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(54) Vertical burner for a domestic heating apparatus

(57) A vertical burner (10) for a domestic heating apparatus (12) fed by granular biomass fuel such as pellets, olive pulp, maize and suchlike, comprises a support frame (13) inside which a combustion unit (11) is installed, having inside it a combustion chamber (25). The combustion unit (11) comprises an internal conveyor body (26) which delimits the combustion chamber (25) inside it and, outside it, a containing chamber (22) for the comburent air, wherein the internal conveyor body (26) is made of material with low heat conductivity and high resistance to temperature, able to maintain, in normal use, the internal temperature of the chamber (25) at a determinate combustion temperature. The internal conveyor body (26) is shaped so as to vertically define one or more parts (28, 30, 32) of the chamber (25), which are shaped with cross sections having predetermined and different geometry so as to determine an ascent of the combustion fumes upward at a determinate speed of outflow, so that they have adequate time to remain in the chamber (25) in order to allow a substantial complete combustion.

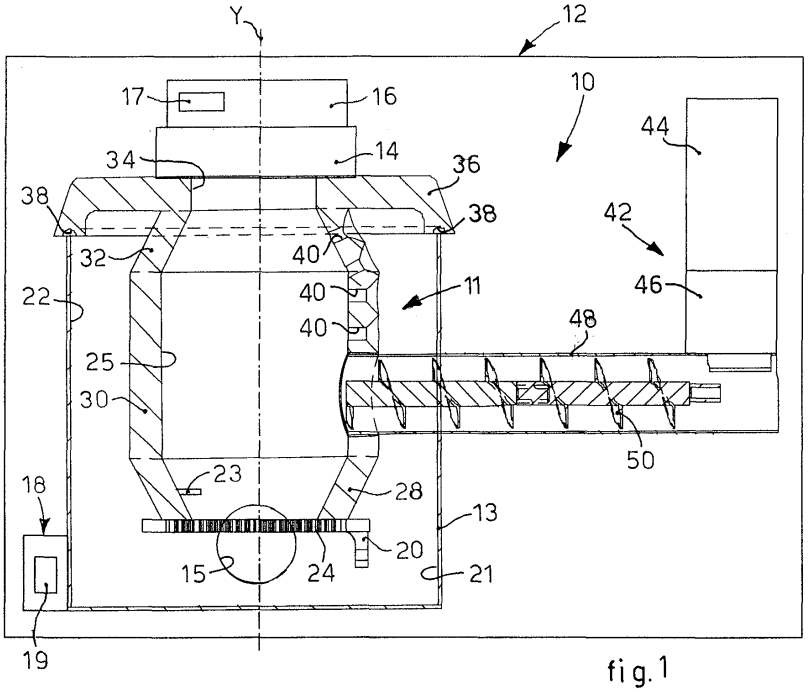

fig.1

EP 2 083 215 A2

Description

FIELD OF THE INVENTION

[0001] The present invention concerns a vertical burner for a domestic heating apparatus, such as a stove, fed by granular biomass fuel, for example pellets, olive pulp, maize or others.

BACKGROUND OF THE INVENTION

[0002] Apparatuses for domestic heating are known, such as a stove using pellets, comprising a frame made of sheet metal which supports a unit to extract the fumes and a unit to feed the pellets, and inside which a combustion unit or burner of the pellets is disposed, consisting of a cast iron brazier, usually in the shape of an open basin and flared upward, and an element to ignite the pellets.

[0003] Moreover, in the frame, above the brazier and next to the fume extraction unit, an air-fume heat exchanger is provided, to heat the air of the room or a water-fume exchanger of a water plant, by means of the heat energy of the combustion fumes.

[0004] The air of the room is conveyed from below, partly into the burner, for combustion, and partly into the heat exchanger, on the air side.

[0005] In the case of apparatuses able to heat a liquid (usually water) this is conveyed inside the exchanger, while the outside part is lapped by the combustion fumes.

