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(71) Applicant: **F.M.T. S.r.l.**
23037 Tirano SO (IT)

(72) Inventor: **Floris, Gianluca**
23037 Tirano SO (IT)

(74) Representative: **Perani & Partners S.p.A.**
Piazza Armando Diaz, 7
20123 Milano (IT)

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(54) **MULTI-FUEL STOVE**

(57) Multi-fuel stove (1) comprising a combustion chamber (2) configured to receive one or more fuels and an oxidiser; a flue gas suction duct (3) connected to the combustion chamber (2) and in fluid communication with the combustion chamber (2); sensors (4) connected to the combustion chamber (2) and/or to the flue gas suction duct (3), said sensors (4) being configured to generate operating data (10) representative of at least one of oxygen concentration, temperature or pressure inside the flue gas suction duct (3), temperature or mass of fuels inside the combustion chamber (2); a control unit (5) comprising: an acquisition module (50) placed in signal communication with the sensors (4) to receive operating data (10) and configured to receive adjustment data representative of a stoichiometric ratio; a processing module (51) in signal communication with the acquisition module (50) and configured to generate a control signal (12) based on the operating data (10) and the adjustment data; an actuation module (52) in signal communication with the processing module (51) to receive said control signal (12) and configured to adjust, according to the control signal (12), the amount of fuel and oxidiser received by the combustion chamber (2).

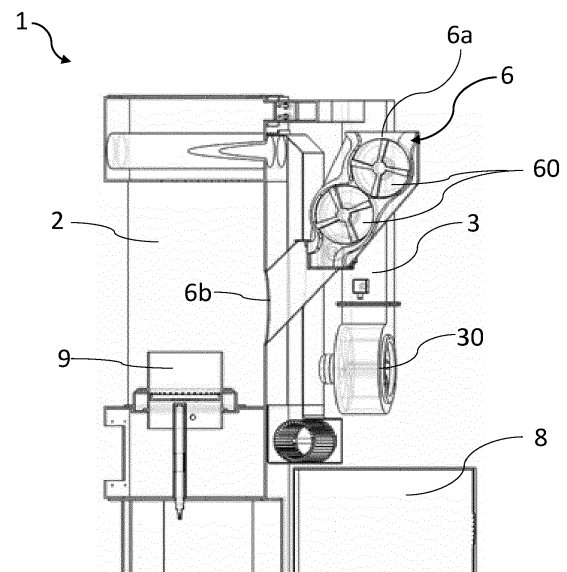


Fig. 1

Description

Technical field

[0001] The present invention relates to a multi-fuel stove, in particular one which can be used with both solid and gaseous fuels, such as pellets and hydrogen gas.

Background

[0002] It is known in the state of the art to use stoves that comprise a combustion chamber configured to receive a solid fuel and an oxidiser. In the known art, combustion takes place inside such chamber.

[0003] The stove comprises a flue gas collection duct connected to the combustion chamber to eject flue gas produced by combustion.

[0004] The stove of the known type also comprises a control unit configured to adjust the supply of solid fuel to the combustion chamber and the flue gas extraction rate from the same chamber. The prior art control unit has an intermittent operation set by a specialised technician based on the type of fuel used in the stove. In particular, the fuel enters the combustion chamber intermittently according to the control unit setting. The fuels used in known stoves include pellets, wood, nutshells and similar biomasses.

[0005] This implies that the operating parameters of the stove of the known type are predefined and cannot be changed by a user. In fact, whenever changing the type of fuel used for combustion is required, it is necessary for a specialised technician to set up again the stove control unit of the known type.

Problem of the prior art

[0006] The stove of the known type is little versatile, as it is pre-set to use a single type of fuel. Indeed, a user cannot decide for himself to use a different type of fuel, which is for instance cheaper at a given time.

[0007] In addition, since the fuel supply to the combustion chamber takes place in a predefined intermittent pattern, it is common to have incomplete combustion and consequently inadequate use of the same fuel.

Summary of the invention

[0008] Within this context, the technical task underlying the present invention is to provide a multi-fuel stove which overcomes the drawbacks of the prior art.

[0009] In particular, it is the purpose of the present invention to propose a multi-fuel stove that is more efficient, versatile and with a lower environmental impact.

[0010] The defined technical task and the specified objects are substantially achieved by a multi-fuel stove comprising the technical characteristics set forth in one or more of the appended claims.

Advantages of the invention

[0011] The present invention solves the technical problem. As a matter of fact, it is possible to create a multi-fuel stove that makes it possible to reduce the pollutants produced during use.

[0012] It is also possible to create a multi-fuel stove that can independently control the operating parameters depending on the fuel used.

