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(54) **Berendezés és eljárás forrógáz előállítására hőhordozóközeg integrált melegítésével**

The invention relates to a device for producing hot gas with integrated heating of a heat transfer medium comprising a brick-lined combustion chamber for producing hot gas and a boiler, which is arranged in the direction of flow of the hot gas downstream of the combustion chamber and is connected to the combustion chamber via a hot gas pipe, for heating the heat transfer medium. The invention also relates to a method for producing hot gas with integrated heating of a heat transfer medium. Finally, the present invention relates to a drying device for drying material containing lignocellulose, in particular wood and/or material containing wood to be recycled.

Hot gas powered drying devices which, for example, are regularly used for drying particulate materials, e.g. shavings, in the wood-processing industry are known from the prior art (DE 20 2007 005 195 U1). Here, the heat content of the hot gas is not only used for drying, but also for heating a heat transfer medium, for example water, steam or thermal oil, which in turn is used in various production processes, for example for heating hot presses for pressing chipboard.

A device known from practice for producing hot gas for an attached dryer with integrated thermal oil heating comprises a fully brick-lined combustion chamber, in which the hot gas is produced via a forward-acting reciprocating grate firing. The hot gas is drawn from the combustion chamber into a fully brick-lined hot gas pipe which branches directly downstream of the combustion chamber. The main flow of the hot gas is then fed into a hot gas cyclone where fly ash still present in the hot gas is largely separated. The cleaned hot gas flow flows out of the hot gas cyclone into a mixing chamber for setting the desired dryer entry temperature and from there flows into the dryer.

The partial flow of the hot gas which was branched off downstream of the combustion chamber flows into a thermal oil boiler having a radiation heat exchanger and a convection heat exchanger where it releases approximately two thirds of its heat energy to the thermal oil. Subsequently, upstream of the mixing chamber the cooled partial flow is fed again into the main flow cleaned in the hot gas cyclone and cools it.

The disadvantage of this system is that the partial gas flow flowing into the thermal oil boiler results in steady contamination of the thermal oil boiler, in particular when using low-grade fuels, such as wood waste or scrap wood, impregnated wood or production waste. This is particularly problematic if as a result of increasing contamination the hot gas temperature level in the thermal oil boiler increases in the area of the radiation heat exchanger, so that the ash particles present in the partial gas flow fed into the thermal oil boiler due to their liquid or sticky consistency at temperatures > approximately 700°C condense on the tube bundles of the convection heat exchanger flowed through with thermal oil. Partial conveying of the cooled partial gas flow exiting the thermal oil boiler back into the thermal oil boiler to lower the temperature level prevailing there also has disadvantages, since higher blower output is required for this purpose and the higher hot gas amounts lead to an increased proneness to erosion in the convection heat exchanger of the thermal oil boiler. Overall, the above described disadvantages result in reduced availability of the plant, since cleaning work has to be carried out in the thermal oil boiler at regular intervals.

A further device for producing hot gas is known from US 3 831 535 A1 which the invention takes as its starting point. Taking US 3 831 535 A1 as its starting point, the invention is based on the object of specifying a device and a method for producing hot gas with integrated heating of a heat transfer medium, which is characterised by a high level of plant availability and an improved overall efficiency compared to devices known from the prior art. In addition, the device and the method are to ensure that the components used have high operational reliability and a long service life. The object is achieved according to the invention with a device according to Claim 1.

In the case of the device according to the invention, by fully feeding the hot gas flow exiting the combustion chamber into the brick-lined hot gas cyclone the entire hot gas flow is freed from the fly ash flowing out of the combustion chamber with the hot gas. The hot gas flow is additionally very thoroughly mixed, whereby a good burnout is achieved. As tests by the applicant have revealed, post-combustion of carbon monoxide additionally occurs in the hot gas cyclone, so that the energy content of the fuel fired in the combustion chamber can be used even more efficiently and the hot gas has a reduced toxicity.

After the cleaned hot gas flow has flowed out of the hot gas cyclone it is completely or partly directed into a boiler for heating a heat transfer medium, for example water, steam or thermal oil. As a result of the efficient particle separation in the hot gas cyclone arranged upstream in the direction of flow of the hot gas, there is only a low level of proneness to contamination in the boiler, so that a plant stoppage due to an increased cleaning requirement in the thermal oil boiler is reduced and hence plant availability is increased overall.

Provision is also made for a bypass pipe to branch off from the hot gas pipe in the direction of flow of the hot gas downstream of the hot gas cyclone, so that the hot gas flow after exiting the hot gas cyclone is divided into a first and a second partial flow, wherein the second partial flow is fed via the bypass pipe into the boiler for heating the heat transfer medium. By means of this division of the hot gas flow into a first and a second partial flow it is possible to supply the first partial gas flow as the main flow directly for a corresponding use, for example to feed it into a dryer, while the second partial flow is branched off for heating the heat transfer medium in the boiler. The respective volume flow of the first and second partial flows can be set in a way which is known per se by setting a corresponding induced draught or by means of control butterfly valves. By means of this particularly preferred embodiment it is also then possible to clean the entire hot gas flow with just one hot gas cyclone if the hot gas flow in the device is divided, on the one hand, in order to heat a heat transfer medium in the boiler and, on the other hand, in order to supply hot gas directly for an application, for example for the heating of a drying device.

In one embodiment, which is not part of the invention, a first and a second hot gas cyclone can be provided. A bypass pipe again branches off from the hot gas pipe, so that the hot gas flow is divided into a first and a second partial gas flow, wherein again the second partial flow is fed via the bypass pipe into the boiler for heating the heat transfer medium. In the case of this embodiment, the first hot gas cyclone is arranged in the direction of flow of the hot gas downstream of the branch-off of the bypass pipe in the hot gas pipe, while the second hot gas cyclone is arranged in the bypass pipe in the direction of flow of the hot gas upstream of the boiler for heating the heat transfer medium. By this means, it is again ensured that the entire hot gas flow, and in particular the partial flow branched off to the boiler, is cleaned in a hot gas cyclone.

According to the invention, the outlet of the boiler and the combustion chamber are connected to one another in a manner suitable for conducting gas, so that the cooled second partial flow exiting the boiler can be at least partly, in particular fully, conveyed back as a cooling gas flow into the combustion chamber. By conveying back the second partial flow cooled in the boiler, the combustion chamber temperature is reduced and less cooling air needs to be supplied. As a consequence, the output of the fresh air blower is reduced and the plant operates with less excess air. Less excess air in turn results in less fresh air being conveyed into the system and as a consequence the components, such as blowers, air pipes, valves etc., can be designed on a smaller scale. Less excess air also means a lower O_2 content and hence in the case of emission measurements a more favourable conversion to a higher O_2 reference content. At the same time, refeeding the second partial flow cooled in the boiler into the first partial flow flowing through the hot gas pipe can be dispensed with, so that the first partial flow remains at a very high temperature level and therefore can be used for various applications, for example for drying more efficiently.