[0006] The most recent European and Italian laws and regulations, such as UNI-EN 13240 for stoves and UNI-EN 14785 for pellet stoves, concerning the reduction of emissions, in particular to reduce the presence of unburnt particles, dust (particulate), PM_{10}, NO_x and carbon monoxide in the discharge fumes, provide a considerable reduction of these emissions for the burners in question.

[0007] The known heating apparatus has the disadvantage that it is difficult, in functioning, to respect such strict norms, because the combustion does not take place constantly at the optimum high temperature required for combustion, resulting in an incomplete combustion and with the resulting emission of unburnt pollutants.

[0008] Purpose of the present invention is to make a vertical burner for a domestic heating apparatus which allows to considerably reduce the presence of unburnt pollutants, dust (particulate), PM_{10}, NO_x and carbon monoxide in the discharge fumes, in order to respect the above new laws.

[0009] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0010] The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

[0011] In accordance with the above purpose, a vertical burner for a domestic heating apparatus fed with granular biomass fuel, such as pellets, olive pulp, maize and suchlike, comprises a support frame inside which a combustion unit with a combustion chamber inside is installed.

[0012] In accordance with a characteristic feature of the present invention, the combustion unit comprises an internal conveyor body, advantageously shaped as a divergent-convergent nozzle, which delimits the combustion chamber inside it and, outside it, a containing chamber for the comburent air.

[0013] The internal conveyor body is made of a material with low heat conductivity and high resistance to temperature, able to maintain, under normal use, the internal temperature of the combustion chamber at a determinate combustion temperature. Moreover, the internal conveyor body is shaped so as to define vertically one or more parts of the chamber, which are shaped with cross sections with a predetermined and different geometry in order to determine the ascent of the combustion fumes upward at a determinate outflow speed, so that they have adequate time to stay in the chamber, such as to enable a substantial complete combustion.

[0014] The aforementioned parts of the combustion chamber advantageously define the geometry as a divergent-convergent nozzle of the internal conveyor body.

[0015] Thanks to the material of which the internal conveyor body is made, which impedes surface cooling in the combustion chamber, and thanks to the optimum and substantial complete combustion of the combustion fumes which it thus obtains in the combustion chamber, the present invention allows to considerably reduce, in the discharge fumes, the presence of unburnt particles, dust, PM_{10}, NO_x, SO_x, and carbon monoxide, in order to respect the various new norms. Indeed with the present invention the passage time, that is, the time the fumes remain in the combustion chamber, is maximized, at the maximum possible temperature of combustion.

[0016] Advantageously, the internal conveyor body is made as a hollow lateral wall structure, surrounding a vertical axis, with a material resistant to the high combustion temperatures and with a low heat conduction property.

[0017] According to a variant, a first part of the combustion chamber is divergent and in its lower part is able to house the grate-brazier on which the combustion of the granular biomass takes place. This first part is flared, or rather it widens toward the top so as to have a cross section which increases, from bottom to top, from a minimum section to a maximum section. There is also at least a second part, provided above the first part, with a substantially constant cross section equal to the maximum section of the first part. This geometry is advantageous in order to increase the time the fumes stay inside.

[0018] According to a variant solution, the internal con-

veyor body is shaped so as to define a third part too, above the second part, which is flared toward the bottom (convergent) in order to have a cross section which diminishes, from bottom to top, from a maximum section to a minimum section.

[0019] Advantageously, the third part is substantially shaped equal and symmetrical to the first part.

[0020] On the whole, the second part has a height at least double that of the third part, thus maximizing the time the fumes stay inside.

[0021] According to a variant, the first part has a truncated cone shape, while the second part is cylindrical.

[0022] Advantageously, the material of which the internal conveyor body is made is refractory based which, keeping the high combustion temperatures constant, allows an effective irradiation of the heat energy toward the inside of the combustion chamber.

[0023] According to an advantageous variant, in order to guarantee a spiral and rotational movement of the fumes in the combustion chamber, and therefore further increase the time the fumes stay inside, a plurality of passageways are provided, made through the internal conveyor body, which are able to allow the passage of comburent air from the containing chamber to the inside of the chamber in order to achieve the post-combustion of the fumes. In particular, the passageways are positioned and shaped so as to determine a substantial spiral movement of the combustion fumes.

