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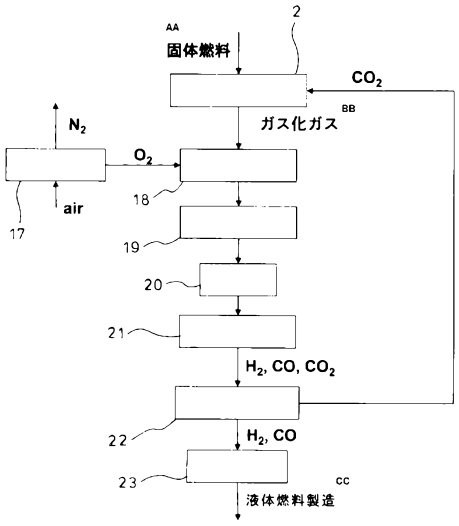
[続葉有]

(54) **Title**: FUEL GASIFICATION EQUIPMENT

(54) 発明の名称: 燃料ガス化設備

[図3]




AA SOLID FUEL
BB GASIFICATION GAS
CC PRODUCTION OF LIQUID FUEL

(57) **Abstract**: A fuel gasification equipment that would realize effective utilization of $CO_2$ gas finally separated from product combustible gases, such as $H_2$ and CO, in supply of a solid fuel to a gasification furnace, thereby attaining stable supply of the solid fuel to the gasification furnace. The equipment comprises $CO_2$ gas separation circulation means for separating $CO_2$ gas from a gasification gas produced by a gasification furnace (2) and leading the same to a solid fuel supply line to the gasification furnace (2).

(57) 要約: 製品となるＨ２やＣＯ等の可燃性ガスから最終的に分離されるＣＯ２ガスを固体燃料のガス化炉への供給用として有効活用し得、固体燃料をガス化炉へ安定して供給し得る燃料ガス化設備を提供する。 ガス化炉２で生成されたガス化ガス中からＣＯ２ガスを分離して固体燃料のガス化炉２への供給系統へ導くＣＯ２ガス分離循環手段を備える。

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— 国際調査報告（条約第 21 条(3)）

# DESCRIPTION

## FUEL GASIFICATION EQUIPMENT

### Technical Field

[0001]

The present invention relates to a fuel gasification equipment.

### Background Art

[0002]

A fuel gasification equipment has been developed which uses as fuel solid fuel such as coal, biomass, waste plastic or various wet wastes to produce a gasification gas.

Figs. 1 and 2 show an example of a conventional fuel gasification equipment comprising a gasification furnace 2 having a fluidized bed 1 of a bed material (such as silica sand or limestone) formed with steam and a fluidizing reaction gas such as air or oxygen to gasify a solid fuel (such as coal or biomass) charged for production of a gasification gas and a flammable solid content, a combustion furnace 5 fed with the flammable solid content produced in the gasification furnace 2 along with the bed material through an introduction pipe 3 and having a

fluidized bed 4 formed with a fluidizing reaction gas to burn the flammable solid content, a material separator 8 such as a hot cyclone for separating the bed material from an exhaust gas introduced via an exhaust gas pipe 6 from the combustion furnace 5 to supply the separated bed material via a downcomer 7 to the gasification furnace 2, a material separator 9 such as a hot cyclone for separating the bed material from the gasification gas produced in the gasification furnace 2, and a recovery vessel 10 for recovering the bed material separated by the separator 9.

[0003]

In Figs. 1 and 2, reference numeral 11 denotes a distribution plate for uniformly blowing into the fluidized bed 1 the steam and the fluidizing reaction gas introduced to the bottom of the gasification furnace 2; 12, a partition for covering an inner portion of the gasification furnace 2 connected to the introduction pipe 3 such that only a bottom of the portion is opened to prevent the bed material in the fluidized bed 1 from directly flowing out into the introduction pipe 3; 13, a distribution plate for uniformly blowing into the fluidized bed 4 the fluidizing reaction gas introduced to the bottom of the combustion furnace 5; 14, a hopper for storing the solid fuel; 15, a screw feeder for cutting and

extracting the stored solid fuel from the hopper 14; and 16, a fuel supply pipe fed with the solid fuel cut and extracted by the screw feeder 15 and connected to a side surface of the gasification furnace 2 at a position higher than a top surface of the fluidized bed 1.

[0004]

In the gasification equipment as described above, the fluidized bed 1 is formed with steam and the fluidizing reaction gas such as air or oxygen in the gasification furnace 2. When the solid fuel such as coal or biomass stored in the hopper 14 is cut and extracted by the screw feeder 15 and charged into the fluidized bed 1 through the fuel supply pipe 16, the solid fuel is partially oxidized and gasified into the gasification gas and the flammable solid content. The flammable solid content produced in the gasification furnace 2 is introduced through the introduction pipe 3 along with the bed material into the combustion furnace 5 having the fluidized bed 4 formed with the fluidizing reaction gas to burn the flammable solid content. An exhaust gas from the combustion furnace 5 is introduced through the exhaust gas pipe 6 into the material separator 8 where the bed material is separated from the exhaust gas. The separated bed material is returned through the downcomer 7 to the gasification furnace 2 for circulation.

[0005]

Since a high temperature is retained in the gasification furnace 2 in the presence of steam supplied to the bottom of the gasification furnace 2 and moisture evaporated from the solid fuel itself and a gas produced by pyrolysis of the solid fuel and a residual fuel are react with steam, a water gasification reaction $C+H_2O=H_2+CO$ and a hydrogen conversion reaction $CO+H_2O=H_2+CO_2$ occur, producing a combustible gasification gas such as $H_2$ and CO.

[0006]

From the gasification gas produced in the gasification furnace 2, the bed material is separated by the material separator 9 and is recovered to the recovery vessel 10.

[0007]

An equipment configuration similar to the fuel gasification equipment shown in Figs. 1 and 2 is disclosed, for example, in Patent Literature 1.

Patent Literature 1: JP 2006-207947A

[0008]

In the conventional fuel gasification equipment as mentioned in the above, the gasification gas produced in the gasification furnace 2 also contains $CO_2$. $CO_2$ contained in the gasification gas is not necessarily utilized effectively in the present situation even though it is finally separated from a product or combustible gas such as $H_2$ and CO.

[0009]

The invention was made in view of the above and has its object to provide a fuel gasification equipment capable of effectively utilizing a $CO_2$ gas finally separated from a product or combustible gas such as $H_2$ and

CO for supply of a solid fuel to a gasification furnace, thereby realizing stable supply of the solid fuel to the gasification furnace.

