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HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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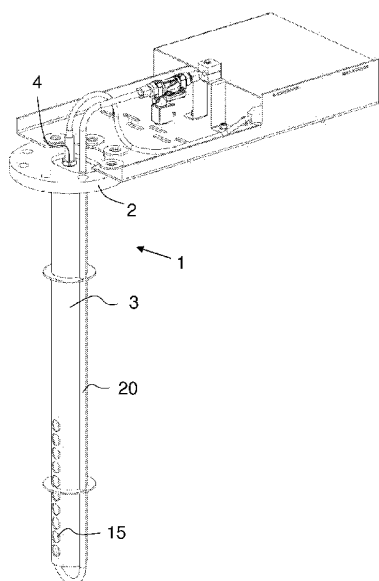


FIG. 2

(57) Abstract: The NO_x measurement device (1) for an internal combustion engine comprises a flange (2) for allowing attachment of the measurement device (1) to an exhaust system component (5, 6), a measurement pipe (3) having a first end and a second end, the first end being attached to the flange (2) and the second end being configured to receive exhaust gas, a NO_x-sensor (4), which is arranged at least partly inside the measurement pipe (3) at the first end of the measurement pipe (3), and a partition wall (16) that is parallel to the axial direction of the measurement pipe (3) and divides the measurement pipe (3) into an inlet side (17) and an outlet side (18).



NO_x measurement device**Technical field of the invention**

The present invention relates to a NO_x measurement device for an internal combustion engine in accordance with claim 1.

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Background of the invention

Due to continuously tightening regulations concerning nitrogen oxide (NO_x) emissions of internal combustion engines in ships and power plants, selective catalytic reduction (SCR) systems are becoming more and more common. In SCR systems, correct dosing of reducing agent, which is usually urea, is important for achieving effective NO_x reduction and for avoiding ammonia slip. To improve accuracy of the dosing of the reducing agent, an SCR system can be equipped with a NO_x-sensor that measures NO_x concentration downstream from SCR elements. A problem related to many NO_x measurement systems is that the lifetime of the sensor can be very limited in the harsh environment of the exhaust system.

Summary of the invention

An object of the present invention is to provide an improved NO_x measurement device for an internal combustion engine. The characterizing features of the measurement device according to the invention are given in claim 1.

The NO_x measurement device according to the invention comprises a flange for allowing attachment of the measurement device to an exhaust system component, a measurement pipe having a first end and a second end, the first end being attached to the flange and the second end being configured to receive exhaust gas, a NO_x-sensor, which is arranged at least partly inside the measurement pipe at the first end of the measurement pipe, and a partition wall that is parallel to the axial direction of the measurement pipe and divides the measurement pipe into an inlet side and an outlet side.

The measurement pipe protects the NO_x-sensor. Because the measurement pipe can be exposed to exhaust gas in the exhaust system, temperature of the

measurement pipe remains close to the exhaust gas temperature, which prevents condensation inside the measurement pipe and helps avoiding corrosion problems. The partition wall enhances exhaust gas flow inside the measurement pipe.

5 According to an embodiment of the invention, the NO_x-sensor is arranged concentrically with the measurement pipe.

10 According to an embodiment of the invention, the NO_x-sensor extends into the measurement pipe beyond the area delimited by the flange. The NO_x-sensor thus extends on that side of the flange that faces the exhaust gas stream in the exhaust system, which helps keeping the temperature of the NO_x-sensor high enough to avoid condensation on the surface of the sensor.

According to an embodiment of the invention, the outlet side is in fluid communication with the inlet side at the first end of the measurement pipe. The exhaust gas is thus arranged to flow on the inlet side from the second end to the first end of the measurement pipe and then on the outlet side back to the second end.

15 According to an embodiment of the invention, the wall of the measurement pipe is provided with one or more inlet openings that are arranged close to the second end for allowing exhaust gas flow into the measurement pipe. By arranging inlet openings in the wall of the measurement pipe, exhaust gas is effectively guided into the measurement pipe.

20 According to an embodiment of the invention, the wall of the measurement pipe is provided with one or more outlet openings that are arranged close to the second end for allowing discharging of exhaust gas from the measurement pipe. The outlet openings in the wall of the measurement pipe ensure effective discharging of the exhaust gas.

25 According to an embodiment of the invention, the measurement device comprises a purging pipe, which is connected to the measurement pipe for introducing pressurized air into the measurement pipe for protecting the NO_x-sensor from exhaust gas between NO_x measurements. The purging pipe is beneficial especially when fuel with high sulfur content is used.

30 According to an embodiment of the invention, the purging pipe is configured to introduce pressurized air into the measurement pipe through the wall of the measurement pipe.

