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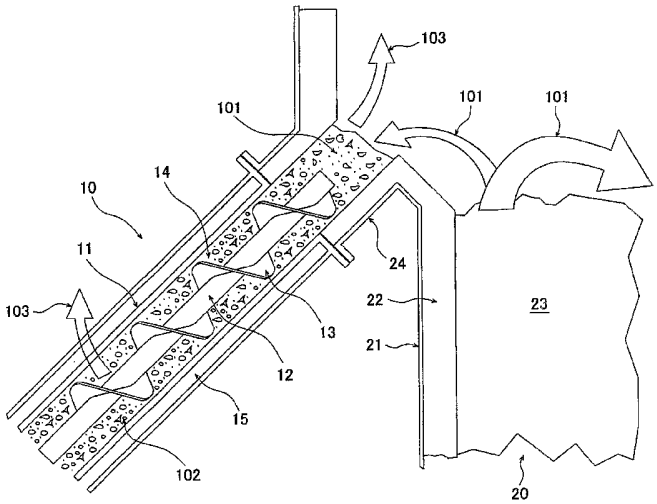

(57) Abstract: To provide a supplying apparatus for supplying a combustible material capable of enhancing the sealing effects of a supplying system for supplying a combustible material, such as combstible wastes, to a fluidized.bed chamber, stably supplying a combustible material having and undefined shape, and reducing cost for installation; and further to provided a facility for gasifying a combustible material using the supplying apparatus for supplying a combustible material; and further to provide a method of gasifying combustible materials. A supplying apparatus for suplying a combustible material 102 onto the fluidized bed 23 of a fluidized-bed gasifier chamber or a fluidized-bed combustion chamber 20, wherein a screw conveyor 10 is provided to be inclined, with transportation of the combustible material directed upward, at an angle of 20 degrees or more and 80 degrees or less with respect to the horizontal plane, causing a bed material 101 to flow into a conveyor casing 11 of the screw conveyor 10 to fill.

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DESCRIPTION

A SUPPLYING APPARATUS FOR SUPPLYING COMBUSTIBLE MATERIAL, A GASIFICATION APPARATUS FOR GASIFYING COMBUSTIBLE MATERIAL AND METHOD FOR GASIFYING COMBUSTIBLE MATERIAL

TECHNICAL FIELD

The invention relates to a supplying apparatus for supplying a combustible material to a fluidized-bed gasifier chamber or a fluidized-bed combustion chamber, a gasification apparatus for gasifying a combustible material and a method for gasifying combustible materials in a fluidized-bed gasifier chamber or a fluidized-bed combustion chamber for use in a facility for gasifying or incinerating combustible materials such as municipal wastes, industrial wastes, waste plastic, biomass (thinned plants, wood chips, construction scrap wood, sludge, etc.), coal, RDF, wastes of high water contents, and the like.

BACKGROUND ART

In recent years, a gasification and slagging combustion method has been employed as a treatment method of combustible wastes such as various wastes. In the gasification and slagging combustion method, combustible wastes are pyrolyzed and gasified. If the amount of oxygen supplied is larger than a required amount of oxygen, then the combustible wastes are excessively combusted to increase the temperature of a furnace. In such a case, stable operation may be inhibited. Thus, it has been desired to strictly manage the amount of air to be supplied.

However, a treatment system of combustible wastes is generally operated at a pressure lower than an atmospheric pressure in many cases in order to prevent ejection of a gas. Accordingly, the treatment system is problematic in that the system cannot sufficiently prevent leak of air from a waste supplying system, which supplies combustible wastes into a furnace.

Although a mechanical device such as a sealing valve has been used to prevent leak of air, such a mechanical device has problems such as engagement into a sealing portion and generation of bridge at a sealing portion because of undefined shapes of wastes. Thus, it has practically been difficult to provide a sealing system to achieve stable operation.

As described above, there has been attempted in recent years to gasify combustible wastes into a generated gas without complete combustion, then purify the generated gas, and utilize the purified gas as a raw material. In such a case, if unnecessary air flows into the generated gas, then the quality of the generated gas is degraded. Therefore, there has been desired a system which can stably supply combustible wastes having undefined shapes and minimize leak of air.

This invention has been made in view of the problems described above. It is therefore an object of the invention to provide: a combustible material supplying apparatus capable of enhancing the sealing effects of a supplying system for supplying a combustible material, such as combustible wastes, to a fluidized-bed chamber, stably supplying a combustible material having an undefined shape, and reducing cost for installation; and further provide a facility for gasifying a combustible material using the combustible material supplying apparatus; and further provide a method of gasifying combustible materials.

DISCLOSURE OF THE INVENTION

In order to achieve the above object, as shown in FIG. 1 for example, an aspect of the present invention is a supplying apparatus 10 for supplying a combustible material 102 to an upper portion of a fluidized bed 23 of a fluidized-bed gasifier chamber or a fluidized-bed combustion chamber 20 comprising, a hopper configured to store a combustible material 102 ,and a mechanical supplying apparatus configured to supply a combustible material 102 from said hopper to said fluidized-bed gasifier chamber or said fluidized-

bed combustion chamber 20 through a flow passage of the combustible material with a flow line directed upward, inclined at an angle of 20 degrees or more and 80 degrees or less with respect to a horizontal plane.

Since, as described above, the supplying apparatus for supplying a combustible material comprises a mechanical supplying apparatus configured to supply a combustible material from the hopper to the fluidized-bed gasifier chamber or the fluidized-bed combustion chamber through a flow passage of the combustible material with a flow line directed upward, inclined at an angle of 20 degrees or more and 80 degrees or less with respect to a horizontal plane, the position where the combustible material is supplied can be lowered. For example, the height of a building in which the facility with the supplying apparatus for supplying a combustible material is installed can be reduced by a lowered position of the material supplying means such as a waste crane.

In one aspect of the present invention, as shown in FIG. 1 for example, the mechanical supplying apparatus comprises a conveyor 10 having a rotating helical vane 13 configured to supply combustible material 102 by means of a rotational action of rotating helical vane 102.

Since, as described above, the mechanical supplying apparatus is so called a screw conveyor or a spiral conveyor in which a helical vane is rotated, a combustible material is forced upward and supplied. As a result, it is possible to achieve high material sealing effects especially by filling the conveyor casing with a bed material to promote crushing of a raw material, which prevents both the leak of air into the chamber and the leak of a gas out of the chamber.

In another aspect of the present invention, as shown in FIG. 6 for example, the conveyor 10 has a plurality of helical vanes 13 disposed generally in parallel.

Since, as described above, the conveyor has two or more helical vanes disposed generally in parallel, crushing of a raw material is promoted especially by filling the conveyor casing with a bed material.

In another aspect of the present invention, as shown in FIG. 3 for example, a conveyor casing 11 to contain the helical vane 13, and the conveyor casing 13 has a projection 111 on the inner surface of the conveyor casing 11, and the projection is figured to maintain the efficiency of transportation.

In such a configuration, the combustible material does not rotate together with the rotating helical vanes. The combustible material therefore is not remained in a position and securely forced upward.

In another aspect of the present invention, as shown in FIG. 1 for example, the supplying apparatus 10 for supplying a combustible material further comprises a medium supplying apparatus configured to supply medium 101 to the mechanical supplying apparatus, and the inside of the mechanical supplying apparatus is stuffed with the medium 101 to prevent gas communication therein.

In such a configuration, medium for preventing gas communication is filled by the medium supplying apparatus. It is therefore possible to promote crushing of a raw material, suppress the variation of the amount of a combustible material to be supplied and achieve high material sealing effects.

In another aspect of the present invention, as shown in FIG. 4 for example, the medium supplying apparatus further comprises a flow passage 16 of medium 101 not being identical to the flow passage of combustible material 102.

In such a configuration, the medium is securely supplied to the mechanical supplying apparatus through the flow passage of the medium to fill it with the medium.

An aspect of the present invention is, as shown in FIG. 8 for example, a gasification apparatus for gasifying a combustible material 102 comprises a supplying apparatus 10 for supplying a combustible material according and a fluidized-bed gasifier chamber 30 supplied with a combustible material 102 from the supplying apparatus 10 for supplying a combustible material.

Since, as described above, the supplying apparatus for supplying a

combustible material is a mechanical supplying apparatus configured to supply a combustible material from said hopper to said fluidized-bed gasifier chamber or said fluidized-bed combustion chamber through a flow passage of the combustible material with a flow line directed upward, inclined at an angle of 20 degrees or more and 80 degrees or less with respect to a horizontal plane, the height of a building in which the gasification apparatus for gasifying a combustible material is installed can be reduced.

An aspect of the present invention is, as shown in FIG. 9 for example, the gasification apparatus for gasifying a combustible material 102 comprises a supplying apparatus 10 for supplying a combustible material 102, a fluidized-bed gasifier chamber 60 configured to gasify combustible material 102 supplied to by supplying apparatus 10 for supplying a combustible material, and a bypass line configured to bypass gasifier chamber 60 to lead a gas 103 generated from the combustible material 102 in supplying apparatus 10 for supplying a combustible material.

