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(54) **A combustion system and a method for combusting fibrous biomass**

(57) Disclosed is a combustion system (1) for combusting fibrous biomass (13). The combustion system (1) comprising a pulverised fuel fired combustion chamber (2) and milling means (3) for pulverising the fibrous biomass (13). The combustion system (1) further comprises gas flow means (4) for establishing a flow of carrier gas (12) through the milling means (3) and into the combus-

tion chamber (2) for carrying the pulverised biomass into the combustion chamber (2) and temperature maintaining means (5) for ensuring that the temperature of the pulverised biomass and carrier gas mix (14) does not drop more than 5% from the milling means (3) and until it reaches the combustion chamber (2).

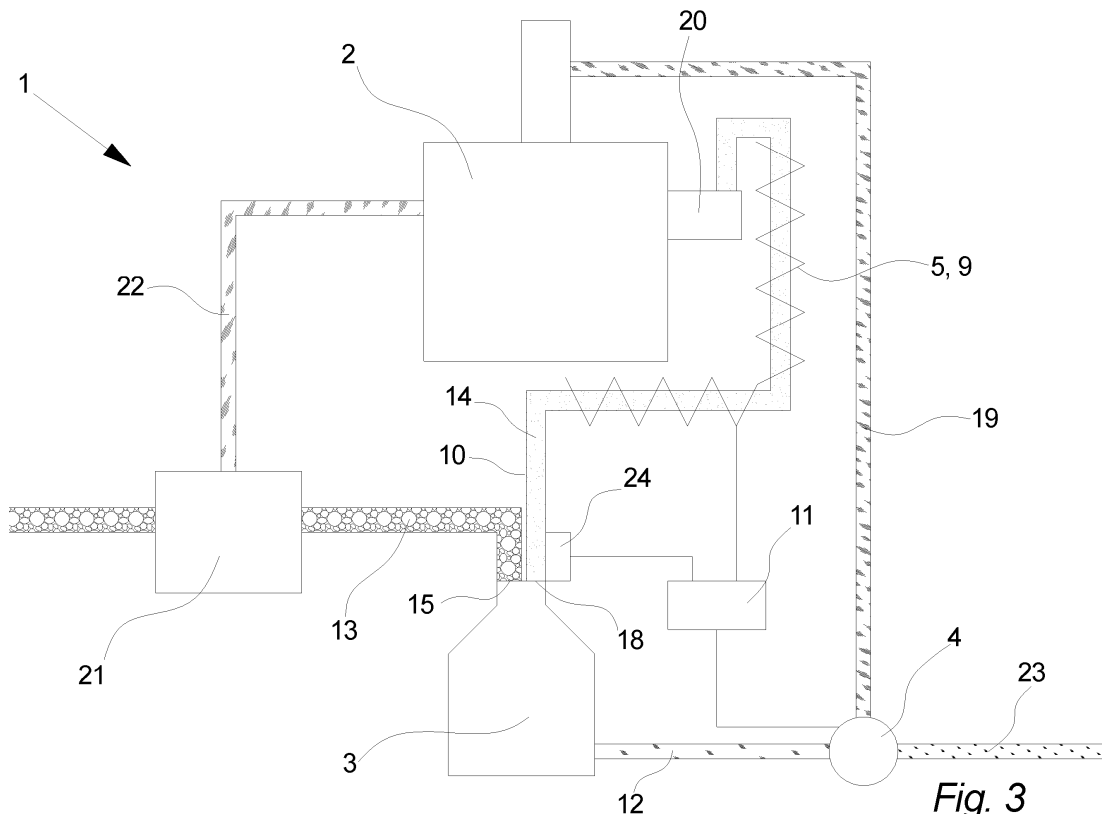


Fig. 3

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Description

Background of the invention

[0001] The invention relates to a combustion system for combusting fibrous biomass, wherein the combustion system comprising a pulverised fuel fired combustion chamber. The invention further relates to a method for combusting fibrous biomass.

Description of the Related Art

[0002] In a typical large scale coal-fired power station the coal is usually first crushed in coal milling means - often referred to as a pulveriser or a grinder. The purpose of the milling means is to pulverise the coal so that it may be delivered directly from the milling means and into a combustion chamber designed specifically to run on pulverised fuel. The milling means can be formed in a number of ways but in one of the most common designs the coal is crushed between a milling table and rollers, mills or balls both being substantially smooth to ensure that the coal is more or less transformed into dust.

[0003] Although many alternative means for producing heat and power has been developed in recent years one of the most common ways of generating heat and power is still by means of large centralised coal-fired power stations. And even though coal is getting more expensive and a desire to change the plants to be more environmentally friendly exists, the plants are typically so specialised that it is impossible or at least very expensive to rebuild them to e.g. run on more inexpensive and/or CO₂ neutral fuel.

[0004] From WO 03/036169 A1 it is known to use solid waste as fuel in a power station by first shredding the waste and then drying it by means of exit steam from the power station's steam turbines. The dry shredded waste is then stored until it is fed to the combustion chamber generating the steam driving the turbines.

[0005] However, this process virtually requires a power station build for this specific purpose and can therefore not be used for making traditionally large scale coal-fired power station more cost-efficient and/or environmentally friendly.

[0006] An object of the invention is therefore to provide for a more cost-efficient and/or environmentally friendly combustion technique.

