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(54) Title: AN IMPROVED SEAWATER SUCTION SYSTEM

(57) Abstract: A seawater suction system (10) and a method of its assembling is provided. The seawater suction system (10) comprises first and second conduits (12, 14) connected to one another, wherein the first conduit (12) is formed from at least two layers of a first material and the second conduit (14) is formed from a single layer of a second material which is different from the first material. The method of assembling the seawater suction hose (10) comprises the steps of providing at least one first conduit (12) and at least one second conduit (14), wherein the first conduit (12) is formed from at least two layers of a first material and the second conduit (14) is formed from a single layer of a second material which is different from the first material connecting the two conduits together; and connecting a suction head to a free end of the first conduit (12).

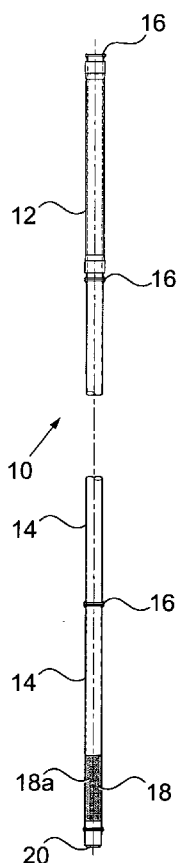


Fig. 1



ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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An Improved Seawater Suction System

5 The present invention relates to a seawater suction system particularly, although not exclusively, suited for use with a Floating Production Storage and Offloading (FPSO) vessel.

10 Conventional seawater suction systems used by FPSO vessels typically comprise a plurality of hoses and caissons. Each hose typically comprises a plurality of flexible hose sections interconnected to form a continuous hose. The continuous hose combines with a caisson on the FPSO to pass seawater into the FPSO. The free end of the hose is fitted with a suction strainer for straining sea water which is drawn into the hose. The suction strainer is fitted with a hypochlorite dispersion ring which is used to
15 disperse hypochlorite around the suction strainer as seawater is drawn through the hose, thereby preventing marine growth in the suction system and the associated pipework of the FPSO. An example of such an arrangement can be seen in WO2008/017937 to the same applicant.

20 Each of the hose sections of such conventional suction systems is typically manufactured from number of layers of material, starting with a flexible rubber liner in which a plurality of steel or wire reinforcement rings are embedded at intervals along the length of the liner. Wrapped around the reinforced liner are a number of layers of a suitable textile ply, and a
25 marine/weather resistant rubber outer layer is placed over the textile ply layers. Steel nipples and flanges are provided at either end of each hose section so that the sections can be attached to one another.

30 An example of a flexible hose section used in a conventional suction system has a nominal bore, or internal diameter, of 20 inches (508mm)

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and a length of 11500mm. A hose section having these dimensions and being manufactured in the manner described above would weigh approximately 1900kg, predominantly due to the layers of material needed and the reinforcement rings. The weight of each section of hose presents
5 handling difficulties on the deck of the vessel during installation of the system at sea. Furthermore, the weight of a system comprising a number of these heavy hose sections, along with drag and other hydrodynamic factors, imparts large loadings on the surface vessel.

10 Additionally, marine growth can occur in conventional flexible rubber hose sections which necessitates the provision of a Hypochlorite distribution line to counter the marine growth. Providing a Hypochlorite line increases the complexity, cost and time of installing the system.

15 It is an object of the present invention to obviate or mitigate one or more of the aforementioned disadvantages.

According to a first aspect of the present invention there is provided a seawater suction system comprising first and second conduits connected
20 to one another so as to allow fluid communication between the two conduits, wherein the first conduit is formed from at least two layers of a first material and the second conduit is formed from a single layer of a second material which is different from the first material.

25 The second conduit has an internal diameter which is substantially identical to an internal diameter of the first conduit, and the second conduit has an external diameter which may be less than an external diameter of the first conduit. The internal and external diameters of the first and second conduits may be substantially constant.

30

The first material may be rubber.

The second material may be a plastics material. The second material may be high density polyethylene (HDPE).

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The system may further comprise a strainer formed in the second conduit. The strainer may comprise a plurality of fluid apertures formed in the second conduit to allow fluid flow into the second conduit. Alternatively, the strainer may be connected to a free end of the second conduit. The strainer may be formed from the second material.

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The system may further comprise a weight member suspended from a free end of the strainer section.

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The system may comprise a plurality of successive first conduits connected to a plurality of successive second conduits. In other words, a number of first conduits may be connected together in series and then connected to a number of second conduits which are also connected together in series.