According to an embodiment of the invention, the purging pipe is connected to the measurement pipe close to the first end of the measurement pipe.

According to an embodiment of the invention, the purging pipe is connected to the measurement pipe in an area that is located within a distance corresponding to one
5 fourth of the length of the measurement pipe from the flange.

According to an embodiment of the invention, the purging pipe extends outside the measurement pipe from the flange towards the second end of the measurement pipe at least a distance corresponding to half of the length of the measurement pipe for allowing heat transfer from exhaust gas to the pressurized air before the pres-
10 surized air is introduced into the measurement pipe. By using the exhaust gas to heat the purging air, the temperature of the measurement pipe can be kept high and condensation problems can be avoided.

According to an embodiment of the invention, the purging pipe forms a U-shaped loop extending around the second end of the measurement pipe. A long purging
15 pipe ensures effective heating of the purging air and the measurement pipe can be used for supporting the purging pipe.

An exhaust system according to the invention comprises a catalytic converter having one or more catalyst elements for selective catalytic reduction, and a NO_x measure-
20 ment device defined above, the measurement pipe of the measurement device being arranged to protrude into an exhaust duct or into the catalytic converter on the downstream side of the catalyst elements.

Brief description of the drawings

Embodiments of the invention are described below in more detail with reference to
25 the accompanying drawings, in which

Fig. 1 shows schematically an SCR system of an internal combustion engine,

Fig. 2 shows a NO_x measurement device according to an embodiment of the inven-
tion,

Fig. 3 shows another view of the NO_x measurement device of figure 2,

Fig. 4 shows an exploded view of the NO_x measurement device of figures 2 and 3, and

Fig. 5 shows a cross-sectional view of the NO_x measurement device figures 2 and 3.

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Description of embodiments of the invention

In figure 1 is shown a simplified illustration of a selective catalytic reduction (SCR) system of an internal combustion engine. The SCR system is suitable particularly for large piston engines, such as main or auxiliary engines of ships or engines that are used at power plants for producing electricity. The system comprises a catalytic converter 6 having three SCR elements 7. The SCR elements 7 are ceramic honeycomb structures that are coated with a catalyst material. Urea, which is used as the reducing agent, is injected into the exhaust gas flow upstream from the catalytic converter 6 through a reducing agent injector 12. The urea is stored in a tank 10 and a dosing pump 9 is used for delivering the correct amount of urea solution to the reducing agent injector 12. A control unit 11 is arranged to control the dosing pump 9. The urea injected into the exhaust system mixes with the exhaust gas and breaks up into ammonia and carbon dioxide due to the heat of the exhaust gas. On the surface of the SCR elements 7, ammonia molecules react with NO_x and form nitrogen and water. Inside the catalytic converter 6, downstream from the SCR elements 7 there is arranged an oxidation catalyst 8. The purpose of the oxidation catalyst 8 is to oxidize carbon monoxide and unburned hydrocarbons. Also at least part of the excess ammonia oxidizes forming mainly nitrogen oxides and water.

For monitoring the NO_x concentration of the exhaust gas after the selective catalytic reduction, a NO_x-sensor 4 has been arranged downstream from the catalytic converter 6. Since NO_x-sensors 4 are usually cross-sensitive to ammonia, it is also possible to locate the sensor 4 between the SCR elements 7 and the oxidation catalyst 8. The NO_x-sensor 4 is part of a NO_x measurement device 1. The NO_x measurement device comprises a flange 2 and a measurement pipe 3.

The NO_x measurement does not need to be continuous, but the NO_x concentration can be measured e.g. only when requested by the control unit 11. When the operating conditions of the engine change, the NO_x concentration of the exhaust gas can

be measured, and the amount of the reducing agent adjusted until correct dosing is achieved. After that, the measurements can be carried out at certain intervals.

