

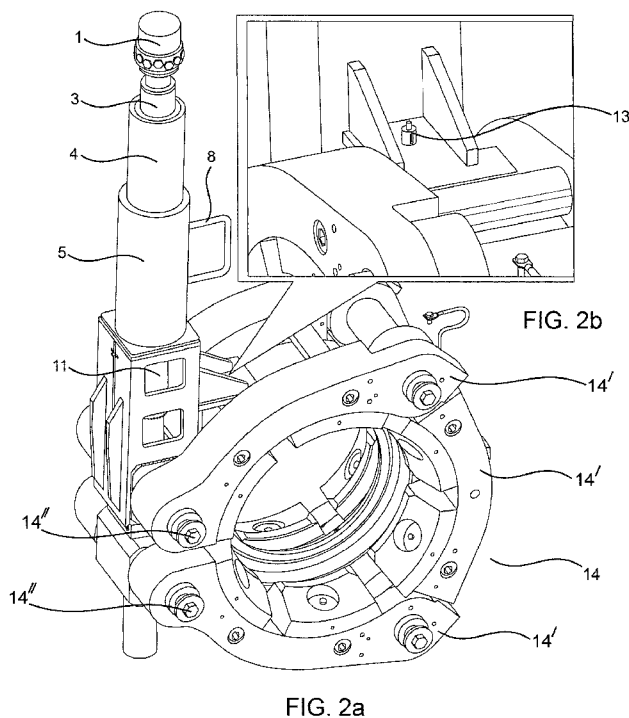


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[Continued on next page]

(54) Title: SUBSEA CLAMP CONNECTOR EMERGENCY RELEASE TOOL AND METHOD



(57) Abstract: A clamp connector emergency release tool designed for subsea operations, when normal release of a subsea clamp connector (14) is not possible, is shown and described. The tool is adapted to be handled and operated remotely by a work class ROV tool. The tool includes a clamp connector (14) adapter housing (7) arranged to engage with and connect to the clamp connector (14) body, a rotatable hole saw (11) mounted on the housing (7), a rotary motor (1) in driving connection with the hole saw (11) and a piston (3) and cylinder assembly (4,5). The piston (3) and cylinder assembly (4,5) enables advancing the rotatable hole saw (11) into the clamp connector (14) body around its jack screw, in order to separate the jack screw together with a threaded portion of said clamp connector (14) in order to separate the jack screw from the clamp connector (14) body.

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**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

**Published:**

- *with international search report (Art. 21(3))*

## Subsea clamp connector emergency release tool and method

The present invention relates in general to an emergency release tool for a connector designed for sub sea operation, and to a method for emergency release of such clamp  
5 connector, applying the tool.

More specifically, the present invention relates to an emergency release tool for a clamp connector adapted for sub sea operation, which tool is applied, when release of a subsea connector by normal mechanism is not possible.  
10

More particularly, the present invention relates to an emergency release tool according to the preamble of claim 1 and to a method for releasing a subsea clamp connector, according to the preamble of claim 9.

15 The clamp connector emergency release tool is adapted to be handled and operated remotely by a work class ROV tool.

### **TECHNICAL BACKGROUND OF THE INVENTION**

20 In onshore and offshore operations such as for hydrocarbon exploration and production, application of subsea clamp connectors is very common. These connectors are applied for attachment of various subsea assemblies. Examples may be marine risers, production flow lines attached to well heads and so on.

25 It is also common knowledge that subsea assemblies need to be removed after the desired operation is over, or if there is some problem with the line. For that purpose, the clamp connectors securing the line need to be unlocked/released in a subsea environment. This has to be done remotely with the assistance of a ROV carrying a ROV tool.  
30

After operation for a substantial period of time, the clamp connector may get jammed up and normal release of the connector is not possible by applying conventional torque

tool. In such a case, an emergency release tool needs to be applied, which should be possible by subsea operation of the ROV.

Over the years, there has been a requirement for such emergency release tool, for  
5 release of clamp connectors, which is capable of sub sea operation when remotely applied, such that the connector is released in a safeguarded manner, ensuring proper detachment of the concerned subsea assemblies. However, significant achievement in this respect is yet to be achieved.

10 The present invention relates to a clamp connector emergency release tool designed for subsea operations when normal release of a clamp connector is not possible, which tool is handled and operated by a work class ROV tool able to cut around the jack screw of a clamp connector in order to open up the clamp connector.

15 Granted US patent 5273376 teaches an emergency release tool for forcefully removing a marine assembly from a subsea assembly. The marine assembly has a first flange and the sub sea assembly has a second flange. The tool has a U-shaped frame which is transported and positioned between the flanges by ROV. Hydraulic means is mounted on the frame. This hydraulic means exerts pressure on the flanges when it is actuated by  
20 a hydraulic fluid. The hydraulic fluid is supplied from means located on ROV. On doing so, the hydraulic means generates a force normal to the frame and pushes the flanges apart.

From the paragraph above, it should be understood that this US patent leaves scopes of  
25 malfunctioning of the complicated arrangement and the methodology applied, which involves forcefully prying and breaking the clamps open. This requires a much larger force to be generated than cutting through the clamp. Hence, achieving the emergency release in a safeguarded manner, enabling ensured and clear release is not achieved.

30 US 2005145389A1 discloses a subsea well casing cutting tool comprising a casing gripper and a rotary cutter drive assembly. This merely discloses an arrangement for straightaway cutting a subsea well casing and removing it, for example, when it is

abandoned. It is not directly related to sub sea emergency release of a clamp connector used for locking sub sea assemblies.

5 Similar comments as above are applicable in respect of granted US patent 4557628A, which discloses an apparatus and method for remotely cutting broken parts of an underwater upright structure for emergency removal of such broken parts. Hence, this also is not directly related to sub sea emergency release of a clamp connector, used for locking sub sea assemblies.

10 Similarly, US 2008/0304915A1 discloses a method and device for attaching a cutting assembly to a sea bed, the cutting assembly comprising a frame work for holding the object to be cut and a cutter head.

15 All the above prior art relate to sub sea operation and involve cutting operation including a cutter drive. None of these have the teaching of the present invention as described herein and claimed in the appended claims.

