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(54) **A POWER PLANT AND METHOD FOR INCREASING THE EFFICIENCY OF THE POWER PLANT**
KRAFTWERK UND VERFAHREN ZUR ERHÖHUNG DES WIRKUNGSGRADES DES KRAFTWERKS
CENTRALE ÉLECTRIQUE ET PROCÉDÉ POUR AUGMENTER LE RENDEMENT DE LA CENTRALE
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Description

TECHNICAL FIELD

[0001] The presently claimed invention relates to a power plant comprising a circulating fluidized bed boiler, where hot ash is stored and utilized for heat recovery and a method for recovering heat of the ash and utilize the recovered heat to increase the efficiency of the power plant.

BACKGROUND

[0002] In currently pulverized coal fired power plants flue gas passes the rotary air preheater where the flue gas heat transfer to access air takes place. The flue gas is loaded with fly ash which will be separated downstream in the electrostatic precipitator. After electrostatic precipitator the ash is discharged to a fly ash silo for further utilization or back to the mine. In other types of boiler for example circulating fluidized bed boiler hot bed ash is also cooled down and discharged to the mine.

[0003] Currently available pulverized coal fired and circulating fluidized bed power plants are not able to use heat of the ash when it is just come out of combustion chamber and yet to reach the rotary air preheater and this heat is wasted. Also a portion of useful steam is extracted from a steam turbine during expansion and is utilized to preheat feedwater which is further sent to a boiler. The use of useful steam reduces efficiency of the steam turbine.

[0004] It is important that any solution to use the heat of the ash is capable of implementation within the current power plants.

[0005] In EP 0 467 913 A1 a method and apparatus for recovering heat from solid material, such as ash, removed from hot processes such as combustion gasification processes and/or from cleaning processes of hot gases is proposed. The ash is conducted from a combustion chamber or from a gas cleaning means into a heat exchanger, where it is brought into heat exchange contact with liquid for transferring heat from the ash to the liquid.

[0006] In US 2012/0276492 A1 a method of recovering heat from bottom ash that is discharged from a combustion process in a furnace is suggested. Fuel and combustion air are fed into a furnace for combusting the fuel in order to generate heat energy to produce steam or hot water in a boiler arrangement, in which flue gases and bottom ash are formed. The bottom ash is discharged from the furnace. Heat is recovered from the flue gases, and heat is recovered to a bottom ash cooling water circuit from the bottom ash discharged from the furnace in order to utilize the recovered heat for preheating the combustion air in a heat exchanger.

[0007] In US 2014/0093828 A1 a boiler system is suggested that includes an arrangement for drying fuel material to be combusted in the boiler system. A combustion

chamber combusts fuel material, and generates ash and flue gases. An ash removal conduit connected to the combustion chamber leads ash out of the combustion chamber. A heat transfer device is arranged in connection with the ash removal conduit.

[0008] In EP 0 6194 55 A2 a pressurized internal circulating fluidized bed boiler is described that is incorporated in a combined cycle electric generating system in which a fuel such as coal, petrol coke or the like is combusted in a pressurized fluidized bed and an exhaust gas produced by the combusted fuel is introduced into a gas turbine. A thermal energy recovery chamber is partitioned from the main combustion chamber by an inclined partition wall.

[0009] Accordingly, any solution must be able to be used as "retrofitted" to fit within existing power plants.

SUMMARY OF THE INVENTION

[0010] The presently claimed invention relates to a power plant as set forth in claim 1 and to a method as set forth in claim 8. Further developments of the herein claimed invention are described in the dependent claims.

[0011] The presently claimed invention offers a technical solution for power plants which are hard coal fired units with pulverized coal fired boiler as well as lignite fired units and circulating fluidized bed boiler. The technical solution is achieved by providing intermediate hot ash storage to store hot ash and utilize inherent heat on demand in the power plant particularly for feed water heating during startup of the boiler. The inherent heat is also used to heat saturated steam in tubes of combustion chamber of the pulverized coal fired boiler in case of a load change. In case of the circulating fluidized bed boiler the inherent heat is also used to heat fluidized bed at the starting time. The hot ash is a fly ash or a bed ash or a mixture of the fly ash and the bed ash. The ash is the fly ash from the pulverized coal fired boiler or a bed ash or a mixture of the fly ash and the bed ash in circulating fluidized bed boiler.

[0012] The technical solution provides several advantages like application of a smaller electrostatic precipitator in power plants as ash is dealt with earlier. Recovered heat utilization leads to less power consumption of steam and electric power in the power plants as well as savings on start-up fuels. A reduction in CO₂ emission as the ash is separated and captured efficiently at a very early stage and a constant feed water temperature is provided during the operation of the boiler.

[0013] For a better understanding of the present invention, its operating advantages, and its uses, reference should be made to the accompanying drawings and descriptive matter in which there are illustrated exemplary embodiments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The advantages and features of the present dis-

closure will be better understood with reference to the following detailed description and claims taken in conjunction with the accompanying drawings, wherein like elements are identified with like symbols, and in which:

FIG. 1 is a schematic illustrating a power plant according to present disclosure;

Fig.2 illustrates a power plant having a pulverized coal fired boiler according to present disclosure;

Fig.2a illustrates a plurality of tubes forming walls of combustion chamber of the pulverized coal boiler; and

Fig. 3 illustrates a power plant having a circulating fluidized bed boiler according to present disclosure;

