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(54) **Boiler and method of feeding of fuels, particularly straw bales in the boiler**

(57) A biomass combustion boiler, particularly firing full biomass bales (3), contains a pre-heating chamber (1) and a combustion chamber (2). A closing plate (4) is located outside the pre-heating chamber (1), in its basic position, and is insertable into the pre-heating chamber (1). In its inserted position it divides the pre-chamber (1) into a lower space (18) freely connected with the combustion chamber (2) and an upper space (19) for newly supplied fuel. Fuel, particularly full straw bales (3), is supplied to the boiler by first inserting closing plate (4) into the pre-heating chamber (1), by then opening of a drop gate (6) of the pre-heating chamber (1) and inserting the fuel into the pre-heating chamber (1). The drop gate (6) of the pre-heating chamber (1) then closes and finally, the closing plate (4) is removed from the pre- heating chamber (1). A pusher pressure piston (5) conveys parts of the fuel from the bottom of pre-heating chamber (1) into the combustion chamber (2).

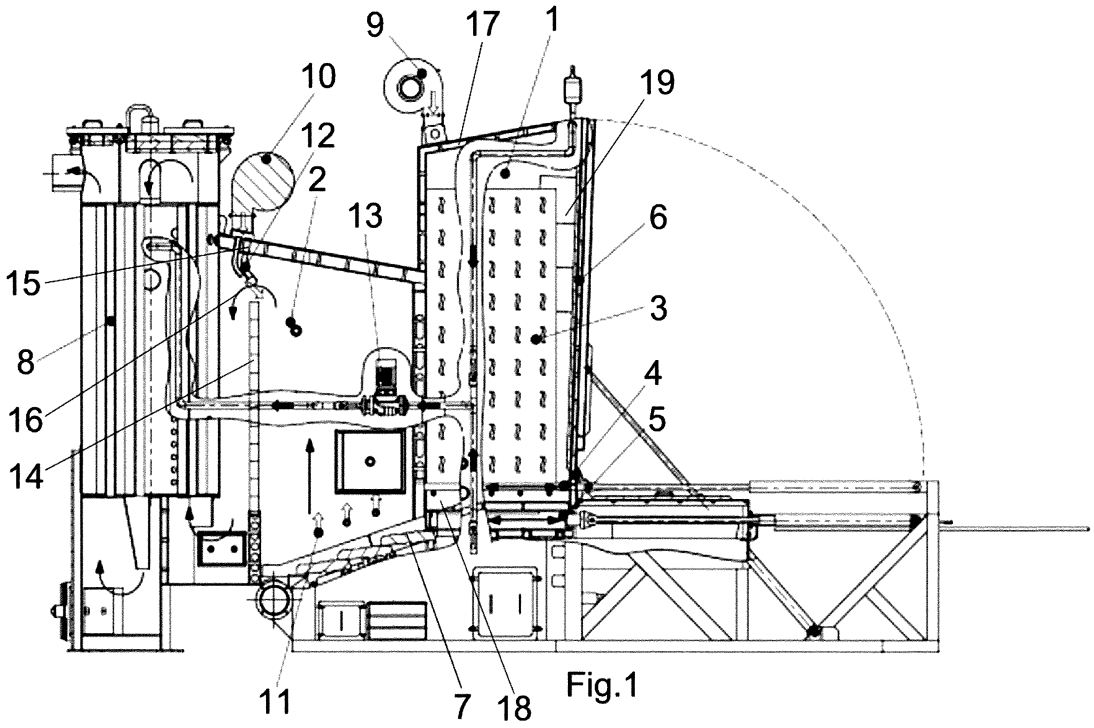

Fig.1

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Description

Technical Field

[0001] The present invention relates to a boiler, more specifically the boiler for combustion of fuels in the form of biomass, including but not limited to full biomass bales.

State of the Art

[0002] At present, a wide range of devices for combustion of biomass is known in the art. The devices also include boilers that allow combustion of straw bales. The devices can be divided into the devices that include a device for straw feeding from bale before feeding of the combustion straw to a combustion chamber and the devices that allow placing of full straw bales in the combustion chamber.

