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(54) Reversible, articulated mechanical coupling and relevant seat, for anchorages under tension.

(57) Reversible, articulated mechanical coupling and relevant seat, for linking anchorages under tension to the foundation bases.

The coupling is constituted by a hollow body (1) open at its top, on whose outer surface a set of teeth (2) protrude, which are positioned in a sunburst fashion; the body is closed at its bottom by a cylindrical appendix (3).

The coupling is stably engaged inside the relevant seat by completely introducing the coupling inside the same seat, and then lifting it.

During the insertion of the coupling, the teeth (2) slide in entry grooves (12,14) of the cylindrical shell, and are guided by these in such a way that, when the coupling is lifted, the same teeth enter blind-top grooves (13), inside which they remain engaged.

The disengagement of the coupling from the seat takes place by first completely sinking the coupling inside the seat.

The teeth are guided by the grooves (15) of the cylindrical shell in such a way that, when the coupling is lifted again, the same teeth enter the entry grooves (12), making it possible the coupling to be extracted from the seat.

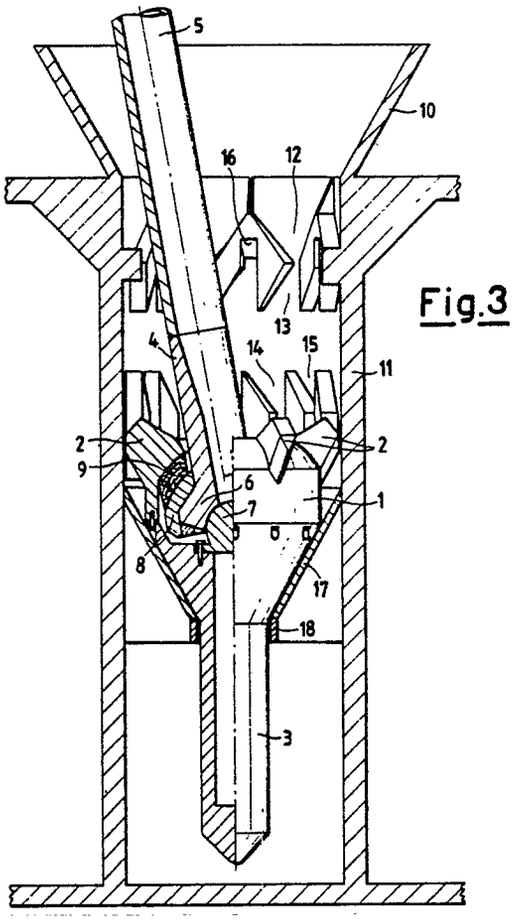

Fig.3

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REVERSIBLE, ARTICULATED MECHANICAL COUPLING AND RELEVANT SEAT, FOR ANCHORAGES UNDER TENSION

The present invention relates to a reversible, articulated mechanical coupling and to the seat for such a coupling, for the structural connection to the foundation bases, positioned at the sea bottom, of the anchorages of offshore platforms with anchorages under tension, known as "TLP", i.e., "Tension Leg Platforms".

It is known that such types of offshore platforms are anchored to the sea bottom by means of a set of anchorages under tension, which are structurally connected to the foundation bases, positioned at the sea bottom, by means of reversible mechanical couplings which get engaged inside suitable seats purposely provided in said foundation bases.

Now then, the various types of reversible mechanical couplings for connecting to the sea bottom offshore platforms of TLP type, known from the prior art, require that the members constituting the same coupling be mechanically or hydraulically actuated in order to realize the engagement and the disengagement of the coupling in/from the relevant seat provided on the foundation bases.

The need for such actuation procedures, to be performed at the sea bottom, involves the use of auxiliary equipment, or of hydraulic lines which connect the coupling with the platform, with consequent increases in costs and duration of the operations, as well as with increasing risks of failure of the same operations due to a malfunctioning of said coupling-actuation equipment or members.

The purpose of the present invention is obviating the above said drawbacks and therefore supplying a novel coupling, which can be engaged and disengaged in/from the relevant seat in an automatic way, by simply sinking and lifting, and, possibly, rotating the anchorage.

Besides that, the coupling of the present invention is constituted by a small number of components, and is endowed with a high mechanical simpleness, with consequent advantages in terms of cost, operating reliability, and sureness that the operations of engagement and disengagement can be carried out.

