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(54) **A combustion system and a method for operating a combustion system**

Verbrennungsanlage und Verfahren zum Betreiben einer Verbrennungsanlage

Système de combustion et procédé pour faire fonctionner un système de combustion

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Description

TECHNICAL FIELD

[0001] The present invention relates to a combustion system and a method for operating a combustion system. The combustion system can for example be a part of a boiler of a power plant for electric energy production, other applications are anyhow possible. In addition the combustion system is used in connection with a solid fuel, preferably highly reactive solid fuels after pulverization.

BACKGROUND

[0002] Power plants for production of electrical energy can be fired using different fuels, such as oil, gas or solid fuels. Among the different fuels, solid fuels give the advantage of low costs when compared to gas or oil.

[0003] In order to fire a solid fuel in a furnace, the solid fuel has to be pulverized and typically also dried.

[0004] WO84/01016 discloses a boiler having a coal fired furnace with burners supplied by a mill. A line diverts a part of the pulverized coal into a silo for storing it and using it in the same boiler at start-up, warm-up and low load stabilization.

[0005] DE102008004400A1 discloses a combustion system which comprises comprises a drying device for reducing water portion in lignite, a cooling unit for lowering the lignite temperature, a storage for intermediately storing the cooled lignite. The lignite from the storage is supplied to a combustion device according to the requirement of a load demand of a power plant fueled by the combustion device. It further comprises a unit for separating the dried lignite into partial streams, a bypass, through which the partial stream of the lignite is guided to the cooling unit and to the storage, a unit for controlling the conveying rate in the partial streams according to the load demand of the power plant, a unit for combining the partial streams behind the storage and above the combustion device, a unit for generating an airflow through the drying device for the turbulence of the lignite, a downstream filter for filtering entrained lignite from the airflow, which is recirculated to the dry lignite stream in the cooling unit, a steam generator, which is admitted by the hot gases of the combustion device, sensors for measuring the mass flow, the associated temperature and/or the associated pressure produced in the stream generator, and a regulating device for generating regulating signals from the values measured with the sensors. A first partial stream is admitted to a first combustion device or a first group of the combustion devices through the bypass and a second partial stream is admitted to a second combustion device or a second group of the combustion devices through the cooling unit and the storage.

[0006] Dry lignite utilization has the potential for a significant cost reduction by replacing oil and gas.

[0007] Dry lignite is anyhow very reactive and after pulverization and drying cannot be stored in a silo in order to use it for start-up, warm-up and low load stabilization.

[0008] The lack of stored dry lignite to use during start-up, warm-up and low load stabilization reduces the operational flexibility of a power plant fired with dry lignite and must thus be addressed.

[0009] The inventors have found a way to store pulverized dry lignite, for example to have it ready when needed according to the operating conditions of the power plant.

SUMMARY

[0010] An aspect of the invention includes providing a combustion system and a method for its operation that allow storing of pulverized dry lignite, for example to have the pulverized dry lignite ready when needed according to the operating conditions of the combustion system and/or to extract and use the pulverized dry lignite outside of the combustion system.

[0011] These and further aspects are attained by providing a combustion system and a method in accordance with the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Further characteristics and advantages will be more apparent from the description of a preferred but non-exclusive embodiment of the combustion system and method, illustrated by way of non-limiting example in the accompanying drawings, in which:

Figure 1 shows a combustion system in an embodiment of the invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0013] With reference to the figure, it shows a combustion system 1 comprising a furnace 2 with one or more main burners 3. The main burners 3 are fed with solid fuel (pulverized dry lignite) by a mill 4 (for example a beater wheel mill) that is supplied with hot flue gas from a resuction duct 5 and raw lignite (i.e. lignite to be pulverized) via a chute 6. The mill 4 is in turn connected to a vapour separation system 7.

[0014] The vapour separation system 7 separates a fuel rich stream, rich in pulverized dry lignite, from a fuel lean stream containing gas and solid particles; in this case, the gas can comprise water vapour, carbon dioxide, carbon monoxide, non-combusted hydrocarbon, and the solid particles entrained fuel solid particles. Vapour separation systems are well known in the art, for example they can take advantage from centrifugal forces to separate solid particles from gas.

