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(54) Title: SYSTEM FOR SENSING LEAKS IN A STUFFING BOX

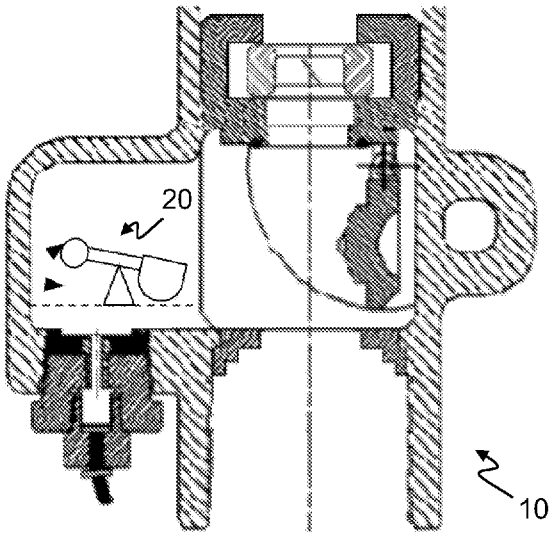


FIG. 1

(57) Abstract: The present invention relates to a leak sensor for stuffing boxes. In this connection, the present invention provides a system configured to sense a leak in a stuffing box, wherein the system comprises a sensing device comprising: a support supporting an elongated structure, wherein the elongated structure is configured to pivot relative to the support; a container fixed to a first end of the elongated structure, suitable for receiving liquid from a leak; and at least one position sensor suitable for detecting a position of the elongated structure, wherein the system is configured such that: when empty, the container remains in a raised position, and a second end of the elongated structure, opposite the first end to which the container is fixed, remains in a lowered position; and when filled with leaked liquid, the container moves to a lowered position compared to its empty raised position, and the second end of the elongated structure moves to a relatively raised position compared to its empty lowered position.

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[Continued on next page]

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SYSTEM FOR SENSING LEAKS IN A STUFFING BOX

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority to BR 10 2017 008806-5, filed 27 April 2017, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to a leak sensor for stuffing boxes.

BACKGROUND OF THE INVENTION

[0003] One of the components of an onshore system for mechanical pumping of petroleum is known as a stuffing box, which is a system consisting of perforated disks (gaskets), generally elastomeric, through which a polished rod slides cyclically.

[0004] The function of these disks, or gaskets, is to prevent leakage of fluid to the environment and maintain a confined system pressure. However, as is widely known by a person skilled in the art, these gaskets wear away naturally over time, and when this occurs there is loss of efficiency of the system and leakage of fluids to the surroundings.

[0005] Leakage of fluid means serious risks for the environment and for the operators, since the equipment may often reach temperatures above 100°C, with various volatile and potentially toxic products.

[0006] Once leakage begins, the process is only stopped when it is noticed by the operators, who then disconnect the equipment to carry out maintenance.

[0007] One solution for detecting leaks in stuffing boxes that is known from the prior art consists of a container supported by a spring at the side of the stuffing box, so that when any leak occurs, the container is filled with the fluid until it reaches a defined weight, deforming the spring and activating an electrical contact that indicates to the control system that there is a leak.

[0008] However, although the system with a spring is capable of detecting a leak, it is dependent on very precise adjustment between the weight of the container, the coefficient of elasticity of the spring and the weight of the fluid for acceptable operation. Therefore this system is excessively sensitive, and may be affected by many variables. In addition, for the spring to be deformed and for

the system to be capable of detecting leaks, generally it is necessary for the volume of oil collected by the container to be very large. Therefore it also takes a long time for a leak to be detected, which may result in negative consequences due to exposure of the operators to the leaked gases.

[0009] Another known solution involves a system with a container and a float, in which the leaking fluid is directed to this container so as to lift the float up to a certain point where an electrical contact is activated, indicating to the control system that there is a leak.

