(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 September 2008 (25.09.2008)

PCT

(10) International Publication Number
WO 2008/115131 A1

(51) International Patent Classification:
G01D 11/24 (2006.01) *H01R 13/56* (2006.01)
H01R 13/52 (2006.01) *H02G 15/013* (2006.01)
H02G 15/007 (2006.01)

(21) International Application Number:
PCT/SE2008/050265

(22) International Filing Date: 11 March 2008 (11.03.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0700665-3 16 March 2007 (16.03.2007) SE

(71) Applicant *(for all designated States except US)*: **SCANIA CV AB (publ)** [SE/SE]; S-151 87 Södertälje (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **LUNDIN, Michael** [SE/SE]; Kyrkogårdsvägen 75, S-121 33 Enskededalen (SE).

(74) Agent: **ELLIOT, Douglas**; Scania CV Ab, UTY/Patents, S-151 87 Södertälje (SE).

(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, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

Published:
— *with international search report*

(54) Title: A SENSOR DEVICE

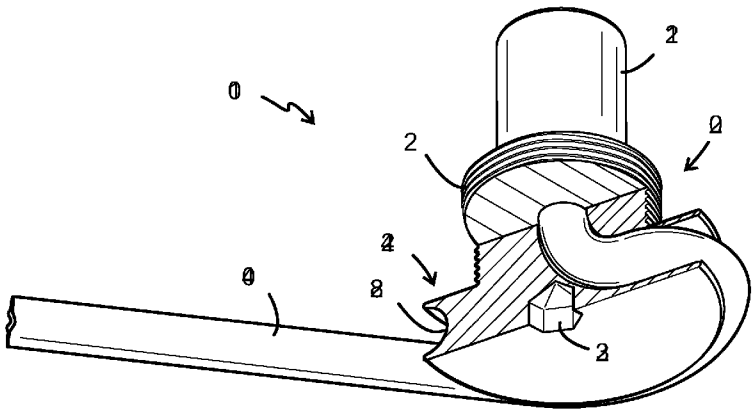

Fig. 2

(57) Abstract: The invention is directed to an improved connection means for asensor. According tothe invention, a sensor (10) comprises a housing (20) which can be mounted to a surface (52), a sensing element (12) on the outside ofsaid housing,anda flexible line (40) (e.g. an electrical cable) operativelyconnected to said sensing elementand extending through said housing. Furthermore, the housing (20) comprises alateral flange (24) comprisinga peripheral recess or groove (28) capable of retaining a portion of said linearound said housing in close proximity to said surface. The housing also comprises a lateral exit for saidline whichopens into said recess.Thus, the flexible line can be wound around the housing while being held snugly within the recess or groove, making it possible to direct the cable in any desired direction while avoiding that the cable bends or forms a loop.

WO 2008/115131 A1

A SENSOR DEVICE

Technical field

The invention relates to a sensor with an improved connection means.

Background art

A sensor, for example for detecting the presence of water in a fuel tank, conventionally comprises a sensing element, such as a probe, located on the outside of a sealed housing or body. The housing may contain electronic circuitry. The upper part of the housing can be equipped with a threaded fitting so that it can be mounted to the surface of a container where measurement is to be performed (e.g. a fuel tank), and the housing also comprises a flange which will hold the sensor against the surface. The sensing element will then extend through an aperture in the surface into the inside of the container. The bottom part of the housing is equipped with a means for connecting the output of the sensor to other electronic circuitry. The standard technique is to use either a connection plug or a pig-tail cable extending from the bottom of the housing.

When the sensor is to be placed in an exposed environment where it will be subjected to heat, dirt, damp etc (for example an engine or transmission box, or the outside of a vehicle), a pig-tail cable is the preferred solution, as it is less susceptible to contamination and vibration-induced damage than a connection plug. A pig-tail also generally requires less space.

However, in certain very exposed positions, even a pig-tail is not robust enough. In the case of a sensor mounted on the underside of a fuel tank on a truck or car, the cable will form a loop suspended a very short distance above the road surface. If the vehicle passes over an object such as a rock or branch, there is a high risk of damage to the cable. One way to avoid this is to clamp the cable to the underside of the vehicle, but this is hard to achieve in practice without bending the cable to the breaking point. (A common rule of thumb is that a round cable may not be bent more than three times its own diameter.)

