



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.12.2022 Bulletin 2022/49

(51) International Patent Classification (IPC):
F23J 11/00 ^(2006.01) **F23G 5/00** ^(2006.01)

(21) Application number: **21177489.8**

(52) Cooperative Patent Classification (CPC):
F23J 11/00; F23G 5/00; F23J 2211/00;
F23J 2213/00

(22) Date of filing: **02.06.2021**

(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

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(54) **INCINERATION PLANT**

(57) The present invention relates to an incineration plant for solid material having

- a combustion chamber (1), in which solid material is introduced and in which the solid material is combusted, whereby flue gases are produced,
- at least three vertically aligned passes (2.1, 2.2a, 2.2b, 2.3) downstream of the combustion chamber (1), wherein
- at least one further pass (2.4) downstream of the at least three vertically aligned passes, wherein the at least three vertically aligned passes (2.1, 2.2a, 2.2b, 2.3) and the at least one further pass (2.4) are arranged such that the flue gases are advanced in a first horizontal direction (3) from the at least three vertically aligned passes (2.1, 2.2a, 2.2b, 2.3) to the further pass (2.4).

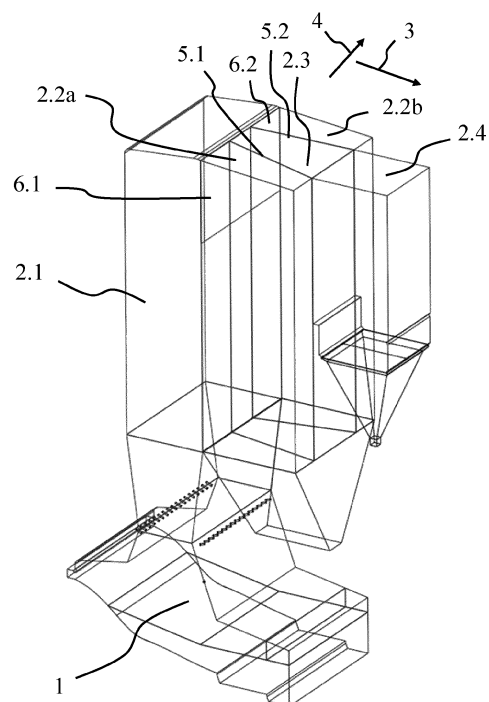


Fig. 1

Description

[0001] The present invention relates to an incineration plant for solid material (such as waste or biomass) having a combustion chamber, in which the solid material is introduced and in which the solid material is combusted, whereby flue gases are produced. The incineration plant further having at least three vertically aligned passes downstream of the combustion chamber, wherein at least one first vertically aligned pass is arranged downstream of the combustion chamber, wherein the flue gases advance upwardly within the at least one first pass, at least one second vertically aligned pass is arranged downstream of the first pass, wherein the flue gases advance downwardly within the at least one second pass, and at least one third vertically aligned pass is arranged downstream of the at least one second pass, wherein the flue gases advance upwardly within the at least one third pass, at least one further pass downstream of the at least three vertically aligned passes and the at least one further pass are arranged such that the flue gases are advanced in a first horizontal direction from the at least three vertically aligned passes to the further pass.

[0002] The incineration plant may also comprise a combustion material inlet and a feed shaft, in which feed shaft the solid material is introduced through the combustion material inlet and which feed shaft leads to the combustion chamber.

[0003] The present invention preferably relates to an incineration plant with a combustion grate in the combustion chamber, with which combustion grate the solid material and combusted solid material can be conveyed through the combustion chamber (also called grate firing). Preferably, a primary air supply is arranged below the top of the combustion grate.

[0004] The combustion grate is usually arranged within a lower section of the combustion chamber. The solid material (such as waste or biomass) and combusted solid material (such as ash and/or slag) can be conveyed by the combustion grate through the combustion chamber from an end of the combustion material feed shaft to a slag container. Primary air is supplied from below the combustion grate to the solid material arranged on the combustion grate, so that the solid material arranged on the combustion grate is combusted with the primary air. The main process steps on the grate (in the direction of travel of the solid material) are: drying of the solid material, devolatilization, combustion, afterburning of the solid residues (mainly ash and slag). The solid material and combusted solid material conveyed by the combustion grate is also referred to as solid material bed.

[0005] The combustion grate is preferably embodied as reciprocating grate, but it is also possible that the combustion grate is embodied in a different way, for example as vibrating grate, travelling grate or roller grate.