Since, as described above, there is provided a bypass line which bypasses gasifier chamber to lead a gas generated from the combustible material in the supplying apparatus for supplying a combustible material, to the downstream of the gasifier chamber, it is possible to suppress the variation of the amount of the gas generated in the gasifier chamber and also possible to securely treat the gas generated in the supplying apparatus for supplying a combustible material with no leak of the gas outside.

Another aspect of the present invention is, as shown in FIG. 8 for example, the gasification apparatus for gasifying a combustible material comprises a supplying apparatus 10 for supplying a combustible material 102, and a fluidized-bed gasifier chamber 30 configured to gasify combustible material 102 supplied to by supplying apparatus 10 for supplying a combustible material 102, wherein at least one of moisture and volatile matter is vaporized from the combustible material 102 within supplying apparatus 10 for supplying a combustible material 102.

Since, as described above, moisture and volatile matter is vaporized from the combustible material within the supplying apparatus for supplying a combustible material and then the combustible material from which the moisture and volatile matter was vaporized is supplied to the fluidized-bed gasifier chamber, it is possible to suppress the variation of the amount of the gas generated in the gasifier chamber and also suppress the variation of the moisture therein.

In one aspect of the present invention, as shown in FIG. 9 for example, the gasification apparatus for gasifying a combustible material further comprises a bypass line configured to bypass gasifier chamber 60 to lead at least one of moisture and volatile matter 103 vaporized in supplying apparatus 10 for supplying a combustible material 102, to the downstream of gasifier chamber 60.

Since, as described above, the moisture and volatile matter vaporized in supplying apparatus for supplying a combustible material bypasses the fluidized-bed gasifier chamber and is led to the downstream of the fluidized-bed gasifier chamber, it is possible to securely treat the gas generated in the supplying apparatus for supplying a combustible material with no leak of the gas outside.

Another aspect of the present invention is, as shown in FIG. 9 for example, a method for gasifying a combustible material 102 in a fluidized-bed gasifier chamber or a fluidized-bed combustion chamber 60, comprises the steps of storing combustible material 102 in a hopper 40, supplying combustible material 102 upwardly from hopper 40 to fluidized-bed gasifier chamber or said fluidized-bed combustion chamber 60 by a mechanical supplying apparatus, to enhance a material sealing function of apparatus by filling inside with medium 101 which constitutes a fluidized-bed 62, and gasifying combustible material 102 supplied to fluidized-bed gasifier chamber or said fluidized bed combustion chamber 60 by the mechanical supplying apparatus.

Since, as described above, the combustible material is supplied

upwardly by the mechanical supplying apparatus and then a bed material is filled in he mechanical supplying apparatus, it is possible to promote crushing of the combustible material and suppress the variation of the amount of the combustible material to be supplied. Furthermore, the combustible material can be gasified while achieving high material sealing effects.

Another aspect of the present invention is, as shown in FIG. 1 for example, a supplying apparatus 10 for supplying a combustible material 102 to a fluidized-bed gasifier chamber or a fluidized-bed combustion chamber 20 comprises a hopper configured to store a combustible material 102, and a mechanical supplying apparatus configured to supply a combustible material 102 from the hopper to the fluidized-bed gasifier chamber or said fluidized-bed combustion chamber 20 through a flow passage of the combustible material with a flow line directed upward, wherein combustible material 102 is supplied together with a medium 101 to prevent gas communication through mechanical supplying apparatus.

Since, as described above, the combustible material is supplied together with a medium to prevent gas communication by supplying apparatus 10 for supplying a combustible material with a flow line directed upward, a mixture of the combustible material and the medium to prevent gas communication is transported, resulting in a supplying apparatus for supplying a combustible material having high material sealing effects.

This application is based on the patent application No. JP-2003-125695, filed on April 30, 2003 in Japan, the content of which is incorporated herein, as part thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view, showing an example of a supplying apparatus for supplying a combustible material according to the invention;

FIG. 2 is a graph, showing an example of the relation between the angle of inclination and the efficiency of transportation, both of a screw conveyor;

FIG. 3 shows an example of a projection which is provided on the inner face of a conveyor casing in which a helical vane is contained, in order for maintaining the efficiency of transportation;

FIG. 4 is a schematic view, showing an example of a supplying apparatus for supplying a combustible material according to the invention;

FIG. 5 is a schematic view, showing an example of a supplying apparatus for supplying a combustible material according to the invention;

FIG. 6 shows an example of a screw conveyor for use in a supplying apparatus for supplying a combustible material according to the invention;

FIG. 7 shows an example of a spiral conveyor for use in a ca supplying apparatus for supplying a combustible material according to the invention;

FIG. 8 is a schematic diagram, showing an example of an incineration facility having a supplying apparatus for supplying a combustible material according to the invention and a fluidized-bed incineration chamber;

FIG. 9 is a schematic view, showing an example of a gasification and slagging combustion facility having a supplying apparatus for supplying a combustible material according to the invention and a fluidized-bed gasifier chamber;

FIG. 10 is a schematic view, showing an example of a gasification reforming facility having a supplying apparatus for supplying a combustible material according to the invention;

FIG. 11 is a schematic view, showing an example of a low-temperature gasification reforming facility having a supplying apparatus for supplying a combustible material according to the invention;

FIG. 12 is a schematic view, showing an example of a gas reforming facility having a supplying apparatus for supplying a combustible material according to the invention and an integrated fluidized-bed gasifier chamber;

FIG. 13 is a schematic view, showing an example of an advanced gasification and slagging combustion facility having a supplying apparatus for supplying a combustible material according to the invention; and

FIG. 14 is a flow chart explanatory of effects of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The above and other objects, features, and advantages of the invention will be apparent from the following description when taken in conjunction with the accompanying drawings which illustrate preferred embodiments of the invention by way of example.

FIG. 1 is a schematic view, showing an example of a supplying apparatus for supplying a combustible material of the invention. In FIG. 1, the hopper to store the combustible material is omitted for simplifying the illustration. The reference numeral 20 denotes a chamber such as a fluidized-bed gasifier chamber or a combustion chamber. The chamber 20 has a chamber casing 21, a fire-resistant layer 22 disposed inside of the chamber casing 21, and a fluidized bed 23 in which a bed material 101 is fluidized. The reference numeral 10 denotes a screw conveyor serving as a supplying apparatus for supplying a combustible material including combustible wastes or the like into the chamber 20. The combustible material includes municipal wastes, industrial wastes, waste plastic, biomass (thinned plants, wood chips, construction scrap wood, sludge, etc.), coal, RDF, wastes of high water contents, where the biomass and wastes of high water contents are known as materials not to provide high material sealing effects. A supplying apparatus for supplying a combustible material according to the present inventions, however, enables to achieve high material sealing effects of the biomass and wastes of high water contents as well as the other combustible materials.

The screw conveyor 10 has a cylindrical conveyor casing 11, a screw 14 disposed within the conveyor casing 11, and a steam jacket 15 provided around the conveyor casing 11. The screw 14 has a rotational shaft 12 and a helical vane 13 attached thereto. The screw conveyor 10 is inclined at an angle of 20 degrees or more and 80 degrees or less with respect to the horizontal plane so that a flow line of the flow passage of the combustible material is directed

upward at the same angle of the screw conveyor 10. Thus, transportation by the screw conveyor 10 is directed upward. The conveyor casing 11 has an end connected to a raw material supply port 24 of the chamber 20. The screw 14 has an end inserted into the raw material supply port 24.

The raw material supply port 24 is located above the fluidized bed 23, i.e. above an surface of a dense fluidized bed. When the screw 14 of the screw conveyor 10 is rotated, a combustible material 102 is supplied through the raw material supply port 24 to the chamber 20 above the surface of the dense fluidized bed. A high-temperature bed material 101 ejected from the fluidized bed 23 flows through the raw material supply port 24 into the conveyor casing 11 of the screw conveyor 10, and the inside of the conveyor casing 11 is filled with the high-temperature bed material 101. Specifically, the entire inside of the conveyor casing 11 is filled with the high-temperature bed material 101 in a clearance between the screw 14 and the conveyor casing 11.

As described above, the inside of the conveyor casing 11 is filled with the combustible material 102 and the bed material 101 to achieve material sealing effects. In other words, the bed material 101, which is smaller than the combustible material 102, enters spaces formed in the combustible material 102 to enhance material sealing effects. The material sealing effects means a function of the combustible material 102 and the bed material 101 to prevent a gas communication under condition of being not complete airtight, but not easy for a gas to communicate even if there exists more or less gas communication. A gas includes air, moisture(vaporized water), combustible gas and combustion gas. A medium having a function to prevent gas communication is, for example, a fine particle material, such as bed material 101, having an average particle diameter of 1 mm or smaller, or a sludged material containing moisture. As a fine particle material, the bed material 101 which forms the fluidized bed 23 is preferable. Use of the bed material 101 prevents a different material from mixing in the fluidized bed 23 and does not require to provide any other material as a medium to prevent gas communication. The bed material 101

may be introduced through the raw material supply port 24 from the fluidized bed 23. Alternatively, if the bed material supplying port 16 (see FIG. 4) is provided at the conveyor casing 11, as described later, then the bed material 101 may be introduced directly from the fluidized bed 23 or may be introduced from the apparatus for processing incombustible extracting 51 (see FIG. 8) through a piping as a flow passage of the bed material 101. Introduction from the apparatus for processing incombustible extracting 51 (FIG. 8) provides the bed material 101 having a lower temperature. Further, in a flow passage from the apparatus for processing incombustible extracting 51 (see FIG. 8) to the conveyor casing 11 may be additionally disposed a device for lowering the temperature of the bed material 101. Fly ash 55 (see FIG. 8) recovered in treatment of gas emission may be used as fine particle material. The fly ash 55 is generally finer particles and therefore enhances material sealing effects. Alternatively, silica sands may be also supplied outside of a system. A sludge produced in a sewage treatment plant may be used as sludged material. Use of the sludge as a medium to prevent gas communication enhances the material sealing effects of the combustible material supplying apparatus 10 and allows to treat the sludge.