In addition, the outlet of the boiler is also connected to the hot gas pipe in a manner suitable for conducting gas, so that the cooled second partial flow exiting the boiler can at least intermittently be mixed with the first partial flow to regulate the hot gas temperature in the first partial flow.

According to a further advantageous embodiment of the invention, provision can be made for the device to have means for denitrifying the hot gas, in order to reduce the toxicity in the hot gas. Denitrification can be effected by selective non-catalytic reduction (SNCR). At least one nozzle for introducing a reducing agent, in particular urea, can be provided in the hot gas pipe for this purpose. Preferably, the at least one nozzle is arranged in the tangential inlet channel of the hot gas cyclone, since the temperature required to efficiently denitrify the hot gas prevails there. Efficient denitrification is also benefitted by the intensive thorough mixing of the hot gas in the cyclone, so that the urea consumption and the ammonia slip can be minimised.

According to a further advantageous embodiment of the invention, the boiler for heating the heat transfer medium has a first flow stage with a radiation heat exchanger and a second flow stage with a convection heat exchanger, wherein the hot gas flow can flow through the first flow stage in the downward direction, and wherein the hot gas flow can subsequently flow through the second flow stage in the upward direction. Designing the boiler in such a way means that the transfer of heat to the heat transfer medium in the first flow section occurs at still very high hot gas temperatures accordingly in particular by heat radiation, while after cooling has already partly taken place the heat transfer in the second flow stage occurs in particular by convection.

In order to minimise contamination of the boiler by particle residues still present in the hot gas, according to a further embodiment of the invention provision can be made for the boiler to have means for spraying a cleaning fluid, in particular water. Regular cleaning of the boiler during operation of the device can take place by spraying such a cleaning fluid. If the boiler in the way mentioned above has a first and a second flow stage, then the means for spraying a cleaning fluid is preferably formed as at least one nozzle arranged in the first flow stage of the boiler. The cleaning fluid can be injected at high pressure into the first flow section of the boiler by means of this nozzle, wherein the nozzle can be designed in such a way that it carries out an oscillating movement, so that in this way the entire area of the heat exchanger area in the first flow stage is exposed to cleaning fluid. The finely injected cleaning fluid through thermal shock leads to flaking off of adhering and partly hard deposits, whereby boiler downtimes can be prevented. Furthermore, by this means an unwanted temperature increase over 700°C in the first flow section can be prevented, so that the condensing of liquid or sticky ash particles in the boiler no longer occurs.

According to a further embodiment of the invention, the combustion chamber of the device comprises a grate firing, in particular a travelling grate firing, wherein solid, granular or fibrous fuel on the grate flowed through by a rising primary air flow is burned by the combustion chamber. The combustion product is the hot gas which flows through the combustion chamber.

Fuel can be continuously fed to the grate by means of a screw conveyor and a chute in the form of a slide, wherein the chute is designed such that it can be cooled by means of a water injection. It is hereby ensured that in the event of a heat build-up, a blockage or a backfire the chute is protected by cooling and inertisation. In addition, the end of the chute projecting into the combustion chamber is preferably brick-lined, so that there is no risk of deformation here due to excessive thermal stress.

In addition to a grate firing, at least one radially aligned burner or at least two tangentially arranged burners can also be provided in the combustion chamber for burning gas and powdered fuel. Due to the capacity of such a burner it can be operated in combination with a grate firing or on its own for producing hot gas. Better mixing of the gas is obtained in the combustion chamber by means of the tangential arrangement of two or more burners, whereby the carbon monoxide content in the hot gas can be significantly reduced by post-combustion of the same.

A further aspect of the invention relates to a drying device for drying in particular wood products and/or wood waste with a device according to any one of Claims 1 to 9, wherein the hot gas flowing out of the hot gas cyclone is at least partly fed into a dryer for drying in particular chopped wood, sawdust, wood shavings, wood fibres, animal feed, cereals and suchlike. What was said above correspondingly applies with regard to the advantages of this drying device.

The object mentioned at the outset is as regards the method achieved by a method for producing hot gas with integrated heating of a heat transfer medium according to Claim 14. The method according to the invention can be carried out with limited plant-specific effort and high operational reliability, wherein a longer service life of the plant components is ensured by reduced contamination as a result of cleaning the entire hot gas flow in the hot gas cyclone by separating fly ash. Reference is again made to the above with regard to the further advantages of the method according to the invention. The hot gas flow after exiting the hot gas cyclone is divided into a first and into a second partial flow, wherein the second partial flow is directed via a bypass pipe into the boiler for heating the heat transfer medium.

According to one embodiment, which is not part of the invention, a first and a second hot gas cyclone can be provided. The hot gas flow again is divided into a first and into a second partial flow, wherein again the second partial flow is fed via the bypass pipe into the boiler for heating the heat transfer medium. In the case of this embodiment, the first partial flow is cleaned in the first hot gas cyclone arranged in the direction of flow of the hot gas downstream of the branch-off of the bypass pipe in the hot gas pipe, while the second partial flow is cleaned in the second hot gas cyclone arranged in the bypass pipe in the direction of flow of the hot gas upstream of the boiler for heating the heat transfer medium. By this means, it is again ensured that the hot gas flow, in particular the branched-off second partial flow, is fully cleaned.

According to a further advantageous embodiment of the method, the first partial flow can be fed into a drying device. The cooled second partial flow exiting the boiler is in any case according to the invention at least partly conveyed back as a cooling gas flow into the combustion chamber.

In order to set a specific hot gas temperature in the first partial flow it can in exceptional cases also be necessary to mix the cooled second partial flow exiting the boiler at least intermittently in with the first partial flow to regulate the hot gas temperature in the first partial flow.

According to a further embodiment of the method, the boiler in operation can be at least intermittently cleaned by spraying a cleaning fluid, in particular water. The formation of deposits by fly ash still present in the hot gas flow can hereby already be effectively prevented in operation.

