



(51) International Patent Classification:

F16F 9/10 (2006.01) F16F 7/12 (2006.01)
E21B 29/12 (2006.01)

(21) International Application Number:

PCT/NO2017/050095

(22) International Filing Date:

19 April 2017 (19.04.2017)

(25) Filing Language:

Norwegian

(26) Publication Language:

English

(30) Priority Data:

20160672 22 April 2016 (22.04.2016) NO

(71) Applicant: TECH DAMPER AS [NO/NO]; Fjordgata 82,
7010 Trondheim (NO).

(72) Inventor: MOBECK, Ole Martin; Bratsbergveien 51,
7037 Trondheim (NO).

(74) Agent: ACAPO AS; P.O. Box 1880 Nordnes, 5817 Bergen
(NO).

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,

(54) Title: SUBSEA DAMPER UNIT

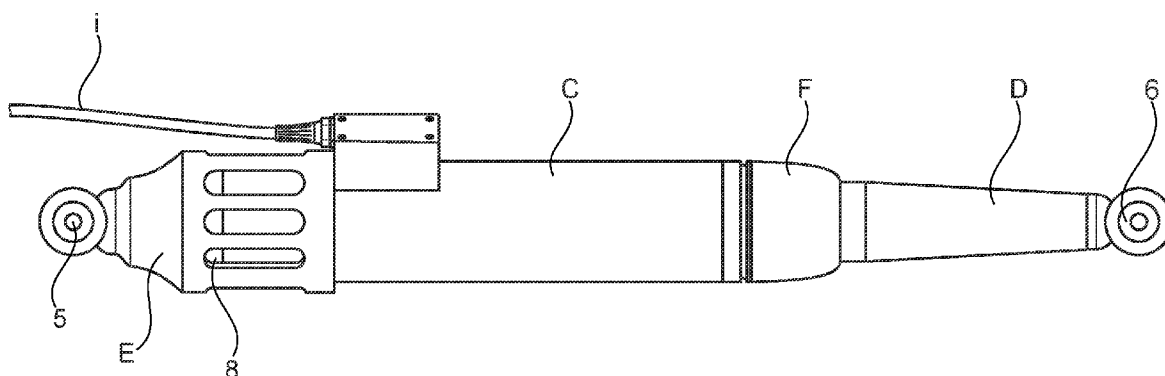


Fig. 1

(57) Abstract: A subsea damper unit comprising a cylinder body (C) equipped with an internal damper chamber (9) filled with damper oil (A), said damper chamber (9) contains a through-running piston rod (D) with a piston (7) that divides the damper chamber (9) into two chamber parts (9a,9b), and where the piston (7) is equipped with one or more valves (3) that permit fluid communication between said chamber parts (9a,9b). Mounted to each end of the cylinder body (C) is a compressible and fluid-filled chamber (F) with a fluid (B) that takes up the same pressure as the surrounding water pressure, where respective fluid chambers (F) are in fluid communication with each other, and the cylinder body (C) comprises a pressurization valve or membrane (3) that transmits the pressure from said fluid (B) in at least one of the compressible fluid chambers (F) to the damper oil (A) in the damper chamber (9).



Subsea damper unit.**Area of the invention**

The present invention relates to a subsea damper unit, comprising a cylinder body
5 equipped with an internal damper chamber filled with damper oil, said damper
chamber contains a through-running piston rod with a piston that divides the damper
chamber into two chamber parts, and where the piston is equipped with one or more
valves that permit fluid communication between said chamber parts.

10 Background to the invention.

Vibrations in oil pipes and gas pipes or other subsea installations are a problem that
has been given increasing attention lately. It appears that the problem is more
extensive than first thought, and it is now recognised that action must be taken to
maintain safety.

15

Vibrations in a structure above a given limit lead to structure tensions, which in turn
will result in wear and breakages over time. Breakages in an oil-carrying pipe will
lead to very unfortunate environmental consequences as well as dramatic
consequences for the company responsible.

20

With an increasing focus on the extension of operating life for a field, it is becoming
more and more important to safeguard the installations against breakages due to
wear. To dampen the vibrations below a critical limit will therefore lead to an
increased lifespan. It can also contribute to the safety of the production in a well.

25

Description of prior art.