[0003] An example of the devices mentioned above is the device for combustion of mass of vegetable origin described in the patent document CS 228635. The device includes a compression chamber joined to a bin with loosely stored fuel. The compression chamber is fitted with a compression screw on a hollow shaft, wherein the shaft is connected to air supply and terminated in the combustion chamber to which output of the combustion chamber is terminated as well. A disadvantage of the device is that the used compression screw allows mass feeding that consists of small particles and feeding of e. g. full straw bales is thus impossible.

[0004] The utility design CZ 4408 describes a combustion chamber for combustion of wooden waste, scutch woody parts, and other flammable waste material, consisting of vertical front wall with fuel input, vertical rear wall and horizontal ceiling designed as water-tube system connected to a pressure section of the boiler, vertical side walls made from refractory material and grate in the lower part where there is a fixed grate in the combustion chamber in its one sixth up to one half of the combustion chamber as measured between the front and rear side in the front wall under the fuel entry located on the front wall, whereas the grate has cascade design and made from ceramic blocks shaped in flat cuboid and the blocks have grooves on the lower side, whereas inclination of the cascade goes from the front wall to the rear wall at 3 to 40 degrees and a movable grate joins the fixed grate. In this specific case, the fuel supply uses a fixed hopper and a portable bin. This is the main disadvantage of this technical solution, which makes it unusable for industrial large-scale use but usable for small combustion devices only.

[0005] Another utility design CZ 11182 describes a boiler for combustion of biomass connected to a heat exchanger, where the vertical boiler chamber is connected to the vertical heat exchanger section, arranged sidewise next to the vertical chamber with sealing arranged on the dividing plane. The heat exchanger section is suspended in swinging motion on the boiler case using a rocker consisting of a triangular swinging connecting member connected to the connecting bolt and an angular brace rod, wherein the triangular swinging member has its upper point pivotally connected with the heat exchanger section and lower point connected to the connecting bolt fixed to the boiler case and holding stability of the rocker, and the other lower point is pivotally supported with the upper end of angular brace rod with its lower point pivotally connected to a base. A disadvantage of the structure is that it is too complex and requires high production costs.

[0006] A device for combustion of full straw bales is also known from the utility design CZ 16473. This device is fitted with a suction fan for combustion products and combustion products pipeline. The combustion chamber is bounded by a dividing wall and rear wall and located inside a shell built on the base plate with left wall, right wall and ceiling, pre-chamber is in addition bounded by opening front wall and dividing wall, left wall, right wall and ceiling and the rear wall equals in height to the shell up to the ceiling under which there are combustion products holes in the rear wall. In its lower part, the dividing wall is shortened and one or multiple tubes connected under the dividing walls to right and left wall with clearance are fitted under the shortening, then there is an adjustable movable grate above the base plate in the inclination from opening front wall to rear walls, wherein the grate partially overlaps to the combustion chamber and there is space for straw supply to the combustion chamber between the upper area of adjustable movable grate and a lowest placed tube. The pre-chamber space is closed with the adjustable movable grate in the lower section, but the combustion chamber is defined in the lower section by the adjustable movable grates behind the dividing wall only and an ash-tray is located on the base area by the rear wall and combustion products duct is made behind the combustion product hole.

[0007] The patent CZ 302597 describes a boiler for combustion of biomass in the form of straw bales, which includes a pre-chamber, combustion chamber, and a heat exchanger. Folding loading gates are mounted on the pre-chamber that rotate around the rotation point located on their lower section. Disadvantage of the boiler is that the next straw bale can be supplied only after combustion of previous straw bale almost finishes. This breaches continuity of operation, wherein uncontrolled burning occurs during loading resulting in increased volume of hazardous substances in combustion products that may exceed pre-determined limits in extreme cases resulting in putting the boiler out of operation.

[0008] As can be seen from the descriptions above, prior art poses many disadvantages, wherein the most important are those described in the patent CZ 302597.

[0009] The aim of the invention is achieving of a boiler structure for continuous combustion of full biomass bales, wherein trouble-free compliance with all limits for hazardous substances in combustion products is attained.

Principle of the Invention

[0010] The deficiencies described above are to a high extent removed and aims of the invention are achieved by a boiler, particularly a boiler for combustion of fuel in the form of biomass, including but not limited full biomass bales, with a pre-chamber and a combustion chamber, wherein the grounds of the present invention lie in the fact that the boiler contains at least one closing plate located outside the pre-chamber in its basic position, wherein the closing plate is insertable into the pre-chamber to divide the pre-chamber into the space freely connected with the combustion chamber and the space for newly supplied fuel. An advantage of the present embodiment is that the insertable closing plate allows separation of the space freely connected with the combustion chamber from the space for newly supplied fuel and therefore, the controlled combustion process is not influenced by opening of a drop gate in any way. Hence, the main disadvantage of the prior art described above is removed.