### **OBJECTS OF THE INVENTION**

20 It is the principal object of the present invention to provide an emergency release tool, capable of releasing a jammed up clamp connector and suitable for sub sea operation by means of a work class ROV, such that the connector is released in a safeguarded manner, enabling clear and emergency release of the clamped sub sea assemblies.

25 It is a further object of the present invention to provide an emergency release tool for use on a clamp connector suitable for sub sea operation by means of a work class ROV, which works when conventional techniques applying a torque tool fails.

30 It is yet another object of the present invention to provide an emergency release tool for use on a clamp connector which is adapted to be applied in emergency situations to release a "Horizontal Connection Module" (HCM) from a "Clamp Connector" (CC), if the usual method of applying the conventional torque tool fails.

It is a further object of the present invention to provide an emergency release tool for use on a clamp connector, suitable for sub sea operation by means of a work class ROV which is simple in use and construction, and does not involve complicated operating steps or components.

5

It is another object of the present invention to provide a method for releasing a sub sea clamp connector by applying an emergency release tool with the help of a work class ROV, such that the connector is released in a sacrosanct manner, enabling clear and emergency release of the clamped sub sea assemblies.

10

How the foregoing objects are achieved and some other advantageous features, still not disclosed in prior art, will be clear from the following non-limiting description.

15

All through the specification including the claims, the words, “connector”, “clamp connector”, “hydraulic fluid”, “work class ROV”, “piston”, “cylinder assembly”, “hole saw”, “hydraulic cylinder”, “jack screw” are to be interpreted in the broadest sense of the respective terms and includes all similar items in the field known by other terms, as may be clear to persons skilled in the art. Restriction/limitation, if any, referred to in the specification, is solely by way of example and understanding of the present invention.

20

## **SUMMARY OF THE INVENTION**

25

Accordingly, the present invention provides a clamp connector emergency release tool designed for subsea operations, when normal release of a subsea clamp connector is not possible. This tool is handled and operated remotely by a work class ROV tool. The tool according to the invention, includes a clamp connector adapter housing arranged to engage with and connect to the clamp connector body, a rotatable hole saw mounted on the adapter housing, a rotary motor in driving connection with the rotatable hole saw and a piston and cylinder assembly arranged to advance the rotatable hole saw into the clamp connector body while cutting around a jack screw of the clamp connector, in order to separate the jack screw together with a threaded portion of the clamp connector body from the remainder of the clamp connector body, for its perfect releasing.

30

5

Preferably, the rotary motor is hydraulically operated and driven and the piston and cylinder assembly are hydraulically actuated.

Preferably, the tool also includes an upper pack box and lower pack box for having  
5 hydraulic fluid sealing arrangement.

In one preferred embodiment, the tool includes an indicator for indicating the engage position and disengage position of the hole saw, with respect to the clamp connector  
10 body.

Moreover, the tool may include a ROV handle arranged on the hydraulic piston  
15 cylinder.

Preferably, the tool includes guiding means arranged on the clamp connector adapter  
20 housing for facilitating its landing on the clamp connector body.

More preferably, the tool includes a landing indicator for indicating correct landing of the housing on the clamp connector body.

In one embodiment the clamp connector is of the kind having two hinges and three  
25 links.

The present invention also provides a method of emergency release of a subsea located clamp connector by use of a connector emergency release tool, when normal release of  
30 a clamp connector is not possible, which tool is handled and operated by a work class ROV tool. The method comprises operating the tool and advancing it into the clamp connector body by cutting the clamp connector body adjacent to its jack screw. This ensures cutting loose the jack screw together with a thread portion of the clamp connector body for separating the jack screw from the clamp connector body. Hence, perfect release of the subsea clamp connector is ensured.

Preferably, the cutting operation as described in the preceding paragraph, takes place by use of a hole saw driven by a rotary motor and advanced by means of a hydraulic piston and cylinder.

## 5 BRIEF DESCRIPTION OF THE ACCOMPANYING FIGURES

Having described the main features of the invention above, a more detailed and non-limiting description of a preferred embodiment is given in the following with reference to the drawings, in which:

10

Figures 1a and 1b illustrate an isometric view and a sectional view respectively, of the emergency release tool according to the present invention.

15

Figure 2a illustrates the emergency release tool according to the present invention, mounted on a clamp connector.

Figure 2b illustrates an enlarged view of a portion shown in figure 2a to clearly show the landing indicator.

20

Figure 3 illustrates in more detail the position indicator of the emergency release tool according to the present invention.

25

Figure 4a illustrates a longitudinal cross section through the emergency release tool and the clamp connector according to the present invention.

Figure 4b illustrates an enlarged view of a portion shown in figure 4a to clearly show the position of the hole saw on the clamp connector body.

30

Figure 5a illustrates a stage when the emergency release tool illustrated in figure 4a has advanced into the body of the clamp connector.

Figure 5b illustrates an enlarged view of the portion of figure 5a, that shows the stage where the hole saw has already cut through the main clamping portion.

Figure 6 illustrates in more detail the position indicator of the emergency release tool according to the present invention, in engaged position.

- 5 Figure 7a illustrates the emergency release tool mounted on the clamp connector as in figure 2a when seen from the front.

Figure 7b illustrates an enlarged view of a portion shown in figure 7a to clearly show the position indicator in disengaged position.

10

### **DETAILED DESCRIPTION OF THE INVENTION**

The following provides a detailed non-limiting description of a preferred embodiment of the present invention which is purely exemplary.

15

The present invention discloses a clamp connector emergency release tool designed for subsea operations when normal release of a clamp connector is not possible. This tool is handled and operated by a work class ROV tool such that the clamp connector is released by cutting the body of the clamp connector, around the jack screw, for opening  
20 up the clamp connector.

20

The emergency release tool has a simple construction and can be applied by the ROV in subsea condition, for cutting around the jack screw as explained in the preceding paragraph. Here lies the uniqueness of the emergency release tool of the present  
25 invention which achieves releasing of a clamp connector, in a subsea environment in a sacrosanct manner, such that the clamped assemblies may be removed.

25

The present invention also relates to a method of releasing a subsea located clamp connector by applying the connector emergency release tool when normal release of a  
30 clamp connector is not possible. This may happen after prolonged sub sea operation, when the clamp connector gets jammed up.