[00010] Although the system with a float is more sensitive, there is a risk of the float being stuck due to freezing of the fluid, since some fluids change their viscosity drastically on cooling, generating a potential adhesive effect on the float and preventing activation of the leak detecting system.

[0010] Some patent documents also disclose various ways of collecting liquid and detecting leaks in stuffing boxes, some of which are presented follow.

[0011] Document CN203481001 (U) discloses a structure for collecting leaked liquid that comprises a channel for collecting leaked liquid that directs this liquid to a collecting pipe, which in turn directs the liquid to a collecting container comprising a level sensor, which indicates the existence of a leak.

[0012] Document US5440917 (A) discloses a leak detector that can be used in a gasket comprising an absorbent ring with two conductive sheets around the entire internal surface of the ring, a low-voltage power source, a low-voltage lamp, a test switch, and insulated wires.

[0013] In that document, the conductive sheets are insulated from one another. However, when there is a leak, the absorbent ring expands due to absorption of leaked liquid, pressing on the conductive sheets so that they come into contact with one another. This contact causes the circuit of the lamp to become "closed", so that the lamp lights up, indicating the existence of a leak.

[0014] Document US5148699 (A) discloses a well head stuffing box that comprises a leak detector installed between the stuffing box and the covering box.

[0015] The leak detector in this document operates by directing leaks arising from the stuffing box, through a pipe to a tank that comprises a float that moves up when the level of the fluid in the tank of fluid rises, thus activating a switch that may be used for activating an alarm or for connecting and

disconnecting equipment when necessary.

[0016] Document US5245860 (A) discloses a method and a device for sensing unacceptable oil leaks in a stuffing box, which includes a tank for receiving the leak divided by a barrier between a first compartment and a second compartment, in which the barrier determines the maximum acceptable level of leakage, so that when the amount of leaked liquid accumulated in the first tank exceeds the defined value, there is leakage of this liquid to the second compartment, which comprises a leak detecting sensor.

[0017] Document US6592126 (B2) discloses a mechanical seal assembly that includes a leak detector that collects a leaked liquid and directs it to a container that comprises an optical fibre sensor for detecting when the level of liquid inside it reaches a defined level.

[0018] Although the prior art provides various devices and systems for detecting leaks in stuffing boxes, many of them are very susceptible to mechanical faults or depend on complex electronics that may be expensive. As will be described in detail hereunder, the present disclosure provides a simple, low-cost alternative for detecting leaks in stuffing boxes.

SUMMARY OF THE INVENTION

[0019] The present disclosure provides a system for sensing a leak in a stuffing box that has a simple arrangement with little possibility of faults, whether mechanical, electronic or due to freezing of the fluid.

[0020] According to a first aspect, there is provided a system configured to sense a leak in a stuffing box, wherein the system comprises a sensing device comprising one or more of: a support supporting an elongated structure, wherein the elongated structure is configured to pivot relative to the support; a container fixed to a first end of the elongated structure, suitable for receiving liquid from a leak; and at least one position sensor suitable for detecting a position of the elongated structure, wherein the system is configured such that: when empty, the container remains in a raised position, and a second end of the elongated structure, opposite the first end to which the container is fixed, remains in a lowered position; and when filled with leaked liquid, the container moves to a lowered position compared to its empty raised position, and the second end of the elongated structure moves to a relatively raised position compared to its empty

lowered position.

[0021] The support may be in contact with the elongated structure between the two ends thereof.

[0022] Optionally the system is positioned in a place where leaked liquid, when present, must necessarily be directed to the container.

[0023] The system may further comprise a weight fixed to the second end of the elongated structure.

[0024] The system may further comprise two position sensors, one for detecting each of a raised position and a lowered position of the weight. Each of the position sensors may be a lever that actuates a contact when pressed by the weight. The contact may be actuated by at least one of electrical contact, mechanical contact and magnetic contact. Each of the position sensors may be at least one of optical sensor, proximity sensor and mass sensor. The container may be lighter than the weight when empty and heavier than the weight when full of leaked liquid. The at least one position sensor may be suitable for detecting elevation of the weight relative to the container.