The above purpose is substantially achieved by means of the fact that the coupling is constituted by a hollow body open at its top, on whose outer surface a set of teeth protrude, which are positioned in a sunburst pattern, and to the bottom end of which a cylindrical appendix is fastened, which makes it easier to insert and correctly position the coupling inside the seat.

Inside the body of the coupling a flexible element of ring shape is fastened, inside which a ring is fastened in its turn, which is mounted on the top surface, of cone frustum shape, or of spherical shape, of the enlarged portion provided at the bottom end of a rod.

Said rod comes out from the top opening of the body of the coupling, and in correspondence of its top end it is welded to, or anyway made integral with, the bottom end of the anchorage.

Said ring, and the members connected to it, i.e., the flexible element, the body of the coupling and the relevant appendix, can rotate relatively to the rod around the vertical axis.

The seat of the coupling, fastened to the foundation basis, comprises a cylindrical shell on whose inner surface grooves are provided, between which at least a set of entry grooves are provided in a number equal to the number of the teeth, between which a set of grooves blind at their top end are provided in order to engage the same teeth.

The coupling is engaged in the relevant seat by completely inserting the coupling inside the same seat, and then lifting it.

When the coupling is inserted, the teeth slide inside the entry grooves of the cylindrical shell, which grooves, by being inclined, involve the rotation around the vertical axis of the body of the coupling; when the coupling is lifted, owing to the effect caused by the rotation occurred during the insertion, the teeth slide inside the blind-top grooves, at whose top end they remain engaged.

The coupling is disengaged from the seat by completely sinking the coupling inside the seat and then extracting said coupling from said seat.

When the coupling is sunk, the teeth are guided by the grooves, which, by being inclined, cause a further rotation around the vertical axis of the body of the coupling; when the coupling is lifted at a later time, owing to the effect of the rotation occurred during the sinking, the teeth enter the entry grooves, thus making it possible the coupling to be extracted from the seat.

When the coupling is engaged in the seat, it is capable of transferring to said seat, through the teeth, the body of the coupling, the flexible element, the ring and the rod, the forces transmitted by the anchorage, which anchorange cam swing by tilting relatively to the vertical by virtue of the deformability of the flexible element.

Further characteristics and preferred forms of practical embodiment of the present invention will become known from the following, wherein the invention is better explained with reference to the hereto attached drawings, which depict a preferred

form of practical embodiment given for merely exemplifying and non-limitative purposes, in that technical or structural changes can be supplied without departing from the scope of the present invention.

- Figure 1 represents a partially sectional front view of the coupling according to the invention, inserted and engaged inside the relevant seat;

- Figure 2 represents a vertical sectional view of the seat of the coupling, according to the present invention; and

- Figure 3 represents a partially sectional front view of the coupling, according to the invention, fully inserted in the relevant seat and with the rod and the anchorage inclined relatively to the vertical direction.

Referring to the figures, the coupling is constituted by a hollow body 1, open at its top, on whose outer surface a set of teeth 2 protrude, which are positioned in a sunburst pattern, and at whose bottom end an appendix 3 is fastened.

Said appendix 3 has an upper cross-section equal to the bottom cross-section of the hollow body 1 of the coupling and the cross-section progressively decreases towards the bottom, down to a diameter beyond which said cross-section remains constant, and the appendix takes its cylindrical shape, possibly ending at its bottom with a cone or a half-sphere.

From the interior of the hollow body 1 of the coupling, through its upper opening, the rod 4 comes out, whose upper end is welded to, or is anyway made integral with, the lower end of the anchorage 5.

The bottom end of said rod 4 ends inside said hollow body 1 of the coupling with an enlarged portion 6 which, is its upper portion, preferably has, at least partially, a from cone-frustum to spherical shape.

In correspondence of its bottom end, said rod 4 rests on the spherical seat 7 fastened inside the appendix 3.

On the upper surface, which preferably has a cone-frustum or spherical shape, of the enlarged portion 6, the ring 8 is mounted, which can rotate relatively to the rod 4 around the vertical axis.

Between the outer surface of the ring 8 and the inner surface of the hollow body 1, the flexible element 9 of ring shape is fastened, which is composed by elastomer and metal, or by other suitable materials; said flexible element 9, by elastically deforming, enables the rod 4, and therefore the lower end of the anchorage 5, to tilt relatively to the vertical direction, as shown in Figure 3.