Material sealing effects of supplied small and large cakes of a combustible material may be enhanced by setting small cakes of a combustible material(co-fuel, etc.) into the space among large cakes of a combustible material. For example, a combustible material crashed to a cake with a diameter of about 30 cm by a reciprocation crushing machine, or that crashed to a cake with a diameter of about 15 cm by a rotating crashing machine may be supplied as large cakes, where biomass(chips, chaffs, wooden pellets, granulated sludge, etc.) with a diameter of about 5 cm or smaller, RDF, other wastes pressed and formed, and the like may be supplied as small cakes, resulting in the aforementioned material sealing effects.

Since the screw conveyor 10 is inclined at an angle 20 degrees or more and 80 degrees or less with respect to the horizontal plane so that

transportation by the screw conveyor 10 is directed upward, the bed material 101 flows into the conveyor casing 11. Thus, a ratio of filling in the conveyor casing 11 is increased. Correspondingly, the resistance to flow of a gas is increased so as to prevent a gas from leaking out from the screw conveyor 10 as a part of a combustible material supplying system into the chamber 20. Specifically, it is possible to prevent air from leaking out from the exterior of the chamber to the interior of the chamber. The angle of the screw conveyor 10 is preferably 30 degrees or larger, more preferably 40 degrees or larger. Increase of the angle increases the ratio of filling and further increases the material sealing effects. Meanwhile, the angle of screw conveyor 10 is preferably 60 degrees or smaller, more preferably 50 degrees or smaller. By limiting the angle of the screw conveyor 10 so as not to be excessively large, there occurs no interference between the screw conveyor 10 and the chamber casing 21. Additionally, the efficiency of transportation of the screw conveyor 10 can be prevented from degradation. However, when the bed material 101 is filled for the purpose of increase in the material sealing effects, then the angle of the screw conveyor 10 may be a predetermined angle out of the range defined above.

Now, in FIG. 2, a relation between the angle of inclination and the efficiency of transportation, of the combustible material supplying apparatus 10 is described. FIG. 2 is a graph, showing a result of a measurement for the efficiency of transportation by using sand as an article to be transported, in which the angle of inclination of the screw conveyor 10 with respect to a horizontal plane varies, for each of different clearances between the outermost edge of the helical vane 13 (see FIG. 1) and the inner face of the conveyor casing 11. The reduction in the efficiency of transportation is less when the angle of inclination is approximately up to 45 degrees. When the angle exceeds 45 degrees, especially 60 degrees, the efficiency is reduced considerably. Beyond 75 degrees, the efficiency becomes near zero. It is believed that the reduction of the efficiency of transportation with the increase of the angle of inclination is

caused by the reduction of friction between the article to be transported and the inner face of the conveyor casing 11 to rotate the article together with the helical vane 13 and thus the article is not pushed out in the axial direction.

Accordingly, as shown in FIG. 3, in the inner face of the conveyor casing as a shell for containing the helical vane 13 of the screw conveyor 10 may be provided with a projection 111 for preventing the combustible material 102 and the bed material 101 from rotating together with the helical vane 13. Rotation of the transported article(the combustible material 102 and the bed material 101) accompanying the helical vane 13 is disturbed by the projection 111, or the clearance formed between the helical vane 13 and the projection 111 is diminished. Thus, rotation of the transported article around the rotary shaft 12(so called co-rotation) is disturbed. In such a manner, since the rotation of the transported article accompanying the helical vane 13 is prevented, the transported article is axially moved by rotation of the helical vane 13 and securely pushed upward, resulting in maintaining the efficiency of transportation. That is, the reduction of the efficiency of transportation is prevented. The clearance between the helical vane 13 and the projection 111 is set 50 mm or less, preferably 20 mm or less, more preferably 5 mm or less. A preferable projection 111 has a shape continuously straightened in the longitudinal direction of the conveyor casing 11 in view of manufacturability and smaller friction in the direction of transportation. The projection 111 may composed of a plurality of short projections linearly spaced each other. The projection 111 may be arranged helically or randomly. Although two projections 111 are shown in FIG. 3, the number of the projection may be one and three or more.

As described above, since the raw material supply port 24 in fluid communication with the end of the conveyor casing 11 of the screw conveyor 10 is located above the surface of the dense fluidized bed, a bed material 101 ejected from the fluidized bed 23 flows through the raw material supply port 24 into the conveyor casing 11. However, a pressure of the fluidized bed 23 is not

applied to the interior of the screw conveyor 10. A gas in the chamber 20 is therefore prevented from flowing through the screw conveyor 10 in a reverse direction and from leaking out of the chamber 20.

The height and an opening angle of the raw material supply port 24, the height of the fluidized bed 23, and a fluidized state in the fluidized bed 23 are properly determined so that the bed material 101 ejected in the fluidized bed 23 due to fluidization is likely to flow into the conveyor casing 11. Thus, the raw material supply port is used as a part of the medium supplying apparatus which transports the bed material 101 into the screw conveyor casing 11.

Now, the constitution of the fluidized bed 23 is described. The fluidized bed 23 is composed of a dense fluidized bed which is located a vertically lower portion of the fluidized bed 23 and densely contains the bed material 101 (silica sands, for example) fluidized by a fluidizing gas, and a splash zone, existing vertically above the dense fluidized bed. In the splash zone the bed material 101 splashes vigorously. Above the fluidized bed 23, that is, above the splash zone is provided a freeboard which mainly containing a gas and merely contains the bed material 101.

If the raw material supply port 24 is disposed in a stationary bed (a range where the bed material 101 is placed during no fluidizing), then a pressure (so called counter pressure) produced by the weight of the bed material 101 acts on the inside of the screw conveyor 10. As a result, the screw conveyor 10 exposed with the counter pressure supplies the combustible material, which requires a large amount of energy to supply, otherwise the fluidized material 102 and the bed material 101 may be forced to flow back. Notwithstanding, the combustible material 102 is quantitatively supplied into the chamber casing 21 through the raw material supply port 24 because there exists a large amount of the bed material 101 around the raw material supply port 24, resulting in a high scraping effect. The screw conveyor 20 is charged with a large amount of bed material 101 ejected therein. When the screw conveyor 10 having an opening angle through which the bed material 101 ejects

into the screw conveyor 10 is inclined, for example, as shown in FIG. 1, larger amount of bed material 101 ejects into and falls on the screw conveyor 10. The angle of inclination is preferably between 30 and 60 degrees, also depending on different operation states.

If the raw material supply port 24 is installed on the freeboard 33 (see FIG. 8) above the splash zone, where no bed material 101 exists, then scraping effect and ejection of the bed material 101 into the screw conveyor 10 are scarcely expected because there exists no bed material, though there exists no counter pressure because of a negative pressure at the region.

If the raw material supply port 24 is installed in the upper portion of the dense fluidized bed, then the counter pressure is lower and a large amount of bed material 101 ejects into the screw conveyor 10. Further, if the bed material 101 is circling in the chamber 20, then a high scraping effect is expected and the combustible material is quantitatively supplied into the chamber casing 21 from the raw material supply port 24. If the raw material supply port 24 is installed in the splash zone, then no counter pressure exists and a large amount of the bed material 101 ejects into the screw conveyor 10.

The screw conveyor 10 is subjected to a humid and reducing atmosphere, i.e. a severely corrosive environment. Therefore, the conveyor casing 11 and the screw 14 are required to be heated so as to maintain their temperatures. In the illustrated example, steam is introduced into the steam jacket 15 provided around the conveyor casing 11 so as to maintain temperatures of the conveyor casing 11 and the screw 14. Thus, it is possible to prevent dew condensation and low-temperature corrosion on an inner surface of the conveyor casing 11. It is desirable that a tip end of the screw 14 is replaceable, or is subjected to surface treatment such as thermal spraying if needed.

