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Adapter for rock or building anchor system

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Abstract

Adapter for rock or building anchor system

An adapter (20) is described for at least electrically connecting a solid anchor system (11), in particular a rock or stone or building anchor system, to a data handling system (30), wherein the solid anchor system (11) comprises an anchor (12) for at least partially introducing into the solid and at least one sensor (13), wherein the anchor has an external thread (15) and electrical contact regions (16) of the sensor (13) at least at an end part (14) of the anchor (12) which is not to be introduced into the solid, wherein the adapter comprises: a first sleeve assembly (23) with an internal thread (24) for screwing onto the external thread (15) of the anchor (12), in particular from the end part of the anchor which is not to be introduced into the solid; a second sleeve assembly (25) which has electrical connections (26) exposed in an interior space (27) of the second sleeve assembly (25) in order to contact the electrical contact regions (16) on the anchor (12) in a state installed at the anchor; wherein the first sleeve assembly (23) is rotatable relative to the second sleeve assembly (25) in a state not installed at the anchor and wherein the interior space (27) is sealed against the surrounding medium in the state installed at the anchor, wherein the anchor (12) is screwed to the first sleeve assembly (23) in particular in the state installed at the anchor.

(Fig. 2)

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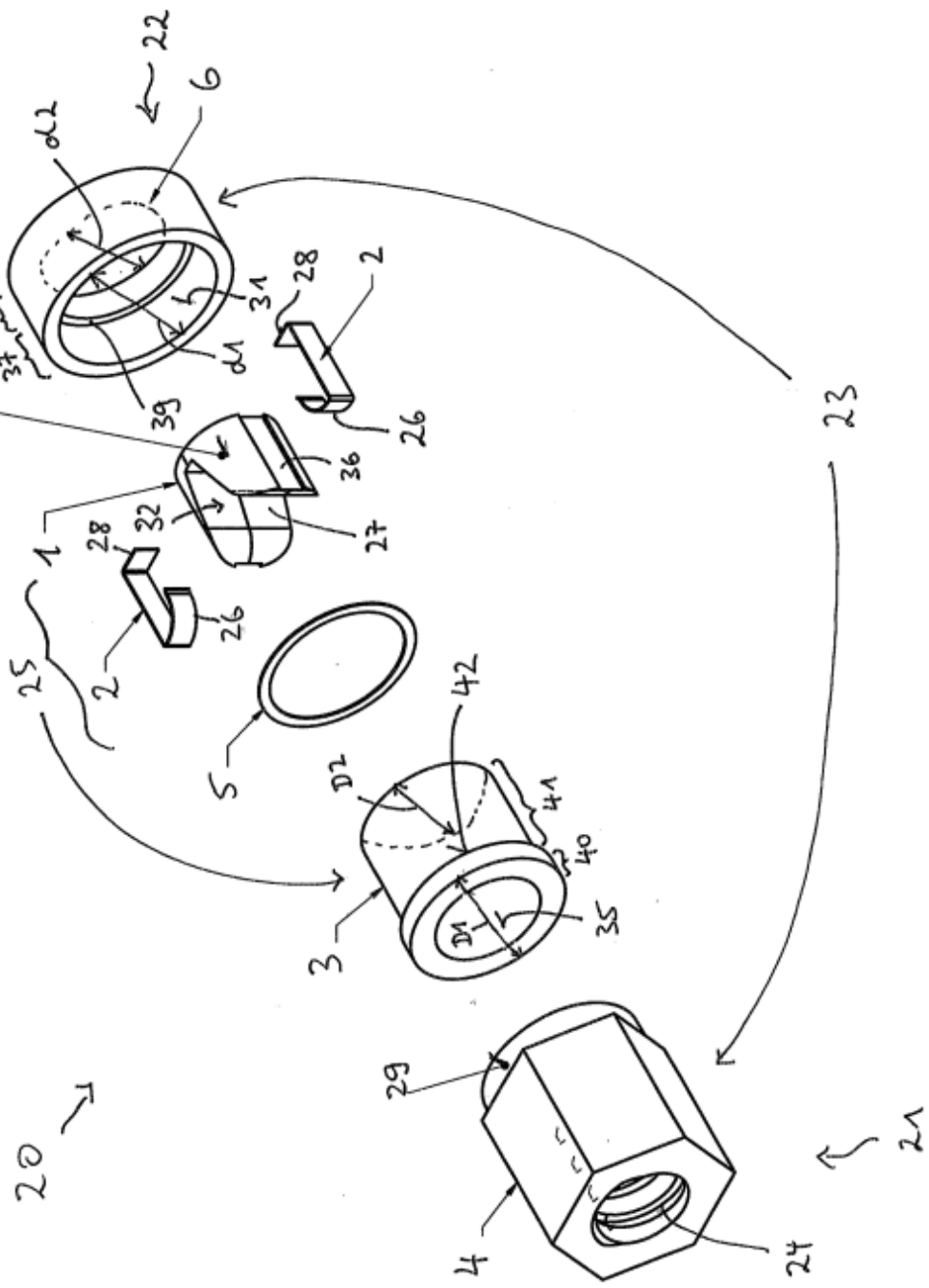

Fig. 2

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Adapter for rock or building anchor system

Technical Field

The invention relates to an adapter for at least electrically connecting a solid anchor system to a data handling system, furthermore relates to a system which comprises a solid anchor system, an adapter and a data handling system, and still furthermore relates to a method of at least electrically connecting a solid anchor system to a data handling system.

Background of the Invention

EP 3 927 942 B1 discloses a rock anchor with a sensor for measuring mechanical stresses. A conductor track is fixed on a fastening section of an anchor, so that the conductor track follows corresponding deformations or movements of the fastening section. An evaluation unit can measure and evaluate an electrical resistance of the conductor track.

WO 2021/028394 A1 discloses a method for producing a deformable conductor using an ink composition.

AT 525566 B1 discloses a sensor-supported hollow rod system which consists of a hollow rod, a coupling element and a nut with a holding plate, and also comprises at least one condition monitoring system. The hollow rod system is configured as a self-drilling system with a lost drill bit facing a borehole interior, and the hollow rod is configured as an at least two-layer tube, comprising an inner measuring tube and an outer casing tube. A housing for an intelligent nut is configured to be able to be screwed onto the sensor carrier. The housing has a viewing opening in order to have a free view of an adapter which is arranged in the interior of the sensor carrier. In order to prevent unintentional ingress of moisture or dust into the interior of the housing, a cover for the housing is provided, which cover is connected to the housing in a force-fitting manner. The cover has the passage opening which is provided for connection to a transmission unit for a long range wide area network. The adapter has a plurality

of indentations or grooves into which a wide variety of strain gauges can be inserted.

However, the system disclosed in the patent specification mentioned above or the components thereof are very complex and correspondingly expensive and furthermore cannot provide satisfactory results under all conditions.

It is therefore an object of the present invention to provide an adapter for electrically connecting a solid anchor system to a data handling system, which adapter is of simple construction, ensures a reliable electrical connection and can additionally be used and functions in the field under harsh environmental conditions.

Summary of the Invention

This object is achieved by the subject matter of the independent claims. Advantageous embodiments of the present invention are described in the dependent claims.

According to an embodiment of the present invention, an adapter according to independent claim 1 is provided. The adapter is provided for at least electrically connecting a solid anchor system (German: Feststoffankersystem), in particular a rock or stone or building anchor system, to a data handling system, wherein the solid anchor system comprises an anchor for at least partially introducing into the solid and at least one sensor, wherein the anchor has an external thread and electrical contact regions of the sensor at least at an end part of the anchor which is not to be introduced into the solid, wherein the adapter comprises: a first sleeve assembly with an internal thread for screwing onto the external thread of the anchor, in particular from the end part of the anchor which is not to be introduced into the solid; a second sleeve assembly which has electrical connections exposed in an interior space of the second sleeve assembly in order to contact the electrical contact regions on the anchor in a state installed at the anchor; wherein the first sleeve assembly is rotatable relative to the second sleeve assembly in a state not installed at the anchor and wherein the interior space is sealed against the surrounding medium in the state installed at the

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anchor, wherein the anchor is screwed to the first sleeve assembly in particular in the state installed at the anchor.

