



(11) **EP 4 249 804 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
27.09.2023 Bulletin 2023/39

(51) International Patent Classification (IPC):
F23N 5/24 (2006.01)

(21) Application number: **22163961.0**

(52) Cooperative Patent Classification (CPC):
F23N 5/242; F23N 2231/18

(22) Date of filing: **24.03.2022**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **WOUDSTRA, Jelmer**
7332 BD Apeldorn (NL)
• **RUTGERS, Job**
7332 BD Apeldorn (NL)

(74) Representative: **Denнемeyer & Associates S.A.**
Postfach 70 04 25
81304 München (DE)

(71) Applicant: **BDR Thermea Group B.V.**
7332 BD Apeldoorn (NL)

(54) **GAS DETECTION METHOD FOR A GAS BOILER**

(57) Gas leakage detection method (100) for at least one combustion appliance (1), in particular a gas boiler, the method (100) comprising: determining (S101) a predicted gas consumption of the combustion appliance (1) based on the operation of said combustion appliance (1); acquiring (S102) gas measuring data based on the measurement of the quantity of combustion gas to be supplied to the combustion appliance (1); and determining (S103) the presence of a gas leakage based on the comparison between the gas measuring data and the predicted gas consumption of the combustion appliance (1).

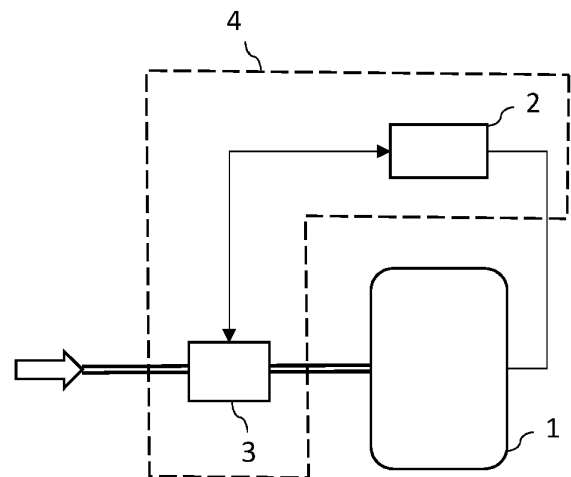


FIG. 2A

Description

[0001] The invention relates to a gas detection method for a combustion appliance, in particular a gas boiler. Also, the invention relates to a computer program product executed by a computer carrying out the above method, a data processing apparatus comprising a processor for executing said computer program product, a computer readable data carrier having stored thereon the computer program product, and a data carrier signal carrying the computer program product. In addition, the invention relates to a system for detecting a gas leakage for at least one combustion appliance, in particular a gas boiler and to a combustion appliance comprising means for carrying out the method and/or said system. Also, the invention relates to a use of the computer program, or the data processing apparatus, or the system for the detection of a gas leakage for at least one combustion appliance, in particular in a gas boiler.

[0002] Combustion appliances such as gas boilers combust gaseous fuel to heat water for domestic use and/or central heating system facilities in buildings. A gas leak in or outside the appliance, both considering the combustible fuel gas or the exhaust flue gas, can be very dangerous. For this reason, gas leakage detection systems using dedicated gas leakage sensors have been developed.

[0003] However, the gas detection systems known in the art are not always efficient. For example, if the gas leakage sensor is located far away from the leakage, the corresponding gas detection can be extremely delayed or cannot occur at all. In addition, based on the type of the sensor, only specific types of gases can be detected and only within a predefined measurement thresholds. Accordingly, these systems are not suitable for detecting relatively small gas leakage over time and for detecting different types of gases at the same time.

[0004] It is therefore desirable to obtain an efficient and cost-effective method for detecting a gas leakage in a combustion appliance independent from the need of having a dedicated gas leakage sensor. Also, it is desirable to obtain a method for detecting relatively small gas leakage rates over time. In addition, it is desirable to obtain a method for detecting leak rates in combustion appliances combusting different types of combustion gases.