In the conveyor casing 11 of the screw conveyor 10, the combustible material 102 and the high-temperature bed material 101 are brought into contact with each other so as to promote loosen of the combustible material. Accordingly, a mass of the combustible material 102 for an instance is

prevented from falling down onto the chamber 20. It is therefore possible to prevent the variation of the amount of combustible material 102 and pressure in the chamber 20. When the combustible material 102 and the high-temperature bed material 101 are brought into contact with each other, moisture in the combustible material 102 is evaporated, and volatile matter in the combustible material 102 is pyrolyzed, to thereby generate steam and a pyrolysis gas 103. A portion of the steam (water vapor) and pyrolysis gas 103 flows through the raw material supply port 24 into the chamber 20 and further flows downstream through a freeboard, which is located at an upper portion of the fluidized bed 23. Near the material supply port 24 where the high temperature bed material 101 is injected, the combustible material 102 and the high temperature bed material 101 are brought in contact with each other to generate a gas. As described above, the combustible material 102 and the bed material 101 are provided with material sealing effects. Accordingly, the generated gas does not pass through the upstream side of the screw conveyor 10 but flows in the chamber 20.

It is desirable that the steam and pyrolysis gas 103 generated at an upstream portion of the conveyor casing 11, i.e., on the upstream of the raw material supply port 24, is extracted so as not to flow in a reverse direction and is introduced into a gas passage prior to heat recovery. With this modification, the steam and pyrolysis gas 103 can be prevented from leaking out of the screw conveyor 10 and processed certainly.

This modification is shown in FIG. 4, which is a schematic view, showing an example of a combustible material supplying apparatus according to the invention. In FIG. 4, like or corresponding parts are designated by the same reference numerals as in FIG. 1 and will not be described repetitively. The combustible material supplying apparatus shown in FIG. 4 has a bed material supply port 16 for supplying a bed material 101 from a bed material circulation line, which will be described later, into the conveyor casing 11 of the screw conveyor 10, and a gas extracting port 17 for extracting steam and a

pyrolysis gas 103. The gas extracting port 17 is located upstream of the bed material supply port 16. Thus, the steam and pyrolysis gas 103 generated in the conveyor casing 11 are prevented from flowing in the reverse direction and can be introduced into a gas passage prior to heat recovery process. Accordingly, the steam and pyrolysis gas 103 can be prevented from leaking out of the screw conveyor 10 and processed certainly.

The bed material 101 supplied from the chamber 20 is preferable as a medium to be supplied through the bed material supply port 16. The bed material 101 of 300°C or more vaporizes moisture and pyrolyzes volatile matter to generate steam and pyrolysis gas. A bed material of 350°C or more is preferable for securely producing a gas. Also, a bed material of 100°C or more can vaporizes moisture to generate steam. In such a manner, moisture and volatile matter is vaporized from a combustible material 102 in the screw conveyor 10 and then the combustible material 102 from which moisture and volatile matter was vaporized is supplied to the chamber 20. Therefore, sharp increase, that is, variation of the amount of gas generated from the supplied combustible material 102 in the chamber 20 is suppressed and the moisture within the chamber 20 can be also suppressed. Further, the gas generated in the screw conveyor 10 is extracted through a gas extracting port 17 and then directly fed to a subsequent stage apparatus resistant to the variation of gas pressure with bypassing the chamber 20, to thereby suppress variation of the amount of gas within the chamber 20 and to achieve stable operation of the chamber 20. Any medium having incombustiblity resistant to high temperature other than the bed material 101 may be used.

The medium supplied through the fluid medium supply port 16 is not required to be high temperature. In such a case, moisture is not vaporized, volatile matter is not pyrolyzed, and therefore both steam and pyrolysis gas cannot be generated. Nevertheless, this medium still retains the same mechanical effects as of a high temperature bed material and also a function as a medium to prevent gas communication, in other words, material sealing

effects. Additionally, existence of a medium suppresses entwinement and adhesion of the combustible material 102 to the vane 13 or the like, and achieves appropriate mixing of the combustible material 102 by shearing force generated between the medium and the combustible material 102, thereby to improve quantitative property of the combustible material to be transported. Since any steam and pyrolysis gas are not generated, the fluidized material supply port 16 is provided but not the gas extracting port 17. Further, any particle material, such as mixed fuel and auxiliary fuel other than incombustible material, such as sands may be used and combusted in the chamber 20.

As shown in FIG. 5, the bed material supply port 16 may be provided upstream of the gas drawing port 17. This arrangement is preferable to make difficult for air to flow to the gas drawing port 17 from the combustible material supply port (not shown) which forms the upstream end of the screw conveyor 10. However, if high temperature bed material 101 is used, then a gas is generated by contact of the bed material 101 supplied through the bed material supply port 16 with the combustible material 102 and the generated gas is likely to flow outside through the combustible material supply port (not shown). It is therefore preferable to shorten the distance between the gas extracting port 17 and the bed material supply port 16 for securing leading the generated gas to the gas extracting port 17.

As shown in FIG. 4, it is preferable to provide the gas extracting port 17 upstream of the bed material supply port 16 since, even if a gas is generated by contact of the bed material 101 supplied through the bed material supply port 16 with the combustible material 102, the generated gas is introduced to the gas extracting port 17 located nearer than the combustible material supply port (not shown). It is therefore preferable to lengthen the distance between the gas extracting port 17 and the combustible material supply port (not shown) to prevent air from flowing in since air is apt to flow into the gas extracting port 17 from the combustible material supply port (not shown).

In the described embodiments of the combustible material supplying apparatus, the screw conveyor 10 has a screw 14 including a rotational shaft 12 and a helical vane 13 attached thereto. However, the screw conveyor 10 is not limited to those embodiments. As shown in FIG. 6, the screw conveyor 10 may have two screws 14 generally disposed in parallel each other. Alternatively, the screw conveyor 10 may have three or more screws disposed generally in parallel each other. With a plurality of screws, the screw conveyor 10 can convey a large raw material and promote crushing of a combustible material 102.

The combustible material supplying apparatus in the embodiments has the screw 14 disposed in the conveyor casing 11. However, the combustible material supplying apparatus is not limited to these embodiments. For example, as shown in FIG. 7, the combustible material supplying apparatus may have a mechanical supplying device such as a spiral conveyor 18 including a rotational shaft 12 disposed in a conveyor casing 11, and a helical vane 13 attached to an end of the rotational shaft 12. In this case, a plurality of rotational shafts 12 each having a helical vane 13 may be arranged parallel to each other in the conveyor casing 11.

FIG. 8 is a schematic diagram showing an example of an incineration facility having the supplying apparatus 10 for supplying a combustible material 102 according to the invention and a fluidized-bed incineration furnace. In FIG. 8, the reference numeral 30 denotes a combustion chamber of a fluidized-bed incineration furnace. The fluidized-bed incineration chamber 30 has a raw material supply port 31 to which one end of the conveyor casing 11 of the screw conveyor 10 is connected. Another end of the conveyor casing11 is connected to a raw material hopper 40, into which a combustible material 102 is introduced. The raw material hopper 40 has a pusher 41 disposed at the bottom to push a combustible material 102 in the raw material hopper 40 into the end of the conveyor casing 11. If the screw conveyor 10 is installed horizontally, then the combustible material 102 is supplied, by gravitation,

through a material hopper which has a vertical axis normal to the horizontal axis of the screw conveyor 10 and connected with an upper portion thereof. When the screw conveyor 10 is placed to be inclined, the combustible material 102 is not appropriately supplied only with gravitation because the axis of the material flow comes near the horizontal axis from the vertical axis. It is therefore preferable to supply the combustible material 102 in assistance of a pusher 41 to pushing the combustible material 102 into the screw conveyor 10.

When the screw 14 of the screw conveyor 10 is rotated, the combustible material 102 pushed by the pusher 41 is moved downstream and supplied through the raw material supply port 31 of the incineration chamber 30 to an upper portion of a fluidized bed 32 (above a surface of the dense fluidized bed). The supplied combustible material is combusted into a combustion gas 104 in the fluidized bed 32. The combustion gas 104 flows through a freeboard 33 of the incineration chamber 30 into an apparatus for processing heat recovery 50. An incombustible 105 in the combustible material 102 is discharged from a bottom of the fluidized bed 32 together with a bed material 101 into an apparatus for processing incombustible extracting 51. In the apparatus for processing incombustible extracting 51, the incombustible 105 is extracted (separated) from the bed material 101.

A portion of a bed material (mainly silica sand) 101 flows through the raw material supply port 31 into the conveyor casing 11 of the screw conveyor 10 due to fluidization of the bed material 101 in the fluidized bed 32. Simultaneously, a bed material 101 separated from the incombustible 105 in the apparatus for processing incombustible extracting 51 is supplied through the bed material supply port 16 of the screw conveyor 10 (see FIG. 4) into the conveyor casing 11. Thus, with a pass of the bed material 101 to the inside of the conveyor casing 11 separate from that through the raw material supply port 31, the conveyor casing 11 is filled with the bed material 101. Accordingly, by high material sealing effects caused by mixture of the bed material 101 and the combustible material 102, external air is prevented from leaking through the

screw conveyor 10 into the incineration chamber 30, and the combustion gas 104 generated in the incineration chamber 30 is prevented from leaking out of the incineration chamber 30 through the screw conveyor 10. Incombustible particles are used as a bed material.

