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(54) **BOILER**

(57) A boiler comprising an enclosure (2) which forms a heating chamber (3) which contains water to be heated and accommodates a firebox (5) which forms a combustion chamber (5) with a burner (6) associated therewith which comprises a combustion head (7), arranged in the combustion chamber (4) and connected to a supply duct (8), and provided with a premixer (9) of combustion air and combustible gas which is interposed along the supply duct (8). The combustion chamber (4) is connected to a stack (12) for the evacuation of the combustion gases into the external environment. Means are further provided for generating a flow of a mixture of air and gas toward the combustion head (7). The particularity of the invention resides in that it comprises at least one duct (13) for conveying the combustion gases which connects the stack (12) to the supply duct (8). Also according to the invention, the flow generation means comprise means which are adapted to place the combustion chamber (4) in partial vacuum with respect to atmospheric pressure.

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Description

[0001] The present invention relates to a boiler.

[0002] Boilers are known for the production of hot water or steam which are constituted by an external enclosure which forms a water heating chamber and accommodates internally a firebox, which is in a heat exchange relationship with the water to be heated that is contained in the heating chamber.

[0003] A combustion chamber is formed in the firebox and accommodates the combustion head of a burner capable of generating a flame in the firebox. In turn, the combustion chamber is connected to a plurality of heat exchange tubes in which the hot combustion gases produced by the flame flow and pass through the heating chamber, so that the hot combustion gases can heat the water contained in the heating chamber.

[0004] The heat exchange tubes merge in a combustion gas collection chamber, from which they are evacuated externally through a stack.

[0005] The burner used in the boilers as described above can be of the forced draft type, also known as jet burner or draft burner, in which a fan, arranged outside the boiler and upstream of the burner, propels by forcing the oxidizing air, drawn from the outside environment, toward the burner.

[0006] Another type of burner that is known and currently used in the boilers described above is constituted by premixed gas burners, normally termed premix burners, in which the combustible gas and the oxidizing air are fully mixed, prior to their combustion reaction, which occurs in the combustion head, by a premixer which is connected to the combustion head by means of a fan, without requiring any secondary air to complete the combustion of the mixture of air and gas.

[0007] One problem of known burners is providing optimum combustion of the mixture formed by oxidizing air and by the combustible gas in order to reduce the forming of NOx that are subsequently sent to the stack of the boiler.

[0008] The total NOx detectable at the stack are constituted mainly by thermal NOx, the generation of which increases with the temperature of the flame in which molecules of nitrogen and oxygen occur which do not take part directly in the combustion and which can originate to a lesser extent also from so-called prompt NOx, which depend on the stoichiometry of the combustion process, and from so-called fuel NOx, which form due to the nitrogen that is present in the fuel.

[0009] In the case of burners of the forced draft type, one solution that is applied in order to reduce the possibility of NOx generation is the provision of recirculation of the exhaust gases to the stack in the burners themselves, in order to reduce the adiabatic temperature of the flame, since the heat generated in the combustion reaction is distributed over a greater mass.

[0010] In burners of the forced draft type, combustion gas recirculation must be adjusted with a valve with automatic adjustment which allows an opening thereof which is variable on the basis of the parameters of the combustion and on flame power, and therefore a combustion gas temperature probe is necessary, an oxygen probe is often necessary, and in any case the presence is also required of an electronic device that modulates the opening of the valve, with consequent constructive complications.

[0011] Suppression of thermal NOx with premix burners is instead achieved currently by supplying an excess of oxidizing air in the combustion mixture, which however inevitably entails a considerable reduction in the combustion efficiency of the boiler.

[0012] The aim of the present invention is to provide a boiler that is capable of improving the background art in one or more of the aspects indicated above.

[0013] Within this aim, an object of the invention is to provide a boiler that is capable of ensuring a reduced emission of NOx without requiring particular structural and constructive complications and without reductions in efficiency.

[0014] Another object of the invention is to provide a boiler which, by virtue of its particular constructive characteristics, is capable of giving the greatest assurances of reliability and safety in its operation.

[0015] A further object of the present invention is to provide a boiler that is easy to manage and does not require specific electronic combustion control systems.

[0016] Another object of the invention is to provide a boiler that does not required the use of automatically adjusted valves to control NOx emission.

[0017] A further object of the present invention is to overcome the drawbacks of the background art in a manner that is alternative to any existing solutions.

[0018] Another object of the invention is to provide a boiler that is relatively easy to provide and can be obtained at competitive costs.

[0019] This aim, as well as these and other objects which will become better apparent hereinafter, are achieved by a boiler according to claim 1, optionally provided with one or more of the characteristics of the dependent claims.

[0020] Further characteristics and advantages of the invention will become better apparent from the description of a preferred but not exclusive embodiment of the boiler according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a perspective view of a boiler according to the invention;

Figure 2 is a lateral elevation view of the boiler according to the invention;

Figure 3 is a front view of the boiler according to the invention;

Figure 4 is a sectional view, taken along the line IV-IV Figure 3;

Figure 5 is a sectional view, taken along the line V-

V of Figure 3;

Figure 6 is an enlarged-scale view of a detail of Figure 5;

Figure 7 is a sectional view, taken along the line VII-VII of Figure 2;

Figure 8 is a sectional view, taken along the line VIII-VIII of Figure 2.

[0021] With reference to the figures, the boiler according to the invention, designated generally by the reference numeral 1, comprises an enclosure 2, which forms a heating chamber 3, in which the water to be heated is contained.