[0005] The object is solved by a gas leakage detection method for at least one combustion appliance, in particular a gas boiler, the method comprising:

determining a predicted gas consumption of the combustion appliance based on the operation of said combustion appliance;
acquiring gas measuring data based on the measurement of the quantity of combustion gas to be supplied to the combustion appliance; and
determining the presence of a gas leakage based on the comparison between the gas measuring data and the predicted gas consumption of the combus-

tion appliance.

[0006] In this way, it is possible to detect a gas leakage even if no dedicated gas sensor is present or if the gas sensor is malfunctioning. Most importantly, the leakage can be promptly detected independent from the source of the leakage (e.g. inside or outside the combustion appliance). Also, it is possible to detect relatively small gas leakage rates over time, independent from a measurement threshold of an individual leakage sensor and can be detected the leakage of different types of gases. For example, the inventive method can be used to detect leak rates in an installation as a result of switching from natural gas to hydrogen.

[0007] The measured gas can be a gas mixture that is supplied to the combustion application. The gas mixture comprises air and combustion gas. Alternatively the measured gas can correspond to the combustion gas.

[0008] In one example, the presence of the gas leakage is determined if a consumption deviation based on the difference between the gas measuring data and the predicted gas consumption of the combustion appliance is greater than a leakage threshold, and/or if the quantity of combustion gas to be supplied to the gas consuming appliance increases over a reference period of time, when the combustion appliance is not operating. In fact, in case the measured gas is higher than the gas assumed to be consumed by the combustion appliance, it is evident that a gas leakage is present. In a similar way, a suddenly increase of the measured gas over short periods of time is a hint of a leak. Once determined the presence of a gas leakage, a detailed investigation of the combustion appliance can be carried out in order to find out the leak source.

[0009] In another example, the method comprises determining whether the combustion gas is supplied to a single combustion appliance or to a plurality of combustion appliances. In this way, it is excluded that difference between the measured gas and the predicted gas consumption of a combustion appliance is due to the presence of another gas consuming appliance present in the heating system.

[0010] In particular, the determination of the presence of a single combustion appliance or a plurality of combustion appliances is carried out by monitoring the gas consumption over a predefined monitoring period of time, in particular more than one day, more in particular between one day and sixty days, and/or by setting a parameter in the control unit.

[0011] In a further example, the predicted gas consumption is determined based on the operation of a fan element, in particular the rotational velocity of the fan element, and/or based on sensor data, in particular gas flow sensor data.

[0012] According to an example, the quantity of combustion gas to be supplied to the combustion appliance is measured using a digital flow meter or an analogic flow meter combined with a reading sensor, in particular an

optical sensor.

[0013] Advantageously, in order to constantly monitoring the gas consumption, the gas measuring data are acquired periodically, in particular every 15 minutes.

[0014] In one example, the method can furthermore comprise the step of monitoring a gas pressure in the combustion appliance over time by a pressure sensor. If a pressure decrease over time is detected, then the combustion appliance can be turned off, and/or a gas valve can be closed, and/or an information message can be sent to a user.

[0015] After determining the presence of a gas leakage, the method can additionally comprise: sending an alarm message to a user, and/or stopping or locking the combustion appliance. In this way, a more dangerous situation is prevented and a user (e.g. installer or technician) can be promptly informed of the leakage. Advantageously, after determining the presence of a gas leakage, the method further comprises sending information data to a terminal or to a cloud platform.

[0016] In another example, the method can further comprise acquiring temperature data by a thermostat and combining said temperature data with the gas measuring data. In this way, it is possible to eventually predict energy labels of the combustion appliance.

[0017] According to one aspect of the invention, a computer program product is provided. This product comprises instructions which, when the program is executed by a computer or control unit, cause the computer or the control unit to carry out the inventive method.