[0013] It is also possible to create a multi-fuel stove that makes effective use of different types of fuel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Further characteristics and advantages of the present invention will become more apparent from the indicative and thus non-limiting description of a preferred, but not exclusive, embodiment of a multi-fuel stove, shown in the accompanying drawings, wherein:

- Figure 1 is a partial section perspective side view of a multi-fuel stove in accordance with the present invention;
- Figure 2 is a partial section perspective side view of the stove of Figure 1;
- Figure 3 is a perspective section view of one first embodiment of a detail of the stove of Figure 1;
- Figure 4 is a perspective section view of a second embodiment of a detail of the stove of Figure 1;
- Figure 5 is a perspective view of a detail of the stove of Figure 1;
- Figure 6 is a perspective view of a detail of the detail of Figure 5;
- Figure 7 is a block diagram representing the operation of the stove of Figure 1.

DETAILED DESCRIPTION

[0015] With particular reference to the appended figures, number 1 denotes a multi-fuel stove object of the present invention.

[0016] The multi-fuel stove 1 comprises a combustion chamber 2 configured to receive one or more fuels and an oxidiser, and a flue gas suction duct 3 connected to such combustion chamber 2.

[0017] In particular, the combustion chamber 2 has a plurality of openings (not indicated in the enclosed figures) and is configured to receive the fuels and the oxidiser and eject the flue gas produced by combustion through these openings.

[0018] The flue gas suction duct 3 is in fluid communication with the combustion chamber 2 and is preferably connected to an opening of the same chamber.

[0019] The multi-fuel stove 1 also comprises sensors 4 connected to the combustion chamber 2 and/or the flue gas suction duct 3. The sensors 4 are configured to generate operating data 10 representative of at least one of

oxygen concentration, temperature or pressure within the flue gas suction duct 3, temperature or mass of fuels within the combustion chamber 2.

[0020] The multi-fuel stove comprises a control unit 5 comprising at least an acquisition module 50, a processing module 51 and an actuation module 52.

[0021] The acquisition module 50 is placed in signal communication with the sensors 4 to receive operating data 10 and is configured to receive adjustment data representative of a stoichiometric ratio. The adjustment data may be representative of the heat output of the stove.

[0022] The processing module 51 is in signal communication with the acquisition module 50 and is configured to generate a control signal 12 based on the operating data 10 and the adjustment data.

[0023] The actuation module 52 is placed in signal communication with the processing module 51 to receive the control signal 12 and is configured to adjust, according to the same control signal 12, the amount of fuel and oxidiser received by the combustion chamber 2.

[0024] It should be noted that the adjustment of the amounts of fuel and oxidiser is carried out according to the control signal 12 which is updated automatically and constantly when the stove 1 is in use.

[0025] Advantageously, adjusting the amount of fuel and oxidiser received by the combustion chamber 2 allows complete combustion of the fuel. It is therefore possible to create a multi-fuel stove 1 that is more efficient, versatile with an automatic control of combustion parameters.

[0026] Preferably, the actuation module 52 is configured to interrupt the operation of the stove 1 according to the control signal 12. In particular, the actuation module 52 can interrupt the combustion inside the combustion chamber 2 if necessary. This is advantageous, as it makes it possible to create a safe multi-fuel stove.

[0027] Still preferably, the control unit 5 comprises a storage module configured to store at least one of the operating data 10, the adjustment data and the control signal 12. The storage module is placed in signal communication with the acquisition module 50 and the processing module 51. In particular, the adjustment data are stored on the storage module during the manufacturing phase of the multi-fuel stove 1.

[0028] In one embodiment, the sensors 4 comprise a lambda probe 40 connected to the flue gas suction duct 3 and configured to generate concentration data representative of the oxygen concentration in the flue gas suction duct 3. In particular, operating data 10 comprise concentration data. It is possible to continuously and automatically determine, by means of the concentration data, whether combustion within the combustion chamber occurs at the correct stoichiometric ratio.

[0029] In particular, the lambda probe 40 makes it possible to determine whether the supply of fuel and oxidiser to the combustion chamber 2 is correct. This is advantageous as it allows to adjust the amount and loading rate of fuel and oxidiser into the chamber 2 in such a way that

the ratio between the two is kept constant and equal at a predefined value.

[0030] In particular, if the oxygen concentration in the flue gas suction duct 3 exceeds a predefined concentration value, the control unit 5 will, according to the control signal 12, increase the fuel supply to the combustion chamber 2 or reduce the oxidiser amount. If the oxygen concentration is lower than the predefined concentration value, the control unit 5 will either increase the oxidiser supply to the combustion chamber 2 or decrease the fuel supply according to the control signal 12. The adjustment data may be representative of the predefined oxygen concentration value.

[0031] According to an aspect, the stove 1 comprises a fuel loading system 6 connected to the combustion chamber 2, preferably, to an opening of the combustion chamber 2.