The solid anchor system can enable anchoring in a solid, such as, for example, in rock or stone or in a building, in particular in a building wall. The solid anchor system can be used, for example, in mining or tunnel construction or building construction and can be suitable therefor.

The anchor can be configured, for example, as a solid (massive) metal rod or as a hollow tube. In a region to be introduced into the solid, the anchor can be equipped with one or more locking(s) or wedging element (s) or spreading element(s). In general, the anchor can be equipped with one or more identical or different wedging element (s) and/or spreading element (s) which cause anchoring or fixing of the anchor in the solid in a region to be introduced into the solid. The anchor can be configured, for example, as a spreading sleeve anchor, wedge sleeve anchor, double wedge anchor, slotted wedge anchor, expansion anchor or a combination of the types mentioned above. The anchor can also be configured as a self-drilling anchor. The anchor can be made at least partially of metal or metal alloy, in particular steel, and/or can encompass an anchor head, anchor foot and an anchor rod. The anchor can be configured or equipped, for example, with spreading elements, but can also be configured as a composite anchor and/or friction anchor.

The external thread does not have to be present along an entire length of the anchor, but rather only has to be provided at an end part of the anchor which is not to be introduced into the solid. In other embodiments, an external thread can also be provided, for example, additionally in a part of the anchor which is to be introduced into the solid at least in an end part of the part of the anchor which is to be introduced into the solid, for example, in order to actuate one or more spreading elements or to actuate one or more wedges for firmly locking the anchor in the solid.

An end part of the anchor which is to be introduced into the solid can be screwed, for example, via the external thread with the aid of a (metal) plate and/or a nut, in particular at the abutting side (side facing away from the rock or

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solid). The anchor can thus be firmly anchored in the solid. The adapter can be screwed onto the end part of the adapter onto the region projecting further into the exterior space via the nut and/or the metal plate; using the internal thread of the first sleeve assembly and the external thread of the end part of the anchor. In this state, the anchor can be spread or wedged at the innermost end (which is introduced into the solid) via spreading jaws or other wedging elements or spreading elements, in order thus to be locked in the solid.

The sensor can be configured integrated with the anchor and/or can be applied partially on the anchor and/or can be provided (spatially) separately from the anchor. At the end part, the anchor has the electrical contact regions of the sensor which are in particular electrically connected to the sensor. According to an embodiment, for example, the sensor can be applied at least partially on an outer surface of the anchor, that is to say can also be connected to the anchor. The sensor can be configured to detect or measure at least one property or a state of the solid into which it is at least partially introduced, for example temperature and/or moisture and/or a deformation and thus the stress within the solid. For example, the sensor can comprise one or more strain strips in order to measure or detect stresses in the solid via the deformation. In other embodiments, the sensor can be configured, for example, to measure and detect temperature and/or pH value and/or gas molecules, for example mine gas, methane, CO2, CO, N2.

Measurement signals of the sensor or of the multiple sensors can be output by the sensor via the electrical contact regions at or on the end part of the anchor. These contact regions of the sensor are contacted (in the state of the adapter installed at the anchor) by the electrical connections of the second sleeve assembly which are exposed in the interior space of the second sleeve assembly. The second sleeve assembly can, for contacting, on the other hand, with the data handling system, comprise further external contacts which are described in more detail below.

The first sleeve assembly can be understood as an assembly which substantially comprises a sleeve shape and which is formed from one or more elements or parts, in particular is formed from two parts which are firmly connected to one

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another. The first sleeve assembly thus enables screwing onto the external thread of the anchor end via the internal thread in order to mechanically connect the adapter to the anchor outside the solid.

The second sleeve assembly can be understood as an assembly comprising one or more elements or components, in particular three components, which comprises at least one sleeve-shaped element or sleeve-shaped component. The second sleeve assembly can in particular comprise at least two electrical connections in order to contact, for example, two measurement signal lines of the sensor via the electrical contact regions of the sensor on the end part of the anchor.

The anchor can comprise an end part which is not to be introduced into the solid, in particular a chisel shape (German: Meißelform) or a tapering shape or a wedge shape, which has the (at least two) electrical contact regions of the sensor on two tapering chisel faces or wedge faces. The tapering end or chisel-shaped end of the anchor can, when the adapter is connected to the anchor, project into the interior space of the second sleeve assembly and be arranged within the interior space such that the electrical contact regions of the sensor electrically contact the electrical connections of the second sleeve assembly.

If the first sleeve assembly is rotatable relative to the second sleeve assembly in a state not installed at the anchor, the second sleeve assembly can be correctly aligned such that the electrical contact regions of the sensor electrically contact the electrical connections of the second sleeve assembly and also such that the tapering end or chisel-shaped end of the anchor can slide or fit into the recess of a guide element, which is described in more detail below.

If the interior space, in the state installed at the anchor, is sealed against the surrounding medium, it can be ensured that reliable electrical contacting between the contact regions of the sensor and the electrical connections of the sleeve assembly is ensured without dust, moisture or other environmental influences impairing contacting. In order to enable sealing against the surrounding medium, it may be necessary to screw the anchor firmly onto the end part of the anchor, in particular to such an extent that compression of a seal,

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which is described further below, is achieved.

The adapter can additionally be configured as a retainer for different types of data handling systems. The data handling system can encompass, for example, a data transmission system and/or data evaluation system. For example, the data handling system can encompass a wireless data transmission system and can be configured to wirelessly transmit the measurement signals received from the sensor to a further evaluation system. The adapter can comprise a mechanical and/or electrical interface on the data handling system side in order to be able to connect different types of data handling systems to the adapter.

Different adapters with different internal thread diameters of the first sleeve assembly can be provided for anchors with different external thread diameters, but matching the respective internal diameter of the adapter. An (identical) second sleeve assembly can, for example, be connected to different first sleeve assemblies in order to provide matching adapters for different anchor external thread diameters.

According to an embodiment of the present invention, the adapter is configured such that the first and/or the second sleeve assembly is closed circumferentially, in particular sealed against the medium of the surroundings, wherein in particular the second sleeve assembly is closed at an outer end face, in particular sealed against the medium of the surroundings, wherein the outer end face of the second sleeve assembly is provided for a contact with the data handling system; and/or wherein, in the state installed at the anchor, the end part of the anchor is arranged within the interior space of the second sleeve assembly.

It can thereby be prevented that surrounding material, such as, for example, moisture, dust, rock fragments, soil, sand, penetrates into the interior space of the second sleeve assembly, which could endanger the reliability of an electrical contacting. The second sleeve assembly can be closed via the outer end face in the axial direction, in particular closed in a manner sealed against the surroundings. The outer end face can, for example, comprise two contacting surfaces or regions which are connected to the electrical connections of the second sleeve assembly and which enable the electrical connections to be

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electrically connected to a data handling system. Reliable derivation of measurement signals of the sensor to the data handling system is thereby enabled.

The second sleeve assembly can, for example, substantially comprise a cylinder or truncated cone shape for mechanical connection to the data handling system, wherein two or more contact points are provided at the outer end face. The second sleeve assembly can, for example, comprise a profiling on a lateral surface which can enable guidance and/or locking with the data handling system, as will be explained in more detail below.