Summary of Invention

[0010]

The invention is directed to a fuel gasification equipment characterized by comprising

a gasification furnace having a fluidized bed of a bed material formed with a fluidizing reactive gas for gasifying a solid fuel charged to produce a gasification gas and a flammable solid content; and

$CO_2$ gas separation/circulation means for separating $CO_2$ gas from the gasification gas produced in the gasification furnace and introducing the separated $CO_2$ gas to a supply system supplying the solid fuel to the gasification furnace and wherein

a fuel supply pipe is connected to a side surface of the gasification furnace at a position lower than a top surface of the fluidized bed to supply the solid fuel from the fuel supply pipe to an inside of the fluidized bed, a fluidizing gas pipe being connected to the fuel supply pipe close to a connection thereof to the gasification furnace for introduction of the $CO_2$ gas separated by the $CO_2$ gas separation/circulation means into the fluidizing gas pipe as fluidizing gas for stable supply of the solid fuel to an inside of the fluidized bed.

[0011]

By the above measures, the following effects are obtained.

[0012]

In the fuel gasification equipment configured as above, the $CO_2$ gas separated from the gasification gas is

effectively utilized for supply of the solid fuel to the gasification furnace, and consequently the solid fuel is stably supplied to the gasification furnace. Further, a type of gasification reaction in the gasification furnace

$C + CO_2 \rightarrow 2CO$

is promoted, leading to improvement of gasification efficiency.

[0013]

In the fuel gasification equipment, the $CO_2$ gas separation/circulation means may be provided by a $CO_2$ separator arranged in front of an FT synthesizer for conducting a Fischer-Tropsch synthesis reaction to adjust an $H_2/CO$ ratio in the gasification gas to approximately 2.

[0014]

In the fuel gasification equipment, the $CO_2$ gas separation/circulation means may be provided by a $CO_2$ separator arranged in front of an ammonia synthesizer for producing ammonia through mixing of $H_2$ in the gasification gas with $N_2$.

[0015]

In the fuel gasification equipment, introduction of the $CO_2$ gas separated by the $CO_2$ gas separation/circulation means into a hopper storing the solid fuel is effective for dryness of the solid fuel and pressure-feeding of the solid fuel with the $CO_2$ gas to steadily supply the same.

[0016]

In the fuel gasification equipment, a fuel supply pipe is connected to a side surface of the gasification furnace at a position lower than a top surface of the fluidized bed to supply the solid fuel from the fuel supply pipe to an inside of the fluidized bed; and a fluidizing gas pipe may be connected to the fuel supply pipe close to a connection thereof to the gasification

furnace for introduction of the $CO_2$ gas separated by the $CO_2$ gas separation/circulation means into the fluidizing gas pipe as fluidizing gas for stable supply of the solid fuel to an inside of the fluidized bed. This allows fine particles of the solid fuel to make full contact with the bed material without scattering unlike a case where the solid fuel is supplied from the fuel supply pipe to the gasification furnace at a position above the fluidized bed, so that the pyrolysis of the solid fuel is

reliably completed to enhance achievable gas calorific value, i.e., cold gas efficiency as well as C- and H-conversion ratios while also enabling the reforming of tar in the gasification gas. It may be conceivable that especially when biomass is used as the solid fuel in the configuration where fuel supply pipe is connected to the side surface of the gasification furnace at a position lower than the top surface of the fluidized bed so that the solid fuel is supplied from the fuel supply pipe to the inside of the fluidized bed, the biomass, which contains more volatile components than coal and is easily gasificable, may heat up to some hundreds of degrees (°C) to melt and gradually stick in the connection of the fuel supply pipe to the gasification furnace, leading to clogging of the fuel supply pipe. In the above-mentioned configuration, however, the $CO_2$ gas is supplied as fluidizing gas from the fluidizing gas pipe connected to the fuel supply pipe to promote the fluidity of the solid fuel; as a result, even when biomass is used as the solid fuel, sticking of molten biomass to the connection of the fuel supply pipe is avoided and the fear of the clogging of the fuel supply pipe is eliminated.

## Advantageous Effects of Invention

[0017]

According to the fuel gasification equipment of the invention, the $CO_2$ finally separated from the product or combustible gas such as $H_2$ and CO can be effectively utilized for supply of the solid fuel to the gasification furnace, and consequently the solid fuel can be stably supplied to the gasification furnace.

Brief Description of Drawings

[0018]

Fig. 1 is an overall schematic diagram showing an example of a conventional fuel gasification equipment;

Fig. 2 is a relevant part diagram showing a gasification furnace in the example of the conventional fuel gasification equipment;

Fig. 3 is a block diagram showing a system configuration of a first embodiment of the invention;

Fig. 4 is a relevant part diagram showing a specific example of the gasification furnace in the first embodiment of the invention;

Fig. 5 is a relevant part diagram showing a modification of the gasification furnace shown in Fig. 4;

Fig. 6 is a relevant part diagram showing another specific example of the gasification furnace in the first embodiment of the invention; and

Fig. 7 is a block diagram showing a system

configuration of a second embodiment of the invention.

Reference Signs List

[0019]

1 fluidized bed

2 gasification furnace

3 introduction pipe

5 combustion furnace

7 downcomer

8 material separator

10 recovery vessel

11 dispersion plate

14 hopper (supply system)

15 screw feeder

16 fuel supply pipe (supply system)

22 $CO_2$ separator ($CO_2$ gas separation/circulation means)

23 FT synthesizer

24 fluidizing gas pipe

25 ammonia synthesizer

Description of Embodiments

[0020]

Embodiments of the invention will be described in conjunction with the drawings.

Figs. 3 and 4 show a first embodiment of the

invention in which portions similar to those in Figs. 1 and 2 are represented by the same reference numerals. This embodiment, which is similar in basic configuration to the conventional one shown in Figs. 1 and 2, is characteristic as shown in Figs. 3 and 4 in provision of $CO_2$ gas separation/circulation means which separates $CO_2$ gas from a gasification gas produced in a gasification furnace 2 and introduces the separated $CO_2$ gas to a supply system for supplying the solid fuel to the gasification furnace 2.

[0021]

The embodiment includes:

an $O_2$ separator 17 which separates air into $O_2$ and $N_2$;

a high-temperature reforming furnace 18 which mixes the gasification gas produced by the gasification furnace 2 and made free from the bed material by the material separator 9 (not shown in Fig. 3, see Fig. 1) with $O_2$ separated by the $O_2$ separator 17 to reform tar and lower hydrocarbons in the gasification gas;

a spray tower 19 which removes dust and trace constituents from the gasification gas reformed by the reforming furnace 18;

a desulfurization tower 20 which desulfurizes the gasification gas made free from the dust and the trace constituents by the spray tower 19;

a fine remover 21 which removes trace constituents such as light tar from the gasification gas desulfurized by the desulfurization tower 20;

a $CO_2$ separator 22 which separates $CO_2$ from the gasification gas ($H_2$, CO and $CO_2$) made free from the trace constituents such as light tar by the fine remover 21; and

an FT synthesizer 23 which conducts a Fischer-Tropsch synthesis reaction to adjust an $H_2/CO$ ratio of the gasification gas made free from $CO_2$ by the $CO_2$ separator 22 to approximately 2 to thereby produce $H_2$ and CO as liquid fuel,

the above-mentioned $CO_2$ gas separation/circulation means being provided by the $CO_2$ separator 22 arranged in front of the FT synthesizer 23.