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0015] In reference to FIG. 1, a schematic of a coal fired power plant 10 is shown. The power plant 10 includes a boiler 20 having a combustion chamber 30 to carry out combustion of fuel 40 to generate heat, ash 50 and flue gas 60 in the combustion chamber 30. The coal is stored in a silo 104. The boiler 20 is connected to an energy recovery system 70. The energy recovery systems 70 recovers heat of the ash 50 and utilize the recovered heat to increase the efficiency of the power plant 10. The recovered heat is transferred to a working fluid 130 for example feed water 132 and steam 135 which is fed to the boiler 20. The working fluid 130 is further heated in the boiler 20 from the heat generated during the combustion and used to drive a steam turbine or a series of steam turbines 100. The boiler 20 is connected to the energy recovery system 70 through a separator 110. The energy recovery system 70 may include an ash storage 80 and a heat exchanger 90 fluidically connected to the ash storage 80. The ash storage 80 may receive and store the ash 50 generated in the boiler 20. The ash 50 may be passed through the heat exchanger 90 to extract the heat of the ash 50. The energy recovery system 70 further includes an ash discharge system 95 which is connected to the heat exchanger 90 to discharge the ash 50 in to ash silo 105.

[0016] Referring now to Figure 2 in an exemplary embodiment the boiler 20 of the power plant 10 may be a pulverized coal boiler, such as pulverized coal boiler 200, herein after 'boiler 200'. The boiler 200 may include a combustion chamber 202 to carry out combustion of fuel to generate heat, ash and flue gas in the combustion chamber 202. In one embodiment, the boiler 200 includes a silo 204 that stores coal to be burned to produce heat, ash 50 and flue gas 60 in the combustion chamber 202. In this embodiment, the coal from the silo 204 may be sent to a pulverizer (not shown) to be crushed in to a powder form. The coal powder is mixed with air that is induced by a fan 205 to produce fuel 206. The fuel 206 may be supplied in to the combustion chamber 202 through burners 207. During combustion of the fuel 206

heat, ash 50 and flue gas 60 are produced. The ash 50 may be a fly ash 52 or a bed ash 55 or a mixture of the fly ash 52 and the bed ash 55.

[0017] The boiler 200 may be connected to an energy recovery system 270 through a separator 210. The energy recovery system 270 may include an ash storage 280 and a heat exchanger 290 fluidically connected to the ash storage 280. The ash storage 280 may receive and store the ash 50 generated in the boiler 200. The ash 50 may be passed through the heat exchanger 290 to extract the heat of the ash 50.

[0018] One part of the ash 50, which is heavy, may be settled in bottom of the combustion chamber 202, and the other part which is lighter may be moved up in the combustion chamber 202. In one form, heavy ash may be the bed ash 55 and the lighter ash may be the fly ash 52. The separator 210 which is connected to the combustion chamber 202 receives the fly ash 52 and the flue gas 60 and separates fly ash 52 from the flue gas 60. For coal fired plants, for example, where bituminous coal is used, the fly ash 52 leaves the separator 210 with a temperature range of 410 °C to 450 °C, and more particularly at 430 °C, is stored in the ash storage 280 and for example lignite coal with a temperature range of 280 °C - 320 °C and more particularly at 300 °C is stored in an ash storage 280. The stored fly ash 52 is discharged through the heat exchanger 290 where inherent heat of the fly ash 52 is utilized to heat the working fluid 130 for example feed water 132 or steam 135 which is supplied to the boiler 200.

[0019] The energy recovery system 270 further includes an ash discharge system 295 which is connected to the heat exchanger 290 to discharge the fly ash 52 in to ash silo 237. As the fly ash 52 is very much fluid, the energy recovery system 270 is arranged in such a way that a gravimetric flow is realized. The recovered heat of the fly ash 52 is further utilized to heat the working fluid 130 for example steam 135 being fed at startup to the boiler 200. Also the recovered heat of the fly ash 52 is utilized to heat a plurality of tubes 230 forming walls of the combustion chamber 202 of the boiler 200 in case of a part load change of the boiler 200 so that the working fluid 130 is flowing through the plurality of tubes 230 is also heated and converted to steam with high temperature to be supplied immediately to the steam turbine 100. The bed ash 55 may also be supplied through a conduit 240 or any other suitable means to the ash storage 280. The fly ash 52 or the bed ash 55 or the mixture of the fly ash 52 and the bed ash 55 may also be discharged directly through the heat exchanger 290 to recover the heat of the ash 50. The ash storage 280 may be covered by an insulated layer to stop the loss of the heat during storage. A controlled valve 260 is provided to control flow of the fly ash 52 to the heat exchanger 290.

[0020] A series of heat transfer surfaces 250 are also provide in the combustion chamber 202 in form of super heater, reheater and economizer which are arranged as per the requirements of the boiler 200. The heat transfer

surfaces 250 further heated the working fluid 130 into super-heated steam, reheated steam.

[0021] Referring now to Figure 3 in an exemplary embodiment the boiler 300 of the power plant 10 is a circulating fluidized bed boiler, herein after 'boiler 300'. The boiler 300 includes a combustion chamber 302 to carry out combustion of fuel to generate heat, ash and flue gas in the combustion chamber 302. In one embodiment, the boiler 300 includes a silo 304 that stores crushed coal to be burned to produce heat, ash 50 and flue gas 60 in the combustion chamber 302. In this embodiment, the crushed coal as a fuel 306 from the silo 304 may be supplied in to the combustion chamber 302 at its bottom. A bed 307 of inert material, according to the invention, sand is formed at the bottom of the combustion chamber 302. The bed 307 is where the crushed coal or fuel 306 spreads. According to the invention, preheated primary air 309 supply is from under the bed 307 at high pressure through primary air fans (not shown). This lifts the bed 307 material and fuel particles 308 and keeps the fuel particles 308 in suspension. The combustion of the fuel particles 308 takes place in this suspended condition. The lifted bed 307 and suspended fuel particles 308 forms a fluidized circulating bed which is maintained at range of 850 °C - 900 °C. Secondary air 314 provides pre-heated combustion air. Nozzles 341 in the combustion chamber 302 walls at various levels distribute the preheated combustion air in the combustion chamber 302.