[0018] In a further aspect of the invention, a data processing apparatus is provided. This data processing apparatus comprises a processor for executing the inventive computer program product. Also, a computer readable data carrier is provided, the carrier having stored thereon the inventive computer program product. In addition, data carrier signal is provided, the signal carrying the computer program product.

[0019] According to a further aspect of the invention, a system for detecting a gas leakage for at least one combustion appliance, in particular a gas boiler, is provided. The system comprises a control unit for determining a predicted gas consumption of the combustion appliance based on the operation of said combustion appliance, and at least a flow meter for measuring the quantity of combustion gas to be supplied to the combustion appliance and generating gas measuring data, wherein the control unit is configured to determine the presence of a gas leakage, based on the comparison between the gas measuring data and the predicted gas consumption of the combustion appliance.

[0020] In this way, a communication between the flow meter and the combustion appliance can be established through the control unit, thereby eventually realizing a smart Internet of Things system. Such a system can detect even the lowest leak rates over time, even in periods when the combustion appliance is not running. Additionally, it is possible to recommend the customer to improve

the installation by sending dedicated alert messages. In particular, the system can be connected to Internet so that the control unit or the combustion appliance can send data to a cloud platform offering the possibility to combine this feature with several other features.

[0021] According to one aspect of the invention, a combustion appliance, in particular a gas boiler, is provided, the combustion appliance comprising means for carrying out the inventive method and/or comprising the inventive system. Examples of combustion appliances can include furnaces, water heaters, boilers, direct/in-direct make-up air heaters, power/jet burners and any other residential, commercial or industrial combustion appliance.

[0022] The combustion gas can be a natural gas, methane, ethylene, propane, butane, coal gas, biogas etc., mixtures of the same, and mixtures of the same additionally comprising hydrogen or hydrogen, in particular pure hydrogen. Pure hydrogen is present if the fuel gas has a at least 98 vol% of hydrogen. In particular, the appliance including the present system can be a gas boiler for the combustion of hydrogen gas. In this case, it is intended a fuel gas that comprises at least 20 mol%, in particular 90%, hydrogen or natural gas or mixtures thereof.

[0023] In another aspect of the invention, the use of the inventive computer program product or of the inventive system is provided. The use is suitable for the detection of a gas leakage for at least one combustion appliance, in particular a gas boiler and more in particular a gas boiler using a fuel gas having at least 20% hydrogen or natural gas.

[0024] In the figures, the subject-matter of the invention is schematically shown, wherein identical or similarly acting elements are usually provided with the same reference signs.

Figure 1 shows a flow chart of a method for gas leakage detection according to an embodiment,

Figure 2A show a schematic representation of a gas detection system according to another embodiment that has only one gas boiler,

Figure 2B show a schematic representation of a gas detection system according to a further embodiment that has two gas boilers.

[0025] With reference to figure 1, a flow chart describing a method 100 for detecting a gas leakage in a combustion appliance 1 is shown. Based on the operation of the combustion appliance 1, the method 100 comprises a prediction of the gas consumption at step S101. This can be carried out by a control unit 2 of the combustion appliance 1 shown in fig. 2A and 2B. A step S102, the method 100 comprises reading and logging gas measuring data. In particular, the quantity of combustion gas, i.e. the volume of gas, supplied to the combustion appliance 1, is measured. This is done by the measurements of a gas meter. The gas measuring data are compared

to the gas consumption prediction made by the control unit 2 to determine the presence of a gas leakage at step S103. Steps S101 and 102 can be performed at the same time.

[0026] At step S106, the method 100 can determine whether or not the combustion appliance 1 is the only gas consumer after the gas meter. An algorithm incorporated in the control unit 2 can determine if more consumers are installed by monitoring gas consumption over longer periods of time. For example, a couple of days or even months can be required to assess this information. Alternatively the installer or end user can set a parameter in the control unit 2 that no other gas consumers are installed, or that other gas consumers are installed (optionally including type of products). This method step can be extremely useful in order to exclude that a deviation between the gas supplied and the gas consumed is indeed due to the presence of a plurality of gas consuming appliances connected to the same gas source.