The fact that the pig-tail extends out from the bottom of the housing may also cause problems in very cramped environments, where there is not room enough for the cable.

The above mentioned problems may be partially solved by having the cable extend laterally out from the side of the housing. However, because the sensor is screwed onto the surface, it is not possible to control the final location of the cable exit. As the cable may end up pointing in any direction, it may again become necessary to bend it, resulting in looping and/or breakage.

Disclosure of the invention

An object of the invention is to provide a sensor with improved connection means, which offers adequate protection in exposed environments, avoids excessive bending or folding of the connecting cable, and takes up a minimum amount of space.

This object is achieved by the addition of a peripheral recess or groove to the sensor housing. The cable exits the housing from a lateral exit opening which is positioned in or near this recess; in other words, the cable extends laterally out from the side rather than from the bottom part of the housing, as in known solutions.

The cable, or flexible line, can then be positioned in the recess and wound in any desired direction for connection to other circuitry. Thus, the width of the recess is preferably at least as large as the cable diameter.

An advantage of the present invention is that because the cable will be safely held within the recess, no loose-hanging loop will be formed, and the risk of the cable snagging in other objects is thereby greatly reduced. An additional advantage is that the inventive solution enables 360° freedom of choice of direction for the cable. Provided that the diameter of the flange is sufficiently large, there will be no risk of excessive bending of the cable. Furthermore, the inventive sensor will take up less space compared to prior art solutions, because there is no cable or connection plug sticking out from the bottom of the sensor.

Other features and advantages of the invention are apparent from the following detailed description and the appended claims.

In the present application, the term "sensor" is used to denote a device that responds to a physical stimulus, such as thermal energy, electromagnetic energy, acoustic energy, pressure, magnetism, motion, or the presence of a substance (e.g. water), by producing an electrical signal. In this disclosure, "sensor" refers to the entire device including a sensing element, housing and flexible line.

The term "folding" is used to denote an excessive bending of the cable beyond the recommended rate. As mentioned, a common rule of thumb for round cables is that the cable should not be bent more than three times its width. For other cable types (e.g. flat cables) other rules may apply.

"Electrical cable" means any type of insulated wire carrying electric signals, such as a 1,2,3-, or 4-conductor. It should be noted that the cable does not necessarily need to be an electrical cable. It would also be possible to use an optical cable, or any other type of flexible line carrying e.g. a gas or liquid. Therefore, the term "flexible line" or simply "line" is sometimes used in the description and claims in place of "electrical cable".

"Flange" refers to a protruding rim, edge or collar (in other words, not necessarily a *thin* edge) used to hold an object in place or attach it to another object.

"Sensing element" refers to the part of the sensor that detects a property of the environment. The sensing element can be embodied in various different ways, e.g. as a longitudinal probe, a strain gauge, a MEMS device, or using LEDs.

Brief description of the drawings

FIG. 1 is a view of a sensor according to the invention mounted to a surface structure;

FIG. 2 is a view, partly in section, of the sensor shown in FIG. 1;

FIG. 3 is a bottom view, partly in section, of the sensor shown in FIG. 1;

FIG. 4 is a bottom view of a sensor according to an embodiment of the invention;

FIG. 5 is a lateral view of the sensor shown in FIG. 4;

FIG. 6 is a lateral view of a sensor according to another embodiment of the invention, comprising a single-flanged groove and mounted by means of a threaded fitting; and

FIG. 7 shows a sensor according to yet another embodiment of the invention, compsiring a single-flanged groove and mounted by means of screws.

Modes for carrying out the invention

FIG. 1 shows a sensor 10 according to the invention mounted to a surface structure 50. The sensing element is not visible, as it extends out on the other side of the surface structure 10. The structure 50 constitutes the wall of a chamber or a space where measurement is to be performed, and could thus be for instance the bottom of a fuel tank, an oil tank, engine or any other type of chamber. An electrical cable (or flexible line) 40 comes out of an exit opening 26 and is guided by a peripheral recess or a groove 28 in the flange 24. The flexible line can be wound around the recess 28 to point in the desired direction. At the other end of the cable 40 there would normally be a connecting means (not shown) in the form of a standard connection plug or the like, so that the cable 40 can be connected to other electronic equipment which will perform further processing or respond to the measuring results. According to this embodiment, the sensor 10 is mounted to a surface 52 of the structure 50 by means of an internal hex nut 32.