According to a further embodiment of the method, the input of fuel and the supply of combustion air into the combustion chamber linked with it are regulated in such a way that a constant negative pressure prevails in the combustion chamber. This means that the firing capacity of the combustion chamber is oriented to the hot gas power requirement of the application respectively connected downstream, for example of a dryer and/or of the boiler for heating the heat transfer medium. If a greater quantity of hot gas is drawn off, and hence there is a greater demand for hot gas power, the negative pressure drops in the combustion chamber and the power control conveys more fuel into the combustion chamber accompanied by a correspondingly increased air volume flow, whereby overall the firing thermal output increases in the desired manner.

Preferably, the fuel input is regulated continuously by means of frequency-controlled screw conveyors.

The invention is explained in more detail below with aid of figures illustrating exemplary embodiments.

Fig. 1 shows a first drying plant known from the prior art with a device for producing hot gas with an integrated thermal oil boiler and a dryer connected downstream, in a highly schematised view,

Fig. 2 shows a second drying plant with a device for producing hot gas with an integrated thermal oil boiler and a dryer connected downstream, in a highly schematised view and

Fig. 3 shows the device for producing hot gas with an integrated thermal oil boiler of the plant from Fig. 2 in a detailed illustration.

A drying plant known from the prior art with a device for producing hot gas with an integrated thermal oil boiler and a dryer connected downstream is illustrated in Fig. 1 in a highly schematised view. Drying plants of this type are used, for example, to dry chopped wood, sawdust, wood shavings, wood fibres, animal feed, cereals etc. Chipboard, fibreboard, oriented strand board, wood pellets, cereal concentrated feed pellets etc. can then be produced with the dried material. The heat transfer medium heated by the hot gas, in this case thermal oil, is required for various processes, for example for pressing chipboard, fibreboard or oriented strand board, for drying impregnated paper and pressing the same onto carrier boards, for heating purposes etc..

The device for producing hot gas of the plant in Fig. 1 is designed with a fully brick-lined combustion chamber 100. This in turn comprises a forward-acting reciprocating grate firing 101, but can as the primary firing also have a travelling grate firing, fluidised bed firing, coal firing, gas firing, oil firing, coal dust firing etc.. Solid or granular fuel is fed to the grate via a feeding unit 102 and burned by the supply of primary air 103 below the grate and by secondary air 104 above the grate, wherein the different combustion phases of drying, heating, gasification and combustion take place along the feed direction of the grate 101a. The ash of the burned fuel at the end of the grate falls into a wet de-asher 160 which conveys the wet ash into a grate ash container 161 which is outside the boiler house.

In order to start up the plant, one or more direct firings 105 for fibrous and powdered waste are located just above the grate 101a which are provided with a gas supporting flame and in this way bring the fuel feed area to ignition temperature. Normally, a further, larger gas/powder combined burner 106 is located at the upper end of the combustion chamber, wherein this burner cannot then be used for starting up the plant, but only for the exclusive combustion or recycling of accumulated fine wood dust. The gas/powder combined burners 106 can be operated parallel to the grate firing 101; their output is geared to the available supply of powder.

The hot gas produced in the brick-lined combustion chamber 100, which due to the high combustion temperature of approximately 940°C has a high proportion of nitrogen oxide (thermal NOx), is fed into a hot gas cyclone 108 via a hot gas pipe 107, which is preferably also fully brick-lined, where it is largely cleansed of particulate contaminants. Subsequently, it is conveyed to an external mixing chamber 130 and finally to the dryer 140.

A certain amount of the hot gases flows via a bypass branch 109 into a separate thermal oil boiler 110. The thermal oil boiler 110 in this case comprises a first flow stage, in which the hot gas flows downwards (downward part) and releases a part of its heat energy in a radiation heat exchanger 110a, in particular via radiation, to the thermal oil flowing through the tubes of the first heat exchanger 110a. In the second flow stage, the hot gas which has already been partly cooled flows upwards again (upward part) and releases further heat energy at lower temperatures in a convection heat exchanger 110b, in particular via convection, to the thermal oil. In the radiation heat exchanger 110a of the first stage, the hot gases are cooled down to a temperature of < 700°C before they flow over the convection heat exchanger 110b of the second stage.

The direction change between the radiation and convection heat exchangers 110a, 110b is in this case formed as a large common funnel (or alternatively) as two separate funnels, where the coarser proportion of ash in the hot gas can settle due to gravity and is conveyed away via double pendulum flap, rotary valve, screw conveyor etc. (each of which is not illustrated) and collected in the ash container 161.

When the hot gas flows through the thermal oil boiler 110 it cools down and transfers the heat to the heat transfer medium, in this case thermal oil. This is, for example, heated from 255°C to 280°C. The hot gas cooled down to approximately 350°C is drawn off into a pipe 112 via an induced draught fan 113 and is conveyed back to the hot gas main flow via a control butterfly valve 114 and a pipe 115 and cools this hot gas main flow.

For its part, the hot gas main flow is conveyed to a mixing chamber 130, in which the hot gas with cold air or with dryer recirculating air/dryer waste air is set to the required hot gas temperature before entering the dryer 140.

In the case of the drying plant in Fig. 1, it has become apparent that with low-grade fuels, such as wood waste and scrap wood, impregnated wood or production waste etc., contamination of the radiation heat exchanger 110a greatly increases, as a result of which due to worsened heat transfer an increase in the exit temperature results, whereby in turn the desired temperature value of approximately 700°C is considerably exceeded. As a result of this, the ash particles are not yet solid grains, but liquid or sticky, which leads to their condensing onto the cold tubes of the convection heat exchanger 110b of the second stage and increases its contamination. After a certain period of operation, the contamination can no longer even be removed with so-called soot blowers, whereby the heat transfer capacity is severely restricted and in extreme cases complete accretion of whole convection tube bundles occurs. If soot blowers are used the intervals between their use must be steadily shortened. Here, the tubes have to be exposed to high air pressure, which in addition considerably increases proneness to erosion.

In order to prevent this adverse effect, in some plant designs provision is made for cooled hot gas to be conveyed back via a pipe 116 with a control butterfly valve 117, so that in this way a temperature of < 700°C is ensured upstream of the convection heat exchanger 110b. However, this disadvantageously requires a higher blower output, wherein the increased amounts of flue gas in the convection heat exchanger resulting from this bring about greater erosion.

Finally, feeding cooled hot gas from the thermal oil boiler 110 into the hot gas flow cleaned in the hot gas cyclone 108 results in a lowering of the temperature level in the hot gas and subsequently in an unwanted reduction in the dryer efficiency because feeding the cooled hot gas into the cleaned hot gas flow has the disadvantage that less dryer recirculating air can be used and hence more waste air forms which is to be conveyed to a waste air purification plant 170. More waste air means more waste heat and therefore a worse dryer energy efficiency.