[0022]

The $CO_2$ gas separated by the $CO_2$ separator 22 as $CO_2$ gas separation/circulation means is introduced, as shown in Fig. 4, into the hopper 14 storing the solid fuel and serving as system for supplying the solid fuel to the gasification furnace 2.

[0023]

Next, an operation of the embodiment will be described.

[0024]

In a case of the first embodiment shown in Fig. 3, in

the high-temperature reforming furnace 18, the gasification gas produced in the gasification furnace 2 and made free from the bed material by material separator 9 (not shown in Fig. 3; see Fig. 1) is mixed with $O_2$ separated by the $O_2$ separator 17 to reform tar and lower hydrocarbons in the gasification gas. In the spray tower 19, dust and trace constituents are removed from the gasification gas reformed by the reforming furnace 18. In the desulfurization tower 20, desulfurized is the gasification gas made free from the dust and the trace constituents by the spray tower 19. In the fine remover 21, trace constituents such as light tar are removed from the gasification gas desulfurized by the desulfurization tower 20. In the $CO_2$ separator 22, $CO_2$ is separated from the gasification gas ($H_2$, CO and $CO_2$) made free from the trace constituents such as light tar by the fine remover 21. In the FT synthesizer 23, the Fischer-Tropsch synthesis reaction is conducted to adjust the $H_2$/CO ratio of the gasification gas made free from the $CO_2$ by the $CO_2$ separator 22 to approximately 2 to thereby produce $H_2$ and CO as liquid fuel. The $CO_2$ gas separated by the $CO_2$ separator 22 as $CO_2$ gas separation/circulation means is introduced, as shown in Fig. 4, into the hopper 14 storing the solid fuel.

[0025]

This introduction of the $CO_2$ gas into the hopper 14 serves for drying of the solid fuel in the hopper 14 as well as pressure-feeding of the solid fuel with the $CO_2$ gas, enabling steady supply of the solid fuel.

[0026]

Further, the $CO_2$ gas is supplied from the hopper 14 through the screw feeder 15 and the fuel supply pipe 16 to the gasification furnace 2 so that a type of gasification reaction

$C + CO_2 \rightarrow 2CO$

is promoted, leading to improvement of gasification efficiency.

[0027]

It may be possible to introduce $N_2$ gas, steam, etc. into the hopper 14 instead. Introduction of the $N_2$ gas into the hopper 14 would cause a drop in calorific value of the gasification gas produced since such inert gas is admixed in the gasification furnace 2; introduction of the steam into the hopper 14 would require extra steam and deteriorate the overall efficiency of the system correspondingly. By contrast, in the embodiment, the $CO_2$ finally separated from the product or combustible gas such as $H_2$ and CO is circulated and utilized, so that there is absolutely no fear of the drop in calorific value of the gasification gas as in the case where the $N_2$ gas is used

or the deterioration of the overall efficiency of the system as in the case where the steam is used.

[0028]

As above, the $CO_2$ gas finally separated from the product or combustible gas such as $H_2$ and CO can be effectively utilized for supply of the solid fuel to the gasification furnace 2, and consequently the solid fuel can be stably supplied to the gasification furnace.

[0029]

Fig. 5 is a relevant part diagram showing a modification of the gasification furnace 2 in which portions similar to those in Figs. 3 and 4 are represented by the same reference numerals. The modification, which is similar in basic configuration to the embodiment shown in Figs. 3 and 4, is characteristic as shown in Fig. 5 that the fuel supply pipe 16 is connected to the side surface of the gasification furnace 2 at a position lower than the top surface of the fluidized bed 1 so that the solid fuel is supplied from the fuel supply pipe 16 to an inside of the fluidized bed 1.

[0030]

With this configuration in which the fuel supply pipe 16 is connected to the side surface of the gasification furnace 2 at a position lower then the top surface of the fluidized bed 1 to supply the solid fuel from the fuel

supply pipe 16 to the inside of the fluidized bed 1, fine particles of the solid fuel are allowed to make full contact with the bed material without scattering unlike cases where the solid fuel is supplied from the fuel supply pipe 16 to the side surface of the gasification furnace 2 at a position above the fluidized bed 1 as in the example of Fig. 4, and the pyrolysis of the solid fuel is reliably completed to enhance achievable gas calorific value, i.e., cold gas efficiency as well as C- and H-conversion ratios while also enabling the reforming of tar in the gasification gas.

[0031]

Fig. 6 is a relevant part diagram showing another specific example of the gasification furnace 2 in the first embodiment (see Fig. 3) of the invention in which portions similar to those in Fig. 3 or 5 are represented by the same reference numerals. The modification, which is similar in fundamental configuration to the fuel gasification equipment shown in Fig. 3 or 5, is characteristic in that, instead of introducing the $CO_2$ gas separated by the $CO_2$ separator 22 (see Fig. 3) as $CO_2$ gas separation/circulation means to the hopper 14 storing the solid fuel, a fluidizing gas pipe 24 is connected to the fuel supply pipe 16 serving as system for supplying the solid fuel to the gasification furnace 2, at a position

close to the connection of the pipe 16 to the furnace 2 as shown in Fig. 6, and the $CO_2$ gas separated by the $CO_2$ separator 22 as $CO_2$ gas separation/circulation means is introduced into the fluidizing gas pipe 24 as fluidizing gas for stably supplying the solid fuel to the inside of the fluidized bed.

[0032]

It may be conceivable that especially when biomass is used as the solid fuel in the configuration like Fig. 5 or 6 where the fuel supply pipe 16 is connected to the side surface of the gasification furnace 2 at a position lower than the top surface of the fluidized bed 1 so that the solid fuel is supplied from the fuel supply pipe 16 to the inside of the fluidized bed 1, the biomass, which contains more volatile components than coal and is easily gasificable, may heat up to some hundreds of degrees (°C) to melt and gradually stick in the connection of the fuel supply pipe 16 to the gasification furnace 2, leading to clogging of the fuel supply pipe 16. In the example of Fig. 6, however, the $CO_2$ gas as fluidizing gas is supplied from the fluidizing gas pipe 24 connected to the fuel supply pipe 16 to promote the fluidity of the solid fuel; as a result, even when biomass is used as the solid fuel, sticking of molten biomass to the connection of the fuel supply pipe 16 is avoided and the fear of the clogging of

the fuel supply pipe 16 is eliminated.