[0022] The ash 50 may be a fly ash 52 or a bed ash 55 or a mixture of the fly ash 52 and the bed ash 55. In boiler 300 the bed ash 55 is produced in the range of 35% to 45% of the ash 50 and settled in a lower portion of the combustion chamber 302. Fine particles of partly burned fuel particles 308, fly ash 52 and bed material 307 are carried along with the flue gas 60 to upper areas of the combustion chamber 302 and then into a separator 310 which is connected the combustion chamber 302. In the separator 310 fine particles of partly burned fuel particles 308, the fly ash 52 and the bed material 307 is captured and separated from the flue gas 60 and falls to a seal pot 312. The heavy particle of partly burned fuel particles 308, the fly ash 52 and the bed material 307 returns to the combustion chamber 302 for recirculation either directly through arm 316 or through another arm 317 after passing through a fluidized bed heat exchanger 318. These heavy particles keep on recirculating till they captured in the separator 310. The fly ash 52 keeps on adding with bed ash 55 in the lower portion of the combustion chamber 302. The flue gas 60 gases from the separator 310 pass to a series of heat transfer surfaces 350 and move out of the boiler 300.

[0023] The boiler 300 is connected to an energy recovery system 370. The boiler 300 may be connected to the energy recovery system 370 through an ash discharge screw 410. The energy recovery system 370 may include an ash storage 380 and a heat exchanger 390 fluidically connected to the ash storage 380. The ash storage 380

may receive and store the bed ash 55 particularly the mixture the fly ash 52 and the bed ash 55 generated in the boiler 300. The bed ash 55 particularly the mixture the fly ash 52 and the bed ash 55 may be passed through the heat exchanger 390 to extract the heat of the bed ash 55.

[0024] In the boiler 300 the bed ash 55, particularly the mixture of the fly ash 52 and the bed ash 55 leaves the boiler on a temperature range of 750 °C - 850 °C. Due to design constraints the bed ash 55 particularly the mixture of the fly ash 52 and the bed ash 55 is supplied pneumatically through a conduit 375 to the ash storage 380 which leads to a heat loss in the temperature range of 100 °C - 200 °C resulting in a final storage temperature of 600°C in the ash storage 380. The stored bed ash 55 particularly the mixture of the fly ash 52 and the bed ash 55 is discharged through the heat exchanger 390 where inherent heat of the bed ash 55 particularly the mixture of the fly ash 52 and the bed ash 55 is utilized to heat the working fluid 130 for example feed water 132 or steam 135 which is supplied to the boiler 300. The energy recovery system 370 further includes an ash discharge system 395 which is connected to the heat exchanger 390 to discharge the bed ash 55 particularly the mixture of the fly ash 52 and the bed ash 55 into a ash silo 420. As the bed ash 55 particularly the mixture of the fly ash 52 and the bed ash 55 is very much fluidic, the energy recovery system 370 is arranged in such a way that a gravimetric flow is realized. The fly ash 52 or the bed ash 55 or the mixture of the fly ash 52 and the bed ash 55 may also be discharged directly through the heat exchanger 390 to recover the heat of the ash 50. The ash storage 380 may be covered by an insulated layer to stop the loss of the heat during storage. A controlled valve 430 is provided to control flow of the ash 50 particularly the mixture of the fly ash 52 and the bed ash 55 to the heat exchanger 390. The stored bed ash 55 particularly the mixture of the fly ash 52 and the bed ash 55 in the ash storage 380 is provided to fluidize bed 307 at startup of the boiler 300 through a conduit 450. A controlled valve 440 is provided to control the flow of the stored bed ash 55 particularly the mixture of the fly ash 52 and the bed ash 55 to the combustion chamber 302.

Reference Numerals

[0025]

10	Plant
20	Boiler
30, 202, 302	Combustion Chamber
40	Fuel
50	Ash
52	Fly Ash
55	Bed Ash
60	Flue Gas
70, 270, 370	Energy Recovery System
80, 280, 380	Ash Storage

90, 290, 390	Heat Exchanger
95, 295	Ash Discharge System
100	Steam Turbine
104,204,304	Silo
105, 237, 420	Ash Silo
110	Separator
130	Working Fluid
132	Feed Water
135	Steam
200	Pulverized coal boiler
202, 302	Combustion chamber
205	Fan
206, 306	Fuel
207	Burner
210,310	Separator
230	Plurality of tubes
240	Conduit
250	Heat transfer surface
260	Controlled valve
270, 370	Energy recovery system
300	Circulating fluidized bed boiler
307	Bed
308	Fuel particles
309	Preheated primary air
312	Seal pot
314	Secondary air
316,317	Arm
318	Fluidized bed heat exchanger
341	Nozzle
350	Heat transfer surface
370	Energy recovery system
375,450	Conduit
395	Ash discharge system
410	Ash discharge screw
430, 440	Controlled valve

Claims

1. A power plant (10) comprising:

a boiler (300) including a combustion chamber (302) configured to carry out combustion of fuel (306) to form ash (50) and flue gas (60);
 an energy recovery system (370) connected to the boiler (300) to recover heat of the ash (50);
 wherein the boiler is a circulating fluidized bed boiler (300) comprising the combustion chamber (302) with a bed (307), the bed (307) comprising sand and ash (50); **characterized in**

that preheated primary air (309) for the combustion chamber (302) is supplied from under the bed (307) through primary air fans at high pressure such that the bed (307) material and fuel particles (308) are lifted and said fuel particles (308) are kept in suspension;

that fine particles of partly burned fuel particles (308), fly ash (52) and bed material (307) that are carried along with the flue gas (60) are captured by a separator (310) and fall to a seal pot (312); and
that heavy particles of partly burned fuel particles (308), the fly ash (52) and the bed material (307) are returned to the combustion chamber (302) for recirculation, either directly through a first arm (316) or through a second arm (317) after passing through a fluidized bed heat exchanger (318).

