be embedded in grout in a borehole, comprising an extended energy-absorbing part, the first end

of the energy-absorbing part comprising an anchor and the second end of the energy-absorbing part comprising a screw joint for prestressing of the rock bolt, wherein the rock bolt comprises an extended tubular part with a jacket and a first and a second end section, and an internal dimension of the tubular part that is larger than the external dimension of the energy-absorbing part and arranged in such a manner that it surrounds the energy-absorbing part and that the first end section of the tubular part is connected with the energy-absorbing part in association with the anchor and the second end section is arranged to make contact with a washer that is a component of the screw joint and to make contact with the washer when the rock bolt is prestressed.

2. The rock bolt according to claim 1, whereby the tubular part extends between the anchor and the screw joint and in this way prevents the energy-absorbing part coming into contact with the grout.

3. The rock bolt according to claim 1, whereby the end sections of the tubular part are united with the energy-absorbing part in association with the anchor and the screw joint.

4. The rock bolt according to claim 3, whereby the tubular part is united by means of welding.

5. The rock bolt according to claim 1, whereby the jacket of the tubular part is provided with a structure to increase friction.

6. The rock bolt according to claim 1, whereby the jacket of the tubular part is perforated.

7. The rock bolt according to claim 1, whereby the jacket of the tubular part is provided with lugs.

8. The rock bolt according to claim 1, whereby the energy-absorbing part comprises a reinforcement member.

9. The rock bolt according to claim 1, whereby the energy-absorbing part comprises a wire.

10. The rock bolt according to claim 1, whereby the energy-absorbing part comprises a steel rod.

11. The rock bolt according to claim 1, whereby the energy-absorbing part comprises an extended body of a composite material.

12. The rock bolt according to claim 3, whereby the tubular part is attached by means of welding.

13. The rock bolt according to claim 1, whereby the anchor comprises a wedge introduced into a slot in the end of the energy-absorbing part.

14. The rock bolt according to claim 1, whereby the anchor comprises a stirring arrangement arranged at the end of the energy-absorbing part.

15. A method for the manufacture of a rock bolt, comprising the following operational steps:

that a length and a diameter of the hole in the rock are determined,

that an extended energy-absorbing part is chosen to correspond to the length of the hole in step 1,

that an extended tubular part is chosen to correspond to the length of the hole in step 1 or the diameter of the energy-absorbing part in step 1,

that the energy-absorbing part is adapted inside of the tubular part,

that one end of the tubular part is permanently attached in association with a first end section of the energy-absorbing part,

that the second end of the tubular part is permanently attached in association with a second end section of the energy-absorbing part, and

that the first end and the second end of the energy-absorbing part are arranged with a screw joint and an anchor, respectively.

16. A method for the manufacture of a rock bolt, comprising the following operational steps:

that a length and a diameter of the hole in the rock are determined,

that an extended energy-absorbing part is chosen to correspond to the length of the hole in step 1,

that an extended tubular part is chosen to correspond to the length of the hole in step 1 or the diameter of the energy-absorbing part in step 1,

that the energy-absorbing part is adapted inside of the tubular part,

that one end of the tubular part is permanently attached in association with a first end section of the energy-absorbing part,

that the first end and the second end of the energy-absorbing part are arranged with a screw joint and an anchor, respectively, and

that a washer that is a component of the screw joint is arranged in such a manner that it makes contact with the second end of the tubular part.

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