[0024] According to a variant, the passageways are conical through holes directed substantially perpendicular with respect to the internal conveyor body. Advantageously, the conical holes are radial toward the center of the chamber.

[0025] According to another variant, the passageways are conical holes which are inclined with respect to the internal conveyor body; advantageously they are substantially tangential to the internal conveyor body. This variant increases the turbulent motion of the fumes in the combustion chamber, with the above mentioned advantageous effects on combustion.

[0026] A further advantage of the present invention is that, given the optimum and substantial complete combustion and reduction in emission of unburnt particles, there is also a reduced solid combustion residue, or ash, at the bottom of the brazier, thus reducing the number of times the brazier needs to be cleaned or emptied.

[0027] A heating apparatus comprising the above burner also comes within the field of the present invention.

[0028] Moreover, according to the present invention, a method for the combustion of granular biomass such as pellets, olive pulp, maize and suchlike, inside the combustion chamber of a vertical burner of a domestic heating apparatus, provides to use an internal conveyor body made of low heat conductivity material which has a high resistance to temperature, which delimits the combustion chamber inside it and is able to maintain, under normal use, the temperature of the chamber at a determinate combustion temperature, and to convey the outflow of the combustion fumes upward and at a determinate speed, making them pass along a plurality of parts of the combustion chamber, which have a different and predetermined cross section so that the combustion fumes have time to remain in the chamber to allow a substantial complete combustion thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a schematic section of the burner for a heating apparatus according to the present invention;
- fig. 2 is a plane view of the burner in fig. 1.

DETAILED DESCRIPTION OF A PREFERENTIAL FORM OF EMBODIMENT

[0030] With reference to fig. 1, a burner 10 according to the present invention is installed in a heating apparatus 12 of the type using pellets. It is clear that, as well as pellets, other granular biomasses can be used, such as olive pulp or maize, with a nominal dimension comprised between a few millimeters and some tens of millimeters.

[0031] The burner 10 comprises a support frame 13 made of metal material which supports a combustion unit 11 mounted inside it.

[0032] The frame 13 has a lower part 21, which functions as a technical compartment, and a higher part of the frame 13, or plenum 22 which functions, to all effects, as a containing chamber for the combustion air, as is better explained in the following part of the description.

[0033] The combustion unit 11 comprises an internal conveyor body 26, disposed in the plenum 22 vertically along an axis Y and resting on a shelf 20, which delimits laterally inside it a combustion chamber 25 which provides at its lower part a grate-brazier 24.

[0034] The internal conveyor body 26 is shaped so as to have a geometry as a divergent-convergent nozzle. Moreover, the internal conveyor body 26 is made of refractory material and develops along the vertical axis Y, substantially for the whole height that goes from the shelf 20 as far as the top of the frame 13. The internal conveyor body 26 is axial-symmetrical, advantageously consisting of a cylindrical central part 30 and two peripheral zones 28 and 32 substantially shaped like a truncated cone, with mating diameters, so as to define said geometry as a divergent-convergent nozzle, as can be clearly seen in figs. 1 and 2.

[0035] The internal conveyor body 26 has a substantially horizontal cover part 36 on its upper end. The cover part 36 closes the plenum 22 of the frame 13 at the top, for this purpose cooperating with packing elements 38

able to achieve a seal between the refractory and the metal material of the frame 13.

[0036] The cover part 36 is the part which actually rests on the structure of the frame 13, supporting the burner 10.

[0037] On the upper part of the frame 13 a heat exchanger 14 is mounted, in which the combustion fumes exchange heat with the air to be heated, which is taken from an internal or external environment, or a liquid (usually water) in the case of water heating plants, according to the two alternatives. Moreover, downstream of the heat exchanger 14 a fume extraction unit 16 is installed, possibly with the help of an aspirator 17.