[0006] Additionally, nozzles may be arranged above the combustion grate within the combustion chamber

and/or within the first pass, with which nozzle(s) secondary air, tertiary air for afterburning or an oxygen poor carrier gas can be provided to the combustion gases.

[0007] The first pass (in German: erster Zug) is to be understood that part of the incineration plant, in which the combustion gases from the combustion chamber advance upwards, wherein secondary air, tertiary air for afterburning or other gases may be added to the combustion gases in the first pass.

[0008] A second and a third pass are arranged downstream of the first pass, each of the second and third pass extending vertically. The flue gases are deflected by 180° when entering from the first pass into the second pass and when entering from the second pass into the third pass. Accordingly, the flue gases meander along the first horizontal direction up and downwards from the combustion chamber to the outlet of the third pass. In a waste incineration plant the first horizontal direction is parallel to the length direction of the combustion chamber, which is measured in the main direction of travel of the solid material bed. The first pass, the second pass and the third pass are each preferably embodied as so-called empty passes, meaning that the passes have a free cross section without heat exchange means extending into the cross section.

[0009] Usually a horizontally aligned (in particular fourth) pass is arranged directly downstream of the third (empty) pass. The fourth (horizontal) pass usually comprises heat exchange tubes which extend through the through flown cross section, so that the flue gases flow around the heat exchange tubes within the fourth (horizontal) pass. The first direction is preferably parallel to the horizontal direction in which the fourth pass extends and in which the flue gases flow within the fourth pass.

[0010] The walls of the combustion chamber, of the first pass, of the second pass, of the third pass and of the subsequent passes are usually equipped with heat exchangers (i.e. tubes), wherein the heat exchange medium (such as water) of the heat exchangers is in particular provided to one common boiler drum. The walls of the combustion chamber are usually lined with refractory products (for example the combustion chamber has a cooled wall consisting of SIC masonry and an integrated or underlying membrane wall), while the wall of the first, second and third pass and further passes is usually directly formed by tubes, wherein adjacent tubes are interconnected by metallic sheets (also called fins). At least an upstream part of the first pass may be lined with refractory products.

[0011] A flue gas purification device downstream of the passes may comprise elements for dedusting, scrubbing and/or desulfurization (such as SCR) of the flue gas. A chimney may be arranged downstream of the flue gas purification device.

[0012] An incineration plant with the above described features is known from WO 2020 / 187 637A1. As the first, second and third passes are arranged behind each other in the first direction, the incineration plant requires

space within this first direction.

[0013] Accordingly, it is an object of the present invention to overcome the drawbacks of the prior art and in particular to provide an incineration plant, which is formed in a more compact manner.

[0014] This object may be achieved with an incineration plant with the features of the independent claim. Further solutions and preferred embodiments are disclosed in the subclaims and in the above and below description, wherein single features of the preferred embodiments can be combined with each other in a technical meaningful manner.

[0015] The object is in particular achieved with an incineration plant as described above, wherein at least two of the vertically aligned passes are arranged adjacent to each other in a second (horizontal) direction, the second direction being perpendicular to the first direction.

[0016] With other words, the present invention suggests that at least two (and preferably exactly two) of the vertically aligned passes are arranged perpendicular (obliquely) to the first direction, the first direction being in particular parallel to the direction of travel of flue gases within a horizontally aligned further pass downstream of the at least three vertically aligned (free) passes. This way the space covered by the at least three passes projected in a vertical direction can be reduced, as at least two of the vertically aligned passes are arranged beside each other with regard to the first direction (and not behind each other in the first direction). Accordingly, the flue gases are not only deflected upwards and downwards along the first direction but the flue gases are deflected perpendicular (orthogonal) to the first direction at at least one transition from one pass to the subsequent pass.

[0017] This arrangement also allows to form the transition from the third vertically aligned pass to the (fourth) horizontally aligned pass without a flow constriction due to both-sided backwards facing steps. For example, the third vertically aligned pass and the fourth pass may have the same width (orthogonal to the second direction). Alternatively, the walls of the third vertically aligned pass may be inclined towards the transition to the fourth pass. This way, a smooth flow distribution is given at the beginning of the fourth pass.

[0018] While it is principally possible that more than three vertically aligned passes are arranged downstream to each other, it is preferred that the incineration plant comprises exactly three vertically aligned passes, wherein a further (fourth) pass directly downstream of the third vertically aligned pass is aligned horizontally. The three vertically aligned passes are preferably free passes with a free cross section and the (fourth) horizontally aligned pass has heat exchange elements (such as heat exchange tubes) which extend through the cross section of the horizontally aligned pass.

