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(54) Title: CABLE PROTECTION DEVICE

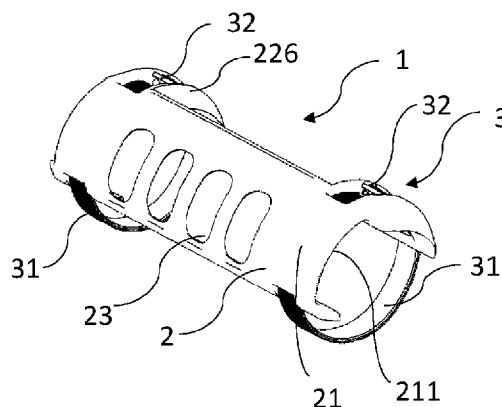


Fig. 1

(57) Abstract: Herein is disclosed a cable protection device (1) for protecting a cable (4) running along a tubular body (5) comprising a coupling (51) having two side edges (511). The cable protection device (1) comprises a body (2) for partly enclosing the tubular body (5) circumferentially. The body (2) is provided with a protective portion (21) having an inside (211), for enclosing a portion of the cable (4) and a clamping portion (22) comprising a contact surface (221) for close contact with the tubular body (5), and also having an outside (226). The cable protection device (1) further comprises a fastening device (3) including a flexible member (31) for strapping the body (2) to the tubular body (5) and a tightening mechanism (32) for tightening the flexible member (31).

TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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CABLE PROTECTION DEVICE

The invention concerns a cable protection device for protecting cables or lines running along a pipe or a tubular body, such as a well pipe. The cable protection device is for clamping the cables to the tubular body and protect them. The cable protection device
5 disclosed herein is particularly adapted to protect cables passing over pipe joints, i.e. running over the coupling connecting two pipes.

The term “cable” is used herein as a collective term for ESP-cables, control lines, hydraulic lines and other cables and sensors which may be run downhole along a well pipe.

There are many known types of fasteners or clamps for fastening cables to pipes, for instance simple metallic straps. There are also known many types of cable protection devices which protect cables running over pipe joints and also strap the cables to the pipe.
10

Patent publication GB 2512365 A discloses an example of a known cable protection device. This device consists of a housing member which is hinged to a strap member, and the housing has a conduit for enveloping control lines.

15 Patent publication WO 2019202163 A1 discloses a gripper for a cable protector. The publication shows two grippers connected by a spine which protects cables running past a pipe joint.

Patent publication WO 2004064215 A1 shows another example of a cable clamp device which comprises first and second arcuate arms joined to each other with a hinge. A locking arm is pivotally joined by a hinge to the second arcuate arm, and a flexible wire loop is
20 attached to the locking arm.

Patent publication ITUA20163802 A1 discloses a coupling and protection device for a ca-

ble arranged externally to a conduit. The device comprises a protective casing and coupling means associated and operatively connected to both longitudinal ends of the protective casing. The coupling means comprises a lever locking system.

Patent publication US4601334 A discloses control line protector for securing and protecting a control line or lines to the exterior of an oil well tubing string. The protector comprises a flexible steel strap to the ends of which a respective trunnion is attached, one of which trunnions is removably mounted. The trunnions are interconnected by two screws which may be rotated to draw the trunnions towards one another.

Patent publication RU190275U1 discloses a device to protect a power cable in a well. The device comprises a molded case, made in one piece with the cable channel and with a central channel. The device comprises arcuate clamping brackets.

Patent publication WO2005103544 A2 a cable clamp device.

Patent publication US6023027 A discloses a guard for cables that extend alongside a coupling in a tubing string.

One disadvantage of prior art cable protectors is that they can be complex both to produce and to install. Another disadvantage is that different sized cable protectors need to be provided for different sized pipes.

The invention has for its object to remedy or to reduce at least one of the drawbacks of the prior art, or at least to provide a useful alternative to prior art.

The object is achieved through features, which are specified in the description below and in the claims that follow.

The invention is defined by the independent patent claim. The dependent claims define advantageous embodiments of the invention.

More specifically, the invention relates to a cable protection device for protecting a cable running along a tubular body, the tubular body comprising a coupling having two side edges, the cable protection device comprising:

- a body for partly enclosing the tubular body circumferentially, the body being provided with:

- a protective portion having an inside, for enclosing the cable; and
- a clamping portion comprising a contact surface for close contact with the tubu-

5 lar body, and an outside; and

- a fastening device comprising

- a flexible member for strapping the body to the tubular body wherein the flexible member is partly arranged on the inside of the protective portion and partly arranged on the outside of the clamping portion, wherein the portion of the flexible member being

10 arranged on the inside of the protective portion is configured for holding the cable securely between the protection device and the tubular body; and

- a tightening mechanism for tightening the flexible member.