[0038] A feeding unit 42 for pellets is also associated with the burner 10, in this case located laterally, which feeds the pellets to the grate-brazier 24 from above, that is, by falling The feeding unit 42 comprises a tank 44 for the pellets, a star valve 46, which functions as a dispenser for the selective passage of the pellet from the tank 44, and a metal feed pipe 48 which receives the pellet form the star valve 46 and which is provided with a spiral screw 50 (figs. 1 and 2) to feed the pellet toward the burner 10 and to introduce it, from above with respect to the bed of embers, inside the burner 10.

[0039] Moreover, on the lower part of the frame 13 a feed unit for combustion air 18 is mounted, which has a ventilator or alternatively a blower 19, in particular installed in the technical compartment 21, which introduces the air through a hole 15, a part into the combustion unit 11 and a part into the heat exchanger 14.

[0040] As we said, the internal conveyor unit 26 functions as a divergent-convergent nozzle and has the first part or combustion part 28, axially, from the bottom to the top, in which the grate-brazier 24 is located (figs 1 and 2) onto which the pellet falls, and an ignition element 23, with an electric resistance, to ignite the pellet. In the first part 28 the combustion flame develops. The first part 28 has a shape which flares upward for the first conveyance of the combustion fumes upward.

[0041] Moving upward, along the axis Y, there is the second or central part 30, with a diameter substantially equal to the maximum size of the first part 28, as can be seen in fig. 1. The height of the central part 30, instead, is at least double the height of the first part 28, so as to increase the time in which the fumes pass through or remain inside it, and hence to promote the complete combustion thereof.

[0042] The second part 30 thus functions as a combustion zone and where the combustion fumes slowly ascend. In particular, in the second part 30 the temperature is substantially always equal to the optimum necessary combustion temperature and there is no surface cooling of the chamber 25, thanks to the effect of irradiance of the heat energy toward the inside of the chamber 25 due to the refractory material which makes up the internal conveyor body 26. The fumes have an extended time in which they remain inside the second part 30, thanks to the wider section than the brazier 24 from which they evolve, and therefore for them the combustion process is completed at the optimum combustion temperature. In other words, the time for which the fumes remain at the maximum possible combustion temperature is maximized, with a considerable reduction in the emission of unburnt particles.

[0043] Then there is the third part 32, which tapers upward, symmetrical and specular with the first part 28, and determines a narrowing of the section where the fumes pass with respect to the intermediate part 30. Overall, the internal conveyor body 26 has a height of about 3 - 4 times the height of conventional burners known in the state of the art, with a geometry having a narrow part (first part 28), a wider part (second part 30), and another narrow part (third part 32), allowing to obtain the effect of slowing down the fumes, as we said.

[0044] In this case, the inside of the chamber 25 is shaped with a circular section, with the internal diameters developing as described above.

[0045] Once combustion is complete, the fumes are conveyed efficiently toward an outlet 34, connected to the fume extraction unit 14.

[0046] The combustion air, arriving from below, passes through the inlet hole 15, into the brazier 24 and, rising into the plenum 22, penetrates into the combustion chamber 25 through the grate 24 and especially through conical holes 40, made as through holes in the internal conveyor body 26.

[0047] For ease of illustration, the conical holes 40 are shown only in the right-hand side of the internal conveyor body 26, in fig. 1, but they can be made along all or part of its perimeter, even at different heights.

[0048] The conical holes 40 can have a central direction, that is, they can be substantially perpendicular to the relative part 28, 30 or 32 in which they are made, so as to have a stream of air substantially radial toward the center.

[0049] Alternatively, the conical holes 40 are slightly inclined with respect to a normal radial direction, so as to determine a stream of air of a tangential type and, consequently, an accentuated spiral or rotational motion of the combustion fumes.

[0050] The stream of comburent air arriving from the conical holes 40 allows post-combustion of the combustion fumes, so as to increase the efficiency and heat yield of the burner 10 and to abate the emissions of carbon monoxide.

[0051] Furthermore, the conical holes 40 determine a spiral or rotational turbulent motion of the fumes, which thus ascend slowly along the combustion chamber 25, increasing the time they remain inside the internal conveyor body 26.

