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

(11) EP 1 359 372 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
05.11.2003 Bulletin 2003/45

(51) Int Cl.[7]: **F23B 1/18**, F23B 1/28, F23G 7/10, F23H 1/02

(21) Application number: **03076097.9**

(22) Date of filing: **15.04.2003**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **09.04.2002 IT CR20020003**

(71) Applicant: **Termocabi S.r.l.**
26035 Pieve S. Giacomo, Cremona (IT)

(72) Inventor: **Corbari, Giuseppe**
26035 Pieve S. Giacomo, Cremona (IT)

(74) Representative: **Mascioli, Alessandro**
Via Leonina 26
00184 Roma (IT)

Remarks:
Pursuant to Rule 84a EPC the priority CR2002A000003 (09.04.02) has been validly claimed.

(54) A burner for pellet fuel

(57) Burner for pellet fuel, connected to fuel feeding means, air feeding means and ignition means, comprising a main body (1), a combustion chamber (2) in which hot combustion gases flow essentially in a longitudinal flow direction (F) and a grate (3) adapted to support the fuel inside said chamber (2), in which said grate (3) is backwards inclined with respect of said flow direction (F), and air delivering means (16, 19) are associated to said grate (3), for blowing air on the pellet fuel placed on said grate (3) so as to provide partial gasification of said fuel.

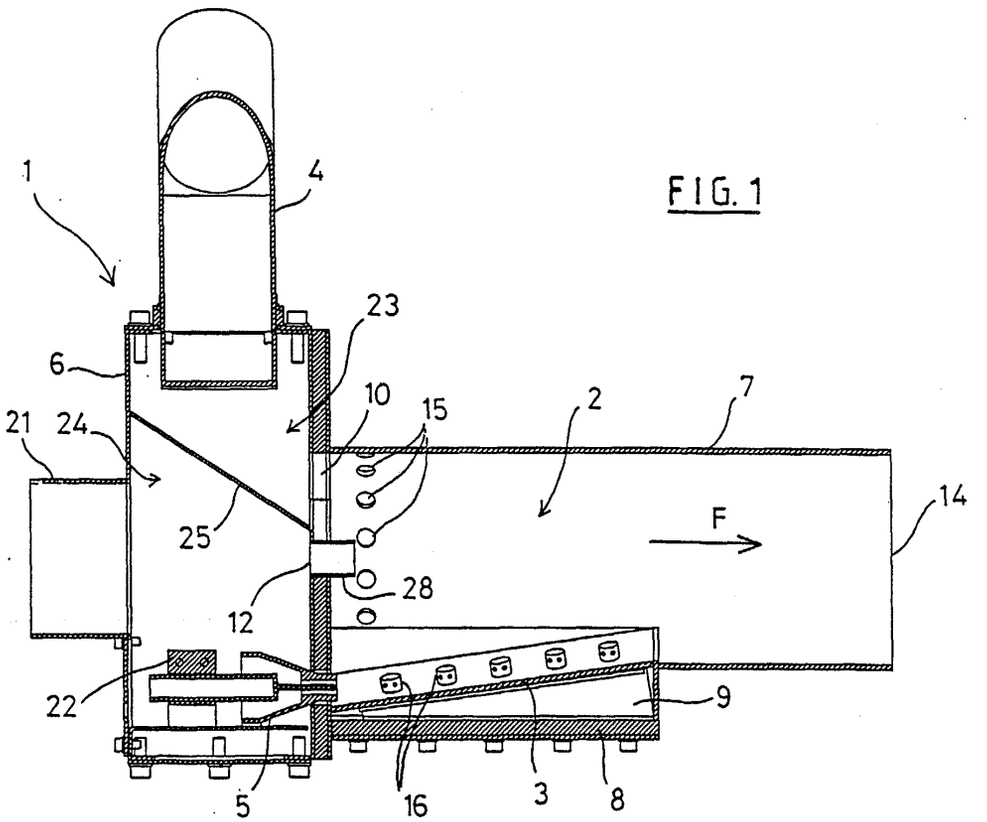

FIG. 1

EP 1 359 372 A2

Description

[0001] The present invention concerns a pellet fuel burner.

[0002] Pellet fuel is well known, usually consisting of wood-shavings, sawdust, biomass or other, compacted into small disks or cylinders approximately 6 - 12 mm in diameter and 10 - 30 mm long.

[0003] Pellet fuel boilers essentially comprise a steel body, a burner, a bundle of pipes or other heat exchanging means, and various devices or accessories usually provided in boilers, such as regulation controls, probes, safety thermostats and pressure switches, a control panel, a separate fuel tank and other.

More in detail, the burner essentially comprises a combustion chamber, a fuel feeding device, simply by gravity or comprising pellets transport means, air feeding means usually comprising a high capacity, low head fan, and an ignition device.

The combustion chamber is communicating with the body of the boiler, so that hot combustion gases flow to the boiler for transfering heat to a heat transfer fluid, usually water at 60 - 80 °C.

[0004] In some pellet burners, the combustion chamber is defined by a nozzle consisting of two coaxial cylinders, the combustion chamber being limited by the inner cylinder. Fuel is directly fed into the inner cylinder, while combustion air is blown into the annular gap between the two cylinders and enters the combustion chamber through holes on the surface of the inner cylinder.

In other burners, the nozzle consists of one single cylinder, or has a polygonal shape, and the combustion air in this case is directly delivered into the combustion chamber.

A grate is usually provided in the combustion chamber, for supporting the solid fuel during the combustion.

[0005] A disadvantage of these pellet burners is that pellets falling in the combustion chamber may roll out of the grate, in a zone of the combustion chamber where temperature is lower or air supply is poor, or they may even fall in the boiler chamber. Pellets that do not remain on the grate burn incompletely, causing bad efficiency, excess of ashes and a certain amount of polluting unburned particles.