[0027] By reading the signal from the gas meter on a frequent basis (e.g. every 10-20 minutes, in particular every 15 minutes), it is possible to determine if the gas consumption suddenly increases over shorter periods of time while the combustion appliance is not used, or if the consumption exceeds the consumption of the appliance. Accordingly, once the presence of a gas leakage is determined, at step S104 the method 100 can send an alarm message to a user by the control unit 2 that the installation should be checked. In alternative or additionally, at step S105 the method 100 can turn off (stop or lock) the combustion appliance 1. In this way, dangerous situations can be promptly avoided.

[0028] Figures 2A and 2B illustrate a system 4 for detecting a gas leakage for at least one combustion appliance 1, for example a gas boiler. In particular, the system 4 comprises a control unit 2 for determining a predicted gas consumption of the gas boiler 1 based on the operation of said gas boiler 1. According to figure 2A and 2B, the control unit 2 is outside the boiler 1 and is directly connected to the boiler 1 to predict the gas consumption of the boiler 1 based on the operative characteristics of said boiler 1. It is clear, however, that the control unit 2 can also be integrated in the boiler 1. The prediction of gas consumption can be calculated by monitoring for example the speed of a fan element or by using a flow sensor or other dedicated sensors.

[0029] The system 4 also comprises a flow meter 3, for example a gas meter, for measuring the quantity of combustion gas to be supplied to the boiler 1. The gas meter 3 is located between the gas boiler 1 and a gas source (indicated with an horizontal arrow in the figure) supplying the gas boiler 1. Figure 2A shows an example where only one gas boiler 1 is supplied by the gas source, whereas figure 2B shows an example where two gas boilers 1 are supplied by the gas source. The gas measuring data can be acquired by a smart gas meter, in particular via a P1 port or online, or by an analogic gas meter adding a for example an optical sensor for reading the

data.

[0030] It is noted that the gas meter 3 communicates with the control unit 2 and then with the gas boiler 1 so that the control unit 2 is configured to determine the presence of a gas leakage, based on the comparison between the gas measuring data and the predicted gas consumption of the boiler 1. A gas leakage can be detected if the gas boiler 1 and/or the other gas devices 1 are not used for longer periods of time (e.g. overnight, holidays, etc.), while the gas meter 3 measures gas consumption during this period of time. Additionally, a gas leakage can be detected if the gas meter 3 measures a significantly higher gas consumption than expected.

[0031] Using the here described gas leakage detection system 4, it is possible to detect low leak rates over time, thereby leading to a less environmental impact and to lower gas consumption costs for the end-user.

Reference Signs

[0032]

1	Combustion appliance
2	Control unit
3	Flow meter
4	System
100	Method

Claims

1. Gas leakage detection method (100) for at least one combustion appliance (1), in particular a gas boiler, the method (100) comprising:

determining (S101) a predicted gas consumption of the combustion appliance (1) based on the operation of said combustion appliance (1); acquiring (S102) gas measuring data based on the measurement of the quantity of combustion gas to be supplied to the combustion appliance (1); and determining (S103) the presence of a gas leakage based on the comparison between the gas measuring data and the predicted gas consumption of the combustion appliance (1).

2. Method (100) according to claim 1, **characterized in that** the presence of the gas leakage is determined if:

- a. a consumption deviation based on the difference between the gas measuring data and the predicted gas consumption of the combustion appliance (1) is greater than a leakage threshold; and/or
- b. the quantity of combustion gas to be supplied to the gas consuming appliance (1) increases

