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(54) GASIFIED BIOFUEL BURNER, ESPECIALLY FOR WOOD PELLETS

(57) Burner contains a casing (1) with a furnace chamber (2) built-in inside and a jet burner (3). The furnace chamber (2) has a basket grate (5) gravitationally powered by a fill pipe (6), limited by fixed walls and a movable wall in the form of a rear wall and a bottom wall rigidly connected at an obtuse angle. The movable wall has an axis of revolution (14), mounted in bearings in side walls and driven by a grate (5) cleaning mechanism actuator. The zone of corner connection of the movable wall is cut by air gaps directed perpendicular to the axis of revolution (14), and behind the rear wall a cleaning comb (19) with teeth has been mounted which in the extreme position of the grate (5) opening permeate into movable wall air gaps. The burner is equipped with an electric blowing igniter. The fill pipe (6) is covered by a secondary air pipe (7), connected with the jet burner (3) by an air chamber (9) above the furnace chamber (2). A control module cooperates with two biofuel level sensors (28, 29) which operate in infra-red radiation range in their own communication codes. The lower sensor (28) has a measurement circle placed directly above the bottom wall, and the upper one (29) has been built-in near the upper edge of the rear wall in the place of the grate (5) closing, under the fill pipe (6).

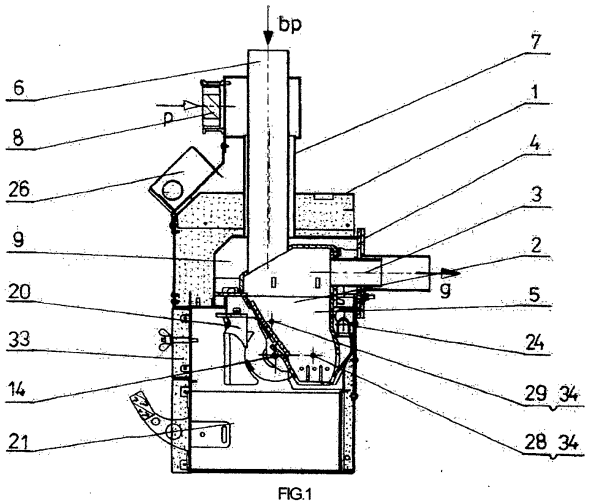

FIG.1

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Description

[0001] The subject of invention is a gasified biofuel burner, especially intended for wood pellets or other fine granulated ecological fuel. The burner is a heat source for different types of receivers: furnaces, boilers, fireplaces, sauna heaters, air heaters and other heat technology devices with power up to approx. 500kW.

[0002] There are many known heating units where heat is obtained as a result of combustion of combustible gas gained through thermal decomposition of fine granulated biofuel in conditions of its partial combustion with considerable deficit of air. Known burner, presented in Polish patent PL 208551, is powered by wood gas obtained from a process of gasification of pellets in a furnace chamber. A jet nozzle for mixing secondary air with wood gas is pulled out on a mounting plate of burner casing. The burner is mounted to a furnace body which is equipped with an exhauster on a channel draining fumes to a chimney. The furnace chamber has a basket grate, gravitationally powered by a fill pipe, limited by a fixed wall and a movable wall of a grate bottom. The grate in the furnace chamber is mounted tilting in a beam-scales system balancing grate dead load (with the required quantity of pellets) by a balance weight placed on a second arm of balance beam. Deflection moment from a balance position initiates a signal to a programmed control module and work interruption of a pellet feeder. Grate bottom wall is opened by a cleaning mechanism actuator which allows for periodic gravitational removal of slag, cinder and other non-combusted remains to an ash pan. An air electric igniter outlet has been connected to the grate bottom zone. In a starting phase, this igniter presses the air at a temperature of about 600 - 700°C. Above the grate there is a built-in perforated barrier which divides the pellet combustion zone from the wood gas inlet to a jet burner. The fill pipe is covered by a secondary air free suction pipe to the jet burner by an air chamber divided above the furnace chamber. A weight pellet level adjustment system on the grate is imprecise and burdened with errors of the mass of remains stuck to the grate which incompletely drop away when the bottom wall is periodically opened and there is variable resistance of beam-scales tilting.