According to an embodiment of the present invention, the adapter further comprises a seal arranged between the first sleeve assembly and the second sleeve assembly for sealing the interior space in the state installed at the anchor.

The seal can, for example, be configured as a sealing ring (e.g. O-ring), made of an elastic material such as rubber. In an assembled state of the adapter (comprising the first sleeve assembly and the second sleeve assembly), the seal does not have to be pressed between the first sleeve assembly and the second sleeve assembly. Only when the assembled adapter is screwed onto the end part of the anchor compression of the sealing ring between the first sleeve assembly and the second sleeve assembly and thus sealing takes place. The sealing can take place by means of a circumferentially extending seal in annular form. Reliable sealing can thus be ensured.

According to an embodiment of the present invention, the first sleeve assembly comprises: a sleeve part with an internal thread; a stepped retaining ring for retaining the second sleeve assembly, wherein for an assembly of the adapter the sleeve part and the retaining ring are connected before being attached to the anchor.

The internal thread of the sleeve part of the first sleeve assembly is configured in terms of size such that it can be screwed onto the external thread of the end part of the anchor. When the sleeve part of the first sleeve assembly and the retaining ring are connected, the second sleeve assembly is connected, in

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particular loosely connected, to the first sleeve assembly but the first and second sleeve assemblies can be rotated relative to one another (about their respective axial directions or longitudinal directions). The connection of the sleeve part of the first assembly to the retaining ring can take place, for example, by compression, adhesive bonding and/or screwing and/or riveting or the like.

According to embodiments of the present invention, a stepped end face does not necessarily have to be provided in the sleeve part and the stepped retaining ring of the first sleeve assembly. Threads could also be provided and the two parts could be present via a press-fit or plug-in connection, for example preferably with a conical (truncated cone-shaped) end part of the sleeve part and a conical (truncated cone-shaped) opening of the retaining ring. The end shape of the anchor, that is to say the geometry at the end part of the anchor, and the shape or geometry of the recess must substantially match one another such that they cannot be rotated or displaced relative to one another in the assembled state. Thereby, at least two of the sensor connections or connection regions located at the anchor are pressed directly against at least two of the contacts in the adapter preferably in a spring-elastic manner.

The pitch (German: Steigung) of the internal thread of the first sleeve assembly determines the introduction of the anchor end into the recess of the guide element with the metal (spring) contacts of the metal elements. In principle, the metal elements can also be replaced by non-metallic conductive elements with spring force.

The orientation of the contacts on the end face of the guide element after the tightening of this nut part (of the adapter) onto the screw part of the anchor is not always the same. This depends, inter alia, on the contact pressure against the sealing ring. A coding on the lateral outer surface of the sleeve part of the second sleeve assembly would be a possibility to align the housing of the data handling system such that the counter-contacts located there are aligned exactly to the metal elements (for example, nose guide, bayonet closure or the like). Instead of an adhesive bonding, a press-fit seat or press-fit thread can also be used. The recesses for the metal elements on the guide element can also comprise counter-structures on the inner lateral surface of the sleeve part, which

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during assembly engage in the recesses with the metal elements and also press the metal elements into the recess.

By suitable measures during assembly, the orientation with the locking is adapted exactly to the requirements or position of the electrical connections of the data handling system. The sensor can also be arranged in the surroundings of the anchor, and the thread can also be present only at the outer end of the anchor. The conductive ink can itself be the sensor or transmit signals of other sensors.

According to an embodiment of the present invention, the sleeve part is connected, in particular tightly glued, to the retaining ring at an outer lateral surface region at an inner lateral surface region, in particular at a first region of a first inner diameter. Reliable connection can thus be achieved and can be achieved in a simple manner. Additionally or alternatively, compression, screwing or riveting can be provided.

According to an embodiment of the present invention, the second sleeve assembly comprises: a stepped sleeve part, which surrounds the inner space along a circumference in a material-tight manner; a guide element with a preferably wedge-shaped or chisel-shaped recess, for guiding a preferably wedge-shaped or chisel-shaped end of the anchor; metal elements which are clamped to the guide element and which provide electrical connections within the recess for contacting the contact regions of the sensor on the anchor.

The guide element can, for example, be substantially cylinder-shaped or truncated cone-shaped (if the recess is imagined to not exist). The guide element can be arranged within the stepped sleeve part and be connected, in particular glued, thereto in a material-tight manner. The metal elements can project at least partially into the recess and/or can also engage around the guide element in the longitudinal direction in order, for example, to provide contact surfaces on an outer end face of the second sleeve assembly.

According to an embodiment of the present invention, each of the metal elements, in particular two metal elements, provides both the electrical

connection within the recess for contacting the contact regions of the sensor on the anchor and, in particular at an end outer face of the second sleeve assembly, a contacting field for a respective contact of the data handling system.

According to an embodiment of the present invention, the guide element, at a part of its outer lateral surface, is connected, in particular tightly glued, to the stepped sleeve part at an inner lateral surface region. Before the connection, in particular tight gluing, the metal elements are clamped to the guide element or inserted therein, so that parts of the metal elements can serve as electrical connections within the recess.

According to an embodiment of the present invention, the guide element, at one or more other parts of the outer lateral surface, in particular running along a longitudinal direction, comprises one or more notch(es) and/or indentation(es) and/or recess(es) for receiving sections of the metal elements and/or for guiding the guide element in the stepped sleeve part in the axial direction, in particular before the gluing of these two parts; and/or wherein the metal elements grip around up to an end face of the guide element, are exposed there to the outside and form contacts for contacting with the data handling system.

The profiling at parts of the outer lateral surface of the guide element can enable the metal elements to be countersunk at an outer surface, that is to say cannot be clamped or connected in a projecting manner, so that the guide element can be pushed together with the inserted metal elements into the stepped sleeve part and can then be connected thereto, in particular can be glued to the outer lateral surface. Material-tight gluing can thus be achieved in a simple manner.

According to an embodiment of the present invention, the adapter is configured such that the retaining ring of the first sleeve assembly comprises a first region of a first inner diameter and a second region of a second inner diameter, which is smaller than the first inner diameter, between which a stepped end face lies, wherein the sleeve part of the second sleeve assembly comprises a first region of a first outer diameter and a second region of a second outer diameter, which is smaller than the first outer diameter, between which a stepped end face lies, wherein the seal is arranged between the stepped end face of the retaining ring

of the first sleeve assembly and the stepped end face of the sleeve part of the second sleeve assembly and is pressed in a sealing manner in the state installed at the anchor.

Simple connection of the first sleeve assembly to the second sleeve assembly can thus be achieved and a material-tight connection can be ensured. When the adapter is screwed to the anchor, oppositely directed forces can be exerted on the stepped end face of the retaining ring of the first sleeve assembly and the stepped end face of the sleeve part of the second sleeve assembly, which thus press the seal and thus cause a material-tight connection.

According to an embodiment of the present invention, the adapter is configured such that the electrical connections in the interior space of the guide element are configured as resilient connection contact tongues which, in the state installed at the anchor, electrically contact the contact regions at the end part of the anchor; and/or wherein the stepped sleeve part of the second sleeve assembly and/or the guide element of the second sleeve assembly and/or the sleeve part of the first sleeve assembly and/or the retaining ring of the first sleeve assembly is/are made of (in particular electrically insulating) plastic which is suitable for injection molding and/or additive manufacturing, in particular thermoplastics, and/or comprises substantially rotational and/or mirror symmetry.

The resilient connection contact tongues can, in the state firmly connected to the anchor, provide pressing forces for pressing the seal, namely when chisel-shaped surfaces, for example, bear against these resilient connection contact tongues at the end part of the anchor and exert forces. Cost-effective and simple manufacture can be achieved by the materials mentioned.

