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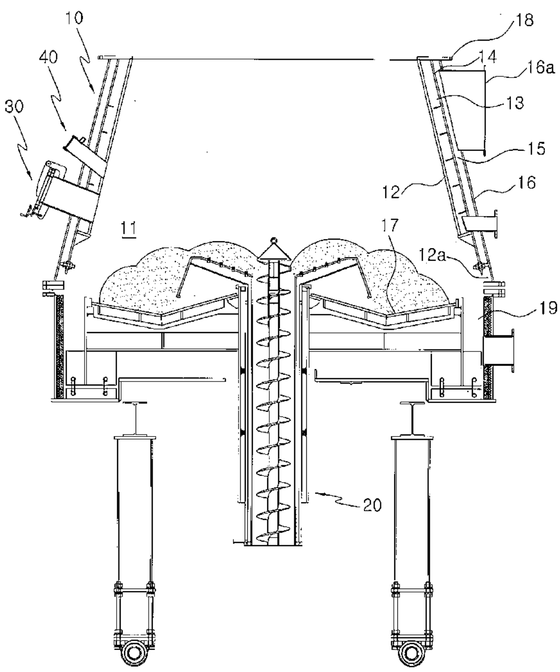
(54) Combustion apparatus with improved combustion efficiency

(57) Provided is a combustion apparatus with improved thermal efficiency having a combustion vessel that receives an air supply from the outside to thus burn a fuel that is supplied from a fuel supply unit, which including: a cylindrical combustion chamber (11) that is surrounded by an inner wall (12) of the combustion vessel (10) to thus burn a fuel; a cooling chamber (13) that comprises an intermediate wall (14) that is formed to be spaced apart from an outer side of the inner wall (12) of the combustion vessel (10), in which a cooling water inlet and a cooling water outlet through which cooling water flows in and out, respectively, are formed at lower and upper sides of the intermediate wall (14), and that is formed at an outer circumference of the combustion chamber (11), to thereby cool the inner wall (12) of the combustion chamber (11) by the cooling water that flows into a space formed between the inner and intermediate walls (12, 14) of the cooling chamber (13) through the cooling water inlet; a lateral combustion air supply chamber (15) that comprises an outer wall (16) that is formed to be spaced apart from an outer side of the intermediate wall (14) of the cooling chamber (13), in which a combustion air supply inlet (16a) through which air necessary for combustion is supplied from the outside is formed at an upper side of the outer wall (16), and that is formed at an outer circumference of the cooling chamber (13), to thereby make the air supplied through the combustion air supply inlet (16a) that is formed in a tangential direction with respect to the cylindrical outer wall (16) turn and fall in a space formed between the intermediate wall (14) of the cooling chamber (13) and the outer wall (16) of the lateral combustion air supply chamber (15), so that the combustion air is supplied to the combustion chamber (11) via an opened lower portion of the lateral combustion air supply chamber (15) (Fig. 2).

FIG. 2



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Description

[0001] The present invention relates to a heat collecting combustion apparatus, and more particularly, to a heat collecting combustion apparatus that collects heat of combustion that is generated by burning a solid fuel and so on in a combustion chamber and uses the collected heat as a recovery energy source.

[0002] In general, industrial facilities that require industrial hot water, steam or gas of high temperature use a combustion apparatus that ignites and burns fuel in a combustion vessel to thus generate thermal energy, respectively. In addition, solid fuels such as RDF (Refuse Derived Fuel) that is made from waste into a fuel or RPF (Refuse Plastic Fuel) that is made from scrapped plastic waste into a fuel are widely being used as fuels that are used in the combustion apparatus in terms of economical efficiency and recycling of resources.

[0003] However, since these conventional combustion apparatuses employ a method of putting and burning a lot of solid fuels into the bottom of the combustion vessel, the solid fuels may be incompletely burnt to thus cause a waste of the solid fuels as well as to lower a thermal efficiency. In addition, since a lot of ashes are generated at a time, it is not so easy to construct automation of the remaining ashes, and it is cumbersome to take out the left ashes from the bottom of the combustion vessel. Further, if solid fuels have been completely burnt on the bottom of the combustion vessel, new solid fuels should be put into the bottom of the combustion vessel and then ignited again, to thereby make it to perform a continuous combustion process difficult and make a caloric value uneven.

[0004] In addition, these solid fuels have caused a problem of discharging a massive amount of gases or particles such as dust, carbon monoxide, soot, gaseous HCL, SOx, NOx, and dioxin that pollute environment during combustion.

[0005] To solve these problems, a combustion apparatus 1000 in Fig.1 has been developed. The heat collecting combustion apparatus 1000 according to the conventional technology, burns solid fuels that are supplied from a fuel hopper 310 into a combustion vessel 100 to thus generate hot combustion gases. Here, air that is necessary for combustion of fuels is supplied from the outside into a combustion chamber 110 via an air cooling chamber 150, a passage 140a of an intermediate wall 140, a swirl flow supply chamber 130, and a passage 120a of an inner wall 120.

[0006] In addition, the combustion gases of high temperature that have been generated by combustion of fuel in the combustion chamber 110 are supplied to a heat collecting unit such as a boiler through an elbow-shaped combustion gas discharge tube 400, to thereby collect heat.

[0007] However, the conventional solid fuel combustion apparatus supplies air that is needed to burn solid fuels to only outer portions of the solid fuels that have been loaded in the combustion chamber. Accordingly, the outer portions of the solid fuels are well burnt but the inner portions thereof may be difficult to contact the air necessary for combustion and thus may be burnt imperfectly. In addition, the inner wall of the combustion chamber is persistently exposed to the combustion gases of high temperature and thus may be deformed and cracked at a long-term use, to accordingly lower durability.

[0008] To solve the above problems of the conventional art, it is an object of the present invention to provide a combustion apparatus that ensures complete combustion of solid fuels loaded inside a combustion chamber and reduces a loss of heat to thus improve a thermal efficiency, as well as that lowers temperature of inner walls of the combustion chamber that is continuously exposed to high temperature combustion gases to thereby enhance durability.