[0052] The reduction in the speed at which the fumes ascend is due to the synergic effect of the widening of the passage section of the internal conveyor body 26 in the part 30, in combination with the effect of turbulent and spiral motion of the fumes due to the stream of post-combustion air arriving from the conical holes 40.

[0053] In this way, the combustion fumes remain, or

"stagnate", longer in the combustion chamber 25 and, due to the fact that the temperature inside the latter, thanks to the refractory material of the internal conveyor body 26, is at a high and optimum combustion temperature, the fumes can complete the combustion process, thus reducing the emission of unburnt particles.

[0054] Once they are completely burnt, the fumes are conveyed to the extraction unit 14, as described above.

[0055] It is clear that modifications and/or additions of parts may be made to the burner 10 for a heating apparatus as described heretofore, without departing from the field and scope of the present invention.

[0056] It is also clear that, although the present invention has been described with reference to specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of burner for a heating apparatus, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

Claims

1. Vertical burner for a domestic heating apparatus (12) fed by granular biomass fuel such as pellets, olive pulp, maize and suchlike, comprising a support frame (13) inside which a combustion unit (11) is installed, having inside it a combustion chamber (25), **characterized in that** the combustion unit (11) comprises an internal conveyor body (26) which delimits the combustion chamber (25) inside it and, outside it, a containing chamber (22) for the comburent air, wherein the internal conveyor body (26) is made of material with low heat conductivity and high resistance to temperature, able to maintain, in normal use, the internal temperature of the chamber (25) at a determinate combustion temperature, and **in that** the internal conveyor body (26) is shaped so as to vertically define one or more parts (28, 30, 32) of the chamber (25), which are shaped with cross sections having predetermined and different geometry in order to determine an ascent of the combustion fumes upward at a determinate speed of outflow, so that they have adequate time to remain in the chamber (25) in order to allow a substantial complete combustion thereof.

2. Burner as in claim 1, **characterized in that** a first part (28) is provided at the lower part in the internal conveyor body (26) and is able to house a grate-brazier (24) on which the combustion of the granular biomass is carried out and is shaped flared upward so as to have a cross section that increases, from the bottom up, from a minimum section to a maximum section, and at least a second part (30), provided above the first part (28), which has a cross section substantially constant and equal to the maximum section of the first part (28).

3. Burner as in claim 2, **characterized in that** the internal conveyor body (26) is shaped so as to define a third part (32) also, above the second part (30), which is shaped flared downward so as to have a cross section that diminishes, from the bottom upward, from a maximum section to a minimum section.

4. Burner as in claim 3, **characterized in that** the parts (28, 30, 32) define the internal conveyor body (26) with a geometry as a divergent-convergent nozzle.

5. Burner as in claim 3, **characterized in that** the third part (32) is substantially shaped equal and symmetrical to the first part (28).

6. Burner as in claim 3, **characterized in that** the second part (30) has a height at least double that of the first part (28).

7. Burner as in claim 2, **characterized in that** the first part (28) is shaped like a truncated cone.

8. Burner as in claim 3, **characterized in that** the second part (30) is cylindrical in shape.

9. Burner as in any claim hereinbefore, **characterized in that** the material of which the internal conveyor body (26) is made is refractory.

10. Burner as in any claim hereinbefore, **characterized in that** the containing chamber (22) is a plenum which develops outside and around the internal conveyor body (26).

11. Burner as in any claim hereinbefore, **characterized in that** it comprises a plurality of passageways (40) made through the internal conveyor body (26), which are able to allow the comburent air to pass from the containing chamber (22) inside the chamber (25) to achieve the post-combustion of the fumes.

12. Burner as in claim 11, **characterized in that** the passageways (40) are positioned and shaped so as to determine a substantially spiral and/or rotational motion of the combustion fumes.

13. Burner as in claim 11 or 12, **characterized in that** the passageways (40) are conical holes (40) which are directed substantially perpendicular with respect to the internal conveyor body (26).

14. Burner as in claim 13, **characterized in that** the conical holes (40) are radial toward the center of the chamber (25).