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The system may further comprise a suction head connected to a free end of the first conduit.

The system may further comprise at least one caisson adapted to receive and hold the suction head of the first conduit. The caisson may be located within the hull of Floating Production Storage and Offloading (FPSO) vessel.

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The second material may alternatively be a carbon-based steel or reinforced fibreglass. The system may further comprise an auxiliary fluid

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line located within the first and second conduits and adapted to supply a fluid to the free end of the second conduit.

According to a second aspect of the present invention there is provided a
5 method of assembling a seawater suction system comprising the steps of:

providing at least one first conduit and at least one second conduit,
wherein the first conduit is formed from at least two layers of a first
material and the second conduit is formed from a single layer of a second
material which is different from the first material, and the first and second
10 conduits are connectable together so as to allow fluid communication
between the two conduits;

connecting the two conduits together; and

connecting a suction head to a free end of the first conduit.

15 The method may also include the further step of connecting a strainer to a
free end of the second conduit.

The method may also comprise the further step of connecting a weight
member to a free end of the strainer.

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The method may also comprise the further steps of providing a caisson
adapted to receive and hold the suction head, and mounting the suction
head and first and second conduits within the caisson.

25 The method may also comprise the further step of attaching an auxiliary
fluid line within the first and second conduits such that the auxiliary fluid
line supplies a fluid to the free end of the second conduit.

An embodiment of the present invention will now be described, by way of
30 example only, with reference to the accompanying drawings, in which:-

Figure 1 shows a seawater suction system comprising a number of conduits;

- 5 Figure 2 is a schematic sectional view of a number of additional components of the seawater suction system located within a Floating Production Storage and Offloading (FPSO) vessel;

10 Figure 3 is a sectional view of a detail of the components shown in Figure 2; and

Figure 4 is a sectional view of a further detail of the components shown in Figure 2.

- 15 Figure 1 shows a seawater suction system 10 comprising a first conduit 12 and a pair of second conduits 14 connected in series with the first conduit 12. Each of the first and second conduits 12, 14 has a generally cylindrical body with connecting means located at either end of the body. In this illustrated example, the connecting means are flanges 16 having a plurality of connecting apertures (not shown) therein. The conduits 12,14 are connected to one another by abutting the corresponding flanges 16 from adjacent conduits 12,14 such that their respective connecting apertures are aligned. A suitable mechanical fixing means such as a studbolt (not shown) is then passed through each of the aligned apertures and a nut tightened onto the end of the studbolt, thereby connecting the adjacent conduits 12,14 to one another. The connecting of the conduits 12,14 is typically undertaken onboard a vessel with which the suction system 10 is to be used.
- 20
- 25

The first conduit 12 is formed from at least two layers of a first material such as, for example, rubber. The first conduit 12 is of a known type having a rubber liner, or inner layer, in which a plurality of steel or wire reinforcement rings are embedded at intervals along the length of the liner.

- 5 Wrapped around the reinforced liner are a number of intermediate layers of a suitable textile ply, and a marine/weather resistant rubber outer layer is placed over the textile ply layers.

- 10 The second conduits 14 are each formed from a single piece or layer of a second material different from the first material. As the second conduits 14 only have a single layer of material and no reinforcing rings, each of the second conduits 14 weighs less than the first conduit 12 despite each conduit 12,14 having substantially the same dimensions. Additionally, each of the first and second conduits 12,14 has a substantially identical
- 15 internal diameter. However, because the second conduit 14 has only a single layer of material the second conduits 14 have an external diameter which is less than the external diameter of the first conduit 12. The second conduits 14 are therefore thinner than the first conduit 12. The internal and external diameters of the first and second conduits 12, 14 are
- 20 preferably constant along their respective lengths.

In the preferred embodiment illustrated, the second material from which the second conduits 14 are formed is high density polyethylene (HDPE).

- 25 The connecting means of the first conduit 12 are preferably formed from steel and encapsulated in a protective coating of the first material to prevent corrosion. The connecting means of the second conduits 14 are preferably formed from the second material and provided with steel backing rings which have been treated with a corrosion-inhibiting coating.

The lower of the two second conduits 14 (when viewed in Figure 1) is provided with a strainer 18 for use with the system 10. The strainer 18 strains seawater which is drawn through the system 10. The strainer 18 is formed in the lower second conduit 14 from a plurality of fluid apertures 18a which allow seawater to pass into the interior of the second conduits 14. In this preferred embodiment, the fluid apertures 18a each have a diameter of 30mm. The system 10 may also comprise a weight member 20 connected to the free end of the lower second conduit 14 for added ballast.