The seat of the coupling, which is fastened to the foundation bases installed at the sea bottom, comprises a cylindrical shell 11 with an entry cone 10 at the top. Inside said cylindrical shell 11, the grooves 12, 13, 14 and 15 are provided; inside such grooves 12, 13, 14 and 15, the teeth 2 of the coupling body slide when this latter is inserted into, or extracted from, the seat.

Inside the cylindrical shell 11, under the region concerned by said grooves, the centering cone 17 is fastened, which is provided with a top opening having a diameter equal to the inner diameter of the shell 11, and with a bottom opening having a diameter slightly larger than the diameter of the cylindrical portion of the appendix 3; at the bottom end of the centering cone 17, the centering ring 18 is fastened.

The entry grooves 12, whose number is equal to the number of the teeth 2, are provided near the upper end of the cylindrical shell 11. In the upper portion, the side walls of each of said entry grooves 12 are inclined relatively to the vertical direction, and are convergent downwards, and in the bottom portion the wall 12a diverges downwards and the wall 12b becomes vertical.

The blind-top grooves 13 are provided near the upper end of the cylindrical shell 11 in the areas between the entry grooves 12. The side wall 13a of each one of the blind-top grooves 13 adjacent to the wall 12b of the entry groove 12 is inclined and convergent upwards, whilst the side wall 13b of each one of the blind grooves 13 is vertical; said blind grooves 13 are closed at their top end by the surface against which the teeth 16 are designed to come to rest.

The lower entry grooves 14 are provided inside the cylindrical shell 11 under the entry grooves 12 and the blind grooves 13.

The lower entry grooves 14 are in a number equal to the number of the teeth, and each one thereof has a side wall 14a which begins on the vertical of the narrowest cross-section of an upper entry groove 12 and continues downwards initially inclined and convergent towards the second side wall 14b, with this latter being vertical and under the inclined side wall of a blind groove 13.

The lower exit grooves 15 are provided inside the cylindrical shell 11 under the entry grooves 12 and the blind grooves 13, in the areas between the lower entry grooves 14.

Each one of the lower exit grooves 15 has a side wall 15a which begins on the vertical of a blind groove 13 and continues downwards initially inclined and convergent towards the second side wall 15b, with this latter being vertical and under the inclined, downwards-divergent side wall of an upper entry groove 12.

The engagement of the coupling inside the relevant seat takes place by inserting the coupling inside the cylindrical shell 11, in this way the teeth 2 of the body 1 of the coupling entering the entry grooves 12; the insertion of the coupling continues

until the teeth slide into the lower entry grooves 14.

During the sinking of the coupling, due to the effect of the slope of the side walls of the entry grooves 12 and of the lower entry grooves 14a, the body of the coupling 1, and, consequently, the flexible element 9 and the ring 8 rotate around the vertical axis.

During the sinking of the coupling, the cylindrical appendix 3 guided by the centering cone 17 enters the centering ring 18; when the coupling is completely inserted in the seat, the body 1 of the coupling rests against the centering cone 17 (see specifically Figure 3).

When after being completely inserted in the seat, the coupling is lifted, the teeth 2 of the body 1 of the coupling enter the blind grooves 13, at whose top end the teeth 2 stop against the tooth resting surfaces 16 provided in the cylindrical shell 11.

Said tooth resting surfaces 16 prevent any further vertical and horizontal movements, as well as any rotations of the body 1 of the coupling.

When the coupling is lifted, due to the effect of the slope of the side walls of the blind grooves 13a, the body of the coupling 1, the flexible element 9 and the ring 8 rotate around the vertical axis.

In order to disengage the coupling from the seat, it is enough to make it sink again inside the cylindrical shell 11; the teeth 2 of the body of the coupling 1, leaving the blind grooves 13, enter the lower exit grooves 15. When, after being completely sunk inside the seat, the coupling is subsequently lifted, the teeth 2 slide into the entry grooves 12, enabling the coupling to be extracted from the seat.

Also during the sinking and the lifting of the coupling in order to engage it in, or disengage it from, the seat, due to the effect of the slope of the side walls of the lower exit grooves 15a and of the entry grooves 12a, the body of the coupling 1, the flexible element 9 and the ring 8 rotate around the vertical axis.