FIG. 2 shows a partially sectioned view of the sensor 10 illustrated in FIG. 1 when it is in a non-mounted condition. The sensor 10 comprises a sensing element in the form of a longitudinal probe 12, a housing 20 with a flange 24, and the electrical cable 40 which exits the housing laterally into the peripheral groove 28. The upper part of the housing 20 is provided with a screw thread 22, which enables the housing 20 to be screwed tightly to the measuring chamber. Optionally, the sensor housing 20 may also contain electronic circuitry (not shown) for processing the signal from the probe 12. In order to protect such circuitry

from exposure to damp, dirt and the like the housing 20 can be sealed by filling it with an epoxy resin. This will further improve the toughness of the sensor 10 as the encased cable 40 becomes more resistant to pulling. Of course, other means of insulating the housing 20 are possible without departing from the spirit of the invention; for instance, the exit opening could be fitted with a rubber gasket.

FIG. 3 is a bottom view of the sensor 10 shown in FIG. 1 when mounted to a surface 52. As is apparent from FIG. 3, the cable 40 may be clamped to the surface 52 using any standard clamping means 42. Clamping may be necessary in order to tighten the cable 40 so that it stays snugly held within the groove 28. However, clamping is made significantly easier compared to prior art because the cable 40 is gently guided in the right direction without folding. In this embodiment, the exit opening 26 faces radially into the recess 28, so that the cable 40 exits at a right angle to the housing 20. To avoid folding the cable 40, the exit opening 26 widens into the recess 28.

FIG. 4 is a bottom view of a sensor 10 according to another embodiment of the invention. The sensor housing 20 has a snail shell-like shape so that the cable exit opening 26 faces tangentially into the groove 28. This represents yet another way to avoid folding of the cable. Note also that according to this embodiment, the flange 30 is formed as an external hex nut 30 for fastening the sensor 10 to a surface. The external hex nut configuration would be advantageous in very cramped environments, as the hex nut can be tightened from the side.

FIG. 5 is a lateral view of the sensor shown in FIG. 4. As can be seen, the cable 40 will exit the housing tangentially, enabling it to be easily wound inside the recess 28.

FIG. 6 is a lateral view of a sensor according to another embodiment of the invention. In this embodiment, the sensor housing 20 is equipped with a single-flanged groove 28'. The groove 28' is defined by the space between the flange 30 and the surface 52. In other words, the flexible line 40 will be held between the flange 30 and the surface 52, once the sensor has been fastened tightly to the surface 52. The sensor is mounted by means of a helical thread (or threaded fitting) 54.

FIG. 7 shows a sensor according to yet another embodiment of the invention. This embodiment is similar to that of FIG. 7 in that the sensor housing 20 comprises a single-flanged groove 28'. However, according to this embodiment the sensor is mounted to the surface 52 by means of two separate screws.

Obviously, other means of fastening the sensor to a surface are also conceivable, e.g. by means of o-rings. However, it should be noted that the inventive idea is particularly advantageous when a threaded fitting is used. This is because when the sensor is screwed onto a surface, there is no way to control exactly in which direction the exit opening will end

up. If the flexible line points in the wrong direction, it can easily be redirected by means of the groove 28.

Although the previous examples have all been directed to a sensor with a probe extending through an aperture in the surface into a measuring chamber, the skilled person will realize that the invention is equally applicable to a sensor performing measurements in the same chamber where it is mounted. Thus, the sensor may be mounted to a surface of a room or compartment, e.g. a ceiling, with the probe extending downward or laterally out from the housing into the same room or compartment. Of course, other types of sensing elements may be used. It follows that the sensing element can be located anywhere on the outside of the housing.

It should also be noted that the flange may be equipped with any other type of key handle in place of the external/internal hex nut mentioned, for example a Torx™ or slot.

It is evident that the shape of the housing and/or flange may vary significantly within the scope of the inventive idea. For instance, the housing could be round, oval, "snail shell-shaped" (as in FIG. 4) or possibly even hexagonal. For round cables, it is preferred that the diameter of the lateral flange is at least three times the cable diameter plus twice the depth of the recess to avoid bending. However, as mentioned above, other rules may apply for other cable types. It is well within the capabilities of the skilled person to arrive at a suitable bending rate for the cable type used, and thereby an appropriate flange diameter, by trial and error. As shown in FIG. 5, the flange 30 can be made as thin as the cable width, but obviously the flange could also be made thicker if desired (e.g. to accomodate electronic circuitry). If the flange is made thicker, the recess would preferably be positioned near the upper part of the flange, so that it will be in close proximity to the surface 52 when the sensor is mounted.