In Fig. 2, now a second improved drying plant compared to the plant in Fig. 1 is illustrated in a highly schematised view having a device for producing hot gas with an integrated thermal oil boiler and a dryer connected downstream. The plant again comprises a combustion chamber 1 having a direct-acting reciprocated firing 2 and a boiler 6 for heating a heat transfer medium, in this case again thermal oil. The plant in Fig. 2 is characterised by the fact that the entire hot gas flow after flowing out of the combustion chamber 1 is fed into a brick-lined hot gas cyclone 4, whereby it is accordingly almost completely freed from the fly ash flowing out of the combustion chamber with the hot gas. The hot gas is additionally very thoroughly mixed in the hot gas cyclone 4, which results in an improved burnout and in particular in post-combustion of carbon monoxide.

As can be identified in Fig. 2, in the direction of flow of the hot gas downstream of the hot gas cyclone 4 a bypass pipe 10a branches off from the hot gas pipe 10, so that the hot gas flow after exiting the hot gas cyclone 4 is divided into a first and a second partial flow, wherein the second partial flow is fed via the bypass pipe 10a into a boiler 6 for heating the thermal oil. The boiler 6 is designed in a comparable way to the one in the plant in Fig. 1 and comprises a first flow stage with a radiation heat exchanger 6a and a second flow stage with a convection heat exchanger 6b. As can also be identified, the outlet of the boiler 6 is connected to the combustion chamber 1 via a hot gas pipe 12, so that the cooled hot gas flow exiting the boiler can be conveyed back as a cooling gas flow into the combustion chamber 1. The combustion chamber temperature, which with stoichiometric combustion and dry fuel assuming an adiabatic combustion process would amount to more than 2000°C, can hereby be effectively restricted to, for example, < 940°C without combustion having to take place with a large amount of excess air. In order to set a desired hot gas temperature, in exceptional cases the cooled hot gas can be mixed in with the hot gas main flow flowing through the hot gas pipe 10 via the control butterfly valve 9 before flowing into the mixing chamber 130. A part of the cooled hot gas can also be conveyed to the waste air purification plant via the control butterfly valve 13.

The drying plant of Fig. 2 is illustrated in a detailed schematic drawing in Fig. 3, in which for reasons of clarity the mixing chamber, the dryer and the waste air/filter system are not illustrated. The drying plant is again designed for firing with solid, granular and powdered fuels. The plant in Fig. 3 again correspondingly has as the central plant components a combustion chamber 1 with grate firing, a fully brick-lined hot gas cyclone 4 arranged directly downstream of the hot gas outlet and a thermal oil boiler 6, into which a part of the hot gas produced in the combustion chamber 1 and cleaned in the hot gas cyclone 4 is fed via a bypass pipe 10a and is used to heat the thermal oil there.

In order to feed fuel into the combustion chamber 1, the solid fuels are conveyed via pull floors 19, separators (not illustrated) and trough chain conveyors 19a via a distribution valve or - as in this case - via a distribution screw conveyor 21 and two shut-off valves 22 to two metering/collecting bins 23.

The fuel is fed in a metered manner from these by means of in total six frequency-controlled screw conveyors 24 via a special fuel chute 29 in the form of a slide to a forward-acting reciprocating grate 2 divided into two grate halves.

The continuously operable, frequency-controlled screw conveyors 24 make control of the combustion in the combustion chamber 1 possible not only via burners, but also via the fuel feed to the grate 2. As can be identified in Fig. 3, the fuel chute 29 initially runs vertically and then conveys the fuel directly to the grate 2 via an inclined section. In the vertical section, the fuel falls in free fall downwards. Pneumatic horizontal shut-off valves 25 are arranged in this area. If the firing is interrupted, there is a boiler failure or failure of the screw conveyors 24, the respective shut-off valves 25 - in the case of an interruption in the firing or in the case of a boiler failure the shut-off valves 22 too - immediately close. The fuel metering is therefore separate from the combustion chamber 1 and is optimally outwardly sealed.

A water injection 26 is provided on the fuel chute 29, which when a presettable temperature is reached (for example 100°C) is activated by opening a magnetic valve 26a, so that water can be injected finely sprayed via a nozzle. As a result of this, the chute 29 is cooled and rendered inert. This can be necessary, for example in the event of a heat build-up, a blockage or a backfire. The end of the chute 29 on the combustion chamber side is brick-lined, so that no metallic parts, which could be permanently deformed under the effect of the radiant heat, protrude into the combustion chamber 1. With the exception of this discontinuous water consumption by water injection and for the water spraying device 35 in the thermal oil boiler explained further below, the plant has no water or cooling water requirement.

In addition to solid fuels, granular or fibrous fuels (recycling) can also be burned on the grate 2. When the combustion chamber 1 is in operation, these are added to the trough chain conveyor 19a by a storage silo 20 via an in-built discharge system (usually a rotating discharge screw conveyor, sliding frame etc.) and a screw conveyor (not illustrated in detail) and thus also fed to the forward-acting reciprocating grate 2 via the feed shaft. The possibility of supplying the fuel to a direct firing is not illustrated in Fig. 3.

In the combustion chamber 1, the forming ash at the end of the forward-acting reciprocating grate 2 falls via a shaft into a wet de-asher 27 and from there is conveyed into a grate ash container 28. In the case of a travelling grate firing, the ash is removed dry by means of screw conveyors and conveyed via further screw conveyors into the grate ash container 28.

In the case of the plant in Fig. 3, powdered fuels are conveyed from powder silos to a powder-metering container and conveyed via metering screw conveyors, rotary valve and conveying air to at least two tangentially arranged burners 3 for gaseous and powdered fuels. For reasons of clarity, the fuel feed in Fig. 3 is not illustrated in detail. The tangential arrangement of the burners 3 improves the mixing and hence quite considerably reduces the CO value in the hot gas. The multifunctional burners 3 are arranged above a secondary air injection 18a, 18b which is explained in detail further below.