30

Thus, the emergency release tool according to the present invention can be effectively applied in emergency situations to release a "Horizontal Connection Module" (HCM) from a "Clamp Connector" if the usual method, using the conventional "Torque Tool", fails.

5

The unique constructional features of the emergency release tool and the method of its working is explained later, in detail with reference to the accompanying drawings. It is known and as stated under the heading "Technical Background of the Invention", sub sea clamp connectors are applied for attaching sub sea assemblies.

10

A clamp connector 14 (best shown in figure 2a) of this kind has three arc shaped links 14' hingedly connected to each other. Each link 14' is made up by a pair arc shaped link pieces placed in parallel a distance apart from each other and connected by pivot pins providing the hingedly connection between the respective links 14'. Such clamp connectors, when activated, forces two pipe flanges axially towards each other. The activation takes place by turning a jack screw by use of a conventional torque tool.

15

The jack screw 15 (best shown in figure 4a) is simply a heavy gauge bolt with external threads through most of its entire extension and terminates in a square or hexagon bolt head, normally not wider than the bolt shaft. As stated above, such clamp connectors 14 are generally of a two hinged 14'' construction, with three links 14' and can be opened up to be withdrawn from a pipe joint, or closed to be tightened around the pipe joint. The connector 14 is able to retain a metal-to-metal seal intended to be located between the pipe flanges.

20

The jack screw 15 passes through a centrally located seal plate and transversally extending blocks arranged on respective clamp connector link ends, with the blocks facing each other when the clamp connector is closing. One of the blocks has internal left hand threads, while the other is provided with internal right hand threads, which engage with corresponding threads on the jack screw 15. The jack screw 15 is rotatable in the seal plate, but still retained by the plate. This is the location where the right hand and left hand threads of the jack screw 15 meet. Thus, by turning the jack screw 15 in one direction the blocks are drawn towards each other in order to tighten the clamp

25

30

connector 14. By turning the jack screw 15 in the other direction, the clamp connector 14 is opened up and released. The configuration of the clamp connector 14 is not shown in closer detail, since this design is not part of the present invention and is per se known to persons skilled in the art.

5

The emergency release tool 1' is illustrated in figures 1a and 1b. As shown in figure 1a, the tool 1' has a hydraulic cylinder comprising of a lower cylindrical housing 5, encasing another housing 4 of a hydraulic piston 3 (best shown in the cross-sectional view 1b). A ROV handle 8 is installed on the cylindrical housing 5 for operating by a  
10 ROV (not shown). The tool 1' also has a clamp connector adapter housing 7 at its lower end. This housing 7 is adapted to land on a clamp connector body 14 (best shown in figures 2a, 4a, 5a) and engage therewith. The housing 7 is also provided with disengage/engage position indicator 6/6', the functions of which are explained later.

15 As shown in figure 1b, a rotation rod 10 is operatively connected to a hydraulic rotary motor 1. Figure 1a also shows the motor bracket 2. A hole saw 11 is connected to the rotation rod 10, which in turn is forced down by the hydraulic piston 3 during operation. The rod 10 is rotatable by the motor 1, so that the rod 10 acts as the rotatable drive of the hole saw 11.

20

The figure 1b also shows an upper pack box 9 and a lower pack box 9' which provides a hydraulic fluid sealing arrangement, for preventing leakage under pressure thereof. On the wall opposite to the disengage/engage indicator 6/6', the clamp connector adapter housing 7 is provided with a landing indicator 13, which indicates proper landing of the  
25 housing 7 on the clamp connector body 14. The guide plates 12 enhance this landing process with precision.

How the various features function is now explained with reference to the figures 2a, 2b, 3, 4a, 4b, 5, 6a, 6b, 7a and 7b where like reference numerals represent like  
30 constructional features as detailed hereinbefore.

The operation starts with the landing of the emergency tool on the clamp connector body 14. This is effected by ROV (not shown). Incidentally, the ROV secures the

emergency release tool 1' in position during the operation and also effects the operation as now explained in detail.

Figure 2a shows this position where the emergency release tool 1' has landed on the clamp connector body 14. The landing indicator 13 shown in figure 2b, gives the indication for correct landing of the tool 1' on the clamp connector body 14 by the ROV (not shown). The landing position in figure 2a, is shown in detail in figure 2b.

The next step involves activating the piston 3 inside the cylinder 4 by actuating hydraulic means (not shown) so that the hole saw 11 is positioned co-axially to and around the jack screw 15 on the connector body 14. The figure 3 in detail shows the indicator position 6 at this stage, which indicator helps in monitoring and effecting the operation. The figure 4a illustrates this position of the hole saw 11 of the emergency release tool, around the jack screw 15. The figure 4b illustrates an enlarged portion of figure 4a to precisely show this position.

The position as detailed in the preceding paragraph is the precutting position.

Now the hydraulic motor 1 is started and the drive of the hole saw 11, i.e. rotation rod 10 starts rotating the hole saw 11. The cylinder 5 is actuated hydraulically by release of hydraulic fluid in the cylinder 5, so that the cylinder 4 with the piston rod 3 comes further down. This ensures that the hole saw 11 starts cutting down into the upper transversal block of the clamp connector 14 around the jack screw 15 and performs penetration. Figure 5a shows this stage.

It can be seen from figure 5a that the hole saw 11 has penetrated and been cutting through the clamp connector body 14 around the jack screw 15, and also into and through the seal plate. The enlarged view in figure 5b further clarifies this.

The figure 6 shows the position 6', as indicated by the indicator where the cutting operation is finished. This again facilitates perfect monitoring of the operation, to take a decision where the operation should end. At this stage (not shown in closer detail), the hole saw 11 has, as mentioned, penetrated the clamp connector body 14 and the seal

11

plate, and around the jack screw 15. By making the piston and cylinder 4, 5 longer, it would be possible to penetrate into the lower block of the clamp connector body 14 around the jack screw 15, actually all the way through if required.

- 5 Now, the clamp connector 14 is totally released since the hole saw has cut the body around the jack screw 15 together with a thread portion of the block(s) of the clamp connector 14.

From this position, disengagement of the hole saw 11 is started. The hydraulic cylinders  
10 4, 5 are pressurized in the opposite direction to pull up the hole saw 11 and the indicator starts to move to disengaged position 6, as shown in detail in figure 7b. The operation now is just reverse of the one described above.

