(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 003 242 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.12.2008 Bulletin 2008/51

(21) Application number: **08397512.8**

(22) Date of filing: **30.05.2008**

(51) Int Cl.:
D21C 11/00 *(2006.01)* ***D21C 11/06*** *(2006.01)*
D21C 11/10 *(2006.01)* ***D21C 11/12*** *(2006.01)*

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

(30) Priority: **15.06.2007 FI 20075451**

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(54) A recovery boiler plant and a method in a recovery boiler

(57) A recovery boiler plant, which comprises a recovery boiler, wherein in the first part (1 a) flue gases travel in a first direction (F1). The furnace also comprises a second part (1 b), where the flue gases proceed in a second direction (F2), which second direction differs from the first direction (F1). In addition, the invention relates to a method in a recovery boiler.

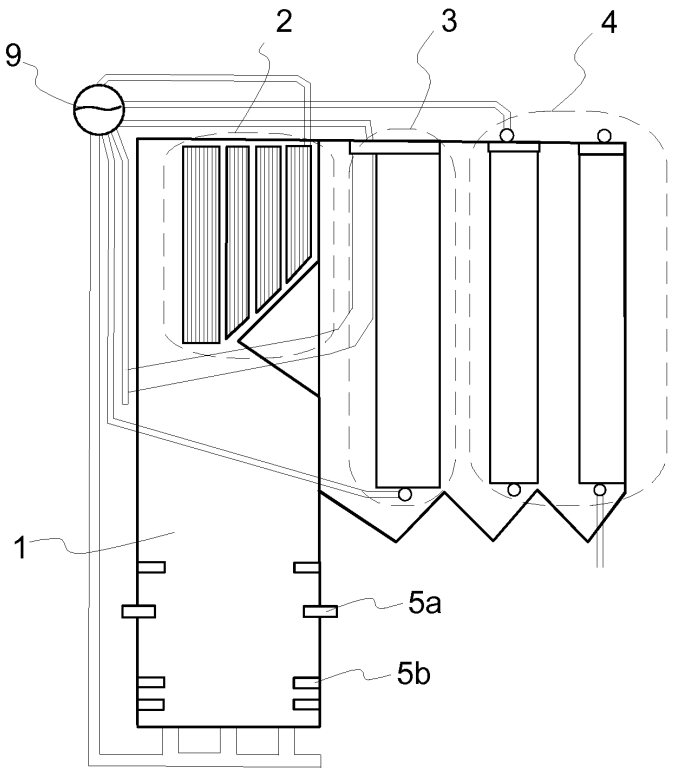

Fig. 1

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Description

Field of the invention

[0001] The invention relates to a recovery boiler plant. In addition, the invention relates to a method in a recovery boiler.

Background of the invention

[0002] A recovery boiler is used in a pulping process to recover the chemicals used in the pulping process and to produce steam. Steam is used in different phases of the pulping process as well as in producing electricity.

[0003] After the pulping process the used cooking liquor, i.e. the so-called black liquor is separated from pulp and directed via the evaporator to be combusted in the recovery boiler. Heat is created in a furnace of the recovery boiler due to combustion, which heat is recovered by utilizing walls and other heat surfaces.

[0004] Figure 1 shows in principle a structure of a recovery boiler according to prior art in a side view in a vertical cross-section. The recovery boiler according to figure 1 comprises the following parts: a furnace 1 i.e. a reactor part, a superheater area 2, a boiler bank area 3 and an economizer area 4. The furnace is surrounded by the walls of the recovery boiler. The recovery boiler is, for the part of the wall tubes and floor tubes forming the floor, typically made of finned tubes, which are connected together by welding into planar structures. There is a medium circulation inside the tubes, which circulation is substantially water-steam circulation. The walls of the recovery boiler comprise nozzles 5a, by means of which black liquor is supplied to the furnace for combustion. In addition, the walls of the recovery boiler comprise air nozzles 5b for supplying the air required for combustion. Air supply may take place in various locations in the furnace.