Figures 2–5 show more detailed views of a NO_x measurement device 1 according to an embodiment of the invention. The measurement pipe 3 is attached to the flange 2 and protrudes perpendicularly outwards from the flange 2. In the embodiment of the figures, the flange 2 is circular and the measurement pipe 3 is arranged in the middle of the flange 2. The NO_x measurement device 1 can be arranged to measure NO_x concentration in an exhaust duct 5, as shown in figure 1. Alternatively, the NO_x measurement device 1 could be arranged to measure the NO_x concentration in a catalytic converter 6 on the downstream side of the catalyst elements 7. The flange 2 can be used for attaching the NO_x measurement device 1 to an exhaust system component, such as the exhaust duct 5 or the catalytic converter 6. The measurement pipe 3 has a first end and a second end. The first end is attached to the flange 2 and the second end is a free end. The measurement pipe 3 is configured to protrude into the exhaust duct 5 or into another exhaust system component, such as the catalytic converter 6. The whole measurement pipe 3 is thus exposed to the exhaust gas in the exhaust system. The second end of the measurement pipe 3 is configured to receive exhaust gas from exhaust gas stream in the exhaust system. The NO_x-sensor 4 is arranged at least partly inside the measurement pipe 3. At least one end of the NO_x-sensor 4 is thus inside the measurement pipe 3. The NO_x-sensor 4 is thus on that side of the flange 2 that faces the exhaust gas stream, i.e. on the measurement pipe side of the flange 2. This keeps the temperature of the NO_x-sensor 4 higher. The measurement pipe 3 is provided with a plurality of inlet openings 15, which are configured to allow exhaust gas flow into the measurement pipe 3. The inlet openings 15 are arranged in the wall of the measurement pipe 3 close to the second end of the measurement pipe 3. In the embodiment of the figures, the inlet openings 15 are arranged in a row in the axial direction of the measurement pipe 3. The inlet openings 15 are arranged on that half of the measurement pipe 3 that is farther from the flange 2.

The inner structure of the NO_x measurement device 1 can be seen in figure 4, which shows an exploded view of the NO_x measurement device 1 of figures 2 and 3, and in figure 5, which shows a cross-sectional view of the NO_x measurement device 1 of figures 2 and 3. The NO_x measurement device 1 comprises a partition wall 16, which is parallel to the axial direction of the measurement pipe 3 and divides the measurement pipe 3 into an inlet side 17 and an outlet side 18. The inlet side 17 and the outlet side 18 are of equal size. In the embodiment of the figures, the

partition wall 16 extends from the first end to the second end of the measurement pipe 3. However, the partition wall 16 could also be slightly shorter than the measurement pipe 3. In the embodiment of the figures, the NO_x measurement device 1 is provided with support elements 21, which are configured to support the partition wall 16 against the inner wall of the measurement pipe 3. The support elements 21 are sheet-like parts, which can be inserted through slots 27 that are formed in the partition wall 16. The partition wall 16 is further supported by means of an end plate 22, which also closes the second end of the measurement pipe 3. Instead of the support elements 21, other kind of means could be used for supporting the partition wall 16. For instance, the partition wall 16 could be cross-shaped and supported directly against the measurement pipe 3.

Exhaust gas enters the inlet side 17 of the measurement pipe 3 via the inlet openings 15. The exhaust gas flows on the inlet side 17 towards the first end of the measurement pipe 3. At the first end of the measurement pipe 3, the inlet side 17 is arranged in fluid communication with the outlet side 18. In the embodiment of figure 4, the partition wall 16 is provided with a cut-out 23 for establishing fluid communication between the inlet side 17 and the outlet side 18. Alternatively, the partition wall 16 could be slightly shorter than the measurement pipe 3 and arranged at a distance from the flange 2, or the partition wall 16 could be provided with one or more openings arranged close to the first end of the measurement pipe 3. At the first end of the measurement pipe 3, the exhaust gas passes the NO_x-sensor 4 and enters the outlet side 18 of the measurement pipe 3. The NO_x-sensor 4 is arranged concentrically with the center axis of the measurement pipe 3. The NO_x-sensor 4 is thus arranged between the inlet side 17 and the outlet side 18. On the outlet side 18 of the measurement pipe 3, the exhaust gas flows towards the second end of the measurement pipe 3 and exits via outlet openings 19. The outlet openings 19 are arranged in the wall of the measurement pipe 3 close to the second end in a similar way as the inlet openings 15. The outlet openings 19 are arranged on that half of the measurement pipe 3 that is farther from the flange 2. The NO_x measurement device 1 is arranged in the exhaust system so that the inlet openings 15 face the upstream side of the exhaust gas stream and the outlet openings 19 face the downstream side of the exhaust gas stream.

In the embodiment of the figures, the NO_x measurement device 1 comprises additional means for protecting the NO_x-sensor 4. The NO_x measurement device 1 shown in the figures can thus be used also in engines that are operated using fuels with high sulfur content. In the embodiment of the figures, the NO_x measurement

device 1 is provided with a purging pipe 20. The purging pipe 20 can be used for introducing pressurized air into the measurement pipe 3 between NO_x measurements. The NO_x-sensor 4 can thus be protected from the exhaust gas between the measurements, which increases the lifetime of the NO_x-sensor 4. In the embodiment of the figures, the purging pipe 20 is configured to introduce pressurized air into the measurement pipe 3 through the wall of the measurement pipe 3. The purging pipe 20 is connected to the measurement pipe 3 close to the first end of the measurement pipe 3. The purging pipe 20 is connected to the measurement pipe 3 in an area that is located within a distance corresponding to one fourth of the length of the measurement pipe 3 from the flange 2. The flange 2 is provided with an opening 24, through which the purging pipe 20 protrudes into the exhaust duct 5 or the catalytic converter 6.