When in use, the body of the cable protection device encloses the tubular body partly in the circumference of the tubular body. Ideally the body encloses up to half of the circum-

15 ference of the tubular body. When arranged on the tubular body, the body of the cable protection device extends longitudinally along the tubular body. The protective portion of the body typically includes a longitudinal recess allowing the cable to stay protected between the body of the cable protection device and the tubular body to which the cable protection device is strapped. Since cables are particularly exposed to damage at the pipe

20 connections, since the coupling of the pipe connection extends further out into the well bore than the rest of the tubing, it is important to protect the cables in this area.

The purpose of having the body enclose the tubular body only partly, is that the cable protection device may be arranged on the tubular body from the side, i.e., without having to slide it on from the pipe end. This gives a flexible solution and allows for easy changing

25 of protection device in case of damage.

The flexible member straps the cable protection device to the tubular body and clamps, or traps, the cable between the tubular body and the body of the cable protection device. One purpose of the flexible member of the fastening device, is that the cable protection device may be strapped either to the coupling or to the pipe, depending on the shape and

size of the cable protection device. Another purpose is that the flexible member allows the recess, or groove, of the protective portion of the body to be the same independent of the size and shape of the cable or cables to be protected. This is because the tightening mechanism and the flexible member make it possible to adjust the tightening of the body against the tubular body. If the cables are of smaller size, the flexible member may be tightened harder than if the cables are bigger. This way, the cables are held securely between the cable protection device and the tubular body. Having a fixed size and shape for the recess, makes the production of cable protection devices easier, and it makes the use of the cable protection device more flexible. The same kind of cable protection device may be used for different types of cables.

The flexible member may be a band, and the tightening of the band may be either stepless or stepwise. The flexible member may comprise polyphenylene sulfide (PPS). In particular, the flexible member may comprise glassfiber reinforced PPS. The flexible member may comprise ratchets, and the tightening mechanism may work similarly to the mechanism of a cable tie.

The tightening mechanism may be arranged on the inside of the body so that it is protected by the body of the cable protection device. The tightening mechanism may be fastened to the body of the cable protection device, or more preferably, it may be fastened to one end of the flexible member. If the tightening mechanism is fastened to the flexible member itself, the body of the cable protection device may comprise a trap or opening for holding the tightening mechanism, so that the flexible member may be thread into the body of the cable protection device from the end without the tightening mechanism until the tightening mechanism is trapped or secured or clicked into place in the body. The advantage of this is that the flexible member may easily be changed in case of damage. The purpose of the tightening mechanism is to tighten and lock the flexible member, so that the cable protection device is securely fastened around the tubular body.

The flexible member is partly arranged on the inside of the protective portion and partly arranged on the outside of the clamping portion. This allows for the flexible member to be in direct contact with the cables to be protected. Strapping the cables directly by the

flexible member, while they are still protected by the protective portion of the cable protection device, has the advantage that cables of different sizes and shapes may be securely held by the cable protection device. This means that the same sized cable protection device may be used for different cables to be protected.

- 5 The clamping portion of the body may further comprise two shoulders, each for bearing against one of the side edges of the coupling, for preventing axial movement of the cable protection device along the tubular body.

The purpose of the shoulders preventing axial movement of the cable protection device is to keep the cable protection device itself in place, relative to the cable running over the coupling, making sure not to expose the cable to unnecessary wear. Cables running along
10 downhole pipes, for instance, are particularly vulnerable when they pass over couplings, i.e., pipe joints, it is therefore an advantage to mount the cable protection device over the coupling, and make sure it does not move along the pipe in the longitudinal/axial direction.

- 15 The fastening device may comprise a further flexible member.

There are different possible embodiments of the cable protection device, and in one embodiment two flexible members may be provided. In this embodiment, one flexible member may be arranged on each side of the cable protection device for strapping the ends of the cable protection device to the tubular body. When the cable protection device is
20 mounted at a pipe connection, over a coupling, the flexible members may be positioned one on each side of the coupling. It must be understood that depending on the size and shape of the body of the cable protection device, more than two flexible members may be provided for strapping the body to the tubular body. In one embodiment, the flexible members are arranged at the far ends of the cable protection device. The body of the
25 cable protection device may typically extend in the axial direction of the tubular body to which it is going to be strapped, and in one embodiment, the body of the cable protection device may be provided with two arms for gripping the tubular body. The flexible members may be placed in connection with the arms. Each arm may for instance be provided with a recess for guiding the flexible member.