[0032] This fuel loading system 6 comprises movement means 60 in signal communication with the actuation module 52. These movement means 60 are configured to send one or more fuels to the combustion chamber 2. In particular, the movement means 60 are configured to activate according to the control signal 12. It is possible to adjust the loading rate of fuel to the combustion chamber 2 according to the control signal 12. Indeed, the control signal 12 may be representative of the operating time of the movement means 60 and/or fuel loading rate.

[0033] In an embodiment, the fuel loading system 6 has an inlet 6a suitable for receiving one or more fuels and an outlet 6b connected to the combustion chamber 2. In particular, the outlet 6b of the fuel loading system 6 is connected to the combustion chamber 2 at an opening thereof.

[0034] Preferably, the movement means 60 comprise one or more elements 61 connected to each other and configured to move, according to the control signal 12, one or more fuels from the input 6a to the output 6b by rotating each around its own axis.

[0035] The connection between the elements 61 is configured to ensure flame safety. In detail, the connection between the elements 61 is configured to interrupt the fluid communication between the input 6a and the output 6b of the loading system 6. The combustion chamber 2 cannot receive fuel without an activation of the movement means 60. The elements 61 are configured to isolate the combustion chamber 2 from fuels located outside thereof.

[0036] Still preferably, the movement means 60 comprise at least one motor 62 connected to the elements 61 and configured to impose a rotational motion on each of such elements 61. The motor 62 is placed in signal communication with the actuation module 52 and is configured to activate and determine the rotation of the elements 61 according to the control signal 12. In particular, the rotation speed of the elements 61 is controlled by the motor 62 according to the control signal 12. The rotation speed of the elements 61 determines the fuel loading

rate into the combustion chamber 2.

[0037] Referring in particular to Figure 6, each element 61 preferably has a side profile and seats 61a that are spaced apart from each other along such side profile. The seats 61a are configured to contain fuel. Advantageously, the seats 61a are shaped to contain a known amount of fuel. The seats 61a are configured to receive and send a fuel as a result of a rotation of the element 61. This is advantageous as it is possible to determine the amount of fuel sent to the combustion chamber 2 according to the rotations of the elements 61.

[0038] It should be noted that the element 61 may be an auger or a pair of rotating drums.

[0039] In the embodiment, the flue gas suction duct 3 comprises suction means 30 in signal communication with the actuation module 52. The suction means 30 are configured to convey a gas from the combustion chamber 2 into the flue gas suction duct 3 according to the control signal 12. In particular, the control signal 12 is representative of the operating time of the suction means 30. In other words, the suction means 30 are configured to convey the flue gas produced by combustion from the combustion chamber 2 into the flue gas suction duct 3.

[0040] In addition, the multi-fuel stove 1 comprises an oxidiser loading duct (not indicated in the enclosed figures) connected to and in fluid communication with the combustion chamber 2. In particular, the oxidiser loading duct comprises a valve 70 placed in signal communication with the actuation module 52. Preferably, the valve 70 is of the type known as a throttle valve. The valve 70 is configured to adjust the oxidiser flow through the same duct towards the combustion chamber 2 according to the control signal 12. In particular, the valve 70 adjusts the supply of oxidiser to the combustion chamber 2.

[0041] In detail, if the oxygen concentration in the flue gas suction duct 3 exceeds the predefined value, the valve 70 will reduce the oxidiser flow inside the oxidiser loading duct, vice versa, the flow will be increased.

[0042] In an embodiment, the stove 1 comprises a hydrogen generator 8 connected to the combustion chamber 2. The hydrogen generator 8 is placed in signal communication with the actuation module 52 and is configured to generate hydrogen gas and supply hydrogen gas as fuel for the combustion chamber 2 according to the control signal 12.

[0043] This is advantageous, as it makes it possible to make a stove that can use both solid and gaseous fuels. In fact, the hydrogen gas produced by the generator 8 can be used for enriching the solid fuel in the combustion chamber 2. In particular, the control signal 12 may be representative of the amount and/or rate of production of the hydrogen gas supplied as fuel to the combustion chamber 2.

[0044] It should be noted that the use of hydrogen gas as fuel reduces the polluting emissions produced by the stove and allows to easily adjust the power output.

[0045] According to an aspect, the combustion chamber 2 comprises a brazier 9 connected to the hydrogen

generator 8. The brazier 9 comprises a plane 90 having an upper surface 90a and an opposite lower surface 90b. In particular, the brazier 9 is configured to receive one or more fuels. In detail, the brazier 9 is configured to receive one or more solid fuels at the upper surface 90a.

[0046] Preferably, the brazier 9 comprises a circular body 91 connected to the plane 90. The plane 90 and the circular body 91 define a combustion zone. In use, combustion inside the combustion chamber 2 takes place at the brazier 9, in particular, at the combustion zone.