[0033]

It goes without saying that, in the example of Fig. 6, alternatively the $CO_2$ gas separated by the $CO_2$ separator 22 (see Fig. 3) as $CO_2$ gas separation/circulation means may be introduced into the hopper 14 storing the solid fuel like the example of Fig. 5.

[0034]

Fig. 7 shows a second embodiment of the invention in which portions similar to those in Fig. 3 are represented by the same reference numerals. This embodiment, which is similar in basic configuration to the embodiment shown in Fig. 3, is characteristic as shown in Fig. 7 that the $CO_2$ gas separation/circulation means is provided by a $CO_2$ separator 22 arranged in front of an ammonia synthesizer 25 which mixes $N_2$ with $H_2$ in the gasification gas to produce ammonia.

[0035]

In this embodiment, an $H_2$ separator 26 is provided to separate $H_2$ from the gasification gas made free from $CO_2$ by the $CO_2$ separator 22. $H_2$ separated by the $H_2$ separator 26 is introduced into the ammonia synthesizer 25 for the ammonia-producing reaction. CO obtained by separation of $H_2$ by the $H_2$ separator 26 is returned to the gasification gas made free from $CO_2$ by the $CO_2$ separator 22.

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[0036]

Also in the system configuration shown in Fig. 7 employed, any of the types shown in Figs. 4, 5 and 6 may be applied for a specific example of the gasification furnace 2 like the case of Fig. 3, and effects similar to those described above can be achieved.

[0037]

It is to be understood that a fuel gasification equipment of the invention is not limited to the above-mentioned embodiments and that various changes and modifications may be made without departing from the scope of the invention.

[0038]

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

[0039]

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

2008360806 12 Dec 2012



CLAIMS

1. A fuel gasification equipment characterized by comprising

a gasification furnace having a fluidized bed of a bed material formed with a fluidizing reactive gas for gasifying a solid fuel charged to produce a gasification gas and a flammable solid content; and

$CO_2$ gas separation/circulation means for separating $CO_2$ gas from the gasification gas produced in the gasification furnace and introducing the separated $CO_2$ gas to a supply system supplying the solid fuel to the gasification furnace and wherein

a fuel supply pipe is connected to a side surface of the gasification furnace at a position lower than a top surface of the fluidized bed to supply the solid fuel from the fuel supply pipe to an inside of the fluidized bed, a fluidizing gas pipe being connected to the fuel supply pipe close to a connection thereof to the gasification furnace for introduction of the $CO_2$ gas separated by the $CO_2$ gas separation/circulation means into the fluidizing gas pipe as fluidizing gas for stable supply of the solid fuel to an inside of the fluidized bed.

2. A fuel gasification equipment as claimed in claim 1, wherein said $CO_2$ gas separation/circulation means is provided by a $CO_2$ separator arranged in front of an FT synthesizer for conducting a Fischer-Tropsch synthesis reaction to adjust an $H_2/CO$ ratio in the gasification gas to approximately 2.

3. A fuel gasification equipment as claimed in claim 1, wherein said $CO_2$ gas separation/circulation means is

provided by a $CO_2$ separator arranged in front of an ammonia synthesizer for producing ammonia through mixing of $H_2$ in the gasification gas with $N_2$.

4. A fuel gasification equipment as claimed in claim 1, wherein the $CO_2$ gas separated by said $CO_2$ gas separation/circulation means is introduced into a hopper storing the solid fuel.

5. A fuel gasification equipment as claimed in claim 2, wherein the $CO_2$ gas separated by said $CO_2$ gas separation/circulation means is introduced into a hopper storing the solid fuel.

6. A fuel gasification equipment as claimed in claim 3, wherein the $CO_2$ gas separated by said $CO_2$ gas separation/circulation means is introduced into a hopper storing the solid fuel.