[0003] It is also known a solution from the PL 216981 patent concerning furnace insert to the furnace for fine granulated solid fuel, especially pellets, where the basket grate has a tilted front wall whose lower edge adheres to the front edge of the bottom wall. The rear wall is created by an upper fixed wall and a lower movable wall whose lower edge leans against the bottom wall. Periodically, in a cycle set up by software, the lower movable wall is moved forward by an actuator, which causes the collection of non-combusted combustion remains from the wall to the ash pan; this happens simultaneously with front wall tilting. The control module applied in the solution stops the pellet feeder operation after obtaining a signal from optoelectronic sensors portal which sensors are set at the maximum level of the pellet layer in the grate. Optoelectronic transmitter and receiver are built-in at the ends of pipe channels led out to the outside of the body side walls where they are set with crevices which allow for connecting pipe channels with surroundings. In conditions of negative pressure which occurs in the furnace chamber, it ensures the required cooling of sensor's elements in suctioned air streams.

[0004] In conditions of determined heat power, high efficiency of the combustion process at possibly the lowest emission of noxious compounds to the atmosphere requires keeping fixed air excess or deficiency coefficient in the furnace chamber. Basically, this condition depends on differences of pressures initiating air supply to the furnace chamber, pellet layer thickness in the grate and maintaining grate cleanliness with a fixed area of air gap cruising.

[0005] In the solution presented in EP 1559957 patent, flat or radially flanged bottom of the grate is cleared by a scraper periodically started, moved in line or rotary. Efficient grate cleanliness requires that except for sliding remains from the upper area also air gap internal areas should be cleaned. This problem with the grate according to KR 101295328 patent has been solved by using a structure composed of three comb elements which in the position of a common ground permeate into each other using teeth. A middle element, mounted in a rotary motion in the body of the grate, has two-sided teeth which implies that with periodic rotation forced by a program not only gravitational dropping of the remains from the middle element to the ash pan occurs but also the remains from air gaps, between teeth of all elements, are pushed out.

[0006] The burner solution according to this invention concerns many features common with the solutions described above. On the other hand, it is characterized by that the grate movable wall which is a uniform element composed of the rear wall joined with the bottom wall at an obtuse angle. In the extreme position of the closed grate, the front edge of the bottom wall adheres to the bottom edge of the front wall. The axis of revolution has been mounted to the rear wall, in bearings in side walls of the grate and it is driven by the cleaning mechanism actuator. The corner zone of connection of both walls has been cut by air gaps directed perpendicular to the axis of revolution. Behind the rear wall a cleaning comb with teeth is placed in such a way that after rotation of the movable wall to the extreme position of grate opening they permeate the air gaps of the movable wall.

[0007] It is beneficial if the front wall is bulged from the lower edge by an internal radius led from the axis of revolution and the upper edge of the rear wall in case of movable wall rotation circles an arc with a radius smaller than a movable crevice from the internal bulge radius.

[0008] It is also beneficial if the burner teeth friction edges of the cleaning comb are tilted to the direction of a radius led from the axis of revolution, in the side view, at best according to an upper wheel quarter curvature.

[0009] Precise adjustment of the required amount of

fuel in the grate is assured by using two biofuel level sensors which operate in the infra-red radiation range and in their own communication codes. Lower measuring circuit has been placed directly above the middle of the bottom wall width, and the other one (upper) nearby the upper edge of the rear wall in the position of closed grate and under the fill pipe. Biofuel level sensor transmitters and receivers are placed at pipe casings perforated with holes on sections projecting from casing side walls, and by their other ends led through side wall thermal insulation layers of the casing to the furnace chamber area, in coaxial positions with holes in side walls of the grate.

[0010] It is also beneficial if the burner has the rear wall with an air gap nozzle directed to the grate bottom wall and the front wall in the middle of its bulge width has a cavity opened towards the grate, joined by a cable with a blowing igniter built into the side wall of the body.

[0011] The axis of revolution should preferably be connected with the actuator by a slipping clutch.

[0012] An essential improvement of the combustion process in the burner according to the invention is to use at the pipe inlet the secondary air of a forced draught fan whose controlled operation optimizes the composition of the gas mixture combusted in the jet burner.

[0013] Thanks to the new structure of the grate with comb cleaning and two-level control of the biofuel level, the burner according to the invention assures automatic combustion process with high precision of feeding, an effect of process efficiency higher than 90% and low emission of noxious compounds to the atmosphere. Precision in conducting the combustion process is obtained by using a signals of lower level sensor in the software to control the work of the igniter, biofuel feeder and the grate cleaning mechanism actuator and upper sensor signals - for ongoing feeder and upper biofuel level operation control. The use of infra-red detectors operating in different communication codes, in different frequencies of electromagnetic waves eliminates possible occurrence of errors in signal receiving.