2. The power plant (10) according to claim 1, wherein the energy recovery system (370) comprising:

an ash storage (380) to receive and store the ash (50);
 a heat exchanger (390) fluidically connected to the ash storage (380) and wherein the ash (50) is passed through the heat exchanger to extract the heat of the ash (50).

3. The power plant (10) according to claim 2, wherein the energy recovery system (370) further comprising:

an ash discharge system (395) connected to the heat exchanger (390) to discharge the ash (50).

4. The power plant (10) according to claim 2, wherein the ash (50) is a fly ash (52) or a bed ash (55) or a mixture of the fly ash (52) and the bed ash (55).

5. The power plant (10) according to claim 4, wherein the recovered heat of the ash (50) is provided to heat a working fluid (130) being fed to the boiler (300).

6. The power plant (10) according to claim 1, wherein the energy recovery system (370) is connected to the circulating fluidized bed boiler (300) through an ash discharge screw (410).

7. The power plant (10) according to claim 4, wherein stored bed ash (55) in the ash storage (380) is provided to fluidize the circulating bed (307) at startup of the circulating fluidized bed boiler (300).

8. A method for increasing efficiency of a power plant (10) comprising:

providing a boiler (300) including a combustion chamber (302), the boiler (300) being in connection with an energy recovery system (370) and configured so that ash (50) and flue gas (60) are produced during combustion of fuel (306) inside the combustion chamber (302);
 recovering heat of the ash (50) through the energy recovery system (370);

wherein the boiler is a circulating fluidized bed boiler (300) comprising the combustion chamber (302) with a bed (307), the bed (307) comprising sand and ash (50);

characterized in that preheated primary air (309) for the combustion chamber (302) is supplied from under the bed (307) through primary air fans at high pressure such that the bed (307) material and fuel particles (308) are lifted and said fuel particles (308) are kept in suspension; and that fine particles of partly burned fuel particles (308), fly ash (52) and bed material (307) that are carried along with the flue gas (60) are captured by a separator (310) and fall to a seal pot (312); and that heavy particles of partly burned fuel particles (308), the fly ash (52) and the bed material (307) are returned to the combustion chamber (302) for recirculation, either directly through a first arm (316) or through a second arm (317) after passing through a fluidized bed heat exchanger (318).

9. The method according to claim 8, wherein the energy recovery system (370) comprises an ash storage (380) and a heat exchanger (390) which are fluidically connected with each other and wherein recovery of heat of the ash (50) comprising the steps of:

receiving and storing the ash (50) in the ash storage (380);
passing the ash (50) through the heat exchanger (390) to recover the heat of the ash (50).

10. The method according to claim 8, wherein the ash (50) is a fly ash (52) or a bed ash (55) or a mixture of the fly ash (52) and the bed ash (57).

11. The method according to claim 8, further including step of:
providing the recovered heat of the ash (50) to heat a working fluid (130) being fed to the boiler (300).

12. The method according to claim 8, further including the step of:
providing stored bed ash (55) of the ash storage (380) to the fluidized circulating bed (307) of the circulating fluidized bed boiler (300) at startup of the circulating fluidized bed boiler (300).

Patentansprüche

1. Kraftwerk (10), umfassend:

einen Kessel (300), der eine Brennkammer (302) einschließt, die konfiguriert ist, um eine Verbrennung von Brennstoff (306) durchzuführen,

um Asche (50) und Rauchgas (60) zu bilden;

ein Energierückgewinnungssystem (370), das mit dem Kessel (300) verbunden ist, um Wärme der Asche (50) zurückzugewinnen;

wobei der Kessel ein zirkulierender Wirbelbett-kessel (300) ist, der die Brennkammer (302) mit einem Bett (307) umfasst, wobei das Bett (307) Sand und Asche (50) umfasst;

dadurch gekennzeichnet, dass vorgewärmte Primärluft (309) für die Brennkammer (302) von unterhalb des Bettes (307) durch Primärluftgebläse mit hohem Druck zugeführt wird, so dass das Bett- (307) -material und die Brennstoffpartikel (308) angehoben werden und die Brennstoffpartikel (308) in Suspension gehalten werden;

dass feine Partikel aus teilweise verbrannten Brennstoffpartikeln (308), Flugasche (52) und Bettmaterial (307), die mit dem Rauchgas (60) mitgeführt werden, von einem Abscheider (310) aufgefangen werden und in einen Dichttopf (312) fallen und

dass schwere Partikel aus teilweise verbrannten Brennstoffpartikeln (308), die Flugasche (52) und das Bettmaterial (307) entweder direkt durch einen ersten Arm (316) oder durch einen zweiten Arm (317) nach dem Strömen durch einen Wirbelbettwärmetauscher (318) zur Rezirkulation in die Brennkammer (302) zurückgeführt werden.