7. A fuel gasification equipment substantially as herein described with reference to the accompanying figures 3-7.

FIG. 1

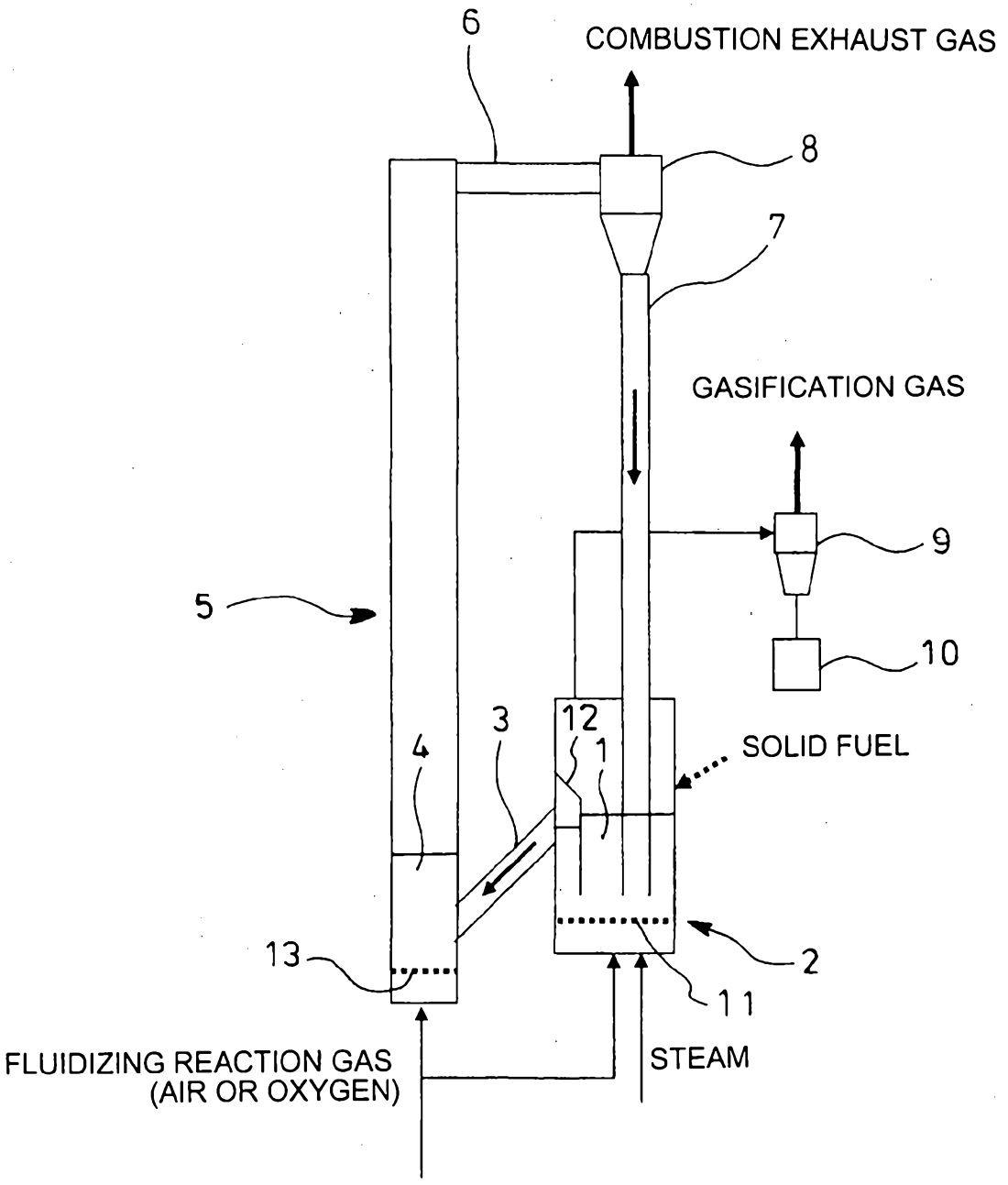

6
COMBUSTION EXHAUST GAS
8
7
GASIFICATION GAS
9
10
5
3
12
1
4
SOLID FUEL
13
2
11
FLUIDIZING REACTION GAS
(AIR OR OXYGEN)
STEAM

FIG. 2

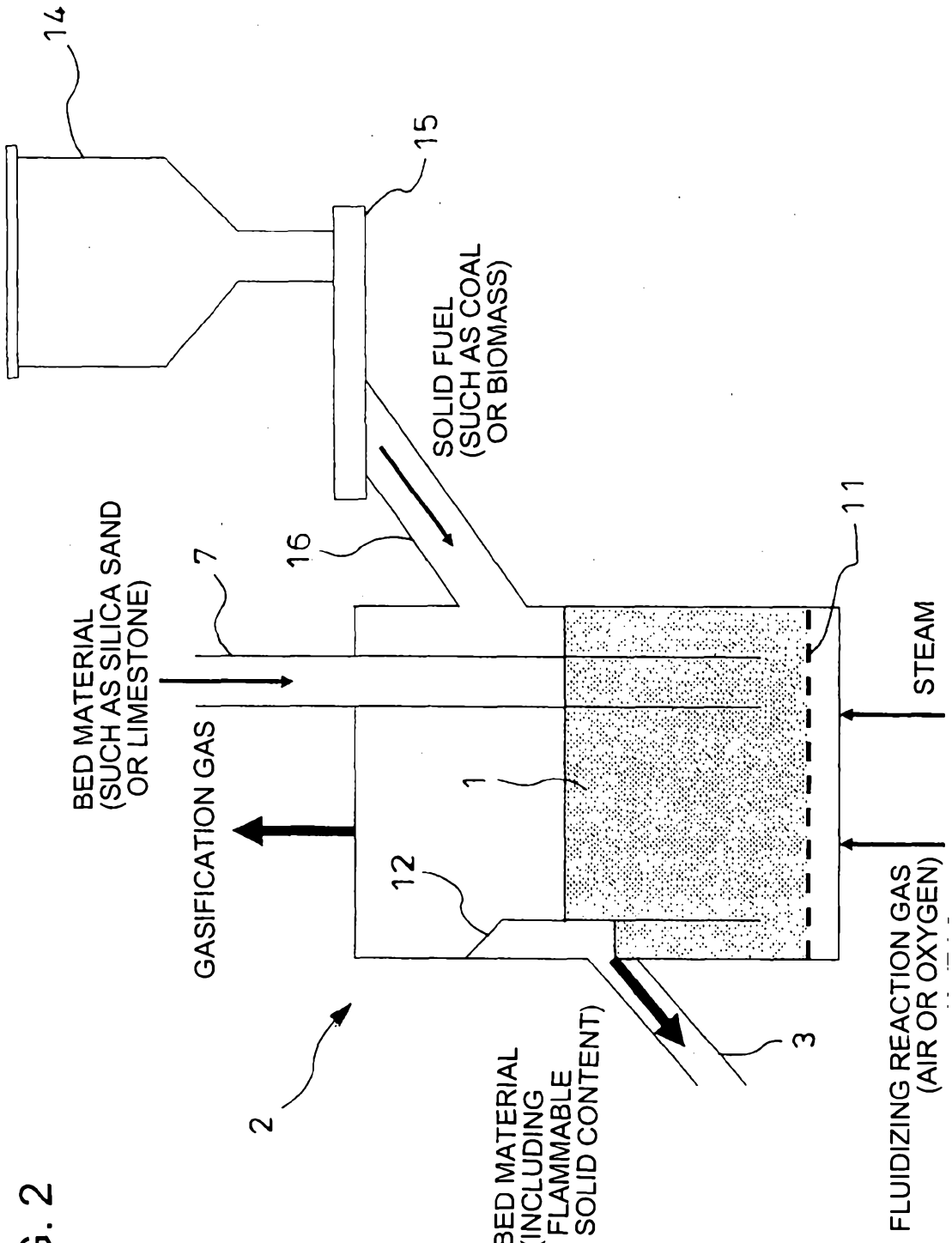
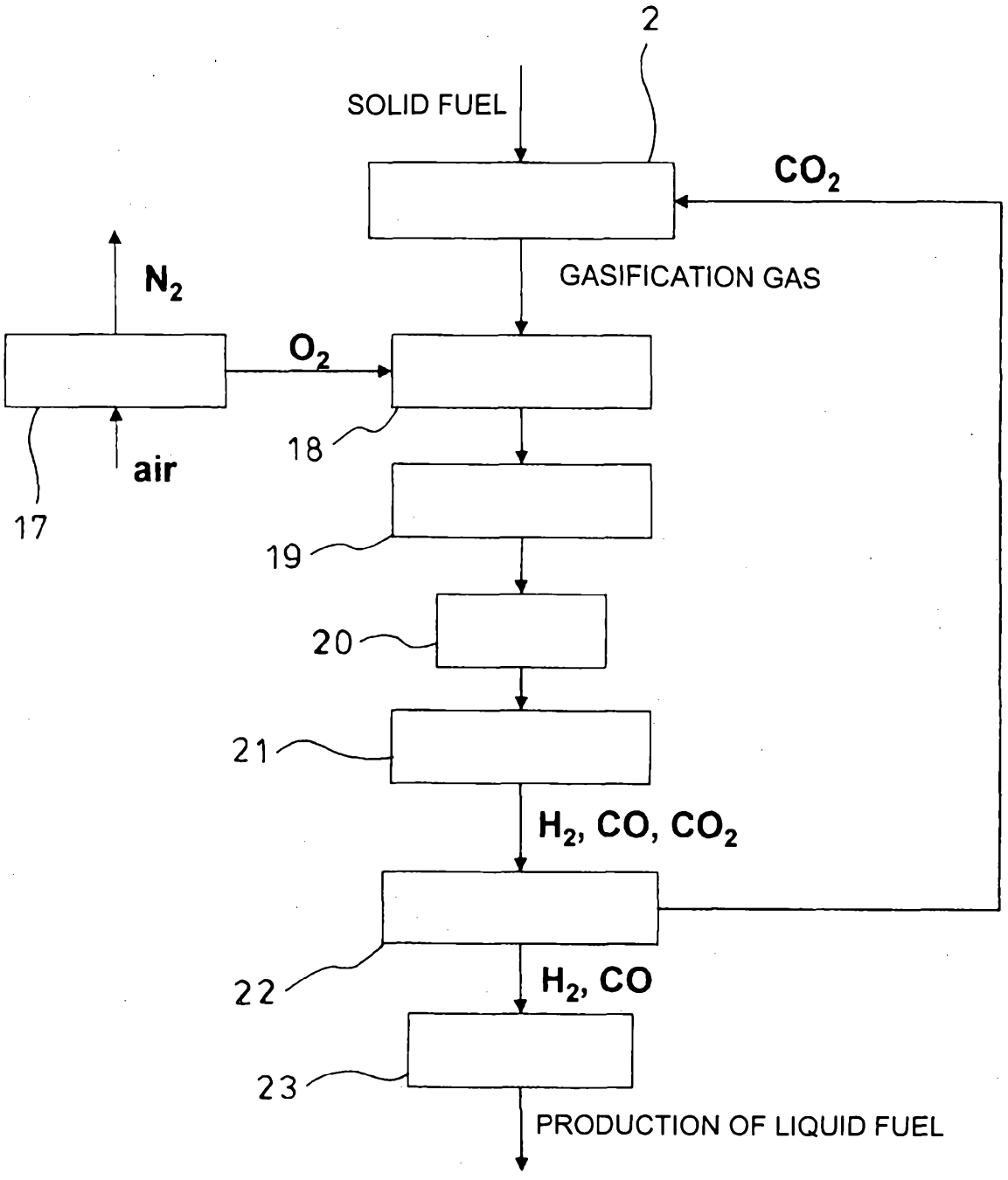