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Referring now to Figures 2-4, a schematic section view through the hull 22 of an FPSO vessel is shown in Figure 2, with more detailed views of certain components shown in Figures 3 and 4. Figure 2 shows a number of caissons 24 located within the hull 22. Each caisson 24 may form an additional component of the suction system 10 when the first and second conduits 12,14 are connected thereto. To facilitate the connection of the first and second conduits 12, 14 to the caisson 24 the system may further comprise a caisson interface, or riser seat, 26 and a riser head or suction head 28. As best illustrated in Figures 3 and 4, each caisson interface 26 is installed on the underside of the keel 30 of the vessel and includes a female conical seat 32 which mates with a male conical seat 34 of the suction head 28 to centralise the head 28 and prevent downward movement of the first and second conduits 12,14. The caisson interface 26 also includes an internal circumferential bearing ring 33 which mates with an external upper circumferential bearing ring 35 of the suction head 28 to prevent tilting of the head 28 relative to the interface 26. The head 28 also includes a connecting flange 36 which is used to connect the upper connecting flange 16 of the first conduit 12 to the head 28.

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Figures 2 and 4 also show a suction pump 40 deployed in the caisson 24 on the right hand side (when viewed in Figure 2) for sucking seawater into the vessel. A number of centralisers 42 located at intervals within the caisson 24 ensure the pump 40 remains centralised.

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Referring to Figures 2 and 3, a suspension tool 44 and a deployment/retrieval tool 46 are shown in the middle caisson 24 (when viewed in Figure 2). These tools 44, 46 are used for the assembly and disassembly of the various components of the suction system 10. The suspension tool 44 is mounted at the top of the caisson 24 and provides a means for securing and suspending the part-assembled suction system in the caisson 24 whilst other components are being fitted. The deployment/retrieval tool 46 deploys and retrieves the assembled system 10 to and from the caisson 24. The deployment/retrieval tool 46 is remotely operated for releasing the system once it is in the correct position. The assembly of the seawater suction system 10 is carried out in a conventional manner, i.e. by suspending each conduit 12,14 at the top of the caisson 24 whilst each subsequent conduit 12,14 hose section 10 is attached thereto by their respective flanges 16. The suction system 10 is also disassembled in a conventional manner, i.e. by lifting the system 10 toward the top of the caisson 24 and reversing the assembly steps described above.

The seawater suction system of the present invention provides a number of advantages over previous proposals. By comprising the system of a first conduit formed in a conventional manner from layers of rubber or a similarly flexible first material, and one or more second conduits formed from a single layer of a second material, the system has a reduced weight compared to conventional suction systems. However, retaining at least one first conduit of the type described above ensures that the system

retains strength and load-bearing capabilities in spite of the weight reduction. Reducing the weight of certain components of the system makes for easier handling of the components during installation and retrieval, with a consequent reduction in the time and cost of carrying out these tasks. Forming the second conduits in a single layer reduces weight and also reduces hydrodynamic loadings on the associated vessel whilst the system is deployed under the water. This reduces vessel draft and improves vessel stability.

10 If the second conduits are formed from HDPE, the invention has the additional benefit that marine growth cannot form within the second conduits. Marine growth in the system can increase the overall weight of the system, the loadings on the vessel and the drag created by the system. These problems are removed in the present invention without having to resort to the use of a Hypochlorite treatment line in the system. This again speeds up assembly/disassembly of the system and additionally has environmental benefits to the sub-sea ecosystem. HDPE also has an exceptionally smooth surface finish, thereby providing a smoother internal bore in the second conduits. The smoother bore improves flow characteristics in the system whilst at the same time reducing pressure drop across the system.

The illustrated embodiment of the system comprises one first conduit and a pair of second conduits. However, it should be recognised that the number of first and second conduits in the system is not limited to this arrangement and may be varied according to requirements. The minimum requirement for the system is one first conduit and one second conduit. The number of second conduits in the system need only be limited by practical considerations. However, it is preferred that a maximum of three first conduits are used in the system to avoid negating the benefits

associated with the system. Where respective pluralities of first and second conduits are used, they are preferably arranged in successive groups instead of alternating the first and second conduits with one another.