The invention

[0007] The invention provides for a combustion system for combusting fibrous biomass. The combustion system comprises a pulverised fuel fired combustion chamber and milling means for pulverising the fibrous biomass. The combustion system further comprises gas flow means for establishing a flow of carrier gas through the milling means and into the combustion chamber for carrying the pulverised biomass into the combustion cham-

ber and temperature maintaining means for ensuring that the temperature of the pulverised biomass and carrier gas mix does not drop more than 5% from the milling means and until it reaches the combustion chamber.

[0008] Preparing fibrous biomass so that it can be used as fuel in a substantially conventional pulverised fuel fired combustion chamber requires a lot of energy - primarily in the form of heat - in that any attempt to pulverise fibrous biomass at low temperatures will lead to release of unwanted substances such as resin, lignin and other, which in a short time will clog the process or in other ways make the pulverising process inefficient. It is therefore advantageous to pulverise the fibrous biomass immediately before it is to be used as fuel in that this enables that the existing heat sources - such as flue gas, steam or other - may be used for preparing the fibrous biomass. But if the temperature of the pulverised biomass and carrier gas mix - particularly including any gasses evaporated or released during the heating and pulverising process - drops more than 5% while moving from the milling means to the combustion chamber the risk of unwanted condensation and sedimentation of e.g. different tar compounds and other released substances increases. It is therefore advantageous to provide the combustion system with temperature maintaining means.

[0009] It is also advantageous to pulverize the fibrous biomass just before it is fed to the combustion chamber in that intermediate storage of the pulverized biomass is hereby avoided. Such intermediate storage would present a number of problems regarding preventing the pulverized biomass from absorbing moisture, the pulverized biomass would present a fire hazard and the mere logistical problems in storing and transporting the pulverized biomass would be difficult and costly to overcome.

[0010] It should be noted that the term "*fibrous biomass*" in this context should be interpreted as any kind of fibrous biological material derived from living, or recently living organisms - in this case particularly but not limited to lignocellulosic biomass. Such biomass can be obtained from a multitude of different plants such as miscanthus, switchgrass, hemp, corn, poplar, willow, sorghum, sugarcane, bamboo and a variety of tree species, ranging from eucalyptus, pine, and spruce to palm trees. Or the fibrous biomass could include corncocks, nut shells, avocado stones, straw or a multitude of other types of fibrous biological material or any combination thereof.

[0011] It should be noted that the term "*milling means*" in this context should be interpreted as any kind of mill suited for grinding and pulverising fibrous biological material i.e. any kind of rolling mill, ball mill, tube mills, ring mills, hammer mills or other or any combination thereof.

[0012] It should also be noted that the term "*gas flow means*" in this context should be interpreted as any kind of gas flow device suitable for generating a flow of carrier gas through the milling means and into the combustion chamber i.e. any kind of fan, blower or ventilator or any kind of means for establishing a pressure difference ca-

pable of generating the gas flow.

[0013] It should also be noted that the term "*temperature maintaining means*" in this context should be interpreted as any kind of temperature maintaining arrangement suitable for ensuring that the temperature of the pulverised biomass and carrier gas mix substantially does not drop while moving from the milling means to the combustion chamber i.e. any kind of insulation, lagging or other passive means or active heating means such as means utilising hot flue gas, hot steam or separate electrical heating means such as immersion heaters, radiative heaters, coil heaters or heat pumps or any combination thereof.

[0014] In an aspect of the invention, said milling means comprises means for pulverising said biomass between substantially smooth milling surfaces. It is advantageous to use substantially smooth milling surfaces in that it reduces the risk of build-up of sticky biomass in the milling means.

[0015] In an aspect of the invention, said milling means comprises integrated heating means for heating said biomass during said milling process.

[0016] Including heating means in the milling means is advantageous in that it hereby is possible to heat the biomass more efficiently.

[0017] In an aspect of the invention, said temperature maintaining means comprises insulation means.

[0018] Making the temperature maintaining means comprises insulation means is advantageous in that it is an efficient and relatively inexpensive way of ensuring that the temperature of the pulverised biomass and carrier gas mix is maintained at an acceptable level.

[0019] It should be noted that by the term "*insulating means*" is to be understood any kind of insulator capable of significantly lowering the thermal conductivity of what it is applied to e.g. the thermal conductivity through the walls of the conduit through which the pulverised biomass and carrier gas mix travels from the milling means to the combustion chamber. Such insulating material include any kind of material having a low thermal conductivity i.e. typically below 0.5 watts per meter kelvin ($W \cdot m^{-1} \cdot K^{-1}$) such as mineral wool or foam, ceramic insulation tiles, glass foam, polyurethane foam, paper, expanded polystyrene or other.

[0020] In an aspect of the invention, said temperature maintaining means comprises active heating means for heating said pulverised biomass and carrier gas mix and/or a conduit through which said pulverised biomass and carrier gas mix moves between said milling means and said combustion chamber.

[0021] Making the temperature maintaining means comprise active heating means is advantageous in that it enables that the temperature of the temperature maintaining means can be controlled more precisely. Furthermore, active heating means will also reduce the warm-up period at start-up hereby increasing the capacity of the system. Even further, given the fact that heat is readily available - e.g. in the form of flue gas or steam - and that

electrical heating means are easy to install, easy to control and does not consume much space, it is advantageous to make the temperature maintaining means comprise such active heating means.

[0022] It should be noted that by the term "*active heating means*" is to be understood any active heater capable of actively heating the conduit and/or the pulverised biomass and carrier gas mix traveling through the conduit so that the temperature of the pulverised biomass and carrier gas mix is maintained above a critical lower level during the entire travel.