14
15
SOLID FUEL
(SUCH AS COAL
OR BIOMASS)
16
7
BED MATERIAL
(SUCH AS SILICA SAND
OR LIMESTONE)
11
STEAM
GASIFICATION GAS
1
12
2
3
BED MATERIAL
(INCLUDING
FLAMMABLE
SOLID CONTENT)
FLUIDIZING REACTION GAS
(AIR OR OXYGEN)

FIG. 3


2
SOLID FUEL
$CO_2$
$N_2$
GASIFICATION GAS
$O_2$
18
air
17
19
20
21
$H_2$, CO, $CO_2$
22
$H_2$, CO
23
PRODUCTION OF LIQUID FUEL

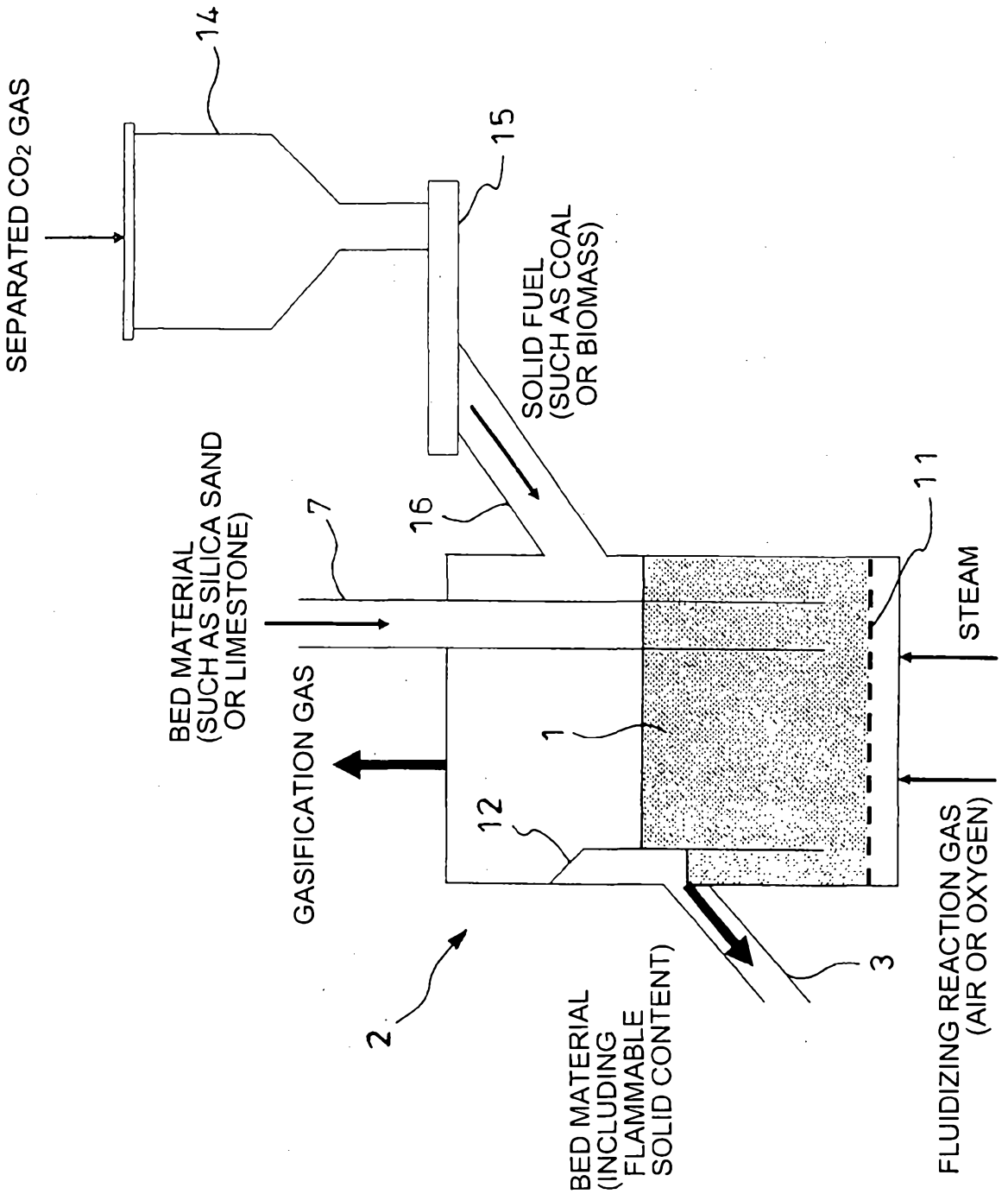

SEPARATED $CO_2$ GAS
14
15
SOLID FUEL
(SUCH AS COAL
OR BIOMASS)
16
7
BED MATERIAL
(SUCH AS SILICA SAND
OR LIMESTONE)
11
STEAM
GASIFICATION GAS
1
12
2
BED MATERIAL
(INCLUDING
FLAMMABLE
SOLID CONTENT)
3
FLUIDIZING REACTION GAS
(AIR OR OXYGEN)