When the indicator is at position 6, the motor drive 1 is stopped and the emergency  
15 release tool is ready for upward removal from the clamp connector body 14. Of course, the motor may be stopped immediately after the cutting operation is over, i.e. before the pulling up operation of the hole saw 11.

The gas compensator camera (not shown) helps avoiding large pressure inside the tool  
20 body, during operation. Emergency pressure release valve (not shown) may be deployed for this purpose as well.

Figure 7a is a front view of the tool, side view whereof is shown in figure 2a. This is  
again in the ideally disengaged position, as in figure 2a. This is shown in closer detail in  
25 figure 7b, as stated before, which is an enlarged view of the front portion of the clamp connector adapter housing 7. This is the position shown as 6 by the position indicator.

At this stage shown in figure 7a, the tool may be removed from the top of the clamp  
connector body 14 by an ROV utilizing the handle 8 on the cylinder 5. Once the  
30 emergency release tool 1' is removed, the clamp connector 14 is disengaged since the jack screw 15 and the thread portion of the clamp connector 14 has become loose from the remainder of the clamp connector 14. Due to the weight and hinged construction of

12

the links 14', the lower transversal block of the lower link 14' will pull the jack screw 15 down from and through the upper block.

Thus, emergency release of a sub sea clamp connector is facilitated by the tool of the  
5 present invention which is operable by an ROV.

The emergency clamp connector release tool of the present invention and the method of applying it, as discussed hereinbefore is thus unique, hitherto unknown.

10 From the foregoing description and also from the appended claims it would be clear to persons skilled in the art, that all the objectives of the present invention are achieved.

The present invention has been described with reference to a preferred embodiment and drawings for the sake of understanding only and it should be clear to persons skilled in  
15 the art, that the present invention includes all legitimate modifications within the ambit of what has been described hereinbefore and claimed in the appended claims.

P a t e n t   c l a i m s

1.

A clamp connector emergency release tool (1') designed for subsea operations, when  
5 normal release of a subsea clamp connector (14) is not possible, said emergency release  
tool being adapted to be handled and operated remotely by a work class ROV tool,  
**characterized in that** said emergency release tool (1') includes a clamp connector  
adapter housing (7) arranged to engage with and connect to the clamp connector body  
10 (14), a rotatable hole saw (11) mounted on said adapter housing (7), a rotary motor (1)  
in driving connection with said rotatable hole saw (11) and a piston (3) and cylinder  
assembly (4,5) arranged to advance said rotatable hole saw (11) into said clamp  
connector body (14) while cutting around a jack screw (15) of the clamp connector (14),  
in order to separate said jack screw (15) together with a threaded portion of said clamp  
15 connector body (14) from the remainder of the clamp connector body (14), for its  
perfect releasing.

2.

The clamp connector emergency release tool according to claim 1, **characterized in  
that** said rotary motor (1) is hydraulically operated and driven and said piston (3) and  
20 cylinder (4,5) assembly are hydraulically actuated.

3.

The clamp connector emergency release tool according to claim 1 or 2, **characterized  
in that** said tool includes an upper pack box (9) and lower pack box (9') for having  
25 hydraulic fluid sealing arrangement.

4.

The clamp connector emergency release tool according to any one of claims 1, 2 or 3,  
**characterized in that** said tool includes an indicator for indicating the engage position  
30 (6') and disengage position (6) of said hole saw (11), with respect to said clamp  
connector body (14).

5.

The clamp connector emergency release tool according to any one of claims 1 to 4  
**characterized in that** said tool includes a ROV handle (8) arranged on the hydraulic  
5 piston cylinder (5).

6.

The clamp connector emergency release tool according to any one of the claims 1 to 5,  
**characterized in that** said tool includes guiding means (12) arranged on the clamp  
10 connector housing (7) for facilitating its landing on said clamp connector body (14).

7.

The clamp connector emergency release tool according to claim 6, **characterized in  
that** said tool includes a landing indicator (13) for indicating correct landing of said  
15 housing (7) on said clamp connector body (14).

8.

The clamp connector emergency release tool according to any of one of the claims 1 to  
7, **characterized in that** said clamp connector is of the kind having two hinges (14'')  
20 and three links (14').

9.

A method of emergency release of a subsea located clamp connector by use of a  
connector emergency release tool (1'), when normal release of a clamp connector is not  
25 possible, which tool is handled and operated by a work class ROV tool, said method is  
**characterized by** operating said tool and advancing it into the clamp connector body  
(14) by cutting said clamp connector body (14) adjacent to the jack screw (15) of the  
clamp connector, thereby cutting loose the jack screw (15) together with a thread  
portion of said clamp connector body (14) for separating the jack screw (15) there from,  
30 thus ensuring perfect release of the subsea clamp connector.

10.

The method according to claim 9, **characterized in that** said cutting operation takes place by use of a hole saw (11) driven by a rotary motor (1) and advanced by means of a hydraulic piston (3) and cylinder (4,5).

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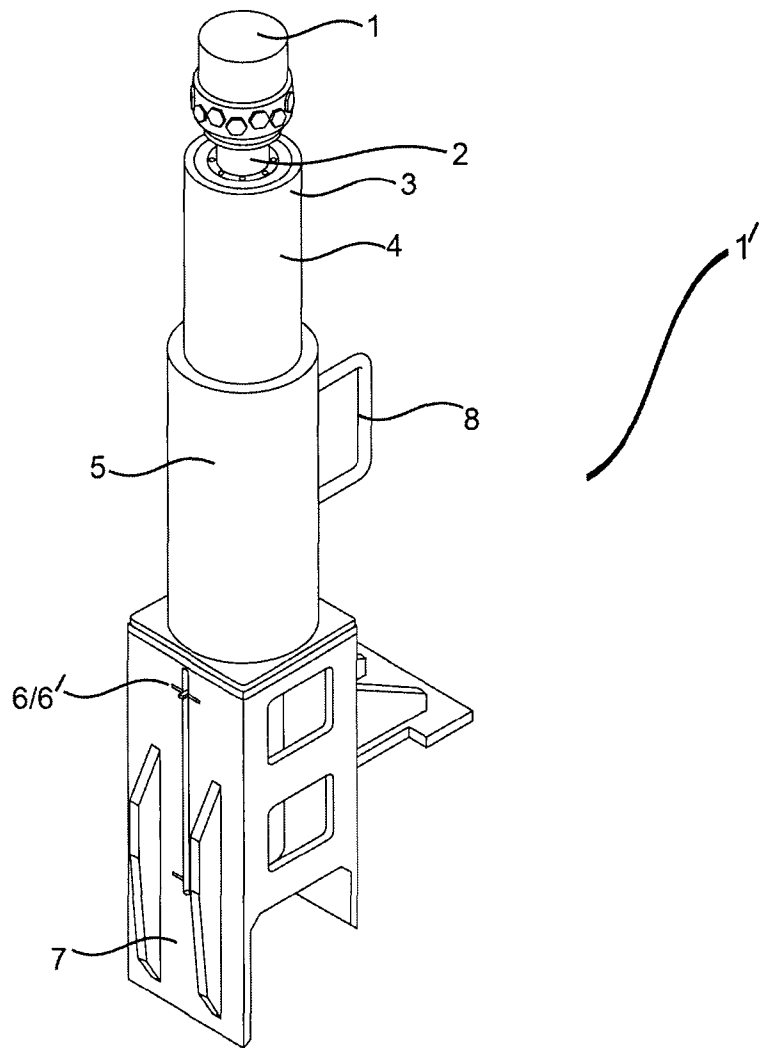