[0019] To reduce the effort to withdraw the heat from the flue gases, it is suggested that directly adjacent vertically aligned passes, which in particular are arranged

adjacent to each other in the second direction, have a preferably water-cooled common wall.

[0020] To provide a smooth distribution of flue gas flow at the transition from one pass to the subsequent pass it is suggested that a common wall is inclined along the first direction. This means, the common wall extending in a vertically aligned plane is inclined with regard to the first direction. For example the common wall may have an inclination with regard to the first direction which is less than 30° but more than 5°.

[0021] Preferably, exactly one third horizontally aligned pass is embodied. The first and second horizontally aligned pass may each comprise multiple passes.

[0022] While it is principally possible, that all of the three vertically aligned passes are arranged adjacent to each other in the second direction, it is preferred that the at least one second vertically aligned pass and the at least one third vertically aligned pass are displaced in the first direction with regard to the preferably exactly one first vertically aligned pass and are adjacent to each other in the second direction. Accordingly, the second and third vertically aligned passes are behind the first vertically aligned pass in the first direction, while the second vertically aligned pass and the third vertically aligned pass are adjacent to each other in the second direction. This way, the first vertically aligned pass can extend over the whole widths (the width being in the second direction) of combustion chamber, while the second and third vertically aligned passes are arranged next to each other in the width direction (second direction) of the combustion chamber.

[0023] In order that the flow behavior of the flue gases is preferably uniformly/smoothly distributed in the transition region from the third vertically aligned pass to the horizontally aligned (fourth) pass a common wall between the at least one second vertically aligned pass and the third vertically aligned pass is inclined along the first direction. The common wall is preferably arranged in such a way, that a downstream end of the common wall is assigned to a side wall of the vertically aligned (fourth) pass.

[0024] In order to provide a very compact design of the incineration plant and in order to provide an even more efficient heat transfer from the flue gases to the heat exchangers in the wall of the incineration plant it is suggested that exactly one third vertically aligned pass is arranged between two second vertically aligned passes, wherein preferably the two second vertically aligned passes and the one third vertically aligned pass are displaced in the first direction with regard to the first vertically aligned pass. This way the one third vertically aligned pass is "sandwiched" between the two second vertically aligned passes (in which the flue gases advance downwards), so that the third vertically aligned pass has a common wall with each of the two second vertically aligned passes. Namely, the third vertically aligned pass has a first common wall with the first second vertically aligned pass and a second common wall with the second

second vertically aligned pass. Furthermore, in this case the third vertically aligned pass may have a common wall with the first vertically aligned pass. Accordingly, three of the usually four walls delimiting the third vertically aligned pass are common walls which comprise heat exchange means.

[0025] During operation of such an incineration plant the flue gases advance upwardly within the first vertically aligned pass, wherein the flue gases are deflected through a first transition into the first second vertically aligned pass and through a second transition into the second second vertically aligned pass. Accordingly, the wall delimiting the first vertically aligned pass towards the second vertically aligned passes and the third vertically aligned pass has two openings at its upper end, which openings form the transition to the second vertically aligned passes. In between these openings the wall is preferably a common wall with the third vertically aligned pass.

[0026] In one configuration of the embodiment it is preferred that the common walls (namely the first common wall and the second common wall) between the third vertically aligned pass and the two second vertically aligned passes are inclined towards each other so that the width of the third pass along the first direction increases. Accordingly, the first and second common wall extend in a vertically arranged plane, wherein the planes are inclined to each other, wherein it was found that the best flow behavior is given, if the width between the first and second common wall increases along the first direction from the side facing the first vertically aligned pass to the horizontally aligned (fourth) pass. This way, the heat exchange tubes extending over the flow through cross section of the fourth pass are optimally impinged by the flue gas, thereby enhancing the heat transfer efficiency, so that the length of the fourth pass may be reduced.

[0027] The invention and the technical background are described with regard to an exemplary embodiment shown in the figures. The figures show schematically

Figure 1: a perspective partly transparent view of an incineration plant,

Figure 2: a top view on passes of the incineration plant of figure 1.

[0028] The incineration plant depicted in the figures comprises a combustion chamber 1. A first vertically aligned pass 2.1 is arranged downstream and above the combustion chamber 1. The first vertically aligned pass 2.1 has a first opening 6.1 and a second opening 6.2 in its upper region.