The air is introduced through the purging pipe 20 into the measurement pipe 3 at a pressure that is higher than the pressure of the exhaust gas at the measurement point. This ensures that exhaust gas concentration in the measurement pipe 3 is effectively reduced or that the measurement pipe 3 can be even kept free of exhaust gas. The NO_x-sensor 4 is thus protected from the heat and impurities of the exhaust gas. The fresh air that is used for flushing the measurement pipe 3 also allows calibration of the NO_x-sensor 4. As shown in figure 1, the NO_x measurement system is provided with a control valve 13, which is used for controlling air flow from a pressure medium source 14 into the purging pipe 20. Before each NO_x measurement, the control valve 13 is closed, and exhaust gas can thus flow into the measurement pipe 3. After the measurement, the control valve 13 is opened and air injection into the measurement pipe 3 is continued until the next NO_x measurement. Instead of using a separate air tank 14, as in figure 1, the pressurized air could be instrument air that is also used for other control purposes in the engine, or alternatively charge air from the air intake duct of the engine downstream from the compressor of a turbocharger. The control unit 11 is arranged to control the NO_x-sensor 4 and the control valve 13. The control valve 13 can be, for instance, a solenoid valve.

The purging pipe 20 is not an essential feature of the invention, but the NO_x measurement device 1 could also be used without the purging pipe 20, especially if the engine is operated using only fuels with low sulfur content.

A problem with many prior art solutions has been that although the purging air can increase the lifetime of the NO_x-sensor 4, the NO_x-sensor 4 has been exposed to condensing exhaust gas because of a cold measurement pipe 3. If measurements

are carried out at long intervals and exhaust gas is prevented from flowing into the measurement pipe 3, the temperature of the measurement pipe 3 decreases. When exhaust gas is introduced into the measurement pipe 3, it can condense on the cold surfaces of the measurement pipe 3 and the NO_x-sensor 4. Especially when fuel
5 with high sulfur content is used, this shortens the lifetime of the NO_x-sensor 4, since sulfur acid can be formed.

For keeping the temperature of the measurement pipe 3 higher, the purging air is heated before introducing the air into the measurement pipe 3. During a NO_x measurement sequence, the surfaces of the measurement pipe 3 and the NO_x-sensor 4
10 are thus warmer than without heating, and condensation of exhaust gas is reduced or prevented. This increases the lifetime of the NO_x-sensor 4. For heating the purging air, the purging pipe 20 extends outside the measurement pipe 3 from the flange 2 towards the second end of the measurement pipe 3. The purging pipe 20 extends outwards from the flange 2 at least a distance corresponding half of the length of
15 the measurement pipe 3. The purging pipe 20 thus comprises a section that is exposed to the exhaust gas in the exhaust system. Heat transfer from the exhaust gas to the purging air is thus allowed, and the temperature of the purging air rises as the air flows from the flange 2 to the measurement pipe 3. In the embodiment of the figures, the purging pipe 20 forms a U-shaped loop extending around the second
20 end of the measurement pipe 3. The purging air thus travels a relatively long distance in the exhaust duct before being introduced into the measurement pipe 3. In the embodiment of the figures, the NO_x measurement device 1 is provided with fixing rings 25, which are used for supporting the purging pipe 20. The fixing rings 25 are configured to fit on the outer surface of the measurement pipe 3. Two notches 26
25 are arranged on the inner perimeter of each fixing ring 25. The notches 25 are configured to accommodate the purging pipe 20, which is clamped between the measurement pipe 3 and the fixing rings 25.

It will be appreciated by a person skilled in the art that the invention is not limited to the embodiments described above, but may vary within the scope of the appended
30 claims.