[0011] In the most favourable embodiment, the closing plate is insertable to the pre-chamber so that full cross-section of the pre-chamber is closed. In this way, the spaces can be perfectly divided.

[0012] Favourably, the closing plate is insertable horizontally into the pre-chamber. This embodiment is favourable for functional reasons because the biomass bale can be placed in a stable way following its tipping from the drop gate to the closing plate.

[0013] In the favourable embodiment, the closing plate is placed in double-faced side guides and fluid cooled. This structure ensures long-term and failure-free operation of the closing plate, wherein risk of distortion of the closing plate and other potential destructions due to high temperature inside the pre-chamber, into which the closing plate is inserted, is greatly reduced.

[0014] Furthermore, it is favourable when the pre-chamber includes a pressure piston, which crosses the pre-chamber in its full cross section back and forth, wherein the most favourable embodiment is provided with the pressure piston in horizontal position. The embodiment is favourable because quality opening of the biomass bale is possible with subsequent movement of the open biomass towards the combustion chamber.

[0015] In the favourable embodiment, the combustion chamber includes at least one secondary air nozzle in the ceiling above brick partition wall, wherein the nozzle is directed against combustion products flow from the combustion chamber to the heat exchanger. Therefore, the conditions for perfect combustion resulting in reduced contents of pollutants in the combustion products can be achieved.

[0016] It is also favourable when the boiler includes also a circulating pump for forced fluid flow through the cooled pre-chamber, drop gate, and the closing plate. The circulating pump is located under ceiling of the pre-chamber so that it draws fluid with common discharge to the heat exchanger from the pre-chamber, drop gate, and the closing plate. This embodiment is favourable for protection of said spaces against overheating and reduces combustion temperature at the same time, which is favourable with respect to good combustion of culm grasses where lower combustion temperature is required when compared e.g. to wood substances.

[0017] The deficiencies described above are to a high extent removed and aims of the invention are achieved by the method of fuel supply, particularly the method of supply of fuel in the form of full biomass bales to the boiler according to this invention, wherein the closing plate is inserted first to the pre-chamber followed by opening of the drop gate of the pre-chamber and the fuel is supplied to the pre-chamber, the drop gate of the pre-chamber then closes and finally, the closing plate is removed from the pre-chamber. This method of the boiler fuel supply allows continuous combustion of fuel that is supplied to the boiler in steps usually arranged in the form of bales.

[0018] The boiler according to the invention allows continuous combustion of fuel supplied in discontinuous way, wherein keeping of suitable combustion conditions is possible as well, which results in compliance with emission limits applicable to pollutants in the combustion products.

Overview of the Figures

[0019] The invention will be described in more detail using the drawing, wherein Fig. 1 illustrates a schematic arrangement of the boiler in side view.

Example of the Performance of the Invention

[0020] The boiler for combustion of fuel in the form of full biomass bales 3, including but not limited in the form of biomass (Fig. 1), contains the pre-chamber 1 and the combustion chamber 2.

[0021] The boiler contains a closing plate 4, which is located outside the pre-chamber 1 in its basic position and insertable into the pre-chamber 1 to divide the pre-chamber 1 into the space 18 freely connected with the combustion chamber 2 and the space 19 for newly supplied fuel.

[0022] The closing plate 4 is insertable to the pre-chamber 1 so that full cross-section of the pre-chamber is closed.

[0023] The closing plate 4 is placed in double-faced side guides.

[0024] The closing plate 4 is fluid cooled.

[0025] Furthermore, the pre-chamber 1 contains a pressure piston 5 that crosses pre-chamber 1 in its full cross section back and forth. The pressure piston 5 is located horizontally.

[0026] The combustion chamber includes 5 secondary air nozzles 12 in the ceiling 15 above brick partition wall 14, wherein the nozzles are directed against combustion products flow 16 from the combustion chamber 2 to the heat exchanger 8. The secondary air nozzles 12 are con-

nected to the secondary air fan 10 located on the ceiling 15 of the combustion chamber 2.