The burners 3 are started with gaseous fuel and can then be switched to operation with powdered fuel. The combustion in the combustion chamber 1 can hereby be exclusively carried out using powdered fuel without having to install the plant's own gas-fired start-up burners. Provision can be made for at least one of the burners 3 to be operated using both high-quality powdered fuel (for example sub-sieve powder from dry chip preparation or sanding dust from the sanding of chipboard etc.) and low-quality powdered fuel (for example from the extraction of a recycling wood preparation), so that the installation of the plant's own direct firing system can be omitted. A maximum quantity of powder can be burned through exclusive operation with the burners 3, whereby arising powder quantity peaks can thereby be optimally utilised. In addition, the burners 3 can be operated with minimal load, in order to keep the plant operational and hot, for example.

Preferably, wood dust from the production of a wood-processing operation is used as fuel. Another fuel for supplying heat in the solid fuel firing system are the scrap wood and production waste arising in-plant and bark and wood waste from the timber yard. Externally delivered untreated wood is also burned.

The fresh air flow required for the combustion in the combustion chamber 1 is supplied to the combustion chamber 1 via a primary air blower 16 and a secondary air blower 17. The primary air is divided into a plurality of zones (wind boxes) and flows in a rising air flow in regulated amounts through the grate 2 and cools it in the process. The secondary air 18 is blown in above the grate 2 via a plurality of front nozzles 18a and rear nozzles 18b. At the same time, the secondary air is used as combustion air for the burners 3. The burners 3 for their part have their own fully automatic air control, wherein the supplied air is divided into primary, secondary and in some cases tertiary air.

The negative pressure in the combustion chamber 1 is ensured by the dryer induced draught fan (cf. Figure 2) and a frequency-controlled induced draught fan 8 which is arranged downstream of the thermal oil boiler 6 and draws off the hot gas in the required amount via the brick-lined hot gas pipe 10. In terms of fuel input and combustion air, the plant is controlled in such a way that there is a constant negative pressure in the combustion chamber 1. The hot gas output of the combustion chamber 1 is therefore always oriented to the hot gas power requirement of the dryer. If higher gas output is requested by the dryer or the thermal oil boiler 6 (a larger quantity of hot gas is drawn off), then the negative pressure sinks in the combustion chamber 1 and the power control conveys more fuel in combination with additional combustion air into the combustion chamber 1 and thereby increases the firing thermal output.

The hot gas exiting the combustion chamber flows, as also illustrated in the schematised view of Fig. 2, fully into the brick-lined hot gas cyclone 4. It is preferably subjected to denitrification in a selective non-catalytic reduction reaction (SNCR). Specifically, a suitable reducing agent, in this case urea, is injected via a plurality of nozzles 30 arranged in the tangential inlet channel of the cyclone 4 into the hot gas, since the temperature required to efficiently denitrify the hot gas prevails here. Efficient denitrification is also benefitted by the intensive, thorough mixing of the hot gas in the cyclone 4, so that the urea consumption and the ammonia slip can be minimised.

Fly ash up to a certain grain size (a grain of 50 µm is with approximately a 50 % probability separated) is separated in the hot gas cyclone 4. The hot gas is very thoroughly mixed in the cyclone 4 by the special cyclone flow, wherein a good burnout is obtained with the post-combustion of carbon monoxide. The amount of fly ash separated in the cyclone 4 is directly conveyed via a double pendulum flap 14 and via a drop shaft to a fly ash container 15 or to the grate ash wet de-asher 27 and via this is conveyed away to the common ash container.

An emergency chimney 5 is arranged on the outlet spiral of the cyclone 4 and is opened when the plant is switched off due to an emergency, wherein the hot gases are drawn out of the combustion chamber 1 by the natural draw of the chimney. In the case of malfunctions in the thermal oil boiler 6 - for example in the case of pipe damage - cold air can also be sucked in via the emergency chimney 5 after the firing has been switched off and the thermal oil boiler 6 can thereby be effectively cooled.

As mentioned, a part of the hot gas after exiting the hot gas cyclone 4 flows into the thermal oil boiler 6 via a bypass pipe 10a. The thermal oil boiler 6 is constructed in the way described in connection with Fig. 2 with a downwardly flowed through first flow stage with a radiation heat exchanger 6a and an upwardly flowed through second flow stage with a convection heat exchanger 6b. In addition, the thermal oil boiler 6 instead of a circulating air system known from the prior art comprises a water spraying device 35 in the first flow stage, by means of which the first flow stage depending on the contamination (temperature increase) during operation can be cleansed of the contaminants deposited, in order in this way to maintain the original heat transfer coefficient. The water spraying device 35 in this case comprises a hose reel with a multi-hole nozzle on its free end, which with a lengthwise and rotating oscillating movement passes the heat exchanger area of the first flow stage and through its nozzles fine jets of water are sprayed at high pressure onto the contaminated tube surfaces. The fine jets of water through thermal shock lead to flaking off of adhering and partly hard deposits, whereby boiler downtimes due to necessary cleaning work can be prevented. In the second flow stage, soot blowers 40 are provided in a way which is known per se from the prior art.

The two flow stages of the thermal oil boiler 6 are in this case and in contrast to Fig. 2 joined by a common ash funnel. Via this ash funnel, the ash can be conveyed away to the closed fly ash container 15 by means of a double pendulum flap 14.

The frequency-controlled induced draught fan 8 is arranged downstream of the convective second flow stage of the thermal oil boiler 6 and draws a defined amount of hot gas through the boiler dependent on the thermal oil power requirement.

The hot gas cooled in the thermal oil boiler 6 is conveyed back to the combustion chamber 1 via a control butterfly valve 11 and a return air duct 12 as cooling air to reduce the adiabatic combustion chamber temperature. The cooled hot gas is mixed in with the hot gas main flow flowing through the brick-lined hot gas pipe 10 via the control butterfly valve 9 in the direction of the dryer (cf. Fig. 2) only in exceptional cases and to regulate a certain hot gas temperature.

Below, the efficiency advantages of the previously described drying plant according to Figs. 2 and 3 compared to the plant according to Fig. 1 known from the prior art shall be briefly outlined.

In the case of the known plant in Fig. 1, the fuel output at a required 20 MW hot gas target output and 16 MW thermal oil target output is 38.59 MW. In order to maintain a certain hot gas minimum temperature of, for example, 750°C, 2.41 MW of cooled hot gas can be directed into the hot gas main flow, while 5.33 MW are to be directly disposed of in the waste air purification plant, for example a wet electrostatic filter 170. The oxygen content in the hot gas is 13.4 % and the excess air $\lambda = 2.6$. The combustion air in this case is waste air from a drying plant at 75°C and the heat output yielded with the quantity of air is 1.82 MW via the primary air and 0.91 MW via the secondary air.