[0014] Full understanding of the invention will be possible with a description of exemplary manufacture of the burner powered by wood pellets shown in a figure where each figure presents:

Fig. 1 - vertical section of the burner,
Fig.2 - burner from the front in half section-half view,' in Fig.3, Fig.4, Fig. 5, Fig.6 and Fig.7 - the grate of the burner shown successively: in cross-sections in a closed position and with an opened grate, view from

above, perspective view from behind and from the front, in Fig.8 and Fig.9 perspective views of the burner from rear and front.

[0015] The burner has the casing (1) in which the furnace chamber (2) is built-in. It is the "g" wooden gas generator which is connected to the jet burner (3) and combusted after mixing with the "p" secondary air. The jet burner (3) extends from the casing front wall (1) and through a mounting plate (4) is inserted into the space of the furnace chamber equipped with a combustion exhaust gas suction fan. The furnace chamber (2) has the basket grate (5) powered gravitationally by "bp" pellets through the vertical fill pipe (6) which is connected with a screw-conveyor not shown in the figure. The fill pipe (6) has been covered by a secondary air pipe (7) which has a forced draught fan (8) built-in at the inlet. The secondary air pipe (7) is connected with the jet burner (3) by an air chamber (9) above the furnace chamber (2). The grate (5) is limited by fixed walls: two side walls (10) and the front wall (11) and the movable wall which is a uniform element composed of horizontal bottom wall (12) and oblique rear wall (13) rigidly connected at an "α" obtuse angle of approx. 130°. The "kd" front edge of the bottom wall (12) in the "A" extreme closed position of the grate (5) adheres to the "kp" lower edge of the front wall (11). From the rear, to the rear wall (13), the axis of revolution (14) is mounted, in bearings in the side walls (10) of the grate (5) and driven by the slipping clutch (15) and the actuator (16) of the motoreducer, mounted on the side wall of the casing (1). The rear wall (13) has a crevice air nozzle (17), placed parallel and below the axis of revolution (14) and directed to the bottom wall (12) of the grate (5). The corner zone of the bottom wall (12) connection with the rear wall (13) is cut by air gaps (18) directed perpendicular to the axis of revolution (14). Behind the rear wall (13), the cleaning comb (19) with teeth (20) is placed according to air gaps (18) graduation. As a result, after the rotation of the movable wall (12 and 13) to the extreme opening position "B" of the grate (5), by permeating through the air gaps (18), the teeth (20) clean them from backlogging combustion remains which are dropping to the ash pan (21). The cleaning efficiency is aided by the arc shape of the teeth (20) friction which, from a side-view, has a shape of an upper quarter of the wheel. From the lower edge, the front wall (11) has a bulge (22) circled by the "r2" internal radius from the axis of revolution (14), whereas the "kt" upper edge of the rear wall (13) in case of the rotation circles an arc with "r1" radius smaller by "s" moving crevice than the "r2" internal radius of the bulge (22). The front wall (11) in the middle of the bulge (22) width has a cavity (23) opened into the space of the grate (5), connected by a cable (24) with a blowing igniter (25) built-in on the side wall of the body (1).

[0016] Signals from two pellets level sensors in the grate (5), which operate in infra-red radiation range and in their own communication codes, are carried by cables in lining pipes (27) to a control module junction box (26) mounted on the casing (1). The lower level sensor (28) which operates at 36 kHz frequency has a measuring circuit located directly above the middle of the bottom wall (12) while the upper level sensor (29) which emits the electromagnetic wave at a frequency of 40 kHz is built-in nearby the "kt" upper edge of the rear wall (13) in the position of closed "A" grate (5) and under the fill pipe (6). The transmitters (30) and the receivers (31) of

the level sensors (28 and 29) are placed at both sides of the casing (1) in the pipe casings (32) perforated with holes at sections projecting from the side walls of the casing (1). The pipe casings (32) are carried by thermal insulation layers (33) of the casing (1) to the furnace chamber (2) space, in coaxial positions with holes (34) in the side walls (10) of the grate (5).

[0017] The programmed control module (26) starts the pellet feeder and the blowing igniter (25) as soon as it receives a "start" signal. After receiving the signal from the lower level of the sensor (28), the feeding will be stopped, and the subsequent loss of signal, which proves the lighting of pellets, initiates the turning off of the igniter (25) and the restart of feeding up to the signal level from the upper sensor (29). The controller maintains the pellet level between the lower (28) and upper (29) sensors. Simultaneously, the signals from the upper sensor (29) which capture single dropping pellets confirm information on the correct operation of the feeder. In a cycle set for specified quality of pellets, the software enforces cleaning activities of the air gaps (18) of the grate (5) by stoving the pellet layers and rotating the movable wall (12 and 13).