- over a reference period of time, when the combustion appliance (1) is not operating.
3. Method (100) according to any one of claims 1 to 2, **characterized in that** the method (100) further comprises:
determining (S106) whether the combustion gas is supplied to a single combustion appliance (1) or to a plurality of combustion appliances (1).
 4. Method (100) according to claim 3, **characterized in that** the determination of the presence of a single combustion appliance (1) or a plurality of combustion appliances (1) is carried out by:
 - a. monitoring the gas consumption over a pre-defined monitoring period of time, in particular more than one day, more in particular between one day and sixty days; and/or
 - b. setting a parameter in the control unit.
 5. Method (100) according to any one of claims 1 to 4, **characterized in that** the predicted gas consumption is determined based on:
 - a. the operation of a fan element, in particular the rotational velocity of the fan element; and/or
 - b. sensor data, in particular gas flow sensor data.
 6. Method (100) according to any one of claims 1 to 5, **characterized in that**,
 - a. the quantity of combustion gas to be supplied to the combustion appliance (1) is measured using a digital flow meter or an analogic flow meter combined with a reading sensor, in particular an optical sensor; and/or
 - b. the gas measuring data are acquired periodically, in particular every 15 minutes.
 7. Method (100) according to any one of claims 1 to 6, **characterized in that**, the method comprises monitoring a gas pressure in the combustion appliance (1) over time by a pressure sensor, wherein if a pressure decrease over time is detected:
 - a. the combustion appliance (1) is turned off; and/or
 - b. a gas valve is closed; and/or
 - c. an information message is sent to a user.
 8. Method (100) according to any one of claims 1 to 7, **characterized in that**, after determining (S103) the presence of a gas leakage, the method (100) comprises:
 - a. sending (S104) an alarm message to a user;
 - and/or
 - b. stopping or locking (S105) the combustion appliance (1).
 9. Method (100) according to any one of claims 1 to 8, **characterized in that**, after determining (S103) the presence of a gas leakage, the method (100) further comprises sending information data to a terminal or to a cloud platform.
 10. Method (100) according to any one of claims 1 to 9, **characterized in that**, the method (100) further comprises acquiring temperature data by a thermostat and combining said temperature data with the gas measuring data for predicting energy labels of the combustion appliance (1).
 11. Computer program product comprising instructions which, when the program is executed by a computer or control unit (2), cause the computer or the control unit (2) to carry out the method (100) according to one of the claims 1 to 10.
 12. Data processing apparatus comprising a processor for executing the computer program product of claim 11, or computer readable data carrier having stored thereon the computer program product of claim 11, or data carrier signal carrying the computer program product of claim 11.
 13. System (4) for detecting a gas leakage for at least one combustion appliance (1), in particular a gas boiler, the system (4) comprising:
 - a control unit (2) for determining a predicted gas consumption of the combustion appliance (1) based on the operation of said combustion appliance (1); and
 - at least a flow meter (3) for measuring the quantity of combustion gas to be supplied to the combustion appliance and generating gas measuring data,
 wherein the control unit (2) is configured to determine the presence of a gas leakage, based on the comparison between the gas measuring data and the predicted gas consumption of the combustion appliance (1).
 14. Combustion appliance (1), in particular a gas boiler, comprising means for carrying out the method (100) according to one of the claims 1 to 10 and/or comprising the system (4) of claim 13, wherein in particular the combustion appliance (1) uses a fuel gas having at least 20 mol% hydrogen or natural gas.
 15. Use of the computer program product according to claim 11 or of the system (4) according to claim 13 for the detection of a gas leakage for at least one

combustion appliance (1), in particular a gas boiler
and more in particular a gas boiler using a fuel gas
having at least 20 mol% hydrogen or natural gas.