According to an embodiment of the present invention, the adapter is configured such that a profile and/or groove and/or indentation for mechanical locking and/or retaining with the data handling system is provided on a lateral outer surface of the stepped sleeve part of the second sleeve assembly, in particular via a bayonet closure and/or snap closure.

The outer end face and/or the lateral outer surface of the second sleeve

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assembly can be formed such that multiple different data handling systems can be electrically and/or mechanically connected thereto. The contact fields on the outer end face of the second sleeve assembly can likewise be arranged and dimensioned such that the different data handling systems can be electrically connected thereto. The mechanical locking can ensure reliable locking of the data handling system (e.g., under harsh field conditions).

According to an embodiment of the present invention, the adapter is configured such that the pressing force is exerted on the seal by the thrust force exerted by the end part of the anchor initially on the, in particular spring-elastic, electrical connections with suitable spring stiffness of the second sleeve assembly and/or as a result of the helical movement of the second sleeve assembly against the seal between the first and second sleeve assembly; and/or wherein in particular the compression of the seal and the elastic deformation paths of the preferably spring-elastic contact tongues of the electrical connections together form counterforces against the anchor by the spring stiffness, by the torque of the threads against the end faces of the sleeve part and the retaining ring facing the seal. Both reliable electrical contacting and reliable sealing can thus be enabled.

According to an embodiment of the present invention, a system is provided, comprising: a solid anchor system, in particular a rock or stone or building anchor system, which comprises an anchor for at least partially introducing into the solid and at least one sensor, wherein the anchor has an external thread and electrical contact regions of the sensor at least at an end part of the anchor which is not to be introduced into the solid; an adapter according to one of the preceding embodiments, in particular comprising a data handling system, wherein in particular the solid anchor system is connected via the adapter to the data handling system at least electrically, in particular also mechanically for retaining.

It should be understood that features which are mentioned, described or provided individually or in any combination for an adapter can likewise be applied or used individually or in any combination for a system according to embodiments of the present invention, according to embodiments of the present invention or vice versa. Such features can likewise be applied or used individually

or in any combination for a method for connecting a solid anchor system to a data handling system, according to embodiments of the present invention or vice versa.

According to an embodiment of the present invention, the system is configured such that the at least one sensor of the solid anchor system comprises one sensor or multiple sensors from the group of strain sensor, deformation sensor, temperature sensor, gas sensor, moisture sensor, acoustic sensor, optical sensor, and/or wherein the sensor is formed in particular by at least one conductor track, in particular applied conductive ink, or is contacted via at least one conductor track which is applied on an outer surface, in particular a recess and/or a notch, of the anchor preferably in the longitudinal direction, and/or wherein ends of the conductor tracks are electrically connected to the contact regions on the end part of the anchor and the contact regions contact the metal elements or electrically conductive elements in a conductive manner. Different properties of the solid, in particular rock or rock or building, or its surroundings (liquid or gaseous) can thus be detected and reliably transmitted from the sensor to the data handling system.

The sensor can be configured, for example, as embodied in EP 3 927 942 B1. According to WO 2021/028394 A1, a deformable conductor can be produced using an ink composition.

According to an embodiment of the present invention, a method of at least electrically connecting a solid anchor system, in particular a rock or stone or building anchor system, to a data handling system is provided, wherein the solid anchor system comprises an anchor for at least partially introducing into the solid and at least one sensor, wherein the anchor has an external thread and electrical contact regions of the sensor at least at an end part of the anchor which is not to be introduced into the solid, wherein the method comprises: providing an adapter which has a first sleeve assembly with an internal thread and a second sleeve assembly which has electrical connections exposed in an interior space of the second sleeve assembly, in particular rotationally aligning the first sleeve assembly relative to the second sleeve assembly in a state not installed at the anchor; screwing the internal thread of the first sleeve assembly

onto the external thread of the anchor, in particular from the end part of the anchor which is not to be introduced into the solid, wherein the interior space is sealed against the surrounding medium in the state screwed to the anchor; contacting the electrical contact regions on the anchor with the electrical connections of the adapter within the interior space of the second sleeve assembly.

The method can be carried out by means of an adapter according to an embodiment of the present invention.

Further advantages and features of the present invention emerge from the following exemplary description of presently preferred embodiments, to which the invention is not restricted.

Brief Description of the Drawings

FIG. 1 shows, in a perspective, exemplary illustration, a system according to an embodiment of the present invention;

FIG. 2 shows, in an exploded illustration, an adapter according to an embodiment of the present invention;

FIGS. 3A to 3E show different views of a fully assembled adapter according to an embodiment of the present invention;

FIGS. 4A and 4B show cross-sectional views of an adapter according to an embodiment of the present invention, and

FIGS. 5A and 5B show a system in a cross-sectional view and in a side view, respectively, according to an embodiment of the present invention.

Detailed Description

The system 10 illustrated in a three-dimensional illustration in **FIG. 1** comprises a solid anchor system 11 which comprises an anchor 12 and at least one sensor

13 (conductive ink applied here in the guide grooves), wherein the anchor 12 has an external thread 15, which is interrupted here by the guide grooves, and electrical contact regions 16 of the sensor 13 at least at an end part 14 which is not to be introduced into the solid. The system 10 further comprises an adapter 20 according to an embodiment of the present invention, and a data handling system 30, wherein the solid anchor system 11 is at least electrically connected via the adapter 20 to the data handling system 30.

In FIG. 1, the system is illustrated in a non-installed state in which the adapter 20 is not yet screwed onto the end part 14 of the anchor 12 and in which the data handling system 30 is also not yet connected to the adapter 20. The adapter has in particular a first side 21, by which it can be screwed to the anchor 12, and a second side 22, via which it can be connected to the data handling system 30.

The adapter 20 illustrated in an exploded illustration in **FIG. 2** comprises a first sleeve assembly 23 with an internal thread 24 for screwing onto the external thread 15 (see FIG. 1) of the anchor 12, in particular in the end part 14 of the anchor 12 which is not to be introduced into the solid. The adapter further comprises a second sleeve assembly 25 which has electrical connections 26 exposed in an interior space 27 of the second sleeve assembly 25 in order to contact the electrical contact regions 16 on the anchor 12 in a state installed at the anchor 12. The first sleeve assembly 23 and the second sleeve assembly 25 are rotatable relative to one another in a state not installed at the anchor 12 and the interior space 27 is sealed against the surrounding medium in a state installed at the anchor. The sealed interior space 27 is formed in a fully assembled state of the adapter 20. As can already be seen from FIG. 2, the first and also the second sleeve assembly 23, 25 are closed circumferentially in a material-tight manner against the surrounding medium.

In **FIG. 3A**, the adapter 20 is illustrated in the assembled state from the second side 22, in **FIG. 3B** in a three-dimensional illustration, in **FIG. 3C** in a side view, in **FIG. 3D** in a three-dimensional illustration illustrating the first side 21 and in **FIG. 3E** illustrated from the first side 21.

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On the second side 22, as illustrated in FIGS. 3A and 3B, the second sleeve assembly 25 has an end face 47, in particular an end face 47 of a guide element 1, wherein contact fields 28 for contacting with the data handling system 30 are formed on the end face 47.

In FIG. 3D, the internal thread 24 of the first sleeve assembly 23 can be seen.

In FIG. 3E, the electrical contact regions 26 exposed in the interior space 27 of the second sleeve assembly 25 can be seen from the first side 21.

As can be seen for example from FIG. 2, the adapter 20 further comprises a seal 5 arranged between the first sleeve assembly 23 and the second sleeve assembly 25 for sealing the interior space 27 in the state installed at the anchor 12 (see FIGS. 5A and 5B).

