(19) Europäisches Patentamt
European Patent Office
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(11) **EP 2 913 293 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.09.2015 Bulletin 2015/36

(51) Int Cl.:
B66D 1/38 *(2006.01)*

(21) Application number: **15250003.9**

(22) Date of filing: **12.02.2015**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **01.03.2014 GB 201403696**

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(54) **Apparatus and method for spooling umbilical cable or wire rope**

(57) Apparatus (101) for spooling umbilical cable (102) or wire rope onto a winch drum (202) without exceeding the minimum bend radius of the cable or wire rope, comprising a carriage (401) mounted on a screw thread (402). The carriage is configured to move on the screw thread across the winch drum and the carriage comprises two sheave wheels (403) in a diametrically opposed arrangement with reference to the vertical tangent line between the two sheave wheels. A first sheave wheel (502) is a lower fixed sheave wheel, and a second sheave wheel (501) is an upper sheave wheel configured to pivot about two bearings (505, 506) positioned on the vertical tangent line (507) between the lower fixed wheel and the upper sheave wheel.

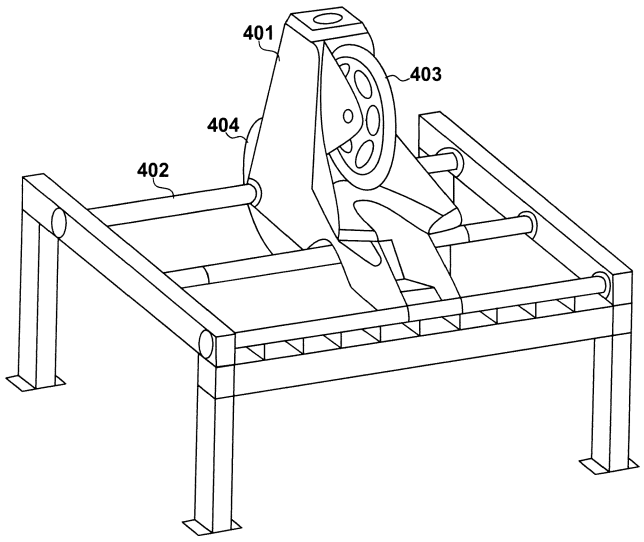

Fig. 4

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Description

[0001] The present invention relates to apparatus and a method for spooling umbilical cable or wire rope onto a winch drum in a manner that does not exceed the minimum bend radius of the umbilical cable or wire rope.

[0002] It is known to spool umbilical cable or wire rope onto a winch drum. Umbilical cable may be used, for example, as a means to allow submersible remotely operated vehicles to perform underwater investigations and explorations at a distance from a vessel and in any direction. The umbilical cable thus needs to be spooled onto a winch drum for storage when not in use. However, known apparatus and methods of spooling umbilical cable or wire rope cause the minimum bend radius of the umbilical cable or wire rope to be exceeded, leading to damage of the umbilical cable and failure of electrical or optical elements within the cable, and also damage of the wire rope. Therefore known apparatus and methods decrease the lifespan of the umbilical cable and wire rope. The present invention overcomes the problems of the prior art by providing apparatus and a method which spool umbilical cable and wire rope onto a winch drum without exceeding the minimum bend radius of the umbilical cable. Advantageously, the present invention enables umbilical cable and wire rope to be spooled onto a winch drum in a manner that neither damages the umbilical cable/wire rope nor causes failure of electrical or optical elements within the cable. Consequently, the apparatus and method of the present invention allow the lifespan of the umbilical cable or wire rope to be prolonged. Furthermore, in contrast to known apparatus and methods of spooling umbilical cable or wire rope, the present invention allows for spooling of any wrap and layer arrangement of umbilical cable or wire rope on a winch drum, in a manner that never exceeds the minimum bend radius of the umbilical cable or rope.

[0003] According to an aspect of the present invention, there is provided apparatus for spooling umbilical cable or wire rope onto a winch drum without exceeding the minimum bend radius of the cable or wire rope, comprising a carriage mounted on a screw thread, wherein said carriage is configured to move on said screw thread across said winch drum and said carriage comprises two sheave wheels, wherein a first sheave wheel is a lower fixed sheave wheel, and wherein a second sheave wheel is an upper sheave wheel in a diametrically opposed arrangement to said first sheave wheel with reference to the vertical tangent line between the lower fixed sheave wheel and the upper sheave wheel, and wherein said second sheave wheel is configured to pivot about two bearings positioned on said vertical tangent line.

[0004] According to a second aspect of the present invention, there is provided a method for spooling umbilical cable or wire rope onto a winch drum without exceeding the minimum bend radius of the cable or wire rope, comprising the step of passing the cable or wire rope straight down between an upper sheave wheel and a lower fixed sheave wheel configured in a diametrically opposed arrangement with reference to the vertical tangent line between the lower fixed sheave wheel and the upper sheave wheel, wherein said upper sheave wheel and said lower fixed sheave wheel are in a carriage mounted on a screw thread. The carriage is configured to move on the screw thread across the winch drum. The upper sheave wheel is configured to pivot about two bearings positioned on the vertical tangent line between the lower fixed wheel and the upper sheave wheel, and the cable or wire rope has an entry point on said upper wheel in the same vertical plane as the entry point of said cable or wire rope on said lower fixed wheel.