Today, there are limited solutions for subsea vibrations. For vibrations at low
frequencies, linear damper rods are most effective. Traditional damper rods have a
low damper effect at low speeds and high hysteresis (slacken).

30

US 2013/0206522 A1 describes a damper unit, comprising a cylinder body equipped
with an internal damper chamber filled with damper oil, a through-running piston rod

with a piston that divides the damper chamber into two chamber parts, where the piston is equipped with one or more valves. A compressible chamber is mounted to the one end of the cylinder body.

- 5 Furthermore, reference is given to US 2012/0241009 A1, US 2008251980 A1 and US 4724970 A.

Objects of the present invention.

- 10 The damper unit according to the invention will, to a large extent, focus on damper control at low speeds, at the same time as it can provide large forces at high speed. Focus is also given to making it easier to get a qualified damper unit for subsea installation by constructing the damper unit such that the pressure of the ocean depths will not influence the damper unit.

- 15 The damper is made independent of the depth of installation due to a constant internal volume, pressure neutrality with respect to the water pressure and also low hysteresis and can have the possibility to deactivate the damper function subsea.

A further object is to provide an alternative construction of a damper unit.

20

Summary of the invention.

In the construction, seals and functioning of the damper unit, special attention is given to the challenges that arise from the pressure differences in and outside the damper during production, fitting and subsea operation.

25

- The damper can be constructed so that it is not necessary to use a gas pressure reservoir to handle the internal volume changes because of the displacement of oil by the piston rod, such as those on conventional, telescopic dampers and hydraulic cylinders. The damper according to the invention can have a constant internal
30 volume during compression and decompression. No shaft seal will thereby be subjected to seawater or higher pressure than what the damper function builds up, irrespective of installation depth.

The damper unit can also have a special function to turn off the damper function and make it powerless. This can be carried out from a ROV panel via a hydraulic hose. The ROV panel is a panel with functions that are mounted on subsea equipment. The panel can be formed such that a mini submarine can operate it.

5

Said objects are reached by a subsea damper unit as given in the introduction, comprising a cylinder body equipped with an internal damper chamber filled with damper oil, said damper chamber contains a through-running piston rod with a piston that divides the damper chamber into two chamber parts, and where the piston is
10 equipped with one or more valves that permit fluid communication between said chamber parts. Mounted to each end of the cylinder body is a compressible and fluid-filled chamber with a fluid that takes up the same pressure as the surrounding water pressure, where respective fluid chambers are in fluid communication with each other, and the cylinder body comprises a pressurization valve or membrane
15 that transfers the pressure from said fluid in at least one of the compressible fluid chambers of the damper oil in the damper chamber.

The piston rod is preferably fastened to respective, compressible fluid chambers.

20 The compressible fluid chambers can be formed as rolling bellows manufactured from rubber, such as reinforced rubber.

Furthermore, the compressible and fluid-filled chambers can be in fluid communication with each other via one or more channels, where the internal
25 diameter of the channel or channels is large enough to prevent choking of the fluid stream.

Said one or more valves in the piston, which control the fluid communication between the chamber parts, comprise a valve for the control of the decompression
30 force and another valve to control the compression force when the piston rod moves.

The pressurization valve that transmits the pressure from at least one of said fluid chambers to the damper oil in the damper chamber can comprise a watertight slide, bellows or the like to avoid mixing of oils.

- 5 One end of the cylinder body can be fastened to a housing equipped with fastening devices, and the piston rod can be equipped with fastening devices at the opposite end.

- 10 The housing surrounds one of said fluid chambers and is preferably equipped with openings that allow ingress of the surrounding seawater.

- 15 For the deactivation of the damper it can be equipped with a valve to be able to turn off the damper force, where the valve controls the fluid communication of the damper oil between the chamber parts via a relief channel, instead of via said one or more valves in the piston.

For the testing of the damper, it can be equipped with a service port for the filling and removal of damper oil in the damper chamber.

- 20 The compressible and fluid filled chambers that are in fluid communication with each other can form a constant volume chamber that renders the damper pressure neutral with respect to the surrounding pressure.

Description of the figures

- 25 Preferred embodiments of the invention shall, in the following, be described in more detail with reference to the enclosed figures, in which;

Figure 1 shows in perspective a damper unit according to the invention.

Figure 2 shows a principle diagram of the first embodiment of a damper unit according to the invention, seen in cross section.