For this reason, known pellet burners usually comprise baffles near the grate or the combustion gas outlet, for holding back fuel elements. In some burners, steps are provided on the interior surface of the combustion chamber, to prevent pellet elements from falling into the boiler chamber.

[0006] The ignition device is usually a hot air device or incandescence device.

In the first case, combustion is started by delivering hot air to the combustion chamber, said hot air being heated by an electric resistance.

[0007] In the second case, the ignition device comprises one or more heating plugs adapted to heat the pellet fuel elements, by means of direct contact, until combustion occurs.

The plugs may be also motorized, so as to stay in contact with the pellet elements during the ignition phase, and then get back so as not to remain exposed to the flame.

[0008] Combustion of the pellets substantially comprise two phases. In the first phase, fuel is partially gasified by high temperature and air blowing into the combustion chamber; in the second phase, the combustion of the gasified fraction and of the remaining solid fraction occurs.

Generally speaking, gasification of the pellet increases the burning efficiency, because gaseous fuel is better mixed with the combustion air, producing less polluting emissions, unburned particles and ashes.

[0009] These burners for pellet fuel, however, have the following inconveniences and problems.

[0010] A first problem consists in the non-uniform distribution of the pellets in the combustion chamber and, in particular, on the grate, that decreases combustion efficiency and increases polluting emissions. This inconvenience may also obstruct the ignition, if a zone without fuel is found near the ignition device.

[0011] Screw feeders, feeding the pellets directly into the combustion chamber, give a partial solution to this problem but increase cost and complication.

Baffles or steps in the combustion chamber may also limit this inconvenience, avoiding that the fuel rolls out of the grate or even into the boiler chamber, but they obstruct air flows and do not allow optimum air-fuel mixing.

Furthermore, in the burners having a rectangular or polygonal nozzle, the irregular shape of the nozzle is a further obstacle to uniform air distribution and good air-fuel mixing.

[0012] Another problem consists in that an incomplete combustion, due to the non uniform distribution of the fuel on the grate and to the non optimal air-fuel mixing, favours the accumulation and the fall of unburned ashes into the air channels, through the air inlet holes directly open on the combustion grate.

This is particularly bothersome, causing frequent stops for cleaning maintenance.

[0013] For all these reasons, a strong air excess is usually maintained in the combustion chamber, but this decreases flame temperature and burning efficiency, and causes high NOx emissions.

[0014] The use of a low-head fan does not give a suitable turbulent air flow in the combustion chamber, and therefore it does not allow optimum air-fuel mixing.

[0015] Yet another problem of the known burners is that the two phases - gasification of the pellet and combustion - take place contemporarily in the whole combustion chamber, by means of the same air flow.

For better efficiency, it would be desirable to introduce two separate air flows into the combustion chamber, namely a primary air flow for pellets gasification, and a

secondary combustion air flow; furthermore, it would be advantageous that the combustion chamber have a pellet gasification zone, where gasification of the pellets mainly occurs, and a gas combustion zone, where combustion of the gas mainly occurs.

[0016] Finally, there are some disadvantages concerning the ignition devices. Hot air devices require a considerable electric power and have high costs; ignition plugs need less electric but they require moving parts, as the plugs must be motorized, they are expensive, complicated and may be a problem for reliability.

[0017] The aim of the present invention to eliminate or reduce the aforesaid inconveniences.

[0018] A general aim of the invention is to realize an improved burner for pellet fuel, with high combustion efficiency and low emissions.

More in particularly, a scope of the invention is to realize a burner in which the fuel is uniformly distributed on the combustion grate, avoiding the problem of zones without fuel, specially near the ignition device.

A further aim is to avoid falling of the pellets from the combustion grate or into the boiler connected to the burner.

Another aim of the invention is to reduce ashes in the combustion chamber, reducing maintenance and cleaning requirements.

It is also an aim of the present invention to obtain good air-fuel mixing, so as to realize a complete combustion without a strong excess of air above the stoichiometric value.

Another aim of the present invention is to realize a burner in which the combustion chamber has a regular shape, without baffles, steps or other elements that could obstacle air circulation and air-fuel mixing.

[0019] Another aim is to realize a burner that improves the gasification phase of the fuel by means of primary air appropriately delivered above the pellet fuel, and secondary combustion air mixed with the gas obtained. Therefore, it is an aim of the present invention to realize a burner with a combustion chamber having a pellet gasification zone, where fuel is gasified thanks to a primary air flow, and a gas combustion zone, where secondary combustion air is fed and the gasified fuel is burned.

[0020] A further aim of the invention is to realize a burner with an ignition device that does not require a high electric power and is efficient and reliable at the same time.

[0021] Finally, it is an aim of the present invention to achieve the above mentioned purposes with a simple, low-cost pellet burner.

[0022] The aims set forth are reached by means of the present invention, consisting of a burner for pellet fuel, connected to fuel feeding means, air feeding means and ignition means, comprising a main body, a combustion chamber in which hot combustion gases flow essentially in a longitudinal direction, and a grate adapted to support the fuel inside said chamber, characterized in that said grate is backwards inclined with respect of said flow direction, and air delivering means are associated to said grate, for blowing air on the pellet fuel placed on it so as to provide partial gasification of said fuel.

[0023] The advantages of the invention consist in that the fuel accumulates on the inclined grate and is not dispersed in the combustion chamber, that may have a regular shape without baffles or steps, yielding better air circulation and combustion efficiency; the burner therefore does not require a strong air excess and NOx emissions are reduced; the air delivering means associated to the grate deliver primary gasification air on the solid fuel pellets and allow to obtain a high degree of gasification, further improving the efficiency; the high efficiency reduces the formation of pollutants and ashes, thus reducing maintenance and cleaning requirements; the ignition is facilitated by providing the ignition means near the zone of the inclined grate where the fuel accumulates, and therefore it is possible to use an ignition device of less power with equal efficiency.

[0024] Said air delivering means advantageously comprise cylindrical nozzles with holes on their lateral surface, arranged to deliver primary gasification air above the whole surface of the grate supporting the fuel.