[0022] Conveniently, the enclosure 2 and other components of the boiler are contained in an external box-like protection and thermal insulation structure 1a.

[0023] The enclosure 2 accommodates a firebox 4 which forms a combustion chamber 5, with which a burner 6 is associated.

[0024] In particular, the burner 6 comprises a combustion head 7, which is arranged in the combustion chamber 5 and is connected to a supply duct 8 and is provided with a premixer 9 of oxidizing air and combustible gas which is interposed along the supply duct 8, so that it can perform a premixing of the air and of the gas fed to the combustion head 7.

[0025] Conveniently, the combustion chamber 5 is connected to a plurality of tubes 10 for conveying the combustion gases which are arranged in a heat exchange relationship with the heating chamber 3, so that the combustion gases can transfer heat to the water contained in the heating chamber 3.

[0026] Conveniently, the conveyance tubes 10 lead into a combustion gas collection chamber 11, which is connected to a stack 12 for the evacuation of the combustion gases into the outside environment.

[0027] Means are further provided for generating the flow of a mixture formed by oxidizing air and combustible gas toward the combustion head 7, so that the combustion head 7 can create and maintain a flame inside the combustion chamber 5.

[0028] The boiler according to the invention comprises at least one duct 13 for conveying the combustion gases, which connects the stack 12 to the supply duct 8 of the burner 6, and in that said flow generation means comprises means adapted to place the combustion chamber 5 in partial vacuum with respect to atmospheric pressure.

[0029] Preferably, said means adapted to place the combustion chamber 5 in partial vacuum are provided by a fan 14 which is arranged in the combustion gas collection chamber 11 and can be rotationally actuated by a motor 14a.

[0030] Advantageously, the combustion gas conveyance duct 13 can be connected to the supply duct 8 of the burner 6 in any point downstream of the premixer 9 along the direction of the flow that passes through the supply duct 8.

[0031] In detail, the supply duct 8 is advantageously connected in input to the outside environment, so as to be supplied with oxidizing air, while the premixer 9 is provided by means of a tubular element 15, which is arranged coaxially to the supply duct 8, so as to create a reduction in the cross-section of the supply duct itself.

[0032] In particular, the tubular element 9 is conveniently provided, at its end directed against the flow that arrives from the supply duct 8, with a portion 15a which is substantially shaped like an ogive and is internally connected to a gas supply duct 16.

[0033] In the side wall of the tubular element 15 there are openings 17 which allow the exit, by Venturi effect, of the gas that arrives from the supply duct 16 so that it can mix with the air that flows within the supply duct 8.

Operation of the boiler according to the invention is as follows.

[0034] The fan 14 is activated so as to create a partial vacuum with respect to the outside environment in the combustion chamber 5 and consequently generate a flow of air, drawn from the outside environment, through the supply duct 8 of the burner 6.

[0035] The air flow in the supply duct 8, by passing through the region in which the tubular element 15 is located, draws by Venturi effect the gas that arrives from the supply duct through the openings 17 of the tubular element 15, so as to create in the supply duct 8 a mixture of air and combustible gas which allows the combustion head 7 to generate a flame in the combustion chamber 5.

[0036] The combustion gases that originate from the flame generated in the combustion chamber 5 by the combustion head are channeled into the conveyance tubes 10, exchange heat with the water contained in the heating chamber 3, and gather, by now depleted, in the combustion gas collection chamber 11, where the fan 14 propels them into the stack 12.

[0037] At least part of the combustion gases that flow within the stack 12 are channeled along the conveyance duct 13 to thus reach the supply duct 8, where they mix with the air and the gas that are fed to the combustion head 7, thus creating a recirculation of the combustion gases inside the boiler which are sent to the burner 6.

[0038] The quantity of recirculation combustion gases that is recirculated through the conveyance duct 13 can optionally be adjusted, at the first ignition of the burner 6, with a manual shutter which is then permanently locked, in order to maintain the achieved optimization of the main combustion parameters, which are constituted by the percentage of oxygen, by the quantity of carbon monoxide (CO) in ppm and by the quantity of NOx in the combustion gases in ppm.

[0039] The variation of the speed of the fan 14 produces a simultaneous variation of combustion air, combustible gas and combustion gases that recirculate in the conveyance duct 13 without requiring any intervention to vary the adjustment performed previously on the manual shutter. This is demonstrated by the fact that the combustion parameters do not undergo substantial variations over the entire modulation range of the burner 6 even if

the temperature of the boiler varies.

[0040] It should be noted that the recirculation of the combustion gases that are sent to the burner 6 through the conveyance duct 13 in the presence of the partial vacuum in the combustion chamber 5 generated by the fan 14 does not entail any loss of efficiency of the boiler but only a drastic reduction in thermal NOx.

[0041] The fact that the combustion chamber 5 is in partial vacuum ensures that there are no unwanted leaks of the depleted combustion gases from the conveyance duct.

[0042] In practice it has been found that the invention achieves the intended aim and objects, providing a boiler that is capable of ensuring a low emission of NOx without deteriorations in the efficiency of the boiler.

[0043] The invention thus conceived is susceptible of numerous modifications and variations; all of which are within the scope of the appended claims; all the details may further be replaced with other technically equivalent elements.

[0044] In practice, the materials used, so long as they are compatible with the specific use, as well as the contingent shapes and dimensions, may be any according to the requirements and the state of the art.