[0025] The elongated structure may be configured to pivot relative to the support at its centre of mass.

[0026] The elongated structure may be configured to pivot relative to the central support on a pivot.

[0027] According to a second aspect, there is provided a method of sensing a leak in a stuffing box, the method comprising: using a sensing device comprising a support supporting an elongated structure, wherein the elongated structure is configured to pivot relative to the support; a container fixed to a first end of the elongated structure, suitable for receiving liquid from a leak; and at least one position sensor suitable for detecting a position of the elongated structure, and the method using the at least one position sensor to determine a change in position of the elongated structure and thus a determine the presence of a leak.

[0028] According to a third aspect of the disclosure there is provided a system for sensing a leak in a stuffing box having a sensing device that comprises (i) a central support supporting an elongated structure, wherein the elongated structure pivots relative to the central support, (ii) a weight fixed to one end of the elongated structure, (iii) a container fixed to the other end of the elongated

structure, opposite the weight, suitable for receiving liquid from a leak, (iv) at least one position sensor suitable for detecting elevation of the weight relative to the container, wherein, when empty, the container remains in a raised position counterbalanced by the weight that remains in a lowered position and, when filled with leaked liquid, the container moves to a lowered position counterbalanced by the weight that moves to a raised position.

[0029] According to a fourth aspect, there is provided a system for sensing a leak in a stuffing box, characterized in that it comprises a sensing device comprising: a central support supporting an elongated structure, in which the elongated structure pivots relative to the central support; a weight fixed to one end of the elongated structure; a container fixed to the other end of the elongated structure, opposite the weight, suitable for receiving liquid from a leak; at least one position sensor suitable for detecting elevation of the weight relative to the container, wherein: when empty, the container remains in a raised position counterbalanced by the weight, which remains in a lowered position; and when filled with leaked liquid, the container moves to a lowered position counterbalanced by the weight, which moves to a raised position.

[0030] The system may be characterized in that the central support is in contact with the elongated structure between the two ends thereof.

[0031] The system may be characterized in that it is positioned in a place where leaked liquid, when present, must necessarily be directed to the container.

[0032] The system may be, characterized in that it comprises two position sensors, one for detecting each of the positions of the weight relative to the container.

[0033] The system may be characterized in that each of the position sensors is a lever that actuates a contact when pressed by the weight.

[0034] The system may be characterized in that the contact is actuated by at least one of electrical contact, mechanical contact and magnetic contact.

[0035] The system may be characterized in that each of the position sensors is at least one of optical sensor, proximity sensor and mass sensor.

[0036] The system may be characterized in that the elongated structure pivots relative to the central support at its centre of mass.

[0037] The system may be characterized in that the container is lighter

than the weight when empty and is heavier than the weight when full of leaked liquid.

[0038] The system may be characterized in that the elongated structure pivots relative to the central support on a pivot.

BRIEF DESCRIPTION OF THE FIGURES

[0039] The detailed description presented hereunder refers to the appended figures and their respective reference numbers, showing embodiments of the present disclosure.

[0040] **Fig. 1** illustrates a sectional view of a stuffing box comprising the leak sensing system according to the preferred embodiment of the present disclosure.

[0041] **Fig. 2** illustrates a schematic view of a sensing device included in the system of the present disclosure in a configuration where a leak has not been detected.

[0042] **Fig. 3** illustrates a schematic view of a sensing device included in the system of the present disclosure in a position where a leak has already been detected.

DETAILED DESCRIPTION OF THE INVENTION

[0043] First, it is emphasized that the following description will start from a preferred embodiment. As will be obvious to a person skilled in the art, however, the invention is not limited to this particular embodiment.