[0015] The combustion system has a first line 8, for removing the fuel rich stream from the vapour separation system 7 and for supplying the fuel rich stream to the main burners 3; the first line 8 is thus connected to the vapour separation system 7 and to the main burners 3.

[0016] The combustion system further has a second line 9 for removing the fuel lean stream (comprising gas and solid particles) from the vapour separation system 7. A recirculation line 10 with a valve is connected between the second line 9 and the mill 4.

[0017] The combustion system also has a cooler 12 fed by the second line 9 for cooling at least the solid particles and a storage silo 13 connected downstream of the cooler 12 for collecting the solid particles cooled at the cooler 12.

[0018] Preferably valves such as rotary valves 14 are provided upstream of the cooler 12 and/or downstream of the silo 13 and/or between the cooler 12 and the silo 13 for sealing the cooler 12 and/or silo 13 and regulating the flow of solid particles through the cooler 12 and silo 13 and regulating the amount of solid particles supplied by the silo 13.

[0019] The cooler 12 cools the pulverized (and very reactive) lignite in order to allow storage without or with a limited risk of self-ignition of the lignite.

[0020] A separator 15 such as a cyclone is provided; the separator 15 is provided between the second line 9 and the cooler 12, for separating the gas from the solid particles of the fuel lean stream.

[0021] The separator 15 comprises an outlet 15a for the solid particles; the outlet 15a is connected to the cooler 12 usually via a rotary valve 14.

[0022] In addition, the furnace 2 also comprises one or more vapour burners 17 and the combustion system comprises a third line 18 between the separator 15 and the vapour burner 17 to remove gas from the separator 15 and supply it to the vapour burners 17.

[0023] The third line 18 has a fan 19 and a control valve 20 for promoting and regulating the flow through the line 18.

[0024] The storage silo 13 can have (but this is not mandatory) an outlet 13a connected typically via a rotary valve 14 to an extraction line 21, for removal and external utilization of the solid particles.

[0025] In addition to the extraction line 21, the outlet 13a of the storage silo 13 is connected to one or more dry lignite burners 22 of the furnace 2.

[0026] A shoe valve 23 can be provided between the outlet 13a of the storage silo 13 and the dry lignite burners 22 and a fan 23a can be provided for supplying carrier gas (for example cold air) to transport the solid particles.

[0027] In addition, the combustion system further comprises a fourth line 24 between the vapour separation system 7 and the vapour burners 17, for supplying the fuel lean stream to the vapour burners 17. The fourth line 24 is preferably connected to the second line 9 and has a valve 25. Additionally, the fourth line 24 can also be connected to the third line 18 (i.e. the fourth line 24 can be a bypass of the separator 15).

[0028] The operation of the combustion system is apparent from that described and illustrated and is substantially the following.

[0029] Raw lignite is supplied via the chute 6 together with hot flue gas into the mill 4. At the mill 4 the lignite is dried and pulverized and supplied to the vapour separation system 7, from which the fuel rich stream (rich in pulverized lignite) is supplied to the main burners 3, and the fuel lean stream is conveyed via the second line 9 into the separator 15 from which gas is supplied to the vapour burners 17 for combustion (usually without flame) in the furnace 2. The solid particles are supplied from the separator 15 to the cooler 12, where the solid particles are cooled, such that no self-ignition occurs when the pulverized dry lignite is stored. The cooled pulverized dry lignite is thus supplied into the silo 13 and stored therein.

[0030] According to the requirements, the pulverized dry lignite can be extracted from the silo 13 for external use via the line 21 or can be used in the furnace 2; in this respect the lignite can be forwarded through the shoe valve 23 to the dry lignite burner 22 for combustion in the furnace 2.

[0031] By an appropriate regulation of the valves 20, 25 and 26 (the valve 26 being located on the second line 9 downstream of the branching of the fourth line 24) and rotary valves 14, the combustion system can be operated in order to:

- supply all fuel rich stream and fuel lean stream into the furnace 2,
- store part or all of the of the solid particles entrained or contained in the fuel lean stream in the silo 13,
- supply all fuel rich stream and fuel lean stream into the furnace 2 and in addition also supply solid particles collected in the silo 13 to the furnace 2.