[0005] Further, the recovery boiler plant comprises superheaters, a flue gas channel and economizers. The superheaters are tube structure elements and there are typically several parallel ones in the superheater area. The steam flowing in the superheaters heats when flue gases heat the tubes from the outside. In recovery boilers the superheater area 2 is located above the nose in the upper part of the furnace in the upmost part of the recovery boiler, via which the flue gases flow from the recovery boiler to the flue gas channel. The flue gas channel typically comprises a boiler bank area 3 and an economizer area 4. In the boiler bank area 3 the water inside the boiler bank boils and the mixture of water and stem moves to a drum that is a part of the water circulation of the recovery boiler. There is typically an economizer area 4 in a part of the flue gas channel, where in the economizers the water that is supplied to replace the steam removed from the water system of the recovery boiler is heated with cooled flue gases.

[0006] The heat surfaces of the recovery boiler plant are connected in different ways to each other so that the water can be heated and further evaporated by means of different heat surfaces, such as boiler banks and economizers, located in both the recovery boiler and in the flue gas channel after it. Finally, the saturated steam can be heated in the superheaters so that superheated high-pressure steam is created.

[0007] In a large recovery boiler plant the furnace can be several meters high, for example, 50 to 70 meters. Tall houses are required in order to place such a furnace in a plant.

Brief summary of the invention

[0008] Now a solution has been created, which enables a lower structure of a recovery boiler plant structure.

[0009] To achieve this purpose, the recovery boiler plant according to the invention is primarily characterized in what will be presented in the independent claim 1. The method according to the invention is, in turn, primarily characterized in what will be presented in the independent claim 7. The other, dependent claims will present some preferred embodiments of the invention.

[0010] The basic idea of the invention is to form a furnace in such a manner that the flue gases proceed in the furnace in at least two different directions.

[0011] In an embodiment in a first part of the furnace of the boiler plant flue gases travel in a first direction. In addition, the furnace also comprises a second part, where flue gases travel in a second direction, which second direction differs from the first direction. In an embodiment the first direction is upwards and the second direction is downwards.

[0012] In an embodiment the recovery boiler plant comprises a superheater area, which is located horizontally next to the second part of the furnace.

[0013] In an embodiment the length of the first part of the furnace is 60 to 140 % of the length of the second part. Preferably, the first part of the furnace and the second part of the furnace are substantially of the same length.

[0014] In an embodiment the recovery boiler plant comprises a frame, from where the first part and the second part of the furnace are suspended.

[0015] In an embodiment the first part of the furnace and the second part of the furnace comprise means for removing smelt. In an embodiment the smelt to be removed from the second part of the furnace is directed to the first part of the furnace, in which case the smelt cumulating from the second part can be changed to a form that is advantageous from the point of view of the process.

[0016] The different embodiments of the above-described arrangement, taken separately and in various combinations, provide several advantages. A low furnace enables a low structure. An advantage of an application, in turn, is the easier mountability of different structures of the recovery boiler plant.

[0017] An application enables the modularization of

the recovery boiler plant, in which case changing the capacity of recovery boiler plant during the life cycle of a recovery boiler is advantageous.

[0018] An application provides a possibility to process flue gases in the second part of the furnace before the superheaters, for example, in order to control emissions. For example, there may be additional burners, air nozzles and/or other additive supplies in the second part of the furnace for controlling the corrosiveness of the emissions and/or flue gases.

[0019] In an embodiment the superheaters are protected from the radiation of the furnace, as well as from black liquor drops escaping from the furnace, i.e. the so-called carryover. An advantage of an application, in turn, is the cheaper superheater structure made possible by it.

[0020] An application enables a better optimization of the heat structure. Optimization of the heat surfaces may be based on the flow velocity of flue gases. In the present solution the dimensions of the different parts of the furnace and the channels can be selected so that the desired flow velocity is reached in different parts. In addition, the flue gas flow model in the superheater area is advantageously better in the present solution than in known solutions, where flue gases travel past the nose in the superheater area.