[0047] In a first embodiment, the brazier 9 is configured to receive hydrogen gas at the upper surface 90a. In particular, the circular body 91 is connected to the plane 90 and the hydrogen generator 8. The circular body 91 has a plurality of holes 92. In detail, the holes 92 are located near the upper surface 90a of the plane. The brazier 9 is configured to receive hydrogen gas through the holes 92.

[0048] In a second embodiment, the brazier 9 is configured to receive hydrogen gas at the lower surface 90b. In particular, the brazier 9 comprises a pierced ring 93 located near the lower surface 90b and connected to the hydrogen generator 8. The brazier 9 is configured to receive hydrogen gas by means of the pierced ring 93.

Claims

1. Multi-fuel stove (1) comprising:

- a combustion chamber (2) configured to receive one or more fuels and an oxidiser;
- a flue gas suction duct (3) connected to the combustion chamber (2) and in fluid communication with the combustion chamber (2);

characterised in that it comprises:

- sensors (4) connected to the combustion chamber (2) and/or to the flue gas suction duct (3), said sensors (4) being configured to generate operating data (10) representative of at least one of oxygen concentration, temperature or pressure inside the flue gas suction duct (3), temperature or mass of fuels inside the combustion chamber (2);
- a control unit (5) comprising:
 - an acquisition module (50) placed in signal communication with the sensors (4) to receive operating data (10) and configured to receive adjustment data representative of a stoichiometric ratio;
 - a processing module (51) in signal communication with the acquisition module (50) and configured to generate a control signal (12) based on the operating data (10) and adjustment data;

- an actuation module (52) in signal communication with the processing module (51) to receive said control signal (12) and configured to adjust, according to said control signal (12), the amount of fuel and oxidiser received by the combustion chamber (2).
2. Multi-fuel stove (1) according to the preceding claim, wherein said sensors (4) comprise a lambda probe (40) connected to the flue gas suction duct (3) and configured to generate concentration data representative of the oxygen concentration in the flue gas suction duct (3), said operating data (10) comprising concentration data.
 3. Multi-fuel stove (1) according to any one of the preceding claims, comprising a fuel loading system (6) connected to the combustion chamber (2) and comprising movement means (60) configured to send one or more fuels to the combustion chamber (2), said actuation module (52) being placed in signal communication with the movement means (60), said movement means (60) being configured to activate according to the control signal (12).
 4. Multi-fuel stove (1) according to any one of the preceding claims, wherein the flue gas suction duct (3) comprises suction means (30) in signal communication with the actuation module (52), said suction means (30) being configured to convey a gas from the combustion chamber (2) into the flue gas suction duct (3) according to the control signal (12).
 5. Multi-fuel stove (1) according to any one of the preceding claims, comprising an oxidiser loading duct connected to and in fluid communication with the combustion chamber (2), said oxidiser loading duct comprising a valve (70) in signal communication with the actuation module (52), said valve (70) being configured to regulate the oxidiser flow through the oxidiser loading duct to the combustion chamber (2) according to the control signal (12).
 6. Multi-fuel stove (1) according to any one of the preceding claims, comprising a hydrogen generator (8) connected to the combustion chamber (2), said hydrogen generator (8) being placed in signal communication with the actuation module (52) and being configured to generate hydrogen gas and supply the hydrogen gas as fuel for the combustion chamber (2) according to the control signal (12).
 7. Multi-fuel stove (1) according to the preceding claim, wherein the combustion chamber (2) comprises a brazier (9) connected to the hydrogen generator (8), said brazier (9) comprising a plane (90) having an upper surface (90a) and an opposite lower surface (90b) and being configured to receive one or more fuels.
 8. Multi-fuel stove (1) according to the preceding claim, wherein the brazier (9) is configured to receive said hydrogen gas at said upper surface (90a).
 9. Multi-fuel stove (1) according to claim 8, wherein the brazier (9) is configured to receive said hydrogen gas at said lower surface (90b).