[0023] In an aspect of the invention, said combustion system comprises control means for controlling the temperature of said carrier gas as it enters said milling means at least partly on the basis on measurements of the temperature of said pulverised biomass and carrier gas mix.

[0024] Specific biomass needs to be heated to a specific temperature before and/or during milling to ensure substantially trouble-free milling process and efficient pulverising and to ensure that this milling temperature is reached and to ensure that the temperature of the pulverised biomass and carrier gas mix does substantially not drop below this milling temperature, it is advantageous to control the entry temperature of the carrier gas at least partly on the basis on measurements of the temperature of the pulverised biomass and carrier gas mix.

[0025] In an aspect of the invention, said combustion system comprises control means for controlling the temperature of said carrier gas so that the temperature of said pulverised biomass and carrier gas mix is above 150°C, preferably above 180°C and most preferred above 200°C when said pulverised biomass and carrier gas mix leaves said milling means.

[0026] It takes a lot of energy to raise the temperature of the biomass but if the temperature is too low the milling process will not run efficiently and trouble-free. Thus, the specified temperature levels provide an advantageous relationship between energy consumption and efficiency.

[0027] In an aspect of the invention, said carrier gas comprises flue gas from combustion of said pulverised biomass in said pulverised fuel fired combustion chamber.

[0028] Airborne pulverised biomass is usually highly flammable (explosive) and it is therefore advantageous to make the carrier gas comprise flue gas to reduce the oxygen level in the carrier gas and thus eliminate - or at least reduce - the explosion risk. Furthermore, given the neighbouring combustion process, hot flue gas is readily available.

[0029] In an aspect of the invention, said carrier gas comprises below 16%, preferably below 15% and most preferred below 14% oxygen.

[0030] As mentioned above, pulverised biomass will under certain circumstances be highly explosive. It is therefore advantageous to reduce the oxygen level of the carrier gas. However, it is difficult and expensive if the oxygen level has to be lowered too much and the present oxygen levels therefore present an advantage.

geous relationship between safety and cost.

[0031] In an aspect of the invention, said fibrous biomass is wood chips.

[0032] Wood chips have a relatively high calorific value, it is relatively easy to pulverise under the right circumstances, it is available in amounts suitable for large power plants at reasonable prices and it is therefore advantageous that the biomass is wood chips.

[0033] The invention further provides for a method for combusting fibrous biomass. The method comprising the steps of:

- establishing a flow of carrier gas through milling means and further through to a pulverised fuel fired combustion chamber,
- loading the fibrous biomass into the milling means,
- pulverising the fibrous biomass in the milling means,
- transporting the pulverised biomass from the milling means to the pulverised fuel fired combustion chamber by means of the carrier gas,

wherein the temperature of the pulverised biomass and carrier gas mix is maintained above 5% below the initial temperature of the pulverised biomass and carrier gas mix measured when the pulverised biomass and carrier gas mix leaves the milling means to the pulverised biomass and carrier gas mix reaches the pulverised fuel fired combustion chamber.

[0034] Different types of biomass will have to be milled at different processing temperatures to ensure an efficient and trouble-free pulverising process. However, no matter the processing temperature it is important that the temperature of the pulverised biomass and carrier gas mix does not drop below 5% of the actual processing temperature while traveling from the milling means to the combustion chamber in order to avoid condensation of gasses emitted from the biomass during the heating and milling process.

[0035] In an aspect of the invention, said method further comprises drying said fibrous biomass to a moisture content below 18%, preferably below 16% and most preferred below 13% before said fibrous biomass is loaded into said milling means.

[0036] It takes a lot of energy to dry the biomass before milling it but if the moisture content of the biomass is too high when entering and during the milling process, it will be difficult to maintain the temperature in the mill at a desired high level and it will be difficult to efficiently pulverise the biomass at an acceptable speed. Thus, the present moisture levels present an advantageous relationship between cost and efficiency.

[0037] In an aspect of the invention, said fibrous biomass is dried at least partly by means of flue gas from combustion of said pulverised biomass in said pulverised fuel fired combustion chamber or by means of other hot gasses produced by means of said combustion.

[0038] Drying the fibrous biomass by means of flue gas from the combustion of the biomass or other hot gasses

- such as steam - generated by this combustion is advantageous in that it enables an efficient and inexpensive drying process.

[0039] In an aspect of the invention, said method further comprises the step of adjusting the entrance temperature of said carrier gas so that the temperature of said pulverised biomass and carrier gas mix is above 150°C, preferably above 180°C and most preferred above 200°C when said pulverised biomass and carrier gas mix leaves said milling means.

[0040] The higher the temperature the more brittle the biomass becomes i.e. it is easier to pulverise it. But it also requires more energy to raise the temperature and the present temperature levels present an advantageous relationship between efficiency and cost.

[0041] In an aspect of the invention, said entrance temperature of said carrier gas is at least partly adjusted on the basis of temperature measurements of said pulverised biomass and carrier gas mix.

[0042] Controlling the entrance temperature of the carrier gas on the basis of temperature measurements of the pulverised biomass and carrier gas mix is advantageous to ensure that the milling process runs at a desired temperature.

[0043] In an aspect of the invention, said carrier gas is formed by mixing flue gas from combustion of said pulverised biomass in said pulverised fuel fired combustion chamber with air.

[0044] Forming the carrier gas by a mix of hot flue gas and cold or preheated air is an advantageous way of controlling the temperature and the oxygen level of the carrier gas.