[0009] To achieve the above object of the present invention, there is provided a combustion apparatus with improved combustion efficiency having a combustion vessel that receives an air supply from the outside to thus burn a fuel that is supplied from a fuel supply unit, the combustion apparatus comprising:

a cylindrical combustion chamber that is surrounded by an inner wall of the combustion vessel to thus burn a fuel;

a cooling chamber that comprises an intermediate wall that is formed to be spaced apart from an outer side of the inner wall of the combustion vessel, in which a cooling water inlet and a cooling water outlet through which cooling water flows in and out, respectively, are formed at lower and upper sides of the intermediate wall, and that is formed at an outer circumference of the combustion chamber, to thereby cool the inner wall of the combustion chamber by the cooling water that flows into a space formed between the inner and intermediate walls of the cooling chamber through the cooling water inlet; and

a lateral combustion air supply chamber that comprises an outer wall that is formed to be spaced apart from an outer side of the intermediate wall of the cooling chamber, in which a combustion air supply inlet through which air necessary for combustion is supplied from the outside is formed at an upper side of the outer wall, and that is formed at an outer circumference of the cooling chamber, to thereby make the air supplied through the combustion air supply inlet that is formed in a tangential direction with respect to the cylindrical outer wall turn and fall in a space formed between the intermediate wall of the cooling chamber and the outer wall of the lateral combustion air supply chamber, so that the combustion air is supplied to the combustion chamber via an opened lower portion of the lateral combustion air supply chamber.

[0010] Preferably but not necessary, the fuel supply unit comprises:

a fuel supply tube that is vertically placed on the lower portion of the combustion vessel and guides the fuels into the combustion chamber; and

a transfer screw that is formed in the fuel supply tube and having a screw shaft and screw blades that are formed on the screw shaft, in order to transfer the fuels into the combustion chamber.

[0011] Preferably but not necessary, a horizontal fuel supply member is formed at the upper end of the transfer screw, and includes: an extension shaft that is extended from the screw shaft to the outside of the fuel supply tube, is protrudingly formed in the combustion chamber, and is rotated together with the screw shaft; and a radial fuel supply element that is protrudingly formed perpendicularly from the axial direction of the extension shaft and thus is rotated together with the extension shaft, to thereby radially supply the fuels that are raised up through the fuel supply tube into the combustion chamber.

[0012] Preferably but not necessary, a fuel height control bracket that has a structure that the diameter of the lower portion thereof is the larger than that of the extension shaft is installed at the upper end of the extension shaft.

[0013] Preferably but not necessary, the combustion apparatus further comprises: a boiler comprising a water tube to which the combustion gases that have been generated by burning the fuel in the combustion chamber are supplied to the boiler to thereby collect heat from the combustion gases, wherein the cooling water discharged from the cooling water outlet in the cooling chamber is connected with the water tube in the boiler via a connection tube so as to be used to collect heat from the combustion gases generated by the combustion vessel.

[0014] Preferably but not necessary, a spirally shaped cooling water guide plate is provided in the cooling chamber so that the cooling water introduced via the cooling water inlet turns and rises up.

[0015] Preferably but not necessary, the fuel supply unit that is installed at the lower portion of the combustion vessel comprises: a lower combustion air supply tube whose diameter is larger than that of the fuel supply tube through which fuel is supplied, and that is formed in the form of a concentric circle, to thereby supply combustion air from the lower portion of the combustion chamber to the bottom surface of the fuel.

[0016] Preferably but not necessary, an upper end portion that is protrudingly formed from the fuel supply tube into the combustion chamber comprises: a diameter enlargement portion whose diameter gradually grows larger upwards; and a slope guide portion that is bent downwards from the end portion of the diameter enlargement portion and is formed slantly downwards.

[0017] Preferably but not necessary, an upper end portion that is protrudingly formed from the lower combustion air supply tube into the combustion chamber comprises: an air feed diameter enlargement portion whose diameter gradually grows larger upwards and that is positioned at the lower side of the diameter enlargement portion of the fuel supply tube, and wherein a number of air feed nozzles are formed in the diameter enlargement portion of the fuel supply tube so that the combustion air supplied from the lower combustion air supply tube is introduced into the combustion chamber.

[0018] Preferably but not necessary, an upper end of the air feed diameter enlargement portion of the lower combustion air supply tube is closed by the slope guide portion of the fuel supply tube.

[0019] Preferably but not necessary, the combustion apparatus further comprises:

a nozzle-cleaning manhole that comprises: a cylindrical body that communicates with the combustion chamber and is formed at the outside of the combustion vessel to be directed to the upper surface of the diameter enlargement portion; a cover that is pivotably engaged to an outer end of the cylindrical body; and a handle that locks/unlocks the cover to the cylindrical body; and

an observation scope that is formed at the upper side of the nozzle-cleaning manhole outside of the combustion vessel and comprises: a cylindrical body that is directed to the diameter enlargement portion; and a window that is installed at the outer end of the cylindrical body.

[0020] Preferably but not necessary, the cylindrical body of the nozzle-cleaning manhole is formed on the extension line of the upper surface of the diameter enlargement portion.

[0021] The present invention provides a combustion apparatus that ensures complete combustion of solid fuels loaded inside a combustion chamber and reduces a loss of heat to thus improve a combustion efficiency, as well as that lowers temperature of inner walls of the combustion chamber that is continuously exposed to high temperature combustion gases to thereby enhance durability.

[0022] The above and other objects and advantages of the present invention will become more apparent by describing the preferred embodiment thereof in more detail with reference to the accompanying drawings in which:

FIG. 1 is a schematic diagram showing a combustion apparatus according to conventional art;

FIG.2 is a schematic diagram showing a combustion apparatus according to an embodiment of the present invention;

FIG. 3 is a cross-sectional view showing one side of a combustion vessel of FIG. 2;

FIG. 4 is a cross-sectional view showing the other side of a combustion vessel of FIG. 2; and

FIG. 5 is a cross-sectional view showing a fuel supply unit of FIG. 2.

[0023] A combustion apparatus according to a preferred embodiment of the present invention will be described with reference to the accompanying drawings, FIGS. 2 to 5.

[0024] FIG. 2 is a cross-sectional view schematically showing a combustion apparatus according to an embodiment of the present invention. FIG. 3 is a cross-sectional view showing one side of a combustion vessel of FIG. 2. FIG. 4 is a cross-sectional view showing the other side of a combustion vessel of FIG. 2. FIG. 5 is a cross-sectional view showing a fuel supply unit of FIG. 2.

[0025] A combustion apparatus according to a preferred embodiment of the present invention, includes a combustion vessel 10 that burns a fuel therein and generates combustion gases of high temperature generated by combustion, and collects heat from the high temperature combustion gases using a boiler.