[0025] For uniform distribution of the pellets on the grate, said fuel feeding means advantageously comprise a feed pipe with a pocket at the outlet section, closed in the movement direction of the pellet inside the pipe and opened at the top, so as to dissipate the kinetic energy of the pellet elements, making them fall on the grate with a mainly vertical motion. Risk of pellets falling from the grate or in the boiler chamber is therefore reduced.

[0026] The ignition device is advantageously a voltaic arc device, which require less power than electric air heaters, and is less expensive and more reliable than ignition plugs, because the ignition device is not motorized, the electrodes are not in direct contact with the fuel and they do not easily get dirty.

[0027] For compactness and cheapness, the burner is advantageously made of a mainly box-shaped distributing element for fuel and combustion air and of a cylindrical nozzle that limits the combustion chamber.

[0028] Further features and advantages of the invention will be more evident from the following description, with the drawings in which a preferred embodiment is shown.

Figure 1 is a longitudinal sectional view of a burner for pellet fuel according to the present invention, where the electromechanical devices for supplying combustion air are not shown.

Figure 2 is a perspective view of the burner of figure 1.

Figure 3 is a front view, from the combustion chamber, of the burner of figure 1.

Figure 4 is a front view of the external flange for fixing the burner to the boiler.

Figure 5 is a cross sectional view of the burner, according to a vertical plane inside the boiler, towards the internal fixing flange.

Figure 6 is a cross-sectional view of the burner, according to the same section plane of figure 5, towards the direction of the hot gases.

Figure 7 is a perspective view of a detail of the combustion grate of the burner according to figure 1.

Figure 8 is a perspective view of a combustion grate, simplified with respect to the grate of figure 7, without the air distributing nozzles.

Figure 9 is a perspective view of the nozzle supporting elements of the grate of figure 7.

Figure 10 is a longitudinal sectional view of the fuel feed pipe of the burner.

Figure 11 is a horizontal sectional view, according to plane XI-XI of figure 1, showing a detail of the burner.

[0029] Referring to the figures, the burner for pellet fuel according to the present invention essentially comprises a main body 1, with a combustion chamber 2, and it is connected to fuel feeding means, air feeding means and ignition means that will be described more in detail hereinbelow.

[0030] The hot combustion gases flow through the combustion chamber 2 in a longitudinal direction F.

[0031] Furthermore, a grate 3 is provided inside said chamber 2, for supporting the fuel pellets.

[0032] Said fuel feeding means comprise at least a fuel pipe 4 for feeding the pellets to the combustion chamber 2, and, if necessary, a screw feeder or a similar device for mechanically lifting and transporting the fuel pellets, as well as an external fuel tank.

[0033] The air feeding means comprise a fan (not shown) and holes or passages for the air, which will be described more in detail hereinbelow.

[0034] The ignition means comprise an igniter 5, advantageously a voltaic arc igniter.

[0035] In a preferred embodiment, as shown in the figures, the body 1 of the burner essentially comprises a distributor 6 and a cylindrical nozzle 7, defining the combustion chamber 2.

Bottom of the chamber 2 is closed by a plate 8, below the grate 3.

[0036] The grate 3, in cooperation with the plate 8, defines a channel 9 working as a primary gasification air manifold.

[0037] The burner also comprises a fuel inlet port 10, openings 11a and 11b for delivering primary air to said channel 9, a passage 12 for feeding secondary combustion air to said chamber 2, an ignition hole 13, passages 30a and 30b for further primary air, a gas discharge outlet 14 and a plurality of gas recirculation holes 15.

[0038] Said openings 11a and 11b may be holes or have a different shape for uniformly feeding of the channel 9.

[0039] The combustion air passage 12 is substantially aligned with the axis of the cylindrical nozzle 7, delivering air to the centre of the combustion chamber 2, above the grate 3, through a pipe 28.

[0040] The ignition hole 13 allows the passage of primary air and the insertion of an igniter 5, so that the electric arc produced by said igniter may reach the solid fuel elements on the grate 3.

[0041] Gas recirculation holes 15 are circumferentially arranged on the surface of the nozzle 7, near the air- and fuel inlet section of the combustion chamber 2.

[0042] The nozzle 7 is advantageously cylindrical as shown in the figures, but in some equivalent embodiments of the invention it may also consist of walls connected one to the other, giving to said chamber 2 a substantially axis-symmetrical polygonal shape.

[0043] The grate 3 is backwards inclined with respect to the direction F, the higher end being towards the gas discharge outlet 14 and the lower end being close to the ignition hole 13.

[0044] The grate 3 comprises nozzles 16 for delivering gasification primary air, flowing through the channel 9, to the solid fuel elements above said grate.

Said nozzles 16 are substantially cylindrical, closed at the end and provided with air delivering openings 17 on the lateral surface.

[0045] The nozzles 16 may be fixed to said grate 3; however, in a more advantageous embodiment, said nozzles are fixed to two nozzle supporting elements 18a and 18b, that may be inserted below said grate 3, the nozzles 16 passing through holes 19 provided on the grate itself.

[0046] In a simplified embodiment of the invention, the nozzles 16 are not provided on the grate 3, and air fed through the channel 9 is delivered to the fuel pellets simply by means of the holes 19.

In equivalent embodiments of the invention, said holes 19 may be replaces by openings with different shape, distributed on the surface of the grate 3.

[0047] Furthermore, the grate 3 has a concave shape and therefore said nozzles 16 are raised above the median line of the grate. Advantageously, edges of the grate 3 are also raised.

[0048] In the shown embodiment, the nozzles 16 are symmetrically arranged on two longitudinal lines so that air jets from openings 17 are uniformly distributed on the fuel above the grate 3.

It is evident that the nozzles 16 may vary in number, shape and disposition on the grate 3, according to the type and dimensions of the burner.

[0049] The distributor 6 is connected to the fuel feed pipe 4, and is connected to the boiler with an exterior flange 20.