A groove may be provided in the contact surface and the cable protection device may further comprise a roller for fitting into the groove for providing extra tensioning of the flexible member in case the cable protection device is rotated.

5 The groove and the roller provide extra tensioning of the flexible member by way of the shape of the groove. Typically, the groove may be shaped so that it is deeper at a mid portion in which the roller is positioned when the cable protection device is first arranged on the tubular body. If the cable protection device is rotated after being strapped to the tubular body, the roller is forced into the more shallow side portion of the groove, and thus pushes the body of the cable protection device slightly outwards from the tubular
10 body and adds to the tightening of the flexible member.

The roller may have a cam profile or it may be circular.

At least a portion of the contact surface of the clamping portion may be serrated.

The purpose of such a serrated portion of the contact surface is to prevent rotation of the cable protection device around the tubular body, or at least to make such rotation less
15 likely. Rotation is already made difficult by the tight strapping of the cable protection device by means of the fastening device, and the serration works in synergy with the fastening device to further prevent rotation.

At least a portion of the contact surface of the clamping portion may be provided with a surface coating for increased friction between the contact surface and the tubular body.

20 Surface coating for increased friction is an alternative to the serration mentioned above and has the same purpose namely to further prevent rotation of the cable protection device. Such surface coating may include tungsten carbide coating, and such coating may include particles. Of course, there are other alternatives, such as rubber or other materials which give a higher friction. A skilled person would know which kind of materials
25 would be suitable in this connection.

The cable protection device may further comprise an insert for being positioned between the contact surface and the tubular body, for providing extra friction.

Instead of a surface coating, an insert may be used for increasing friction between the contact surface of the cable protection device and the tubular body to which it is fastened. Such insert may comprise silicon carbide.

5 The cable protection device may further be provided with at least one sharp element arranged in connection with the contact surface, for gripping into the tubular upon tightening of the flexible member.

By the term “sharp element” is herein meant for instance a pointed element, like a set screw. Any element which may be arranged in connection with the contact surface and which is sharp, hard and small enough to bite into the surface of the tubular body, is suitable for this purpose. A set screw is given as an example of such an element.

10

In the following is described examples of preferred embodiments illustrated in the accompanying drawings, wherein:

Fig. 1 shows an embodiment of a cable protection device in perspective view;

15 Fig. 2 shows the body of the cable protection device in perspective view from another angle;

Fig. 3 shows a side view of the cable protection device of Fig. 1, mounted on a tubular body;

Fig. 4 shows a cross-section of Fig. 3;

20 Fig. 5 shows an end view of the body of the cable protection device arranged on a tubular body (cross-section of pipe and cables);

Fig. 6 illustrates the function of the elastic band of the cable protection device, and an example of how it may be arranged;

Fig. 7 shows a cross-section along the center line of the tubular body, of the tubular body and the cable protection device;

Fig. 8a shows an embodiment of the cable protection device provided with extra tightening means;

Fig. 8b shows the extra tightening means of Fig. 8a at a larger scale; and

Fig. 9 shows an embodiment of the cable protection device.

5 The figures are shown in a simplified and schematic manner, and details that are not important in order to highlight what is new about the invention may have been omitted from the figures. The various elements in the figures are not necessarily shown to scale relative to each other. Like or corresponding elements will be indicated by the same reference numeral in the figures.

10 Reference is first made to Figures 1-3 which will be described together and which illustrate one embodiment of a cable protection device 1 as disclosed herein. The cable protection device 1 comprises a body 2 and a fastening device 3. The fastening device 3 comprises a flexible member 31 and a tightening mechanism 32. The flexible member 31 may be a band. The shown embodiment of the cable protection device 1 comprises two flexible members 31 and thus also two tightening mechanisms 32. The body 2 comprises two
15 portions namely a protective portion 21 for enclosing a portion of a cable 4 running along a tubular body 5, see Fig. 3, and a clamping portion 22 comprising a contact surface 221 for close contact with the tubular body 5. The protective portion 21 has an inside 211, and the clamping portion 22 has an outside 226. In the shown embodiment the flexible
20 member 31 runs along the inside 211 of the protective portion 21 and along the outside 226 of the clamping portion 22. This arrangement allows the flexible member 31 both to strap the body 2 to the tubular body 5 and to tighten directly against the cables 4 to be protected. On Figure 2, the contact surface 221 and shoulder 222 are indicated on both sides of the protective portion 21. The tubular body 5 comprises a coupling 51 having two
25 side edges 511. The body 2 is shown having openings 23 in the protective portion 21. These openings 23 are for reducing the amount of material needed for producing the cable protection device 1. The clamping portion 22 of the body 2 may be provided with shoulders 222 for bearing against the side edges 511 of the coupling 51.