There are also no implied limitations to the shape of the recess or groove 28, other than that it needs to be wide and deep enough to securely hold the flexible line or cable 40 in place. Provided the housing is made large enough, the recess could conceivably spiral around the housing in several loops. This would provide the additional advantage of allowing the cable to be wound around the housing in more than one turn, picking up possible slack. The recess could also be made deeper or wider to fulfill the same purpose. If the recess is made deeper, the cable can be wound several turns, overlapping itself. If the recess is wider, the cable will instead spiral inside the groove, each new loop resting beside the previous one.

The exit opening 26 preferably extends through the housing facing tangentially into the recess 28. This will help directing the cable into the recess. However, the exit opening could also extend straight through the housing wall, causing the cable to face radially into the recess, although this solution is less optimal with regard to bending of the cable.

The foregoing detailed description is given primarily for clarity of understanding, and is not to be construed as unnecessarily limiting the scope of the invention. For instance, the invention is obviously not limited to use in connection with a fuel tank or even a vehicle, but is applicable to any situation where a robust, space-saving sensor is required. The flexible line or cable could be of any shape (e.g. round or flat) as long as the recess is shaped to accomodate it. Other modifications will become obvious to those skilled in the art upon reading this disclosure, and may be made without departing from the spirit of the invention or the scope of the appended claims.

Claims

1. A sensor (10) comprising:

a housing (20) to be mounted to a surface (52);

a sensing element (12) on the outside of said housing; and

a flexible line (40) operatively connected to said sensing element and extending through said housing;

characterized by said housing (20) comprising:

a lateral flange (24; 30) comprising a peripheral recess (28; 28') capable of retaining a portion of said line around said housing in close proximity to said surface; and

a lateral exit (26) for said line and opening into said recess.

2. The sensor according to claim 1, wherein said recess being a peripheral groove (28) in said flange (24; 30).

3. The sensor according to claim 1 or 2, wherein said recess being a single-flanged groove (28') in said flange (24; 30).

4. The sensor according to any of the preceding claims, wherein said exit (26) facing radially into the recess (28).

5. The sensor according to any of the preceding claims, wherein said exit (26) being widened into the recess (28).

6. The sensor according to any of claims 1-3, wherein said exit (26) facing tangentially into the recess (28).

7. The sensor according to any of the preceding claims, wherein said flange (24; 30) being formed with a key handle.

8. The sensor according to claim 7, wherein said key handle is embodied as an external or internal hex nut-like configuration, a torx™ or a slot.

9. The sensor according to any of the preceding claims, wherein the diameter of said lateral flange (24; 30) is at least three times the diameter of said flexible line (40) plus twice the depth of said recess (28).

10. The sensor according to any of the preceding claims, wherein said housing (20) being equipped with a threaded fitting (22) for mounting to said surface (52).