Description of the drawings

[0021] In the following, the invention will be described in more detail with reference to the appended principle drawings, in which

Fig. 1 shows a known recovery boiler plant

Fig. 2 shows an embodiment

Fig. 3 shows another embodiment

Fig. 4 shows a third embodiment

[0022] For the sake of clarity, the drawings only show the details necessary for understanding the invention. The structures and details that are not necessary for understanding the invention but are obvious for anyone skilled in the art have been omitted from the figures in order to emphasize the characteristics of the invention.

Detailed description of the invention

[0023] A recovery boiler according to figure 1 was discussed in connection with the background of the invention and prior art. The recovery boiler according to figure 2 comprises the following parts: a furnace 1 i.e. a reactor part, a superheater area 2, a boiler bank area 3 and an economizer area 4.

[0024] The furnace 1, i.e. the reactor part is formed of two part, which in this description are called the first part of the furnace 1a and the second part of the furnace 1 b. It can also be said that the furnace according to figure 2 comprises a first combustion chamber and a second combustion chamber, which are connected to each other via a turning chamber. In the first part 1a of the furnace flue gases (i.e. gases formed during combustion) travel in a first direction F1, and in the second part 1b of the furnace flue gases travel in a second direction F2, which second direction differs from the first direction.

[0025] The furnace 1 comprises membrane walls. Advantageously the walls of the first part 1a of the furnace and the second part 1b of the furnace are formed of finned tubes, which are connected together by welding into planar structures. There is a medium circulation inside the tubes, which circulation is substantially water-steam circulation.

[0026] The material to be combusted (black liquor) is supplied to the first part 1a of the furnace, as well as all or most of the air needed for combustion with suitable supply devices 5a, 5b, such as, for example, nozzles. In the figures the black liquor nozzles 5a and the air nozzles 5b are shown in principle only as single planes. However, it is advantageous to place especially air nozzles 5b to the walls of the furnace 1 on several planes. A part of the air supply nozzles 5b may also be located in the second part 1 b of the furnace.

[0027] In a recovery boiler according to the example, black liquor is combusted traditionally in the first part 1a of the furnace. Flue gases proceed in the first part 1a of the furnace of this application substantially upwards (first direction F1). From the upper part of the first part 1a of the furnace the flue gases move to the second part 1 b of the furnace. The first part 1a of the furnace and the second part 1 b of the furnace are connected to each other via some suitable aperture or other structure. The aperture or the like connecting the first part 1a of the furnace and the second part 1 b of the furnace may comprise tubes, such as, for example, screen tubes, between which the flue gases may flow (the tubes are not shown in the figures). By means of the tubes it is possible to direct water/steam between the walls between the first part 1a and the second part 1 b of the furnace and the upper part of the boiler. If necessary, by means of the tubes it is also possible to lower the temperature of the flue gases when moving from the first part 1 a of the furnace to the second part 1 b of the furnace.

[0028] The second part 1b of the furnace is next to the first part 1 a in the example. Flue gases travel in the second part 1 b of the furnace of this application substantially downwards (second direction F2). In the second part 1b the temperature of the flue gases decreases to the same level as in a furnace of a conventional recovery boiler. The temperature of the flue gases is lowered so that the superheaters will endure better. For example, the temperature of the flue gases when entering the second part 1b of the furnace is approximately 1150 °C and when leaving the second part approximately 900 to 1000 °C.

[0029] From the second part 1b of the furnace it is easy

to form a well controlled zone. The properties can be affected, for example, by the diameter of the second part 1 b of the furnace. With the dimensioning and fittings of the second part 1 b of the furnace it is possible to affect, *inter alia,* the temperature of the flue gases, the flow velocity and delay, and in addition, emissions. The second part 1 b of the furnace may also comprise additional burners, air nozzles and/or other additive supplies. The steady and controlled temperature and flow profile of the second part 1 b of the furnace can, if necessary be utilized, inter alia, in decreasing emissions, for example by using the SNCR method (selective non-catalytic reduction). The second part 1b of the furnace can, if necessary, also be utilized for controlling the corrosiveness of flue gases.