Claims

1. A NO_x measurement device (1) for an internal combustion engine, the measurement device (1) comprising
 - a flange (2) for allowing attachment of the measurement device (1) to an exhaust system component (5, 6),
 - a measurement pipe (3) having a first end and a second end, the first end being attached to the flange (2) and the second end being configured to receive exhaust gas,
 - a NO_x-sensor (4), which is arranged at least partly inside the measurement pipe (3) at the first end of the measurement pipe (3), and
 - a partition wall (16) that is parallel to the axial direction of the measurement pipe (3) and divides the measurement pipe (3) into an inlet side (17) and an outlet side (18).
2. A measurement device (1) according to claim 1, wherein the outlet side (18) of the measurement pipe (3) is in fluid communication with the inlet side (17) at the first end of the measurement pipe (3).
3. A measurement device (1) according to claim 1 or 2, wherein the NO_x-sensor (4) is arranged concentrically with the measurement pipe (3).
4. A measurement device (1) according to any of claims 1–3, wherein the NO_x-sensor (4) extends into the measurement pipe (3) beyond the area delimited by the flange (2).
5. A measurement device (1) according to any of the preceding claims, wherein the wall of the measurement pipe (3) is provided with one or more inlet openings (15) that are arranged close to the second end for allowing exhaust gas flow into the measurement pipe (3).
6. A measurement device (1) according to any of the preceding claims, wherein the wall of the measurement pipe (3) is provided with one or more outlet openings (19) that are arranged close to the second end for allowing discharging of exhaust gas from the measurement pipe (3).
7. A measurement device (1) according to any of the preceding claims, wherein the measurement device (1) comprises a purging pipe (20), which is connected to the measurement pipe (3) for introducing pressurized air into the measurement pipe (3) for protecting the NO_x-sensor (4) from exhaust gas between NO_x measurements.

8. A measurement device (1) according to claim 7, wherein the purging pipe (20) is configured to introduce pressurized air into the measurement pipe (3) through the wall of the measurement pipe (3).

5 9. A measurement device (1) according to claim 8, wherein the purging pipe (20) is connected to the measurement pipe (3) close to the first end of the measurement pipe (3).

10 10. A measurement device (1) according to claim 8 or 9, wherein the purging pipe (20) is connected to the measurement pipe (3) in an area that is located within a distance corresponding to one fourth of the length of the measurement pipe (3) from the flange (2).

15 11. A measurement device (1) according to any of claims 7–10, wherein the purging pipe (20) extends outside the measurement pipe (3) from the flange (2) towards the second end of the measurement pipe (3) at least a distance corresponding to half of the length of the measurement pipe (3) for allowing heat transfer from exhaust gas to the pressurized air before the pressurized air is introduced into the measurement pipe (3).

12. A measurement device (1) according to claim 11, wherein the purging pipe (20) forms a U-shaped loop extending around the second end of the measurement pipe (3).

20 13. An exhaust system for an internal combustion engine, the exhaust system comprising a catalytic converter (6) having one or more catalyst elements (7) for selective catalytic reduction, and a NO_x measurement device (1) according to any of the preceding claims, wherein the measurement pipe (3) of the measurement device (1) is arranged to protrude into an exhaust duct (5) or into the catalytic converter (6) on the downstream side of the catalyst elements (7).
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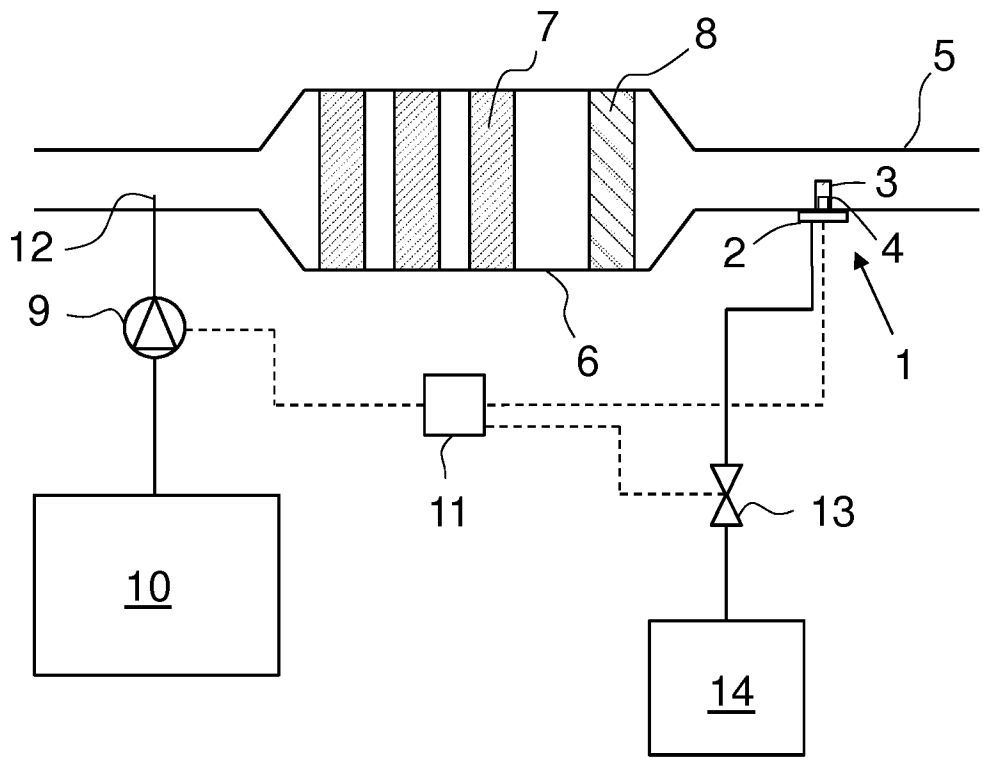


