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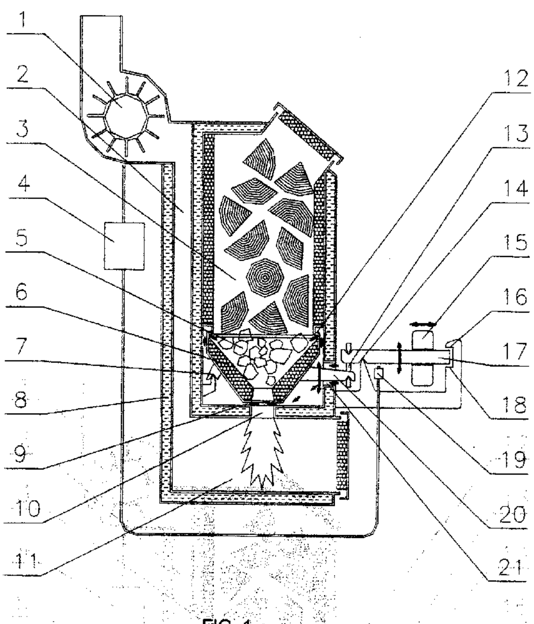

FIG. 1

(57) Abstract: The burning boiler with automatic detection of the optimum thickness of the basic fuel layer containing the movable bottom (6), while this movable bottom (6) of the loading area (3) is interconnected with the position sensor (19) or force sensor (26) for detecting the optimum thickness of the basic fuel layer. According to the advantageous embodiment of the invention, the position sensor (19) or the force sensor (26) is interconnected with the controller (4) which controls the combustion product: fan (1). The surfaces (6.1) of the movable bottom (6) of the loading area (3) are integral and tilted down towards the combustion product exhaust nozzle (10). The top edge of the movable bottom (6) determines the primary air supply (12) in the loading area (3). The bottom edge of the movable bottom (6) determines the secondary air supply (9) in the nozzle (10).

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BOILER WITH AUTOMATIC DETECTION OF OPTIMUM THICKNESS OF THE FUEL LAYER

Technical Field

The invention concerns burning boilers with automatic detection of the optimum thickness of the basic fuel layer, in particular solid fuel boilers.

Background Art

More sophisticated designs, which are characterized by a higher combustion quality and better operating comfort are more and more popular in the field of solid fuel combustion. They are represented mainly by the boilers with bottom burning and manual fuel loading, specifically gasification boilers.

The bottom burning boilers, also called two-chamber boilers, are either of grate-type or gasification-type.

The grate boilers have a grate at the bottom of the loading area and usually a slot for burning gas exhaust in the burn-out area on one side just above the grate. The loading area and the burn-out area are usually positioned beside each other. There is a space for ash under the grate. These boilers are used for the combustion of coal or wood.

The gasification boilers have a compact bottom which is usually flat with a slot for the burning gas exhaust in the centre of this bottom. The burn-out area is usually positioned under the loading area. These boilers are used mostly for the combustion of wood.

Unlike burn-through heaters where flames flow upwards through the fuel, fuel in bottom burning boilers burns only in the bottom part of the loading area. Secondary air is supplied in the stream of burning gases in the slot (nozzle) and combustible gases are burnt out in the burn-out area. In case of grate boilers, ash drops under the grate, while in the gasification boilers a part of the ash usually remains on the bottom of the loading area, while some of the ash is carried away with a stream of combustion products in the burn-out area.

Bottom burning boilers reach significantly better parameters when compared with structurally simpler burn-through heaters, called also single-chamber boilers. They save the environment, provide better comfort for operation and, above all, they offer better fuel utilization.

More sophisticated heaters often allow detection of loaded fuel burning out up to so called basic layer. The basic layer means the glowing carbon parts remaining from the loaded fuel.

If the heater controller detects fuel burning out up to the basic layer during operation, the combustion air supply is stopped and the heater switches to "keeping embers mode". A sufficiently thick basic layer keeps the fire burning in this condition for several hours. It also allows consequent restoration of operation without ignition, by adding fuel only. A sufficiently thick basic layer is also desirable if the fire is later extinguished completely as it makes ignition considerably easier thanks to the fact that it can be used as ignition fuel.