[0030] In the example of figure 2 the removal of flue gases takes place from the second part 1b of the furnace through such an aperture, whose upper edge is approximately in the mid-point of the wall of the furnace. The presented solution enables making the furnace 1 of the recovery boiler into such that its height is ½ to ¾ of the length of the furnace. The length of the furnace 1 here refers to the length of the furnace in the travel direction F1, F2 of flue gases. In the example of figure 2 the total length of the furnace 1 is the sum of the height of the first part 1a of the furnace and the second part 1 b of the furnace, in which case the height of the furnace is substantially half of the total length of the furnace. The low structure of the furnace 1 enables a lower structure of the recovery boiler plant than in known solutions, because the furnace is typically the highest part of the recovery boiler plant.

[0031] The first part 1 a of the furnace and the second part 1 b of the furnace are advantageously equally long. The length of the first part 1 a of the furnace may also be 60 to 140 % of the length of the second part 1 b of the furnace, depending on the application.

[0032] After the furnace 1 flue gases flow to the superheater area 2. The superheater area 2 is in the example located substantially lower than in conventional recovery boilers. Thanks to the two-part furnace, the superheaters 2 are not in direct visual contact with the flames of the furnace 1. This has an advantageous effect on the durability of the superheaters 2. Flue gases are directed from the second part 1 b of the furnace to the superheater area 2, where the superheaters are located sequentially in a cross-flow. In the example the superheaters 2 are of a so-called suspended type, in which case the stay clean easier. Heat exchange of the superheater area 2 can be efficiently optimized by the flow velocity of flue gases. In the present solution the dimensions of the different parts 1 a, 1 b of the furnace and the channels can be selected so that the desired flow velocity is achieved for flue gases.

[0033] The boiler bank area 3 is located immediately after the superheater area 2. The boiler bank area 3 comprises heat surfaces formed by elements formed of parallel tubes, i.e. boiler banks. In the example the boiler bank is also in an efficient cross-flow.

[0034] The economizer area 3 comprises heat surfaces, i.e. economizers, which are also formed by elements formed of parallel tubes. The economizers in the economizer area 4 may be of a cross-flow type. It is also possible to use longitudinal flow economizers, in which case, however, their length may have to be limited.

[0035] In addition, figure 2 shows a drum 9 belonging to the water and steam system. During use the drum 9 contains both water and steam, which are directed via pipeworks to different targets for heating the water and/for superheating the steam. For example, the drum 9 is connected to the walls of the furnace 1 and to different heat surfaces. Naturally the recovery boiler plant also comprises other structures, which are not shown in the figures. These kinds of structures are obvious to a person skilled in the art, but they are not essential for explaining and understanding the invention.

[0036] In the example according to figure 2 both the first part 1 a of the furnace and the second part 1 b of the furnace are vertical, i.e. flue gases F1, F2 travel substantially vertically in them. In another application according to figure 3 the first part 1 a of the furnace is vertical and the second part 1 b of the furnace is horizontal, in which case flue gases F2 travel substantially vertically in the second part. In a third application according to figure 4 the first part 1 a of the furnace is vertical and the second part 1 b of the furnace is diagonal, in which case flue gases F2 travel substantially diagonally in the second part.

[0037] It can be said that the furnaces according to figures 2 to 4 comprise a first combustion chamber (corresponds substantially to the first part 1a of the furnace) and a second combustion chamber (corresponds substantially to the second part 1 b of the furnace), which are connected to each other via an inversion chamber. In addition, the solutions according to figures 2 and 4 comprise a second turning chamber, which connects the second combustion chamber to the superheater area 2. In the combustion chamber the flue gases F1, F2 travel substantially linearly and in the turning chamber the direction of flue gases is changed.