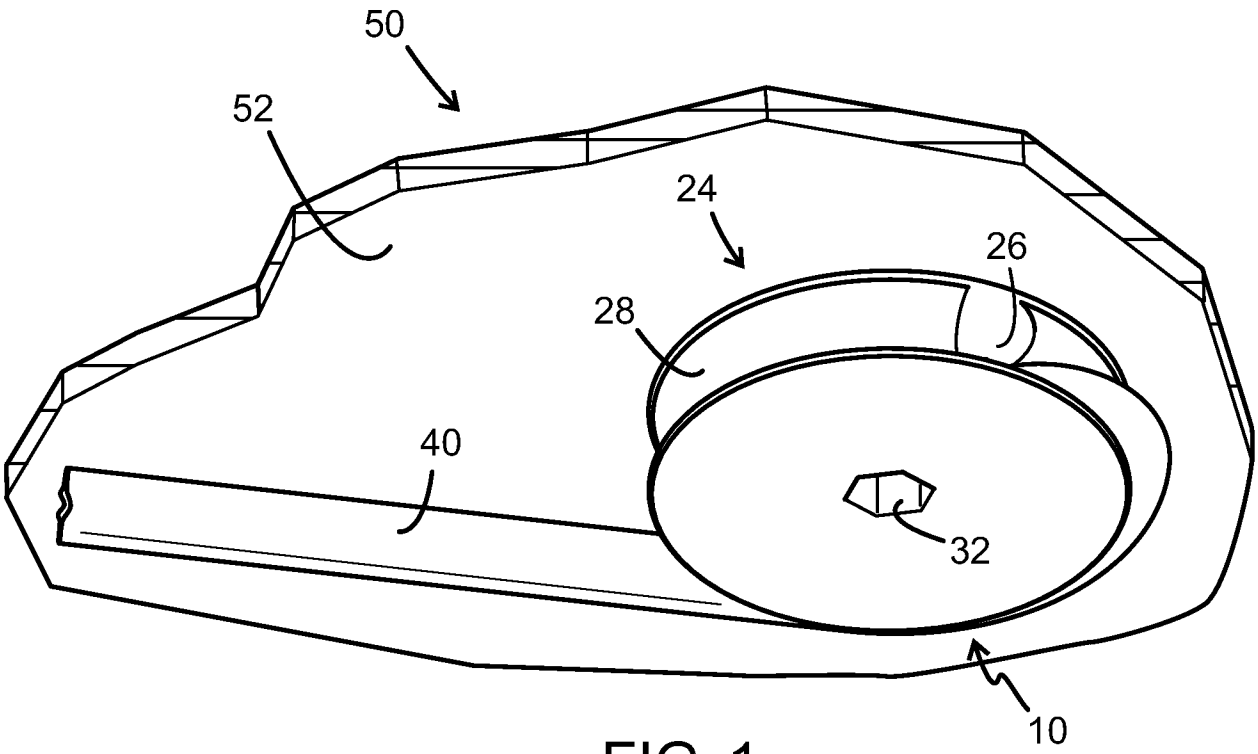

FIG. 1

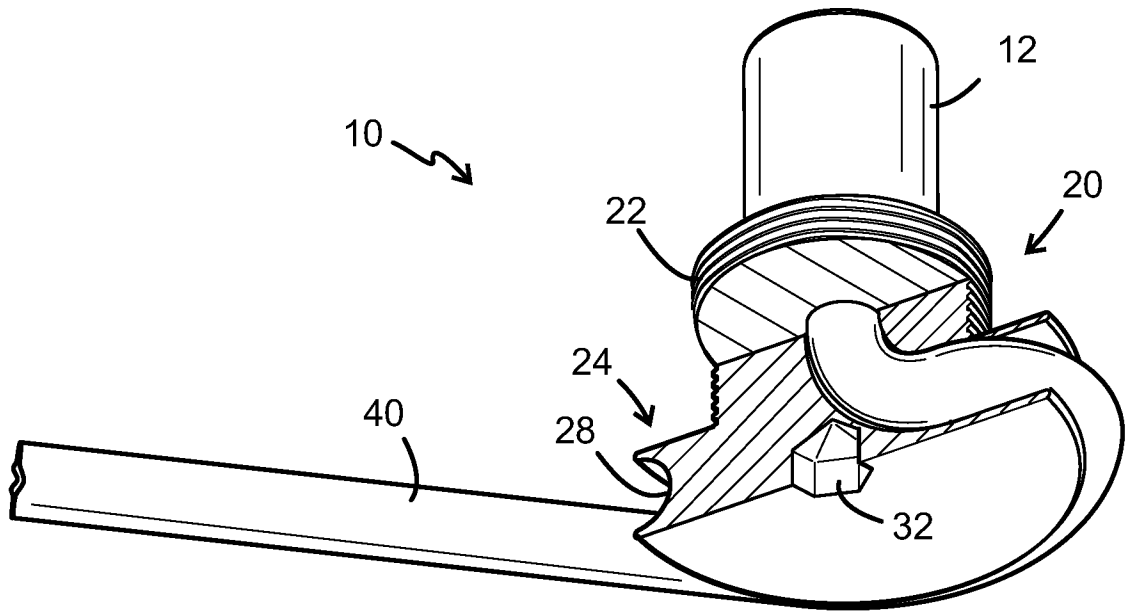

FIG. 2

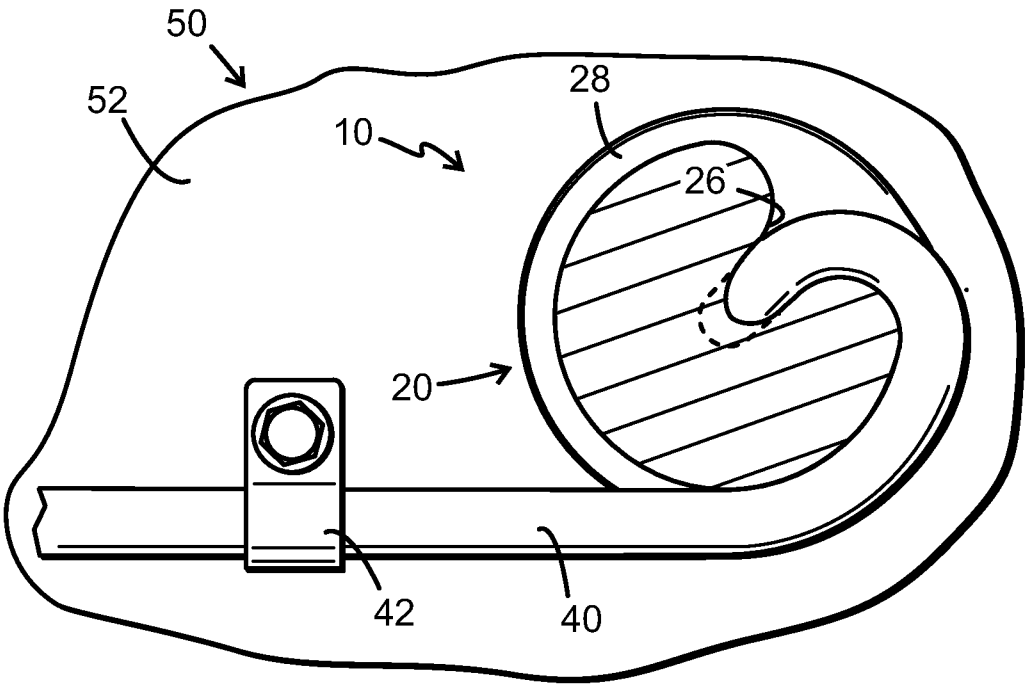

FIG. 3

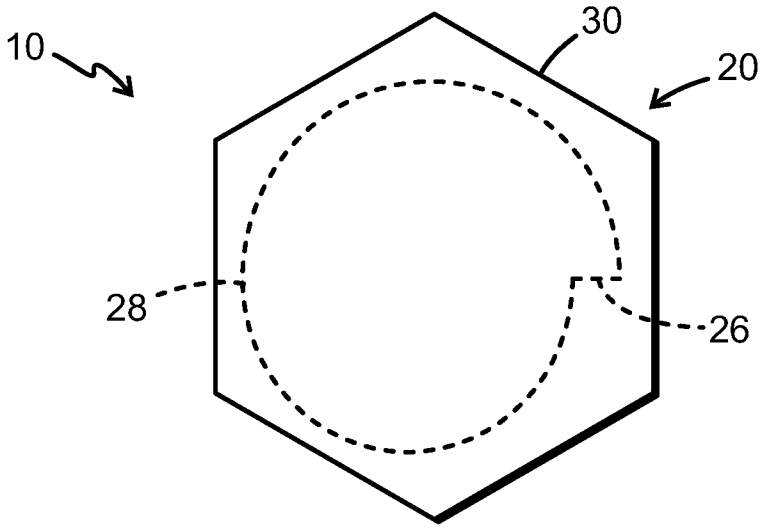

FIG. 4

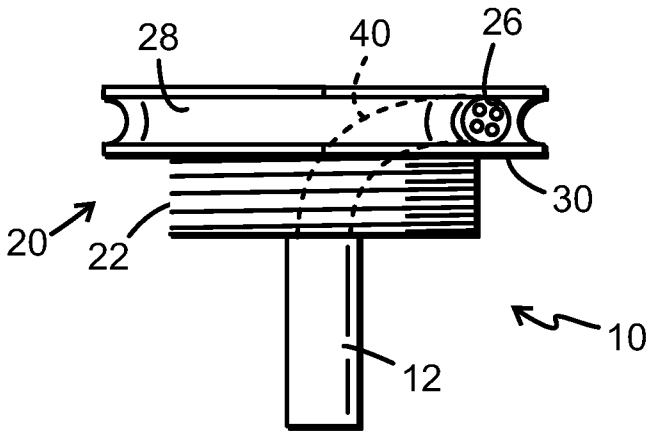

FIG. 5

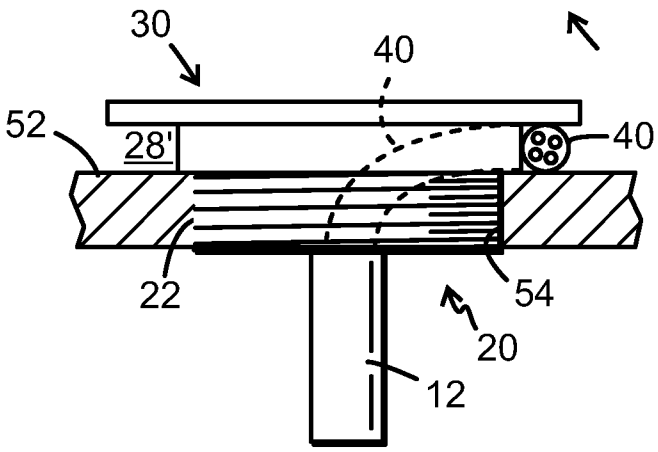

FIG. 6

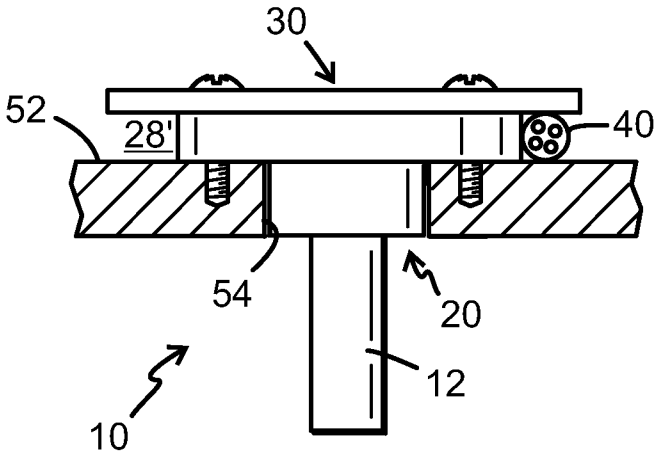

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2008/050265

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
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)

IPC: H02G, H01R, G01D

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 202004006211 U1 (PEPPER + FUCHS GMBH), 20 October 2005 (20.10.2005), paragraphs [0011]-[0017],fig.1-10,abstract --	1-10