15. Burner as in claim 11 or 12, **characterized in that** the passageways (40) are conical holes (40) which are directed inclined with respect to the internal con-

veyor body (26).

16. Burner as in claim 15, **characterized in that** the conical holes (40) are substantially tangential to the internal conveyor body (26).

17. Burner as in claim 2, **characterized in that** it comprises an outlet (34), to convey the fumes outside the chamber (25), which has a cross section substantially equal to the minimum section of the first part (28).

18. Burner as in any claim hereinbefore, **characterized in that** it comprises feed means (44) able to feed the granular biomass from above, over the grate-brazier (24) or the bed of the embers.

19. Burner as in any claim hereinbefore, **characterized in that** the combustion unit (11) has an upper part (36) that functions as a closing means for the frame (13).

20. Burner as in claim 19, **characterized in that** it comprises sealing means (38) between the frame (13) and the upper part (36).

21. Apparatus for domestic heating comprising a burner (10) as in any claim hereinbefore.

22. Apparatus as in claim 21, **characterized in that** it comprises heat exchange means (14) for heat exchange between the combustion fumes and the air or liquid fluid to be heated.

23. Apparatus as in claim 21 or 22, **characterized in that** it comprises a unit (16) to extract the fumes, above the burner (10).

24. Apparatus as in claim 23, **characterized in that** the extraction unit (16) comprises suction means (17).

25. Apparatus as in claim 21 or 22, **characterized in that** it comprises a unit (18) to introduce the air, below the burner (10).

26. Apparatus as in claim 25, **characterized in that** the introduction unit (18) comprises ventilation means (19).

27. Method for the combustion of granular biomass fuel such as pellets, olive pulp, maize and suchlike, inside the combustion chamber (25) of a vertical burner (10) of an apparatus (12) for domestic heating, **characterized in that** it provides to use an internal conveyor body (26) made of material with low heat conductivity and high resistance to temperature, which delimits inside it the chamber (25) and is able to maintain, in normal use, the temperature of the chamber (25) at a determinate combustion temperature, and to convey the outflow of combustion fumes upward, at a determinate speed, making them pass along a plurality of parts (28, 30, 32) of the chamber (25), which have a different and predetermined cross section so that the combustion fumes remain in the chamber (25) for such a time as to allow a substantial complete combustion thereof.