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Whilst the preferred embodiment of the system shows a strainer formed at one end of one of the second conduits, the strainer may alternatively be a separate component formed from the second material and connected to the free end of the lower second conduit 14.

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Whilst preferred, the invention is not limited to the use of second conduits formed from HDPE. Examples of other suitable second materials are carbon-based steel and reinforced fibreglass. A single piece or layer of either of these alternative materials may also be used to form the second conduit(s), with the same benefits in terms of reduction of weight, hydrodynamic forces and drag. Where the second conduits are formed from either of these alternative materials, an auxiliary fluid line is included in the system for the supply of Hypochlorite to the free end of the system.

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These and other modifications and improvements may be incorporated without departing from the scope of the invention.

Claims

1. A seawater suction system comprising first and second conduits connected to one another so as to allow fluid communication between the two conduits, wherein the first conduit is formed from at least two layers of a first material and the second conduit is formed from a single layer of a second material which is different from the first material.
5
2. A seawater suction system as claimed in claim 1, wherein the second conduit has an internal diameter which is substantially identical to an internal diameter of the first conduit, and the second conduit has an external diameter which is less than an external diameter of the first conduit.
10
3. A seawater suction system as claimed in claim 1 or claim 2, wherein the first material is rubber.
15
4. A seawater suction system as claimed in any preceding claim, wherein the second material is a plastics material, or a carbon-based steel, or reinforced fibreglass.
20
5. A seawater suction system as claimed in claim 4, wherein the second material is high density polyethylene (HDPE).
6. A seawater suction system as claimed in any preceding claim, wherein the system further comprises a strainer formed in the second conduit.
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7. A seawater suction system as claimed in claim 6, wherein the strainer includes a plurality of fluid apertures formed in the second conduit to allow fluid flow into the second conduit.
- 5 8. A seawater suction system as claimed in claimed in any of claims 1 to 5, wherein the system further comprises a strainer connected to a free end of the second conduit.
9. A seawater suction system as claimed in any of claims 6 to 8,
10 wherein the strainer is formed from the second material.
10. A seawater suction system as claimed in any preceding claim, wherein the system further comprises a weight member suspended from a free end of the second conduit.
- 15 11. A seawater suction system as claimed in any preceding claim, wherein the system comprises a plurality of successive first conduits connected to a plurality of successive second conduits.
- 20 12. A seawater suction system as claimed in any preceding claim, wherein the system further comprises a suction head connected to a free end of the first conduit.
13. A seawater suction system as claimed in claim in claim 12, wherein
25 the system further comprises at least one caisson adapted to receive and hold the suction head of the first conduit.
14. A seawater suction system as claimed in claim 13, wherein the caisson is located within the hull of a Floating Production Storage and
30 Offloading (FPSO) vessel.

15. A seawater suction system as claimed in any preceding claim,
wherein the system further comprises an auxiliary fluid line located within
the first and second conduits and adapted to supply a fluid to the free end
5 of the second conduit.

16. A method of assembling a seawater suction system comprising the
steps of:
providing at least one first conduit and at least one second conduit,
10 wherein the first conduit is formed from at least two layers of a first
material and the second conduit is formed from a single layer of a second
material which is different from the first material, and the first and second
conduits are connectable together so as to allow fluid communication
between the two conduits;
15 connecting the two conduits together; and
connecting a suction head to a free end of the first conduit.

17. A method of assembling a seawater suction system as claimed in
claim 16, wherein the second conduit comprises a strainer formed in the
20 second conduit.

18. A method of assembling a seawater suction system as claimed in
claim 17, wherein the strainer includes a plurality of fluid apertures formed
in the second conduit to allow fluid flow into the second conduit.
25

19. A method of assembling a seawater suction system as claimed in
claim 16, wherein the system comprises the further step of connecting a
strainer to a free end of the second conduit.

20. A method of assembling a seawater suction system as claimed in any of claims 16 to 19, wherein the system comprises the further step of connecting a weight member to a free end of the strainer.