In the event of feeding the entire amount of hot gas cooled in the thermal oil boiler into the hot gas main flow, the mixing temperature ideally considered would only be 533°C (actually, with the heat losses, approximately 460°C results). Accordingly, it would no longer make sense to mix the the dryer waste air in with the hot gas and thus operate the dryer efficiently in recirculating air operation.

In the case of the plant shown in Figs. 2 and 3, the fuel output again for a 20 MW hot gas target output and 16 MW thermal oil target output is only 34.41 MW, from which an efficiency increase of approximately 12 % results. In order to maintain the hot gas minimum temperature of again 750°C, again 2.41 MW of cooled hot gas can be directed into the hot gas main flow, while 5.33 MW as heat recovery can be conveyed back into the combustion chamber 1 for cooling. The oxygen content in the hot gas is in this case only 9.3 % and the excess air $\lambda = 1.8$.

In the event of the 2.41 MW heat output not being fed into the hot gas main flow, the hot gas temperature theoretically would remain at 920°C and hence would be ideal for the overall efficiency of the dryer. In reality, temperature losses occur with the hot gas due to heat losses, infiltrated air, etc. and the temperature will sink by up to approximately 100°C. It is clear from this that it makes sense to convey preferably 100 % of the amount of hot gas in the thermal oil burner 6 back to the combustion chamber again.

716280/DO

BERENDEZÉS ÉS ELJÁRÁS FORRÓGÁZ ELŐÁLLÍTÁSÁRA HŐHORDOZÓKÖZEG INTEGRÁLT MELEGÍTÉSÉVEL

SZABADALMI IGÉNYPONTOK

1. Berendezés forrógáz előállítására hőhordozóközeg integrált melegítésével, amely berendezés magában foglal egy falazott égésteret (1) forrógáz előállítására és egy, a forrógáz áramlási irányában az égéstér (1) után elhelyezett és az égéstérrel (1) egy forrógázas vezetéken (10) át összekötött kazánt (6) a hőhordozóközeg melegítésére, amely égéstér (1) és kazán (6) között el van helyezve legalább egy, a forrógázas vezetékbe (10) integrált, falazott, forrógázas ciklon (4), úgyhogy az égéstérből (1) kiáramló forrógáz teljes mértékben a legalább egy forrógázas ciklonon (4) halad át,

azzal jellemezve, hogy

a forrógáz áramlási irányában a forrógázas ciklon (4) után egy megkerülő vezeték (10a) ágazik le a forrógázas vezetékről (10), úgyhogy a forrógázáram a forrógázas ciklonból való kilépés után egy első és egy második részáramra oszlik, és a második részáram a megkerülő vezetéken (10a) keresztül bevezetésre kerül a kazánba (6) a hőhordozóközeg melegítése céljából, hogy a kazán (6) kimenete gázvezetően össze van kötve a forrógázas vezetékkel (10), úgyhogy a kazánból (6) kilépő, lehűlt második részáram – a forrógáz hőmérsékletének szabályozása végett az első részáramban – ehhez legalább időnként hozzákeverhető, és hogy a kazán (6) kimenete és az égéstér (1) egymással gázvezetően van összekötve, úgyhogy a kazánból (6) kilépő, lehűlt második részáram legalább részben, különösen teljes mértékben hűtőgázáramként visszavezethető az égéstérbe (1).

2. Az 1. igénypont szerinti berendezés,

azzal jellemezve, hogy

a berendezés rendelkezik a forrógáz nitrogénmentesítésére szolgáló eszközökkel, amely nitrogénmentesítő eszközök legalább egy fúvókaként (30) vannak kialakítva, amely redukálószernek, különösen karbamidnak a forrógázas ciklon érintőirányú beömlő csatornájába való bevezetésére szolgál.

3. Az 1. vagy a 2. igénypont szerinti berendezés,

azzal jellemezve, hogy

a kazánnak (6) van egy első áramlási szakasza sugárzásos hőcserélővel (6a) és egy második áramlási szakasza konvekciós hőcserélővel (6b), amelyek közül az első áramlási szakaszon a forrógázáram lefelé tud átáramolni, a második áramlási szakaszon ezután a forrógázáram felfelé tud átáramolni.

4. Az 1-3. igénypontok egyike szerinti berendezés,

azzal jellemezve, hogy

a kazán (6) rendelkezik tisztítófolyadék, különösen víz bepermetezésére szolgáló eszközökkel.

5. A 3. és a 4. igénypont szerinti berendezés,

azzal jellemezve, hogy

az eszközök legalább egy, a kazán (6) első áramlási szakaszában elhelyezett fúvókaként (35) vannak kialakítva.

6. Az 5. igénypont szerinti berendezés,

azzal jellemezve, hogy

a fúvóka (35) úgy van kialakítva, hogy a tisztítófolyadék bepermetezésekor ingamozgást végez.

7. Az 1-6. igénypontok egyike szerinti berendezés,

azzal jellemezve, hogy

az égéstérnek (1) rostélyos tűztere, különösen mozgórostélyos tűztere van, és a rostélyon (2) átáramló, felemelkedő elsődleges levegőáram szállítja át a rostélyon lévő szilárd, szemcsés vagy rostos tüzelőanyagot az égéstéren (1).

8. A 7. igénypont szerinti berendezés,

azzal jellemezve, hogy

a berendezésnek van egy továbbítócsigája (24) és csúszda formájában egy surrantója (29) a tüzelőanyagnak a rostélyra (2) történő folytonos feladása céljából, amely surrantó (29) úgy van kialakítva, hogy vízbefecskendezéssel (26) hűthető.

9. Az 1-8. igénypontok egyike szerinti berendezés,

azzal jellemezve, hogy

az égéstérben (1) legalább két, érintőirányban elhelyezett égő (3) áll rendelkezésre gáz és por alakban lévő tüzelőanyag elégetéséhez.

10. Szárítóberendezés fából készült termékek és/vagy fahulladék szárítására, együtt egy, az 1-9. igénypontok egyike szerinti berendezéssel, amelynél a forrógázas ciklonból (4) kiáramló forrógáz legalább részben egy szárítóba (140) kerül bevezetésre különösen aprított fa, fűrészpor, gyaluforgács, farost, állati takarmány, gabona és hasonlók szárítása céljából.