[0032] The operation of the combustion system according to the embodiment of the invention is thus particularly flexible without impairing safety.

[0033] The present invention also refers to a method for operating a combustion system according to claim 7.

[0034] Advantageously, the combustion system according to the invention allows a reliable production and storage of dry lignite, a flexible utilization of the dry lignite during operation, the replacement of expensive fossil fuel (oil and/or gas) by dry lignite also at start up (because dry lignite is stored).

[0035] In practice the materials used and the dimensions can be chosen at will according to requirements and to the state of the art.

REFERENCE NUMBERS

[0036]

1	combustion system
2	furnace
3	main burner
4	mill
5	resuction duct
6	chute
7	vapour separation system

8	first line
9	second line
10	recirculation line (mill bypass)
12	cooler
13	storage silo
13a	outlet
14	rotary valve
15	separator
15a	outlet
17	vapour burner
18	third line
19	fan
20	valve
21	extraction line
22	dry lignite burner
23	shoe valve
23a	fan
24	fourth line
25	valve
26	valve

Claims

1. A combustion system (1) comprising
a furnace (2) with at least a main burner (3),
a mill (4) for milling a solid fuel,
a vapour separation system (7) connected to the mill (4),
a first line (8) for removing a fuel rich stream from the vapour separation system (7) and supplying the fuel rich stream to the at least a main burner (3),
a second line (9) for removing a fuel lean stream from the vapour separation system (7), the fuel lean stream comprising gas and solid particles,
a cooler (12) fed by the second line (9) for cooling at least the solid particles,
a storage silo (13) connected downstream of the cooler (12) for collecting at least the solid particles cooled at the cooler (12),
a separator (15) between the second line (9) and the cooler (12), for separating the gas from the solid particles, the separator (15) comprising an outlet (15a) for the solid particles connected to the cooler (12); and **characterized in that**
the furnace (2) comprises one or more vapour burners (17) and the combustion system further comprises:

a third line (18) between the separator (15) and the one or more vapour burners (17) to remove gas from the separator (15) and supply it to the one or more vapour burners (17); and
a fourth line (24) between the vapour separation system (7) and the one or more vapour burners (17) for supplying the fuel lean stream to the one or more vapour burners (17).

2. The combustion system (1) of claim 1, **characterised by** comprising a fan (19) on the third line (18).

3. The combustion system (1) of claim 1, **characterised in that** the storage silo (13) comprises an outlet (13a) connected to an extraction line (21), for removal and external utilization of the solid particles.

4. The combustion system (1) of claim 1, **characterised in that** the furnace (2) further comprises one or more dry lignite burners (22), wherein the storage silo (13) comprises an outlet (13a) connected to the dry lignite burners (22).

5. The combustion system (1) of claim 4, **characterised by** comprising a shoe valve (23) between the outlet (13a) of the storage silo (13) and the dry lignite burners (22).

6. The combustion system (1) of claim 1, **characterised in that** the fourth line (24) is connected to the second line (9).

7. A method for operating a combustion system (1) having a furnace (2) with at least a main burner (3) for combusting a solid fuel and one or more vapour burners (17), the method comprising
providing a mixture of gas and pulverized fuel, separating the mixture in a fuel rich stream and a fuel lean stream, the fuel lean stream comprising gas and solid particles,
combusting the fuel rich stream in the furnace (2), partly combusting the fuel lean stream in the furnace;
separating gas from the solid particles of the fuel lean stream;
cooling at least the solid particles of the fuel lean stream,
storing at least the solid particles of the fuel lean stream,
characterized by
supplying the fuel lean stream to the one or more vapour burners (17);
supplying the gas separated from the solid particles of the fuel lean stream to the one or more vapour burners (17).