Currently popular heaters are able to detect the basic layer on the basis of the temperature of combustion products, the time interval from the last fuel loading or the quantity of oxygen in combustion products. However, the disadvantages of all these methods are relatively high inaccuracy and unreliability. During operation, it happens that the basic layer detected is either too thin or, on the contrary, too thick.

A thin basic layer is undesirable because of the loss of slow-burning ability, i.e. it shortens the period of fuel glowing, which increases demands for operation when igniting again. Another disadvantage is represented by the fact that there is a great excess of air during burning when the boiler is operated with a thin basic layer, i.e. most of combustion air does not participate in the burning, and discharges heat in the chimney without the required effect. Moreover, the too great air excess cools the burning process, which results in a higher production of harmful combustion products, above all carbon monoxide.

A too-thick basic layer is also undesirable owing to the fact that it contains volatile fuel components which are released in a form of hydrocarbons, acids and water vapour during slow-burning shut-down mode. Hydrocarbons contaminate the atmosphere and cause deposits on the internal walls of heaters and chimneys while acids and humidity cause corrosion, with a consequent shortening of the service life of both the heater and the chimney.

The ability to detect the optimum size, volume or weight of the basic layer is a key feature of the heater, which also results in the improvement of the heater's and chimney's comfort, safety and service life, and better general economy and environmental protection during operation.

The only known heater in which this principle is used is the VERNER Ik 13/10.2 fireplace - a single-chamber burn-through heater - which has been sold since 2012. The grate is installed in a rotary mounting on one side of this heater so that it allows slight tilting. The weight of the other side is transferred by a brace to the shorter arm of a double-arm lever. A flap for combustion air and a movable bob is attached to the longer arm of this lever. After loading, the weight of the fuel acts on the grate which overbalances the lever by the brace so that the shorter arm is in the lower position and the longer one in the upper position – i.e. the flap for combustion air will be open. The arm is overbalanced in the opposite position after the fuel burns up to the basic layer and the flap for combustion air covers the air supply opening – the heater switches to "keeping embers mode".

A solution according to the utility model No. 24378 by Ing. Robert Verner is also popular. In general, this solution claims an idea of control of combustion on the basis of the continuous monitoring of fuel weight in the combustion area. It does not consider the detection of the basic layer specifically.

It is not known that there a heater exists with bottom burning or with two-chamber design which utilizes the information on the basic layer weight to detect the optimum size of the basic layer. In the case of the heater with bottom (two-chamber) burning, specifically with the gasification boiler, weight detection is considerably more technically demanding when compared with the heater with bottom (single-chamber) burning. It requires an original design of the connection of the weighing mechanism to the controller and also an original primary and secondary air supply design. As to the gasification boilers, this design requires a continuous ash discharge system (as ash which accumulates on the bottom of the loading area in most existing gasification disables precise detection of the weight of the remaining fuel.

Disclosure of Invention

Deficiencies in popular boilers are eliminated to a considerable extent by the boiler according to the invention which incorporates a movable bottom. The essence of the invention consists in the fact that the movable bottom of the loading area is interconnected with a position sensor or a force sensor for detection of the optimum thickness of the basic fuel layer.

According to the first advantageous embodiment of the invention, the position sensor or the force sensor is interconnected with the controller which controls the combustion product fan.

The boiler operates so that the controller obtains information about fuel burning out up to the basic layer on the basis of the bottom tilting.

E.g. there is a boom on one side of the movable bottom; this boom is interconnected with, for example a double-arm lever under which a position sensor is installed. The position sensor is interconnected with the boiler controller. Fuel burning out up to the basic layer will result in lever deflection which will activate the position sensor. The controller will turn off the fan on the basis of information from the position sensor, and the boiler switches to slow-burning mode. Structurally, the lever mechanism can be substituted with a spring. When the boom is interconnected with a force sensor, this force sensor informs the regulator of the force of the boom acting on it during operation. The controller compares then this information with the adjusted value. If both the values are identical, the fan for combustion products is turned off and the boiler switches to slow-burning mode.