The first sleeve assembly 23 comprises a sleeve part 4 with the internal thread 24, and a stepped retaining ring 6 for retaining the second sleeve assembly 25, wherein for an assembly of the adapter 20 the sleeve part 4 and the retaining ring 6 are connected before being attached to the anchor 12. In particular, the sleeve part 4 can be tightly glued to the retaining ring 6 at an outer lateral surface region 29 at an inner lateral surface region 31 (see FIG. 2).

The second sleeve assembly 25 comprises an in particular stepped sleeve part 3, which surrounds the inner space 27 along a circumference in a material-tight manner. The second sleeve assembly 25 further comprises a guide element 1 with a preferably wedge-shaped or chisel-shaped recess 32 for guiding a preferably wedge-shaped or chisel-shaped end 33 of the anchor 12. Further, the second sleeve assembly comprises two electrically conductive elements, preferably metal elements 2, which are clamped to the guide element 1 and which provide the electrical connections 26 within the recess 32 for contacting the contact regions 16 of the sensor in the anchor 12.

A lateral outer surface 44 of the stepped sleeve part 3 of the second sleeve assembly 25 comprises a profile and/or groove 45 for mechanical locking and/or retaining with the data handling system 30.

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The guide element 1, at a part of its outer lateral surface 34, is tightly connected, preferably glued, to the stepped sleeve part 3 at an inner lateral surface region 35. The guide element 1, at two parts of the outer lateral surface 34, comprises indentations or notches 36 for receiving sections of the electrically conductive elements or metal elements 2.

The retaining ring 6 of the first sleeve assembly 23 comprises a first region 37 of a first inner diameter d1 and a second region 38 of a second inner diameter d2, which is smaller than the first inner diameter d1, between which a stepped end face 39 lies. The sleeve part 3 of the second sleeve assembly 25 comprises a first region 40 of a first outer diameter D1 and a second region 41 of a second outer diameter D2, which is smaller than the first outer diameter D1, between which a stepped end face 42 lies.

The seal 5 is arranged between the stepped end face 39 of the retaining ring 6 of the first sleeve assembly 23 and the stepped end face 42 of the sleeve part 3 of the second sleeve assembly 25 and is pressed in a sealing manner in the state installed at the anchor 12.

The electrical connections 26 in the interior space 27 of the guide element 1 are configured as spring-elastic connection contact tongues which, in the state installed at the anchor 12, electrically contact the contact regions 16 at the end part 14 or 33 of the anchor.

FIGS. 4A and 4B (detail B from FIG. 4A) illustrate, in a sectional side view, an adapter 20, according to an embodiment of the present invention, for example the adapter illustrated in FIGS. 1, 2, 3 in an assembled state. It can be seen from FIG. 4B that the sealing ring 5 is arranged between the stepped end face 39 of the stepped retaining ring 6 and the stepped end face 42 of the sleeve part 3 of the second sleeve assembly 25 and is pressed there in order to seal the interior space 27 in a material-tight manner. 46 denotes an adhesive for connecting sleeve part 4 and retaining ring 6 as an example of a possible permanent connection.

FIGS. 5A and 5B illustrate, in a side sectional view and side view, respectively, a solid anchor system 11 as it is connected to the adapter 20 in an installed state. The end part 33 of the anchor 12, in the state installed at the anchor, is arranged within the interior space 27 of the guide element 1 or the second sleeve assembly 25 and contacts the spring-elastic connection contact tongues 26 of the metal elements 2 with its contact regions 16. The ends of the metal elements or electrically conductive elements 2 are guided around at the outer end face 47 of the guide element 1 in order to provide electrical contact fields 28 for contacting with the data handling system 30 (not illustrated).

In the illustrated embodiment, the solid anchor system comprises the anchor 12 with a strain sensor 13, wherein the strain sensor 13 is formed by a conductor track 43, in particular printed ink. In other embodiments, a conductor track 43 can be used as an electrical connection track in order to enable, for example, sensor signals of another sensor which is not attached directly to the anchor but can be spatially separated therefrom.

In order to install the adapter 20 onto or at the solid anchor system 11, a method for connecting the solid anchor system to a data handling system can be carried out. In this case, the internal thread 24 of the first sleeve assembly 23 is screwed onto the external thread 15 of the anchor, wherein the interior space 27 is sealed against the surrounding medium in the state screwed to the anchor 12. Further, the electrical contact regions 16 on the anchor 12 are contacted with the electrical connections 26 of the adapter within the interior space 27 of the second sleeve assembly 25.

In order to form the second sleeve assembly 25, the metal elements or electrically conductive elements 2 can be suspended in the guide element 1 in the recesses 36 provided therefor. Thereafter, the sleeve part 3 can be connected, preferably glued or pressed, to the guide element 1 which contains the metal elements or electrically conductive elements 2.

In order to form the first sleeve assembly 23, the sleeve part 4 of the first sleeve assembly 23 is connected, preferably likewise glued or pressed, to the stepped retaining ring 6. The second sleeve assembly 25 remains freely movable in the

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axial direction within the frame of the part of the region 37 not occupied by the lateral outer surface region 29 of the sleeve part 4 and also rotatable about the axis until the first sleeve assembly 23 is correctly aligned by screwing the first sleeve assembly onto the anchor 12 and subsequently the adapter 20 is sealed and fixed by pressure on the seal 5. The contacts on the outside of the front side, that is to say the contacts 28 on the front side 47 for example (see FIG. 3B or FIG. 4A), are sealed separately by means of a seal and data handling system.

Embodiments of the present invention enable the use of rock anchors with a printed sensor and a module for data acquisition of a suitable signal connection and the assembly of a module for data recording and data transmission. The connection must reliably withstand the high mechanical and weather-dependent stresses in mining over several years. The signal connection is protected against moisture, dust and chemicals. Further, embodiments of the present invention offer flexibility with respect to the different diameters of the rock anchors by a corresponding adaptation of the internal thread and at most further dimensions of the adapter. Embodiments of the present invention provide adapters between rock anchors and different data handling modules. The adapter can be produced corresponding to the diameters and the thread of the anchors without major design changes. The connection to the data evaluation or handling module can, if possible, be maintained and can serve as a default for different manufacturers of data transmission units.

The adapter can be constructed from a maximum of seven to eight parts, which are joined together, for example, by adhesive bonding. For example, only plastic, preferably ABS, and two pieces of conductive contacts can be used as materials, wherein the parts can be joined together by adhesive bonding. The contact production between the sensor and the module can be produced by the adapter without an additional working step. For this purpose, the end of the anchor (chisel shape) and the contact surfaces in the adapter are (negatively) adapted to the production of the rock anchor.

It is noted that the term “comprise” does not exclude other elements and that the “one” does not exclude a plurality. Elements which are described in connection with different exemplary embodiments can also be combined. It

should also be noted that reference signs in the claims should not be interpreted as limiting the scope of protection of the claims.

Claims

1. An Adapter (20) for at least electrically connecting a solid anchor system (11), in particular a rock or stone or building anchor system, to a data handling system (30), wherein the solid anchor system (11) comprises an anchor (12) for at least partially introducing into the solid and at least one sensor (13), wherein the anchor has an external thread (15) and electrical contact regions (16) of the sensor (13) at least at an end part (14) of the anchor (12) which is not to be introduced into the solid, wherein the adapter comprises:

a first sleeve assembly (23) with an internal thread (24) for screwing onto the external thread (15) of the anchor (12), in particular from the end part of the anchor which is not to be introduced into the solid;

a second sleeve assembly (25) which has electrical connections (26) exposed in an interior space (27) of the second sleeve assembly (25) in order to contact the electrical contact regions (16) on the anchor (12) in a state installed at the anchor;

wherein the first sleeve assembly (23) is rotatable relative to the second sleeve assembly (25) in a state not installed at the anchor and wherein the interior space (27) is sealed against the surrounding medium in the state installed at the anchor,

wherein, in particular in the state installed at the anchor, the anchor (12) is screwed to the first sleeve assembly (23).