- 30 Figure 3 shows a principle diagram of a second embodiment of a damper unit according to the invention, seen in cross section.

Figure 4 shows more details of a given embodiment of the damper unit according to the invention, seen in cross section.

Description of preferred embodiments of the invention.

5 The damper unit according to the invention can be mounted between a fastening point (anchor, the ground, a rig, something heavy) and a pipe or other technical installation that has a low frequency vibration or has a need for dampening. For example, sudden pressure blows in a pipe. The damper unit can also be mounted between pipes in a flex loop pipe (pipe in a spiral form to be able to handle
10 movements) where low frequency vibrations can arise between the pipes because of external and internal pressures and flow phenomena.

Initially, the assembly of the damper unit shall be explained, thereafter the function of the damper unit will be explained. As shown in the principle diagram in figure 2, the
15 damper unit according to the invention comprises a housing E that can be equipped with an attachment lug 5. The housing E comprises, or is connected to, a cylinder body C that has an internal piston rod D that extends out from both ends of the cylinder body C. The cylinder body C is internally hollow and filled with a damper oil A in a damper chamber 9 and which is divided into two chambers 9a,9b by an
20 intermediate piston 7, where the piston 7 is equipped with one or more valves 1 to control the damper force.

Mounted at respective ends of the cylinder body C are two compressible fluid chambers F which, in the example shown, contain oil B for a constant volume
25 chamber. In a preferred embodiment, these compressible fluid chambers F are formed as rolling bellows (figure 3) or accordion bellows (figure 2) in reinforced rubber, but can also be formed from another flexible material. However, the expression "bellows" is used in the subsequent text to describe both types of bellows. The housing E is open to the surrounding environment, i.e. the surrounding
30 seawater, via an opening 8, so that the pressure from the seawater affects the bellows F. Two bellows F are mounted at each end of the cylinder body C and are

connected to each other via a line or channel G so that said constant volume chamber is formed.

5 A valve 3 is equipped to at least one end of the cylinder body C to transmit the pressure to the damper oil A. Correspondingly, a service port 4 can be mounted to the damper oil chamber 9 for filling and pressurising of the chamber 9, for example, to be able to test the damper on land.

10 An essential feature of the invention is that by the use of a through-running piston rod D one does not get a volume change in the damper and thereby avoids a gas reservoir to handle this. But it is important to pressurise the damper oil A to avoid cavitation and this is obtained by transferring the seawater pressure that acts on the bellows F, where the pressure goes via the oil/fluid B in the bellows F and is transmitted to the damper oil A via a valve/membrane 3. This ensures that the
15 damper is pressure neutral with respect to the seawater pressure and no gaskets/seals need to be exposed to seawater. That the two bellows F are coupled together via the channel(s) G contributes to generate no volume changes in the damper.

20 The damper piston and the damper valve

It is preferred that the damper is made with a large diameter for the damper piston 7 to move large amounts of oil from small movements as this increases the control of the damper force at low damper speed. The valve pack 1 that chokes the oil and decides the damper force is mounted directly on the piston 7, and there can be a
25 valve to control the decompression force and another valve for the compression, which ensures that the damper hysteresis is very low.

Pressure neutral construction

30 Dampers with a large piston diameter move large amounts of oil and this can cause cavitation behind the piston at large speeds, but this can be overcome by pressurising the damper oil. It is not desirable to operate with a gas reservoir to achieve this and pressure from the surrounding seawater is not used either. When

the damper according to the invention is lowered down to installation depth, the pressure from the seawater will press against the bellow F, and this pressurises the oil B in the bellow F, and the pressure will be transmitted into the damper oil A in the damper chamber 9 via the valve 3. In this way, the whole of the damper will be
5 pressure neutral with respect to the seawater pressure on the outside and there will be no pressure load on the cylinder body C or the bellows F as a consequence of the damper being mounted in deep water.

The valve 3 will not see any flow, only a pressure transmission. It can therefore
10 comprise a watertight slide, membrane or bellows to avoid mixing of oils or to be able to relieve the pressure if the damper is taken up from an extreme depth.

However, in the drawings a non-return valve is mounted that opens for pressure in towards the damper oil A in the damper chamber 9. When the damper is installed at ocean depths the pressure on the damper oil A is pressurised due to the seawater
15 pressure and no cavitation will arise.