[0045] The disclosures in Italian Patent Application No. 102017000106691 from which this application claims priority are incorporated herein by reference.

[0046] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A boiler comprising an enclosure (2) which forms a heating chamber (3) which contains water to be heated and accommodates a firebox (4) which forms a combustion chamber (5) with a burner (6) associated therewith which comprises a combustion head (7), arranged in the combustion chamber (4) and connected to a supply duct (8), and provided with a premixer (9) of combustion air and combustible gas which is interposed along said supply duct (8), said combustion chamber (5) being connected to a stack (12) for the evacuation of said combustion gases into the external environment, means being provided for generating a flow of a mixture of air and gas toward said combustion head (7), **characterized in that** it comprises at least one duct (13) for conveying said combustion gases which connects said stack (12) to said supply duct (8), said flow generation means comprising means which are adapted to place said combustion chamber (5) in partial vacuum with respect to atmospheric pressure.

2. The boiler according to claim 1, **characterized in that** said combustion chamber (5) is connected to a plurality of tubes (10) for conveying the combustion gases, which are arranged in a heat exchange relationship with said heating chamber (3) and lead into a combustion gas collection chamber (11) which is connected to said stack (12), said means adapted to place said combustion chamber (5) in partial vacuum comprising a fan (14) arranged in said combustion gas collection chamber (11).

3. The boiler according to one or more of the preceding claims, **characterized in that** said combustion gas conveyance duct (13) is connected to said supply duct (8) downstream of said premixer (9).

4. The boiler according to one or more of the preceding claims, **characterized in that** said supply duct (8) is connected in input to the external environment, said premixer (9) comprising a tubular element (15) which is arranged coaxially to said supply duct (8) in order to create a cross-section reduction in said supply duct (8), said tubular element (15) being connected internally to a gas supply duct (16) and being provided with a plurality of openings (17) for the outflow of the gas into said supply duct (8).

5. The boiler according to one or more of the preceding claims, **characterized in that** said fan (14) is controlled by a variable-speed electric motor.