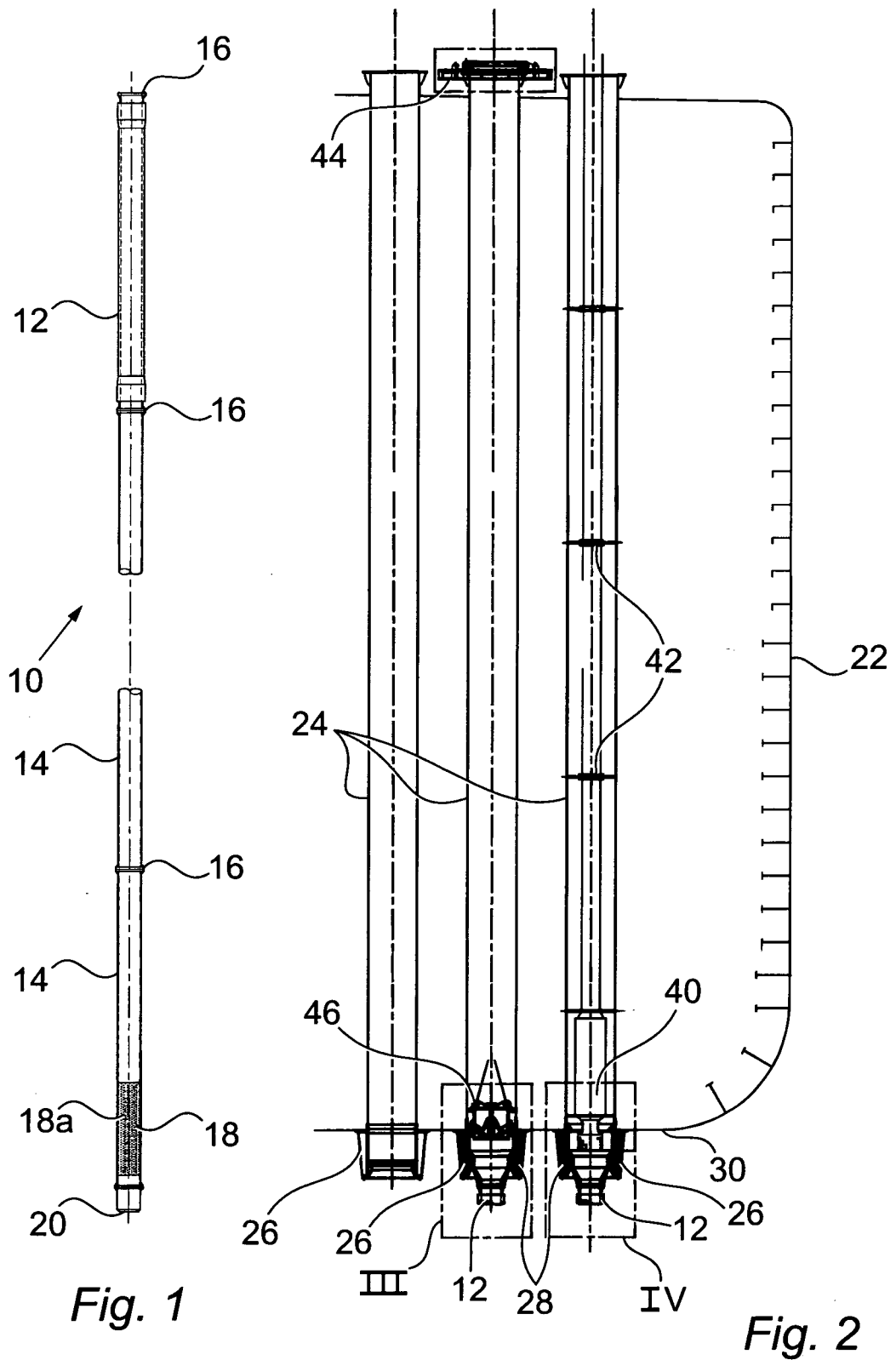
5 21. A method of assembling a seawater suction system as claimed in any of claims 16 to 20, wherein the system comprises the further steps of providing a caisson adapted to receive and hold the suction head, and mounting the suction head and first and second conduits within the caisson.

10

22. A method of assembling a seawater suction system as claimed in any of claims 16 to 21, wherein the system comprises the further step of attaching an auxiliary fluid line within the first and second conduits such that the auxiliary fluid line supplies a fluid to the free end of the second
15 conduit.

23. A method of assembling a seawater suction system as claimed in claim 22, wherein the auxiliary fluid line supplies hypochlorite to the free end of the second conduit.