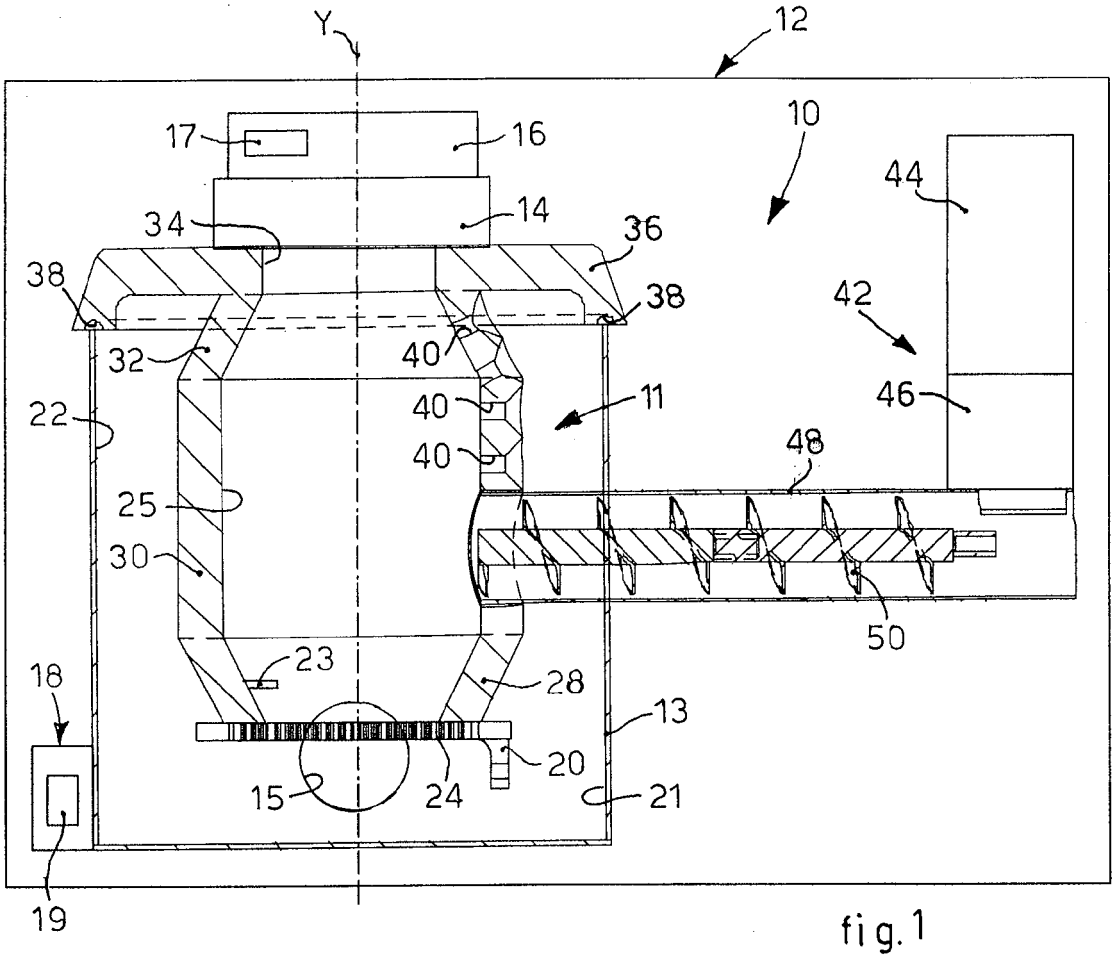
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fig. 1

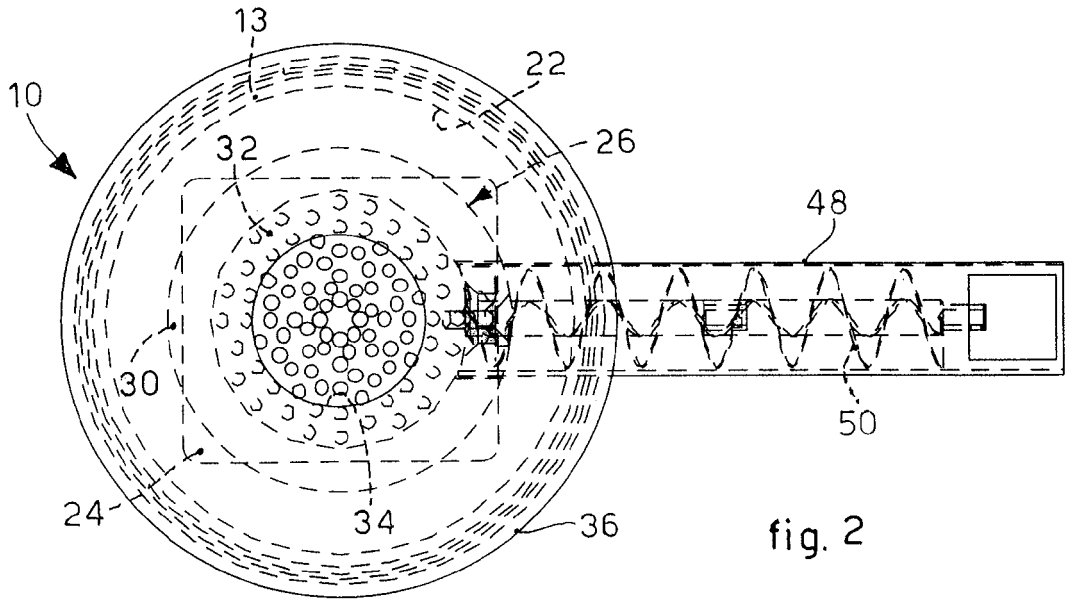
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fig. 2