[0038] In the recovery boiler plants shown in figures 2 to 4 the superheater area 2 and the furnace 1 are located in such a manner that they are horizontally parallel. Especially the superheater area 2 is located next to the second part 1 b of the furnace. The superheater 2 is not located directly above the furnace 1, especially the first part 1a of the furnace. Thus, the superheater area 2 is not in direct contact with the flames. The superheaters of the superheater area 2 are protected from the radiation of the furnace, as well as from black liquor drops escaping from the furnace, i.e. the so-called carryover. The advantageous location of the superheater area enables cheaper superheater structures than in known solutions.

[0039] In the furnace 1 the flue gases comprise substances used in the pulping process, which in the temperatures prevailing in the furnace are in a molten form. These substances are recovered for further use, which

is shy the first part 1 a of the furnace and the second part 1 b of the furnace comprise suitable means for recovering the smelt. For example, the second part 1 b of the furnace can be equipped with such smelt removal structures 6b, which bring the smelt from the second part to the first part 1 a of the furnace, substantially to the char bed on the bottom of the first part of the furnace, as shown in figures 2 and 3. The char bed is a smelt layer forming of the residue from the combustion process on the bottom of the furnace of the recovery boiler, which layer has a hill-like form.) Advantageously the smelt accumulating from the second part 1 b of the furnace can be changed in the first part 1a of the furnace to a better form from the point of view of the pulping process. The first part 1a of the furnace is preferably equipped with smelt removal structures 6a, through which the smelt is directed to the tank. For example, the smelt can be removed through spouts and apertures placed in the lower part of the furnace. It is also possible to place the smelt spouts 6a, 6b in the lower part of the first part 1 a of the furnace and the second part 1 b of the furnace in such a manner that via the smelt spouts the smelt is directed to a common tank for further use. One such a solution is shown in figure 4.

[0040] In the example the recovery boiler plant comprises a frame 7, which is used for supporting the structures of the recovery boiler plant. In the example the recovery boiler is suspended from the frame 7 in such a manner that both the first part 1 a of the furnace and the second part 1 b of the furnace are attached to the frame of the recovery boiler plant with suspension structures 8. Suspension takes place advantageously from the upper part of the furnace 1. The length of the boiler of the recovery boiler plant may vary due to the changes in the temperature, in which case the location of the lower part of the suspended boiler varies.

[0041] The discloses furnace structure 1 enables the modularization of the recovery boiler plant, in which case adding and/or reducing the capacity of the recovery boiler plant is possible within certain limits by adding/removing modules. For example, the first part 1a of the furnace is its own module, as well as the second part 1b of the furnace. Also the superheaters 2, boiler banks 3 and economizers 4 are advantageously their own modules. For example, in the beginning of the life cycle of a recovery boiler plant, less power is needed, but increased need of power should be prepared for. Thus, it is possible to obtain a relatively large first part 1a of the furnace, to which it is possible to supply larger amounts of fuel. A small module is selected as the second part 1 b of the furnace, to which the superheaters 2, boiler banks 3 and economizers 4 are connected. At a later stage when the power is increased, a module of another second part 1 b of the furnace is connected to the first part 1a of the furnace and to it, correspondingly, the superheaters 2, boiler banks 3 and economizers 4. Thus, the recovery boiler plant comprises double second parts 1 b of the furnace and superheaters 2, boiler banks 3 and economizers 4.

[0042] By combining, in various ways, the modes and structures disclosed in connection with the different embodiments of the invention presented above, it is possible to produce various embodiments of the invention in accordance with the spirit of the invention. Therefore, the above-presented examples must not be interpreted as restrictive to the invention, but the embodiments of the invention may be freely varied within the scope of the inventive features presented in the claims hereinbelow.