[0044] **Fig. 1** illustrates a sectional view of a stuffing box **10**. The stuffing box **10** comprises a leak sensing system according to a preferred embodiment. As illustrated in **Figs. 2** and **3**, the system has a sensing device **20**. The sensing device **20** comprises a central support **30**. The central support **30** supports an elongated structure **40**, such as a bar. The elongated structure **40** can pivot relative to the central support **30**. The central support **30** is “central” in that it is positioned between the two ends of the elongated structure **40**, but it need not be exactly “central” between the two ends of the elongated structure **40.**

[0045] As illustrated in any one of **Figs. 1** to **3**, the sensing device is in the form of a seesaw. That is, the elongated structure **40** pivots relative to the central support **30**. Optionally, the elongated structure **40** pivots relative to the central support **30** at its centre of mass.

[0046] Optionally, the elongated structure **40** pivots relative to the central support **30** on a pivot (not shown).

[0047] The sensing device **20** can further comprises a weight **50**. The weight **50** can be fixed to one end of the elongated structure **40**.

[0048] At the opposite end of the elongated structure **40**, on the other side of the support **30**, a container **60** is provided, suitable for receiving liquid from a leak. In an embodiment where the central support **30** supports the elongated structure **40** at its centre of mass, the container **60**, when empty, is lighter than the weight **50**. When full of leaked liquid, the container **60** is heavier than the weight **50**.

[0049] Therefore, when empty, the container **60** remains in a raised position counterbalanced by the weight **50**, which remains in a lowered position, as illustrated in **Fig. 2**. When filled with leaked liquid, the container **60** moves to a lower position, relative to its empty raised position, counterbalanced by the weight **50**, which moves to a lowered position, relative to the empty raised position as illustrated in **Fig. 3**. As will be understood, it is not necessary for the container **60** to move from a position that is higher than the weight **50** to a position that is lower than the weight **50** for the sensing device **20** to operate. Whilst a larger movement (e.g. with the container **60** moving from a maximum raised position that the pivot arrangement allows to a minimum lowered position) can provide greater sensitivity, the sensing device **20** can operate based on smaller movements too (e.g. with the container **60** moving from a raised position with respect to the pivot point to a slightly less raised position).

[0050] For the system to function most suitably, it is desirable for the sensing device **20** to be positioned in the stuffing box **10** so that any leakage of liquid is directed to the container **60**. In this way, the container **60** will be filled as soon as possible, so that the leak is detected.

[0051] Preferably, at least one position sensor suitable for detecting a position of the elongated structure **40** is provided. In the depicted embodiment, the position of the elongated structure **40** can be detected by detecting the elevation of the weight **50** relative to the container **60**. As illustrated in **Figs. 2** and **3**, two position sensors **70**, **80** can provided, one each for detecting the high and low positions of the weight **50** relative to the container **60**. Thus, when the lower

sensor **70** is actuated, for example by contact with the weight **50**, it is a signal that there is no leak. Conversely, when the upper sensor **80** is actuated, also by contact with the weight **50**, it is a signal that the container is full, indicating a leak.

[0052] In the embodiment illustrated in **Figs. 2** and **3**, each of the position sensors **70**, **80** is a lever that actuates a contact when pressed by the weight **50**. The contact actuated can be at least one of an electrical contact, a mechanical contact and a magnetic contact.

[0053] It should be emphasized that any type of position sensor may be employed in the present invention, such as an optical sensor, proximity sensor, mass sensor, among others. Moreover, the spacing between the sensors can be varied, to vary the amount of liquid that must be collected before the high position sensor is actuated. This is a way of varying the sensitivity of the sensor. Those skilled in this field would be able to explore any known techniques for determining the position of the weight relative to the container. Thus, this reinforces the fact that the present invention is not limited to the types of sensors listed here.