List of markings in the figure

[0018]

1. casing
2. furnace chamber
3. jet burner
4. mounting plate
5. grate
6. fill pipe
7. secondary air pipe
8. forced draught fan
9. air chamber
10. side wall
11. front wall
12. bottom wall
13. rear wall
14. axis of revolution
15. slipping clutch
16. actuator
17. air nozzle
18. air gap
19. cleaning comb
20. tooth
21. ash pan
22. bulge
23. cavity
24. cable
25. blowing igniter
26. junction box control module
27. lining pipe for cables
28. lower biofuel level sensor
29. upper biofuel level sensor
30. transmitter
31. receiver
32. pipe casing
33. thermal insulation layer
34. measuring circle hole in the side wall of the grate

α. an angle between the bottom wall and the rear wall

A. extreme position of closed grate

A extreme position of opened grate

kd. front edge of the bottom wall

kp. lower edge of the front wall

kt. upper edge of the rear wall

r2. internal bulge radius

r1. radius of the upper edge of the rear wall

s. moving crevice

p. secondary air jet

g. wood gas jet

bp. pellet powering from a feeder

Claims

1. Gasified biofuel burner, especially for wood pellets, having a casing (1) with a furnace chamber (2) and a jet burner (3) built-in, going through a mounting plate (4) where the furnace chamber (2) has a basket grate (5) gravitationally powered by a fill pipe (6) limited by fixed walls (10, 11) and a movable wall (12, 13), directed by an actuator (16) of grate (5) cleaning mechanism. Besides, it is equipped with an electric blowing igniter (25) and a touchless biofuel level sensor (29) from which signal is sent to a programmed control module. Furthermore, a fill pipe (6) is covered by a secondary air pipe (7) connected with the jet burner (3) by an air chamber (9) divided above the furnace chamber (2). The burner is **characterized in that** a movable wall (12, 13) of the grate (5) is a uniform element made of a rear wall (13) and a bottom wall (12) joined at an obtuse angle (α), where a (kd) front edge of the bottom wall in (A) extreme closed position of the grate (5) adheres to the lower edge of the (kp) front wall, whereas to the rear wall (13) is mounted an axis of revolution (14), mounted in bearings at side walls (10) of the grate (5) and driven by a actuator (16) of cleaning mechanism, where corner zone of connection of both walls (12, 13) is cut by air gaps (18), directed perpendicular to the axis of revolution (14) and, moreover, behind the rear wall (13) a cleaning comb (19) with teeth (20) has been mounted, placed in such a way that after the rotation of the movable wall (12, 13) to the extreme position of a (B) opening of the grate (5) they are permeating air gaps (18) of the movable wall (12, 13).

2. The burner according to the claim 1 **characterized in that** the front wall (11) has a bulge (22) circled by the (r2) internal radius from the axis of revolution (14), and the (kt) upper edge of the rear wall in case of the rotation circles an arc at (r1) radius smaller by

(s) moving crevice than the (r2) internal radius of the bulge (22).

3. The burner according to the claim 1 **characterized in that** the teeth friction edges (20) of the cleaning comb (19) in a side-view are tilted to the direction of a radius led from the axis of revolution (14), preferably according to an upper wheel quarter curvature.

4. The burner according to the claim 1 **characterized in that** it has two biofuel level sensors (28, 29) on the grate (5) operating in infra-red radiation range in their own communication codes, where the lower one (28) has a measuring circuit placed directly above the middle of the bottom wall (12), and the second one - upper (29), built-in nearby the upper edge of the (kt) rear wall in the closed position (A) of the grate (5) and under the fill pipe (6).

5. The burner according to the claim 4 **characterized in that** biofuel level sensor (28, 29) transmitters (30) and receivers (31) are placed in pipe casings (32) perforated with holes at sections projecting from the casing (1) side walls, and which by their other ends have been led through the thermal insulation layers (33) of the casing (1) side walls to the furnace chamber (2) space, in coaxial positions with holes (34) in the side walls (10) of the grate (5).

6. The burner according to the claim 1 **characterized in that** the rear wall (13) has a crevice air nozzle (17), parallel to the axis of revolution (14) and directed to the bottom wall (12) of the grate (5).

7. The burner according to the claim 1 **characterized in that** the front wall (11) in the middle of the width of the bulge (22) has a cavity (23) opened towards the space of the grate (5), connected by a cable (24) with a blowing igniter (25) built-in on the side wall of the casing (1).

8. The burner according to the claim 1 **characterized in that** the axis of revolution (14) is connected with the actuator (16) by a slipping clutch (15).

9. The burner according to the claim 1 **characterized in that** the at secondary air pipe (7) inlet, a forced draught fan has is built-in (8).