[0005] The invention will now be described by way of example only, with reference to the accompanying drawings, of which:

Figure 1 shows a boat containing apparatus embodying the present invention for spooling umbilical cable;
Figure 2 shows umbilical cable spooling around a winch drum;
Figures 3A and 3B show two examples of prior art;
Figure 4 illustrates the apparatus embodying the present invention for spooling umbilical cable;
Figure 5 shows a cross section of the apparatus embodying the present invention;
Figure 6 shows a cross section of the apparatus embodying the method of the present invention for spooling umbilical cable onto a winch drum; and
Figure 7 shows umbilical cable spooling around a sheave wheel.

Figure 1

[0006] The apparatus **101** embodied by the present invention is shown in Figure 1, spooling umbilical cable **102** which is attached to submersible remotely operated vehicle (ROV) **103**. The submersible ROV **103** is fitted with cameras, lights and manipulating devices to enable underwater investigations to be performed. Apparatus **101** is bolted to standard A-frame **104** which itself is attached to vessel **105**.

[0007] Umbilical cable **102** acts as a means to allow submersible ROV **103** to perform underwater investigations and explorations at a distance from vessel **105** and in any direction. Umbilical cable **102** may be up to **3000** metres long and is a load-bearing steel armoured cable containing electrical conductors and fibre optics to allow power, video and data signals to be transmitted back and forth between submersible ROV **103** and vessel **105**.

Figure 2

[0008] When not in use, umbilical cable **201** is spooled onto winch drum **202** which is attached to frame **203**, itself configured to be secured to a vessel (not shown). Umbilical cable **201** may be up to **3000** metres long and

is a load-bearing steel armoured cable. Umbilical cable **201** weighs between 10 and 15 tonne and provides up to six kilovolt (6kV). Umbilical cable **201** is therefore an extremely valuable piece of equipment and must be spooled onto winch drum **202** in a manner that does not damage umbilical cable **201**. As shown in Figure 2, umbilical cable **201** must be spooled around winch drum **202** in a manner that does not lead to kinking or internal damage of umbilical cable **201**.

Figure 3A

[0009] A standard spooling system of the prior art is illustrated in Figure 3A, comprising winch drum **301** having two rollers **302**. Umbilical cable **303** is spooled via the two rollers **302** onto winch drum **301**. However, the diameter of rollers **302** is too small for the size of umbilical cable **303**, meaning that the minimum bend radius (as set out by the manufacturer of said umbilical) of umbilical cable **303** is always exceeded, leading to failure of internal electric elements of umbilical cable **303** as it is wound onto winch drum **301**. This known spooling apparatus therefore does not handle umbilical cable **303** correctly, leading to damage of umbilical cable **303** and consequently decreasing the lifespan of umbilical cable **303**. Furthermore, this known spooling apparatus does not cater for spooling any desired layer or wrap arrangement of umbilical cable and is therefore limited in its use.

Figure 3B

[0010] An alternative known spooling system of the prior art is illustrated in Figure 3B, which comprises single sheave wheel **304**. Umbilical cable **305** ought theoretically to position onto sheave wheel **304 in a** straight alignment. However, in practice, umbilical cable **305** comes onto sheave wheel **304** at an angle **306**, potentially causing a kink. The kink causes the minimum bend radius of the umbilical cable to be exceeded, adding stress to umbilical cable **305**. This alternative known spooling apparatus therefore does not handle umbilical cable **305** correctly, leading to damage of umbilical cable **305** and consequently decreasing the lifespan of umbilical cable **305**. Furthermore, this known spooling apparatus does not cater for spooling any desired layer or wrap arrangement of umbilical cable and is therefore limited in its use.

[0011] Active Heave Compensation describes the paying out and paying in of the umbilical cable that is required to keep a submersible ROV stationary at a depth underneath the surface. Active Heave Compensation is thus required because the ROV is connected to its host vessel and therefore moves up and down with wave and tidal movement. These two known prior art spooling systems are especially prone to causing kinking of the umbilical cable in the rapid movements of Active Heave Compensation.

Figure 4

[0012] The apparatus embodied in the present invention is illustrated in Figure 4. The apparatus embodied in the present invention advantageously overcomes the problems of the prior art spooling systems. The apparatus comprises carriage **401** mounted on screw thread **402**, allowing carriage **401** to move back and forth across winch drum (not here shown). Carriage **401** includes two sheave wheels in a diametrically opposed arrangement. A first sheave wheel is lower sheave wheel **404** which is fixedly secured into carriage **401**. A second sheave wheel is an upper sheave wheel **403** configured to pivot about two bearings (not shown).

[0013] Lower sheave wheel **404** is fixed in carriage **401** and moves across winch drum as carriage **401** moves across winch drum on screw thread **402**. The manner in which carriage **401** moves across winch drum is known as "levelwind" and this is known.

[0014] Upper sheave wheel **403** is always the upper wheel and pivots about two bearings, the positioning of which is critical. The two bearings are in line with the vertical tangent point between the lower fixed wheel **404** and the upper sheave wheel **403**. The umbilical cable has an entry point on the upper wheel **403** in the same vertical plane as the entry point on the lower wheel **404**.

[0015] The apparatus embodied by the present invention thereby overcomes the problems presented by the prior art. The apparatus embodied by the present invention provides a spooling system that neither allows the umbilical cable to kink during spooling nor causes internal elements of the cable to be damaged as it is wound onto the winch drum, because the minimum bend radius of the cable is never exceeded. The present invention allows for the umbilical cable to always be correctly handled. This correct handling means that no damage is inflicted on the umbilical cable during spooling, thereby increasing the lifespan of the umbilical cable and requiring it to be replaced less frequently than in known spooling systems. Furthermore, unlike prior art spooling systems, the apparatus and method embodied by the present invention is advantageously universally applicable to all arrangements of umbilical cable in any particular layer or wrap. This is because when the umbilical cable is spooling onto a full drum, the umbilical cable runs tangentially onto the drum from the lower sheave wheel.