[0054] Although the above discussion has focussed on an embodiment in which a weight **50** is used to counterbalance the container **60**, it will be appreciated that other embodiments may not require the weight **50**. That is, in some arrangements the weight of the elongated structure **40** may be sufficient to provide the counterbalance. Such arrangements include ones in which the support **30** is not positioned centrally, and is positioned closer to the end of the elongated structure **40** to which the container **60** is attached, or ones in which the elongated structure **40** is not uniform along its length. In such arrangements, the end of the elongated structure **40**, rather than the weight, may actuate the position sensors **70, 80**, and it is that end which may move from relatively lowered position to a relatively raised position as the container **60** fills with leaked fluid.

[0055] In still other arrangements, it may be the container **60** that actuates the at least one position sensor **70, 80**, or the at least one position sensor **70, 80** may detect a position of the elongate structure **40** based on the relative position of the container **60** with respect to the weight **50** (or opposite end of the elongated structure **40**).

[0056] Thus, the present invention provides a system for sensing a leak in a stuffing box comprising a simple arrangement with little possibility of faults,

whether mechanical or electronic. This system is not subject to the common faults of the prior art, since it dispenses with the need for precise adjustment of the components and functions independently of freezing of the liquid from a leak.

[0057] Countless variations falling within the scope of protection of the present application are permitted. This reinforces the fact that the present invention is not limited to the particular configurations/embodiments described above. As such, modifications of the above-described apparatuses and methods, combinations between different variations as practicable, and variations of aspects of the invention that are obvious to those of skill in the art are intended to be within the spirit and scope of the claims.

CLAIMS

1. System configured to sense a leak in a stuffing box, wherein the system comprises a sensing device comprising:

a support supporting an elongated structure, wherein the elongated structure is configured to pivot relative to the support;

a container fixed to a first end of the elongated structure, suitable for receiving liquid from a leak; and

at least one position sensor suitable for detecting a position of the elongated structure,

wherein the system is configured such that:

when empty, the container remains in a raised position, and a second end of the elongated structure, opposite the first end to which the container is fixed, remains in a lowered position; and

when filled with leaked liquid, the container moves to a lowered position compared to its empty raised position, and the second end of the elongated structure moves to a relatively raised position compared to its empty lowered position.

2. System according to claim 1, wherein the support is in contact with the elongated structure between the two ends thereof.

3. System according to claim 1 or 2, wherein the system is positioned in a place where leaked liquid, when present, must necessarily be directed to the container.

4. System according to any one of claims 1 to 3, further comprising a weight fixed to the second end of the elongated structure.

5. System according to claim 4 wherein the system comprises two position sensors, one for detecting each of a raised position and a lowered position of the weight.

6. System according to claim 5, wherein each of the position sensors is a lever that actuates a contact when pressed by the weight.

7. System according to claim 6, wherein the contact is actuated by at least one of electrical contact, mechanical contact and magnetic contact.

8. System according to claim 5, wherein each of the position sensors is at least one of optical sensor, proximity sensor and mass sensor.

9. System according to any one of claims 4 to 8, wherein the container is lighter than the weight when empty and is heavier than the weight when full of leaked

liquid.

10. System according to any one of claims 4 to 9, where in the at least one position sensor is suitable for detecting elevation of the weight relative to the container.

11. System according to any one of claims 1 to 10, wherein the elongated structure is configured to pivot relative to the support at its centre of mass.

12. System according to any one of claims 1 to 11, wherein the elongated structure is configured to pivot relative to the central support on a pivot.

13. A method of sensing a leak in a stuffing box, the method comprising:

using a sensing device comprising

a support supporting an elongated structure, wherein the elongated structure is configured to pivot relative to the support;

a container fixed to a first end of the elongated structure, suitable for receiving liquid from a leak; and

at least one position sensor suitable for detecting a position of the elongated structure,

and using the at least one position sensor to determine a change in position of the elongated structure and thus a determine the presence of a leak.