[0029] The first opening 6.1 leads to a first second vertically aligned pass 2.2a and the second opening 6.2 leads to a second second vertically aligned pass 2.2b. The flue gases from the combustion chamber 1 advance upwardly within the first vertically aligned pass 2.1, wherein a part of the flue gases flow through the first

opening 6.1 into the first second vertically aligned pass 2.2a and the other part of the flue gases flow through the second opening 6.2 into the second second vertically aligned pass 2.2b. The flue gases advance downwardly within the first and second second vertically aligned passes 2.2a and 2.2b.

[0030] One vertically aligned third pass 2.3 is arranged downstream of the two second vertically aligned passes 2.2a and 2.2b. The third vertically aligned pass 2.3 has a first common wall 5.1 with the first second vertically aligned pass 2.2a and a second common wall 5.2 with the second second vertically aligned pass 2.2b. Furthermore, the third vertically aligned pass 2.3 has a common wall with the first vertically aligned pass 2.1. The common walls and also the other walls of the passes may comprise tubes in order to withdraw the heat from the flue gases. The flue gases advancing downwardly within the second vertically aligned passes 2.2a and 2.2b are deflected around the respective lower edge of the common walls 5.1 and 5.2 and advance jointly upwardly within the third vertically aligned pass 2.3.

[0031] A horizontally aligned further (fourth) pass 2.4 is arranged downstream of the third vertically aligned pass 2.3, wherein the flue gases advance in a first horizontal direction 3 within the horizontally aligned pass 2.4.

[0032] As can be seen from the figures the third vertically aligned pass 2.3 is arranged adjacent to the first second vertically aligned pass 2.2a and to the second second vertically aligned pass 2.2b in a second direction 4, which second direction 4 is perpendicular to the first direction 3. By such an arrangement the foot print of the vertically aligned passes (the cross section of the vertically aligned passes projected in a vertical direction) and in particular the overall lengths of the vertical aligned passes 2.1, 2.2a, 2.2b and 2.3 in the first direction 3 can be severely decreased.

[0033] In order to provide a favorable flow behavior of the flue gases and an efficient heat transfer within the horizontally aligned (fourth) pass, the first common wall 5.1 and the second common wall 5.2 are inclined to each other in such a manner, that the width between the first common wall 5.1 and the second common wall 5.2 (and therefore the widths of the third vertically aligned pass 2.3) in the second direction 4 increases along the first direction 3 towards the horizontally aligned pass 2.4.

Reference signs

[0034]

1	combustion chamber
2.1	first vertically aligned pass
2.2a	first second vertically aligned pass
2.2b	second second vertically aligned pass
2.3	third vertically aligned pass
2.4	horizontally aligned pass
3	first horizontal direction
4	second horizontal direction

- 5.1 first common wall
- 5.2 second common wall
- 6.1 first opening
- 6.2 second opening

Claims

1. Incineration plant for solid material having

- a combustion chamber (1), in which solid material is introduced and in which the solid material is combusted, whereby flue gases are produced,

- at least three vertically aligned passes (2.1, 2.2a, 2.2b, 2.3) downstream of the combustion chamber (1), wherein

- at least one first vertically aligned pass (2.1) is arranged downstream of the combustion chamber (1), wherein the flue gases advance upwardly within the at least one first pass (2.1),
- at least one second vertically aligned pass (2.2a, 2.2b) is arranged downstream of the first pass (2.1), wherein the flue gases advance downwardly within the at least one second pass (2.2a, 2.2b), and
- at least one third vertically aligned pass (2.3) is arranged downstream of the at least one second pass (2.2a, 2.2b), wherein the flue gases advance upwardly within the at least one third pass (2.3),

- at least one further pass (2.4) downstream of the at least three vertically aligned passes, wherein the at least three vertically aligned passes (2.1, 2.2a, 2.2b, 2.3) and the at least one further pass (2.4) are arranged such that the flue gases are advanced in a first horizontal direction (3) from the third vertically aligned pass (2.3) to the further pass (2.4),

characterized in that

at least two of the vertically aligned passes (2.2a, 2.2b, 2.3) are arranged adjacent to each other in a second horizontal direction (4), the second direction (4) being perpendicular to the first direction (3).

- 2. Incineration plant according to claim 1, wherein a further pass (2.4) directly downstream of the at least three vertically aligned passes is a horizontally aligned pass.
- 3. Incineration plant according to one of the preceding claims, wherein directly adjacent vertically aligned passes (2.2a, 2.2b, 2.3) have a common wall (5.1, 5.2).