Figure 4 shows a cross-section through a tubular body 5 and a coupling 51 whereon a cable protection device 1 is arranged. This Figure shows that an inner diameter of the cable protection device 1 is slightly bigger than an outer diameter of the tubular body 5 and that there are shoulders 222 on both sides of the protective portion 21. Furthermore, the figure shows that the cable 4 to be protected is running along the tubular body 5 and is protected by the protective portion 21 of the cable protection device 1. The flexible members 31 are placed in connection with arms 223. Each arm 223 shown here provided with a recess 224 for guiding the flexible member 31.

Figure 5 shows the body 2 of the cable protection device 1 from the side when placed on the tubular body 5. Three cables 2 of different sizes are here shown protected by the protective portion 21 of the body 2, and it is further illustrated that the clamping portion 22 of the body 2 is in close contact with the tubular body 5.

Figure 6 illustrates how the fastening device 3 may be arranged partly covered by and lining the body 2 for clamping the cables 4 to the tubular body 5. The flexible member 31 runs along the inside 211 of the protective portion 21 of the body 2, and straps the cables 4 directly. The flexible member 31 is here shown as a thick black line. A tightening mechanism 32 is provided for tightening the flexible member 31.

Figure 7 is a cross section through the centre line of the tubular body 5, further illustrating the flexible members 31 clamping the cable 4 to the tubular body 5.

In addition to the features already described hereinabove for figure 5, figure 8a shows an embodiment of the cable protection device 1 wherein a tensioning means is provided in the form of a groove 224 and a roller 6. The groove 224 is provided in the contact surface 221 of the clamping portion 22 of the body 2. The groove 224 can be seen in more detail on figure 8b. The groove 224 is provided with a slightly deeper middle portion wherein the roller 6 is positioned. Whenever the cable protection device 1 is rotated, the roller 6 will be forced out of the deeper middle portion of the groove 224 and thereby pushes the body 2 radially out from the tubular body 5, consequently tensioning the flexible members 31.

Figure 9 illustrates further possible variations of some features of the cable protection device 1. In this embodiment, the flexible member 31 of the fastening device 3 is shown with a stepped surface providing stepwise tightening. Furthermore, in this embodiment a bore 225 is provided in the contact surface 221. Inside said bore 225 is provided a sharp
5 element 7, for instance a set screw. It must be understood that a different sharp element could have been arranged on the contact surface 221 or, as shown here, in the bore 225 in the contact surface 221. The purpose of the sharp, or pointed, element 7 is to provide a grip in the tubular body 5, for preventing rotation of the cable protection device 1.

It should be noted that the above-mentioned embodiments illustrate rather than limit the
10 invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element
15 does not exclude the presence of a plurality of such elements.

C l a i m s

1. A cable protection device (1) for protecting a cable (4) running along a tubular body (5), the tubular body (5) comprising a coupling (51) having two side edges (511), the cable protection device (1) comprising:
 - 5 - a body (2) for partly enclosing the tubular body (5) circumferentially, the body (2) being provided with:
 - a protective portion (21) having an inside (211), for enclosing the cable (4); and
 - a clamping portion (22) comprising a contact surface (221) for close
 - 10 contact with the tubular body (5), and an outside (226); and
 - a fastening device (3) comprising:
 - a flexible member (31) for strapping the body (2) to the tubular body (5) wherein the flexible member (31) is partly arranged on the inside (211) of the protective portion (21) and partly arranged on the outside (226) of the clamping
 - 15 portion (22), wherein the portion of the flexible member (31) being arranged on the inside (211) of the protective portion (21) is configured for holding the cable (4) securely between the protection device (1) and the tubular body (5); and
 - a tightening mechanism (32) for tightening the flexible member (31).
2. The cable protection device (1) according to claim 1, wherein the clamping portion (22) of the body (2) further comprises two shoulders (222), each for bearing
- 20 against one of the side edges (511) of the coupling (51), for preventing axial movement of the cable protection device (1) along the tubular body (5).
3. The cable protection device (1) according to any one of the preceding claims, wherein the fastening device (3) comprises a further flexible member (31).
- 25 4. The cable protection device (1) according to any one of the preceding claims, wherein a groove (224) is provided in the contact surface (221) and the cable protection device (1) further comprises a roller (6) for fitting into the groove (224) for providing extra tensioning of the flexible member (31) in case the cable protection device (1) is rotated.