2. Kraftwerk (10) nach Anspruch 1, wobei das Energierückgewinnungssystem (370) Folgendes umfasst:

einen Aschespeicher (380) zum Aufnehmen und Speichern der Asche (50);
einen Wärmetauscher (390), der fluidtechnisch mit dem Aschespeicher verbunden ist und wobei die Asche (50) durch den Wärmetauscher geleitet wird, um die Wärme der Asche (50) zu entziehen.

3. Kraftwerk (10) nach Anspruch 2, wobei das Energierückgewinnungssystem (370) ferner Folgendes umfasst:

ein Ascheaustragsystem (395), das mit dem Wärmetauscher (390) verbunden ist, um die Asche (50) auszutragen.

4. Kraftwerk (10) nach Anspruch 2, wobei die Asche (50) eine Flugasche (52) oder eine Bettasche (55) oder eine Mischung aus der Flugasche (52) und der Bettasche (55) ist.

5. Kraftwerk (10) nach Anspruch 4, wobei die rückgewonnene Wärme der Asche (50) zum Erwärmen eines dem Kessel (300) zugeführten Arbeitsfluids

(130) bereitgestellt wird.

6. Kraftwerk (10) nach Anspruch 1, wobei das Energierückgewinnungssystem (370) über eine Ascheaus-
tragsschnecke (410) mit dem zirkulierenden Wirbel-
bettkessel (300) verbunden ist.

7. Kraftwerk (10) nach Anspruch 4, wobei die gespei-
cherte Bettasche (55) in dem Aschespeicher (380)
bereitgestellt wird, um das zirkulierende Bett (307)
beim Anfahren des zirkulierenden Wirbelbettkessels
(300) zu verwirbeln.

8. Verfahren zum Erhöhen des Wirkungsgrades eines
Kraftwerks (10), umfassend:

Bereitstellen eines Kessels (300), der eine
Brennkammer (302) einschließt, wobei der Kes-
sel (300) mit einem Energierückgewinnungs-
system (370) in Verbindung steht und so konfi-
guriert ist, dass Asche (50) und Rauchgas (60)
während der Verbrennung von Brennstoff (306)
innerhalb der Brennkammer (302) erzeugt wer-
den;

Rückgewinnen von Wärme der Asche (50)
durch das Energierückgewinnungssystem
(370);

wobei der Kessel ein zirkulierender Wirbelbett-
kessel (300) ist, der die Brennkammer (302) mit
einem Bett (307) umfasst, wobei das Bett (307)
Sand und Asche (50) umfasst;

dadurch gekennzeichnet, dass vorgewärmte
Primärluft (309) für die Brennkammer (302) von
unterhalb des Bettes (307) durch Primärluftge-
bläse mit hohem Druck zugeführt wird, so dass
das Bett- (307) -material und die Brennstoffpar-
tikel (308) angehoben werden und die Brenn-
stoffpartikel (308) in Suspension gehalten wer-
den;

und dass feine Partikel aus teilweise verbrann-
ten Brennstoffpartikeln (308), Flugasche (52)
und Bettmaterial (307), die mit dem Rauchgas
(60) mitgeführt werden, von einem Abscheider
(310) aufgefangen werden und in einen Dicht-
topf (312) fallen und

dass schwere Partikel aus teilweise verbrannten
Brennstoffpartikeln (308), die Flugasche (52)
und das Bettmaterial (307) entweder direkt
durch einen ersten Arm (316) oder durch einen
zweiten Arm (317) nach dem Strömen durch ei-
nen Wirbelbettwärmetauscher (318) zur Rezir-
kulation in die Brennkammer (302) zurückge-
führt werden.

9. Verfahren nach Anspruch 8, wobei das Energierück-
gewinnungssystem (370) einen Aschespeicher
(380) und einen Wärmetauscher (390) umfasst, die
fluidtechnisch miteinander verbunden sind, und wo-

bei die Rückgewinnung von Wärme der Asche (50)
die folgenden Schritte umfasst:

Aufnehmen und Speichern der Asche (50) in
dem Aschespeicher (380);
Leiten der Asche (50) durch den Wärmetau-
scher (390), um die Wärme der Asche (50) zu-
rückzugewinnen.

10. Verfahren nach Anspruch 8, wobei die Asche (50)
eine Flugasche (52) oder eine Bettasche (55) oder
eine Mischung der Flugasche (52) und der Bettasche
(57) ist.

11. Verfahren nach Anspruch 8, ferner einschließlich
den Schritt:

Bereitstellen der rückgewonnenen Wärme der
Asche (50) zum Erwärmen eines dem Kessel (300)
zugeführten Arbeitsfluids (130).

12. Verfahren nach Anspruch 8, ferner einschließlich
den Schritt:

Bereitstellen von gespeicherter Bettasche (55) des
Aschespeichers (380) an das verwirbelte zirkulieren-
de Bett (307) des zirkulierenden Wirbelbettkessels
(300) beim Anfahren des zirkulierenden Wirbelbett-
kessels (300).