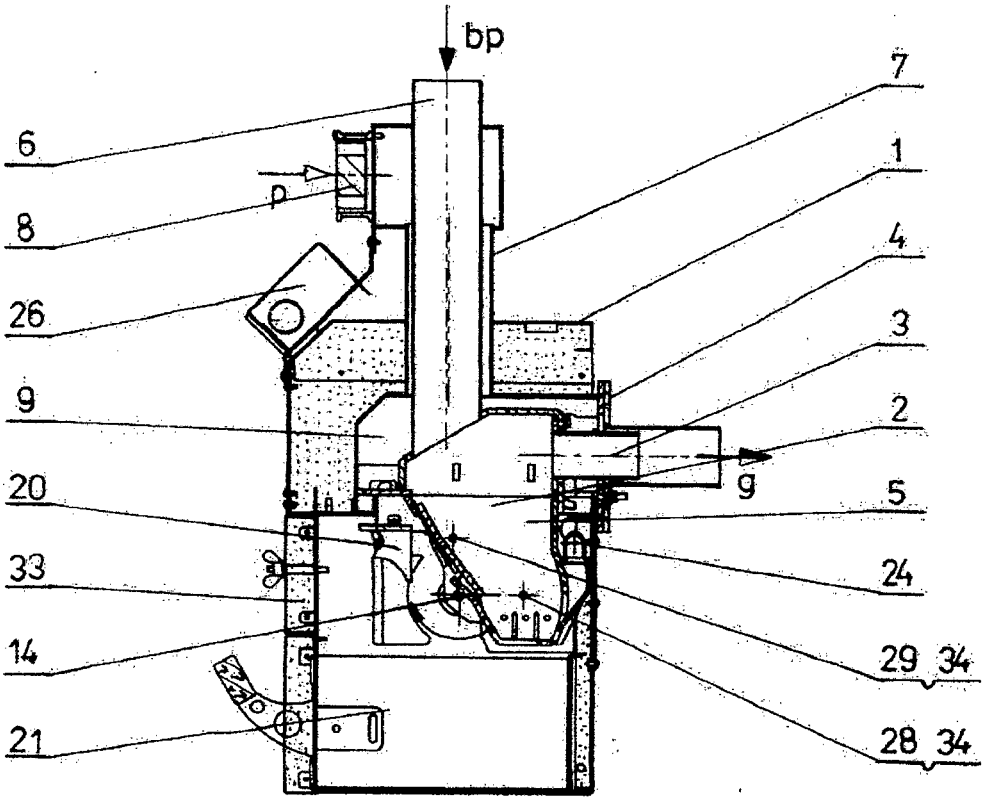
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FIG.1

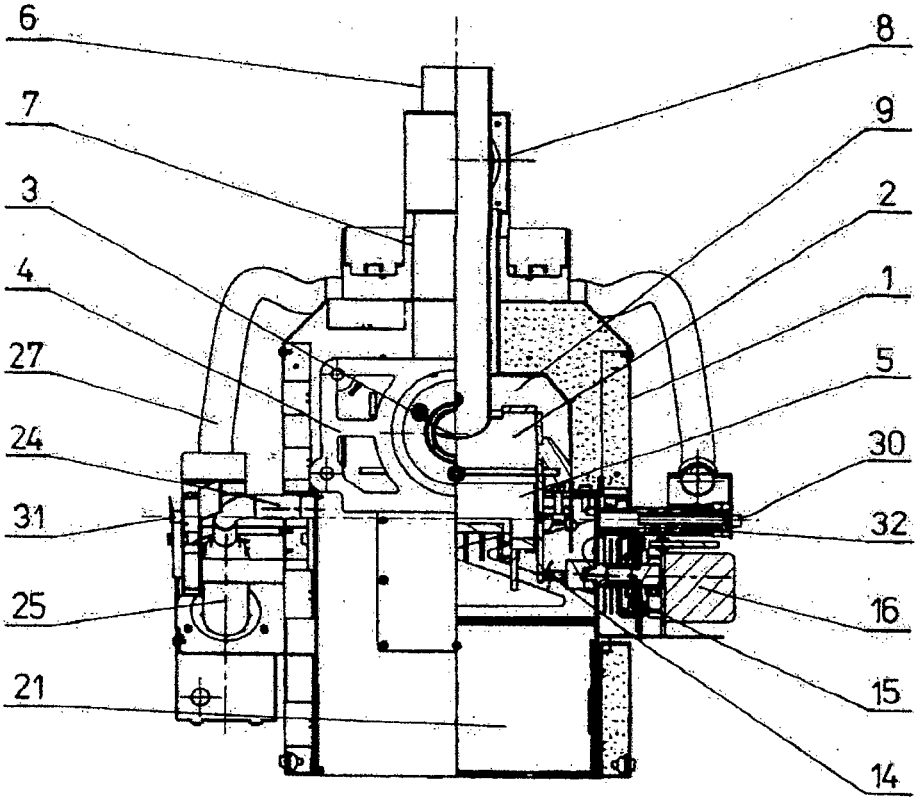
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FIG.2