[0045] In an aspect of the invention, said fibrous biomass is pulverised at a temperature above 200°C, preferably above 220 °C.

[0046] It is expensive and complex to ensure that the milling means are capable of operating properly at such high temperatures but if the temperature is too low during the milling process the biomass will not become so brittle that it can be pulverised and the risk of lignin or similar substances being pressed out of the biomass - instead of being evaporated and/or transformed into more volatile substances - increases, which may cause clogging or inefficient milling process. Thus, the present temperature levels present an advantageous relationship between cost and efficiency.

[0047] In an aspect of the invention, said method is a method for combusting fibrous biomass by means of a combustion system according to any of previously discussed combustion systems.

Figures

[0048] The invention will be described in the following with reference to the figures in which

fig. 1 illustrates a cross section of a simplified embodiment of milling means, as seen from the front,

fig. 2 illustrates an embodiment of a combustion system, as seen from the front, and

fig. 3 illustrates a flow diagram of an embodiment of a combustion system, as seen from the front.

Detailed description of the invention

[0049] Fig. 1 a cross section of a simplified embodiment of milling means 3, as seen from the front.

[0050] In this embodiment the milling means 3 comprises a centrally arranged entrance duct 15 through which the fibrous biomass 13 is fed to the milling table 16. In this embodiment the milling table 16 is rotating around a vertical axis by means of an electrical motor (not shown) so that the un-driven mill rollers 17 are also being rotated around horizontal axis by the rotation of the milling table 16. The biomass 13 is then milled between the rotating table 16 and the rollers 17. However, in another embodiment the rotational axis of the mill rollers 17 would be tilted e.g. 5°-15° in relation to horizontal.

[0051] The pulverized biomass is then carried out through one or more mill exits 18 by means of a carrier gas 12 entering the milling means at/below the edge of the milling table 16.

[0052] In this embodiment the exit ducts 18 are formed with sharp turns so that heavier elements of the pulverized biomass are hurled back onto the milling table 16 to be further pulverized.

[0053] However, in another embodiment the milling means 3 could be designed and arranged in numerous other ways e.g. depending on the specific use, the temperature capacity, the biomass and other.

[0054] In this embodiment the fibrous biomass 13 is heated to a temperature above 200°C before and during milling to carbonize the biomass 13 and thereby reduce its mechanical strength and ductility so that the fibers in the material breaks more easy and so that more volatile components in the biomass evaporates before and during the milling process. This is advantageous in that e.g. if the biomass 13 is some sort of wood at least parts of the lignin in wood material evaporates before milling so that the lignin is not simply pressed out of the wood. Lignin is very sticky and would easily clog the milling process or other parts of the combustion system 1.

[0055] Different biomass has to be heated above different temperature levels to ensure that potentially process-harming materials evaporates or is combusted and that the biomass becomes fragile enough to be pulverized but in general the biomass 13 should be heated to a temperature above 200°C and to be sure that the biomass 13 is sufficiently heated the biomass 13 is in this embodiment heated to between 250°C and 270°C.

[0056] It does take time to heat e.g. wood chip to a temperature above 200°C all the way to the core of each chip so in this embodiment the milling table 16 is provided with integrated heating means 7 so that as the outer layers of the biomass 13 becomes brittle from the heat treat-

ment, it breaks off and exposes the inner layers and thus enables faster heating of the inner layers - hereby increasing the capacity of the milling means 3.

[0057] In another embodiment further parts of the milling means 3 could be provided with integrated heating means 7 such as the milling rollers 17, milling table 16 or balls (not shown), entrance duct 15, mill exit 18 or other.

[0058] As explained above the milling means 3 does in this embodiment comprise milling rollers 17 but in another embodiment the milling means 3 could instead or also comprise milling balls or even hammering or pressing mill surfaces. No matter which type of milling means 3 is used it is advantageous that the milling surfaces 6 - i.e. the surfaces in between which the biomass is pulverized - are substantially smooth so that the biomass 13 does not build-up in between teeth, in indentations, in cracks or other.

[0059] In this embodiment the fibrous biomass 13 is wood chip but in another embodiment the fibrous biomass 13 could in principle be any kind of biological material comprising some sort of fibers at least assisting in holding the biomass together.

[0060] Fig. 2 illustrates an embodiment of a combustion system 1, as seen from the front.

[0061] In this embodiment two individually operated milling means 3 are connected to the same pulverised fuel fired combustion chamber 2 but in another embodiment only one milling means 3 would be connected to a single pulverised fuel fired combustion chamber 2 or more than two - such as three, four, five, six or more milling means 3 - would be connected to the same pulverised fuel fired combustion chamber 2.

[0062] In this embodiment each of the mill exits 18 of a specific milling means 3 is connected to the same burner means 20 on the combustion chamber 2 through dedicated conduits 10 but in another embodiment each mill exit 18 could be connected to independent burners 20, a different mill exits 18 could be connected to different burner means 20 or the mill exits 18 of more milling means 3 could be connected to the same burner 20.

[0063] To ensure that the temperature of the pulverised biomass and carrier gas mix 14 leaving the milling means 3 does substantially not drop until it is delivered to the burner means 20 the conduits 10 is in this embodiment provided with insulation means 8 in the form of lagging. If the temperature of the pulverised biomass and carrier gas mix 14 drops more than 5% - i.e. substantially more than 13.5°C, if the exit temperature at the milling means 3 is 270°C - the volatile substances (particularly tar substances) that did evaporate in or before the milling process will start to condensate in the conduit 10 and gradually clog the passage through the conduits 10.