11. Eljárás forrógáz előállítására hőhordozóközeg integrált melegítésével, amely eljárás során a forrógázt falazott égéstérben (1) állítjuk elő, és egy, a forrógáz áramlási irányában az égéstér (1) után elhelyezett kazánba (6) vezetjük a hőhordozóközeg melegítése céljából, továbbá az égéstérből (1) kilépő forrógázáram teljes mennyiségét a kazánba való belépés előtt átvezetjük legalább egy falazott, forrógázas ciklonon (4),

azzal jellemezve, hogy

a forrógázáramot a forrógázas ciklonból (4) való kilépés után egy első és egy második részáramra osztjuk, és a második részáramot egy megkerülő vezetéken (10a) keresztül vezetjük a kazánba (6) a hőhordozóközeg melegítése céljából,

és hogy a kazánból (6) kilépő, lehűlt második részáramot legalább részben hűtőgázáramként visszavezetjük az égéstérbe (1).

12. A 11. igénypont szerinti eljárás,

azzal jellemezve, hogy

a forrógázáram első részáramát bevezetjük egy szárítóberendezésbe (140).

13. A 11. vagy a 12. igénypont szerinti eljárás,

azzal jellemezve, hogy

a kazánból (6) kilépő, lehűlt második részáramot – a forrógáz hőmérsékletének szabályozása végett az első részáramban – ehhez legalább időnként hozzákeverjük.

14. A 11-13. igénypontok egyike szerinti eljárás,

azzal jellemezve, hogy

a kazánt (6) üzem közben legalább időnként tisztítófolyadék, különösen víz bepermetezésével tisztítjuk.

15. A 11-14. igénypontok egyike szerinti eljárás,

azzal jellemezve, hogy

a tüzelőanyag bevitelét és az égési levegő bevezetését az égéstérbe (1) úgy szabályozzuk, hogy az égéstérben (1) állandó vákuumot tartunk fent.

(A meghatalmazott)

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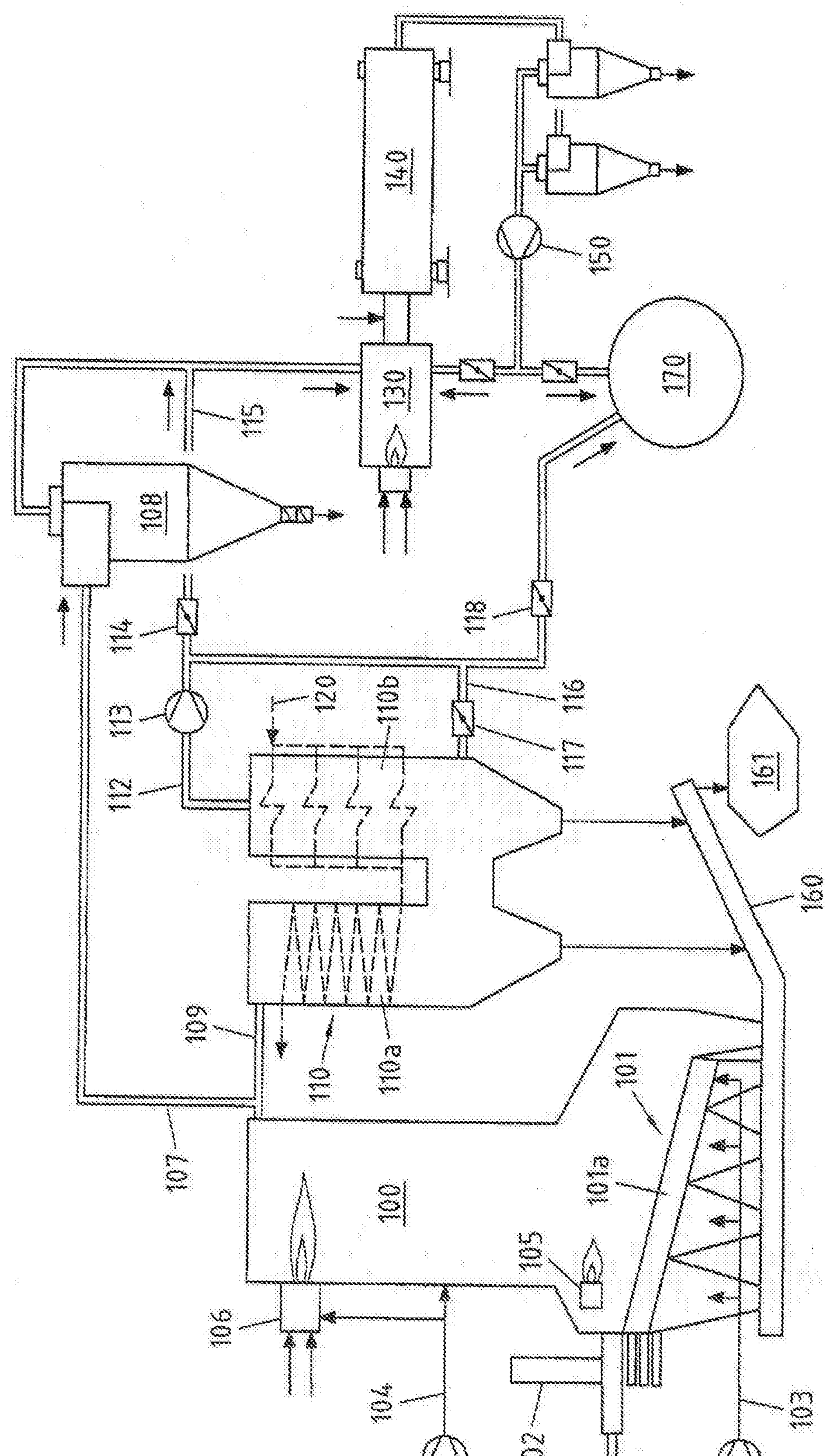