FIG. 4

FIG. 5

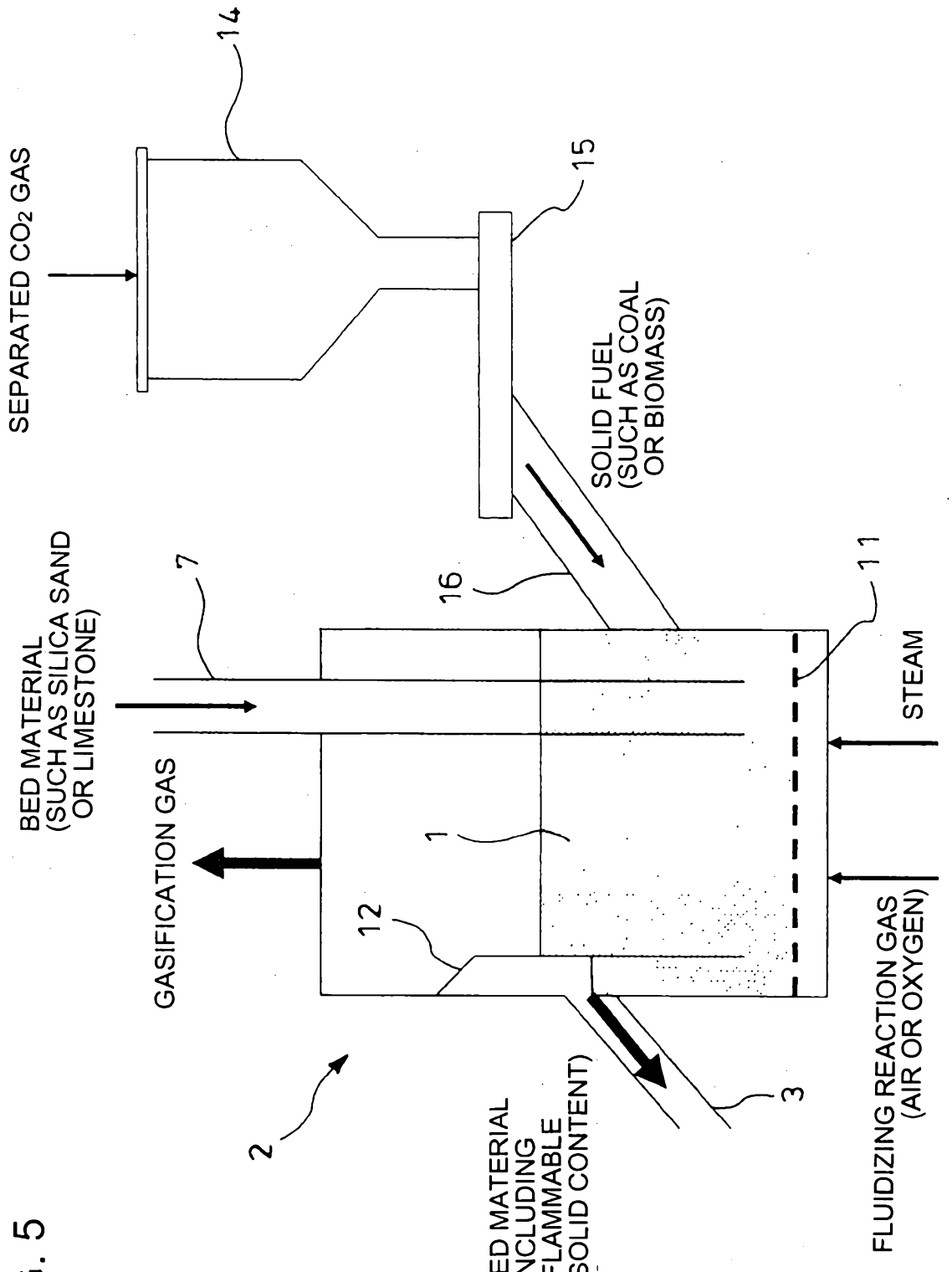

SEPARATED $CO_2$ GAS
14
15
SOLID FUEL
(SUCH AS COAL
OR BIOMASS)
16
7
BED MATERIAL
(SUCH AS SILICA SAND
OR LIMESTONE)
11
STEAM
GASIFICATION GAS
1
12
2
BED MATERIAL
(INCLUDING
FLAMMABLE
SOLID CONTENT)
3
FLUIDIZING REACTION GAS
(AIR OR OXYGEN)