Revendications

1. Centrale électrique (10) comprenant :

une chaudière (300) incluant une chambre de
combustion (302) configurée pour effectuer une
combustion de carburant (306) pour former des
cendres (50) et du gaz de combustion (60) ;
un système de récupération d'énergie (370) rac-
cordé à la chaudière (300) pour récupérer de la
chaleur des cendres (50) ;

dans laquelle la chaudière est une chaudière à
lit fluidisé circulant (300) comprenant la cham-
bre de combustion (302) avec un lit (307), le lit
(307) comprenant du sable et des cendres (50) ;

caractérisée en ce que de l'air primaire pré-
chauffé (309) pour la chambre de combustion
(302) est fourni depuis sous le lit (307) à travers
des ventilateurs d'air primaire à haute pression
de telle sorte que les particules de matériau du
lit (307) et de carburant (308) sont soulevées et
lesdites particules de carburant (308) sont main-
tenues en suspension ;

que des particules fines de particules de carbu-
rant partiellement brûlées (308), de cendres vo-
lantes (52) et de matériau de lit (307), qui sont
transportées avec le gaz de combustion (60)
sont capturées par un séparateur (310) et tom-
bent dans un pot tampon (312) ; et

- que des particules lourdes de particules de carburant partiellement brûlées (308), des cendres volantes (52) et du matériau de lit (307) sont renvoyées vers la chambre de combustion (302) pour une recirculation, directement par un premier bras (316) ou par un deuxième bras (317) après avoir traversé un échangeur de chaleur à lit fluidisé (318). 5
2. Centrale électrique (10) selon la revendication 1, dans laquelle le système de récupération d'énergie (370) comprend : 10
- un stockage de cendres (380) pour recevoir et stocker les cendres (50) ; 15
- un échangeur de chaleur (390) raccordé de manière fluide au stockage de cendres (380) et dans laquelle les cendres (50) traversent l'échangeur de chaleur pour extraire de la chaleur des cendres (50). 20
3. Centrale électrique (10) selon la revendication 2, dans laquelle le système de récupération d'énergie (370) comprend en outre : 25
- un système d'évacuation de cendres (395) raccordé à l'échangeur de chaleur (390) pour évacuer les cendres (50).
4. Centrale électrique (10) selon la revendication 2, dans laquelle les cendres (50) sont des cendres volantes (52) ou des cendres de lit (55) ou un mélange des cendres volantes (52) et des cendres de lit (55). 30
5. Centrale électrique (10) selon la revendication 4, dans laquelle la chaleur récupérée des cendres (50) est fournie pour chauffer un fluide de travail (130) étant alimenté dans la chaudière (300). 35
6. Centrale électrique (10) selon la revendication 1, dans laquelle le système de récupération d'énergie (370) est raccordé à la chaudière à lit fluidisé circulant (300) à travers une vis d'évacuation de cendres (410). 40
7. Centrale électrique (10) selon la revendication 4, dans laquelle des cendres de lit stockées (55) dans le stockage de cendres (380) sont fournies pour fluidiser le lit circulant (307) au démarrage de la chaudière à lit fluidisé circulant (300). 45
8. Procédé pour augmenter l'efficacité d'une centrale électrique (10) comprenant : 50
- la fourniture d'une chaudière (300) incluant une chambre de combustion (302), la chaudière (300) étant en raccordement avec un système de récupération d'énergie (370) et configurée de sorte que des cendres (50) et du gaz de combustion (60) sont produits pendant la combustion de carburant (306) à l'intérieur de la chambre de combustion (302) ;
- la récupération de chaleur des cendres (50) à travers le système de récupération d'énergie (370) ;
- dans lequel la chaudière est une chaudière à lit fluidisé circulant (300) comprenant la chambre de combustion (302) avec un lit (307), le lit (307) comprenant du sable et des cendres (50) ;
- caractérisé en ce que** de l'air primaire préchauffé (309) pour la chambre de combustion (302) est fourni depuis sous le lit (307) à travers des ventilateurs d'air primaire à haute pression de telle sorte que les particules de matériau du lit (307) et de carburant (308) sont soulevées et lesdites particules de carburant (308) sont maintenues en suspension ;
- et que des particules fines de particules de carburant partiellement brûlées (308), de cendres volantes (52) et de matériau de lit (307) qui sont transportées avec le gaz de combustion (60) sont capturées par un séparateur (310) et tombent dans un pot tampon (312) ; et
- que des particules lourdes de particules de carburant partiellement brûlées (308), des cendres volantes (52) et du matériau de lit (307) sont renvoyées vers la chambre de combustion (302) pour une recirculation, directement à travers un premier bras (316) ou à travers un deuxième bras (317) après avoir traversé un échangeur de chaleur à lit fluidisé (318).
9. Procédé selon la revendication 8, dans lequel le système de récupération d'énergie (370) comprend un stockage de cendres (380) et un échangeur de chaleur (390) qui sont raccordés de manière fluide l'un à l'autre et dans lequel la récupération de chaleur des cendres (50) comprend les étapes consistant à : 55
- recevoir et stocker les cendres (50) dans le stockage de cendres (380) ;
- faire passer les cendres (50) à travers l'échangeur de chaleur (390) pour récupérer la chaleur des cendres (50).
10. Procédé selon la revendication 8, dans lequel les cendres (50) sont des cendres volantes (52) ou des cendres de lit (55) ou un mélange des cendres volantes (52) et des cendres de lit (57).
11. Procédé selon la revendication 8, incluant en outre l'étape consistant à : 60
- fournir la chaleur récupérée des cendres (50) pour chauffer un fluide de travail (130) étant alimenté dans la chaudière (300).
12. Procédé selon la revendication 8, incluant en outre

l'étape consistant à :

fournir des cendres de lit stockées (55) du stockage de cendres (380) au lit circulant fluidisé (307) de la chaudière à lit fluidisé circulant (300) au démarrage de la chaudière à lit fluidisé circulant (300).