[0026] First, the combustion vessel 10 is formed in a cylindrical shape, and contains and burns a solid fuel therein(the solid fuel in the present invention indicates all solid-type fuels including RDF, RPF, wood pellet, coal, and so on). The combustion vessel 10 includes: a combustion chamber 11 that is surrounded by an inner wall of the combustion vessel 10 to thus burn a fuel; a cooling chamber 13 that cools the inner wall of the combustion chamber 11; and a lateral combustion air supply chamber 15 that is formed at the side surface of the combustion chamber 11 in order to supply air necessary for combustion supplied from the outside for the combustion chamber 11.

[0027] The cooling chamber 13 plays a role of lowering temperature of the inner wall 12 that continues to contact the hot combustion gases of high temperature. As shown in FIG. 2 and FIG.3, the cooling chamber 13 is formed in a space formed between the inner wall 12 of the cylindrical combustion vessel 10 and an intermediate wall 14 that is formed to be spaced apart from an outer side of the inner wall 12 of the cylindrical combustion vessel 10 whose inner diameter is narrowed upwards. Here, a cooling water inlet 14a and a cooling water outlet 14b through which cooling water flows in and out, respectively, are formed at lower and upper sides of the intermediate wall 14. The cooling water inlet 14a is formed in a tangential direction with respect to the intermediate wall 14 of the cylindrical combustion vessel 10. In addition, as shown in FIG. 3, a spirally shaped cooling water guide plate 13a is provided at the inner side of the intermediate wall 14 in the cooling chamber 13 so that the cooling water introduced via the cooling water inlet 14a turns and rises up along the cooling water guide plate 13a and discharged through the cooling water outlet 14b that is formed at the upper side of the intermediate wall 14. The cooling water discharged through the cooling water outlet 14b is introduced into a boiler(not shown) via connection tube, so as to be used to collect heat from the hot combustion gases of high temperature that has been generated in the combustion chamber 11.

[0028] The lateral combustion air supply chamber 15 is formed in a space formed between the intermediate wall 14 of the cylindrical combustion vessel 10 and an outer wall 16 that is formed to be spaced apart from an outer side of the intermediate wall 14. A combustion air supply inlet 16a through which air necessary for combustion is supplied from the outside is formed at an upper side of the outer wall 16. The lower portion 12a of the lateral combustion air supply chamber 15 is opened. The combustion air supply inlet 16a is formed in a tangential direction with respect to the cylindrical outer wall 16. Accordingly, the air supplied through the combustion air supply inlet 16a turns and falls down in the inside of the lateral combustion air supply chamber 15, and then is supplied into the combustion chamber 11 via an opened lower portion 12a of the lateral combustion air supply chamber 15.

[0029] In addition, a nozzle-cleaning manhole 30 and an observation scope 40 are formed at the outside of the combustion vessel 10. The nozzle-cleaning manhole 30 and the observation scope 40 are for cleaning air feed nozzles 21 c when the air feed nozzles 21 c are blocked by solid fuel.

[0030] The nozzle-cleaning manhole 30 includes a cylindrical body 31 that communicates with the combustion chamber 11 and is formed at the outside of the combustion vessel 10 to be directed to the extension line of the upper surface of the diameter enlargement portion 21 a of a fuel supply tube 21; a cover 32 that is pivotably engaged to an outer end of the cylindrical body 31; and a handle 33 that locks/unlocks the cover 32 to the cylindrical body 31. The cover 32 is pivotably connected in a pivot shaft 34 in a bracket of one end of the cylindrical body 31, and the handle 33 that is screw-engaged in the bracket of the other end of the cylindrical body 31 is rotated to lock or unlock the cover 32 to the cylindrical body 31.

[0031] The observation scope 40 is formed at the upper side of the nozzle-cleaning manhole 30 outside of the combustion vessel 10, and includes a cylindrical body 41 that is directed to the diameter enlargement portion 21 a, and a window 42 that is installed at the outer end of the cylindrical body 41.

[0032] The upper portion of the combustion vessel 10 is opened in order to exhaust the hot combustion gases of high temperature that are generated by burning a fuel, and the exhausted hot combustion gases are introduced into the boiler through a combustion gas discharge tube (not shown) in order to collect heat. The boiler collects heat from the hot combustion gases and thus obtains hot steam of high temperature. Meanwhile, an ash ejection outlet 19 is formed at the lower edge of the combustion vessel 10 to thereby discharge ashes of the burnt solid fuels. In addition, a rotary type fire grate 17(grate is plate for loading the solid fuel in the top surface thereof) is rotatably installed at the lower portion of the combustion chamber 11. The rotary type fire grate 17 is made in the form of a disc, and plays a role of burning solid fuels loaded in the top surface thereof. The rotary type fire grate 17 is sloped downwards from the center thereof to the outer side inflection point thereof and then is sloped upwards from the outer side inflection point to the outermost side thereof. Accordingly, both side cross-sections of the rotary type fire grate 17 are formed into a V-shaped form. A fuel supply unit 20 for supplying solid fuels for the rotary type fire grate 17 is formed at the center of the rotary type fire grate 17.

[0033] A fuel inlet 24 is formed at one side of the lower portion of the fuel supply unit 20, and a fuel supply tube 21 is provided in the fuel supply unit 20 to thereby supply solid fuels into the combustion chamber 11 by a transfer screw 22. In addition, a lower combustion air supply tube 23 whose diameter is larger than that of the fuel supply tube 21 and that is formed in the form of a concentric circle is formed at the outer side of the fuel supply tube 21, in which the lower combustion air supply tube 23 supplies combustion air from the lower portion of the combustion chamber 11 into the inside of the combustion chamber 11 by an air supply unit 25 such as a ring blower.

[0034] An upper end portion that is protrudingly formed from the fuel supply tube 21 into the combustion chamber 11 includes: a diameter enlargement portion 21 a whose diameter gradually becomes larger upwards; and a slope guide portion 21 b that is bent downwards from the end portion of the diameter enlargement portion 21 a and is formed slantly downwards. The diameter enlargement portion 21 a and the slope guide portion 21 b make the fuels be supplied to the fire grate 17 more stably. A number of air feed nozzles 21 c are formed at the diameter enlargement portion 21 a so that the combustion air supplied from the lower combustion air supply tube 23 is introduced into the combustion chamber 11.