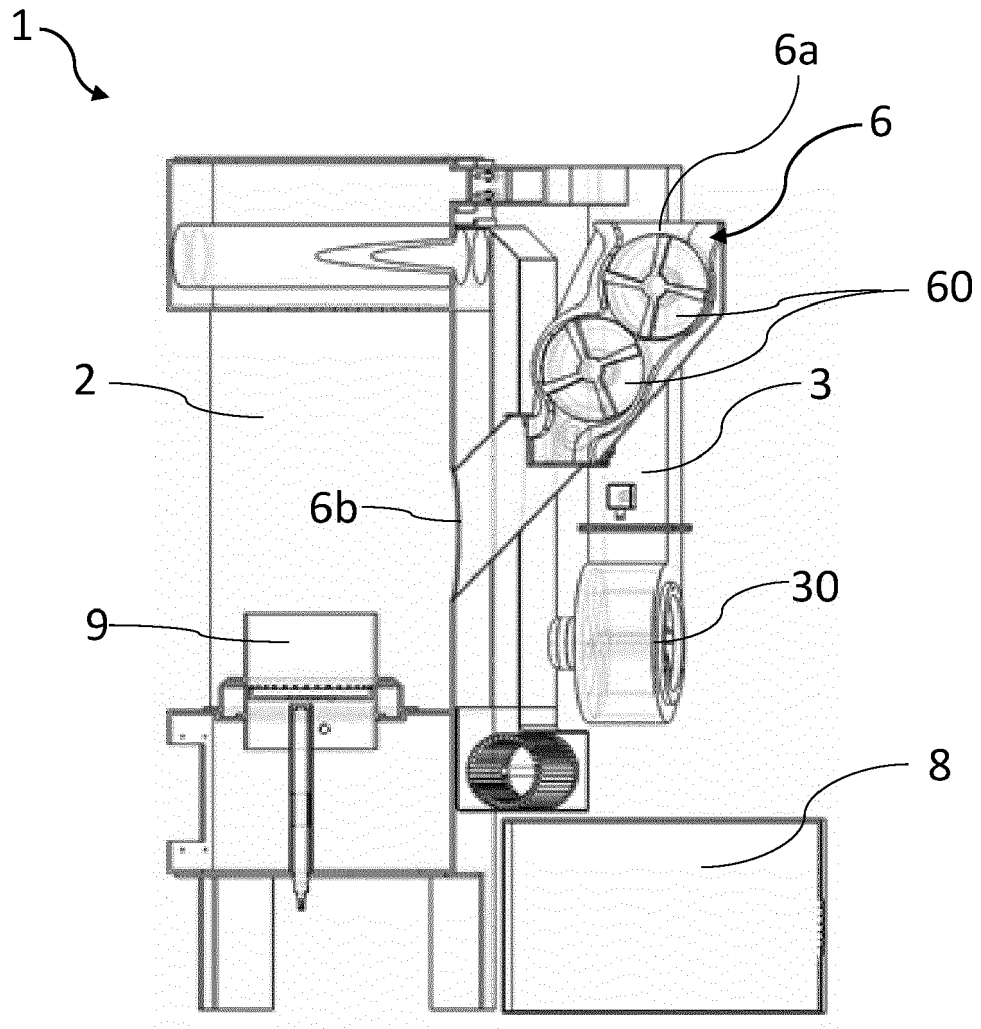


Fig. 1

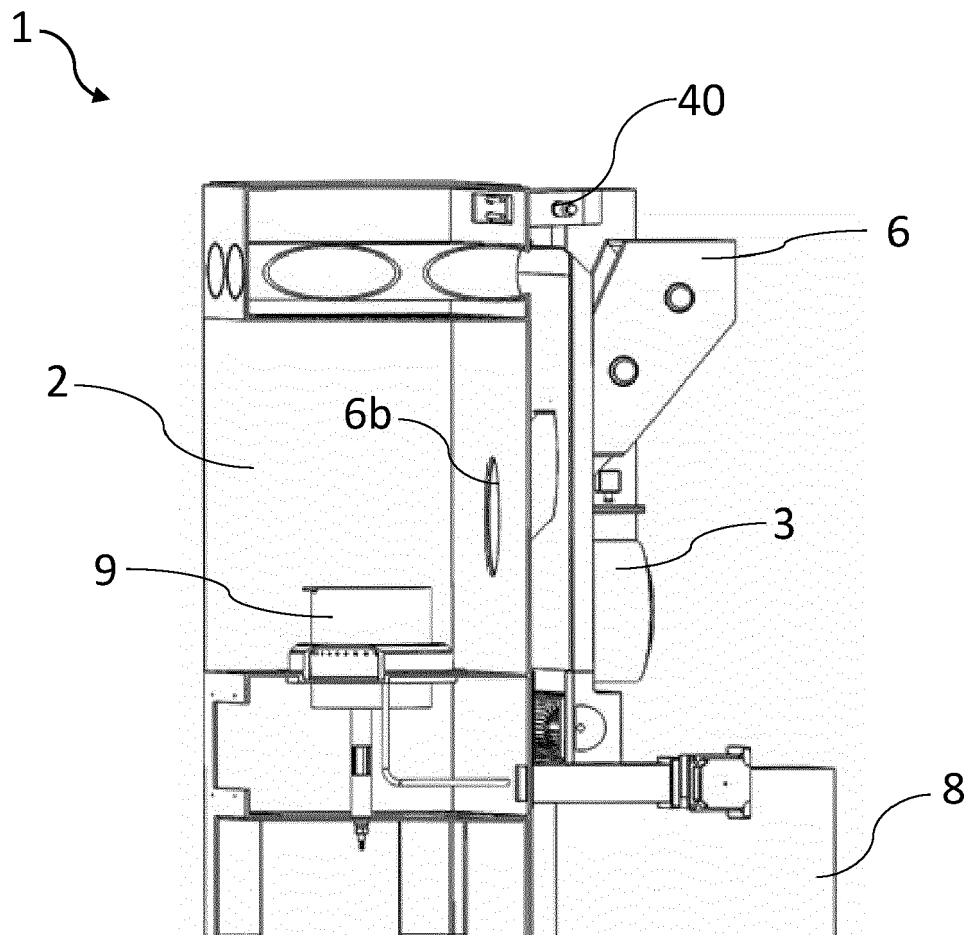


Fig. 2