2. The adapter according to the preceding claim,

wherein the first and/or the second sleeve assembly (23, 25) is closed circumferentially, in particular sealed against the surrounding medium, wherein in particular the second sleeve assembly (25) is closed at an outer end face (47), in particular sealed against the surrounding medium, wherein the outer end face of the second sleeve assembly is provided for a contact (28) with the data handling system (30); and/or

wherein, in the state installed at the anchor, the end part (33) of the anchor (12) is arranged within the interior space (27) of the second sleeve assembly (25).

3. The adapter according to one of the preceding claims, further comprising a seal (5) arranged between the first sleeve assembly (23) and the second sleeve assembly (25) for sealing the interior space (27) in the state installed at the anchor.

4. The adapter according to one of the preceding claims, wherein the first sleeve assembly comprises:

a sleeve part (4) with an internal thread (24);

a stepped retaining ring (6) for retaining the second sleeve assembly (25), wherein for an assembly of the adapter the sleeve part (4) and the retaining ring (6) are connected before being attached to the anchor.

5. The adapter according to the preceding claim, wherein the sleeve part (4) is connected, in particular tightly glued, to the retaining ring (6) at an outer lateral surface region (29) at an inner lateral surface region (31), in particular at a part of the first region (37) of a first inner diameter (d1).

6. The adapter according to one of the preceding claims, wherein the second sleeve assembly comprises:

a stepped sleeve part (3), which surrounds the inner space (27) along a circumference in a material-tight manner;

a guide element (1) with a preferably wedge-shaped or chisel-shaped recess (32), for guiding a preferably wedge-shaped or chisel-shaped end (33) of the anchor (12);

metal elements or elements with high electrical conductivity (2), which are clamped to the guide element (1) and which provide the electrical connections (26) within the recess (32) for contacting the contact regions (16) of the sensor on the anchor.

7. The adapter according to the preceding claim, wherein the guide element (1), at a part of its outer lateral surface (34), is connected, in particular tightly glued and/or pressed, to the stepped sleeve part (3) at an inner lateral surface region (35).

8. The adapter according to one of the two preceding claims,

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wherein the guide element (1), at one or more other parts of the outer lateral surface (34), in particular running along a longitudinal direction, comprises one or more notch(es) and/or indentation(s) and/or recess(es) (36) for receiving sections of the metal elements or electrically conductive elements (2) and/or for guiding the guide element (1) in the stepped sleeve part (3) in the axial direction, in particular before the gluing of these two parts; and/or

wherein the metal elements or electrically conductive elements (2) grip around up to an end face (47) of the guide element (1), are exposed there to the outside and form contacts (28) for contacting with the data handling system.

9. The adapter according to one of the preceding claims, referring back to both claim 4 and 6,

wherein the retaining ring (6) of the first sleeve assembly (23) comprises a first region (37) of a first inner diameter (d1) and a second region (38) of a second inner diameter (d2), which is smaller than the first inner diameter, between which a stepped end face (39) lies,

wherein the sleeve part (3) of the second sleeve assembly (25) comprises a first region (40) of a first outer diameter (D1) and a second region (41) of a second outer diameter (D2), which is smaller than the first outer diameter, between which a stepped end face (42) lies,

wherein the seal (5) is arranged between the stepped end face (39) of the retaining ring (6) of the first sleeve assembly and the stepped end face (42) of the sleeve part (3) of the second sleeve assembly and is pressed in a sealing manner in the state installed at the anchor.

10. The adapter according to one of the preceding claims,

wherein the electrical connections (26) in the interior space of the guide element (1) are configured as spring-elastic connection contact tongues which, in the state installed at the anchor, electrically contact the contact regions (16) at the end part (33) of the anchor (12); and/or

wherein the stepped sleeve part (3) of the second sleeve assembly and/or the guide element (1) of the second sleeve assembly and/or the sleeve part (4) of the first sleeve assembly and/or the retaining ring (6) of the first sleeve assembly is/are made of plastic which is suitable for injection molding and/or

additive manufacturing, in particular thermoplastics, and/or comprises substantially rotational symmetry and/or mirror symmetry.

11. The adapter according to one of the preceding claims, wherein a profile and/or groove (45) and/or indentation for mechanical locking and/or retaining with the data handling system (30) is provided on a lateral outer surface (44) of the stepped sleeve part (3) of the second sleeve assembly, in particular via a bayonet closure and/or snap closure.

12. The adapter according to one of the preceding claims, wherein a pressing force is exerted on the seal (5) by the thrust force exerted by the end part (33) of the anchor (12) initially on the, in particular spring-elastic, electrical connections (26) of the second sleeve assembly (25) against the spring stiffness and/or as a result of the helical movement of the second sleeve assembly (25) against the seal (5) between the first and second sleeve assembly; and/or

wherein in particular the compression of the seal and the elastic deformation paths of the preferably spring-elastic contact tongues of the electrical connections together form counterforces against the anchor by the tightening torque of the threads against the end faces of the sleeve part (6) facing the seal.

13. A system (10), comprising:

a solid anchor system (11), in particular a rock or stone or building anchor system, which comprises an anchor for at least partially introducing into the solid and at least one sensor, wherein the anchor has an external thread and electrical contact regions of the sensor at least at an end part of the anchor which is not to be introduced into the solid;

an adapter (20) according to one of the preceding claims,

in particular a data handling system (30),

wherein in particular the solid anchor system (11) is connected via the adapter (20) to the data handling system (30) at least electrically, in particular also mechanically for retaining.

14. The system according to the preceding claim,

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wherein the at least one sensor (13) of the solid anchor system comprises one sensor or multiple sensors from the group of strain sensor, deformation sensor, temperature sensor, gas sensor, moisture sensor, acoustic sensor, optical sensor, and/or

wherein the sensor is formed in particular by at least one conductor track (43), in particular applied conductive ink, or is contacted via at least one conductor track which is applied on an outer surface, in particular a recess and/or a notch, of the anchor (12) preferably in the longitudinal direction, and/or

wherein ends of the conductor tracks are electrically connected to the contact regions (16) on the end part of the anchor and the contact regions (16) contact the metal elements or electrically conductive elements (2) in a conductive manner.

15. A method of at least electrically connecting a solid anchor system (11), in particular a rock or stone or building anchor system, to a data handling system (30), wherein the solid anchor system comprises an anchor (12) for at least partially introducing into the solid and at least one sensor (13), wherein the anchor (12) has an external thread (15) and electrical contact regions (16) of the sensor (13) at least at an end part (14) of the anchor which is not to be introduced into the solid, wherein the method comprises:

providing an adapter which has a first sleeve assembly (23) with an internal thread (24) and a second sleeve assembly (25) which has electrical connections (26) exposed in an interior space (27) of the second sleeve assembly,

in particular rotationally aligning the first sleeve assembly relative to the second sleeve assembly in a state not installed at the anchor;

screwing the internal thread (15) of the first sleeve assembly (23) onto the external thread (15) of the anchor (12), in particular from the end part of the anchor which is not to be introduced into the solid, wherein the interior space (27) is sealed against surrounding media in a material-tight manner in the state screwed to the anchor;

contacting the electrical contact regions (16) on the anchor with the electrical connections (26) of the adapter (20) within the interior space (27) of the second sleeve assembly (25).