A	DE 20218228 U1 (HENGSTLER GMBH), 13 May 2004 (13.05.2004), Fig.1-2.See the whole document, abstract --	1-10
A	US 4678867 A (J.A.BONGARD ET AL), 7 July 1987 (07.07.1987), figure 1, abstract --	1-10
A	US 4722695 A (W.ZWICKER ET AL), 2 February 1988 (02.02.1988), figure 3, abstract --	1-10

[X] Further documents are listed in the continuation of Box C. [X] 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
10 June 2008	11 -06- 2008
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Rune Bengtsson / itw Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2008/050265

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4802864 A (L,H.MICHAELS ET AL), 7 February 1989 (07.02.1989), figure 11, abstract -- --------	1-10

International patent classification (IPC)
G01D 11/24 (2006.01)
H01R 13/52 (2006.01)
H02G 15/007 (2006.01)
H01R 13/56 (2006.01)
H02G 15/013 (2006.01)

Download your patent documents at www.prv.se
The cited patent documents can be downloaded at www.prv.se by following the links:

- In English/Searches and advisory services/Cited documents (service in English) or
- e-tjänster/anförda dokument (service in Swedish).

Use the application number as username.
The password is **AUGBEGOYVN**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

DE	202004006211	U1	20/10/2005	NONE			
DE	20218228	U1	13/05/2004	NONE			
US	4678867	A	07/07/1987	DE	3725467	A	30/06/1988
				JP	63041100	A	22/02/1988
US	4722695	A	02/02/1988	DE	3446463	A,C	15/05/1986
US	4802864	A	07/02/1989	US	4758174	A	19/07/1988