8. The method of claim 7, **characterised by** extracting the solid particles for external utilization.

9. The method of claim 7, **characterised by** combusting the solid particles in the furnace.

Patentansprüche

1. Verbrennungssystem (1), umfassend
einen Ofen (2) mit mindestens einem Hauptbrenner (3),

eine Mühle (4) zum Mahlen eines Festbrennstoffs,
ein Dampftrennungssystem (7), das mit der Mühle (4) verbunden ist,
eine erste Leitung (8) zum Entfernen eines brennstoffreichen Stroms vom Dampftrennungssystem (7) und Zuleiten des brennstoffreichen Stroms zu dem mindestens einen Hauptbrenner (3),
eine zweite Leitung (9) zum Entfernen eines brennstoffarmen Stroms aus dem Dampftrennungssystem (7), wobei der brennstoffarme Strom Gas und feste Partikel umfasst,
einen Kühler (12), der von der zweiten Leitung (9) zum Kühlen mindestens der festen Partikel gespeist wird,
ein Speichersilo (13), das stromabwärts des Kühlers (12) zum Sammeln mindestens der festen Partikel, die beim Kühler (12) gekühlt werden, verbunden ist,
einen Abscheider (15) zwischen der zweiten Leitung (9) und dem Kühler (12), um das Gas von den festen Partikeln zu trennen, wobei der Abscheider (15) einen Auslass (15a) für die festen Partikel umfasst, der mit dem Kühler (12) verbunden ist; und
dadurch gekennzeichnet, dass der Ofen (2) einen oder mehr Dampfbrenner (17) umfasst und das Verbrennungssystem weiter umfasst:

eine dritte Leitung (18) zwischen dem Abscheider (15) und dem einen oder den mehreren Dampfbrennern (17), um Gas vom Abscheider (15) zu entfernen und es dem einen oder den mehreren Dampfbrenner (17) zuzuleiten; und
eine vierte Leitung (24) zwischen dem Dampftrennungssystem (7) und dem einen oder den mehreren Dampfbrennern (17), zum Zuleiten des brennstoffarmen Stroms zu dem einen oder die mehreren Dampfbrenner (17).

2. Verbrennungssystem (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** es einen Lüfter (19) auf der dritten Leitung (18) umfasst.

3. Verbrennungssystem (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** das Speichersilo (13) einen Auslass (13a) umfasst, der mit einer Extraktionsleitung (21) zum Entfernen und zur externen Nutzung der festen Partikel verbunden ist.

4. Verbrennungssystem (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** der Ofen (2) weiter einen oder mehrere Trockenbraunkohlebrenner (22) umfasst, wobei das Speichersilo (13) einen Auslass (13a) umfasst, der mit den Trockenbraunkohlebrennern (22) verbunden ist.

5. Verbrennungssystem (1) nach Anspruch 4, **dadurch gekennzeichnet, dass** es ein Schiebeventil (23) zwischen dem Auslass (13a) des Speichersilos (13) und den Trockenbraunkohlebrennern (22) umfasst.

6. Verbrennungssystem (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die vierte Leitung (24) mit der zweiten Leitung (9) verbunden ist.

7. Verfahren zum Betreiben eines Verbrennungssystems (1) mit einem Ofen (2) mit mindestens einem Hauptbrenner (3) zum Verbrennen eines festen Brennstoffs und einem oder mehreren Dampfbrennern (17), das Verfahren umfassend
Bereitstellen eines Gemisches aus Gas und pulverisiertem Treibstoff,
Trennen des Gemisches in einen brennstoffreichen Strom und einen brennstoffarmen Strom, wobei der brennstoffarme Strom Gas und feste Partikel umfasst,
Verbrennen des brennstoffreichen Stroms im Ofen (2),
teilweises Verbrennen des brennstoffarmen Stroms im Ofen;
Abtrennen von Gas von festen Partikeln des brennstoffarmen Stroms;
Kühlen mindestens der festen Partikel des brennstoffarmen Stroms,
Speichern mindestens der festen Partikel des brennstoffarmen Stroms, **gekennzeichnet durch**
Zuleiten des brennstoffarmen Stroms zu dem einen oder den mehreren Dampfbrennern (17);
Zuleiten des von den festen Partikeln getrennten Gas des brennstoffarmen Stroms zu dem einen oder den mehreren Dampfbrennern (17).