By supplying the bed material 101 separated in the apparatus for processing incombustible extracting 51 to the conveyor casing 11 of the screw conveyor 10, it is possible to eliminate a bed material circulation line to return the bed material 101 separated in the apparatus for processing incombustible extracting 51 to the fluidized bed 32.

When the combustible material 102 and the high-temperature bed material 101 are brought into contact with each other in the conveyor casing 11 of the screw conveyor 10, moisture in the combustible material 102 is evaporated and the combustible material 102 is pyrolyzed. Therefore, steam (water vapor) and pyrolysis gas 103 is generated. A portion of the steam (water vapor) and pyrolysis gas 103 generated in the conveyor casing 11 flows through the raw material supply port 31 into the freeboard 33, and the rest is extracted from the gas extracting port 17 (see FIG. 4) and supplied to the freeboard 33.

The apparatus for processing heat recovery 50 has a waste heat boiler for producing steam 52 and an air preheater for producing preheated air 53, which is used as fluidizing air or combustion air to be supplied to the incineration chamber 30. Heat is recovered from the combustion gas 104 in the apparatus for processing heat recovery 50 to lower the temperature of the combustion gas 104. The combustion gas 104 is then supplied to having a bag filter or the like to remove fly ash 55. Thereafter, the combustion gas 104 is supplied to an apparatus for processing dechlorination 56 to dechlorinate the combustion gas 104 and an apparatus for processing denitration 57 to denitrate the combustion gas 104 and then released as an exhaust gas 106 to an atmosphere through a chimney (not shown).

FIG. 9 is a schematic view showing an example of a gasification and

slagging combustion facility, which is a model of a gasification apparatus, having the combustible material supplying apparatus according to the invention and a fluidized-bed gasifier which is equipped with a gasifier chamber. In FIG. 9, like or corresponding parts are designated by the same reference numerals as in FIG. 8 and will not be described repetitively. A combustible material 102 is supplied through a raw material supply port 61 of a gasifier chamber 60 to an upper portion of a fluidized bed 62 (above an surface of a dense fluidized bed) by the screw conveyor 10. The combustible material 102 is pyrolyzed and gasified in the fluidized bed 62 to generate a gas 107. The generated gas 107 flows through a freeboard 63 of the gasifier chamber 60 into an apparatus for processing ash melting 70. In the apparatus for processing ash melting 70, the generated gas 107 is combusted at a high temperature together with char (fixed carbon) contained in the generated gas 107 to melt ash in the generated gas 107 into slag 71, which is discharged to the exterior of the system. A combustion gas 107' from which ash has been removed is supplied to an apparatus for processing complete combustion 72.

The conveyor casing 11 of the screw conveyor 10 is filled with a bed material 101, as in the case of FIG. 8. Accordingly, by high material sealing effects caused by mixture of the bed material 101 and the combustible material 102, external air is prevented from leaking through the screw conveyor 10 into the gasifier chamber 60, and the generated gas 107 generated in the gasifier chamber 60 is prevented from leaking out of the gasifier chamber 60 through the screw conveyor 10.

When the combustible material 102 and the high-temperature bed material 101 are brought into contact with each other in the conveyor casing 11 of the screw conveyor 10, moisture in the combustible material 102 is evaporated and combustible material 102 is pyrolyzed. Therefore, steam (water vapor) and pyrolysis gas 103 is generated. A portion of the steam (water vapor) and pyrolysis gas 103 flows through the raw material supply port 61 into the freeboard 63, and the rest is extracted from the gas extracting port 17 (see FIG.

4) and supplied to the apparatus for processing complete combustion 72, which the rest of the steam and pyrolysis gas 103 is completely combusted together with the combustion gas 107' supplied from the apparatus for processing ash melting 70.

A combustion gas 109 generated by complete combustion in the apparatus for processing complete combustion 72 is subjected to heat recovery in an apparatus for processing heat recovery 50. The combustion gas 109 is then supplied to an apparatus for processing dust removal 54 to remove fly ash 55. Thereafter, the combustion gas 109 is supplied to an apparatus for processing dechlorination 56 to dechlorinate the combustion gas 109 and an apparatus for processing denitration 57 to denitrate the combustion gas 109 and then released as an exhaust gas 206 to an atmosphere through a chimney (not shown).

FIG. 10 is a schematic view, showing an example of a gasification reforming facility, which is a model of a gasification apparatus, having the combustible material supplying apparatus according to the invention. In FIG. 10, like or corresponding parts are designated by the same reference numerals as in FIGs. 8 and 9 and will not be described repetitively. A combustible material 102 is supplied through a raw material supply port 61 of a gasifier chamber 60 to an upper portion of a fluidized bed 62 (above an surface of a dense fluidized bed) by the screw conveyor. 10. The combustible material 102 is pyrolyzed and gasified in the fluidized bed 62 to generate a gas 107. The generated gas 107 flows through a freeboard 63 of the gasifier chamber 60 into an apparatus for processing gas reforming and ash melting 74. In the apparatus for processing gas reforming and ash melting 74, the generated gas 107 is reformed, and simultaneously a portion of the generated gas 107 is combusted at a high temperature to melt ash into slag 71, which is discharged to the exterior of the system. The combustion gas 107 is discharged from the apparatus for processing gas reforming and ash melting 74 to an apparatus for processing heat recovery 50.

Heat is recovered from the generated gas 107 in the apparatus for processing heat recovery 50 to lower the temperature of the generated gas 107. The generated gas 107 is then supplied to an apparatus for processing gas cleaning and dust removal 75. In the apparatus for processing gas cleaning and dust removal 75, water is ejected to the generated gas 107 to clean the generated gas 107 and drainage 76 and ash (fly ash) 77 is removed. The generated gas 107 which has been cleaned is supplied to an apparatus for processing gas refine 78 to generate a product gas 108.

The conveyor casing 11 of the screw conveyor 10 is filled with a bed material 101, as in the cases of FIGs. 8 and 9. Accordingly, by high material sealing effects due to a mixture of the bed material 101 and the combustible material 102, external air is prevented from leaking through the screw conveyor 10 into the gasifier chamber 60, and the generated gas 107 generated in the gasifier chamber 60 is prevented from leaking, out of the gasifier chamber 60 through the screw conveyor 10.

When the combustible material 102 and the high-temperature bed material 101 are brought into contact with each other in the conveyor casing 11 of the screw conveyor 10, moisture in the combustible material 102 is evaporated and combustible material 102 is pyrolyzed. Therefore, steam (water vapor) and pyrolysis gas 103 is generated. A portion of the steam (water vapor) and pyrolysis gas 103 flows through the raw material supply port 61 into the freeboard 63, and the rest is extracted from the gas extracting port 17 (see FIG. 4) and supplied to the freeboard 63.

FIG. 11 is a schematic view, showing an example of a low-temperature gasification reforming facility, which is a model of a gasification apparatus, having a combustible material supplying apparatus according to the invention. In FIG. 11, like or corresponding parts are designated by the same reference numerals as in FIGs. 8 through 10 and will not be described repetitively. A combustible material 102 is supplied through a raw material supply port 61 of a gasifier chamber 60 to on upper portion of a fluidized bed 62 (above an surface

of a dense fluidized bed) by the screw conveyor 10. The combustible material 102 is pyrolyzed and gasified in the fluidized bed 62 to generate a gas 107. The generated gas 107 flows through a freeboard 63 of the gasifier chamber 60 into an apparatus for processing gas reforming 80, where the generated gas 107 is reformed. Then, the generated gas 107 is supplied to an apparatus for processing heat recovery 50, where heat is recovered from the generated gas 107 to lower the temperature of the generated gas 107. The generated gas 107 is then supplied to an apparatus for processing gas cleaning and dust removal 75. In the apparatus for processing gas cleaning and dust removal 75, water is ejected to the generated gas 107 to clean the generated gas 107 and drainage 76, and ash 77 is removed. The generated gas 107 which has been cleaned is supplied to an apparatus for processing gas refine 78 to generate a product gas 108.

The conveyor casing 11 of the screw conveyor 10 is filled with a bed material 101, as in the cases of FIGs. 8 through 10. Accordingly, by high material sealing effects caused by mixture of the bed material 101 and the combustible material 102, external air is prevented from leaking through the screw conveyor 10 into the gasifier chamber 60, and the generated gas 107 generated in the gasifier chamber 60 is prevented from leaking out of the gasifier chamber 60 through the screw conveyor 10.

When the combustible material 102 and the high-temperature bed material 101 are brought into contact with each other in the conveyor casing 11 of the screw conveyor 10, moisture in the combustible material 102 is evaporated and combustible material 102 is pyrolyzed. Therefore, steam (water vapor) and pyrolysis gas 103 is generated. A portion of the steam (water vapor) and pyrolysis gas 103 flows through the raw material supply port 61 into the freeboard 63, and the rest is extracted from the gas extracting port 17 (see FIG. 4) and supplied to the freeboard 63.