FIG. 1

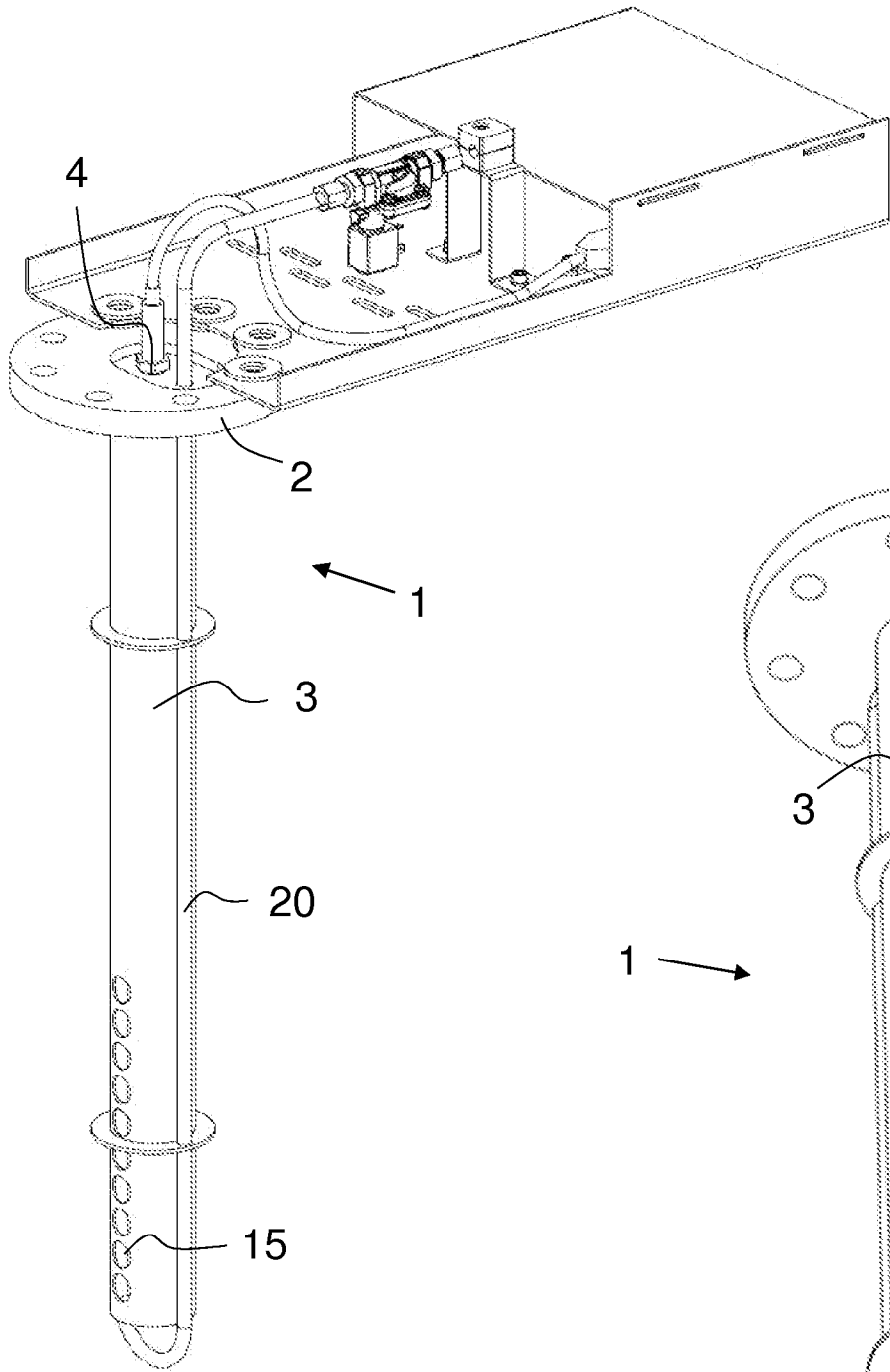


FIG. 2

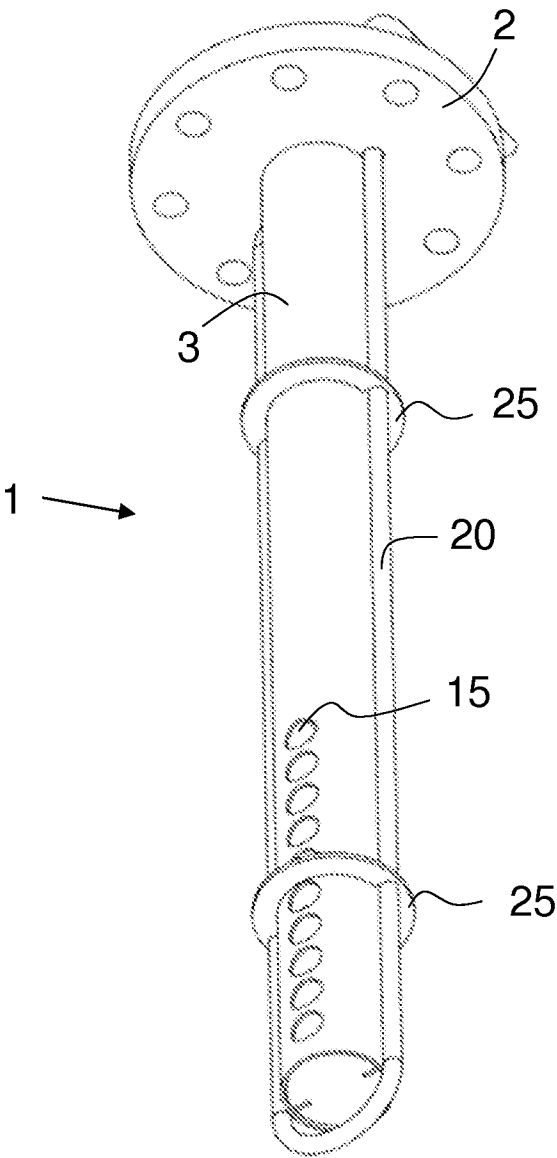