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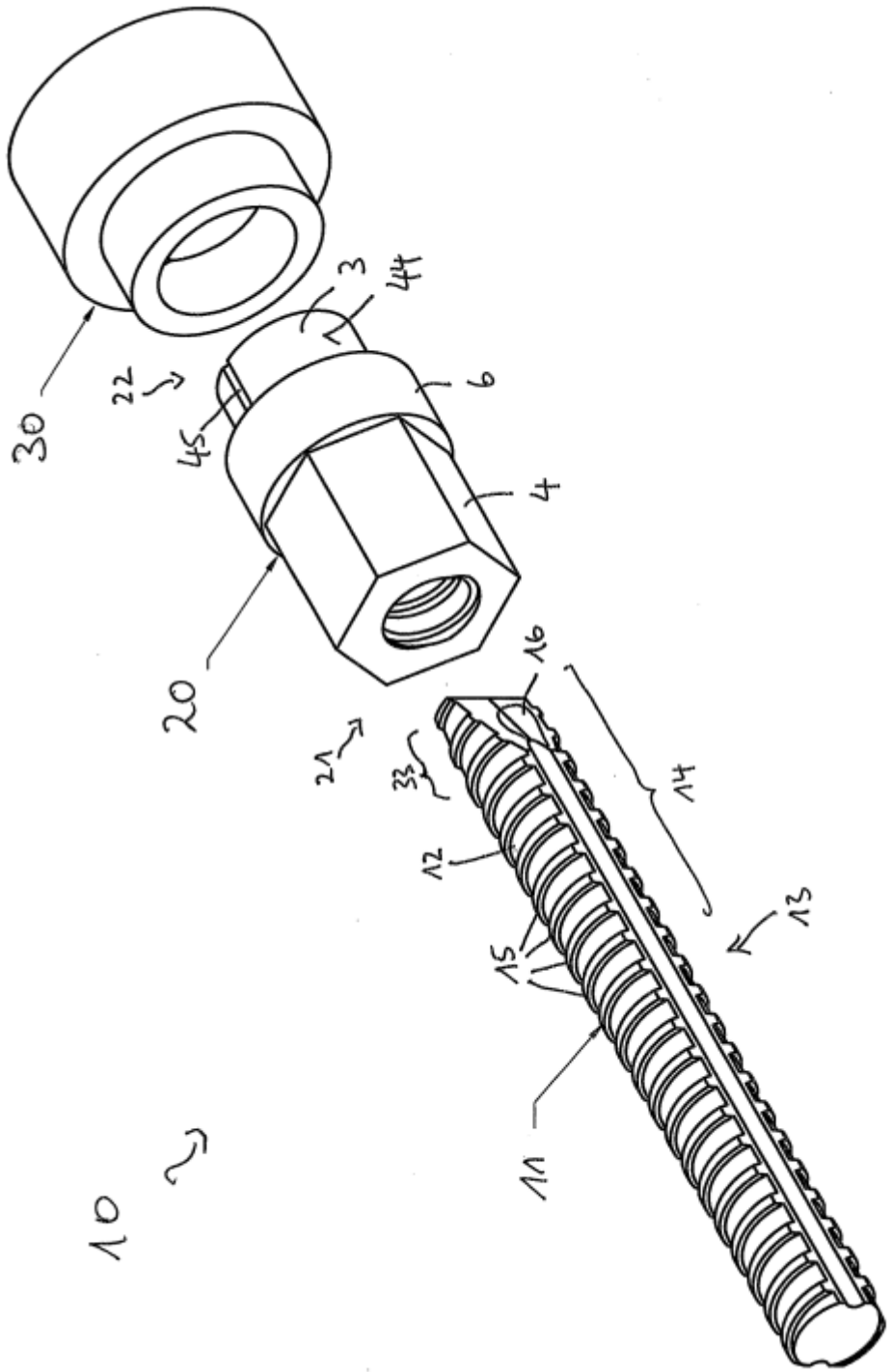

Fig. 1

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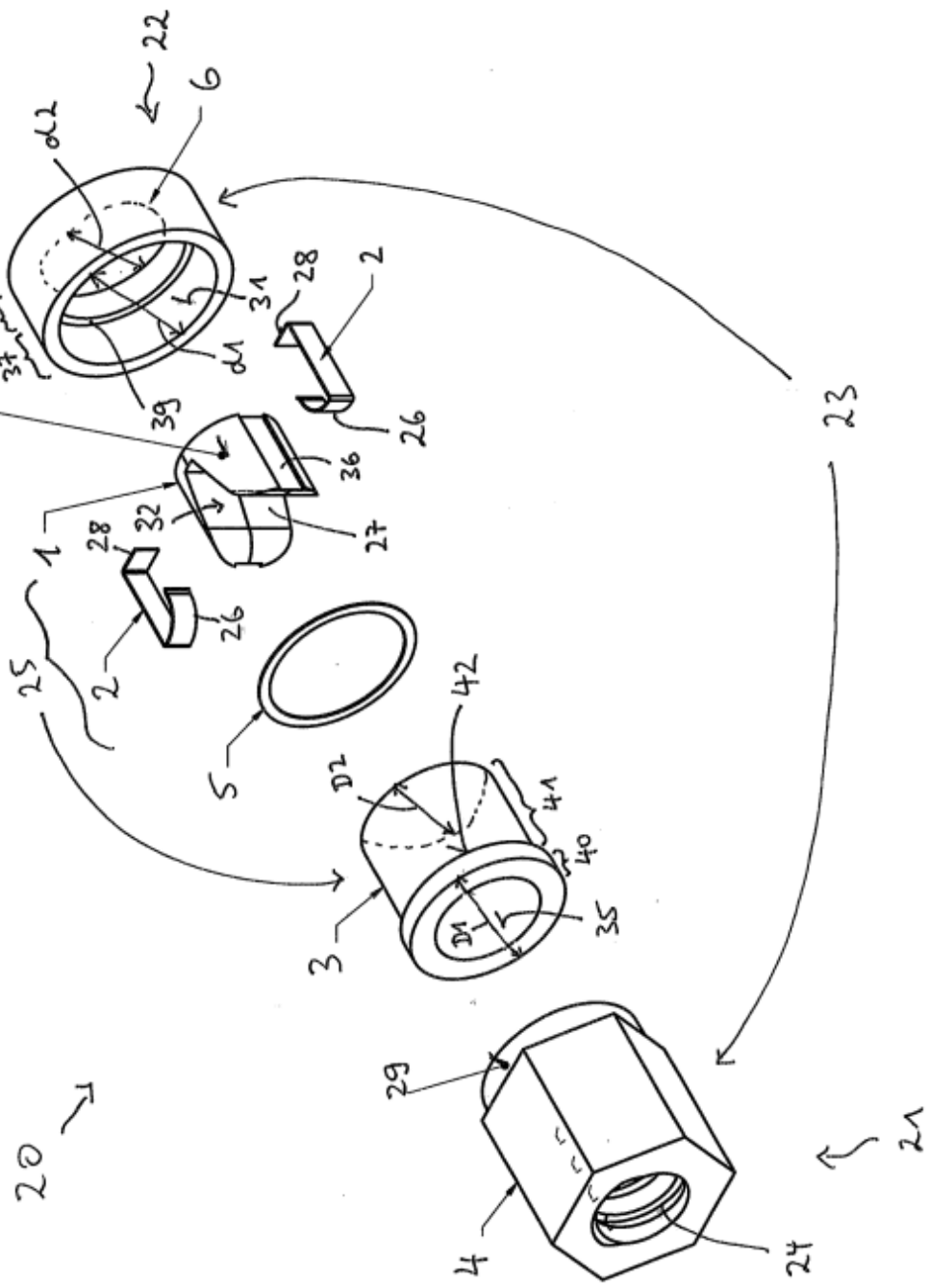