[0064] In this embodiment at least a part of the carrier gas 12 is drawn from the exhaust of the pulverised fuel fired combustion chamber 2 in the form of flue gas 19. However, this aspect is discussed in more details in relation with figure 3.

[0065] In this embodiment the combustion system 1 is arranged to generate steam to drive the power turbines of an electrical power plant. However, in another embodiment the combustion system 1 could be used in relation with a district heating system, a cement plant or other facilities demanding a massive heat source.

[0066] Fig. 3 illustrates a flow diagram of an embodiment of a combustion system 1, as seen from the front.

[0067] In this embodiment of the invention the combustion system 1 comprises drying means 21 for drying the fibrous biomass 13 and thereby reduce its moisture content before it is fed to the milling means 3 through the entrance duct 15. In this embodiment the biomass 13 is dried to a residual moist content of 10% but in another embodiment the biomass 13 could be dried to another residual moist content e.g. adapted to the specific type of biomass 13, the moisture content of the carrier gas 12, the specific milling means 3 or other.

[0068] In this embodiment the combustion system 1 is arranged to generate steam to drive the power turbines of an electrical power plant so in this embodiment the fibrous biomass 13 is dried by means of steam 22 taken from this process. However, in another embodiment the biomass 13 could be dried by means of flue gas 19 from the combustion process, by means of an independent and/or external heat source or any combination thereof.

[0069] To ensure that volatile substances substantially do not evaporate from the biomass 13 during the drying process the biomass is typically dried at a temperature around 100°C. However, in another embodiment the drying process could also be used for preparing the biomass 13 for the milling process by preheating the biomass to a temperature above 200°C e.g. if the drying process was pressurised.

[0070] In the milling means 3 the fibrous biomass 13 is pulverised as discussed in relation with figure 1. The pulverised biomass is transported from the milling means 3 to the burner means 20 of the combustion chamber 2 by means of a carrier gas 12. Besides transporting the pulverised biomass the carrier gas 12 is also at least assisting in getting the temperature in the milling means 3 above 200°C. Thus, in this embodiment the carrier gas 12 is at least partly formed by flue gas 19 from the combustion process in the combustion chamber 2 and to adjust the temperature of the carrier gas 12, the flue gas 19 is in this embodiment mixed with air 23 in gas flow means 4. However in another embodiment the carrier gas 12 could also/or instead comprise other gasses such as heated air, cold flue gas, other gasses extracted from the combustion processes or succeeding processes, externally supplied gasses or any combination thereof.

[0071] In this embodiment the flow rate of the carrier gas 12 is controlled by the gas flow means 4 by controlling the pressure of the pre-pressurised flue gas 19. However, in another embodiment the gas flow means 4 would comprise active pressurising means e.g. in the form of pumps, fans or other means generating the desired flow and pressure of carrier gas 12.

[0072] In another embodiment the carrier gas 12 would be made from a part of the flue gas 19 from the combustion chamber 2 e.g. being drawn before a flue gas suction fan arranged in the combustion chamber exhaust, where after the desired flow of the carrier gas is made and controlled by a dedicated booster fan.

[0073] In this embodiment the pulverised biomass and carrier gas mix 14 is guided from the milling means 3 to the combustion chamber 2 by means of a conduit 10. To ensure that the temperature of the pulverised biomass and carrier gas mix 14 is maintained at or at least very near to the temperature at which the biomass is milled, until it reaches the burner means 20, at least a part of the conduit 10 is in this embodiment provided with temperature maintaining means 5 in the form of active heating means 9. In this embodiment the active heating means 9 is electrical heating means.

[0074] In this embodiment the combustion system 1 is also provided with control means 11 connected to the gas flow means 4 so that the entry temperature of the carrier gas 12 in this case is controlled on the basis of measurements of the temperature of the pulverised biomass and carrier gas mix 14. In this embodiment the temperature of the pulverised biomass and carrier gas mix 14 is measured by means of temperature sensor means 24 located at the mill exit 18 but in another embodiment the temperature sensor means 24 could be located anywhere on or at the conduit 10, on or at the burner means 20 or on or at the milling means 3.

[0075] In this embodiment the control means 11 is also arranged to control the active heating means 9 on the basis of output from the temperature sensor means 24 but in another embodiment the temperature maintaining means 5 could comprise its own temperature control system e.g. comprising temperature sensors.

[0076] In another embodiment the temperature of the drying process in the drying means 21 and/or the temperature of the integrated heating means 7 in the milling means 3 could also be controlled by the control means 11 and/or by means of individual control means.

[0077] In this embodiment the combustion system 1 is arranged to run as a continuous process i.e. fibrous biomass 13 is continuously fed to the milling means 3 so that pulverised biomass and carrier gas mix 14 is constantly fed to the combustion chamber 2. However, in another embodiment the combustion system 1 could include intermittent operation.

[0078] The invention has been exemplified above with reference to specific examples of designs and embodiments of combustion chamber 3, milling means 4, temperature maintaining means 5 etc. However, it should be understood that the invention is not limited to the particular examples described above but may be designed and altered in a multitude of varieties within the scope of the invention as specified in the claims.