Figure 5

[0016] A cross section of the apparatus embodied in the present invention is shown in Figure 5. Upper sheave wheel **501** and lower sheave wheel **502** are contained in carriage **503**, which itself moves back and forth over winch drum **504** during the spooling process as the umbilical cable wraps around winch drum **504**.

[0017] Lower sheave wheel **502** is fixed in position in carriage **503** and moves only across drum **504** as carriage **503** moves across drum **504**.

[0018] Upper sheave wheel **501** pivots about two bearings, an upper bearing **505** and a lower bearing **506.** Bearings **505** and **506** are in line with the vertical tangent point **507** between the lower fixed wheel **502** and the upper sheave wheel **501**. This means that the entry point of the umbilical cable on the upper sheave wheel **501** is on the same vertical line **507** as the entry point on the lower sheave wheel **502**. The umbilical cable therefore moves straight up or down between upper sheave wheel **501** and lower sheave wheel **502**, and bearings **505** and **506** are totally in line with the umbilical.

Figure 6

[0019] As illustrated in Figure 6, when spooling onto winch drum **601**, umbilical cable **602** comes onto upper sheave wheel **603** in accordance with arrow **606**, around upper sheave wheel **603** and through bottom bearing **604**, then passes straight down between upper sheave wheel **603** and lower sheave wheel **605** and onto drum **601**. Therefore, umbilical cable **602** always passes straight down between the two sheaves **603** and **605** in accordance with arrow **607** and there is never any movement of umbilical cable **602** between the two sheaves **603** and **605**. This is to ensure that there is no kinking or twisting of umbilical cable **602**. This movement of umbilical cable **602** also ensures that the minimum bend radius of the umbilical cable is never exceeded whilst umbilical cable **602** is spooled onto winch drum **601**. The pivoting action of upper sheave wheel **603** ensures umbilical cable **602** is sent off in the right direction (to either the drum or overboarding of sheave wheel).

[0020] Therefore, as shown in Figure 6, the present invention also provides a method for spooling umbilical cable onto a winch drum without exceeding the minimum bend radius of the cable, comprising the step of: passing the cable straight down between an upper sheave wheel and a lower fixed sheave wheel configured in a diametrically opposed arrangement in a carriage mounted on a screw thread, wherein said carriage is configured to move on said screw thread across said winch drum, wherein said upper sheave wheel is configured to pivot about two bearings positioned on the vertical tangent line between the lower fixed wheel and the upper sheave wheel, and wherein said cable has an entry point on said upper wheel in the same vertical plane as the entry point of said cable on said lower fixed wheel.

[0021] The method also comprises the step of spooling the umbilical cable around a winch drum, forming a wrap of cable around each circumference of drum. The method also comprises the step of spooling the umbilical cable around the winch drum, forming a plurality of layers on the winch drum.

[0022] The umbilical cable winds around the drum, and the winding of umbilical cable around a single circumference of drum constitutes a wrap. The umbilical cable then winds on top of itself in layers (akin to a hosepipe), up to ten layers and possibly more.

[0023] When the lower fixed sheave wheel moves across winch drum, lower fixed sheave wheel is always directly vertically above one wrap each time the umbilical cable winds around the drum. This ensures that the umbilical cable is always in line and there is never any kinking of the umbilical cable during the spooling process.

[0024] When unspooling from winch drum **601**, umbilical cable **602** moves up past lower sheave wheel **605**, through bottom bearing **604** and around upper sheave wheel **603**, before being lowered into the water, moving in a direction which is opposite to arrows **606** and **607**. Therefore, the umbilical cable always passes straight up between the two sheaves **603** and **605** and there is never any movement of umbilical **602** between the two sheaves **603** and **605**.

Figure 7

[0025] As illustrated in Figure 7, umbilical cable **702** always lies within the "valley" of sheave wheel **701**. During the spooling process, the umbilical cable on the upper sheave wheel is in the same vertical plane as the entry point of the umbilical cable on the lower sheave wheel. There is thus no movement between the upper and lower sheave wheels, and the umbilical simply moves up between the two sheaves. The fact that umbilical cable **702** lies within the "valley" of sheave wheel **701** aids in the fact that there is no movement between the upper and lower sheave wheels, and the umbilical simply moves up between the two sheaves.

Claims

1. An apparatus for spooling umbilical cable or wire rope onto a winch drum without exceeding the minimum bend radius of the cable or wire rope, **characterised by**:

   a carriage mounted on a screw thread, wherein said carriage is configured to move on said screw thread across said winch drum and said carriage comprises two sheave wheels,
   wherein a first sheave wheel is a lower fixed sheave wheel,
   and wherein a second sheave wheel is an upper sheave wheel in a diametrically opposed arrangement to said first sheave wheel with reference to the vertical tangent line between the lower fixed sheave wheel and the upper sheave wheel,
   and wherein said second sheave wheel is configured to pivot about two bearings positioned on said vertical tangent line .

2. The apparatus of claim 1, wherein said Umbilical cable is connectable to a submersible remotely operated vehicle.

3. The apparatus of claim 2, wherein said umbilical cable conveys power, control signals and communication signals to said submersible remotely operated vehicle.

4. The apparatus of claim 1, wherein said umbilical cable or wire rope spools around said winch drum, forming a wrap of cable or wire rope around each circumference of drum.

5. The apparatus of claim 4, wherein said lower fixed wheel is always vertically above a wrap of cable or wire rope on said winch drum when said umbilical cable or wire rope spools around said winch drum.