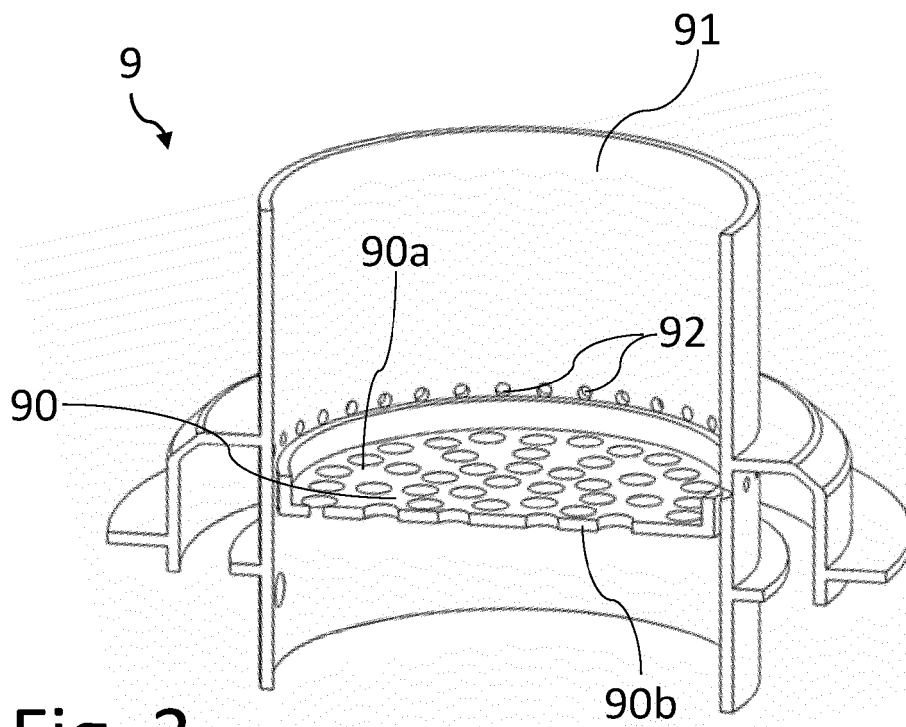


Fig. 3

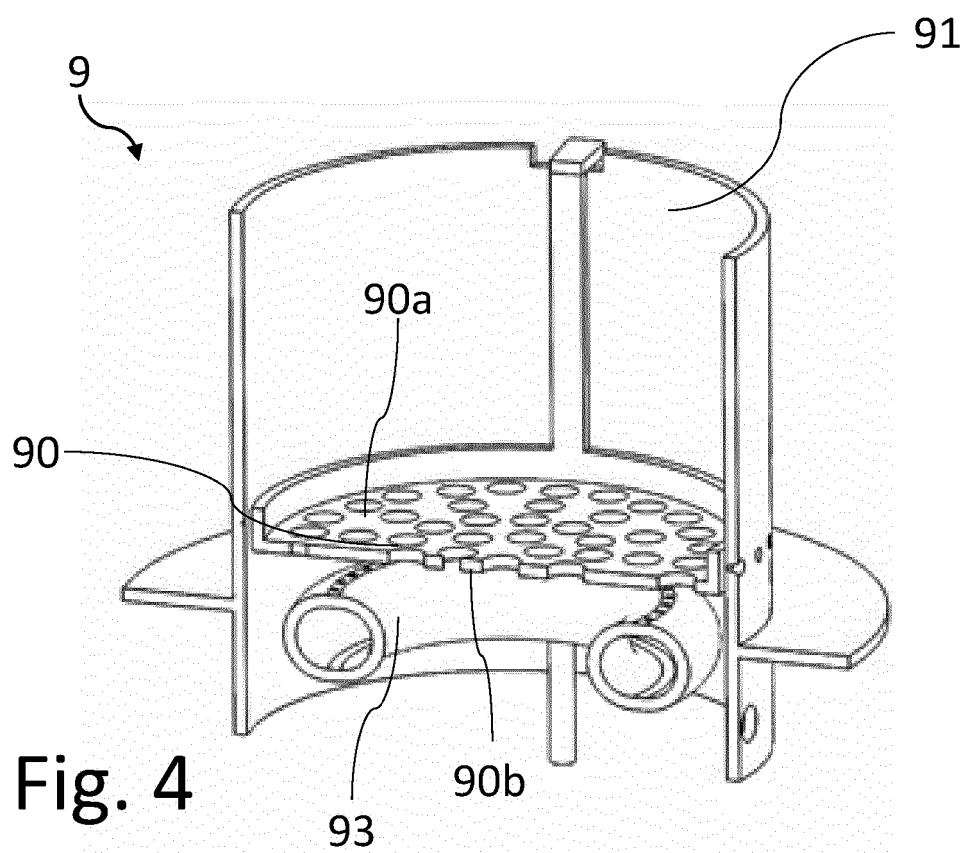