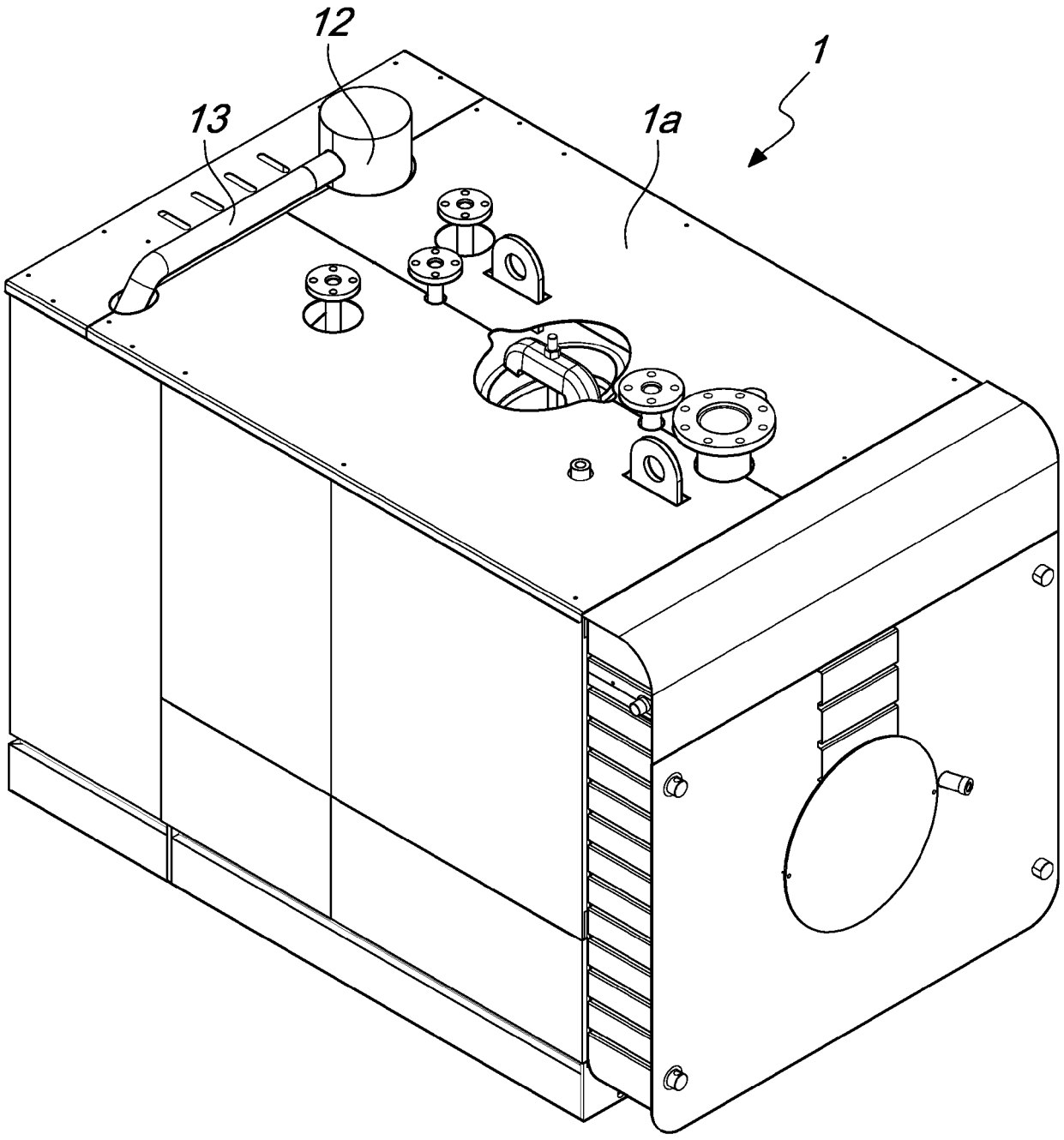
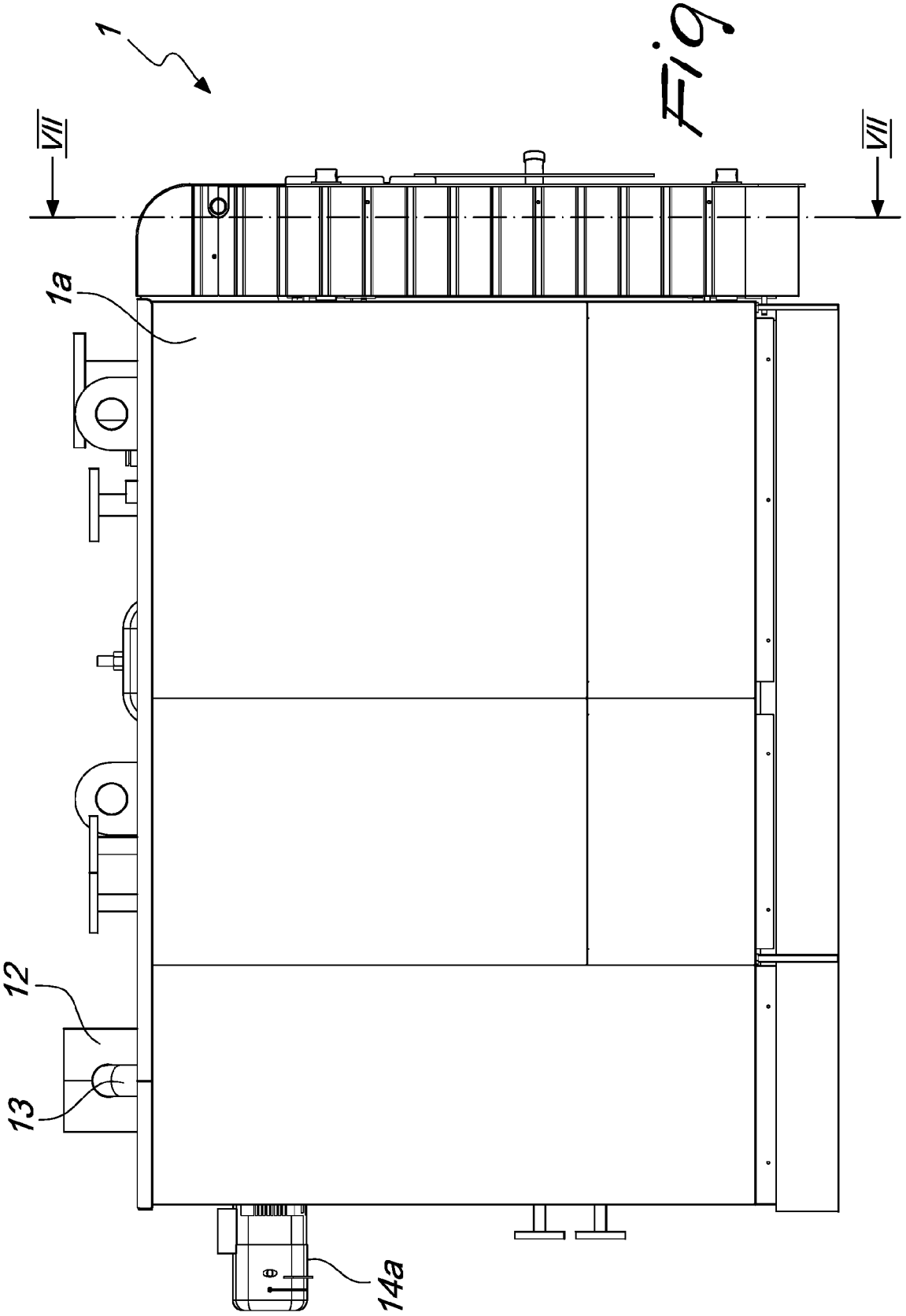