List**[0079]**

1. Combustion system
2. Combustion chamber
3. Milling means
4. Gas flow means
5. Temperature maintaining means
6. Milling surface
7. Integrated heating means
8. Insulation means
9. Active heating means
10. Conduit
11. Control means
12. Carrier gas
13. Fibrous biomass
14. Pulverised biomass and carrier gas mix
15. Entrance duct
16. Milling table
17. Mill roller
18. Mill exit
19. Flue gas
20. Burner means
21. Drying means
22. Steam
23. Air
24. Temperature sensor means

Claims

1. A combustion system (1) for combusting fibrous biomass (13), said combustion system (1) comprising, a pulverised fuel fired combustion chamber (2),

milling means (3) for pulverising said fibrous biomass (13),
 gas flow means (4) for establishing a flow of carrier gas (12) through said milling means (3) and into said combustion chamber (2) for carrying said pulverised biomass into said combustion chamber (2), and
 temperature maintaining means (5) for ensuring that the temperature of said pulverised biomass and carrier gas mix (14) does not drop more than 5% from said milling means (3) and until it reaches said combustion chamber (2).

2. A combustion system (1) according to claim 1, wherein said milling means (3) comprises means for pulverising said biomass (13) between substantially smooth milling surfaces (6).

3. A combustion system (1) according to claim 1 or 2, wherein said milling means (3) comprises integrated heating means (7) for heating said biomass (13) during said milling process.

4. A combustion system (1) according to any of the preceding claims, wherein said temperature maintaining means (5) comprises insulation means (8).

5. A combustion system (1) according to any of the preceding claims, wherein said temperature maintaining means (5) comprises active heating means (9) for heating said pulverised biomass and carrier gas mix (14) and/or a conduit (10) through which said pulverised biomass and carrier gas mix (14) moves between said milling means (3) and said combustion chamber (2).

6. A combustion system (1) according to any of the preceding claims, wherein said combustion system (1) comprises control means (11) for controlling the temperature of said carrier gas (12) as it enters said milling means (3) at least partly on the basis on measurements of the temperature of said pulverised biomass and carrier gas mix (14).

7. A combustion system (1) according to any of the preceding claims, wherein said combustion system (1) comprises control means (11) for controlling the temperature of said carrier gas (12) so that the temperature of said pulverised biomass and carrier gas mix (14) is above 150°C, preferably above 180°C and most preferred above 200°C when said pulverised biomass and carrier gas mix (14) leaves said milling means (3).

8. A combustion system (1) according to any of the preceding claims, wherein said carrier gas (12) comprises flue gas from combustion of said pulverised biomass in said pulverised fuel fired combustion chamber (2).

9. A method for combusting fibrous biomass (13), said method comprising the steps of:

- establishing a flow of carrier gas (12) through milling means (3) and further through to a pulverised fuel fired combustion chamber (2), 5
- loading said fibrous biomass (13) into said milling means (3),
- pulverising said fibrous biomass (13) in said milling means (3), 10
- transporting said pulverised biomass from said milling means (3) to said pulverised fuel fired combustion chamber (2) by means of said carrier gas (12), 15

wherein the temperature of said pulverised biomass and carrier gas mix (14) is maintained above 5% below the initial temperature of said pulverised biomass and carrier gas mix (14) measured when said pulverised biomass and carrier gas mix (14) leaves said milling means (3) to said pulverised biomass and carrier gas mix (14) reaches said pulverised fuel fired combustion chamber (2). 20

10. A method according to claim 9, wherein said method further comprises drying said fibrous biomass (13) to a moisture content below 18%, preferably below 16% and most preferred below 13% before said fibrous biomass (13) is loaded into said milling means (3). 25 30
11. A method according to claim 10, wherein said fibrous biomass (13) is dried at least partly by means of flue gas from combustion of said pulverised biomass in said pulverised fuel fired combustion chamber (2) or by means of other hot gasses produced by means of said combustion. 35
12. A method according to claim 9 or 11, wherein said method further comprises the step of adjusting the entrance temperature of said carrier gas (12) so that the temperature of said pulverised biomass and carrier gas mix (14) is above 150°C, preferably above 180°C and most preferred above 200°C when said pulverised biomass and carrier gas mix (14) leaves said milling means (3). 40 45
13. A method according to claim 12, wherein said entrance temperature of said carrier gas (12) is at least partly adjusted on the basis of temperature measurements of said pulverised biomass and carrier gas mix (14). 50
14. A method according to any of claims 9 to 13, wherein said carrier gas (12) is formed by mixing flue gas from combustion of said pulverised biomass in said pulverised fuel fired combustion chamber (2) with air. 55

15. A method according to any of claims 9 to 14, wherein said method is a method for combusting fibrous biomass (13) by means of a combustion system (1) according to any of claims 1 to 8.