5. The cable protection device (1) according to claim 4, wherein the roller (6) has a cam profile.
6. The cable protection device (1) according to any one of the preceding claims, wherein at least a portion of the contact surface (221) of the clamping portion (22) is serrated.
7. The cable protection device (1) according to any one of claims 1-5, wherein at least a portion of the contact surface (221) of the clamping portion (22) is provided with a surface coating for increased friction between the contact surface (221) and the tubular body (5).
8. The cable protection device (1) according to any one of claims 1-3, further comprising an insert for being positioned between the contact surface (221) and the tubular body (5), for providing extra friction.
9. The cable protection device (1) according to any one of claims 1-3, further provided with at least one sharp element (7) arranged in connection with the contact surface (221), for gripping into the tubular (5) upon tightening of the flexible member (31).

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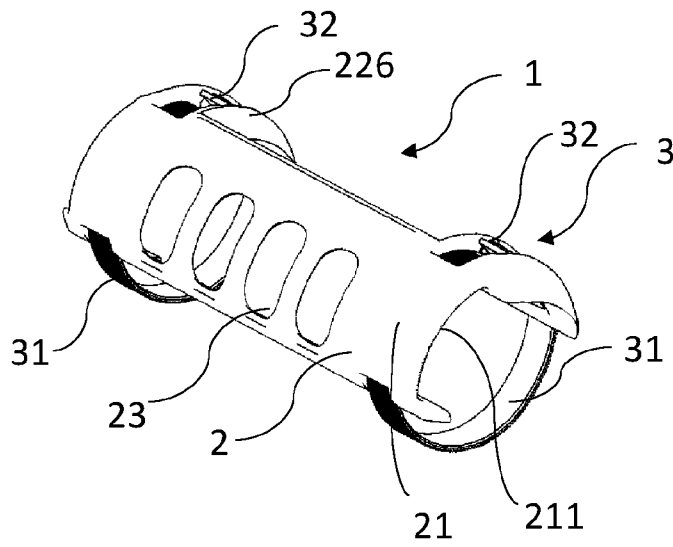