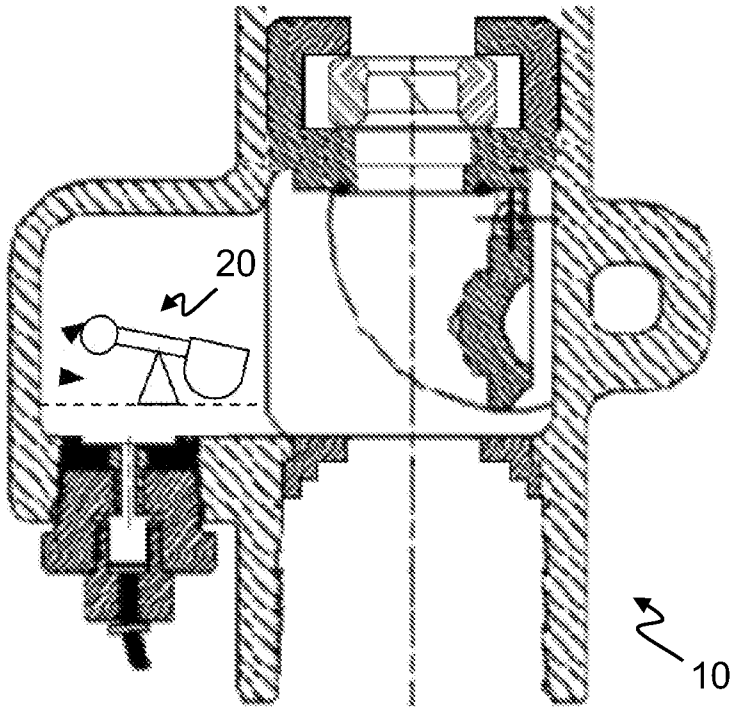


FIG. 1

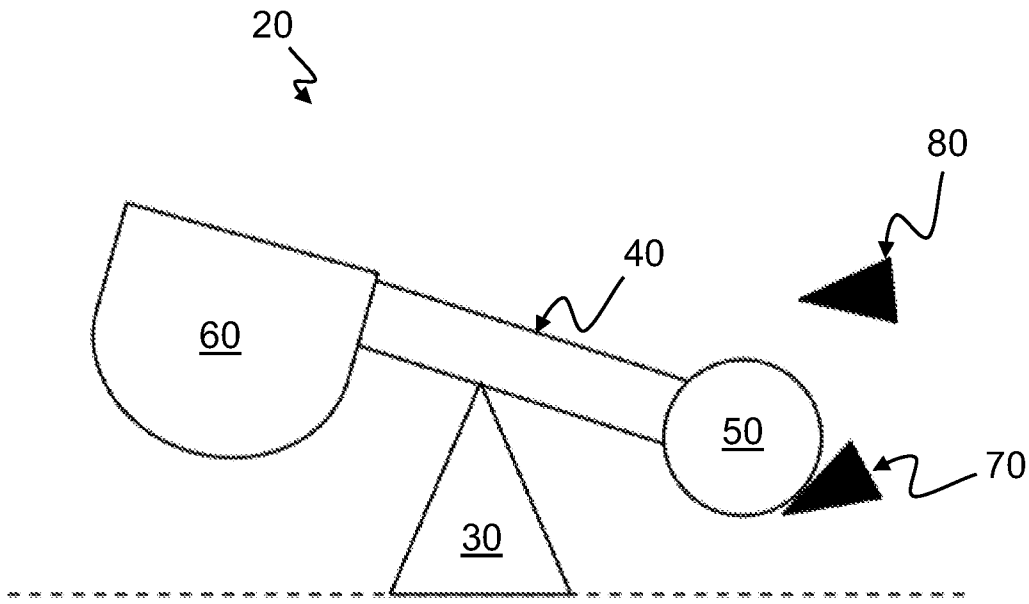


FIG. 2

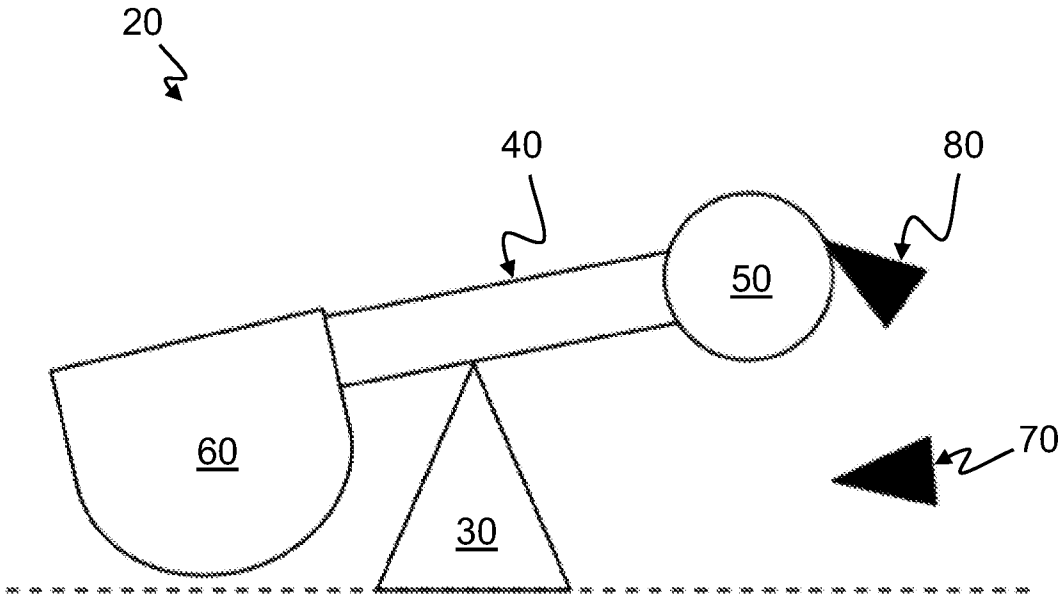


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/051125

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01M3/32
ADD.

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)
G01M E21B F16C A61B A61L

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 practicable, 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.
A	US 2016/281478 A1 (BREWER JACK G [US] ET AL) 29 September 2016 (2016-09-29) abstract Paragraphs [00], figures 1-10	1-13
A	WO 2006/133681 A1 (ZAHNRADFABRIK FRIEDRICHSHAFEN [DE]; KRUSE JOCHEN [DE]; SPRATTE JOACHIM) 21 December 2006 (2006-12-21) abstract page 1 - page 13 figure 1	1-13
A	EP 1 785 150 A1 (OLYMPUS MEDICAL SYSTEMS CORP [JP]) 16 May 2007 (2007-05-16) abstract	1-13

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

☒ See patent family annex.

* Special categories of cited documents :

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"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

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Date of the actual completion of the international search	Date of mailing of the international search report
18 July 2018	25/07/2018

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2018/051125

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016281478 A1	29-09-2016	CA 2924910 A1	25-09-2016
		US 2016281478 A1	29-09-2016
WO 2006133681 A1	21-12-2006	AT 412832 T	15-11-2008
		CN 101198801 A	11-06-2008
		DE 102005027825 A1	04-01-2007
		EP 1891343 A1	27-02-2008
		JP 2008544174 A	04-12-2008
		KR 20080022081 A	10-03-2008
		US 2008193207 A1	14-08-2008
		WO 2006133681 A1	21-12-2006
EP 1785150 A1	16-05-2007	CN 1966092 A	23-05-2007
		CN 201026201 Y	27-02-2008
		EP 1785150 A1	16-05-2007
		JP 4789590 B2	12-10-2011
		JP 2007135705 A	07-06-2007
		US 2007169799 A1	26-07-2007