[0050] On the internal side of the boiler, an interior flange 29 connects the nozzle 7 to the boiler.

[0051] The distributor 6 further comprises an air inlet pipe 21 and a support 22 for the ignition device 5. A fan (not shown), feeding air through said pipe 21, may be fixed to or housed inside the distributor 6.

[0052] The distributor 6 is internally divided in an upper chamber 23 and a lower chamber 24, substantially insulated by means of a baffle 25 advantageously inclined towards the port 10.
Furthermore, the lateral walls of the distributor 6 comprise thermal insulating spaces 26, that may be hollow or filled with a thermal insulating material.

[0053] The fuel pipe 4 ends inside said chamber 23, which is communicating with the combustion chamber 2 through the port 10.

[0054] The outlet section of the pipe 4 into the chamber 23 comprises a pocket 27, open at the top and mainly closed in a direction transversal to the axis of the pipe.

[0055] The lower chamber 24 is communicating with the combustion chamber 2 through the passages 11a and 11b, 30a and 30b, the primary air and ignition hole 13 and the secondary air passage 12.

[0056] The burner according to the invention works as follows.
Fuel is supplied through the fuel pipe 4 to chamber 23, slides on the baffle 25, and enters the combustion chamber 2 falling through the port 10, above the grate 3.

[0057] Kinetic energy of the fuel pellets is dissipated by bumping against the pocket 27 at the outlet end of the pipe 4, so as they fall mainly vertically onto said grate 3, without spreading in the combustion chamber 2 or rolling to said opening 14, from where they could enter the boiler chamber.

[0058] The inclination of said grate 3 facilitates the accumulation of the pellets mainly at the ignition hole 13, thus allowing the igniter 5 to easily start the combustion.

[0059] Combustion air is delivered to the chamber 24 of the distributor 6 through a pipe 21 and enters the combustion chamber 2 through the openings 11a and 11b, the passage 12, the hole 13 and the passages 30a and 30b.

[0060] Air passing through openings 11a, 11b, hole 13 and passages 30a and 30b is the primary gasification air.
A portion of the primary air enters the channel 9 below the grate 3, through the openings 11a and 11b, and is delivered to fuel pellets through the nozzles 16.

[0061] Another part of primary air enters the chamber 2 just above the lower part of the inclined grate 3, through the hole 13 and the passages 30a and 30b.
Thanks to the primary air flow and to the high temperatures, the pellet is partially gasified and a combustible gas is produced, rising from the grate 3 to the centre of the chamber 2.

[0062] Air entering the chamber 2 through the passage 12, fed by the pipe 28, is secondary combustion air that is mixed with said combustible gas.
Furthermore, air flowing through the chamber 24 cools the walls of the distributor 6, avoiding excessive temperature of the distributor itself and of the fuel entering the chamber 23 through fuel pipe 4.

[0063] Hot combustion gases flow through the gas discharge opening 14, from the combustion chamber 2 to the boiler, mainly according to a longitudinal direction F.

[0064] Venturi effect, produced by secondary air entering the nozzle 7 through the pipe 28, sucks part of the combustion gases into the chamber 2 through gas recirculation holes 15.
Good mixing of recirculated combustion gases and fresh air-fuel mixture is given by the circumferential arrangement of holes 15, reducing emission of unburned particles and NOx.

[0065] Primary air delivered through nozzles 16, passages 30a and 30b and passage 13 allows a relevant fraction of the fuel to be gasified.

[0066] Due to the inclination of said grate (3), no baffles or steps are necessary for keeping the pellet, secondary air flows are not obstructed and good air-fuel mixing is achieved.

[0067] The combustion efficiency is high and also the formation of unburned substances and of ashes is reduced.
This also means that the burner does not require strong air excess, reducing formation of NOx.

[0068] The burning efficiency may be further improved, using a high-head fan, like those commonly used in methane or oil fed burners. In fact, a high head fan generates a turbulent flow in the combustion chamber, improving the air-fuel mixing.

[0069] Maintenance, specially for cleaning the combustion chamber 2 and the grate 3 and for replacing the nozzles, is made easier by the possibility of disassembling the lower plate 8 and removing the nozzle support elements 18 a and 18b from the grate 3

[0070] The preferred embodiment, with the body of the burner mainly consisting of the distributor 6 and the nozzle 7, as described, is particularly compact and functional.

Claims

1. A burner for pellet fuel, connected to fuel feeding means, air feeding means and ignition means, comprising a main body (1), a combustion chamber (2) in which hot combustion gases flow essentially in a longitudinal flow direction (F) and a grate (3) adapted to support the fuel inside said chamber (2), **characterized in that** said grate (3) is backwards inclined with respect of said flow direction (F), and air delivering means (16, 19) are associated to said grate (3), for blowing air on the pellet fuel placed on it so as to provide partial gasification of said fuel.

2. A burner according to claim 1, ***characterized in that*** said grate (3) has a concave cross section.

3. A burner according to claim 3, ***characterized in that*** said air delivering means comprise substantially cylindrical nozzles (16), closed at the top and hav-

ing openings (17) on the lateral surface.

4. A burner according to claim 3, ***characterized in that*** said nozzles (16) are fixed to nozzle support elements (18a, 18b) reversibly connectable to said grate (3).

5. A burner according to claim 1, ***characterized in that*** said fuel feeding means comprise a fuel pipe (4), the outlet section thereof comprises a pocket (27) open on the top and mainly closed in a direction transversal to the axis of said pipe (4).

6. A burner according to claim 1, ***characterized in that*** said air feeding means comprise:

- at least one primary air opening (11) adapted to feed air through a channel (9) below said grate (3), connected to said air delivering means (16, 19);
- primary air openings (13, 30), for delivering air above the initial lower section of said grate (3);
- at least one secondary air passage (12), for blowing air substantially to the axial zone of said combustion chamber (2).