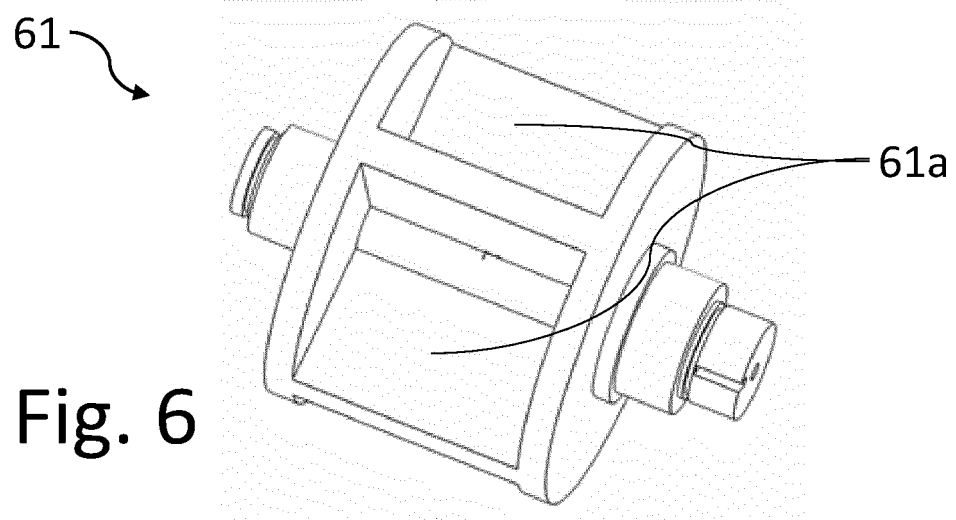
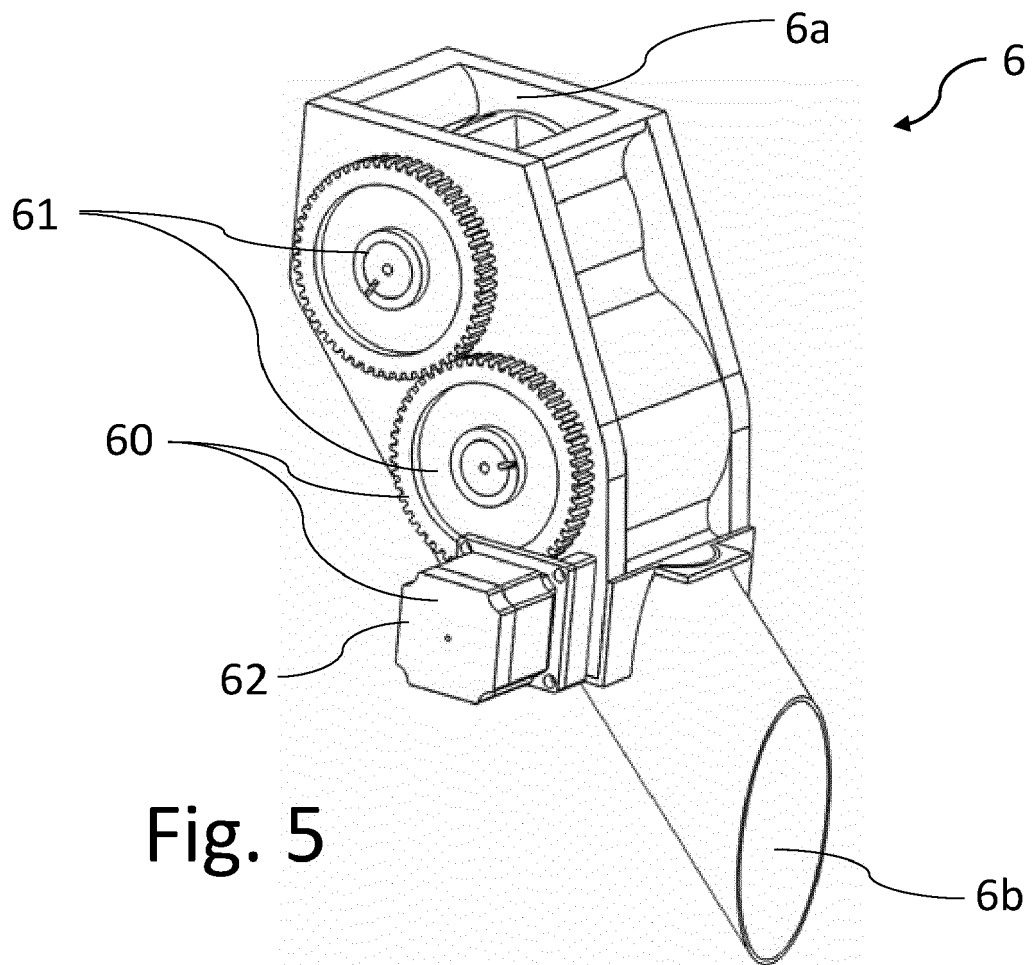
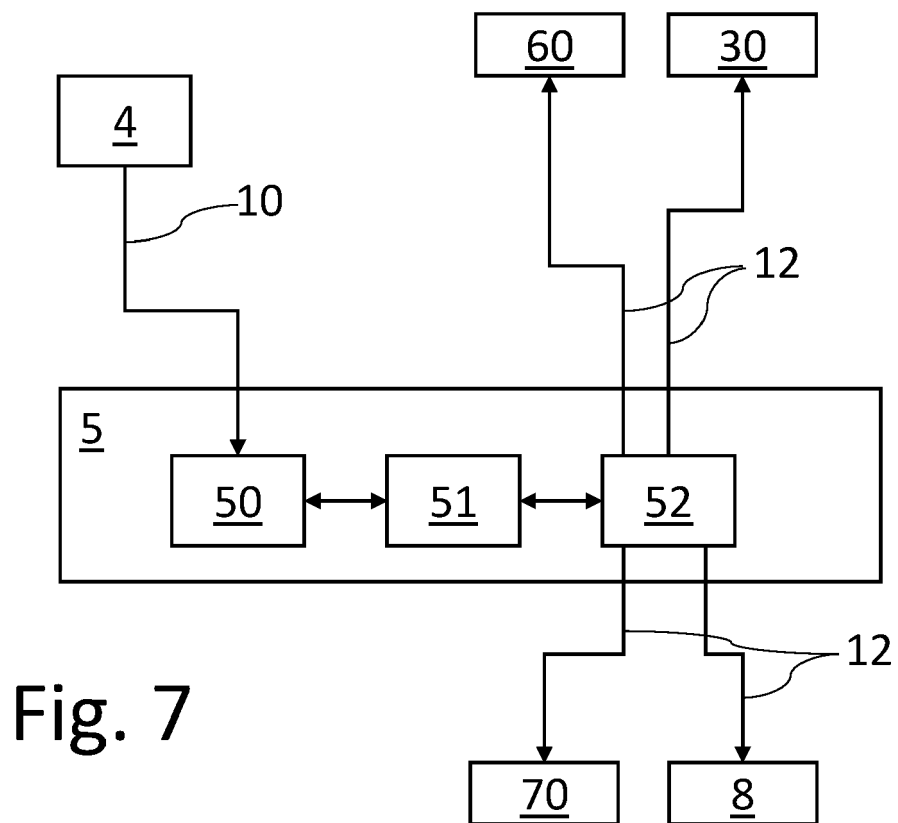