5

10

15

20

25

30

35

40

45

50

55

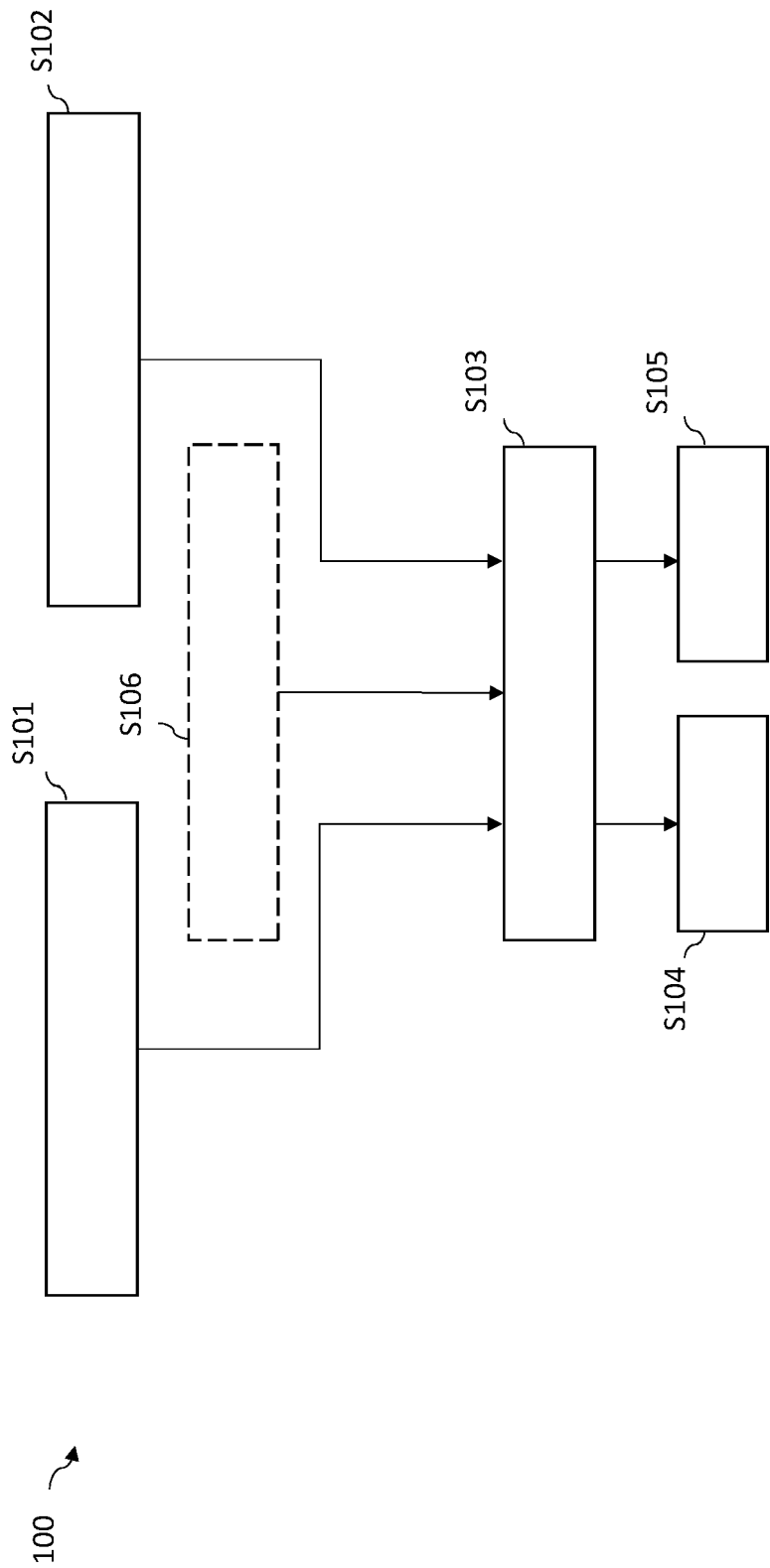


FIG. 1

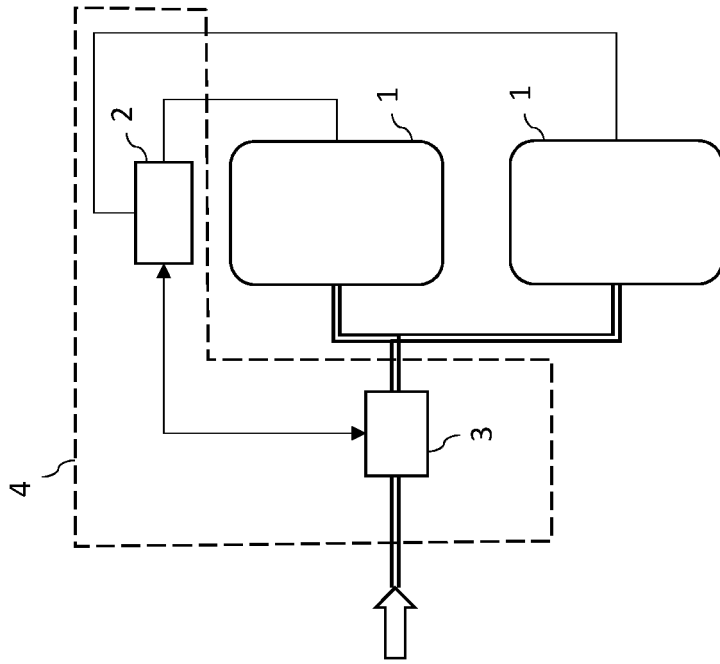


FIG. 2B

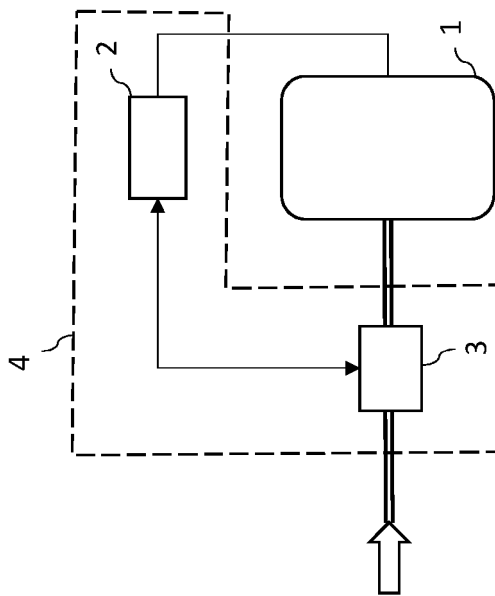


FIG. 2A



EUROPEAN SEARCH REPORT

Application Number

EP 22 16 3961

5

10

15

20

25

30

35

40

45

50

55

1

EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2012/125022 A2 (R P VAN DER DONK BEHEER B V [NL]; HEIJMANS ADVIES B V J [NL] ET AL.) 20 September 2012 (2012-09-20) * page 18, line 3 - page 41, line 3; figure 8 *	1, 2, 5-9, 11-15	INV. F23N5/24
X	JP S60 126517 A (TOSHIBA ELECTRIC EQUIP) 6 July 1985 (1985-07-06) * claim 1; figures 1-9 *	1-6, 8, 9, 11-15	
X	EP 3 557 132 A1 (ELECTROLUX APPLIANCES AB [SE]) 23 October 2019 (2019-10-23) * paragraph [0027] - paragraph [0058]; figures 1-5 *	1, 2, 5-9, 11-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F23N
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 16 September 2022	Examiner Theis, Gilbert
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 22 16 3961

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

16-09-2022

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
WO 2012125022 A2		20-09-2012	EP	2686601 A2		22-01-2014
			NL	2006387 C2		17-09-2012
			RU	2013145604 A		20-04-2015
			US	2014231531 A1		21-08-2014
			WO	2012125022 A2		20-09-2012

JP S60126517 A		06-07-1985	JP	H0372891 B2		20-11-1991
			JP	S60126517 A		06-07-1985

EP 3557132 A1		23-10-2019	AU	2019254245 A1		17-09-2020
			BR	112020020937 A2		02-03-2021
			EP	3557132 A1		23-10-2019
			ES	2885100 T3		13-12-2021
			US	2021199291 A1		01-07-2021
			WO	2019201592 A1		24-10-2019