Fig. 2

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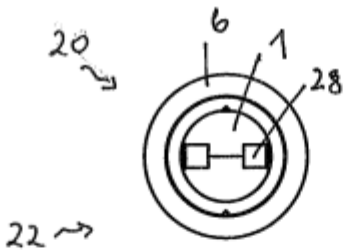

Fig. 3A

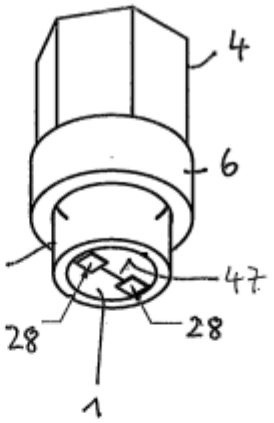

Fig. 3B

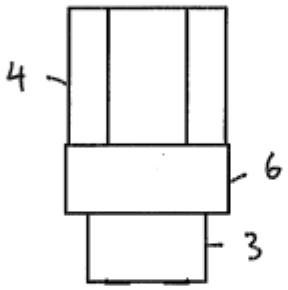

Fig. 3C

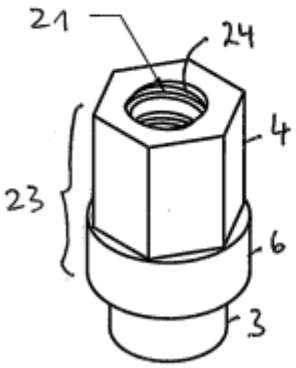

Fig. 3D

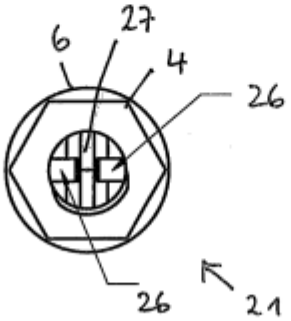

Fig. 3E

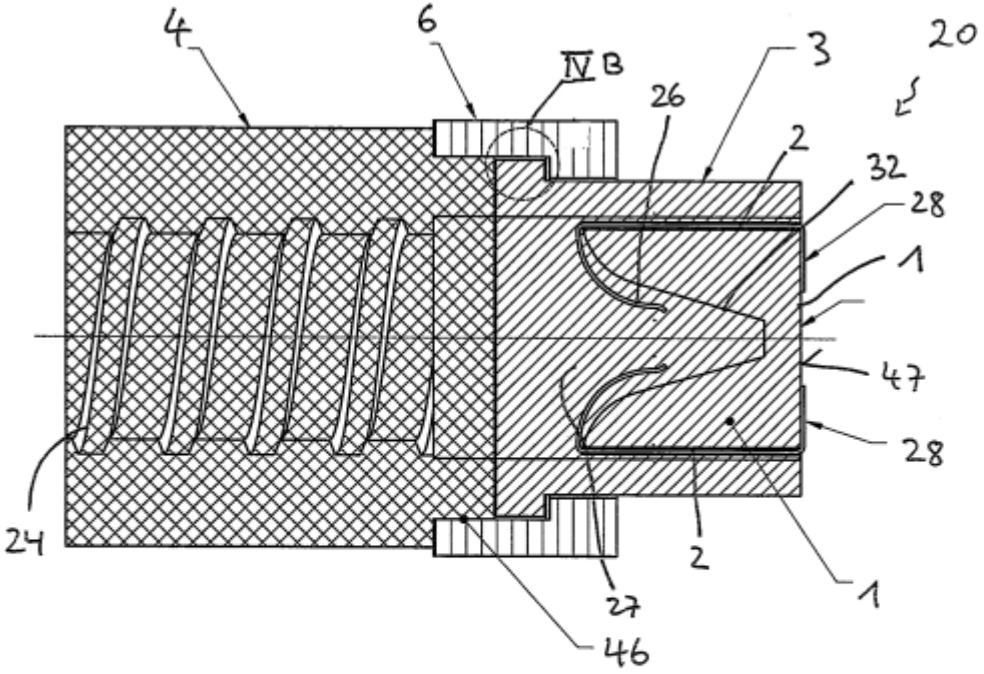

Fig. 4A

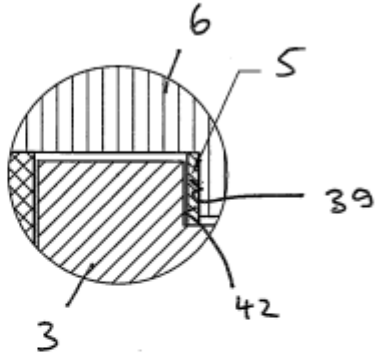

Fig. 4B

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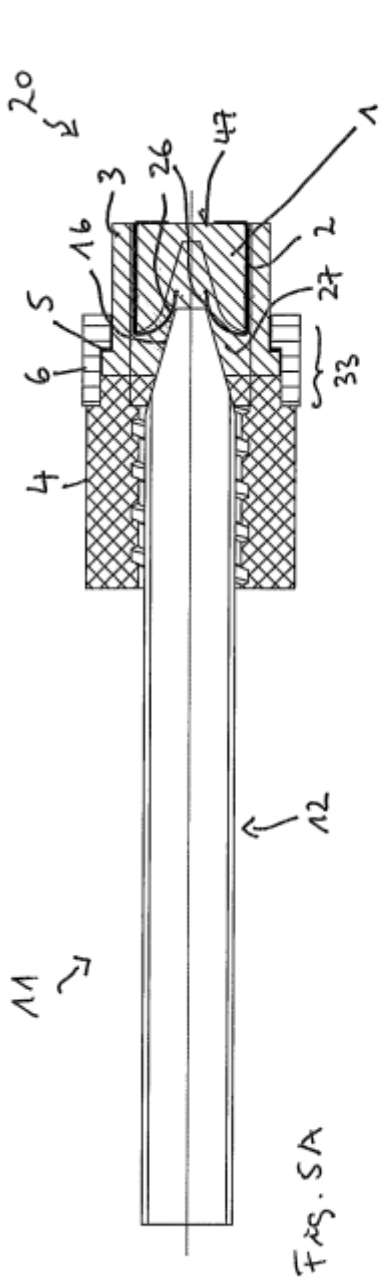

Fig. 5A

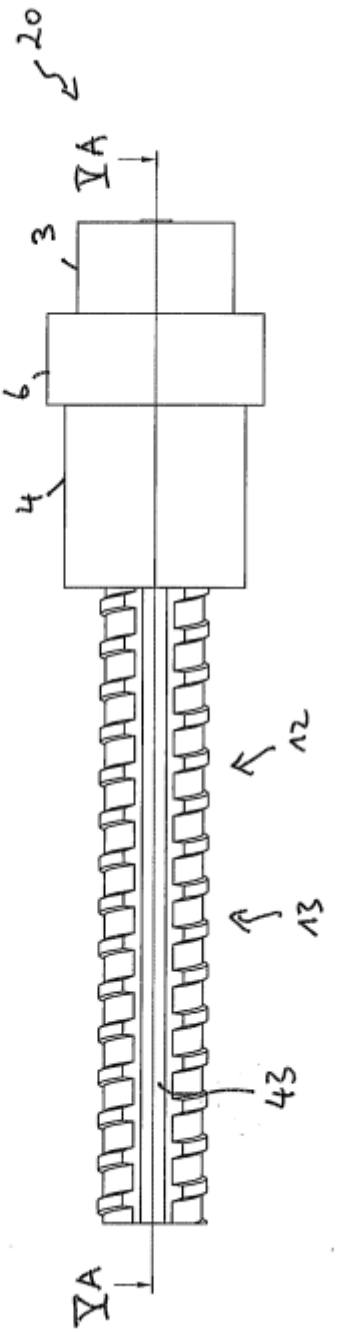

Fig. 5B