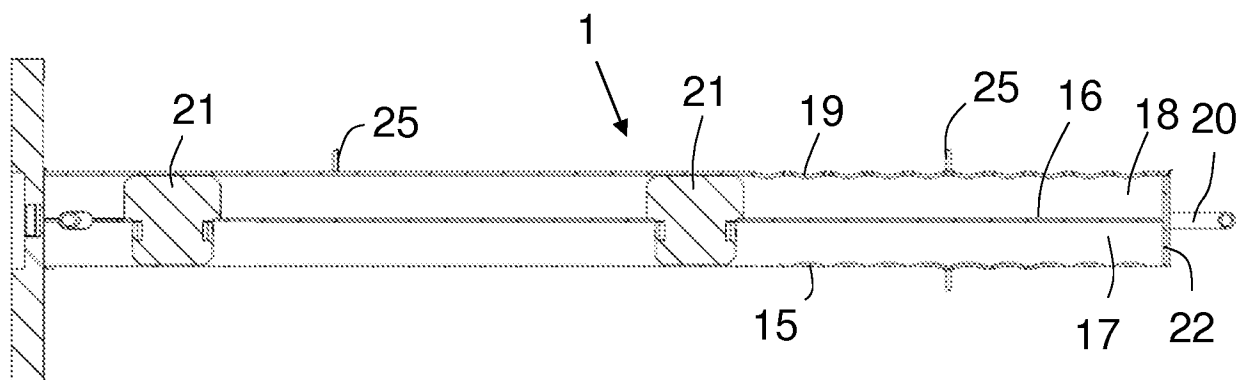
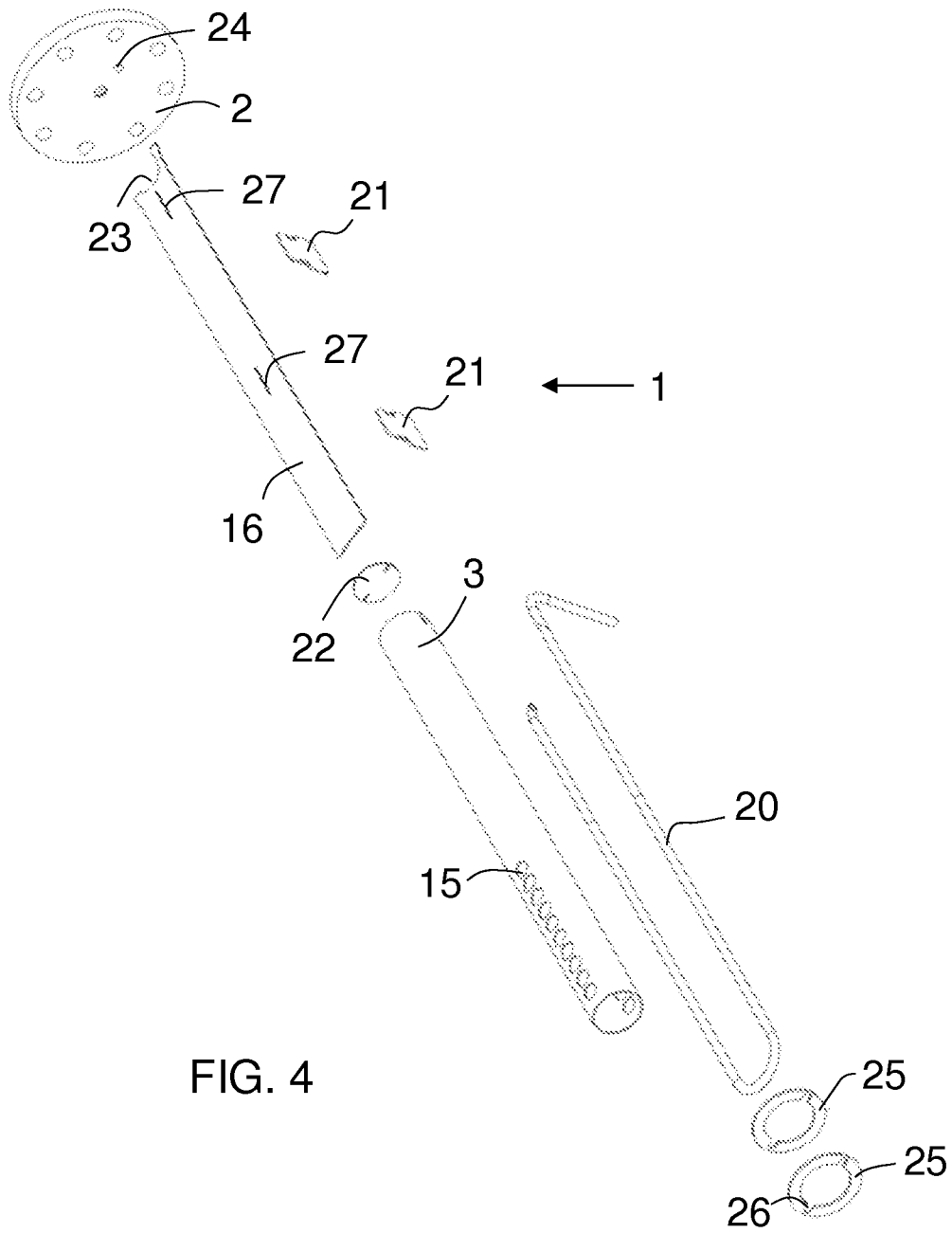