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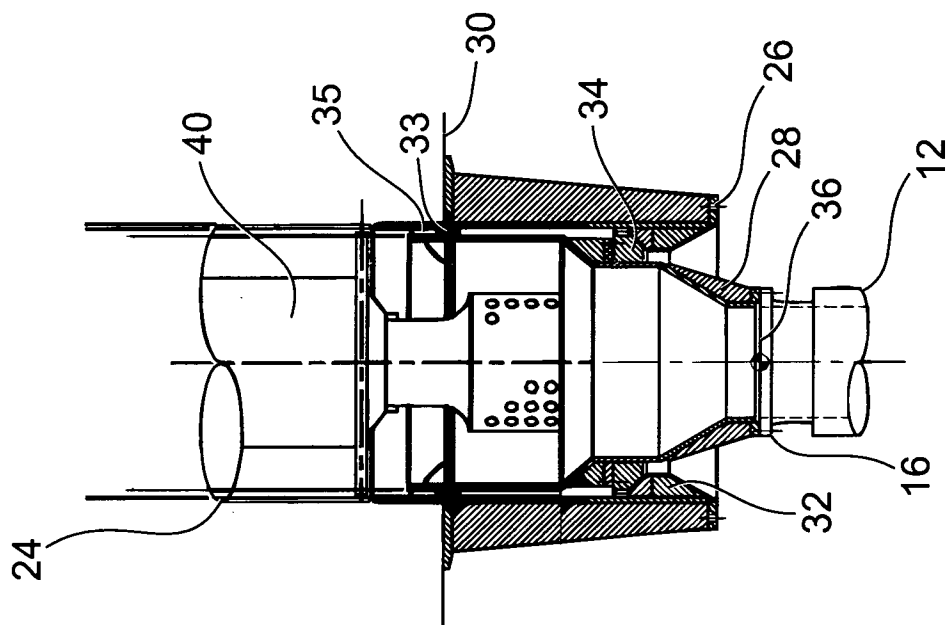


Fig. 4

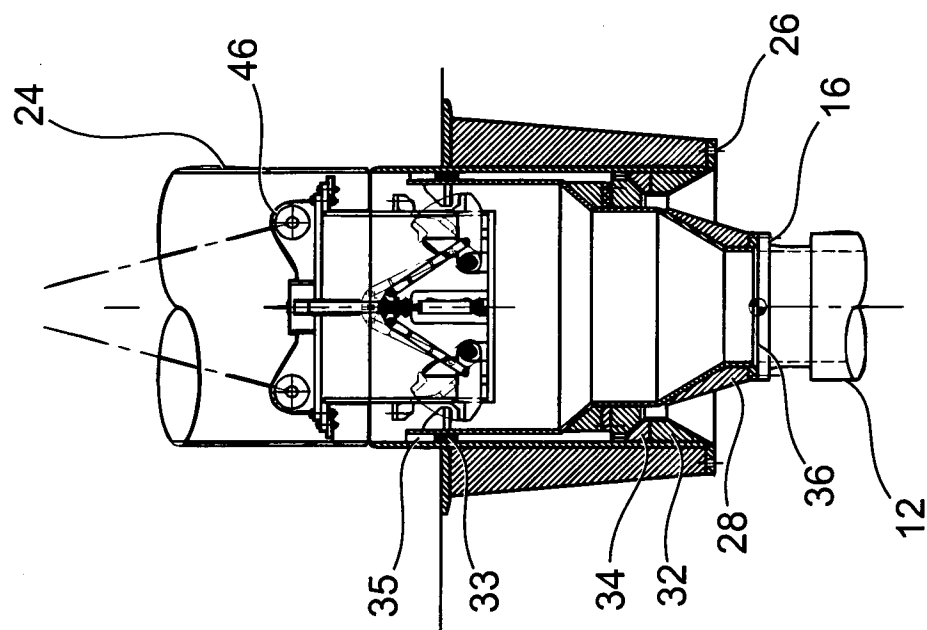


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/053119

A. CLASSIFICATION OF SUBJECT MATTER
INV. B63B13/00 F16L1/15 E21B17/01

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)
F16L B63B E21B

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 529 999 A (GOODYEAR TIRE & RUBBER [US] VEYANCE TECHNOLOGIES INC [US]) 11 May 2005 (2005-05-11)	1-5, 11
Y	paragraphs [0001], [0004] - [0008], [0012] - [0019] claims 6, 8 figures	6-10, 12-23
Y	WO 2008/017937 A (EMSTEC GMBH & CO KG [DE]; BRINK BURHARD [DE]) 14 February 2008 (2008-02-14) cited in the application the whole document	6-10, 12-23

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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- *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.
- *G* document member of the same patent family

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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Jankowska, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1529999	A	11-05-2005	BR PI0404601 A	21-06-2005
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