The afore-mentioned embodiments can be combined in various ways, e.g. it is possible to have a force sensor in contact with the lever mechanism instead of a position sensor e.g. in order to reduce the force of the boom acting on the sensor and to allow a cheaper force sensor to be chosen.

It is advantageous for the application of the invention to the gasification boilers when the surfaces of the bottom of the loading area are integral and tilted towards the combustion product discharge nozzle.

The design according to the invention is able to detect the optimum size of the basic layer precisely and reliably on the basis of an implemented device which detects the weight of this basic layer.

An overview of figures in the drawings

The invention is clarified in more detail in the attached drawings, which depict:
Fig. 1 Schematic side view of the boiler in which a lever with a position sensor is used.
Fig. 2 Schematic side view of the boiler in which a spring is used instead of the lever mechanism illustrated in Fig. 1.
Fig. 3 Schematic side view of the boiler in which a force sensor is used.

Examples of invention embodiments

An example of an embodiment of the invention illustrated in Fig. 1 is described using a specific heater – a gasification boiler for wood pieces. Its basis consists of a steel body with water-cooled walls 8. The body contains the loading area 3 which is interconnected in its lower part with the nozzle 10 with the burn-out area 11, which is interconnected with the combustion product exchanger 2. The walls of the loading area 3 are lined with refractory material. The movable bottom 6 of the loading area 3 is formed of a steel body with the shape of a truncated cone narrowing in the direction down, lined by refractory material, so that its surfaces are tilted towards the nozzle 10. The movable bottom 6 is of a tilting type with the turning axis in a pair of blade edge mountings 7 positioned on one side of the movable bottom 6. There is a boom 20 on the opposite side of the movable bottom 6 which passes through a passage in the bottom which forms a route for combustion air supply 21. The boom 20 is interconnected through the bolt 13 with the shorter arm of the double arm lever 17 with the turning axis in the blade edge mounting 14 of the lever. The longer arm of the double-arm lever 17 contains the movable bob 15. There is a position sensor 19 consisting of an electric proximity sensor positioned under the longer arm of the lever 17. The sensor 19 is connected through a wire to the controller 4, which controls combustion product exhaust fan 1.

The function of the described example of embodiment from Fig. 1 is as follows:

Fuel gasification takes place in the loading area 3 as a result of primary air supplied through the inlet 12. In this way, fuel is converted to the basic layer 5, which is formed by glowing carbon material and, at the same time, it releases hot gases which flow through the nozzle 10, where secondary air is supplied in them through the secondary air inlet 9. Combustible components of hot gases are burnt in the burn-out area 11 as a result of the effect of secondary air. The created combustion products flow through the combustion product exchanger 2, where they pass their heat into the water cooled walls 8. Circulation of air, gases and combustion products in the boiler is carried out by means of the combustion product fan 1 controlled by the controller 4. Ash from burnt fuel slides down the tilted areas of the movable bottom 6 in the burning-out area 11. The weight of the movable bottom 6 and fuel loaded on it is partially supported by the blade edge mounting 7; the remaining weight of the movable bottom 6 is supported by the boom 20 through the bolt 13 on the shorter arm of the lever 17. The longer arm of the lever 17 is affected by its own weight and by the weight of the bob 15. The weight is positioned so that the balance of forces on the lever 17 occurs in the condition when there is a weight corresponding to the optimum thickness of the basic layer 5 acting on the movable bottom 6.