6. The apparatus of claim 4, wherein said umbilical cable or wire rope forms a plurality of wraps on said winch drum.

7. The apparatus of any of claims 1 to 6, wherein said umbilical cable or wire rope spools around said winch drum, forming a plurality of layers of cable or wire rope on said winch drum.

8. The apparatus of claim 4 or claim 7, wherein said apparatus is configured to operate for any wrap or layer configuration of cable or wire rope.

9. The apparatus of any of claims 1 to 8, wherein said upper sheave wheel moves only under tension of the umbilical cable or wire rope.

10. The apparatus of any of claims 1 to 9, wherein said umbilical cable or wire rope has an entry point on said upper wheel in the same vertical plane as the entry point of said cable or wire rope on said lower fixed wheel.

11. A method of spooling umbilical cable or wire rope onto a winch drum without exceeding the minimum bend radius of the cable or wire rope, **characterised by** the steps of:

passing the cable or wire rope straight down between an upper sheave wheel and a lower fixed sheave wheel configured in a diametrically opposed arrangement with reference to the vertical tangent line between the lower fixed sheave wheel and the upper sheave wheel,
wherein said upper sheave wheel and said lower fixed sheave wheel are in a carriage mounted on a screw thread, and wherein said carriage is configured to move on said screw thread across said winch drum,
wherein said upper sheave wheel is configured to pivot about two bearings positioned on the vertical tangent line between the lower fixed wheel and the upper sheave wheel,
and wherein said cable or wire rope has an entry point on said upper wheel in the same vertical plane as the entry point of said cable or wire rope on said lower fixed wheel.

12. The method of claim 11, further comprising the step of spooling said umbilical cable or wire rope around said winch drum, forming a wrap of cable or wire rope around each circumference of drum.

13. The method of in claim 12, wherein when said carriage moves on said screw thread across said winch drum, said lower fixed sheave wheel is always vertically above a wrap of cable or wire rope in said winch drum when said umbilical cable or wire rope spools around said winch drum.

14. The method of claim 12, wherein said umbilical cable or wire rope forms a plurality of wraps on said winch drum.

15. The method of claim 12, further comprising the step of spooling said umbilical cable or wire rope around said winch drum, forming a plurality of layers of cable or wire rope on said winch drum.