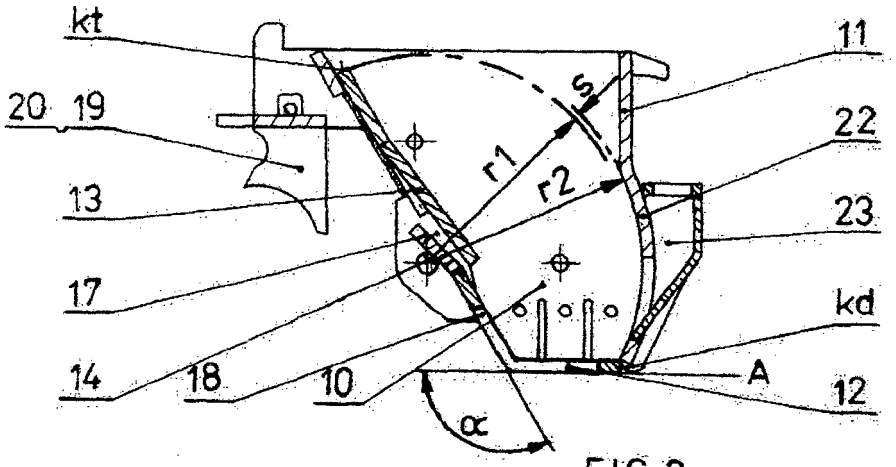

FIG.3

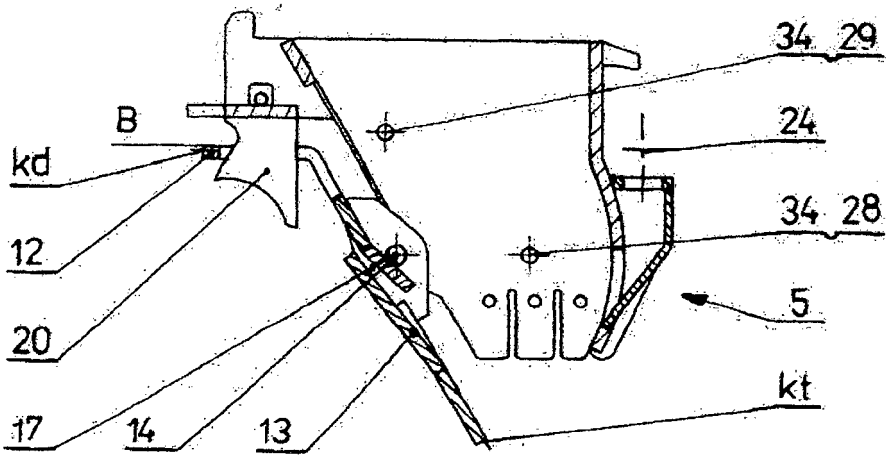

FIG.4

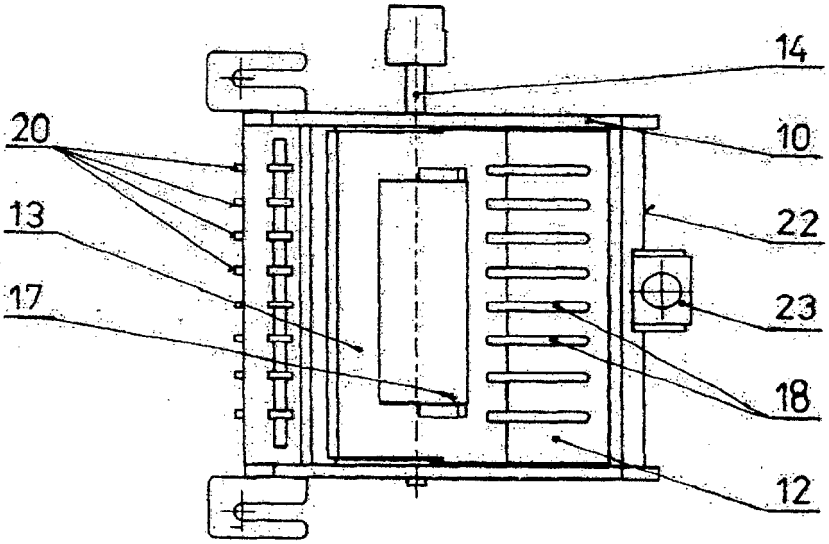

FIG.5

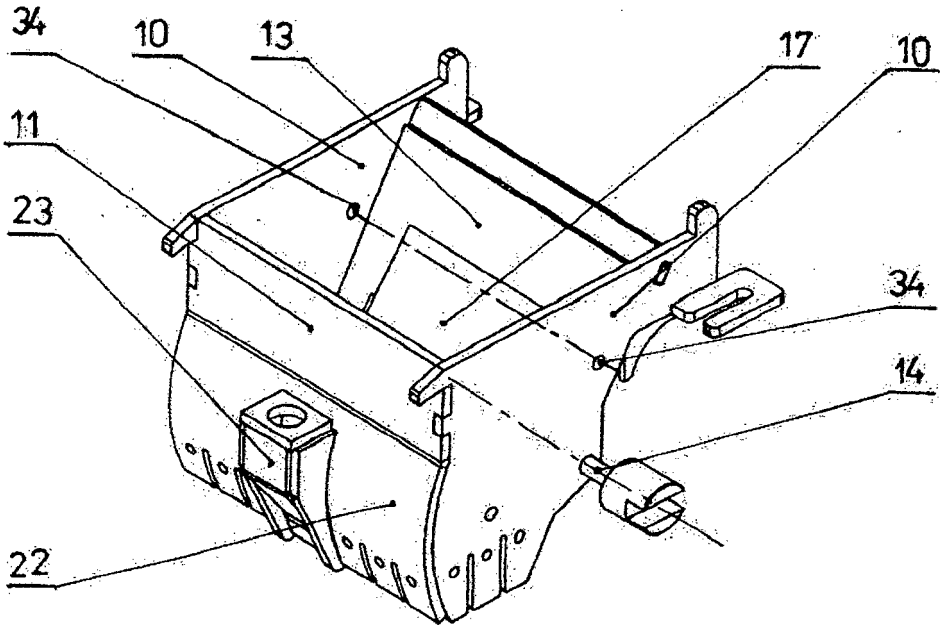

FIG.6

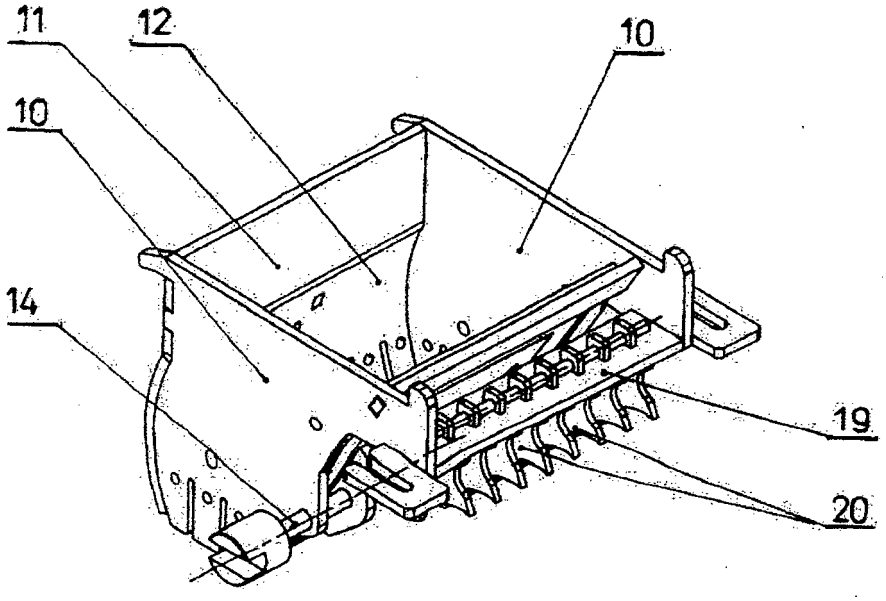

FIG.7

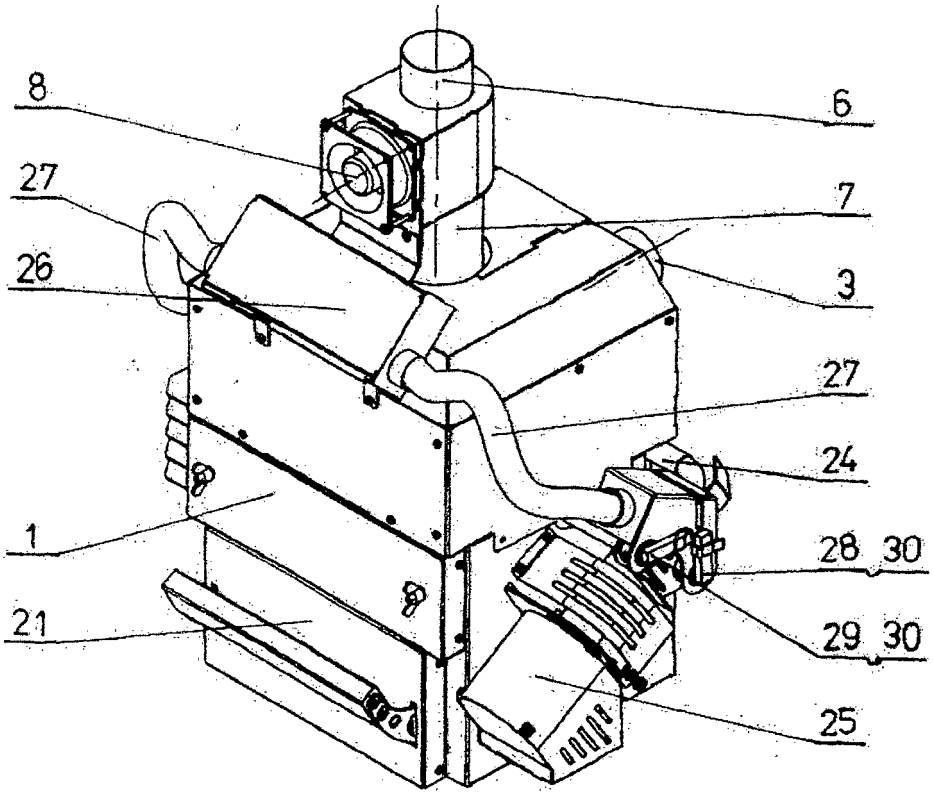