4. Incineration plant according to claim 3, wherein the common wall (5.1, 5.2) is water cooled.

5. Incineration plant according to claim 3 or 4, wherein the common wall (5.1, 5.2) is inclined along the first direction (3).

6. Incineration plant according to one of the preceding claims, wherein the at least one second vertically aligned pass (2.2a, 2.2b) and the third vertically aligned pass (2.3) are displaced in the first direction (3) with regard to the first vertically aligned pass (2.1) and are adjacent to each other in the second direction (4).

7. Incineration plant according to claim 6, wherein a common wall (5.1, 5.2) between the at least one second vertically aligned pass (2.2a, 2.2b) and the third vertically aligned pass (2.3) is inclined along the first direction.

8. Incineration plant according to one of the preceding claims, wherein one third vertically aligned pass (2.3) is arranged in between two second vertically aligned passes (2.2a, 2.2b).

9. Incineration plant according to claim 8, wherein the third vertically aligned pass (2.3) has a common wall (5.1, 5.2) with each of the two second vertically aligned passes (2.2a, 2.2b).

10. Incineration plant according to claim 9, wherein the common walls (5.1, 5.2) between the third vertically aligned pass (2.3) and the two second vertically aligned passes (2.2a, 2.2b) are inclined towards each other, so that the width of the third pass (2.3) along the first direction (3) increases.