Fig. 4







EUROPEAN SEARCH REPORT

Application Number

EP 21 18 1514

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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 2015/038994 A1 (CLEARSTAK LLC [US]; HALLOWELL FEFFREY R [US]) 19 March 2015 (2015-03-19) * paragraphs [0033] - [0038], [0158]; claim 1; figure 1 *	1-9	INV. F24B1/02 F24B5/02 F24C1/04 F23N5/02
X	EP 3 236 154 A1 (V F M CVBA [BE]) 25 October 2017 (2017-10-25) * paragraph [0043]; claims 1,12 *	1,2,6-9	
X	WO 2019/145854 A1 (BELLINTANI CLAUDIO [IT]; SORRENTINO GIUSEPPE [IT]) 1 August 2019 (2019-08-01) * claims 1,9; figure 1 *	1-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			F24B F24C F23G F23N
2 The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 8 December 2021	Examiner Meyers, Jerry
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 18 1514

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2015038994 A1	19-03-2015	EP 3044513 A1	20-07-2016
		US 2015081086 A1	19-03-2015
		US 2019072330 A1	07-03-2019
		WO 2015038994 A1	19-03-2015
EP 3236154 A1	25-10-2017	BE 1024116 A1	16-11-2017
		EP 3236154 A1	25-10-2017
WO 2019145854 A1	01-08-2019	NONE	