Fig. 1

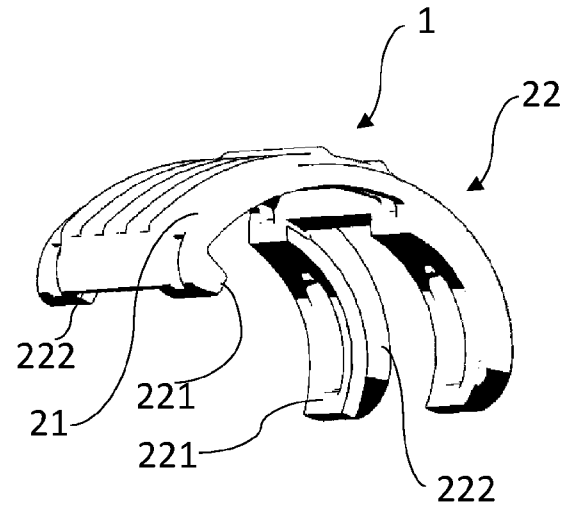


Fig. 2

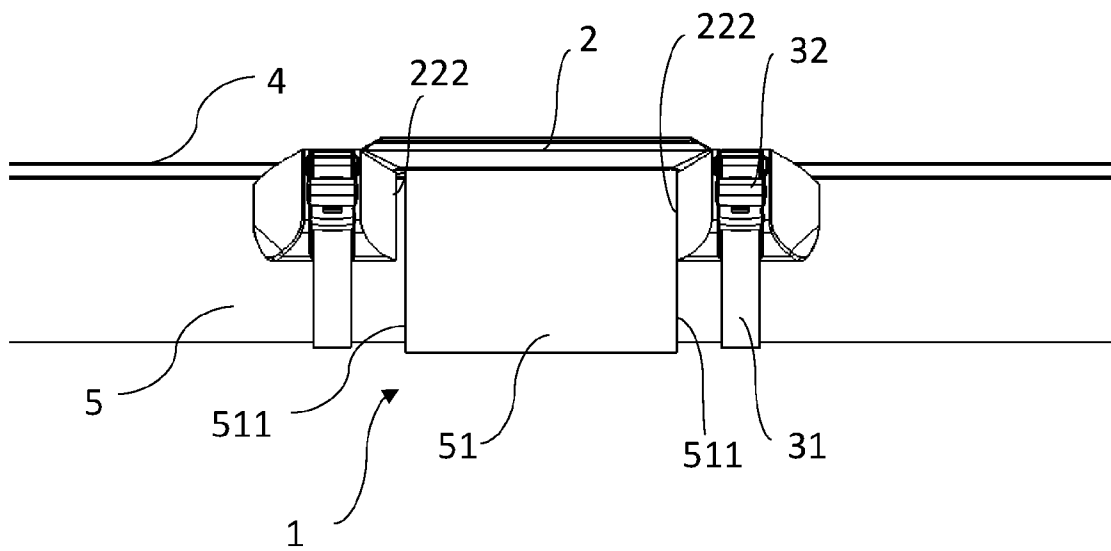


Fig. 3

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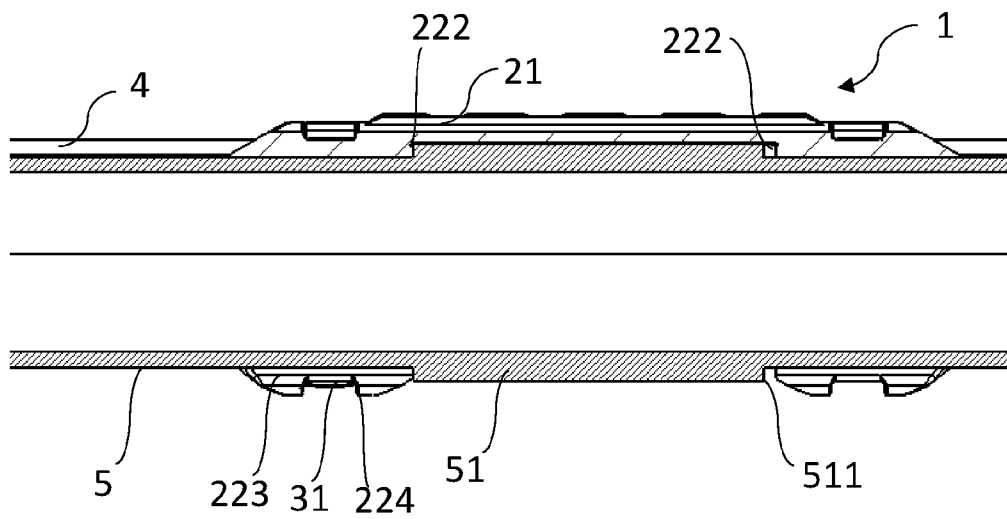