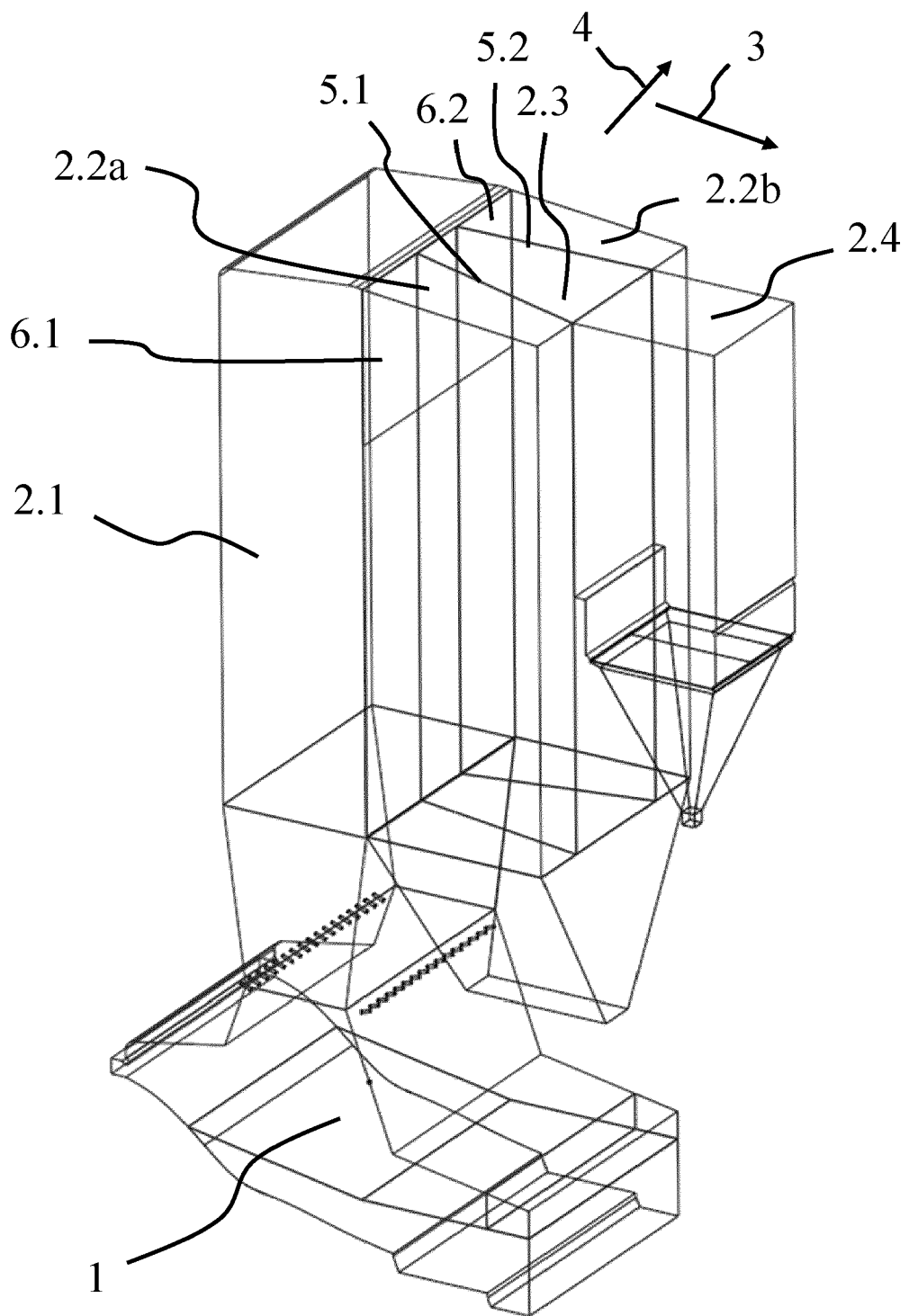


Fig. 1

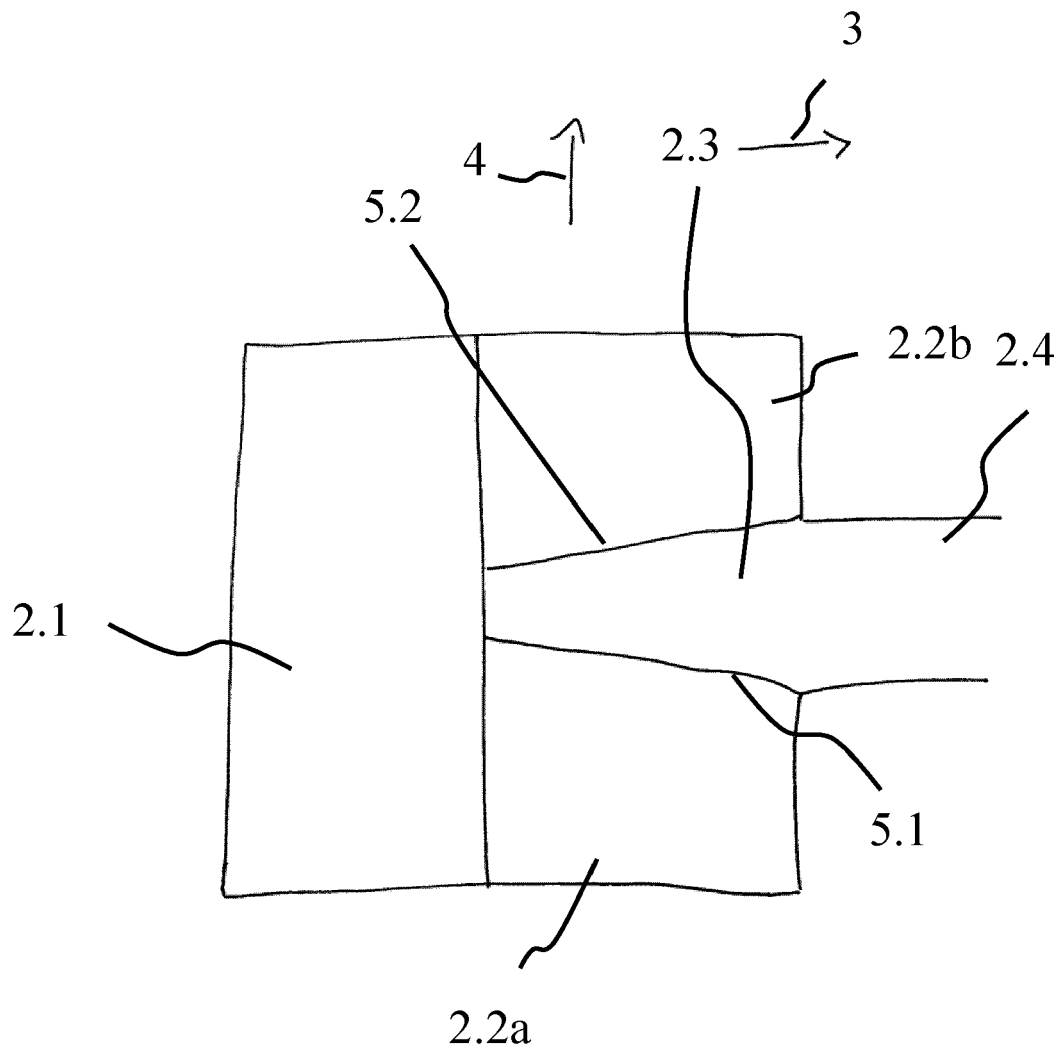


Fig. 2



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Application Number
EP 21 17 7489

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Place of search Munich		Date of completion of the search 17 November 2021	Examiner Vogl, Paul
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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