[0035] In addition, an upper end portion that is protrudingly formed from the lower combustion air supply tube 23 into the combustion chamber 11 includes an air feed diameter enlargement portion 23a whose diameter gradually grows larger upwards and that is positioned at the lower side of the diameter enlargement portion 21 a of the fuel supply tube 21, and an upper end of the air feed diameter enlargement portion 23a is closed by the slope guide portion 21 b of the fuel supply tube 21. Thus, the combustion air supplied through the lower combustion air supply tube 23 is guided by the air feed diameter enlargement portion 23a and then is supplied to the bottom of the fuels through a number of the air feed nozzles 21 c that are formed at the diameter enlargement portion 21 a of the fuel supply tube 21 that is formed at the upper side thereof.

[0036] Meanwhile, an air supply unit 25 such as a ring blower may be provided at the other side of the lower portion of the fuel supply tube 21, so that combustion air can be supplied through the fuel supply tube 21 in order to prevent the solid fuels that are burnt in the combustion chamber 11 from being reversed into the solid fuels that exist in the fuel supply tube 21.

[0037] According to the above-described configuration, the solid fuels are supplied to the center of the upper surface of the rotary type fire grate 17 by the fuel supply tube 21, and the combustion air is directly supplied to the bottom of the solid fuels through the air feed nozzles 21 c that are formed at the diameter enlargement portion 21 a of the fuel supply tube 21.

[0038] A transfer screw 22 that is formed in the fuel supply tube 21 and thus transfers the fuels into the combustion chamber 11 includes a screw shaft 22d and screw blades 22e that are formed on the screw shaft 22d. The transfer screw 22 rotates by a motor(not shown) and transfers the fuels. A horizontal fuel supply member 22a is provided at the upper end of the screw shaft 22d and is rotated together with the screw shaft 22d. The horizontal fuel supply member 22a is extended to the outside of the fuel supply tube 21, and is protrudingly formed in the combustion chamber 11. The horizontal fuel supply member 22a includes: an extension shaft 22f that is extended from the screw shaft 22d and is rotated with the screw shaft 22d, a radial fuel supply element 22b that is formed at the circumference of the extension shaft 22f, and a fuel height control bracket 22c that is installed at the upper end of the extension shaft 22f.

[0039] The radial fuel supply element 22b that radially supplies the fuels that are supplied through the fuel supply tube 21 into the combustion chamber 1 1 is formed by a certain length in the length direction of the transfer screw 22.

[0040] The radial fuel supply element 22b is protrudingly formed perpendicularly from the axial direction of the extension shaft 22f and thus is rotated together with a transfer screw 22, to thereby radially supply the fuels that are raised up through the fuel supply tube 21 into the combustion chamber 11. As described above, the solid fuels that are supplied from the fuel supply tube 21 are radially consistently supplied into the combustion chamber 11, to thereby prevent clinkers from blocking the air feed nozzles 21 c.

[0041] In addition, The fuel height control bracket 22c that is protrudingly formed perpendicularly from the axial direction of the extension shaft 22f is installed at the end of the extension shaft 22f that is protrudingly formed in the combustion chamber 11. As shown in FIG 5, the fuel height control bracket 22c has a conical shape at the upper portion thereof, and has a structure that the diameter of the lower portion thereof is the larger than that of the extension shaft 22f so that the fuels do not move upwards continuously but are pushed outwards. Accordingly, height of the fuels that are loaded on the diameter enlargement portion 21 a and the upper portion of the fire grate 17 in the combustion chamber 11 can be properly controlled, to thereby ensure perfect combustion of fuels.

[0042] Hereinbelow, an operational process of the combustion apparatus according to the embodiment of the present invention as constructed above will be described.

[0043] First, a certain amount of solid fuels are supplied into a combustion chamber 1 1 from a fuel hopper (not shown) by the rotation of a transfer screw 22 that is installed in a fuel supply tube 21. A radial fuel supply element 22b of the horizontal fuel supply member 22a that is protruded into the combustion chamber 11 is rotated together with the screw shaft 22d to radially supply the fuels that are raised up through the fuel supply tube 21 into the combustion chamber 11. By this configuration, the fuel supply unit 20 makes fuels whose particles are small and light rise up and be burnt by combustion air that is supplied from the air feed nozzles 21 c, and makes fuels whose particles are relatively large and heavy radially consistently supplied into the combustion chamber 11 in the neighbourhood of the fuel supply tube 21 by the radial fuel supply element 22b, to thereby prevent clinkers from blocking the air feed nozzles 21 c. Accordingly, the present invention can solve conventional problems of incompletely burning fuels that are continuously piled up to the upper portion of the fuel supply tube since the fuels contact combustion air in a small area, and preventing the fuels that are not discharged to the outer side of the fuel supply tube from being produced into clinkers that prevent the fuels from being burnt.

[0044] And the solid fuels supplied into the combustion chamber 11 are preheated and ignited by a preheating burner (not shown) and an ignition burner (not shown), to then be burnt. The solid fuels supplied to the upper side of the rotary type fire grate 17 are burnt and moves to the edge of the rotary type fire grate 17 due to a continuous supply of fuels as time passes. The fuels whose portion is changed into liquid-phase fuels as the solid fuels are burnt, stay and are burnt in a V-shaped gully portion whose cross-section is the same as that of the rotary type fire grate 17. Accordingly, a problem that the liquid-phase fuels that have been produced during performing a combustion process flows down in the case that cross-section of the rotary type fire grate is slantly formed only in one direction, can be solved. In addition, ashes that have been produced as the fuels have been burnt are discharged through an ash ejection outlet 19 at the edge of the rotary type fire grate 17, during rotation of the rotary type fire grate 17.