7. A burner according to claim 1, ***characterized in that*** said ignition means comprise an igniter (5) and at least one ignition hole (13) through which the heating action of said ignition means (5) is transmitted to the fuel on said grate (3), wherein said hole (13) is provided in correspondence with the lowest end of said grate (3), so that the fuel is accumulated close to said hole (13) due to the inclination of said grate (3).

8. A burner according to at least one of the preceding claims, ***characterized in that*** said main body (1) comprises a distributor element (6) for the fuel and for the combustion air, as well as a cylindrical nozzle (7) associated to said element (6) which limits said combustion chamber (2).

9. A burner according to claim 8, ***characterized in that*** the distributor element (6) comprises an upper chamber (23) and a lower chamber (24), separated by a baffle (25) and substantially insulated one from the other, wherein:

- said upper chamber (23) is connected to said fuel feeding means and it is communicating with said combustion chamber (2) through a feeding port (10);
- said lower chamber (24) is connected to said air feeding means and to said ignition means, and is communicating with said combustion chamber (2) through openings adapted to air delivering and combustion firing (11, 12, 13, 30).

10. A burner according to claim 8, ***characterized in that*** the surface of said cylindrical nozzle (7) comprises a plurality of gas recirculation holes (15), arranged on a circumference.

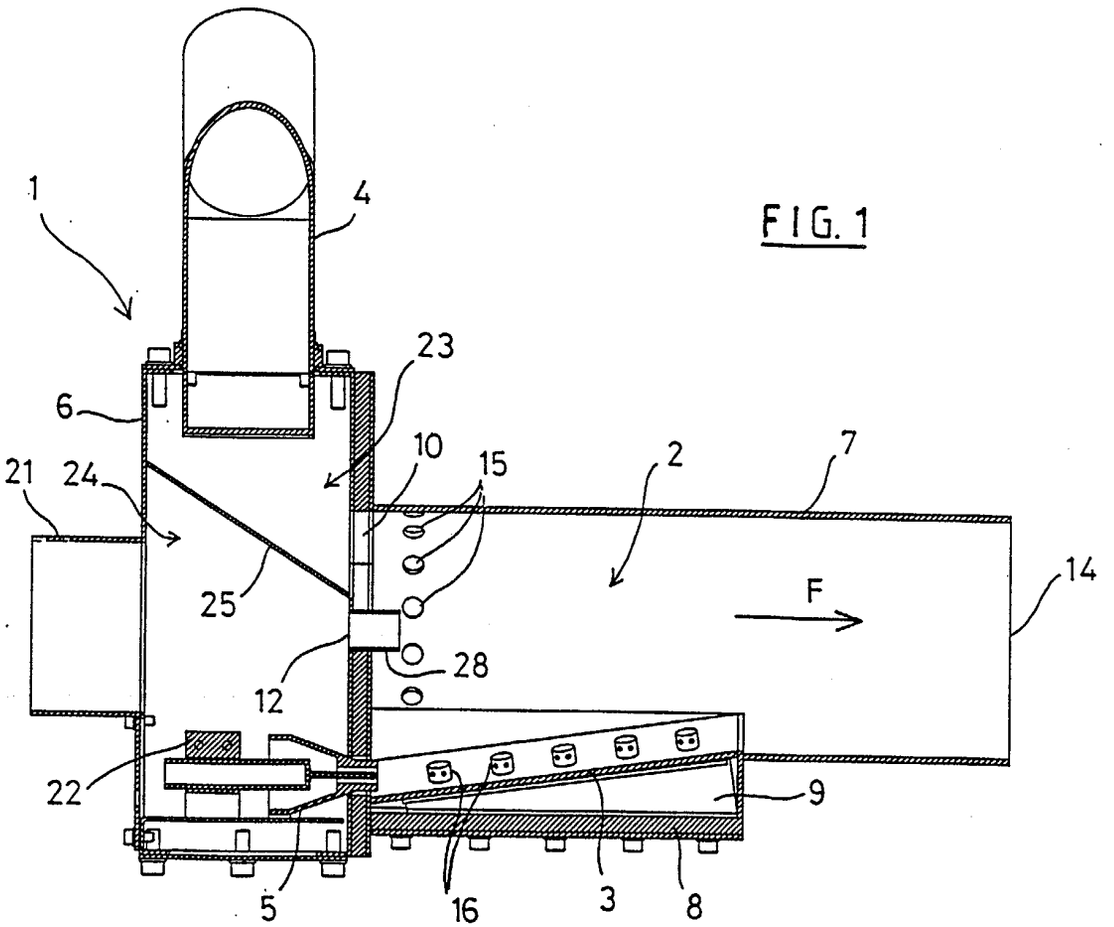