After the user loads the fuel, the weight of fuel and movable bottom 6 overbalances the lever 17 so that its longer arm is lifted and supported on the top stop 16, while the movable bottom 6 is slightly tilted down. When the loaded fuel is burnt out up to the basic layer 5, the longer arm of the lever 17 with the bob 15 overbalances the weight of the basic layer 5 and the movable bottom 6, which results in the lowering of the longer arm of the lever 17 thus activating the position sensor 19, and it is supported on the bottom stop 18 simultaneously. The movable bottom 6 is tilted slightly upwards as a result of this action. The position sensor 19 sends the controller 4 information by a wire that a fuel load has been burnt out up to the adjusted basic layer 5. The controller then interrupts the boiler operation - it turns the combustion product fan 1 off. The user of the boiler usually starts the fan several hours (3-6 hours) after the interruption of the operation, loads more fuel in the loading area 3 of the boiler and the complete process is repeated. If the basic layer 5 is extinguished completely (after approximately 8 hours), the user fires the layer again by putting a piece of burning paper or firelighter on it and only then adds another fuel load.

The boiler illustrated in Fig. 2 differs from the preceding one by using the draw spring 22 instead of the lever mechanism with the bob; the spring is attached to the boom 20 of the movable bottom 6 on one end and to the bolt with lug 23 with the control nut 25 which catches the bolt with lug 23 in the catcher 24 on the other end.

The function of the boiler from Fig. 2 differs from the example of the embodiment from Fig. 1 by the fact that the boom 20 is lifted by pull of the spring 22. The control nut 25 is adjusted so that preloading of the spring 22 creates such a force so that the boom 20 is deflected upwards after reaching the optimum basic fuel layer 5 and the position sensor 19 is activated.

The boiler illustrated in Fig. 3 differs from the preceding embodiments by the fact that the boom 20 is in contact with the force sensor 26, which is interconnected with the controller 4.

Operation of the boiler in Fig. 3 differs from the preceding examples of embodiments by the fact that the force sensor 26 informs the controller 4 about the force of the boom 20 acting on it during operation. The controller 4 compares this information with the adjusted value and when the values are identical, the controller 4 turns the combustion product fan 1 off and the boiler switches to "keeping embers mode". Adjustment of the basic layer thickness is carried out by means of the controller elements (buttons) 4.

What the embodiments in Figs. 1 and 2 have in common is the operation of the lever mechanism or spring 22, which balances the boom force and thus allows its movement. The balance of forces then results in deflection which is detected by the position sensor 19. Adjustment of the thickness of the basic layer 5 is carried out mechanically.

In case of the boiler embodiment in Fig. 3, the force of the boom 20 is intercepted directly by the force sensor 26 interconnected with the controller 4. The adjustment of the thickness of the basic layer is carried out electronically.

CLAIMS

1. The boiler with burning with automatic detection of the optimum thickness of the basic fuel layer (6) **characterized in that** the movable bottom (6) of the loading area (3) being interconnected with the position sensor (19) or force sensor (26) for detecting the optimum thickness of the basic fuel layer.

2. The boiler according to the claim 1, **characterized in that** the position sensor (19) or force sensor (26) being interconnected with the controller (4) which controls the combustion product fan (1).

3. The boiler according to the preceding claims **characterized in that** the surfaces (6.1) of the movable bottom (6) of the loading area (3) being integral and tilted down towards the combustion product exhaust nozzle (10).

4. The boiler according to the preceding claims **characterized in that** the top edge of the movable bottom (6) determining the primary air supply (12) in the loading area (3).

5. The boiler according to the preceding claims **characterized in that** the bottom edge of the movable bottom (6) determining the secondary air supply (9) in the nozzle (10).

List of reference symbols

1. Combustion product fan
2. Combustion product exchanger
3. Loading area
4. Controller
5. Basic fuel layer
6. Movable bottom
7. Bottom blade edge mounting
8. Water cooled walls
9. Secondary air supply
10. Nozzle
11. Burn-out area
12. Primary air supply
13. Bolt
14. Lever blade edge mounting
15. Bob
16. Top stop
17. Lever
18. Bottom stop
19. Position sensor
20. Boom
21. Combustion air supply
22. Spring
23. Bolt with lug
24. Catcher
25. Nut
26. Force sensor