FIG. 1a

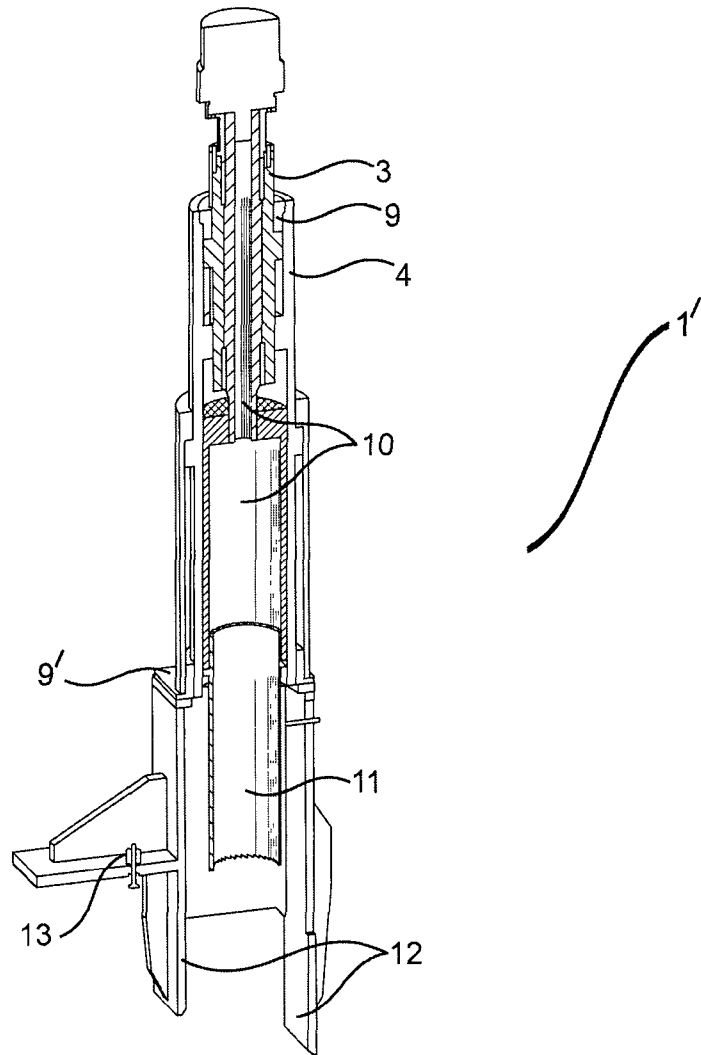


FIG. 1b

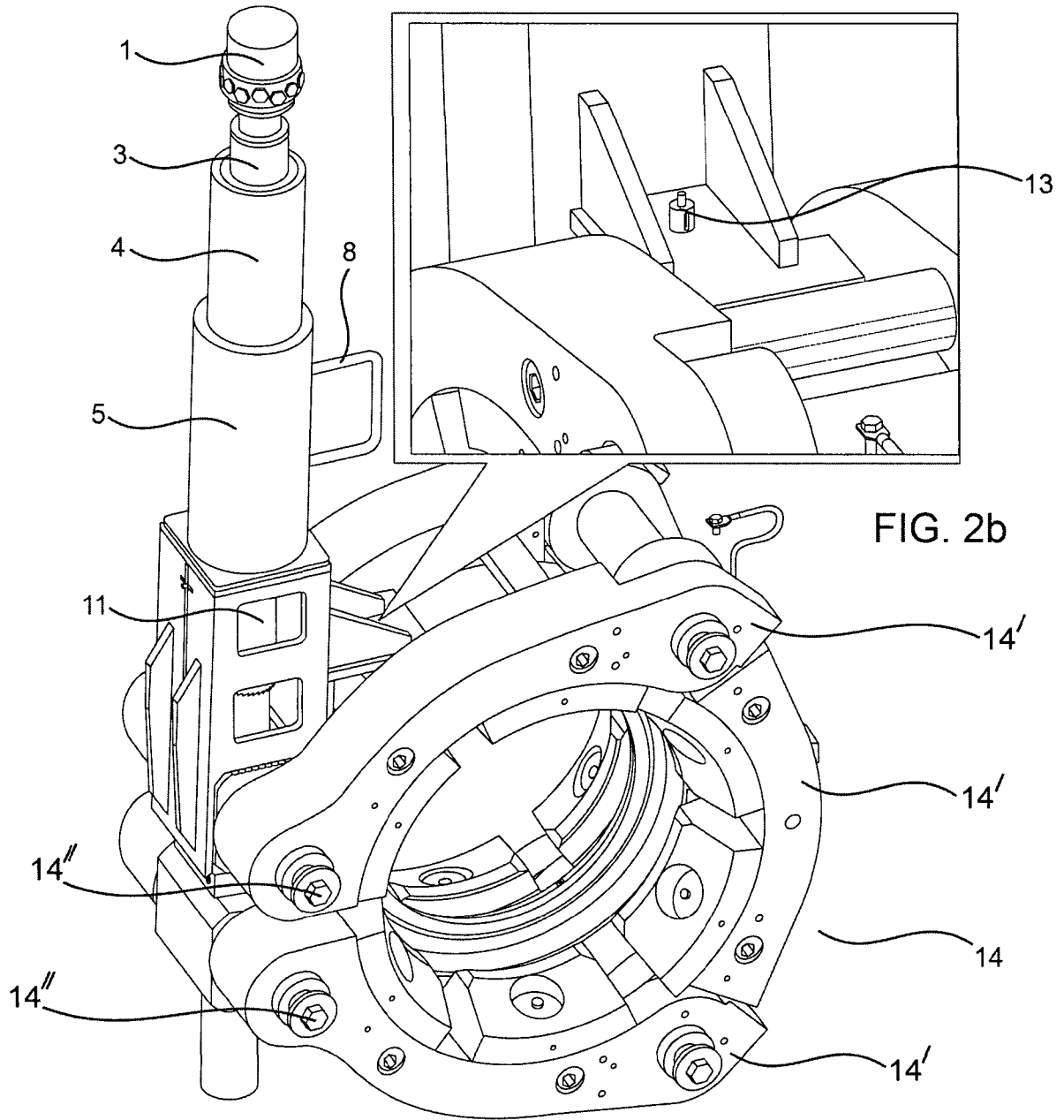