Fig.1 Prior Art

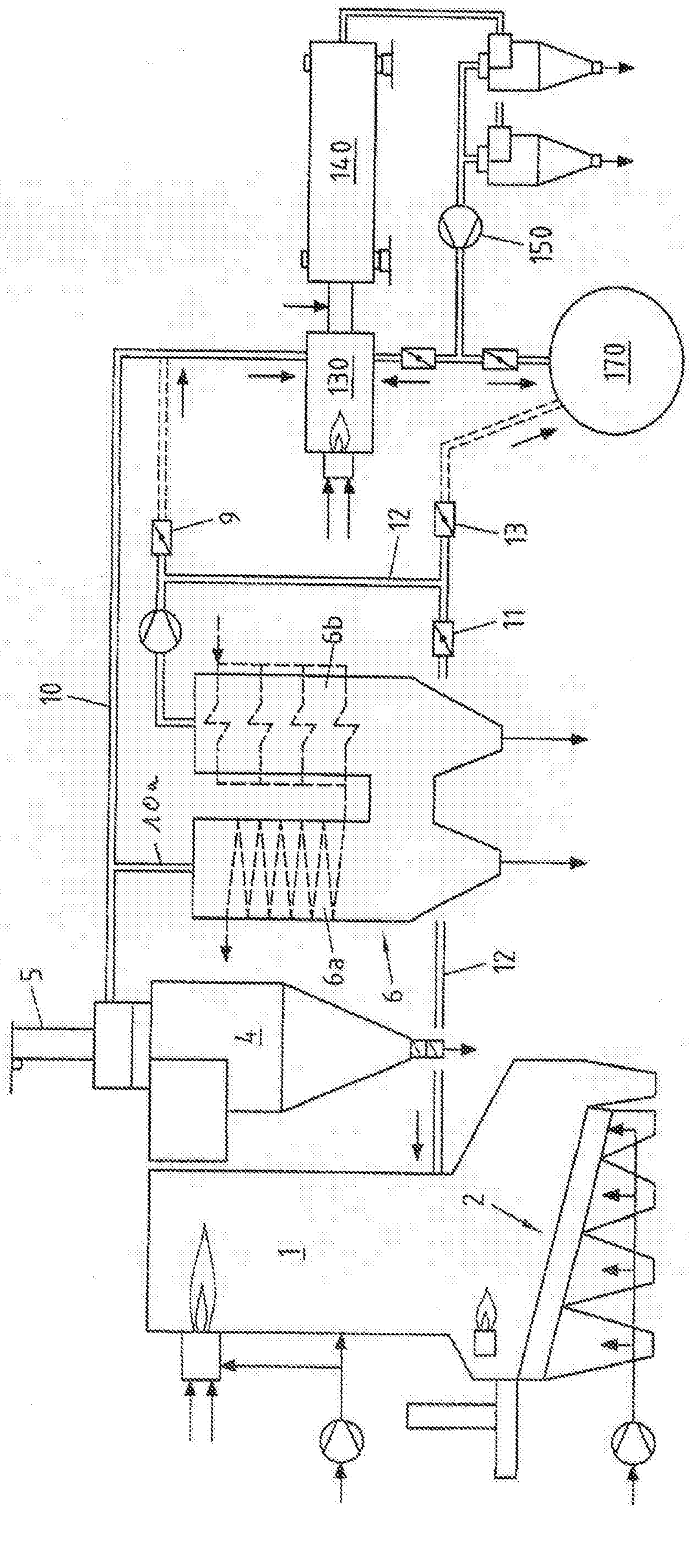

Fig.2

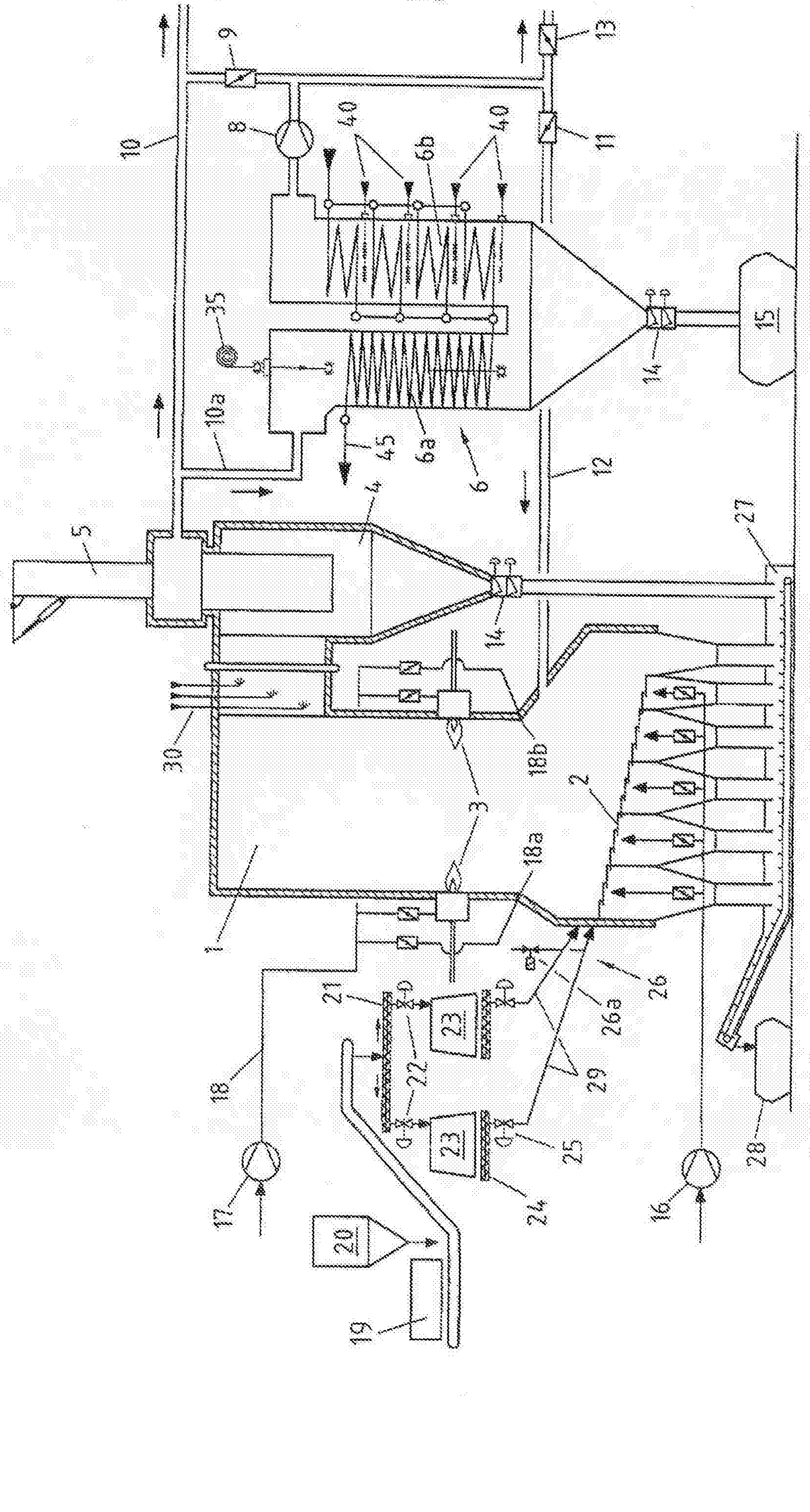
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Fig.3