[0027] The primary air fan 9 connected with the primary air nozzles 11 is located on the ceiling 17 of the pre-chamber 1.

[0028] Furthermore, the boiler includes a circulating pump 13 for forced fluid flowing through the pre-chamber 1, a drop gate 6, and the closing plate 4, wherein it is located under the ceiling 17 of the pre-chamber 1 so that it draws liquid with common discharge to a heat exchanger 8 from the pre-heating chamber 1, the drop gate 6, and the closing plate 4.

[0029] According to the method of fuel supply in the form of full biomass bales 3 in the boiler, the closing plate 4 is inserted first to the pre-chamber 1 followed by opening of the drop gate 6 of the pre-chamber 1 and the fuel is supplied to the pre-chamber 1, the drop gate 6 of the pre-chamber 1 then closes and finally, the closing plate 4 is removed from the pre-chamber 1. The movable pressure piston 5 moves a part of open biomass bale 3 on ongoing basis to the fire chamber 7.

Industrial Application

[0030] The boiler according to the invention can be used for combustion of biomass, including but not limited to the biomass arranged in the form of bales, including but not limited to big cube straw or hay bales.

List of Reference Marks

[0031]

1	pre-chamber
2	combustion chamber
3	bale
4	closing plate
5	pressure piston
6	drop gate
7	fire chamber
8	heat exchanger
9	primary air fan
10	secondary air fan
11	primary air nozzle
12	secondary air nozzle
13	circulating pump
14	brick partition wall
15	ceiling
16	flow of combustion products
17	ceiling of pre-chamber
18	space freely connected to the combustion chamber
19	space for newly supplied fuel

Claims

1. A boiler, including but not limited to the boiler for combustion of fuel in the form of biomass, including but not limited to form of full biomass bales (3), containing a pre-chamber (1) and a combustion chamber (2), **characterized in that** it contains at least one closing plate (4) located outside the pre-chamber (1) in its basic position, wherein it is insertable into the pre-chamber (1) to divide the pre-chamber (1) into the space (18) freely connected with a combustion chamber and the space (19) for newly supplied fuel.

2. The boiler according to claim 1 **characterized in that** the closing plate (4) is sildable to the pre-chamber (1) so that full cross-section thereof is closed.

3. The boiler according to any of the preceding claims **characterized in that** the closing plate (4) is insertable horizontally to the pre-chamber (1).

4. The boiler according to any of the preceding claims **characterized in that** the closing plate (4) is placed in double-faced side guides.

5. The boiler according to any of the preceding claims **characterized in that** the closing plate (4) is cooled.

6. The boiler according to any of the preceding claims **characterized in that** the pre-chamber (1) further contains a pressure piston (5) that crosses the pre-chamber (1) in its full cross section back and forth.

7. The boiler according to claim 6 **characterized in that** the pressure piston (5) is located horizontally.

8. The boiler according to any of the preceding claims **characterized in that** the combustion chamber (2) contains at least one secondary air nozzle (12) in the ceiling (15) above brick partition wall (14), wherein the nozzle is directed against combustion products flow (16) from the combustion chamber (2) to the heat exchanger (8).

9. The boiler according to any of the preceding claims **characterized in that** it further includes a circulating pump (13) for forced fluid flowing through the pre-chamber (1), a drop gate (6), and the closing plate (4) that is located under the ceiling (17) of the pre-chamber (1) so that it draws liquid with common discharge to the heat exchanger (8) from the pre-heating chamber (1), the drop gate (6), and the closing plate (4).

10. A method of fuel supply, including but not limited to fuel supply in the form of full biomass bales (3) to the boiler according to any of the preceding claims, **characterized in that** the closing plate (4) is inserted first to thepre-chamber (1) followed by opening of the drop gate (6) of the pre-chamber (1) and the fuel is supplied to the pre-chamber (1), the drop gate (6) of the pre-chamber (1) then closes and finally, the closing plate (4) is removed from the pre-chamber (1).