[0045] Meanwhile, when the solid fuels are burnt in the combustion chamber 11, cooling water is introduced into a cooling chamber 13 through a cooling water inlet 14a of the cooling chamber 13 that is formed at the outer circumference of the inner wall 12 of the combustion chamber 11 and the introduced cooling water is rotated and raised up by a cooling water guide plate 13a to thereby cool the inner wall 12 to then be discharged through a cooling water outlet 14b. Then, the cooling water discharged from the cooling chamber 13 is stored in a boiler feed water tank via a connection tube, and then is introduced into a boiler, to thereby collect heat from the hot combustion gases by a heat exchanging process. As described above, the combustion apparatus according to the present invention includes the cooling chamber 13 that is formed at the outer circumference of the inner wall 12 of the combustion chamber 11, to thereby prevent durability from being lowered due to an excessive temperature rise of the inner wall 12 of the combustion chamber 11. In addition, according to the combustion apparatus according to the present invention, the cooling water is preheated through the heat exchanging process with respect to the inner wall 12 of the cooling chamber 13, and then is introduced into the boiler again, to thereby collect heat from the hot combustion gases that have been generated by the combustion apparatus according to the present invention, and to thus prevent durability from being lowered due to deform, deterioration or crack that may occur at the inner wall 12 of the combustion chamber 11 that is continuously exposed to the hot combustion gases, and simultaneously avoid an unnecessary loss of heat to accordingly enhance a thermal efficiency.

[0046] In addition, combustion air necessary for burning solid fuels is fed to the combustion chamber 11 through the lateral combustion air supply chamber 15 and the lower combustion air supply tube 23 from the outside. First, the combustion air supplied through the air supply inlet 16a that is formed in a tangential direction with respect to the upper portion of the outer wall 16 of the cylindrical combustion vessel 10 turns and falls down in the lateral combustion air supply chamber 15, to then be supplied into the combustion chamber 11 through the opened lower portion 12a of the lateral combustion air supply chamber 15. Thus, the combustion air is supplied while turning, in the lateral combustion air supply chamber 15, that is, at the lateral surface of the combustion chamber 11. As a result, although the combustion chamber 11 is small in comparison with a case where combustion air is supplied in a straight line direction with respect to the fuels, the combustion air is directly in contact with most of the fuels, to thereby lower a manufacturing cost and enhance a thermal efficiency.

[0047] On the following, a method of injecting combustion air by the lower combustion air supply tube 23 will be described. The combustion air that is supplied by the lower combustion air supply tube 23 that is formed at the outer side of the fuel supply tube 21 is supplied into the combustion chamber 11 through the air feed nozzles 21 c that are formed at the diameter enlargement portion 21 a of the fuel supply tube 21, and thus is supplied to the lower portion of the solid fuels loaded in the combustion chamber 11. Accordingly, the outer portion of the solid fuels loaded in the combustion chamber 11 as well as the lower and inner portions of the solid fuels is also smoothly burnt, to thereby enhance combustion efficiency.

[0048] The hot combustion gases of high temperature that has been generated by burning the solid fuels in the combustion chamber 11 are introduced into the boiler through the opened upper portion of the combustion chamber 11, and the hot combustion gases that have been supplied to the boiler are used to generate hot water or steam for an industrial purpose by a heat exchanging process.

[0049] Meanwhile, due to a continuous supply of solid fuels to the diameter enlargement portion 21 a, the air feed nozzles 21 c that are formed at the diameter enlargement portion 21 a of the fuel supply tube 21 can be blocked by solid fuel or ashes that have been produced when the solid fuels have been burnt. In this case, since combustion air cannot be supplied to the bottom of the solid fuels, it results in lowering the combustion efficiency. At this time, the handle 33 of the nozzle-cleaning manhole 30 is rotated to unlock the cover 32 from the cylindrical body 31, and the cylindrical body 31 is opened by the rotation of the cover 32. Then, under observing the inside of the combustion chamber 11 through the observation scope 40, by injecting a long bar-shaped tool into the combustion chamber 11 through the cylindrical body 31, the ashes in the air feed nozzles 21 c are removed and the blocking of air feed nozzles 21 c is relieved.

[0050] Therefore, the present invention provides the effect that prevents the combustion efficiency from being lowered, by removing the blocking of the air feed nozzles 21 c formed at the diameter enlargement portion 21 a of the fuel supply tube 21.

[0051] As described above, in the present invention, since the swirl flow is generated and is swirled in the combustion chamber 11, most of the fuel may be contacted with the combustion air even though the combustion chamber 1 1 and the fire grate are small; therefore, it is possible to reduce the manufacturing cost and to design for complete combustion because the combustion air is continuously supplied directly to the solid fuel, at the same time, it is possible to increase the temperature of the combustion gas generated by the combustion of the fuel and to improve the thermal efficiency.

[0052] In addition, if a conventional incinerator burns a high calorie fuel like RPF and so on that the present invention can use, the inner wall of the combustion chamber of the conventional incinerator may be melted down due to an excessive temperature rise of the combustion chamber, but the combustion apparatus according to the present invention includes the cooling chamber 13 that is formed at the outer circumference of the inner wall 12 of the combustion chamber 11, to thereby overcome the problem of the conventional incinerator and prevent durability from being lowered due to an excessive temperature rise of the inner wall of the combustion chamber.

[0053] As described above, an example of using solid fuels has been described in a combustion apparatus according to a preferred embodiment of the present invention. However, the combustion apparatus according to the present invention is not limited to the example of using the solid fuels but can be applied to examples of using gas fuels or liquid fuels.

[0054] Although the present invention has been described in detail with respect to the limited embodiments and drawings, it is not limited thereto. It is apparent to one who has an ordinary skill in the art that there may be a number of modifications and variations within the same technical spirit of the invention. It is natural that the modifications and variations belong to the following appended claims.

Claims

1. A combustion apparatus with improved combustion efficiency having a combustion vessel that receives an air supply from the outside to thus burn a fuel that is supplied from a fuel supply unit, the combustion apparatus comprising:

> a cylindrical combustion chamber (11) that is surrounded by an inner wall (12) of the combustion vessel (10) to thus burn a fuel;
>
> a cooling chamber (13) that comprises an intermediate wall (14) that is formed to be spaced apart from an outer side of the inner wall (12) of the combustion vessel (10), in which a cooling water inlet (14a) and a cooling water outlet (14b) through which cooling water flows in and out, respectively, are formed at lower and upper sides of the intermediate wall (14), and that is formed at an outer circumference of the combustion chamber (11), to thereby cool the inner wall (12) of the combustion chamber (11) by the cooling water that flows into a space formed between the inner and intermediate walls (12, 14) of the cooling chamber (13) through the cooling water inlet (14a);
>
> a lateral combustion air supply chamber (15) that comprises an outer wall (16) that is formed to be spaced apart from an outer side of the intermediate wall (14) of the cooling chamber (13), in which a combustion air supply inlet (16a) through which air necessary for combustion is supplied from the outside is formed at an upper side of the outer wall (16), and that is formed at an outer circumference of the cooling chamber (13), to thereby make the air supplied through the combustion air supply inlet (16a) that is formed in a tangential direction with respect to the cylindrical outer wall (16) turn and fall in a space formed between the intermediate wall (14) of the cooling chamber (13) and the outer wall (16) of the lateral combustion air supply chamber (15), so that the combustion air is supplied to the combustion chamber (11) via an opened lower portion of the lateral combustion air supply chamber (15),