8. Verfahren nach Anspruch 7, **gekennzeichnet durch** Extrahieren der festen Partikel zur externen Nutzung.

9. Verfahren nach Anspruch 7, **gekennzeichnet durch** Verbrennen der festen Partikel im Ofen.

Revendications

1. Système de combustion (1) comprenant
un four (2) avec au moins un brûleur principal (3),
un broyeur (4) pour broyer un carburant solide,
un système de séparation de vapeur (7) raccordé au broyeur (4),
une première ligne (8) pour le retrait d'un courant riche en carburant du système de séparation de vapeur (7) et la fourniture du courant riche en carburant à l'au moins un brûleur principal (3),
une deuxième ligne (9) pour le retrait d'un courant pauvre en carburant du système de séparation de vapeur (7), le courant pauvre en carburant comprenant du gaz et des particules solides,
un refroidisseur (12) alimenté par la deuxième ligne (9) pour le refroidissement d'au moins les particules solides,
un silo de stockage (13) raccordé en aval du refroi-

disseur (12) pour la collecte d'au moins les particules solides refroidies sur le refroidisseur (12),
un séparateur (15) entre la deuxième ligne (9) et le refroidisseur (12), pour la séparation du gaz des particules solides, le séparateur (15) comprenant une sortie (15a) pour les particules solides raccordées au refroidisseur (12) ; et **caractérisé en ce que**
le four (2) comprend un ou plusieurs brûleurs de vapeur (17) et le système de combustion comprend en outre :

une troisième ligne (18) entre le séparateur (15) et les un ou plusieurs brûleurs de vapeur (17) pour retirer du gaz du séparateur (15) et le fournir aux un ou plusieurs brûleurs de vapeur (17) ; et
une quatrième ligne (24) entre le système de séparateur de vapeur (7) et les un ou plusieurs brûleurs de vapeur (17) pour l'alimentation en courant pauvre en carburant des un ou plusieurs brûleurs de vapeur (17).

2. Système de combustion (1) selon la revendication 1, **caractérisé en ce qu'**il comprend un ventilateur (19) sur la troisième ligne (18).

3. Système de combustion (1) selon la revendication 1, **caractérisé en ce que** le silo de stockage (13) comprend une sortie (13a) raccordée à une ligne d'extraction (21) pour le retrait et l'utilisation externe des particules solides.

4. Système de combustion (1) selon la revendication 1, **caractérisé en ce que** le four (2) comprend en outre un ou plusieurs brûleurs de lignite sèche (22), dans lequel le silo de stockage (13) comprend une sortie (13a) raccordée aux brûleurs de lignite sèche (22).

5. Système de combustion (1) selon la revendication 4, **caractérisé en ce qu'**il comprend une valve à patin (23) entre la sortie (13a) du silo de stockage (13) et les brûleurs de lignite sèche (22).

6. Système de combustion (1) selon la revendication 1, **caractérisé en ce que** la quatrième ligne (24) est raccordée à la deuxième ligne (9).

7. Procédé de fonctionnement d'un système de combustion (1) présentant un four (2) avec au moins un brûleur principal (3) pour la combustion d'un carburant solide et un ou plusieurs brûleurs de vapeur (17), le procédé comprenant
la fourniture d'un mélange de gaz et de carburant pulvérisé,
la séparation du mélange en un courant riche en carburant et un courant pauvre en carburant, le courant pauvre en carburant comprenant du gaz et des particules solides,
la combustion du courant riche en carburant dans le four (2),
la combustion partielle du courant pauvre en carburant dans le four ;
la séparation de gaz des particules solides du courant pauvre en carburant ;
le refroidissement d'au moins les particules solides du courant pauvre en carburant,
le stockage d'au moins les particules solides du courant pauvre en carburant, **caractérisé par**
l'alimentation en courant pauvre en carburant des un ou plusieurs brûleurs de vapeur(17) ;
l'alimentation en gaz séparé des particules solides du courant pauvre en carburant des un ou plusieurs brûleurs de vapeur (17).