The internal volume of the damper

The piston rod D is through-running and will therefore not cause any volume changes in the cylinder body C. A bellows F made from rubber is mounted at either
20 end of the piston rod D on the outside of the cylinder body C and this gives two chambers 10a,10b that are filled with oil. The chambers 10a,10b are connected to the channel(s) G. When the damper moves, the volume of one of the chambers will increase and the other decrease, where the relationship between the increase and decrease in volume is the same. The oil B will change sides via the channel(s) G
25 when the damper moves and the volume remains constant in the damper. Therefore, there will be no pressure changes in this system. The channel(s) G should be sufficient in number and large enough so that there is no chocking effect when the oil B flows through the channel(s) G. The piston rod gaskets will not be exposed to seawater either. Because of this construction with constant volume, the damper will
30 not provide any static pushing force with the piston rod D and the seawater pressure will not be able to push the piston rod D into the damper either because of the

pressure. The housing E will be open as the seawater presses against the rolling bellows F.

Deactivation of the damper

5 It is desirable to be able to turn off the damper force on the damper for servicing or moving of the equipment the damper is mounted onto while it is subsea. This can be carried out in that one opens a valve 2 which is connected via a channel H to the two damper chambers 9a,9b. The oil A will then flow through the channel H instead of through the damper valve 1 in the piston 7 when the damper moves. The valve 2 can
10 be opened with the help of hydraulic pressure from an ROV panel that is mounted so that it can be easily accessible for an ROV. One can also have an electrical remote control or mechanical operation of the valve directly from the damper. The hydraulic valve 2 in the drawing is such that with a rupture of the hose, the valve will close so that normal damper function will be maintained.

15

Robust

Because of the damper being pressure neutral with respect to the seawater pressure it will not have to be dimensioned from the consideration of very high pressures at large depths. The cylinder body C, the bellows F and the piston rod gaskets around
20 the piston rod D will not feel any difference in the load if they are mounted at, for example, 50 metres or 500 metres depths.

Testing and maintenance

To be able to test the damper on land during production, one must pressurise the oil
25 to avoid cavitation. This can be carried out via the service port 4. There, one can also fill and remove oil. The damper will initially not function satisfactorily at high speeds under normal atmospheric pressure without the oil A being pressurised.

Explanation of the drawings.

30 A: Damper oil
B: Oil for the constant volume chamber
C: Main damper body, cylinder

- D: Piston rod
- E: Housing with attachment lug
- F: Rolling bellows or accordion bellows in reinforced rubber
- G: Oil channel for the constant volume chamber
- 5 H: Oil channel to deactivate the damper function
- I: Hydraulic hose to the ROV panel
- 1: Valves mounted on the damper piston to control the damper force
- 2: Valve to be able to turn off the damper force
- 3: Valve that transmits in the seawater pressure to pressurise the damper oil
- 10 4: Service port for the damper oil chamber to fill and pressurise the chamber to be able to test the damper on land.
- 5,6: Fastening device in the form of attachment lugs
- 7: Damper piston
- 8: Opening for the surrounding seawater
- 15 9,9a,9b: Damper chambers
- 10a, 10b: Bellows chambers

CLAIMS.

1. Subsea damper unit, comprising a cylinder body (C) equipped with an internal damper chamber (9) filled with damper oil (A), said damper chamber (9) contains a
5 through-running piston rod (D) with a piston (7) that divides the damper chamber (9) into two chamber parts (9a,9b), and where the piston (7) is equipped with one or more valves (3) that permit fluid communication between said chamber parts (9a,9b),
c h a r a c t e r i s e d i n
that a compressible and fluid-filled chamber (F) with a fluid (B) that takes up
10 the same pressure as surrounding water pressure is mounted to each end of the cylinder body (C), where respective fluid chambers (F) are in fluid communication with each other, and
that the cylinder body (C) comprises a pressurization valve or membrane (3) that transmits the pressure from said fluid (B) in at least one of the compressible fluid
15 chambers (F) to the damper oil (A) in the damper chamber (9).
2. Subsea damper unit according to claim 1, c h a r a c t e r i s e d i n that the piston rod (D) is fastened to respective, compressible fluid chambers (F).
- 20 3. Subsea damper unit according to claim 1, c h a r a c t e r i s e d i n that the compressible fluid chambers (F) are formed as rolling bellows or accordion bellows manufactured from rubber, such as reinforced rubber.
- 25 4. Subsea damper unit according to claim 1, c h a r a c t e r i s e d i n that the compressible and fluid-filled chambers (F) are in fluid communication with each other via one or more channels (G), where the internal diameter of the channel (G) or the channels is large enough to prevent chocking of the fluid stream.
- 30 5. Subsea damper unit according to claim 1, c h a r a c t e r i s e d i n that said one or more valves (3) in the piston (7), and which control the fluid communication between the chamber parts (9a,9b), comprises a valve to control the decompression force and another valve to control compression force.