FIG. 2b

FIG. 2a

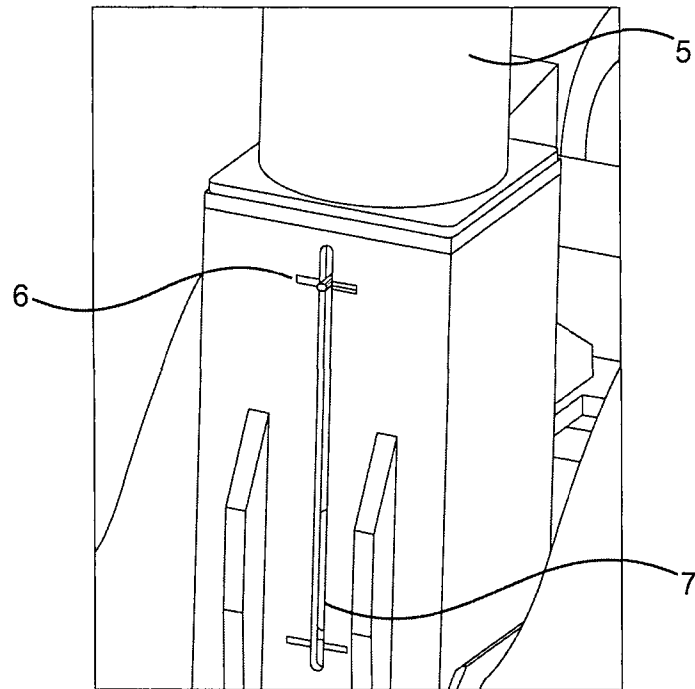


FIG. 3