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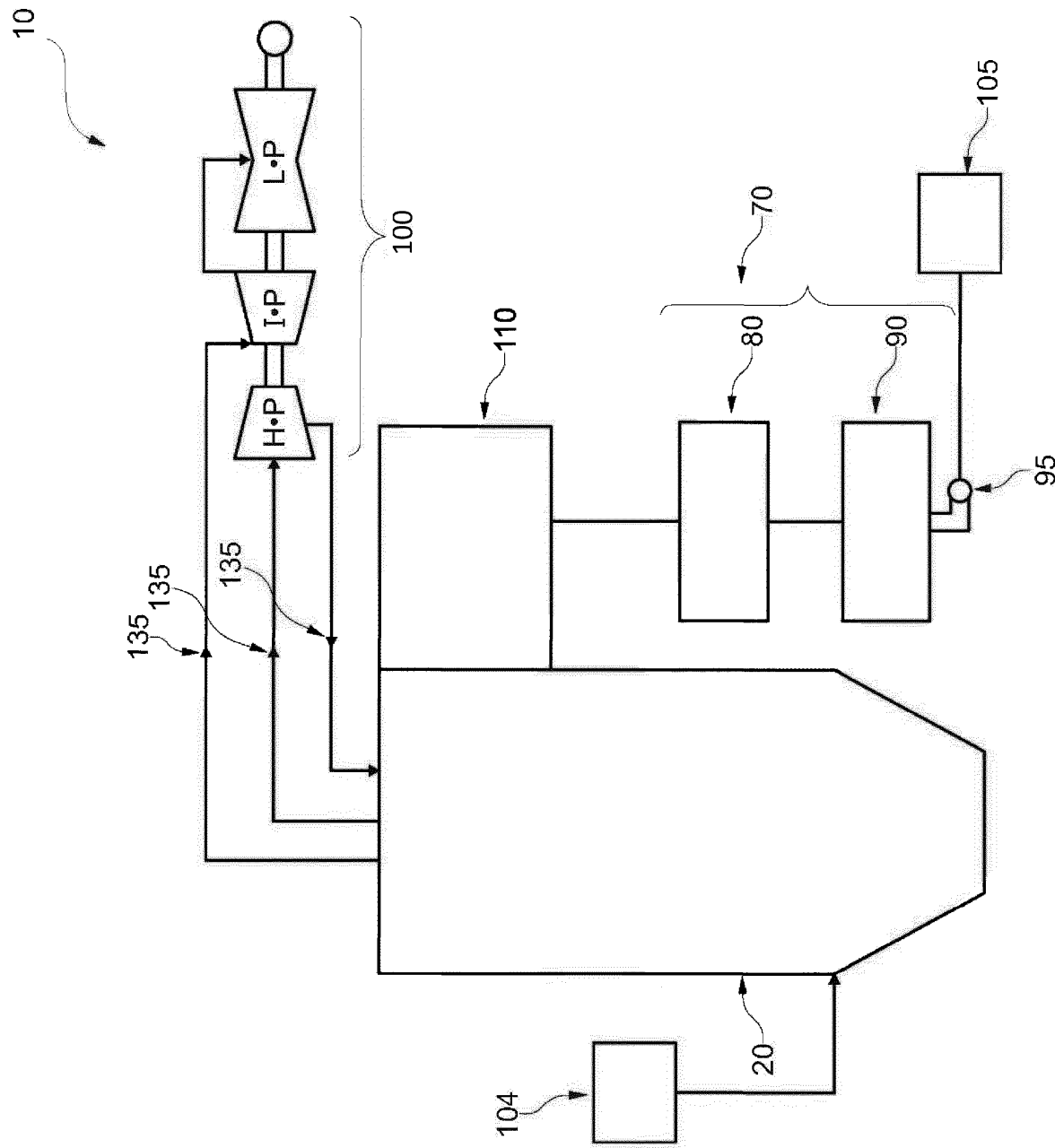