6. Subsea damper unit according to claim 1, characterised in that the pressurization valve (3) that transmits the pressure from at least one of said fluid chambers (F) to the damper oil (A) in the damper chamber (9) comprises a watertight slide, bellows or the like to avoid mixing of the oils.

5

7. Subsea damper unit according to claim 1, characterised in that one end of the cylinder body (C) is fastened to a housing (E) equipped with fastening devices (5), and that the piston rod (D) at the other end is equipped with fastening devices (6).

10

8. Subsea damper unit according to claim 6, characterised in that the housing (E) surrounds one of said fluid chambers (F) and is equipped with openings (8) that allow ingress of the surrounding seawater.

15

9. Subsea damper unit according to claim 1, characterised in that for deactivation of the damper it is equipped with a valve (2) to be able to turn off damper force, where the valve (2) controls fluid communication of the damper oil (A) between the chamber parts (9a,9b) via a relief channel (H), instead of through said one or more valves (3) in the piston (7).

20

10. Subsea damper unit according to claim 1, characterised in that for testing of the damper it is equipped with a service port (4) for filling and removal of damper oil (A) in the damper chamber (9).

25

11. Subsea damper unit according to claim 1, characterised in that the compressible and fluid-filled chambers (F) that are in fluid communication with each other form a constant volume chamber that makes the damper pressure neutral with respect to the surrounding pressure.