Claims

1. A recovery boiler plant, which comprises a recovery boiler, wherein in a first part (1a) of a furnace flue gases travel in a first direction (F1), **characterized in that** the furnace also comprises a second part (1b), where the flue gases travel in a second direction (F2), which second direction differs from the first direction (F1),and in addition the recovery boiler plant comprises a superheater area (2), which is located horizontally next to the second part (1 b) of the furnace.

2. The recovery boiler plant according to claim 1, **characterized in that** the first direction (F1) is upwards and the second direction is downwards (F2).

3. The recovery boiler plant according to claim 1 or 2, **characterized in that** the length of the first part (1a) of the furnace is 60 to 140 % of the length of the second part (1 b) of the furnace.

4. The recovery boiler plant according to claim 3, **characterized in that** the first part (1a) of the furnace and the second part (1 b) of the furnace are equally long.

5. The recovery boiler plant according to any of the preceding claims, **characterized in that** the recovery boiler plant comprises a frame (7), from which the first part (1a) and the second part (1 b) of the furnace are suspended.

6. The recovery boiler plant according to claim 4, **characterized in that** the first part (1 a) of the furnace and the second part (1 b) of the furnace comprise means (6a, 6b) for removing smelt.

7. The recovery boiler plant according to any of the preceding claims, **characterized in that** the second part (1b) of the furnace comprises means for controlling the corrosiveness of the emissions and flue gases.

8. A method in a recovery boiler, wherein flue gases in a furnace are brought to a first direction (F1) in a first

part (1a) of the furnace, **characterized in that** flue gases are brought in the furnace also to a second direction (F2) in a second part (1b) of the furnace, which second direction differs from the first direction (F1),and the flue gases are brought from the second part (1 b) of the furnace to a superheater area (2), which is located horizontally next to the second part (1b) of the furnace

9. The method according to claim 8, **characterized in that** in the second part (1 b) of the furnace additives are supplied to the flue gases in order to control emissions and corrosiveness.

10. The method according to claim 8 or 9, **characterized in that** the first direction (F1) is upwards and the second direction is downwards (F2).