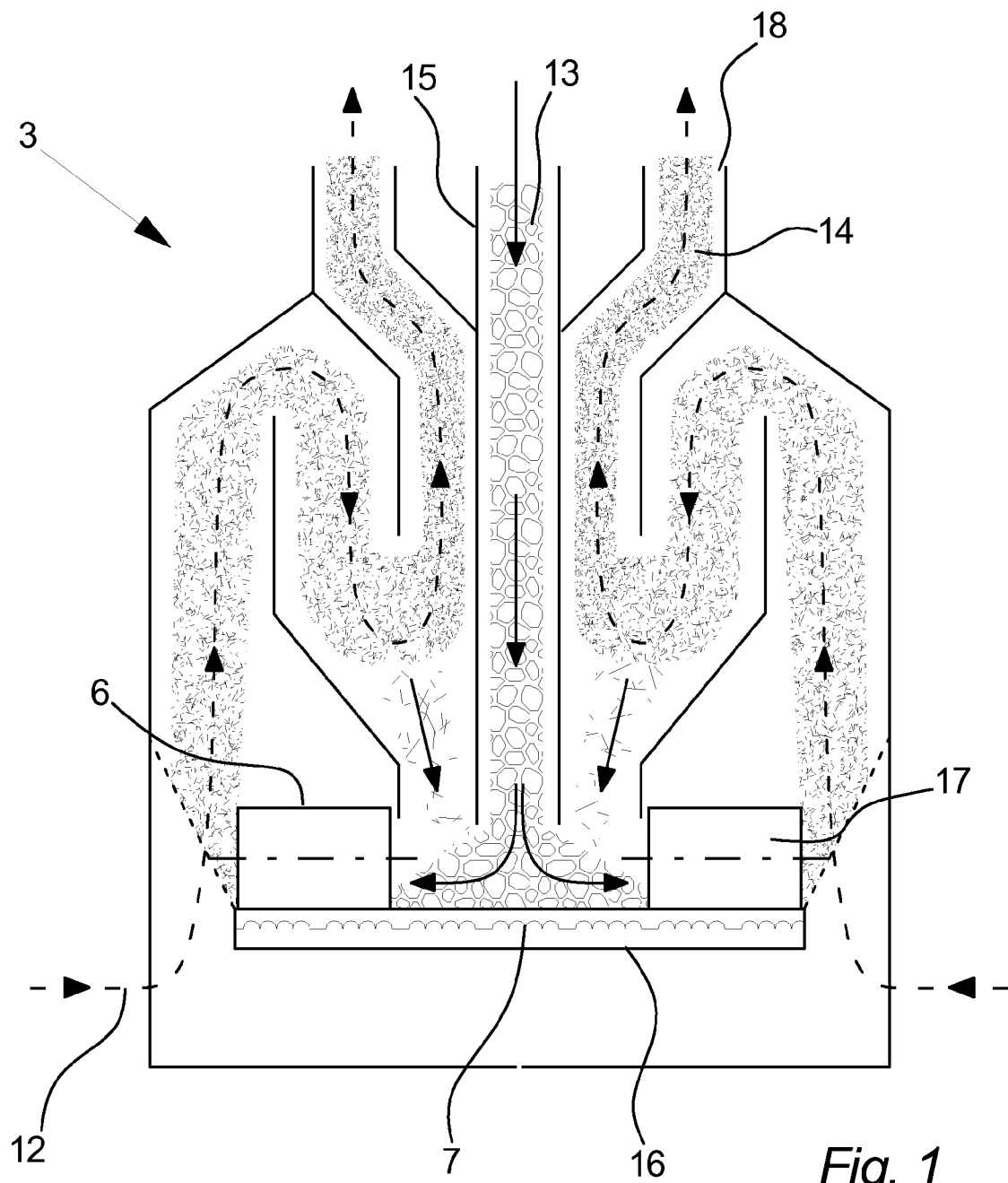


Fig. 1

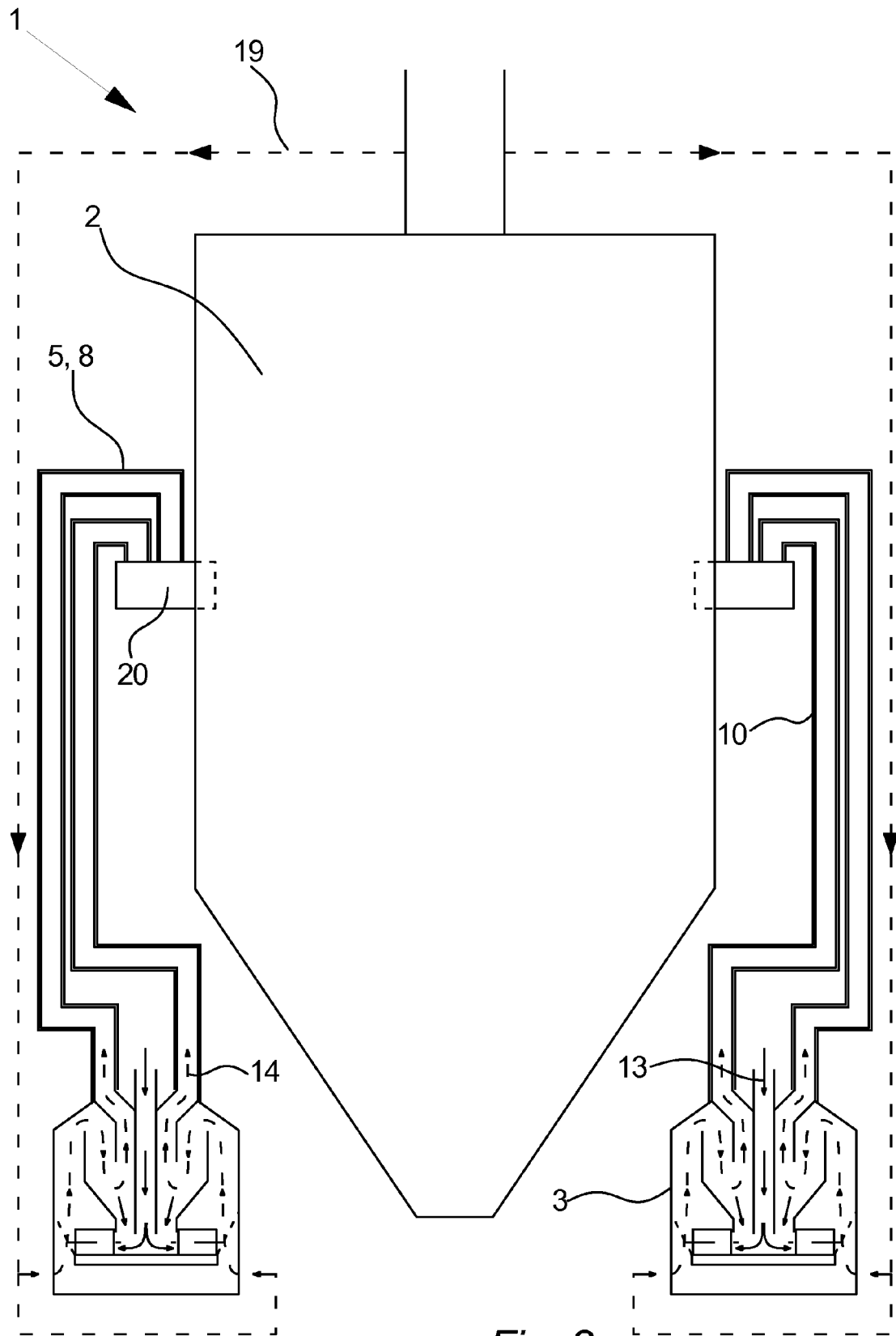


Fig. 2

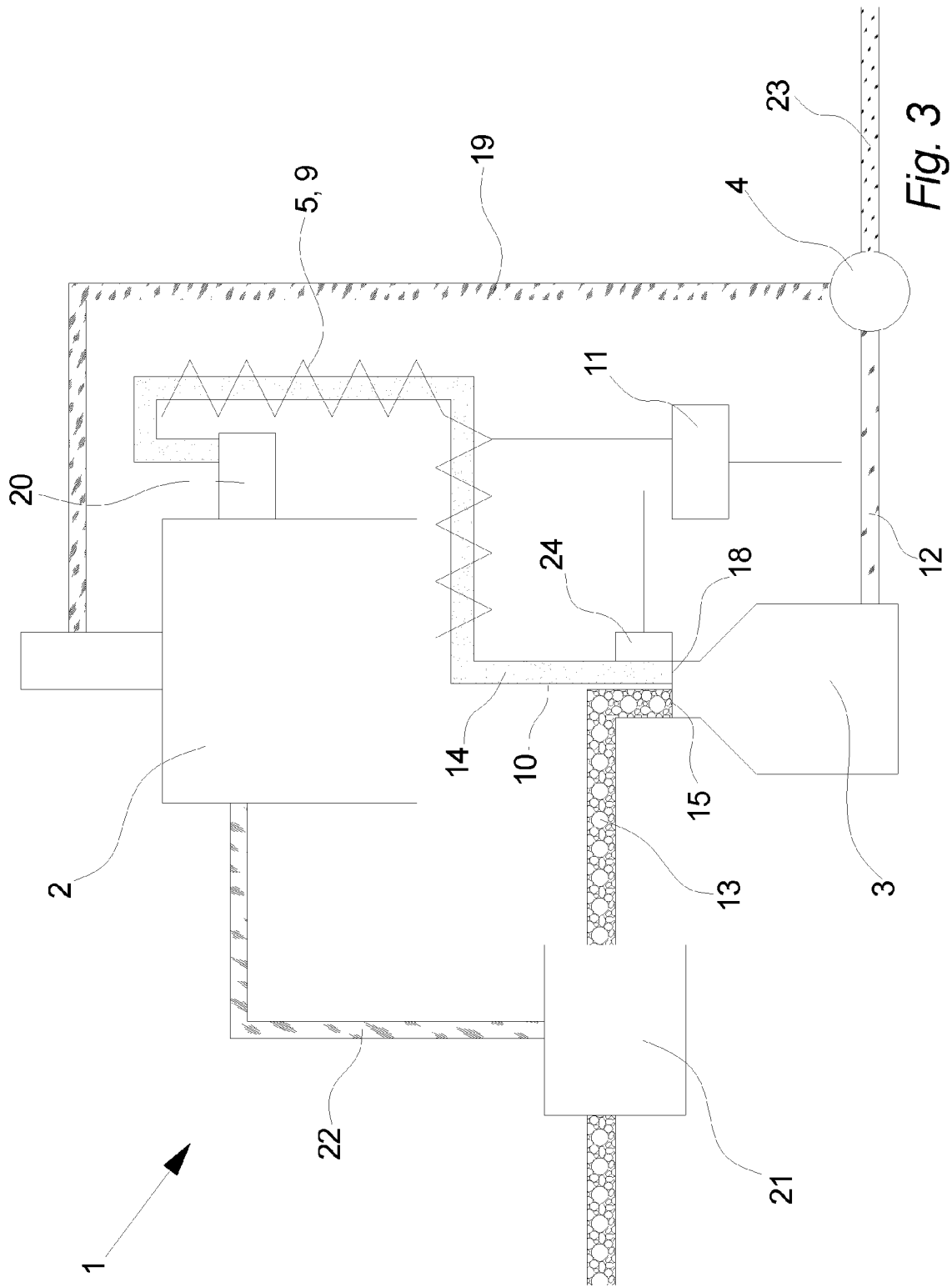


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 14 15 6185

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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