FIG. 12 is a schematic view, showing an example of a gas reforming facility, which is a model of a gasification apparatus, having the combustible

material supplying apparatus according to the invention and an integrated fluidized-bed gasifier. The integrated fluidized-bed gasifier is a gasification facility having a fluidized-bed gasifier 90 in which a gasifier chamber 91 for pyrolyzation and gasification and a combustion chamber 92 for combustion of char produced by pyrolyzation are included and a bed material 101 is allowed to circulate freely between both chambers 91, 92. A fluidized bed 91b in the gasifier chamber 91 is fluidized by a gas which does not include oxygen such as steam, and is heated to keep a temperature between about 600 and 850°C by a bed material 101 circulating from the combustion chamber 92. The combustible material 102 supplied to the gasifier chamber 91 is pyrolyzed and gasified. A fluidized bed 92b in the combustion chamber 92 is fluidized by an oxygen containing gas, such as air. A pyrolyzation residue fed from the gasifier chamber 91 is completely combusted in the combustion chamber 92. Heat of combustion resulting from this combustion reaction heats the fluidized bed 92b in the combustion chamber 92. The fluidized bed 92b in the combustion chamber 92 has a temperature kept between about 700 and 950°C, which is higher than that of the fluidized bed 91b in the gasifier chamber 91. In FIG. 12, like or corresponding parts are designated by the same reference numerals as in FIGs. 8 through 11 and will not be described repetitively. The integrated fluidized-bed gasifier 90 has a raw material supply port 93. An end of the conveyor casing 11 of the screw conveyor 10 is connected to the raw material supply port 93 of the gasifier chamber 91. Another end of the conveyor casing 11 is connected to a raw material hopper 40, into which a combustible material 102 is introduced. The raw material hopper 40 has a pusher 41 disposed at the bottom to push a combustible material 102 in the raw material hopper 40 into the other end of the conveyor casing 11.

A combustible material 102 is supplied through the gasifier chamber 91 of the integrated gasifier 90 to an upper portion of a fluidized bed 91b (above an surface of a dense fluidized bed) by the screw conveyor 10. The combustible material 102 is pyrolyzed and gasified in the fluidized bed 91b to generate a gas

107. The generated gas 107 flows through a freeboard 91a of the gasifier chamber 91 into an apparatus for processing gas reforming 80, where the generated gas 107 is reformed. Then, the generated gas 107 is supplied to an apparatus for processing heat recovery 50, where heat is recovered from the generated gas 107 to lower the temperature of the generated gas 107. The generated gas 107 is then supplied to an apparatus for processing gas cleaning and dust removal 75. In the apparatus for processing gas cleaning and dust removal 75, water is ejected to the generated gas 107 to clean the generated gas 107 and drainage 76, and ash 77 is removed. The generated gas 107 which has been cleaned is supplied to an apparatus for processing gas refine 78 to generate a product gas 108.

The fluidized bed 91b of the gasifier chamber 91 and a fluidized bed 92b of the combustion chamber 92 are communicated with each other below a lower end of a partition wall 94. Thus, a bed material and char are moved from the fluidized bed 91b of the gasifier chamber 91 to the combustion chamber 92. The char is combusted in the combustion chamber 92 to generate a combustion gas 104. The combustion gas 104 is supplied to an apparatus for processing heat recovery 50, where heat is recovered from the combustion gas 104 to lower the temperature of the combustion gas 104. The combustion gas 104 is then supplied to an apparatus for processing dust removal 54 to remove fly ash 55. Thereafter, the combustion gas 104 is supplied to an apparatus for processing dechlorination 56 to dechlorinate the combustion gas 104 and an apparatus for processing denitration 57 to denitrate the combustion gas 104 and then released as an exhaust gas 106 to an atmosphere through a chimney (not shown).

An incombustible 105 in the combustible material 102 is discharged from a bottom of the fluidized bed 92b of the combustion chamber 92 together with a bed material 101 into an apparatus for processing incombustible extracting 51. In the apparatus for processing incombustible extracting 51, the incombustible 105 is separated from the bed material 101. The bed

material 101 is supplied through the bed material supply port 17 of the screw conveyor 10 (see FIG. 4) into the conveyor casing 11. As in the cases of FIGs. 8 through 11, the bed material 101 from the fluidized bed 91b also flows into the conveyor casing 11. Thus, the conveyor casing 11 of the screw conveyor 10 is filled with a bed material 101. Accordingly, by high material sealing effects caused by mixture of the bed material 101 and the combustible material 102, external air is prevented from leaking through the screw conveyor 10 into the gasifier chamber 91, and the generated gas 107 generated in the gasifier chamber 91 is prevented from leaking out of the gasifier chamber 91 through the screw conveyor 10.

When the combustible material 102 and the high-temperature bed material 101 are brought into contact with each other in the conveyor casing 11 of the screw conveyor 10, moisture in the combustible material 102 is evaporated and combustible material 102 is pyrolyzed. Therefore, steam (water vapor) and pyrolysis gas 103 is generated. A portion of the steam (water vapor) and pyrolysis gas 103 flows through the raw material supply port 93 into the freeboard 91a, and the rest is extracted from the gas extracting port 17 (see FIG. 4) and supplied to the freeboard 92a of the combustion chamber 92.

A pressure of the freeboard 91a of the gasifier chamber 91 should preferably be set to be higher than that of the freeboard 92a of the combustion chamber 92. In such a case, the steam and pyrolysis gas 103 generated in the conveyor casing 11 can certainly be supplied to the combustion chamber 92 to reduce fear of explosion or poisoning. Further, since the combustion chamber 92 can be disposed near the screw conveyor 10, it is possible to prevent troubles in an introduction duct for the steam and pyrolysis gas 103.

FIG. 13 is a schematic view, showing an example of an advanced gasification and slagging combustion facility, which is a model of a gasification apparatus, having the combustible material supplying apparatus according to the invention and a gasification and slagging combustion furnace including an integrated gasifier. The advanced gasification and slagging combustion facility

is a wastes treatment facility in which the integrated gasifier chamber 90 is combined with an apparatus for processing ash melting and complete combustion (ash melting chamber) 81. In the advanced gasification and slagging combustion facility, only the generated gas 107 from the gasifier chamber 91 is heated at a high temperature and it is therefore possible to reduce the size of the ash melting chamber 81 and the exhaust gas treatment facility 50, 54, 56 and 57 comparing to the traditional gasification and slagging combustion facility. In FIG. 13, like or corresponding parts are designated by the same reference numerals as in FIGs. 8 through 12 and will not be described repetitively. A combustible material 102 is supplied to the gasifier chamber 91 by the screw conveyor 10. The combustible material 102 is pyrolyzed and gasified in the fluidized bed 91b to generate a gas 107. The generated gas 107 flows through a freeboard 91a of the gasifier chamber 91 into an apparatus for processing ash melting and complete combustion 81. In the apparatus for processing ash melting and complete combustion 81, ash in the generated gas 107 is melted into slag 71, which is discharged to the exterior of the system, and simultaneously the generated gas 107 is completely combusted. The combustion gas 110 which has been completely combusted is supplied through an apparatus for processing heat recovery 50, an apparatus for processing dust removal 54, an apparatus for processing dechlorination 56, and an apparatus for processing denitration 57 and then released as an exhaust gas 106 to an atmosphere.

As in the case of FIG. 12, when the combustible material 102 and the high- temperature bed material 101 are brought into contact with each other in the conveyor casing 11 of the screw conveyor 10, moisture in the combustible material 102 is evaporated and combustible material 102 is pyrolyzed. Therefore, steam (water vapor) and pyrolysis gas 103 is generated. A portion of the steam (water vapor) and pyrolysis gas 103 flows through the raw material supply port 93 into the freeboard 91a, and the rest is extracted from the gas extracting port 17 (see FIG. 4) and supplied to the freeboard 92a of the

combustion chamber 92.

In the respective facilities shown in FIGs. 8 through 13, the screw conveyor 10 serving as a combustible material supplying apparatus has one screw 14 in the conveyor casing 11. However, the screw conveyor 10 is not limited to these examples. As shown in FIG. 6, the screw conveyor 10 may have two or more screws 14 disposed substantially parallel to each other. Alternatively, as shown in FIG. 7, it is possible to use a spiral conveyor 18 having a rotational shaft 12 disposed in a conveyor casing 11 and a helical vane 13 attached to an end of the rotational shaft 12. In this case, a plurality of rotational shafts 12 each having a helical vane 13 may be arranged in parallel each other in the conveyor casing 11. It is also possible to use other mechanical combustible material supplying devices. Although the bed material 101 to be supplied to the screw conveyor 10 is, as shown in those drawings, located downstream of the gas drawing port 17, it may be disposed upstream thereof as shown in Fig. 5.

As described above, a mechanical combustible material supplying device such as the screw conveyor 10 is inclined at an angle of 20 degrees of more and 80 degrees or less with respect to the horizontal plane so that transportation of the combustible material of the screw conveyor 10 is directed upward. As a result, it is possible to lower a position from which a raw material is supplied, to mix a raw material with a high-temperature bed material in advance, and to enhance sealing performance of a raw material supply port of a furnace. Accordingly, as shown in FIG. 14, the following effects can be obtained:

(S1) Since a raw material supplying position, i.e. a position of a raw material hopper 40, can be lowered, the following effects can be obtained.

(S1-1) It is possible to reduce the height of a crane for supplying a combustible material such as wastes into the raw material hopper 40.