Fig. 1

Fig. 2



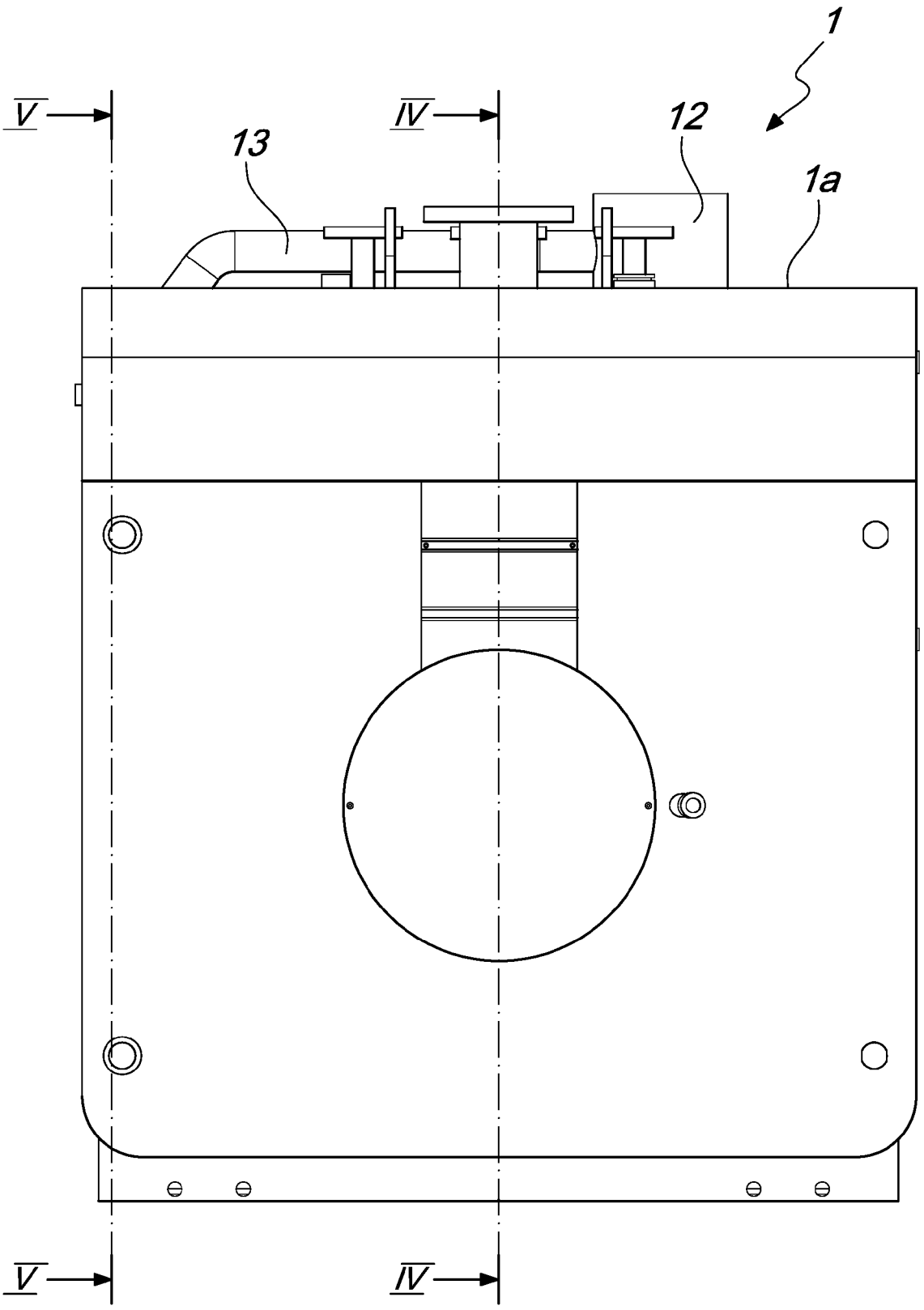


Fig. 3