The coupling can also be made without the ring 8 and with the flexible element 9 being directly fastened to the enlarged portion 6 of the rod 4; in such event, the engagement and disengagement of the coupling in/from the seat will still take place according to the above dislosed procedure, but, in this case, when the coupling is lifted and sunk inside the seat, also the rod 4 and the anchorage 5 will rotate.

The shape of the grooves as shown in Figure 2 makes it possible the coupling to be engaged in, or disegnaged from, the seat, by simply sinking and lifting the same coupling, without any need for controlling the amplitude of the rotations of the body of the coupling, in that these are determined by the geometry of the grooves; however, it is also possible to realize grooves with a different geometry, on condition that entry grooves and exit grooves for the teeth of the coupling, and blind-top grooves in order to prevent further vertical and horizontal movements of the teeth, and therefore of the same coupling body, once that said teeth have entered them, are provided.

Claims

1. Set of reversible mechanical coupling and relevant seat, wherein the seat is provided in a foundation basis in order to anchor to said basis one of the anchorages of an offshore platform of tension leg platform type, and the coupling makes it possible the anchorage to be engaged in the said seat, or to be disengaged from it, characterized in that the coupling is constituted by a hollow body open at its top, on whose outer surface a set of teeth positioned in a sunburst pattern protrude, and at whose bottom end a downwards-tapered appendix is fastened, by a rod whose upper end is integral with the bottom end of the anchorage, with said rod passing through the top opening of said body and ending, inside said body, with an enlarged portion, which in its top portion preferably has, at least partially, a from cone-frustum to spherically shaped surface, by a flexible element of ring shape positioned between the upper surface of said enlarged portion, and the inner surface of said body and either directly or indirectly fastened to said surfaces, with the seat of the coupling comprising a cylindrical shell on whose inner surface at least a set of grooves are provided, which are constituted by entry grooves, in a number equal to the number of the teeth, separated by grooves blind at their top, in order to block said teeth, with also said blind grooves being in a number equal to the number of the teeth, wherein the entry grooves have side walls initially inclined relatively to the vertical direction and convergent downwards and wherein the blind grooves have side walls which are either inclined and upwards convergent, or vertical, and these latter grooves are closed in correspondence of their top end.

2. Set of reversible mechanical coupling and relevant seat according to claim 1, characterized in that the appendix fastened at the bottom end of the body of the coupling has an initial cross-section equal to the bottom cross-section of the body of the same coupling, and said initial cross-section progressively decreases downwards down to a diameter which remains constant and takes its cylindrical shape, possibly ending with a cone or a semisphere, with inside the cylindrical shell of the seat and under the grooves a centering cone being fastened, which has an upper opening of a diam-

eter equal to the inner diameter of the shell, and a bottom opening having a diameter slightly larger than the diameter of the cylindrical portion of said appendix.

3. Set of reversible mechanical coupling and relevant seat according to claim 1, characterized in that the flexible element is fastened, on the upper side, to the interior surface of the body of the coupling, and on the lower side, to a ring, which is mounted on the upper surface, preferably of from cone-frustum to spherical shape, of the enlarged portion of the rod, relatively to which rod the ring can rotate around the vertical axis.

4. Set of reversible mechanical coupling and relevant seat according to claim 1, characterized in that the side walls of each one of the entry grooves, which are initially inclined and converging downwards, continue: the one, inclined and divergent; and the other vertically, with each one of the blind grooves having its side wall adjacent to the said vertical wall of the entry grooves inclined and convergent upwards, and its other side wall being vertical, and inside the cylindrical shell a second set of grooves being provided, which is positioned at a lower level relatively to the first set, with said second set of grooves being constituted by lower entry grooves, which are provided in a number equal to the number of the teeth, separated by lower exit grooves, wherein each one of the lower entry grooves has a side wall which begins on the vertical of the narrowest cross-section of an upper entry groove, and continues downwards, initially inclined and convergent towards the second side wall of the groove, with this latter wall being vertical and under the inclined side wall of a blind groove, and wherein each one of the lower exit grooves has a side wall which begins on the vertical of a blind groove and continues downwards initially inclined and convergent towards the second side wall, with this latter being vertical and under the inclined, downwards-divergent side wall of an upper entry groove.