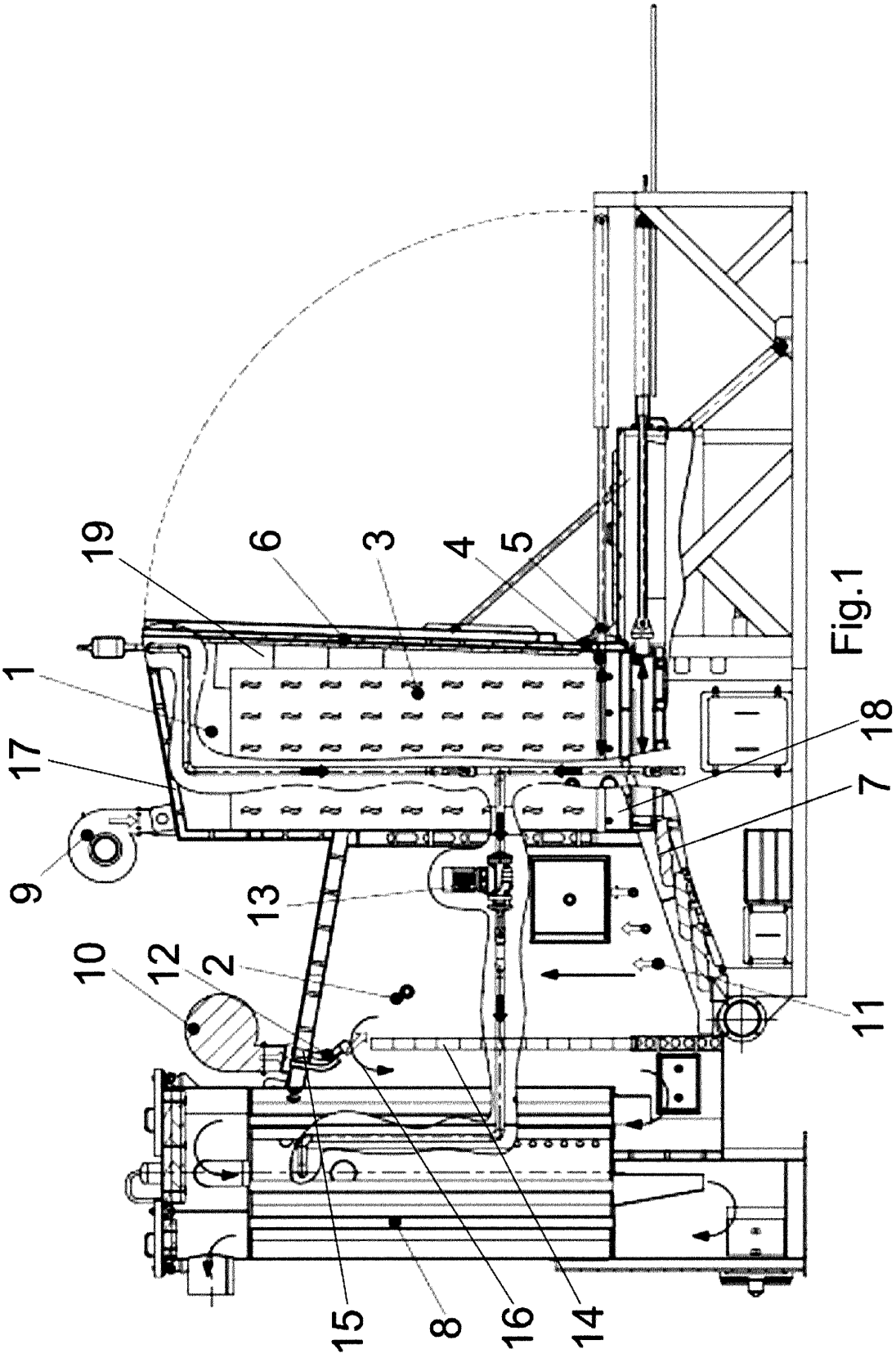

Fig.1

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EUROPEAN SEARCH REPORT

Application Number
EP 14 46 6003

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 Y	SK 500 302 011 A3 (TTS ENERGO S R O [CZ]) 4 February 2013 (2013-02-04) * the whole document * -----	1-3,5-8, 10 9	INV. F23B30/10 F23B40/00 F23B90/04
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TECHNICAL FIELDS SEARCHED (IPC)

F23B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 April 2014	Vogl, Paul

CATEGORY OF CITED DOCUMENTS

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24-04-2014

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- CS 228635 **[0003]**
- CZ 4408 **[0004]**
- CZ 11182 **[0005]**
- CZ 16473 **[0006]**
- CZ 302597 **[0007] [0008]**