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FIG.8

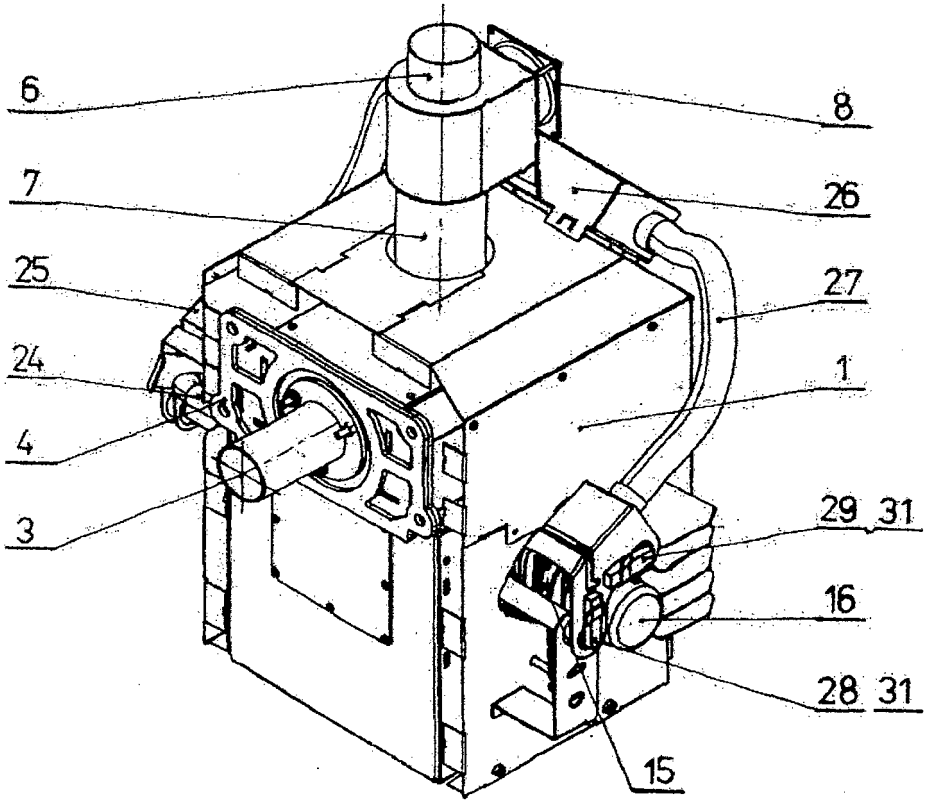
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FIG.9

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EUROPEAN SEARCH REPORT

Application Number
EP 16 00 0566

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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
The Hague	5 September 2016	Munteh, Louis

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X : particularly relevant if taken alone
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