wherein the fuel supply unit (20) comprises:

a fuel supply tube (21) that is vertically placed on the lower portion of the combustion vessel (10) and guides the fuels into the combustion chamber (11); and

a transfer screw (22) that is formed in the fuel supply tube (21) and includes a screw shaft (22d) and screw blades (22e) that are formed on the screw shaft (22d), in order to transfer the fuels into the combustion chamber (11), and

wherein a horizontal fuel supply member (22a) is formed at the upper end of the transfer screw (22), and includes an extension shaft (22f) that is extended from the screw shaft (22d) to the outside of the fuel supply tube (21) and is protrudingly formed in the combustion chamber (11) and is rotated together with the screw shaft (22d); and a radial fuel supply element (22b) that is protrudingly formed from the outside of the extension shaft (22f) and is rotated together with the extension shaft (22f), to thereby radially supply the fuels that are raised up through the fuel supply tube (21) into the combustion chamber (11).

2. The combustion apparatus according to claim 1, wherein the horizontal fuel supply member (22a) further comprises a fuel height control bracket (22c) that is instated at the upper end of the extension shaft (22f) and has a structure that the lower portion thereof connected with the extension shaft (22f) is larger than the extension shaft (22f) in diameter.

3. The combustion apparatus according to claim 1, further comprising:

a boiler comprising a water tube to which the combustion gases that have been generated by burning the fuel in the combustion chamber (11) are supplied to the boiler to thereby collect heat from the combustion gases, wherein the cooling water discharged from the cooling water outlet (14b) in the cooling chamber (13) is connected with the water tube in the boiler via a connection tube so as to be used to collect heat from the combustion gases generated by the combustion vessel (10).

4. The combustion apparatus according to claim 1, wherein a spirally shaped cooling water guide plate (13a) is provided in the cooling chamber (13) so that the cooling water introduced via the cooling water inlet (14a) turns and rises up.

5. The combustion apparatus according to any one of claims 1 to 4, wherein the fuel supply unit (20) that is installed at the lower portion of the combustion vessel (10) comprises a lower combustion air supply tube (23) whose diameter is larger than that of the fuel supply tube (21) through which fuel is supplied, and that is formed in the form of a concentric circle, to thereby supply combustion air from the lower portion of the combustion chamber (11) to the bottom surface of the fuel.

6. The combustion apparatus according to claim 5, wherein an upper end portion that is protrudingly formed from the fuel supply tube (21) into the combustion chamber (11) comprises: a diameter enlargement portion (21 a) whose diameter gradually grows larger upwards; and a slope guide portion (21 b) that is bent downwards from the end portion of the diameter enlargement portion and is formed slantly downwards.

7. The combustion apparatus according to claim 6, wherein an upper end portion that is protrudingly formed from the lower combustion air supply tube (23) into the combustion chamber (11) comprises an air feed diameter enlargement portion (23a) whose diameter gradually grows larger upwards and that is positioned at the lower side of the diameter enlargement portion (21 a) of the fuel supply tube (21), and wherein a number of air feed nozzles (21 c) are formed in the diameter enlargement portion (21 a) of the fuel supply tube (21) so that the combustion air supplied from the lower combustion air supply tube (23) is introduced into the combustion chamber (11).

8. The combustion apparatus according to claim 7, wherein an upper end of the air feed diameter enlargement portion (23a) of the lower combustion air supply tube (23) is closed by the slope guide portion (21 b) of the fuel supply tube (21).

9. The combustion apparatus according to claim 7, further comprising:

a nozzle-cleaning manhole (30), including a cylindrical body (31) that communicates with the combustion chamber (11) and is formed at the outside of the combustion vessel (10) to be directed to the upper surface of the diameter enlargement portion (21 a); a cover (32) that is pivotably engaged to an outer end of the cylindrical body (31); and a handle (33) that locks/unlocks the cover (32) to the cylindrical body (31); and

an observation scope (40) that is arranged to look through the combustion vessel (11) from the exterior, including a cylindrical body (41) that is formed at the upper side of the nozzle-cleaning manhole (30) outside of the combustion vessel (10) and is directed to the diameter enlargement portion (21 a); and a window (42) that is installed at the outer end of the cylindrical body (41).

10. The combustion apparatus according to claim 9, wherein the cylindrical body 31 of the nozzle-cleaning manhole (30) is formed on the extension line of the upper surface of the diameter enlargement portion (21 a).