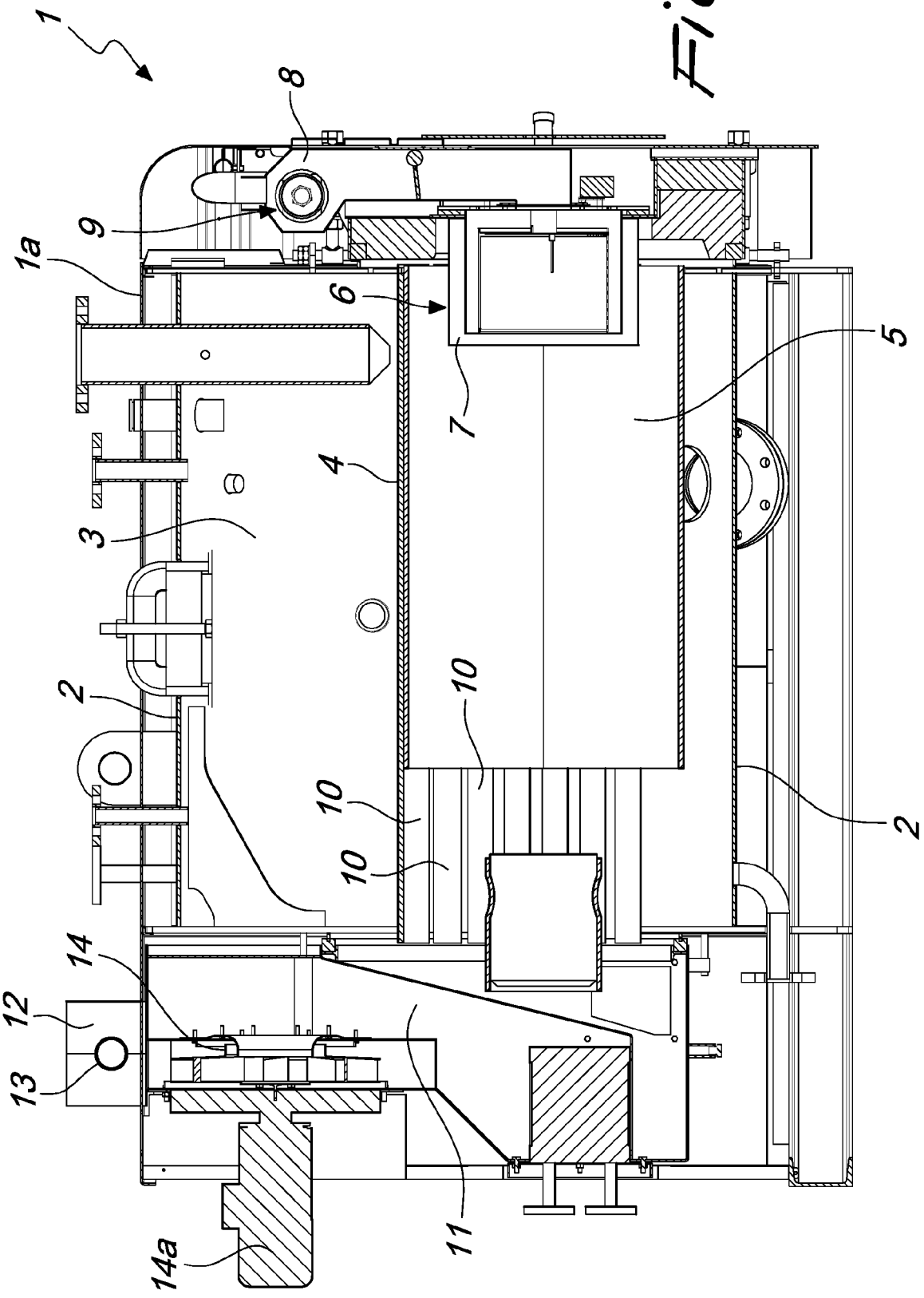
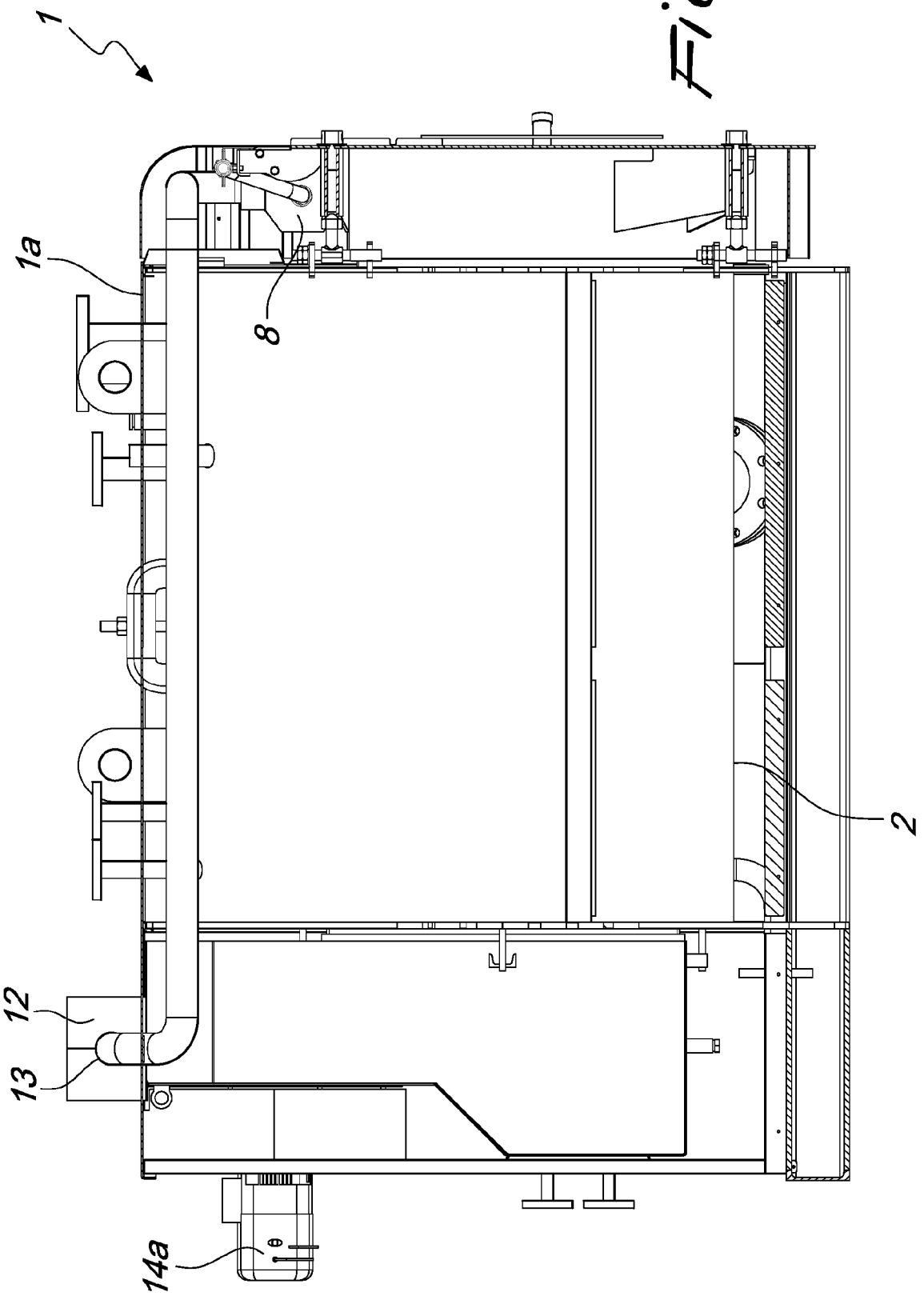