Fig. 1

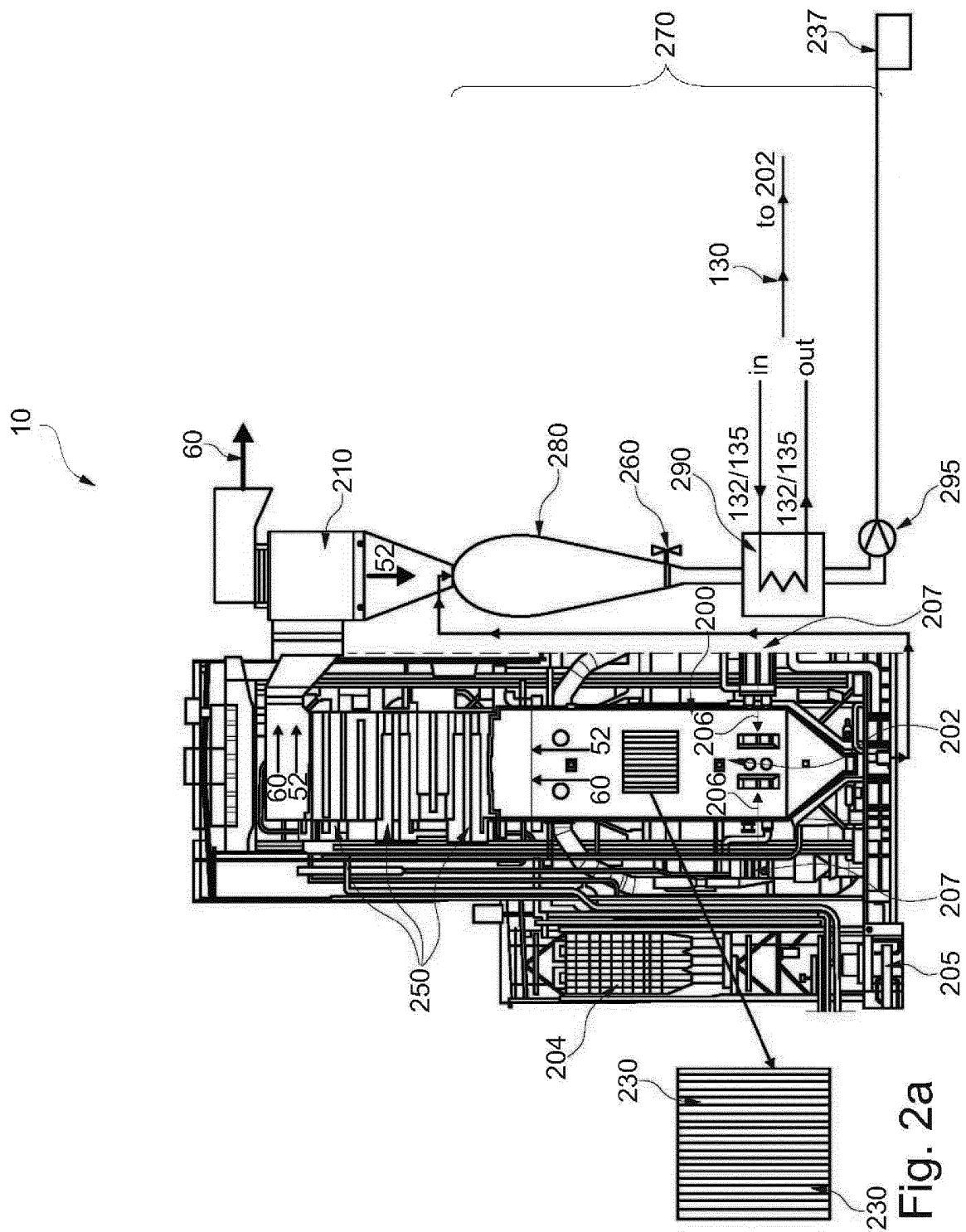


Fig. 2

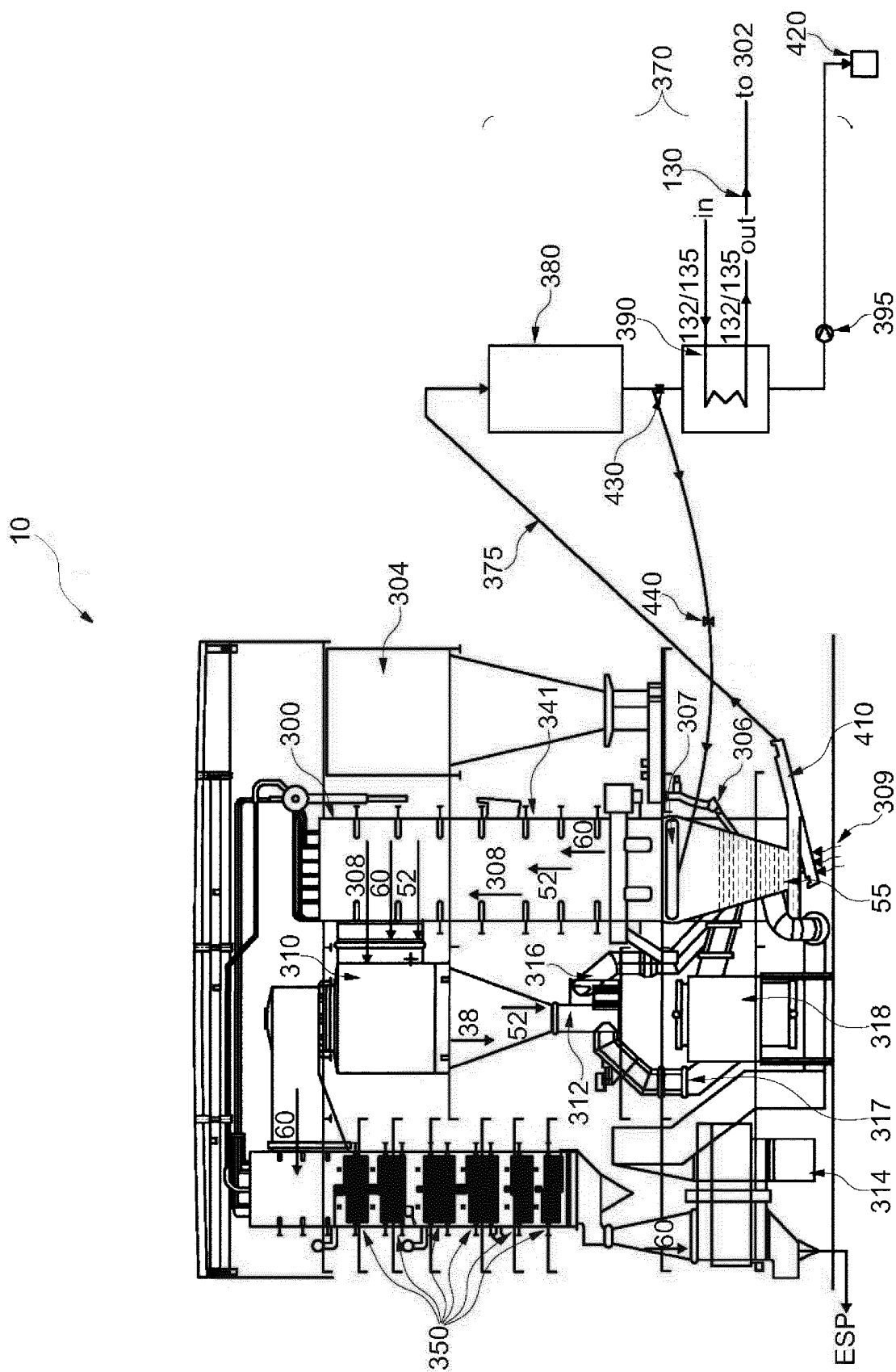


Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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