8. Procédé selon la revendication 7, **caractérisé par** l'extraction des particules solides pour l'utilisation externe.

9. Procédé selon la revendication 7, **caractérisé par** la combustion des particules solides dans le four.

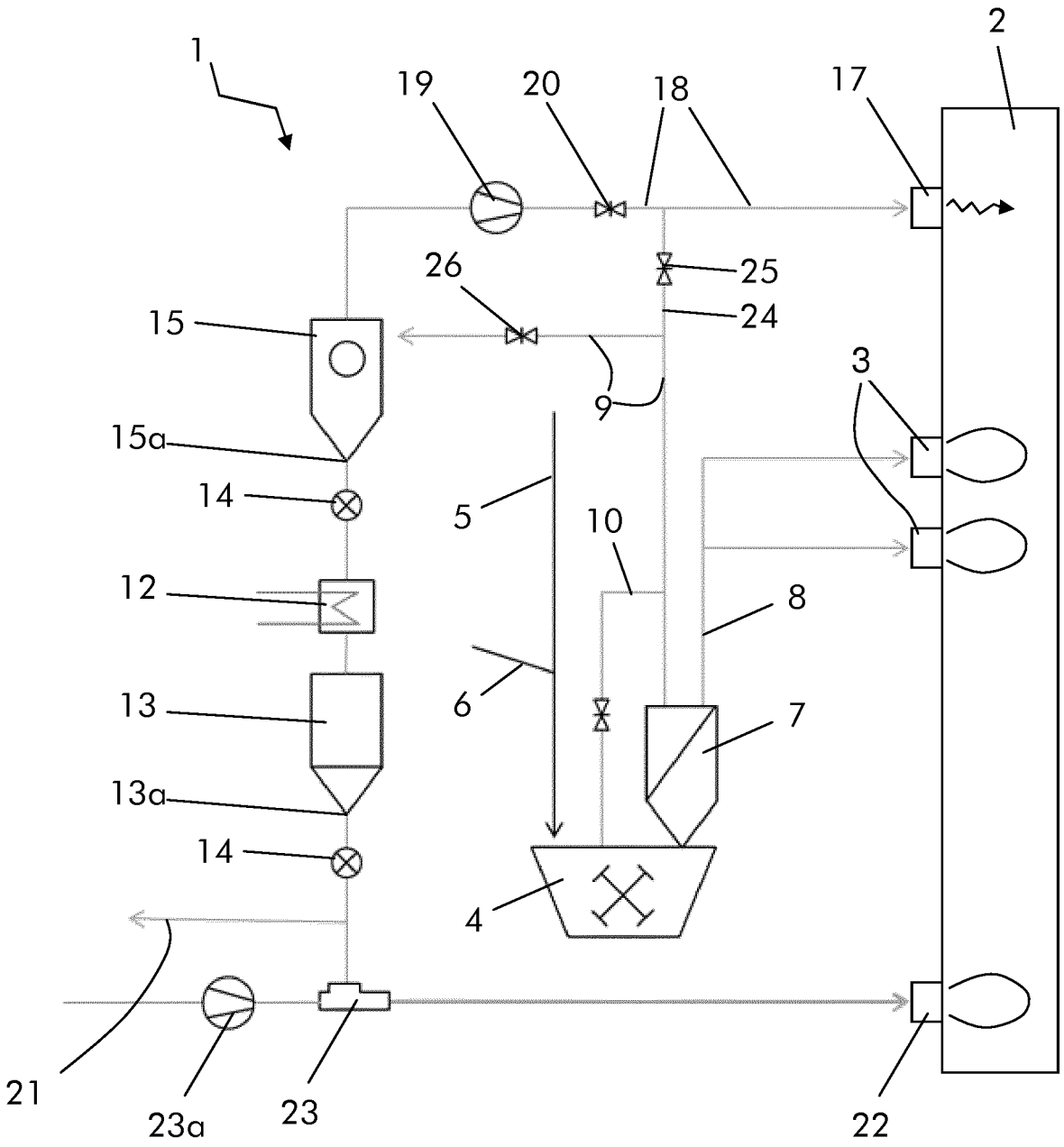
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Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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