5. Set of reversible mechanical coupling and relevant seat as herein substantially disclosed and illustrated.

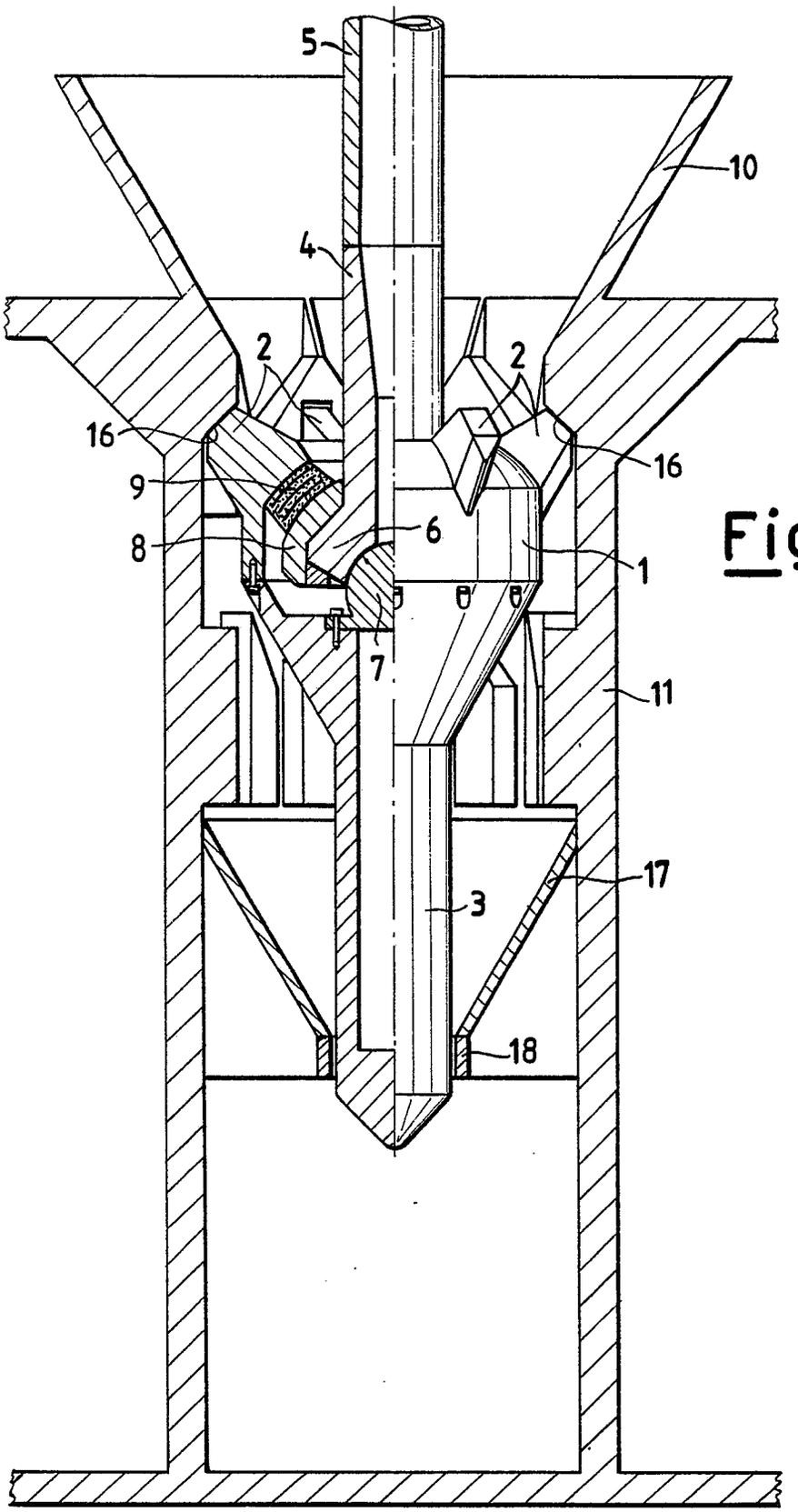

Fig.1

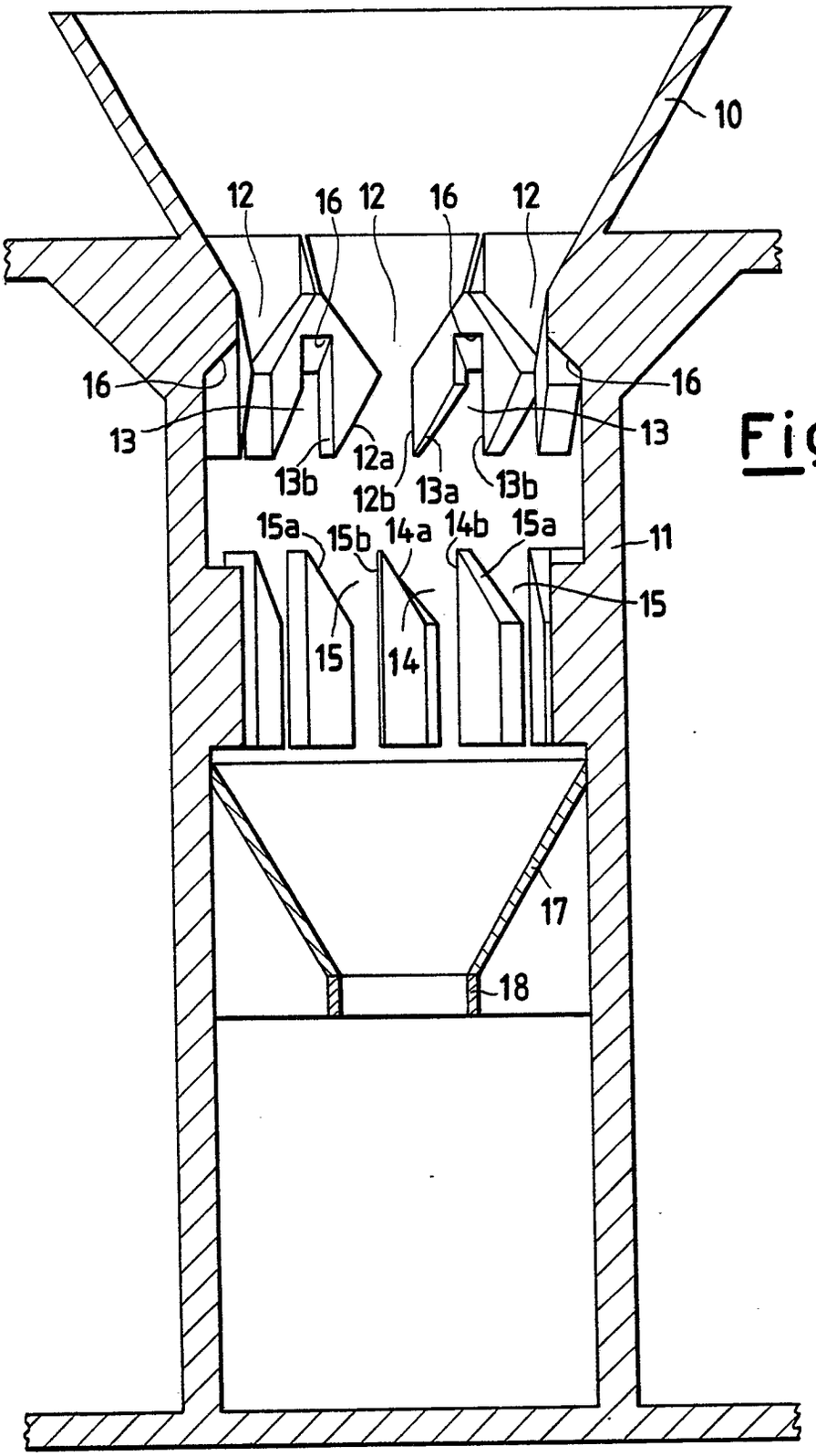
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Fig.2