(S1-2) Accordingly, the height of a building can be reduced.

(S1-3) As a result, construction cost of the facility can be

reduced.

(S2) Since the raw material is mixed with the high-temperature bed material in advance, i.e., the combustible material and the high-temperature bed material are mixed with each other in a screw conveyor 10 in advance, the following effects can be obtained.

(S2-1) A combustible material is broken up.

(S2-2) A raw material is homogenized before being supplied to a chamber,

(S2-3) It is possible to prevent variations in amount of raw material to be supplied,

(S2-4) Therefore, it is possible to prevent variations in amount of gas.

(S2-5) Margins in a gas facility can be reduced,

(S2-6) The combustible material is pyrolyzed before being supplied into a chamber. Specifically, since the combustible material is brought into contact with the high-temperature bed material before being supplied into the chamber, the combustible material is pyrolyzed and volatile matter is obtained.

(S2-7) Accordingly, volatile matter is prevented from being released from the combustible material in the chamber.

(S2-8) Thus, it is possible to prevent variations in amount of gas generated, as with (S2-4),

(S2-9) Therefore, it is possible to prevent variations in pressure in the chamber,

(S2-10) Accordingly, the chamber can have a relatively high pressure therein. Thus, it is possible to prevent air from leaking out of the chamber, as described later in (S3-1),

(S2-11) Moisture in the raw material is evaporated. Specifically, since the combustible material is brought into contact with the high-temperature bed material before the combustible material is supplied into the

chamber, moisture in the raw material is evaporated.

(S2-12) Thus, it is possible to prevent the evaporation of moisture in the chamber.

(S2-13) As a result, the amount of moisture supplied to the chamber can be reduced. Accordingly, in a case of a gasification and slagging combustion furnace, it is possible to reduce consumption of auxiliary fuel, as described later in (S3-3).

(S3) Since sealing performance of a raw material supply port of a chamber can be enhanced, i.e., a conveyor casing 11 of a screw conveyor 10 is filled with a bed material to enhance material sealing effects, the following effects can be obtained.

(S3-1) It is possible to prevent air from leaking into the chamber.

(S3-2) Thus, it is possible to prevent uncontrollable gas flow from flowing into the chamber.

(S3-3) Therefore, in a case of a gasification and slagging combustion chamber, consumption of auxiliary fuel can be reduced,

(S3-4) It is possible to prevent leaking of a gas from the chamber,

(S3-5) Therefore, it is possible to reduce risk of backfire,

(S3-6) Simultaneously, it is possible to reduce risk of poisoning,

(S3-7) As a result, safety can be ensured,

(S3-8) Thus, cost for security countermeasures can be reduced.

(S4) Initial cost can be reduced because of reduction of construction cost (S1-3), reduction of margins in the gas facility (S2-5), and reduction of cost for security countermeasures (S3-8),

(S5) Running cost can be reduced because of reduction of consumption of auxiliary fuel in a case of a gasification and slagging combustion furnace (S3-3),

(S6) On the whole, it is possible to achieve customer satisfaction,

Here, as a first embodiment according to the invention, a combustible material supplying apparatus for supplying a combustible material to the upper portion of a fluidized bed of a fluidized-bed gasifier chamber or combustion chamber may be characterized in that means for mechanically supplying a raw material with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane.

Since, as described above, the combustible material supplying apparatus is means for mechanically supplying a raw material with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane, the material supplying position can be lowered. For example, the height of a building in which the facility is installed can be reduced by a lowered position of the material supplying means such as a crane for carrying combustible materials such as wastes.

Further, as a second embodiment of the invention, the combustible material supplying apparatus of the first embodiment according to the invention may comprise a conveyor having a helical vane for rotation to supply the combustible material as means for mechanically supplying a raw material.

Since, as described above, the means for mechanically supplying a raw material is so called a screw conveyor or spiral conveyor in which a helical vane is rotated, a combustible raw material is forced upward and supplied. It is therefore possible to achieve high material sealing effects especially by filling the conveyor casing with a bed material to promote crushing of a raw material, which prevents both the leak of air into the chamber and the leak of a gas out of the chamber.

Further, as a third embodiment of the invention, the combustible material supplying apparatus of the second embodiment according to the invention may be characterized in that the conveyor has two or more helical vanes generally disposed in parallel.

Since, as described above, the conveyor has two or more helical vanes generally disposed in parallel, crushing of a raw material is promoted especially by filling the conveyor casing with a bed material.

Further, as a fourth embodiment of the invention, a facility for gasifying a combustible material having a fluidized-bed gasifier chamber and a combustible material supplying means for supplying a combustible material to the gasifier chamber, and gasifying the combustible material supplied to the upper portion of the fluidized bed by the combustible material supplying means, may be characterized in that; the combustible material supplying means is means for mechanically supplying a raw material which is inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane; and a bed material supplying means is provided for filling the means for mechanically supplying a raw material with a bed material to form a fluidized bed of the fluidized-bed gasifier chamber.

Since, as described above, the combustible material supplying means is means for mechanically supplying a raw material which is disposed to be inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle, and a bed material supplying means is provided, it is possible to promote crushing of a raw material and suppress the variation of the amount of the raw material to be supplied, while achieving high material sealing effects when the bed material supplying means is filled with the bed material having a high temperature through the bed material supplying means.

Further, as a fifth embodiment of the invention, a facility for gasifying a combustible material having a fluidized-bed gasifier chamber and a combustible material supplying means for supplying a combustible material to the gasifier chamber and for gasifying the combustible material supplied to the upper portion of the fluidized bed may be characterized in that: the combustible material supplying means is means for mechanically supplying a raw material

which is inclined, with transportation of combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane; a bed material supplying means is provided for filling the means for mechanically supplying a raw material with a bed material to form a fluidized bed of the fluidized bed gasifier chamber; and a bypass means is provided which bypasses the gasifier chamber and leads the gas generated by the contact of the combustible material with the bed material in the means for mechanically supplying a raw material, to the downstream of the gasifier chamber.

Since, as described above, there is provided a bypass means which bypasses the gasifier chamber and leads the gas generated from the combustible material in the means for mechanically supplying a raw material, to the downstream of the gasifier chamber, it is possible to suppress the variation of the amount of the gas generated in the gasifier chamber and also possible to securely treat the gas generated in the means for mechanically supplying a raw material with no leak of the gas outside, in addition to the effects of the fourth embodiment of the invention.

Further, as a sixth embodiment of the invention, a combustible material gasification method of supplying a combustible material to a fluidized-bed gasifier chamber and gasifying the combustible material; may be characterized by comprising the steps of: supplying the combustible material through means for mechanically supplying a raw material which is inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane; filling the means for mechanically supplying a raw material with a bed material to form a fluidized bed of the fluidized-bed gasifier chamber therein; supplying the combustible material to the fluidized-bed gasifier chamber while enhancing material sealing effects of a material supplying system; and gasifying the combustible material.

Since, as described above, the combustible material is supplied through

means for mechanically supplying a raw material which is inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane and the means for mechanically supplying a raw material is filled with a bed material, it is possible to promote crushing of a raw material, to suppress the variation of the amount of a raw material to be supplied and to achieve high material sealing effects during gasification.

Further, as a seventh embodiment of the invention, a combustible material gasification method of supplying a combustible material to a fluidized-bed gasifier chamber and gasifying the combustible material may be characterized by comprising the steps of: supplying the combustible material through means for mechanically supplying a raw material which is inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane; filling the means for mechanically supplying a raw material with a bed material to form a fluidized bed of the fluidized-bed gasifier chamber therein; supplying the combustible material to the fluidized-bed gasifier chamber while enhancing material sealing effects of a material supplying system; positively contacting the combustible material with the bed material in the means for mechanically supplying a raw material to evaporate the moisture and volatile matter from the combustible material; supplying the combustible material, from which the moisture and volatile matter was removed, to the fluidized-bed gasifier chamber; and gasifying the combustible material.

Since, as described above, the combustible material and the bed material having a high temperature are positively made in contact, moisture and volatile matter is vaporized from the combustible material, and the combustible material from which moisture and volatile matter was removed is supplied to the fluidized-bed gasifier chamber, it is possible to suppress the variation of the amount of the gas generated in the gasifier chamber and also suppress the variation of the amount of the moisture therein.

Further, as an eighth embodiment of the invention, a combustible material gasification method of supplying a combustible material to a fluidized-bed gasifier chamber and gasifying the combustible material may be characterized by comprising the steps of: supplying the combustible material through means for mechanically supplying a raw material which is inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane; and filling the means for mechanically supplying a raw material with a bed material to form a fluidized bed of the fluidized-bed gasifier chamber therein; supplying the combustible material to the fluidized-bed gasifier chamber while enhancing material sealing effects of a material supplying system; positively contacting the combustible material with the bed material in the means for mechanically supplying a raw material to evaporate the moisture and volatile matter from the combustible material; leading the generated steam and volatile matter bypassing the fluidized-bed chamber to the downstream thereof; supplying the combustible material, from which the moisture and volatile matter was removed, to the fluidized-bed gasifier chamber; and gasifying the combustible material.