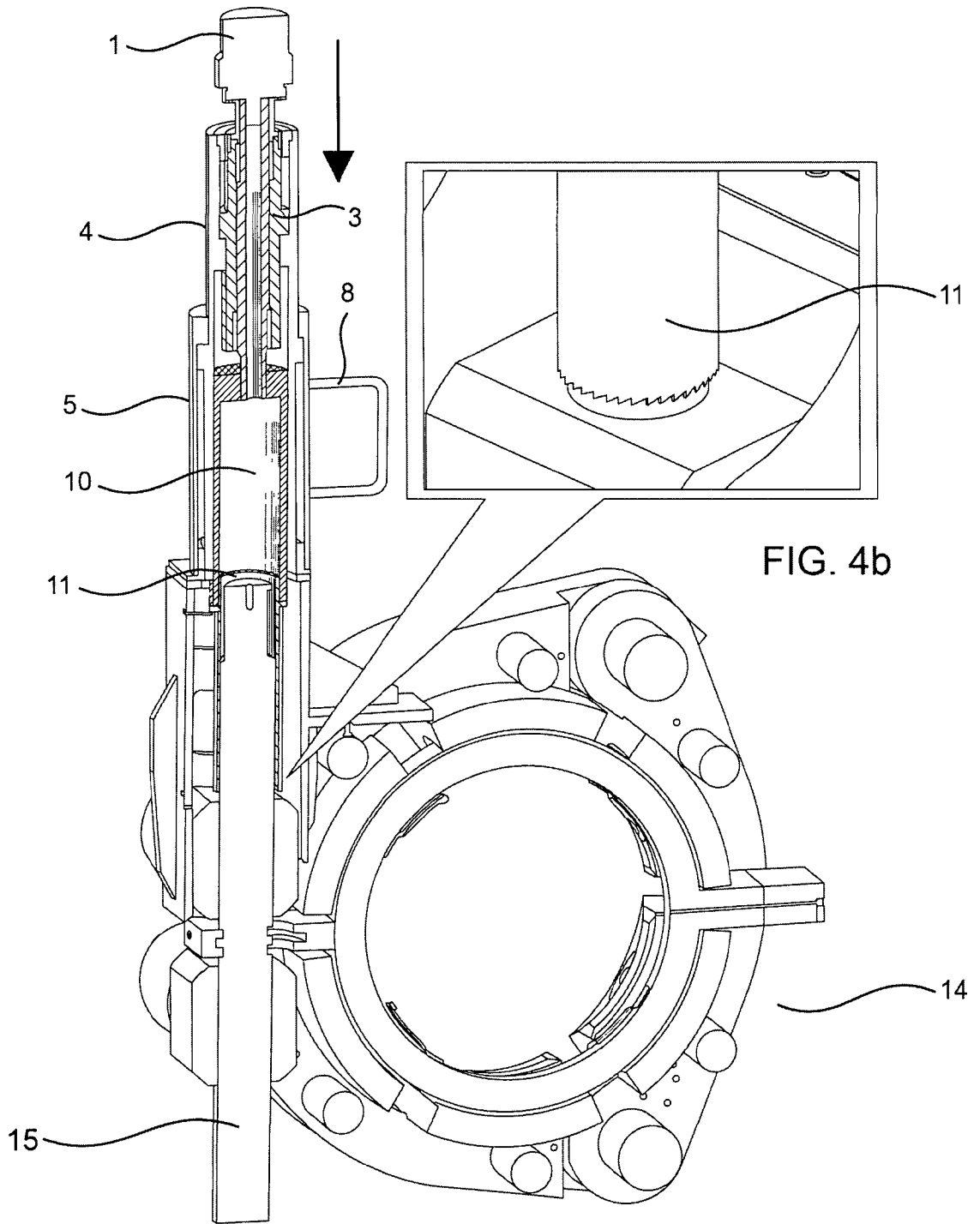
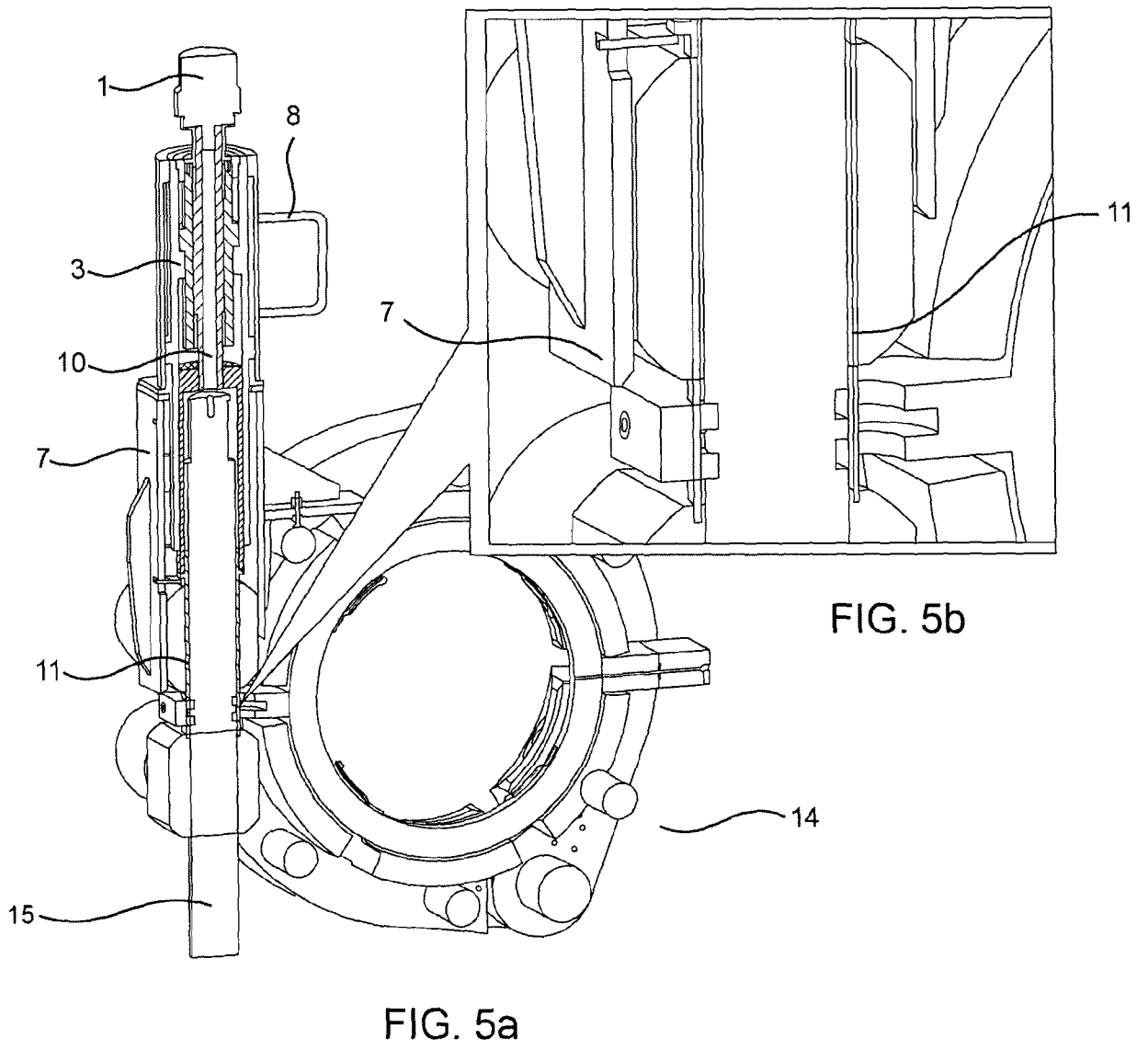