Fig. 4

Fig. 5



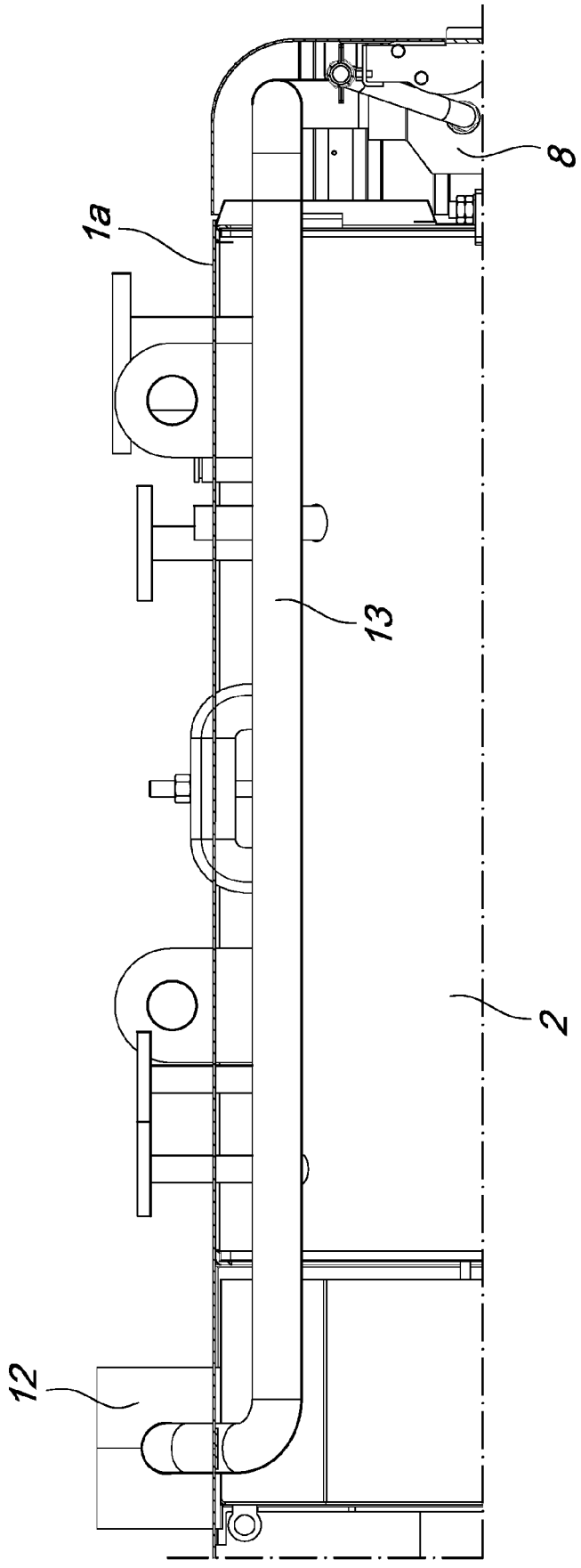


Fig. 6

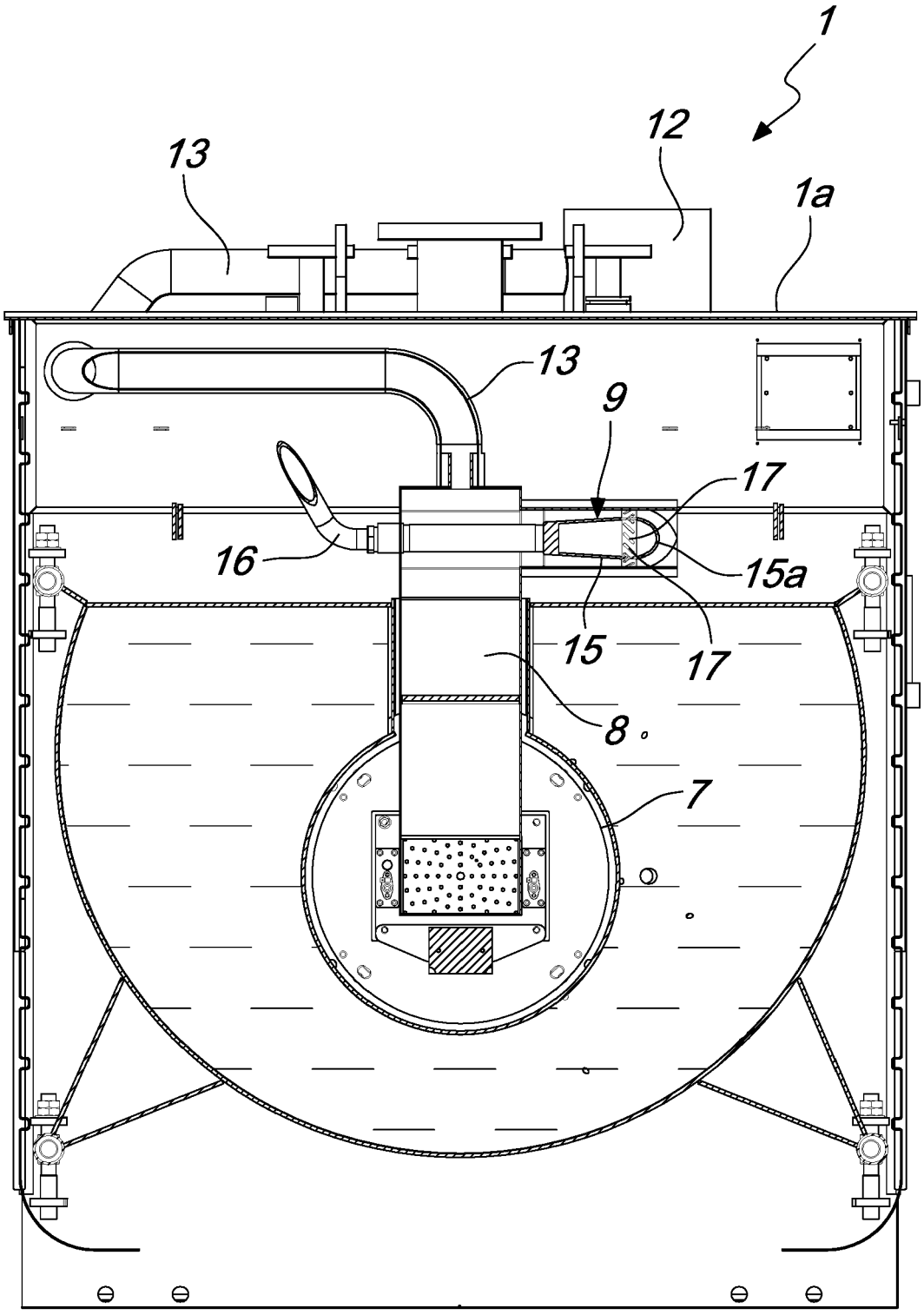


Fig. 7

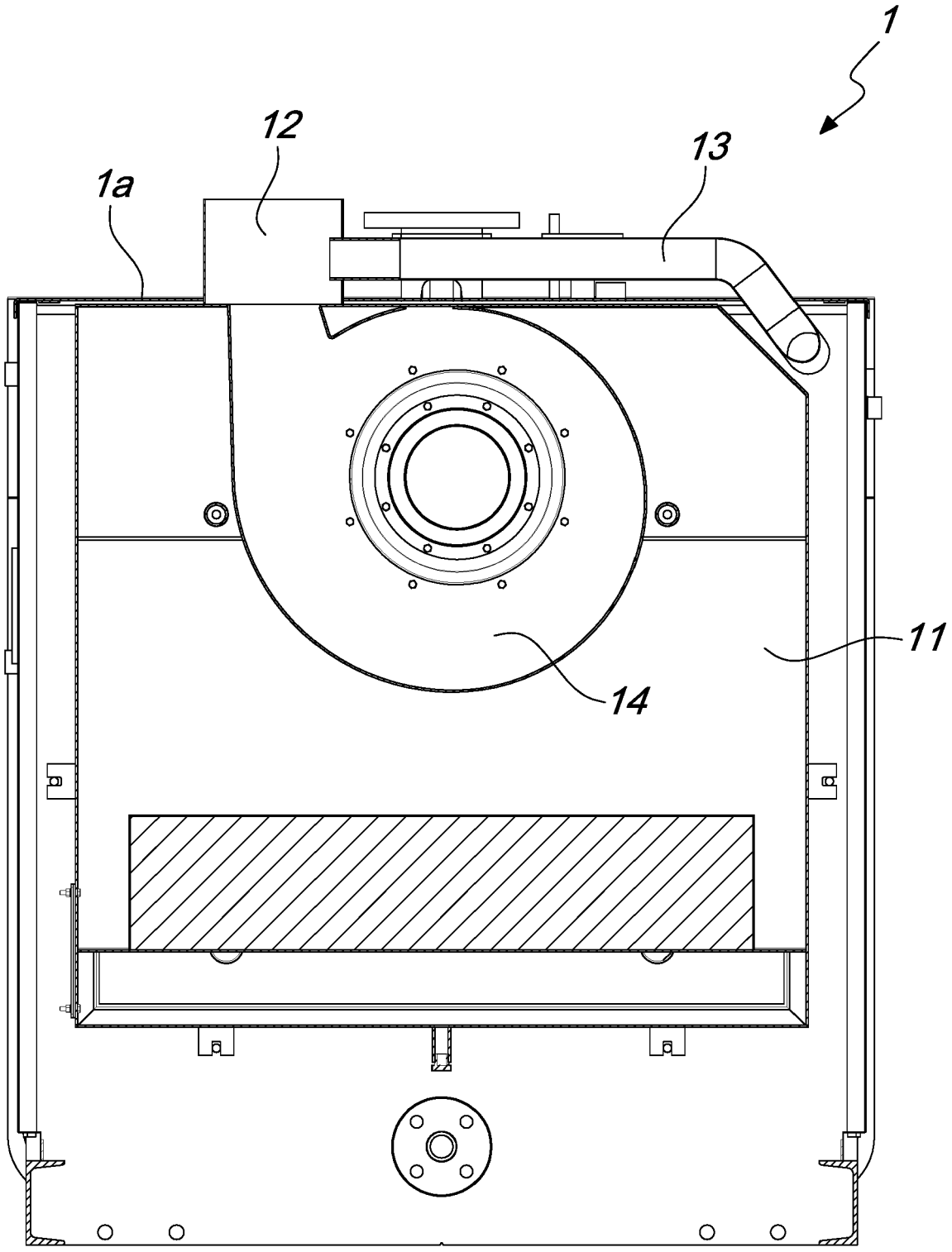


Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 18 19 4990

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	FR 2 314 448 A1 (VIDALENQ MAURICE [FR]) 7 January 1977 (1977-01-07) * page 1 - page 4; figures 1,2 *	1-4 5	INV. F24H1/24 F24H1/28 F23D14/62
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TECHNICAL FIELDS SEARCHED (IPC)
F24H
F23D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 January 2019	Riesen, Jörg

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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REFERENCES CITED IN THE DESCRIPTION

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