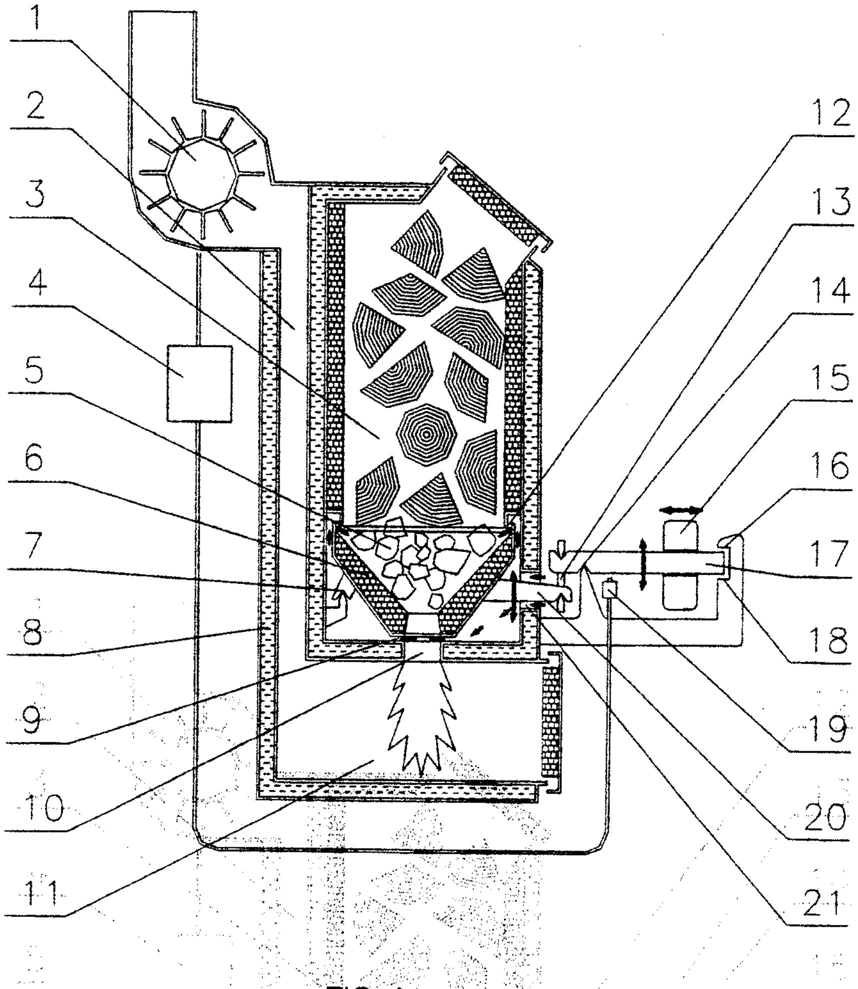


FIG. 1

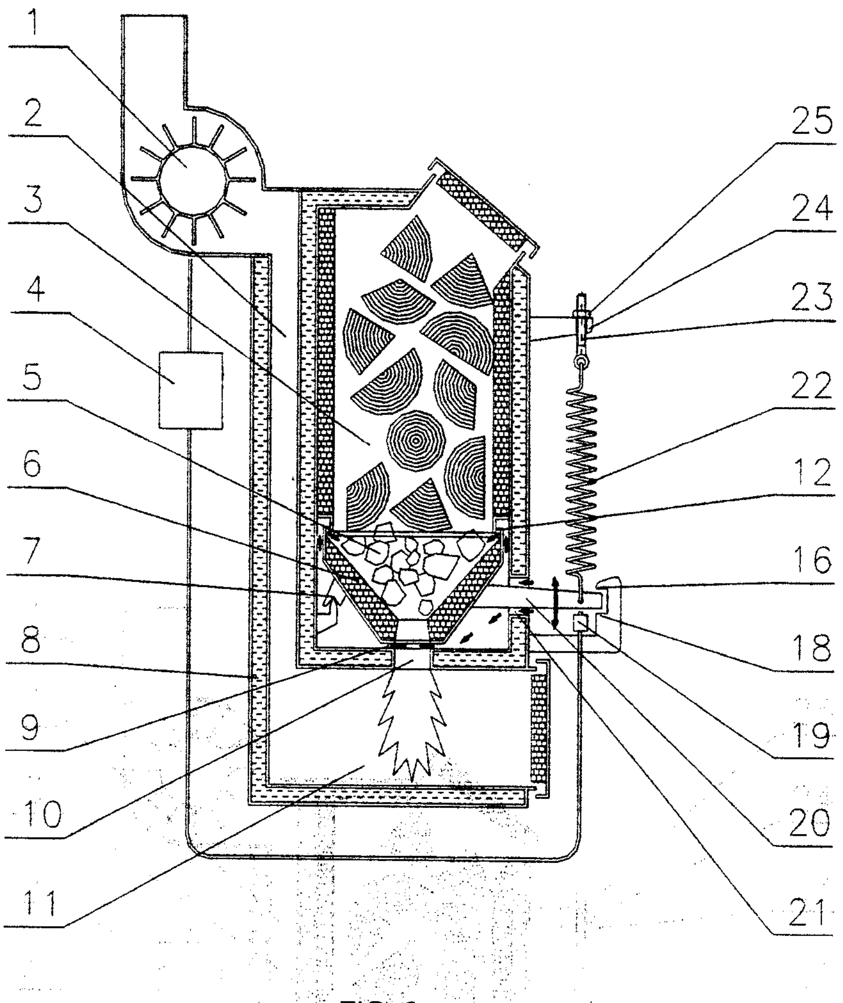


FIG. 2

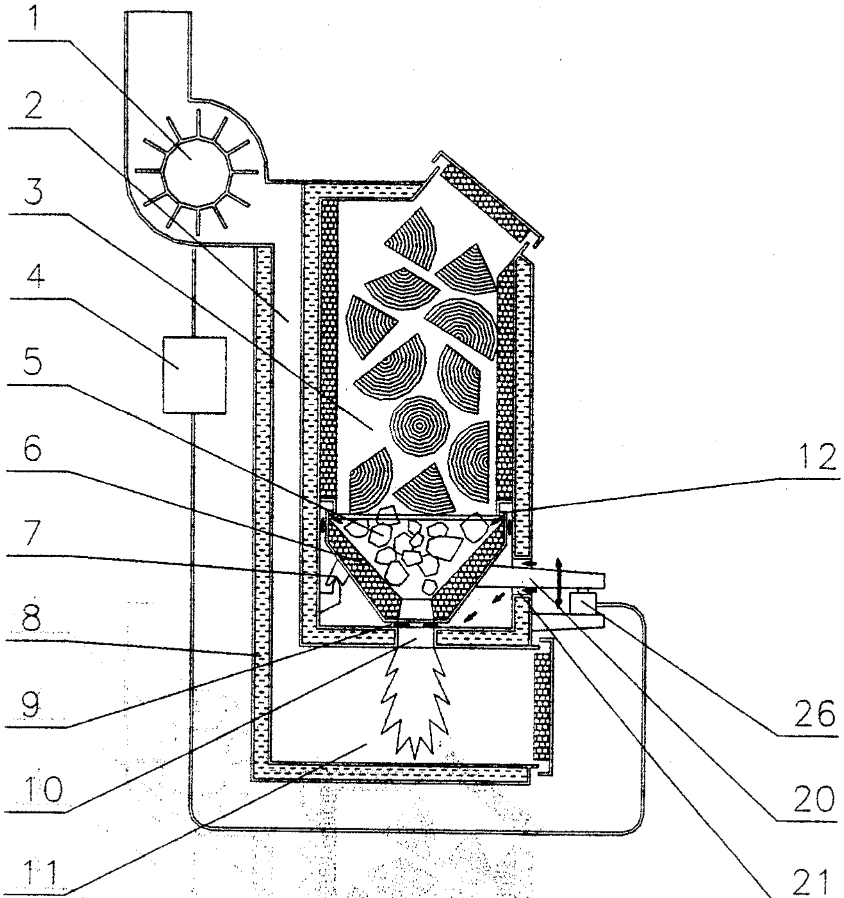
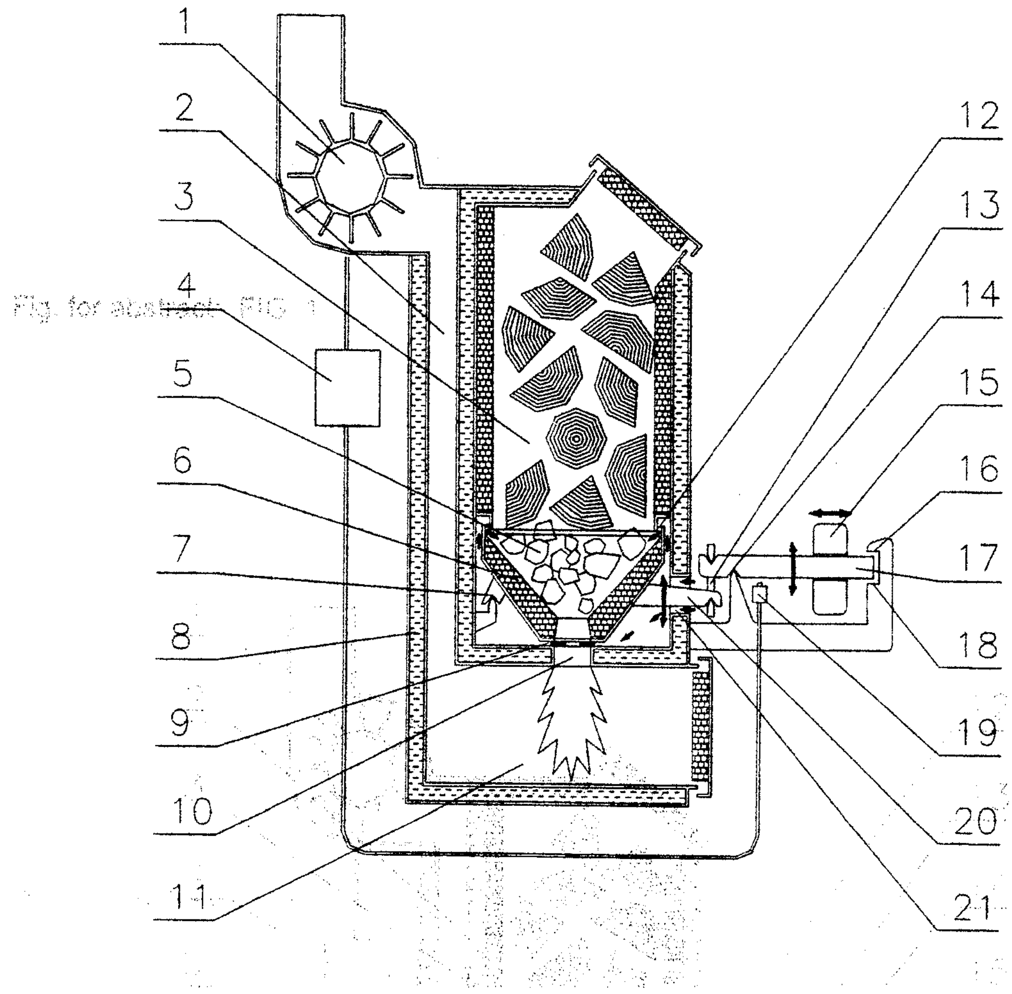


FIG. 3

Fig. for abstract: FIG. 1



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
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ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F23N F23H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 865 254 A2 (MOZZATO GERMANO [IT]) 12 December 2007 (2007-12-12) abstract; claims 1-5; figures 1-5 -----	1-5
X	US 4 313 387 A (SATO KANICHI) 2 February 1982 (1982-02-02) abstract; claim 6; figures 1-7 -----	1-5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2016/000117

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