FIG. 4b

FIG. 4a



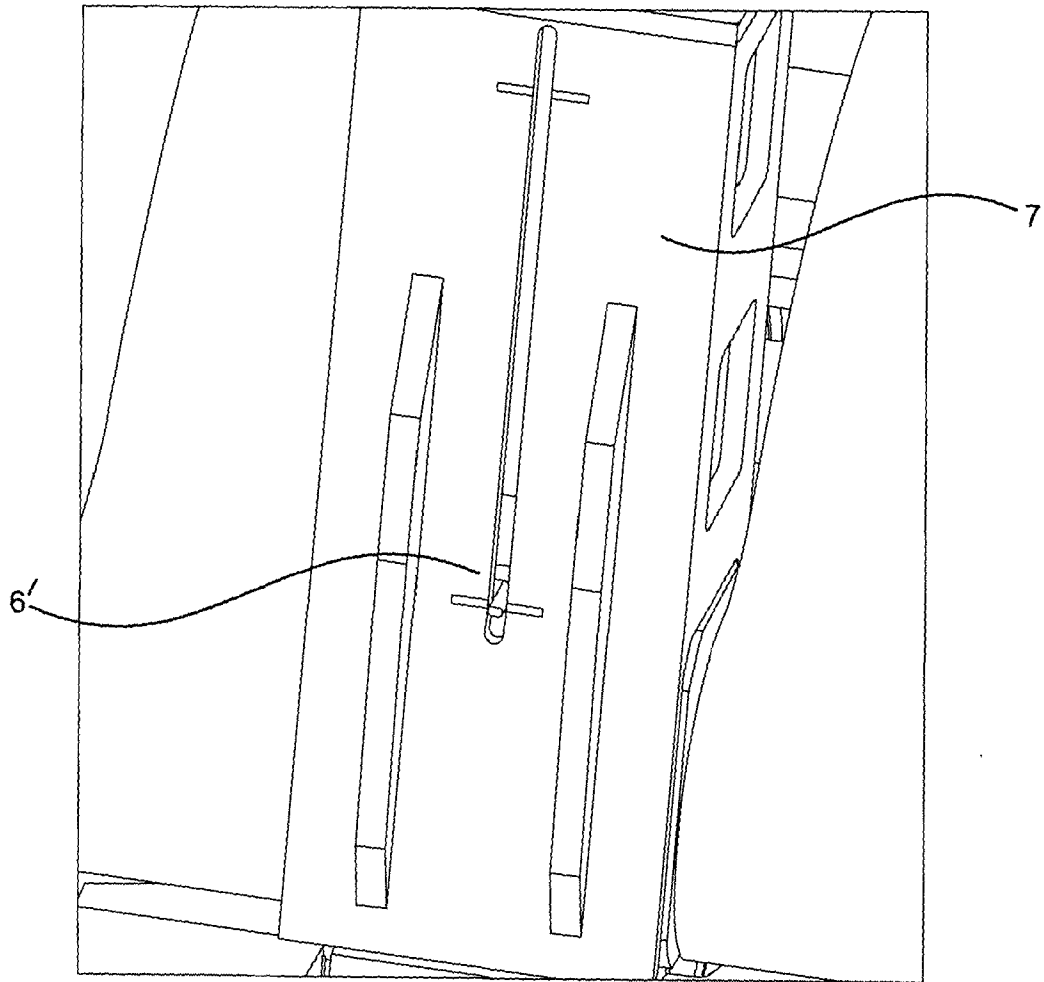
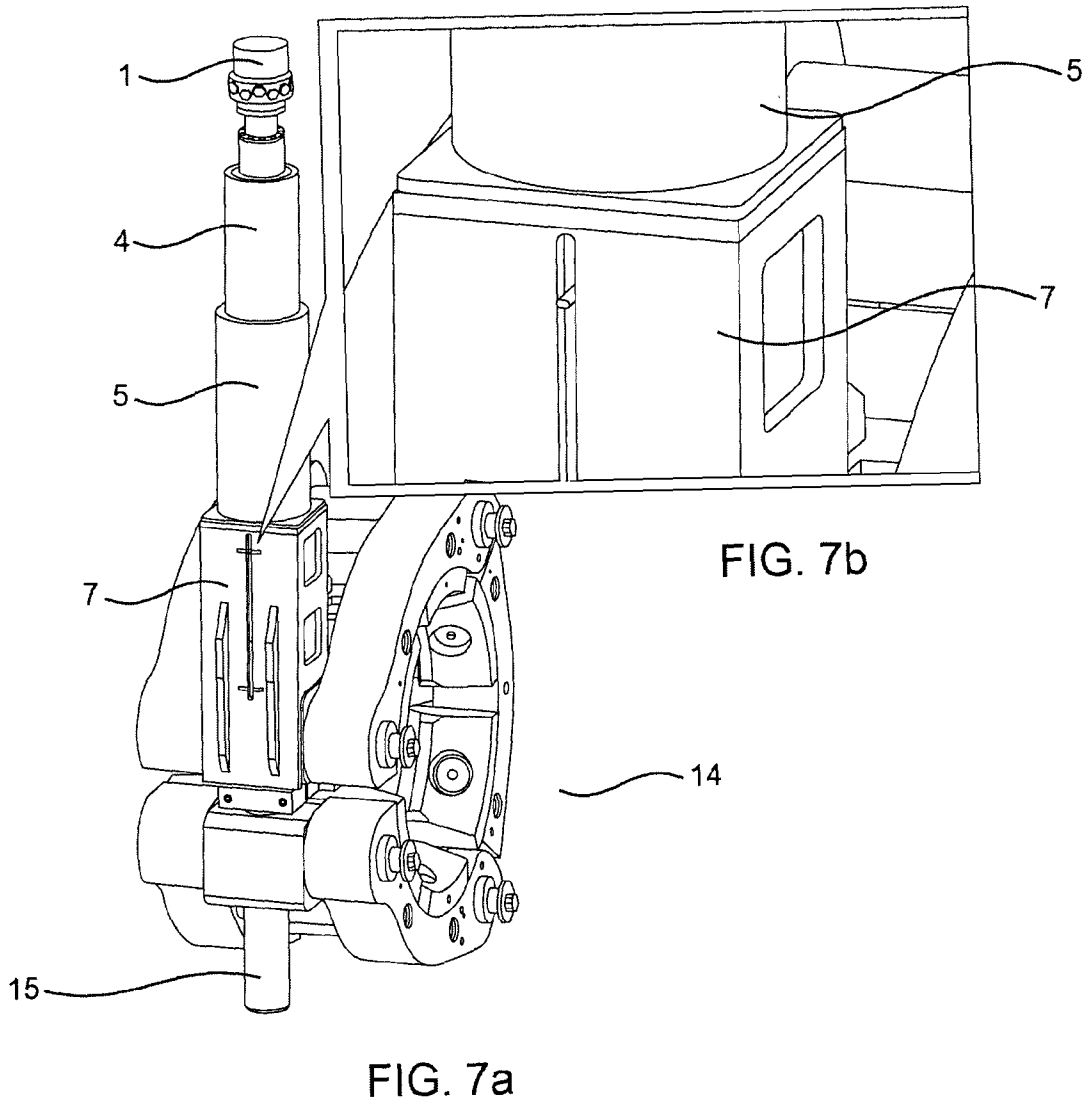


FIG. 6



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/NO2012/000017

## A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: B23D, E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5273376 A1 (RITTER JR PAUL B), 28 December 1993 (1993-12-28); whole document --	1-10
A	WO 2006126884 A1 (NORSE CUTTING & ABANDONMENT AS ET AL), 30 November 2006 (2006-11-30); whole document --	1-10
A	US 20020106247 A1 (RUSSELL LARRY R), 8 August 2002 (2002-08-08); whole document -- -----	1-10

 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

"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

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"&amp;" document member of the same patent family

Date of the actual completion of the international search

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**Continuation of:** second sheet

**International Patent Classification (IPC)**

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INTERNATIONAL SEARCH REPORT  
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PCT/NO2012/000017

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