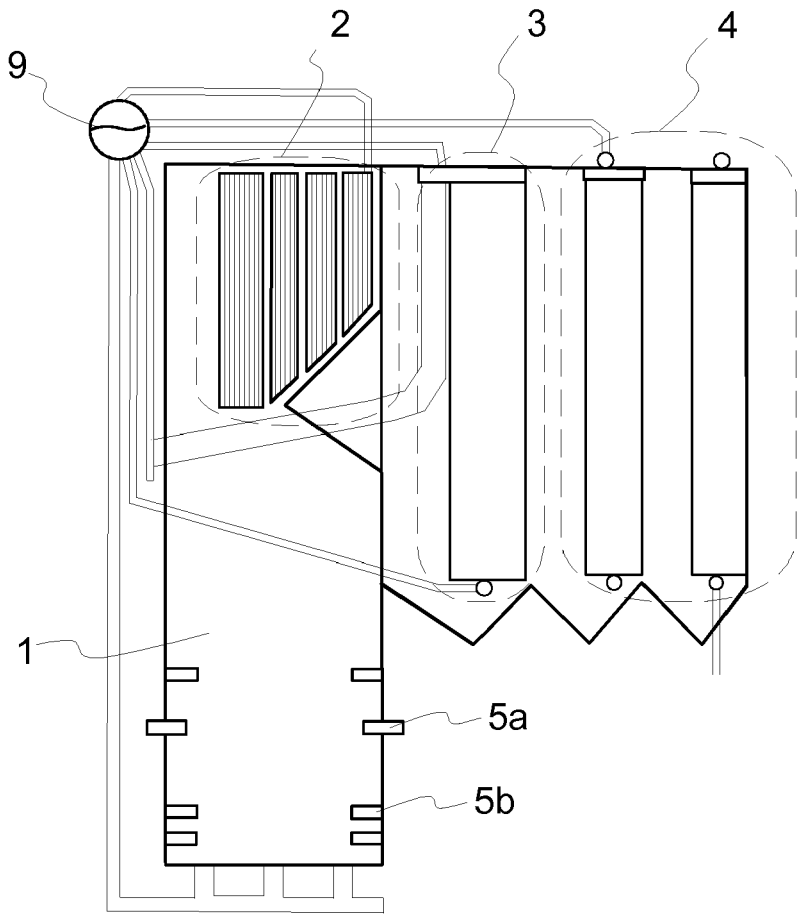

Fig. 1

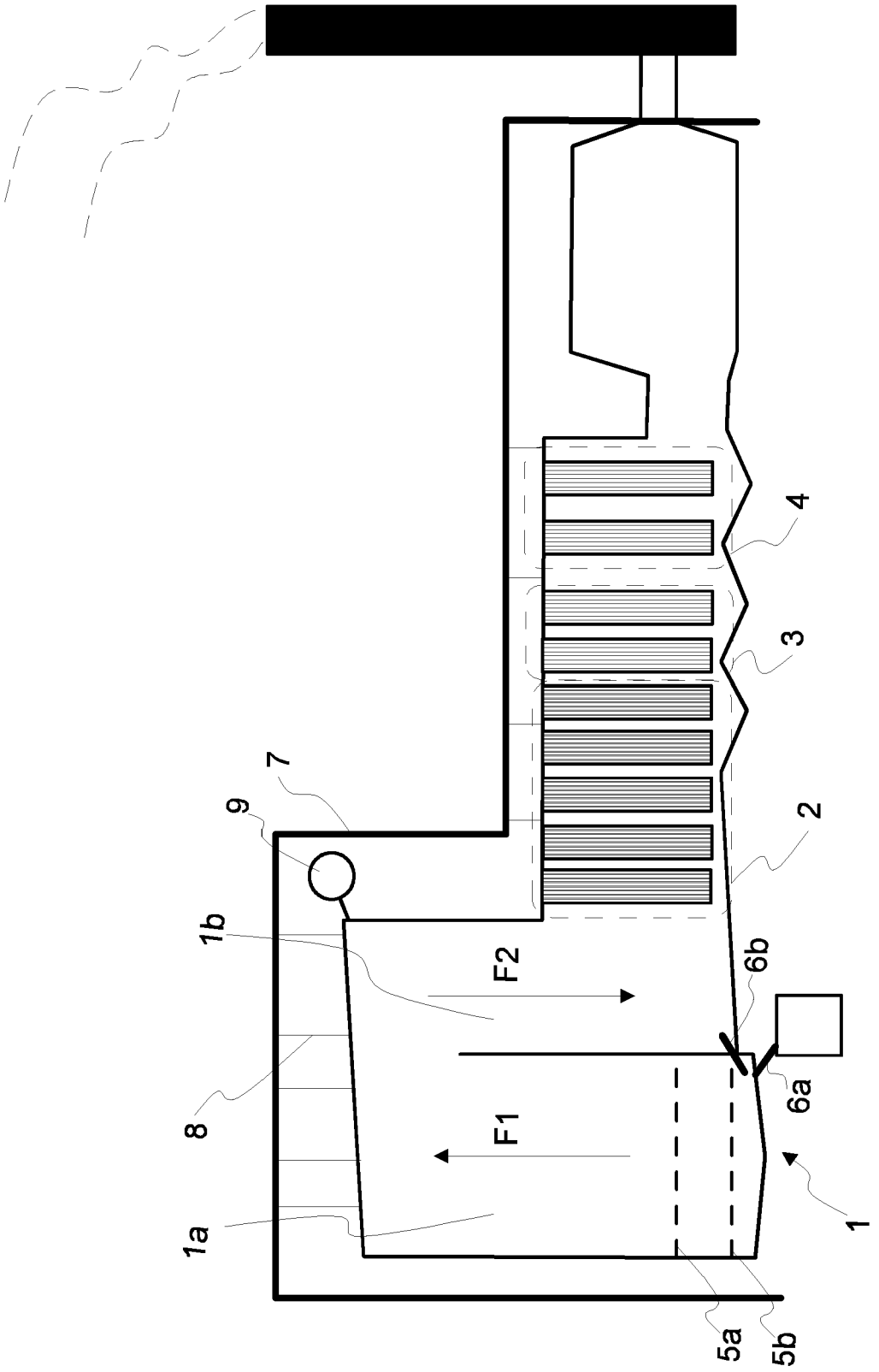

Fig. 2

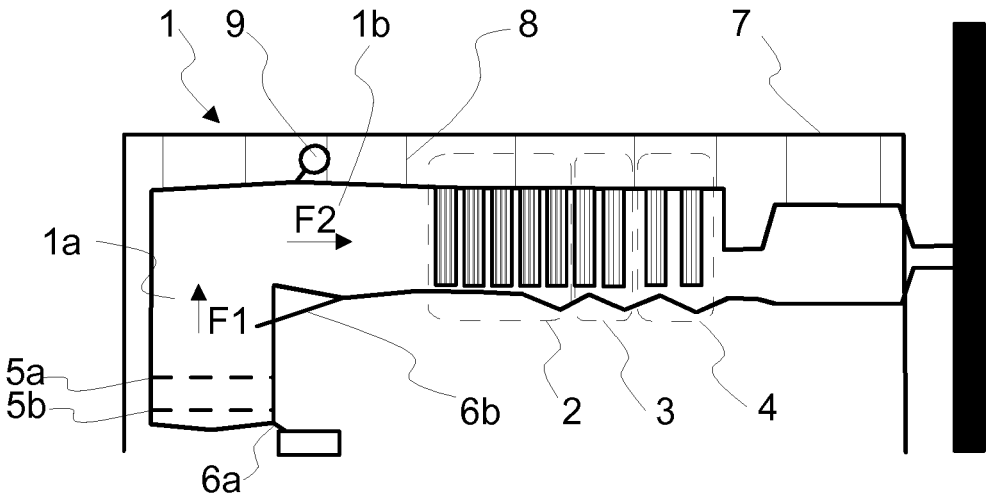

Fig. 3

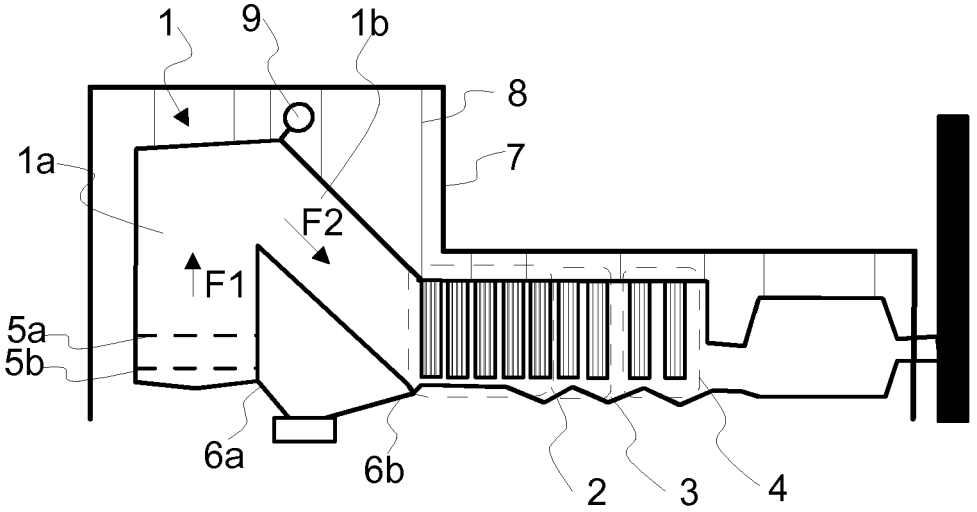

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 08 39 7512

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 October 2008	Naeslund, Per

CATEGORY OF CITED DOCUMENTS

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