Fig. 4

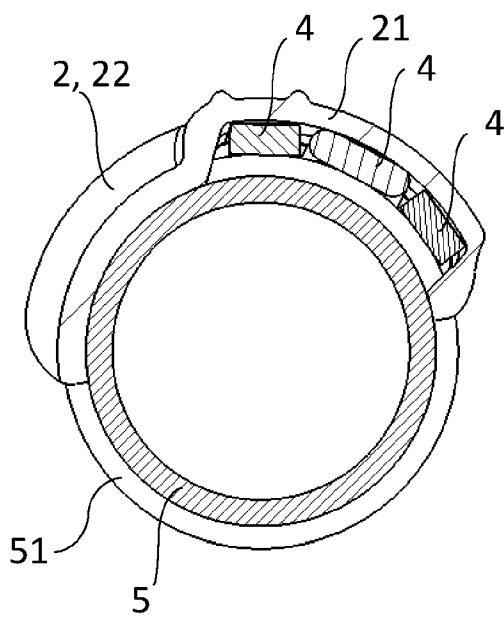


Fig. 5

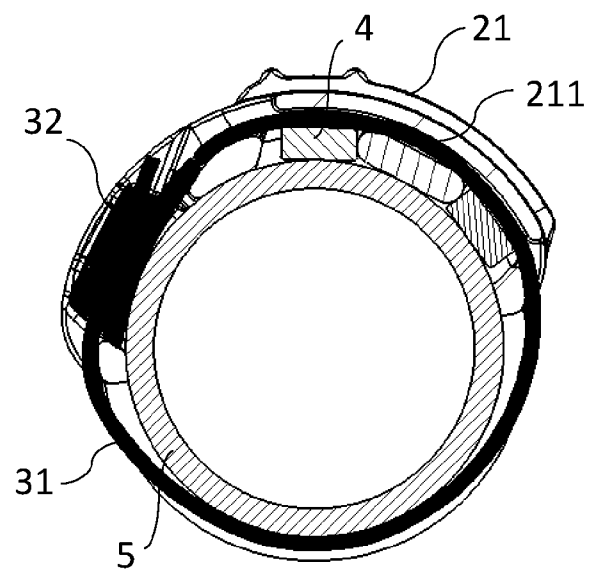


Fig. 6

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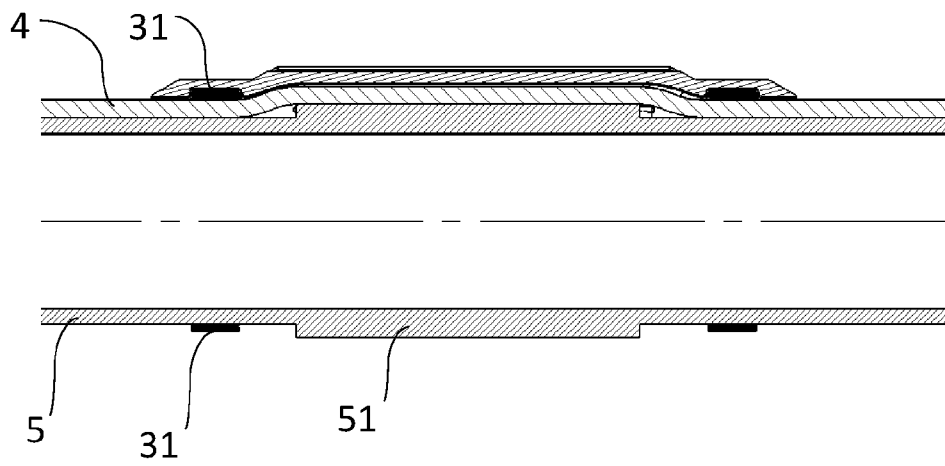