FIG. 1

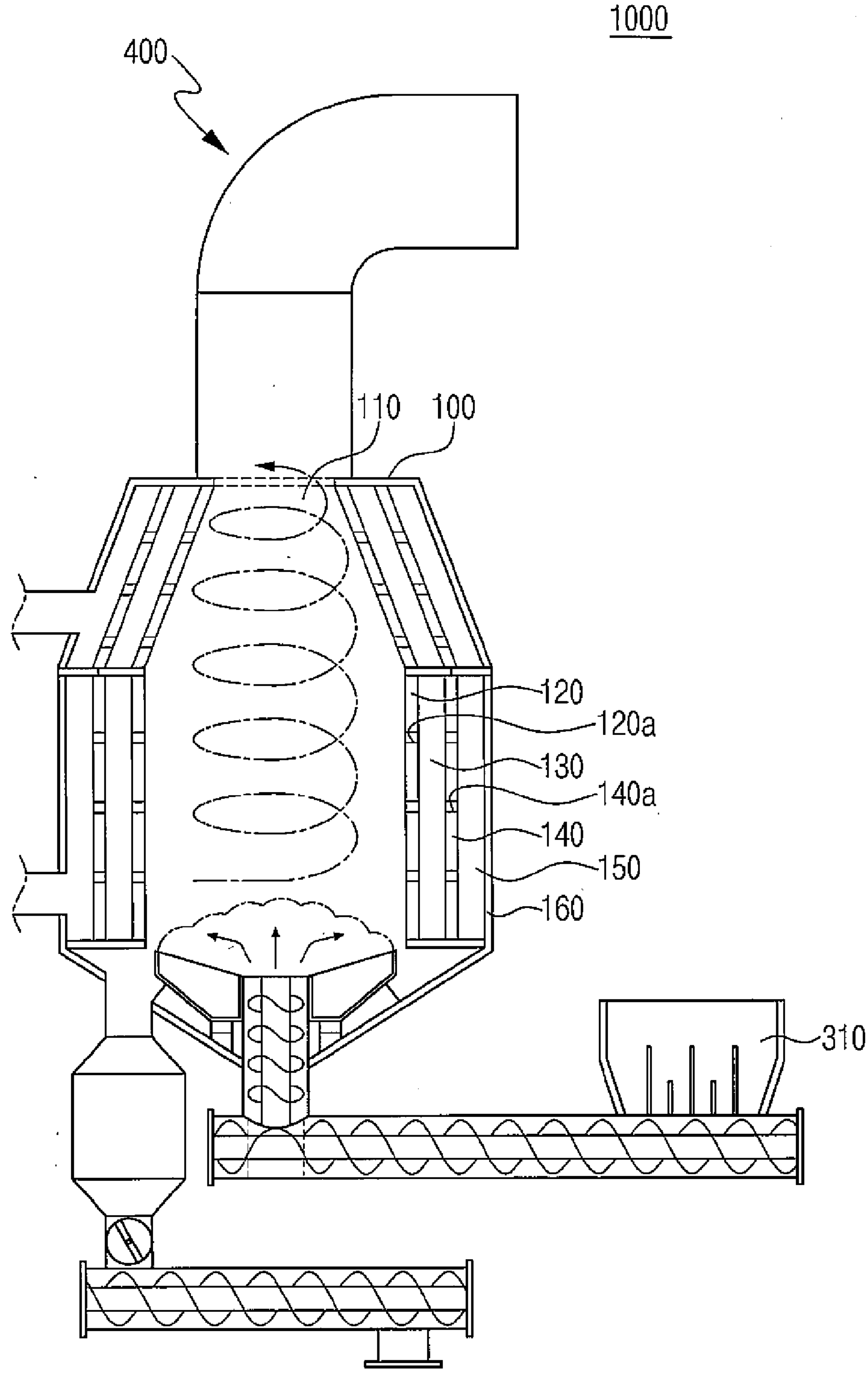

FIG. 2

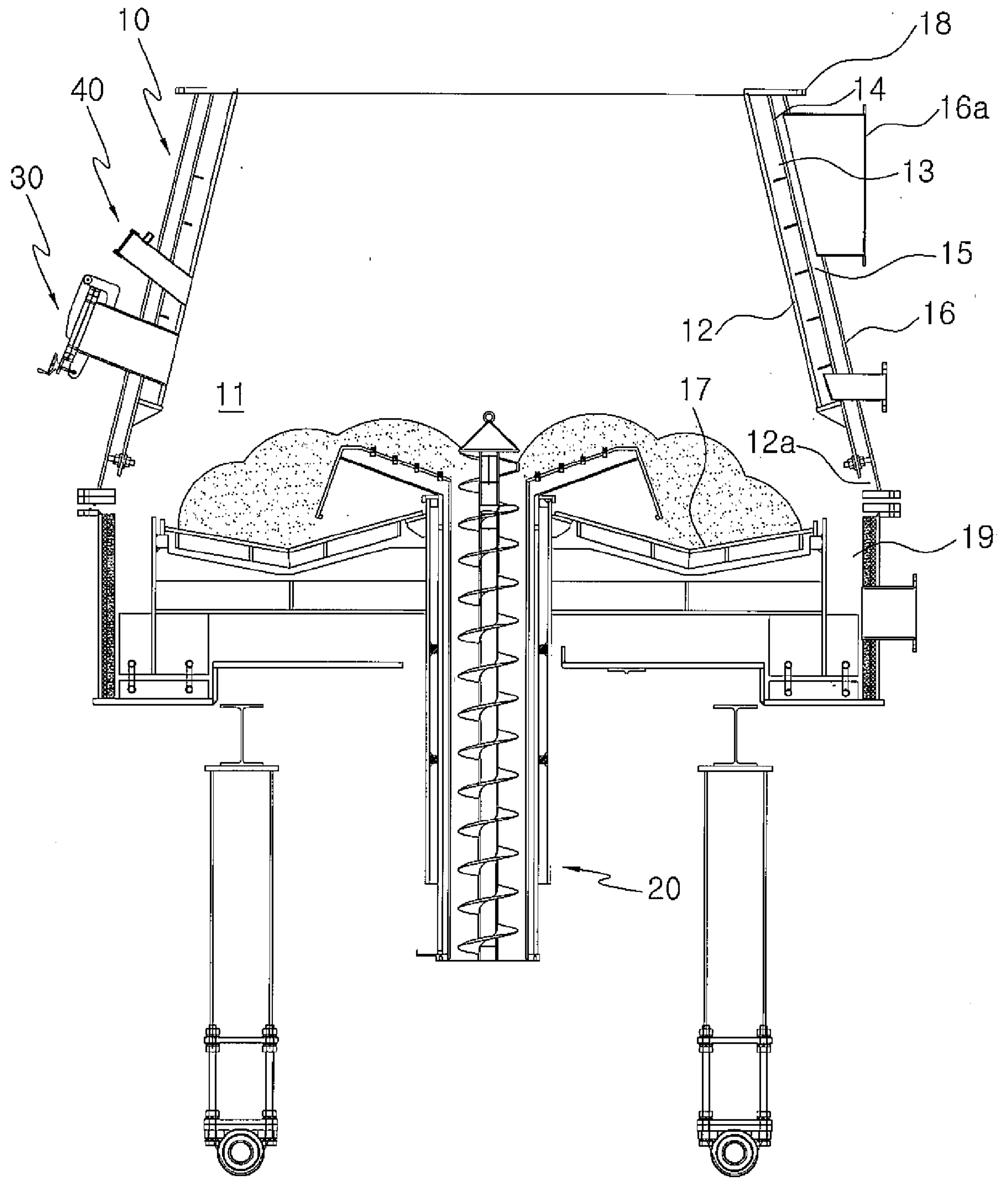