30

1/4

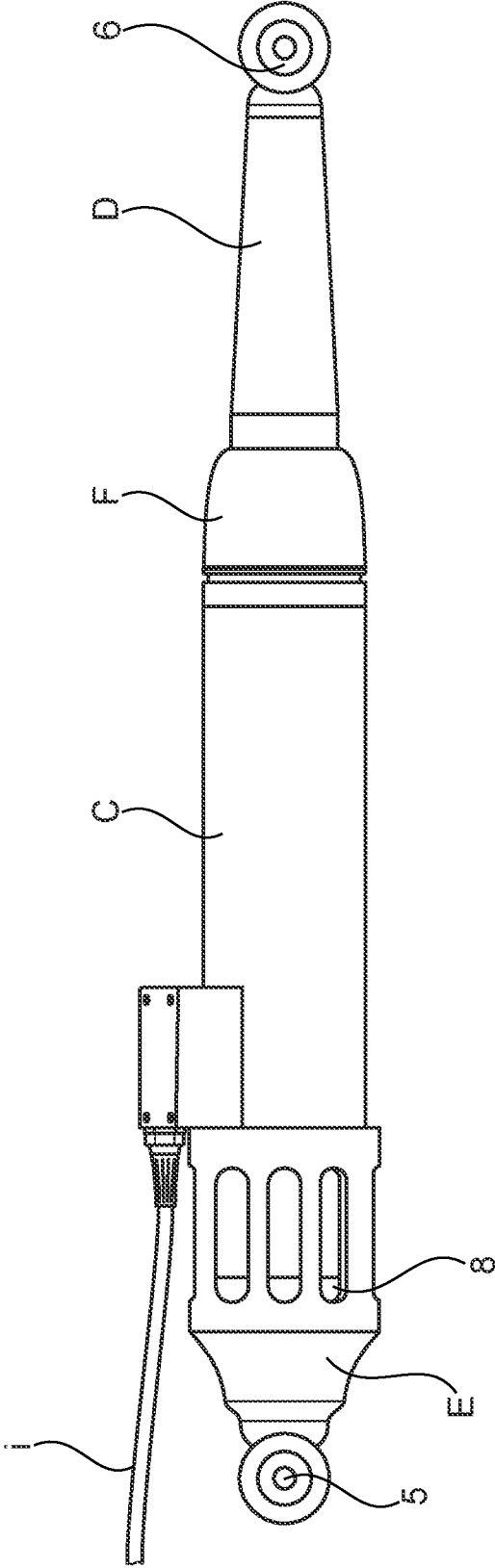


Fig. 1

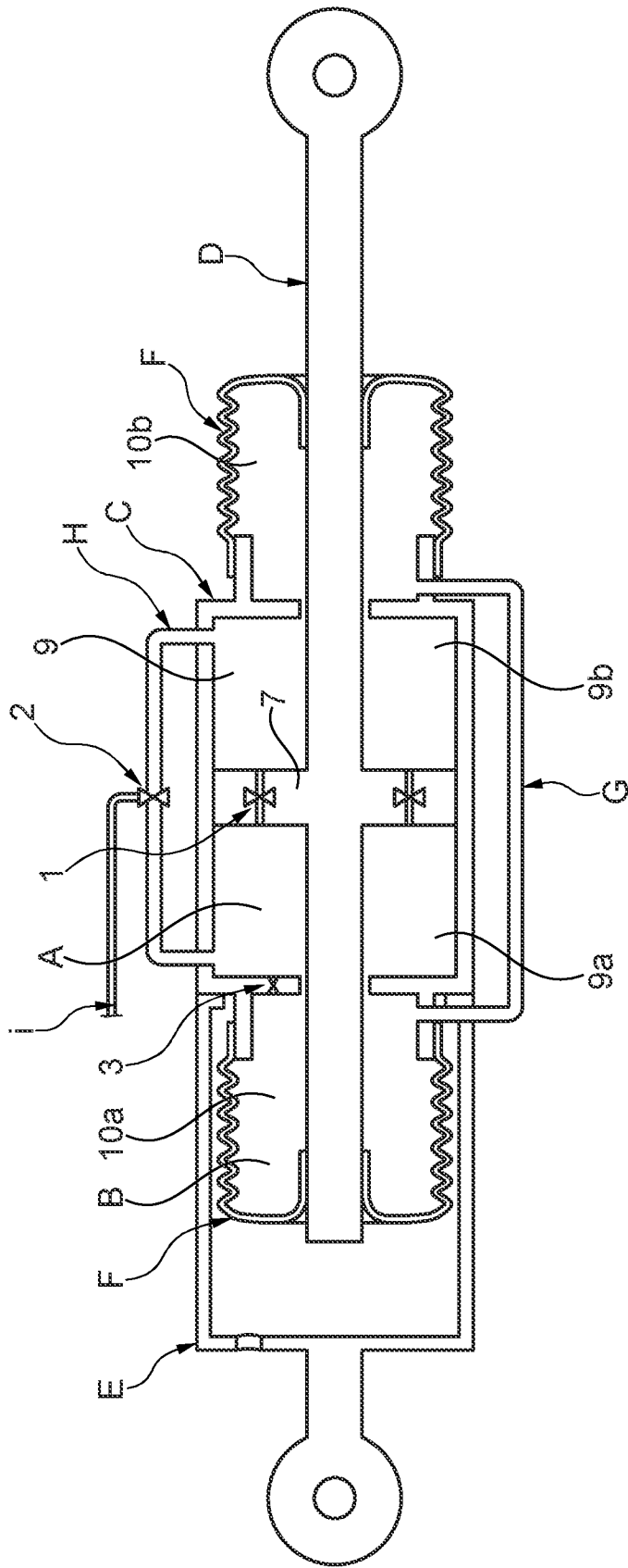


Fig. 2

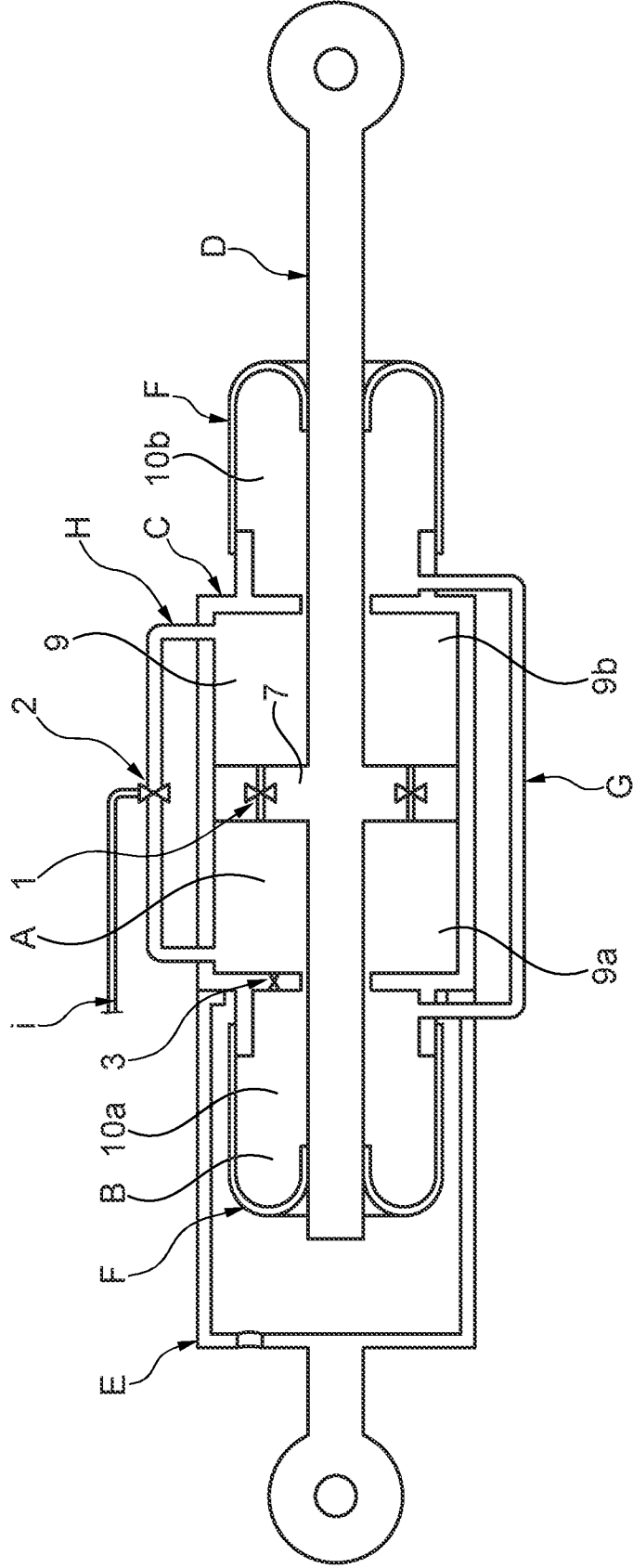


Fig. 3

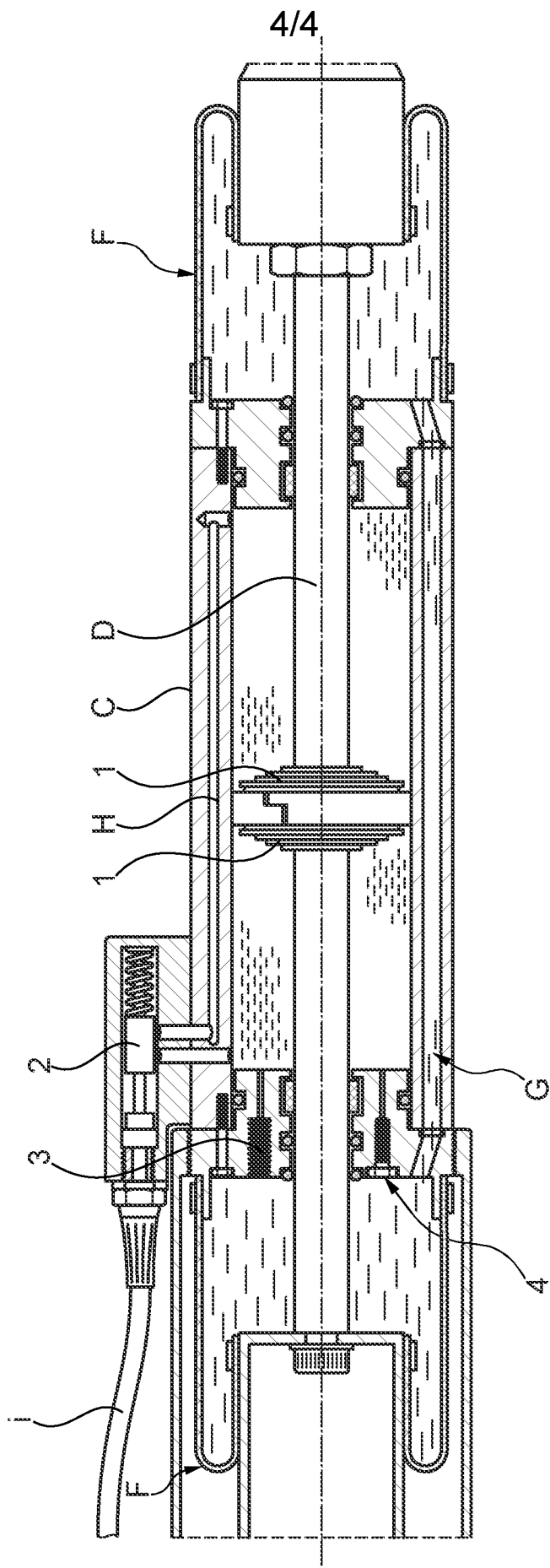


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO2017/050095

A. CLASSIFICATION OF SUBJECT MATTER F16F 9/10 (2006.01), E21B 29/12 (2006.01), F16F 7/12 (2006.01) 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) F16F, E21B Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched DK, NO, SE, FI: Classes as above. Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPODOC, WPI, FULL TEXT: ENGLISH, GERMAN, FRENCH		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2013/0206522 A1 (CULTRARO A), 2013.08.15 Paragraphs [0015], [0023], claim 1 and fig. 1	1-11
A	US 2008/0251980 A1 (ORMOND M J), 2008.10.16 Paragraph [0004], abstract and fig. 1	1-11
A	US 4721053 A (BREWERTON R W), 1988.01.26 Claim 1 and fig. 1	1