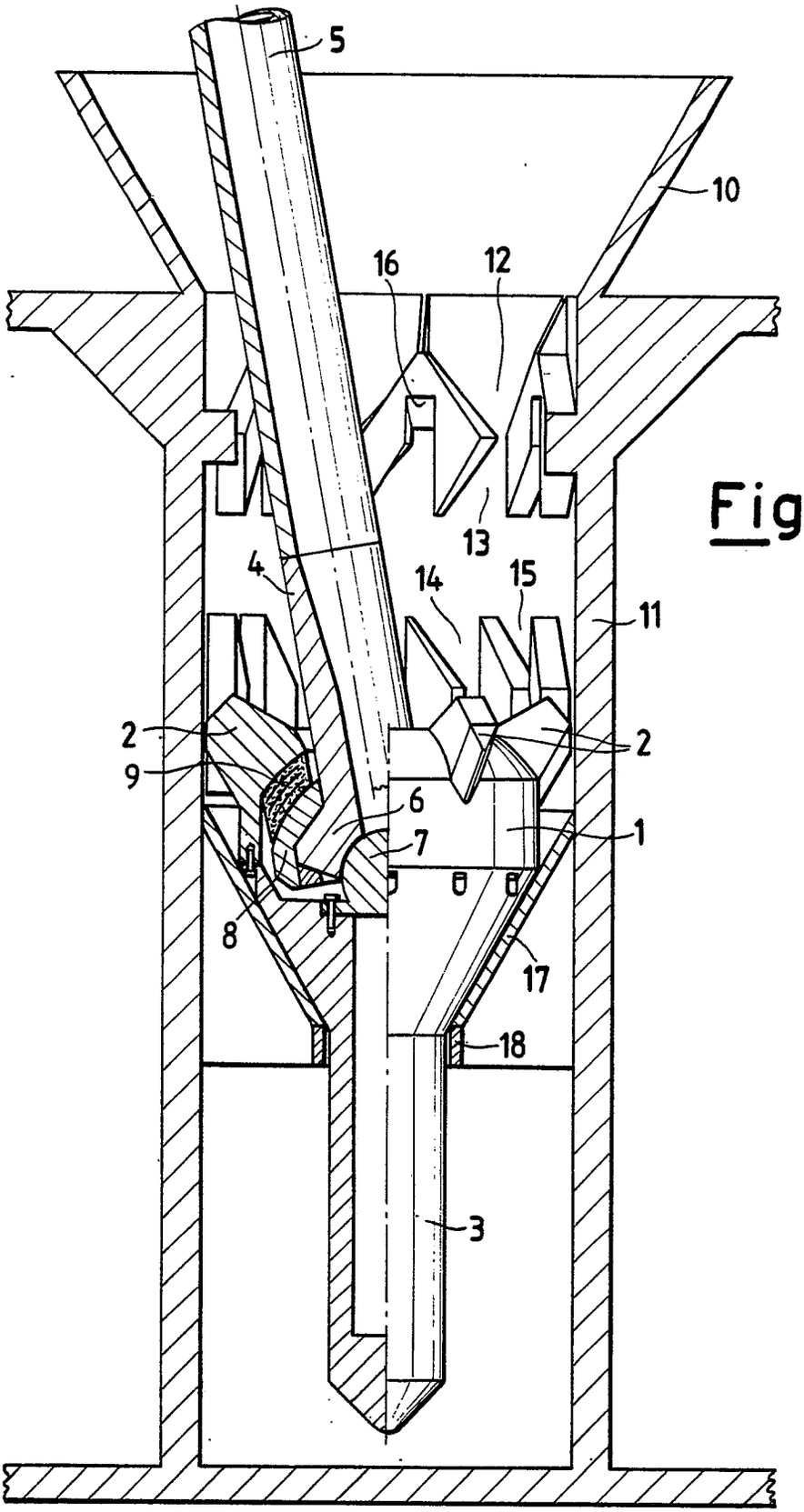

Fig.3

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EUROPEAN SEARCH REPORT

Application Number

EP 88 20 1523

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	GB-A-2 178 101 (HUNTING OILFIELD SERVICES) * Page 1, line 75 - page 3, line 108; claim 11 *	1,3,4	B 63 B 21/50 F 16 B 1/00
A	FR-A-2 577 631 (REXNORD) * Figures 6,7 *	1,2,4	
A	GB-A-2 104 039 (HEEREMA ENGINEERING SERVICE) * Figures 1,4; page 3, lines 15-32 *	1,4	
A	GB-A-2 105 769 (BAJ VICKERS) * Figure 1 *	2,3	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 63 B
F 16 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-11-1988	HUNT A.E.

CATEGORY OF CITED DOCUMENTS

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