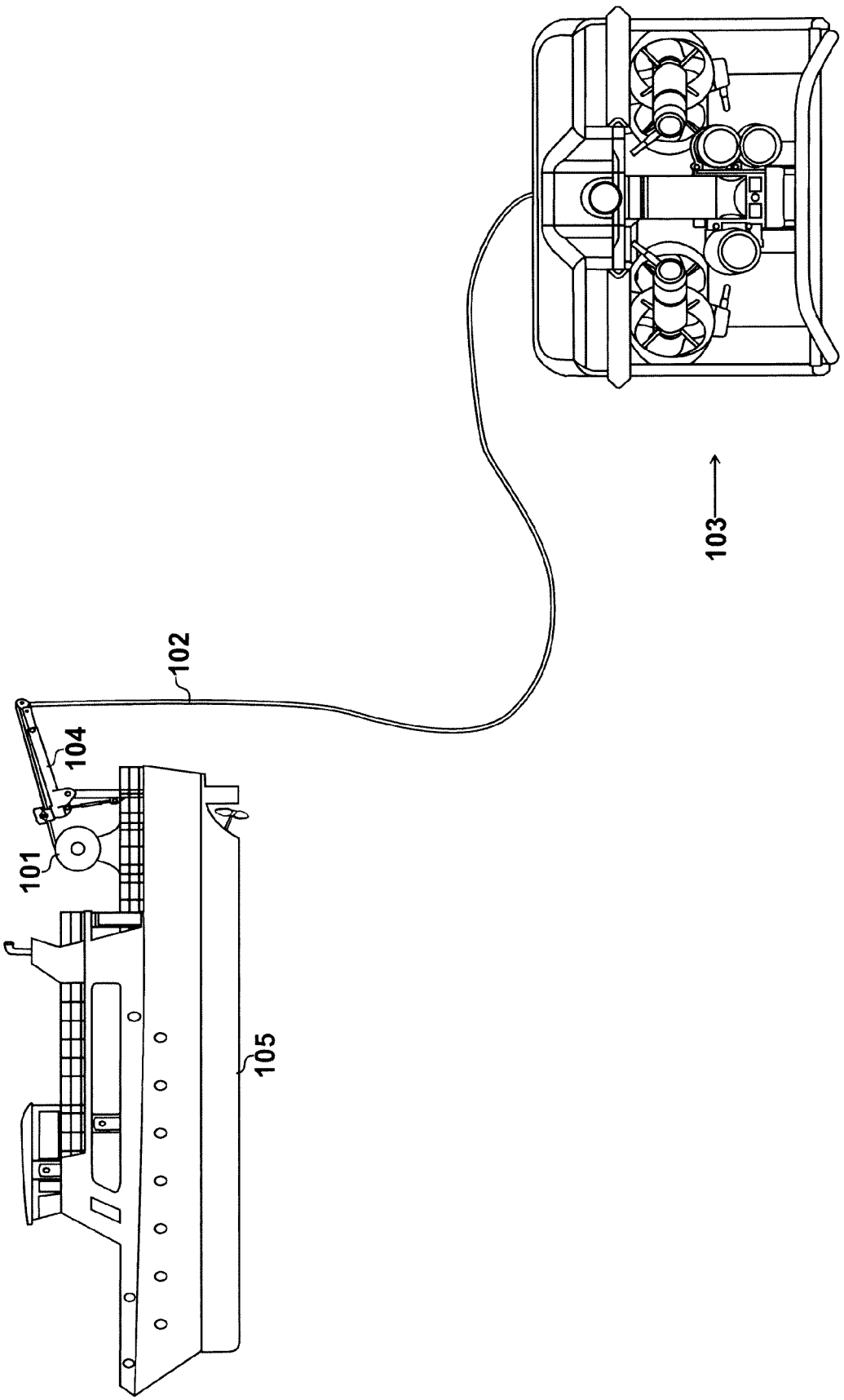

Fig. 1

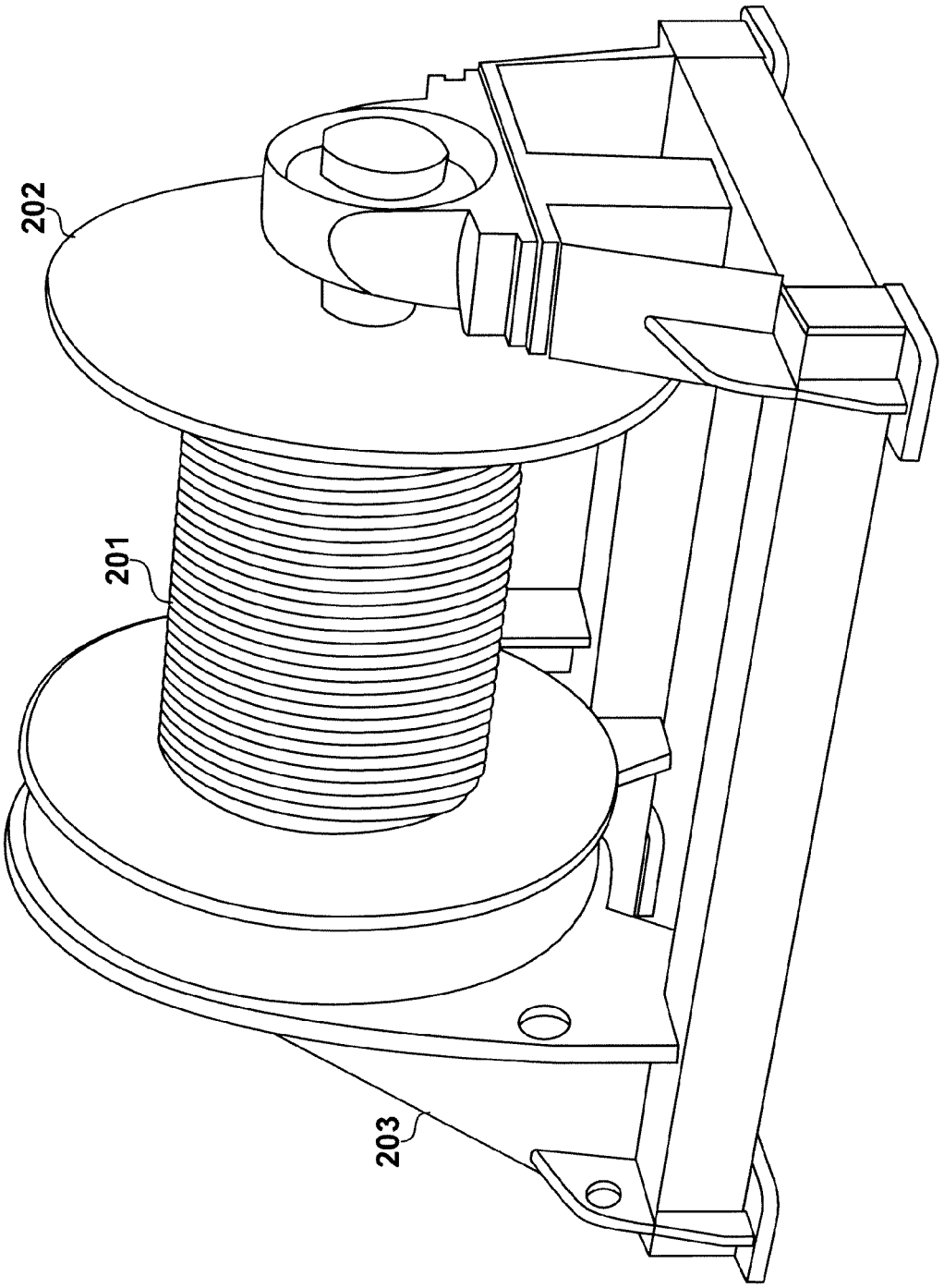

Fig. 2

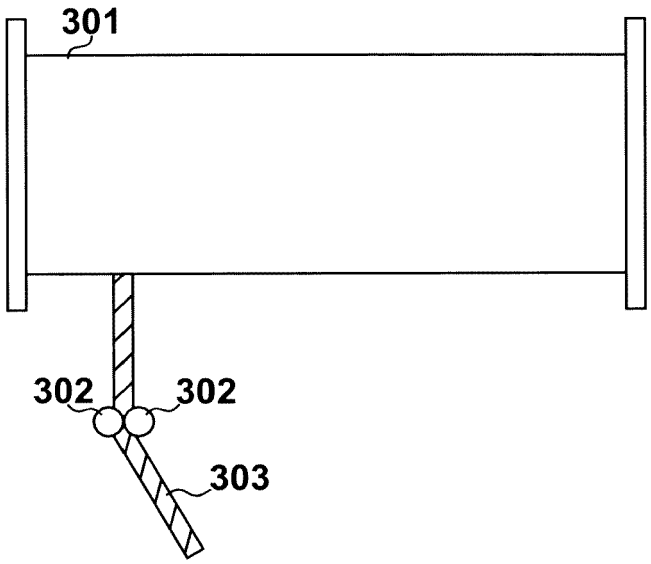

Fig. 3A

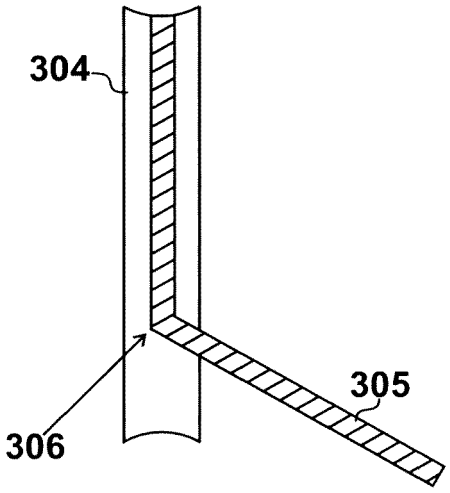

Fig. 3B

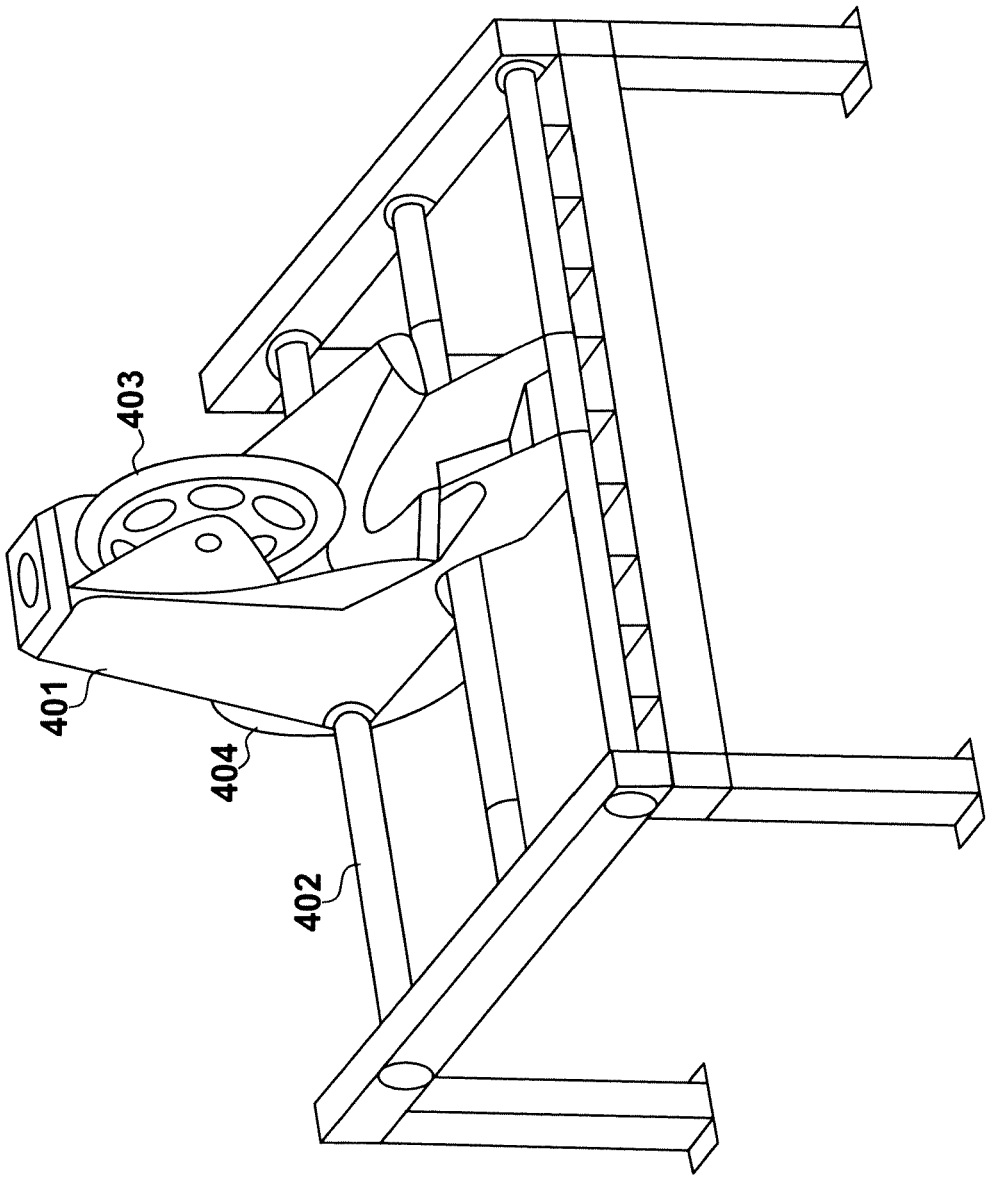

Fig. 4

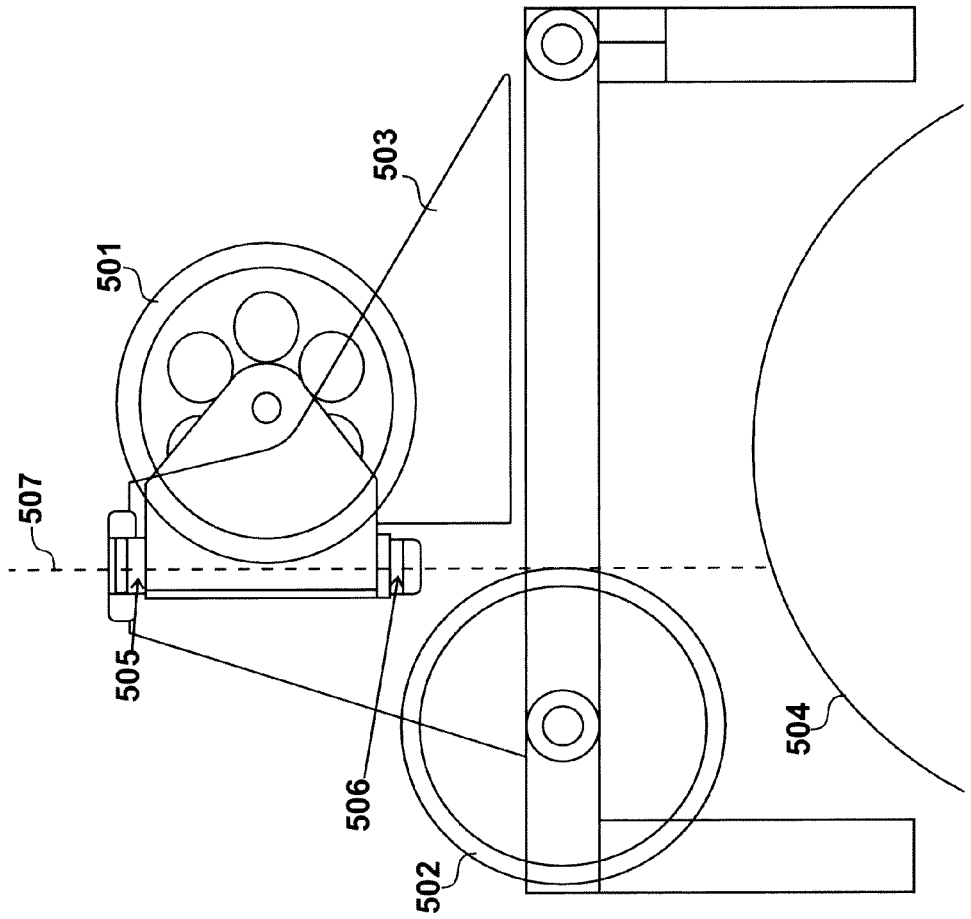

Fig. 5

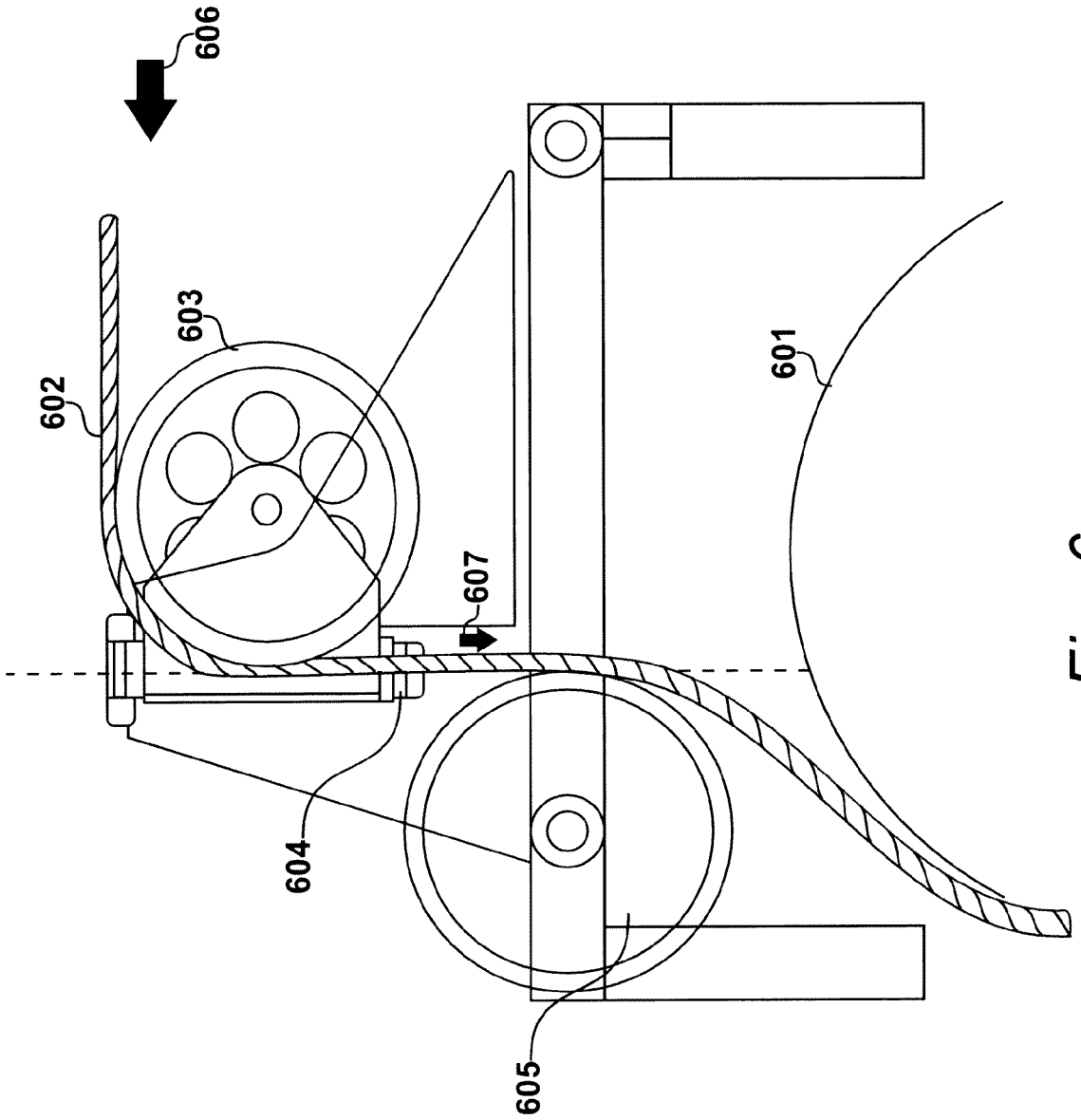

Fig. 6