FIG. 3

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INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
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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)
F01N F02D

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.
X	DE 10 2010 046851 A1 (SCANIA CV AB [SE]) 29 March 2012 (2012-03-29)	1-6,13
Y	figure 3	7-12
A	DE 102 03 310 A1 (DAIMLER CHRYSLER AG [DE]) 31 July 2003 (2003-07-31) figures 1-6	1-13
A	WO 2015/044256 A1 (AVL LIST GMBH [AT]) 2 April 2015 (2015-04-02) figure 2	1-13
A	WO 2013/165296 A1 (SCANIA CV AB [SE]) 7 November 2013 (2013-11-07) figures 1-5	1-13
	----- -/-	



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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 2 161 569 A2 (DEUTZ AG [DE]) 10 March 2010 (2010-03-10) figure 3	7-12
Y	----- WO 2014/162049 A1 (WÄRTSILÄ FINLAND OY [FI]) 9 October 2014 (2014-10-09) figures 1-3 -----	7-12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/FI2018/050092

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102010046851 A1	29-03-2012	NONE	
DE 10203310 A1	31-07-2003	DE 10203310 A1	31-07-2003
		US 2003172741 A1	18-09-2003
WO 2015044256 A1	02-04-2015	AT 513007 A2	15-12-2013
		DE 112014004412 A5	16-06-2016
		WO 2015044256 A1	02-04-2015
WO 2013165296 A1	07-11-2013	BR 112014026382 A2	27-06-2017
		CN 104271913 A	07-01-2015
		EP 2893165 A1	15-07-2015
		KR 20150015494 A	10-02-2015
		SE 1250447 A1	05-11-2013
		US 2015122002 A1	07-05-2015
		WO 2013165296 A1	07-11-2013
EP 2161569 A2	10-03-2010	DE 102008046121 A1	11-03-2010
		EP 2161569 A2	10-03-2010
WO 2014162049 A1	09-10-2014	CN 105050693 A	11-11-2015
		EP 2981346 A1	10-02-2016
		KR 20150137112 A	08-12-2015
		WO 2014162049 A1	09-10-2014