FIG. 1

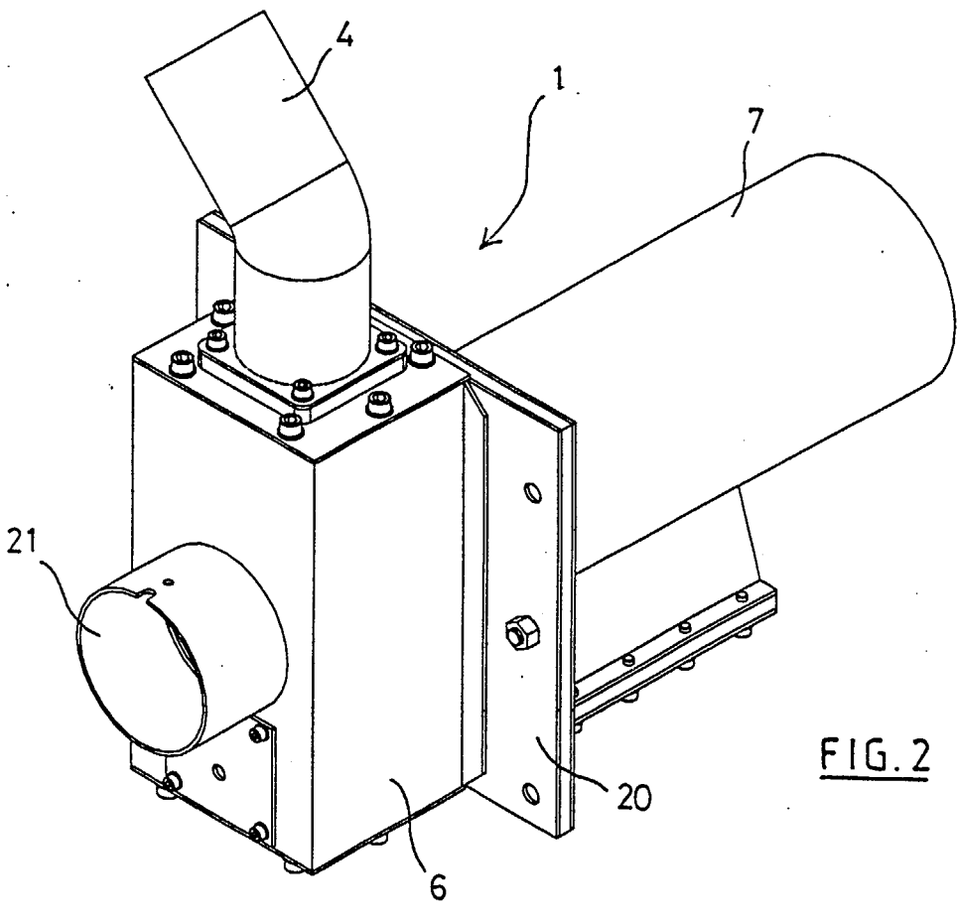

FIG. 2

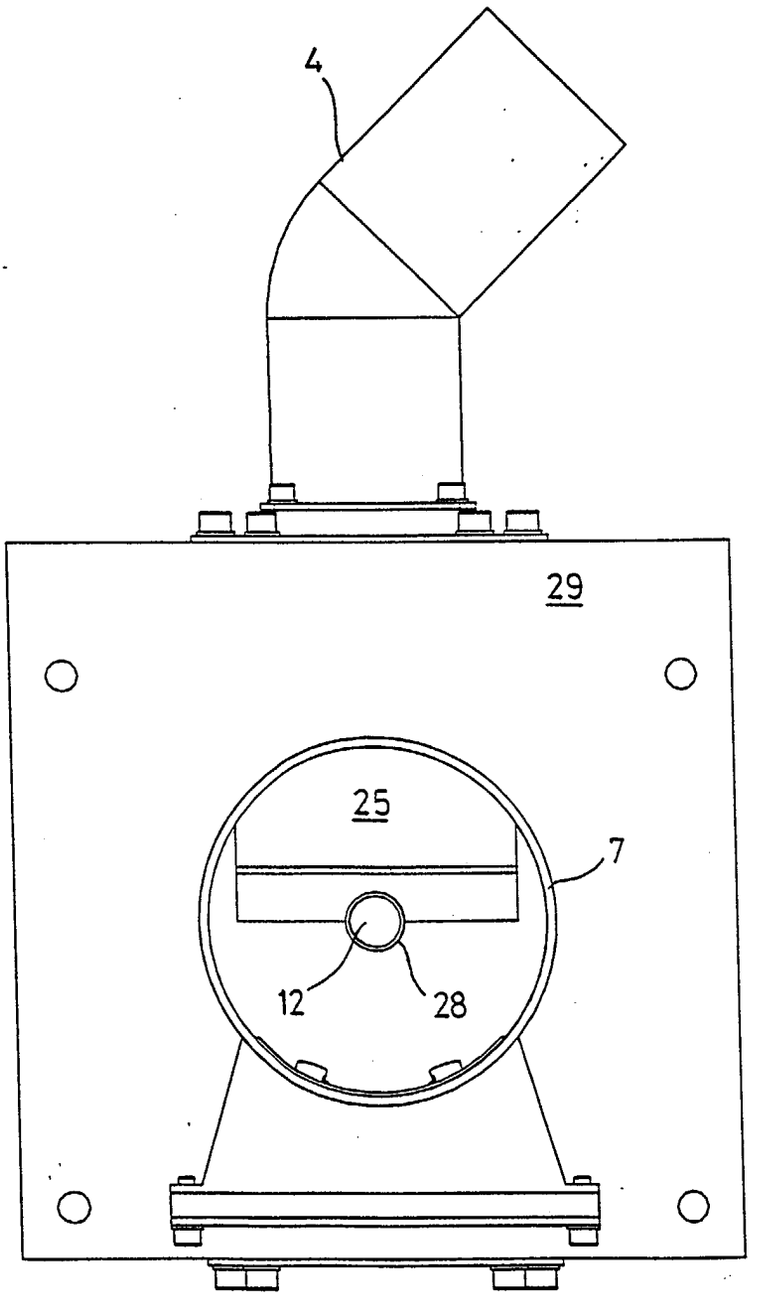

FIG. 3

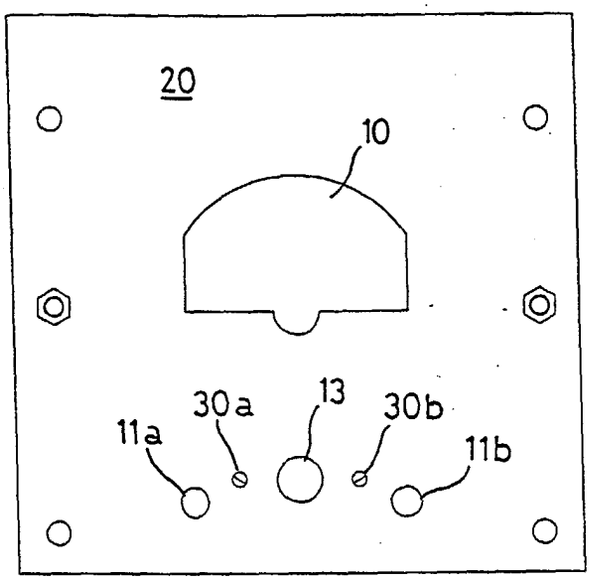

FIG. 4

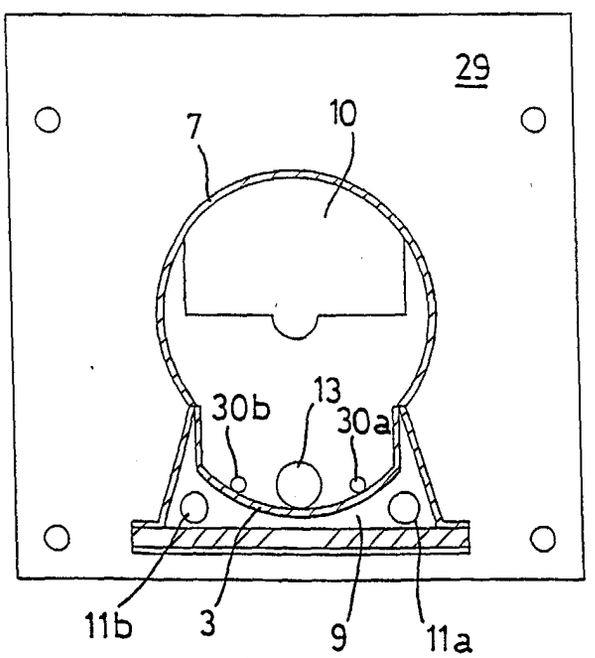

FIG. 5

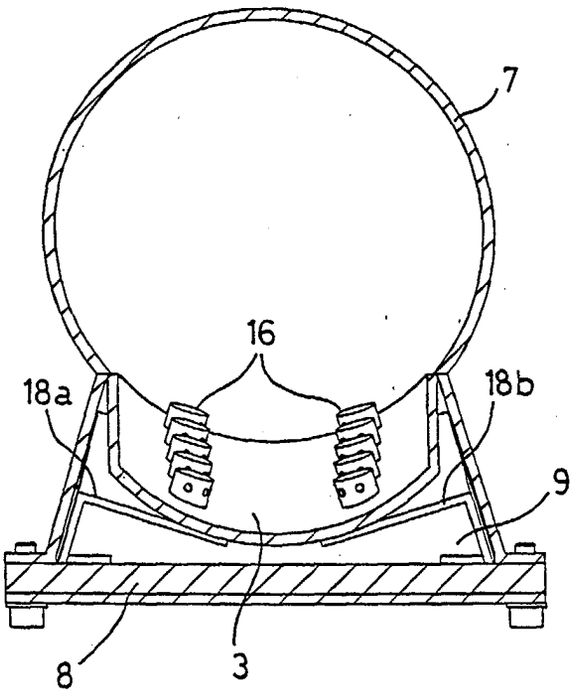

FIG. 6

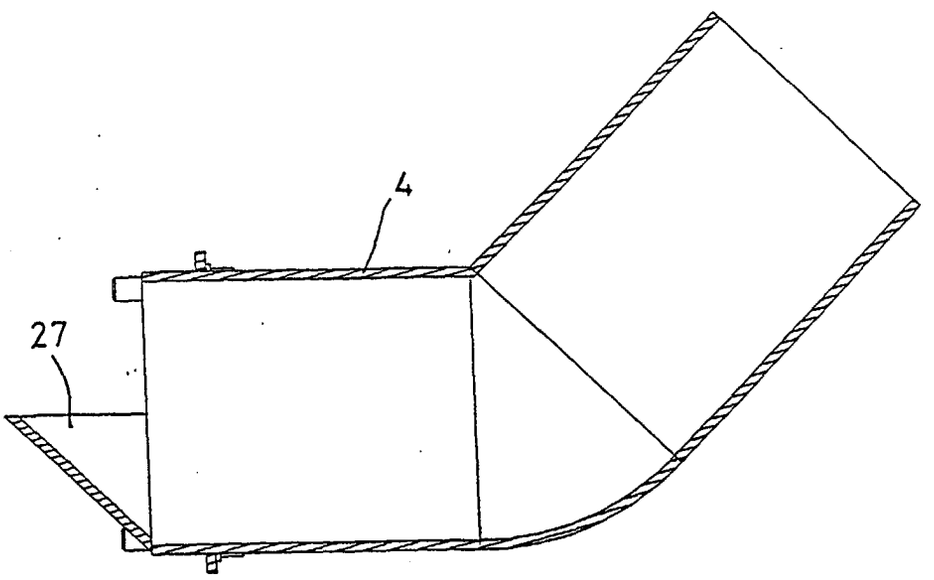

FIG. 10

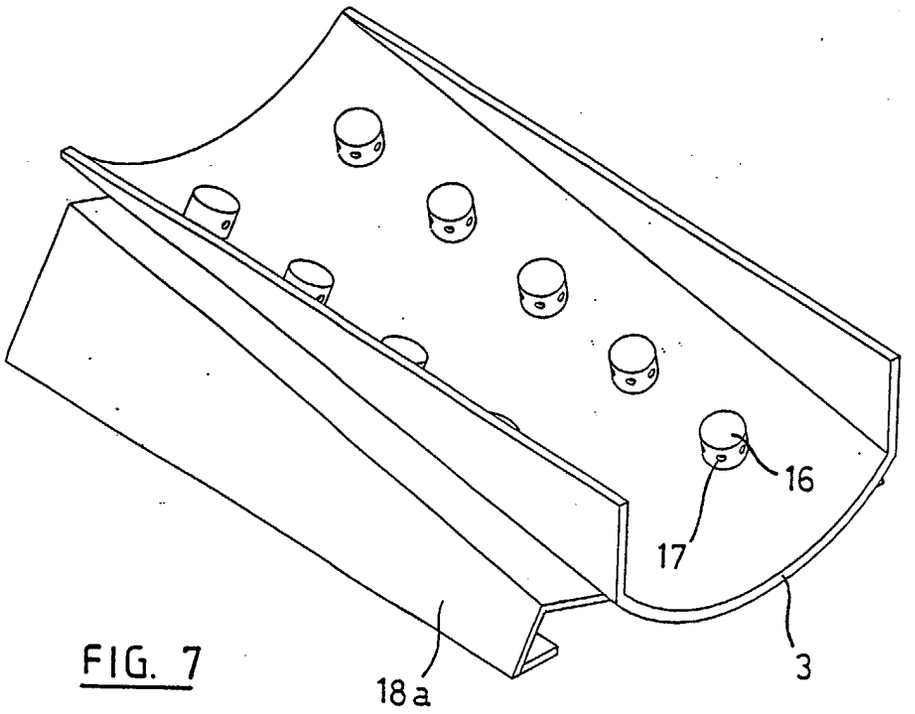

FIG. 7

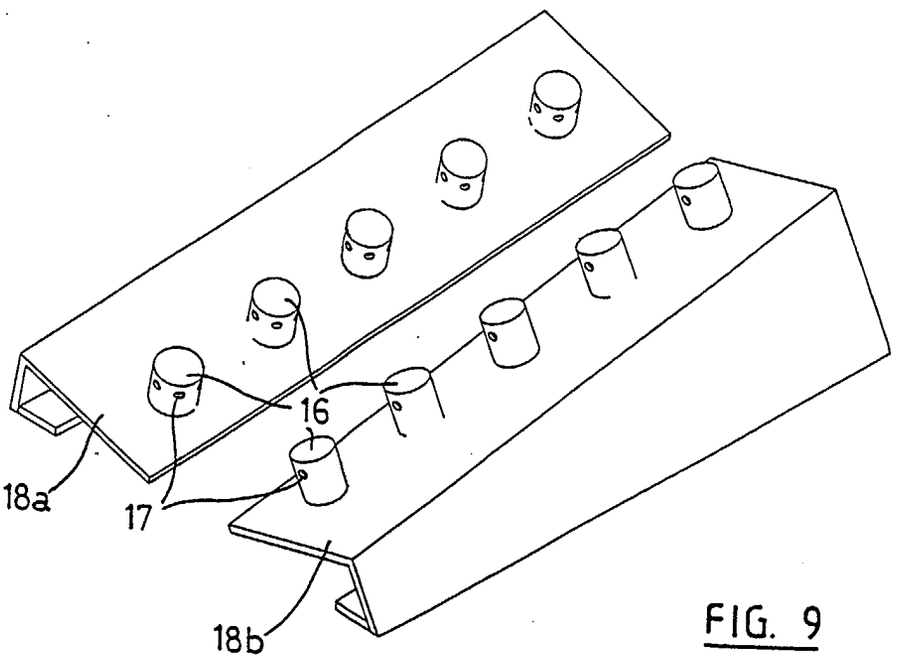

FIG. 9

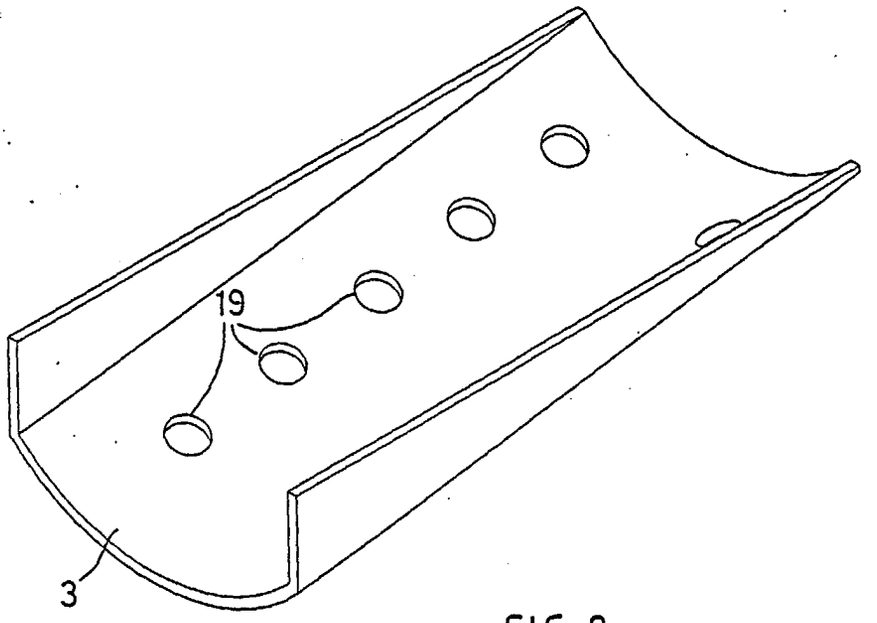

FIG. 8

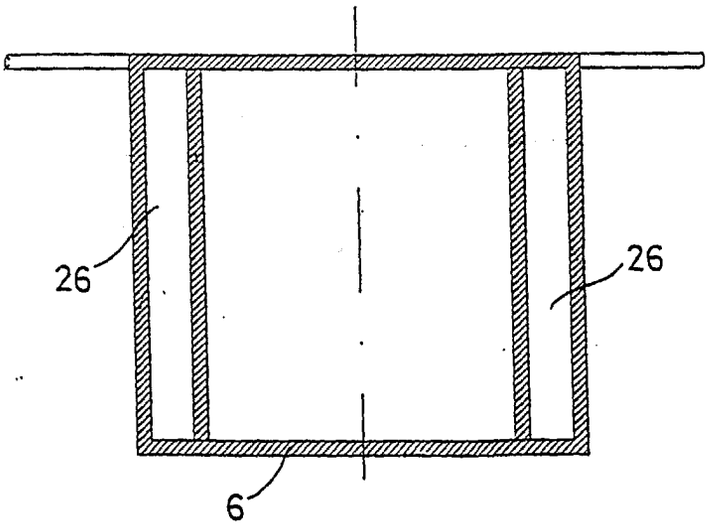

FIG. 11