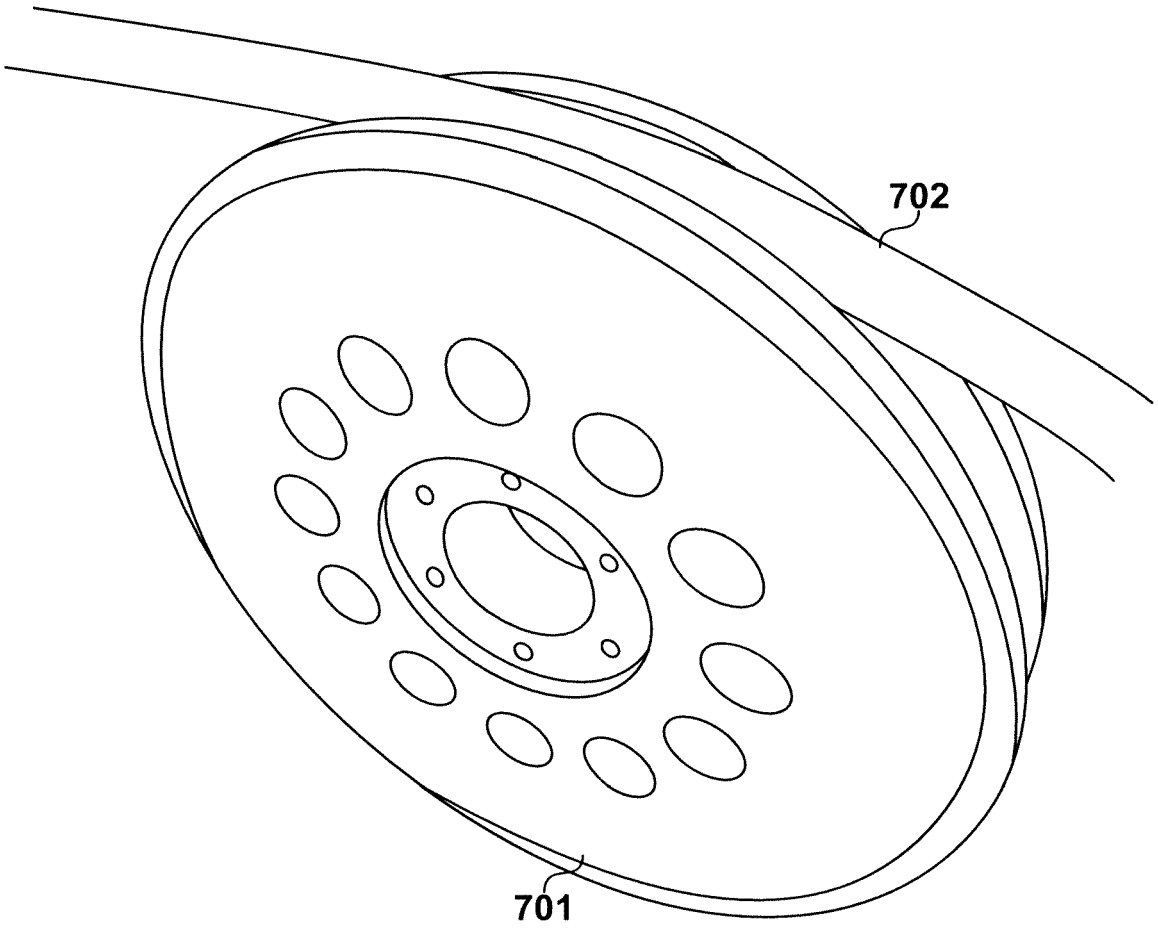

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 15 25 0003

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	CN 103 183 293 A (UNIV CHINA GEOSCIENCES WUHAN) 3 July 2013 (2013-07-03) * figures *	1-15	INV. B66D1/38
A	CN 202 829 400 U (715TH RES INST SHIPBLD IND) 27 March 2013 (2013-03-27) * figure 3 *	1,11	
A	WO 02/38487 A1 (COFLEXIP [FR]; PERRY SLINGSBY SYSTEMS LTD [GB]; HANSON KENNETH [GB]) 16 May 2002 (2002-05-16) * abstract; figures *	1,11	
A	WO 02/06146 A1 (HYDROVISION LTD [GB]; SOTHCOTT IAN [GB]; GRANT DAVID ALEXANDER WILLIAM) 24 January 2002 (2002-01-24) * abstract; figures *	1,11	

TECHNICAL FIELDS SEARCHED (IPC)
B66D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 June 2015	Verheul, Omiros

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 103183293 A	03-07-2013	NONE	
CN 202829400 U	27-03-2013	NONE	
WO 0238487 A1	16-05-2002	AU 1245302 A	21-05-2002
		WO 0238487 A1	16-05-2002
WO 0206146 A1	24-01-2002	AU 7084601 A	30-01-2002
		EP 1303453 A1	23-04-2003
		WO 0206146 A1	24-01-2002

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