FIG. 3

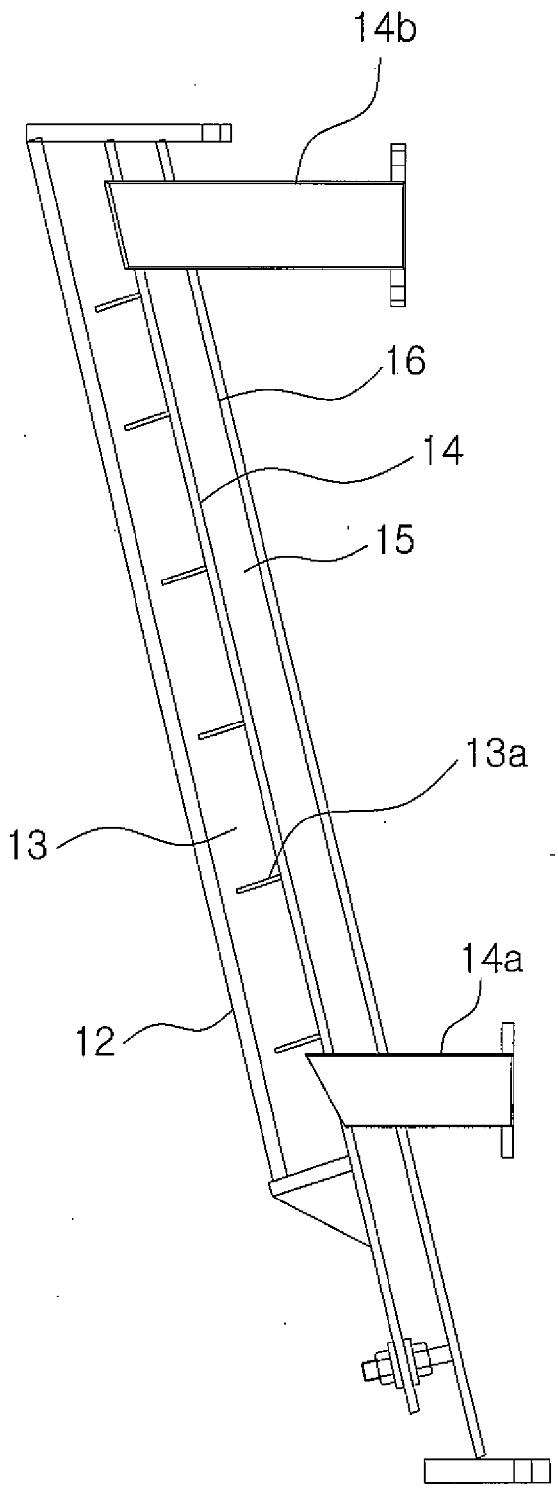

FIG. 4

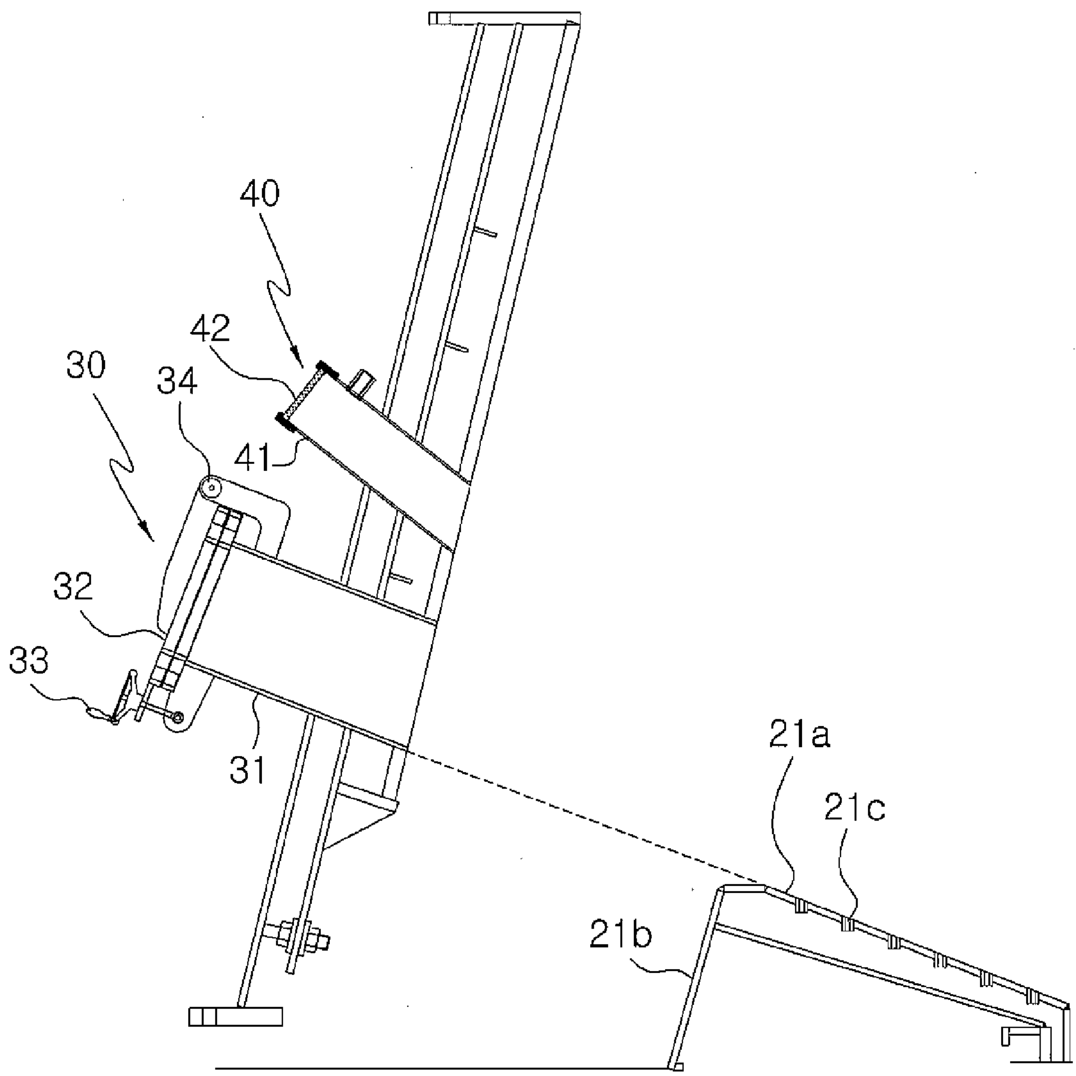

FIG. 5