A	US 2013/0189138 A1 (EROSHENKO V), 2013.07.25 Paragraphs [0018], [0019] and fig. 1, 2	1
A	US 4724970 A (KUEHN H), 1988.02.16 Claim 1, abstract and fig. 3	1
☐ 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 "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
27/06/2017		06/07/2017
Name and mailing address of the ISA Nordic Patent Institute Helgeshøj Allé 81 DK - 2630 Taastrup, Denmark. Facsimile No. + 45 43 50 80 08		Authorized officer Tatiana P. Mortensen Telephone No. +47 22 38 74 28

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/NO2017/050095

Patent document cited in search report / Publication date	Patent family member(s) / Publication date
US 2013206522 A1 2013.08.15	ITTO 20100845 A1 2012.04.20 WO 2012052934 A1 2012.04.26 CN 103201533 A 2013.07.10 EP 2630388 A1 2013.08.28 SI 2630388T T1 2015.05.29
US 2008251980 A1 2008.10.16	AU 2009233731 A1 2009.10.15 WO 2009126711 A1 2009.10.15 NO 20101557 A 2010.12.03 GB 2471051 A 2010.12.15 BRPI 0910909 A2 2015.09.29 MY 158641 A 2016.10.31
US 4721053 A 1988.01.26	GR 82524 B 1985.04.24 NO 845088 A 1985.06.24 DK 621684 A 1985.06.24 AU 3656584 A 1985.06.27 EP 0147176 A2 1985.07.03 KR 850004430 A 1985.07.15 GB 2152183 A 1985.07.31 JPS 60157534 A 1985.08.17 BR 8406606 A 1985.10.15 ES 8603780 A1 1986.05.16 NZ 210498 A 1987.05.29 IN 163211 B 1988.08.20 AT 37511T T 1988.10.15 CA 1256327 A 1989.06.27 SU 1544181 A3 1990.02.15 FI 82006B B 1990.09.28 IE 55960 B1 1991.02.27
US 2013189138 A1 2013.07.25	FR 2964434 A1 2012.03.09 WO 2012032088 A1 2012.03.15 KR 20130052672 A 2013.05.22 CN 103119320 A 2013.05.22 EP 2614269 A1 2013.07.17 JP 2013536930 A 2013.09.26 RU 2013115380 A 2014.10.20
US 4724970 A 1988.02.16	DE 3546277 A1 1987.07.02 EP 0228050 A2 1987.07.08 JPS 62157184 A 1987.07.13 NO 865297 A 1987.08.11