FIG. 6

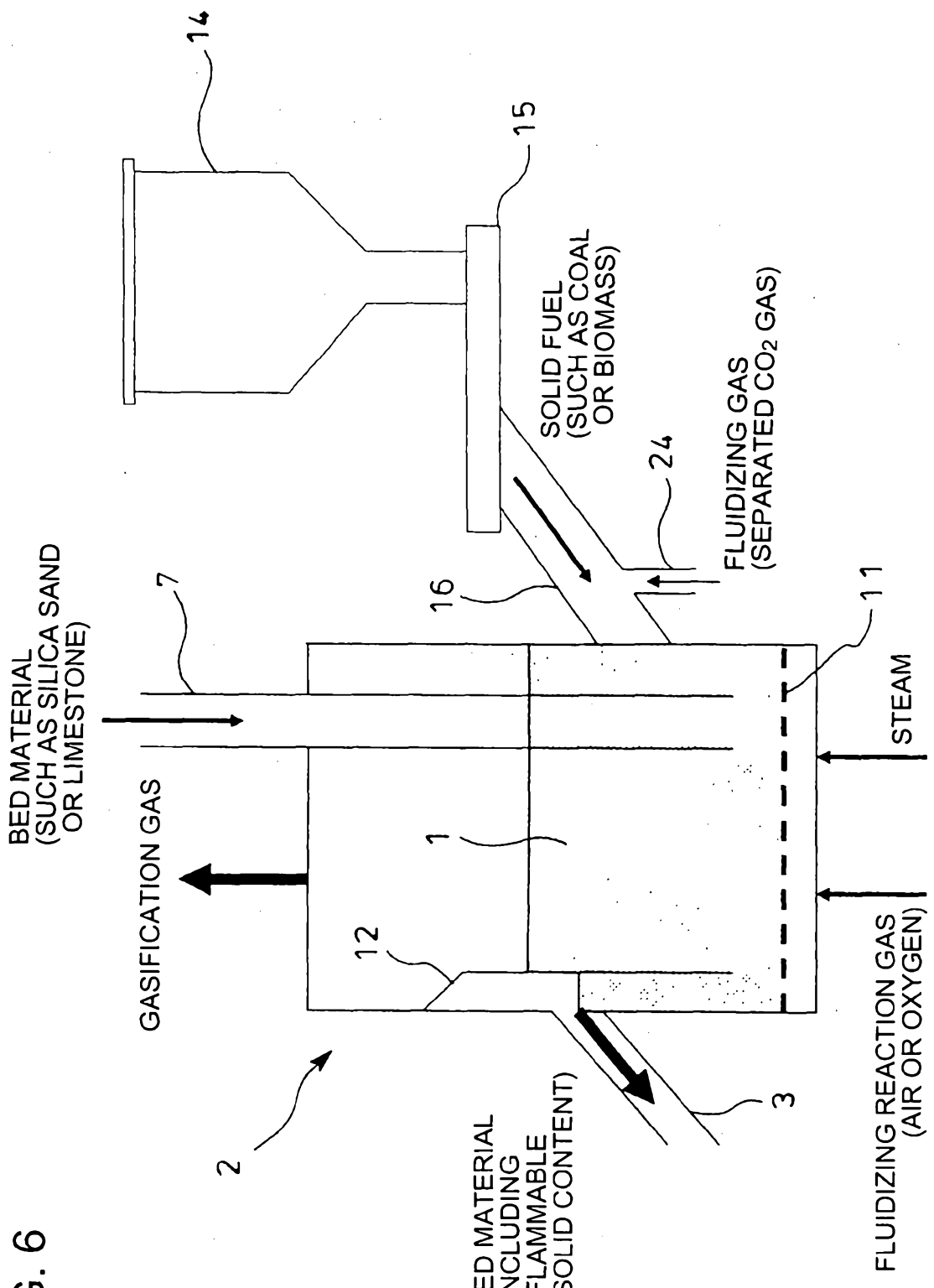
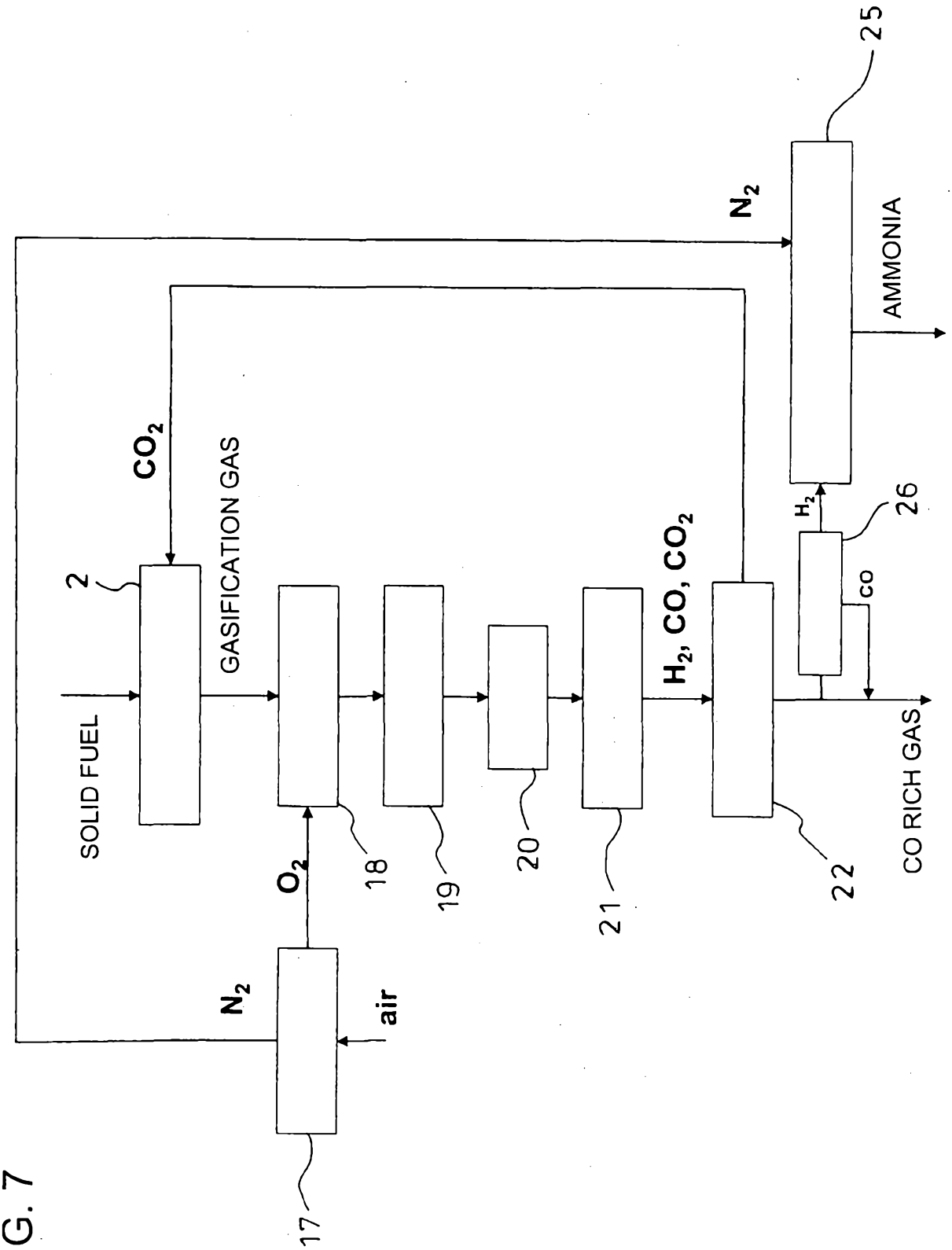

14
15
SOLID FUEL
(SUCH AS COAL
OR BIOMASS)
24
FLUIDIZING GAS
(SEPARATED $CO_2$ GAS)
16
11
7
BED MATERIAL
(SUCH AS SILICA SAND
OR LIMESTONE)
STEAM
GASIFICATION GAS
1
12
2
3
BED MATERIAL
(INCLUDING
FLAMMABLE
SOLID CONTENT)
FLUIDIZING REACTION GAS
(AIR OR OXYGEN)

FIG. 7


SOLID FUEL
2
$CO_2$
GASIFICATION GAS
$O_2$
$N_2$
air
17
18
19
20
21
$H_2$, CO, $CO_2$
22
CO RICH GAS
CO
$H_2$
26
$N_2$
25
AMMONIA