Fig. 7

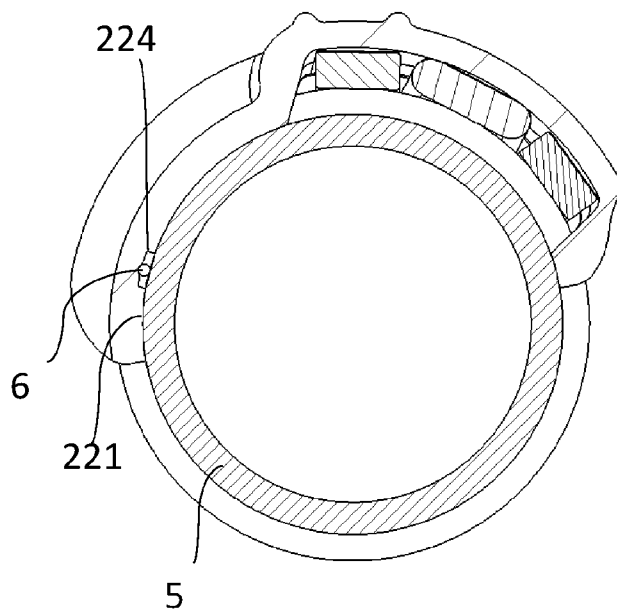


Fig. 8a

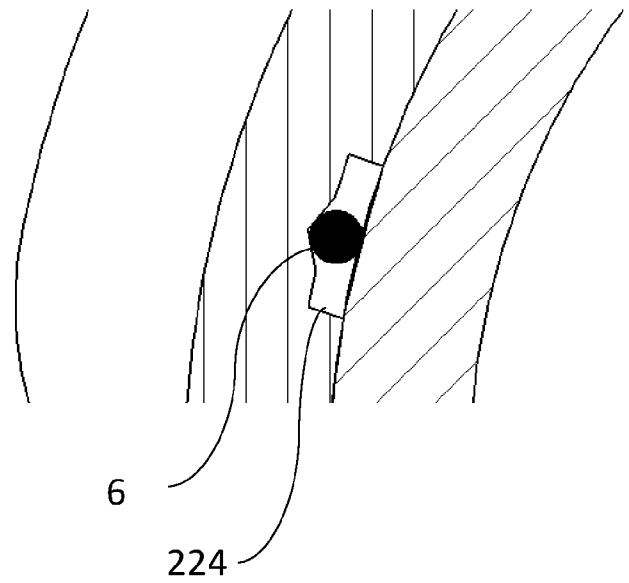


Fig. 8b

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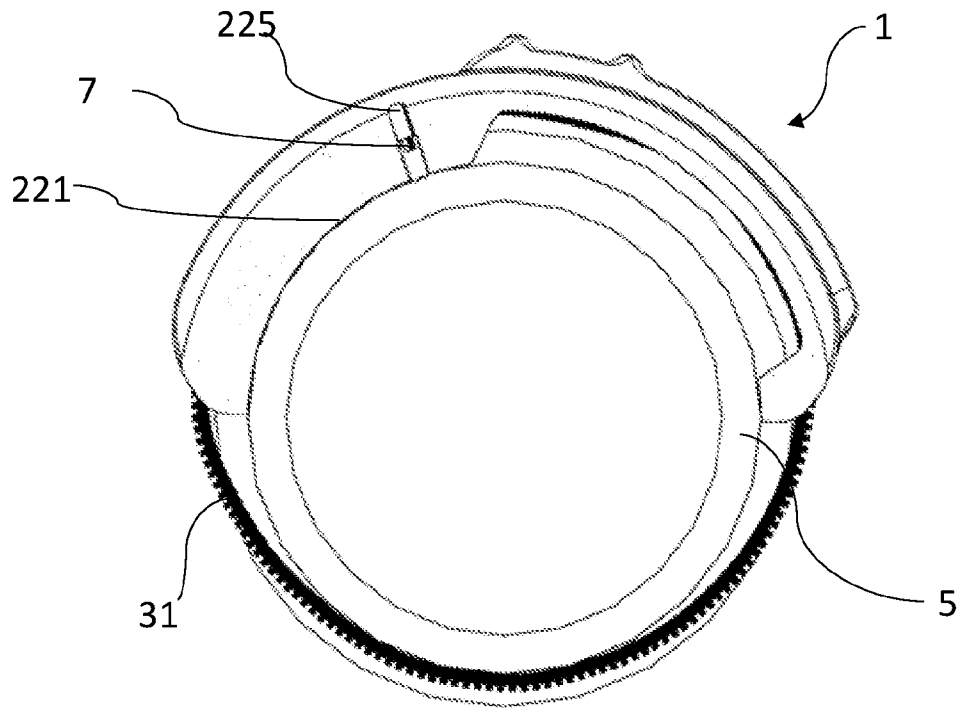


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO2022/050115

A. CLASSIFICATION OF SUBJECT MATTER E21B 17/10 (2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) E21B, F16L Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched DK, Fi, NO, SE: Classes as above Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPI, EPODOC, Full-text patentdatabases		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015/0026955 A1 (RODRIGUE JESSE [US]) 29 January 2015 (2015-01-29) paragraphs [0034], [0041] and [0042]	1-9
A	US 4601334 A (LOVEGROVE, P. J.) 22 July 1986 (1986-07-22) column 5 lines 1 to 4, figure 1a	1-9
A	WO 2004064215 A1 (HEAD PHILIP [GB]) 29 July 2004 (2004-07-29) page 5 line 19 to page 7 line 5 and figures 1-5	1-9
A	IT UA20163802 A1 (MPR S R L) 25 November 2017 (2017-11-25) detailed description and figs. 1-6 and 11-14	1-9
A	RU 190275U U1 (NOVOSELOV V N) 25 June 2019 (2019-06-25) whole document	1-9
A	WO 2005/103544 A2 (PERFORMANCE OIL TOOLS LTD [GB]) 03 November 2005 (2005-11-03) claims 1, 2, 5 to 8 and page 2 to page 6	1-9
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “D” document cited by the applicant in the international application “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family		
Date of the actual completion of the international search 08 August 2022		Date of mailing of the international search report 08 August 2022
Name and mailing address of the ISA/XN Nordic Patent Institute Helgeshoj Allé 81, 2630 Taastrup Denmark Telephone No. +45 43 50 85 00 Facsimile No. +4543508008		Authorized officer Bjørn LØVÅS Telephone No. +47 22 38 73 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO2022/050115**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6023027 A (NEFF, S. E.) 08 February 2000 (2000-02-08) column 5 lines 38 to 52 and figure 10	1-9
A	GB 2512365 A (PETROCLAMP SDN BHD [MY]) 01 October 2014 (2014-10-01) claim 1	1-9
A	US 2013/0139359 A1 (OTTEN GREGORY K [US] et al.) 06 June 2013 (2013-06-06) paragraphs [0027] to [0033]	1-9

INTERNATIONAL SEARCH REPORT
Information on patent family members

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