Since, as described above, the steam and volatile matter generated in the means for mechanically supplying a raw material bypass the gasifier chamber and flow into the downstream thereof, it is possible to securely treat the gas generated in the means for mechanically supplying a raw material with no leak of the gas outside, in addition to the effects of the seventh embodiment of the invention.

Further, as a ninth embodiment of the invention, a combustible material supplying apparatus for supplying a combustible material together with incombustible particles may be characterized in that there is provided means for mechanically supplying a raw material which is inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane.

Since, as described above, the combustible material is supplied together with incombustible particles by the means for mechanically supplying a raw material which is inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane, a mixture of the combustible material and the incombustible particles is transported, resulting in a combustible material supplying apparatus having high material sealing effects.

According to the first embodiment, the combustible material supplying apparatus is the means for mechanically supplying a raw material and disposed to be inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane. The raw material supply position can be lowered and it is therefore possible to provide a combustible material supplying apparatus allowing to reduce the height of a building in which the facility is installed and to suppress the total construction cost of the entire facility.

According to the second embodiment, the means for mechanically supplying a raw material is so called a screw conveyor or spiral conveyor in which a helical vane is rotated, and a combustible raw material is forced upward and supplied. It is therefore possible to provide a combustible material supplying apparatus having high safety and high material sealing effects especially by filling the conveyor casing with a bed material to promote crushing of a raw material, which prevents both the leak of air into the chamber and the leak of a gas out of the chamber, in addition to the effects of the first embodiment.

According to the third embodiment, the conveyor has two or more helical vanes generally disposed in parallel. It is therefore possible to provide a combustible material supplying apparatus allowing to promote crushing of a raw material especially by filling the conveyor casing with a bed material and to suppress the variation of the amount of the combustible material to be supplied, in addition to the effects of the first and second embodiments.

According to the fourth embodiment, the combustible material supplying means is means for mechanically supplying a raw material which is disposed to be inclined, with its downstream end directed upward, at an angle not smaller than a predetermined angle, and a bed material supplying means is provided. It is therefore possible to provide a facility for gasifying a combustible material having high safety and high material sealing effects, which allows to promote crushing of a raw material and suppress the variation of the amount of the raw material to be supplied, while achieving high material sealing effects when the bed material supplying means is filled with the bed material having a high temperature through the bed material supplying means.

According to the fifth embodiment, there is provided a bypass means which bypasses the gasifier chamber and leads the gas generated from the combustible material in the means for mechanically supplying a raw material, to the downstream of the gasifier chamber. It is therefore possible to provide a facility for gasifying a combustible material having high safety and high material sealing effects, which allows to suppress the variation of the amount of the gas generated in the gasifier chamber and also to securely treat the gas generated in the means for mechanically supplying a raw material with no leak of the gas outside, in addition to the effects of the fourth embodiment of the invention.

According to the sixth embodiment, the combustible material is supplied through means for mechanically supplying a raw material which is inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane and the means for mechanically supplying a raw material is filled with a bed material. It is therefore possible to provide a method of gasifying a combustible material, which allows to promote crushing of a raw material, to suppress the variation of the amount of a raw material to be supplied and to achieve high material sealing effects during gasification.

According to the seventh embodiment, the combustible material and the bed material having a high temperature are positively contacted in the means for mechanically supplying a raw material, moisture and volatile matter is vaporized from the combustible material, and the combustible material, from which moisture and volatile matter was removed is supplied to the fluidized-bed gasifier chamber. It is therefore possible to provide a method of gasifying a combustible material, which allows to suppress the variation of the amount of the gas generated in the gasifier chamber and also to suppress the amount of the moisture therein, in addition of the effects of the sixth embodiment.

According to the eighth embodiment, the steam and volatile matter generated in the means for mechanically supplying a raw material bypass the gasifier chamber and flow into the downstream thereof, it is possible to securely treat the gas generated in the means for mechanically supplying a raw material with no leak of the gas outside, in addition to the effects of the seventh embodiment of the invention.

According to the ninth embodiment, since the combustible material is supplied together with incombustible particles by means for mechanically supplying a raw material which is inclined, with transportation of the combustible material directed upward, at an angle not smaller than a predetermined angle with respect to the horizontal plane, a mixture of the combustible material and the incombustible particles is transported. It is therefore possible to provide a combustible material supplying apparatus having high material sealing effects.

It should be noted that the detailed description and specific examples are preferred embodiments of the invention, only for the purpose of the description thereof. Because it is apparent for the person ordinary skilled in the art to modify and change in a variety of manners, within the scope and spirits of the invention. The applicant does not intend to dedicate any disclosed embodiments to the public, and to the extent any disclosed modifications or alterations may not literally fall within the scope of the claims,

they are considered to be part of the invention under the doctrine of the equivalents.

As is described heretofore, according to the invention, it is possible to provide a combustible material supplying apparatus, a facility for gasifying a combustible material, and a method of gasifying a combustible material, which allow the increase of the sealing effects of the supplying system for supplying a combustible material, such as combustible wastes, to the fluidized-bed chamber, the stable supply of undefined shapes of wastes, and the reduction of the construction cost.

CLAIMS

1. A supplying apparatus for supplying a combustible material to an upper portion of a fluidized bed of a fluidized-bed gasifier chamber or a fluidized-bed combustion chamber comprising:

a hopper configured to store a combustible material; and

a mechanical supplying apparatus configured to supply a combustible material from said hopper to said fluidized-bed gasifier chamber or said fluidized-bed combustion chamber through a flow passage of the combustible material with a flow line directed upward, inclined at an angle of 20 degrees or more and 80 degrees or less with respect to a horizontal plane.

2. The supplying apparatus for supplying a combustible material according to Claim 1, wherein said mechanical supplying apparatus comprises a conveyor having a rotating helical vane configured to supply said combustible material by means of a rotational action of said rotating helical vane.

3. The supplying apparatus for supplying a combustible material according to Claim 2, wherein said conveyor has a plurality of helical vanes disposed generally in parallel.

4. The supplying apparatus for supplying a combustible material according to Claim 2 or 3, said apparatus further comprising:

a conveyor casing to contain said helical vane, said conveyor casing having a projection on the inner surface of said conveyor casing, said projection being configured to maintain the efficiency of transportation.

5. The supplying apparatus for supplying a combustible material according to any one of Claims 1 to 4 further comprising:

a medium supplying apparatus configured to supply medium to said mechanical supplying apparatus, an inside of said mechanical supplying apparatus being stuffed with said medium to prevent gas communication therein.

6. The supplying apparatus for supplying a combustible material

according to Claim 5, wherein said medium supplying apparatus further comprises:

a flow passage of said medium not being identical to said flow passage of said combustible material.

7. A gasification apparatus for gasifying a combustible material, comprising:

the supplying apparatus for supplying a combustible material according to any one of Claims 1 to 6; and

a fluidized-bed gasifier chamber supplied with a combustible material from the supplying apparatus for supplying a combustible material.

8. A gasification apparatus for gasifying a combustible material, comprising:

the supplying apparatus for supplying a combustible material according to Claim 5 or 6;

a fluidized-bed gasifier chamber configured to gasify said combustible material supplied to by said supplying apparatus for supplying a combustible material; and

a bypass line configured to bypass said gasifier chamber to lead a gas generated from the combustible material in said supplying apparatus for supplying a combustible material.

9. A gasification apparatus for gasifying a combustible material, comprising:

the supplying apparatus for supplying a combustible material according to Claim 5 or 6; and

a fluidized-bed gasifier chamber configured to gasify said combustible material supplied to by said supplying apparatus for supplying a combustible material;

wherein at least one of moisture and volatile matter is vaporized from the combustible material within said supplying apparatus for supplying a combustible material.

10 The gasification apparatus for gasifying a combustible material according to Claim 9, said apparatus further comprising:

a bypass line configured to bypass said gasifier chamber to lead at least one of said moisture and volatile matter vaporized in said supplying apparatus for supplying a combustible material, to a downstream of said gasifier chamber.

11. A method for gasifying a combustible material in a fluidized-bed gasifier chamber or a fluidized-bed combustion chamber; comprising the steps of:

storing said combustible material in a hopper;

supplying said combustible material upwardly from said hopper to said fluidized-bed gasifier chamber or said fluidized-bed combustion chamber by a mechanical supplying apparatus, to enhance a material sealing function of said apparatus by filling inside with medium which constitutes a fluidized-bed; and ;

gasifying said combustible material supplied to said fluidized-bed gasifier chamber or said fluidized bed combustion chamber by said mechanical supplying apparatus.

12. A supplying apparatus for supplying a combustible material to a fluidized-bed gasifier chamber or a fluidized-bed combustion chamber, said apparatus comprising:

a hopper configured to store a combustible material; and

a mechanical supplying apparatus configured to supply a combustible material from said hopper to said fluidized-bed gasifier chamber or said fluidized-bed combustion chamber through a flow passage of the combustible material with a flow line directed upward:

wherein said combustible material is supplied together with a medium to prevent gas communication through said mechanical supplying apparatus.

FIG.1

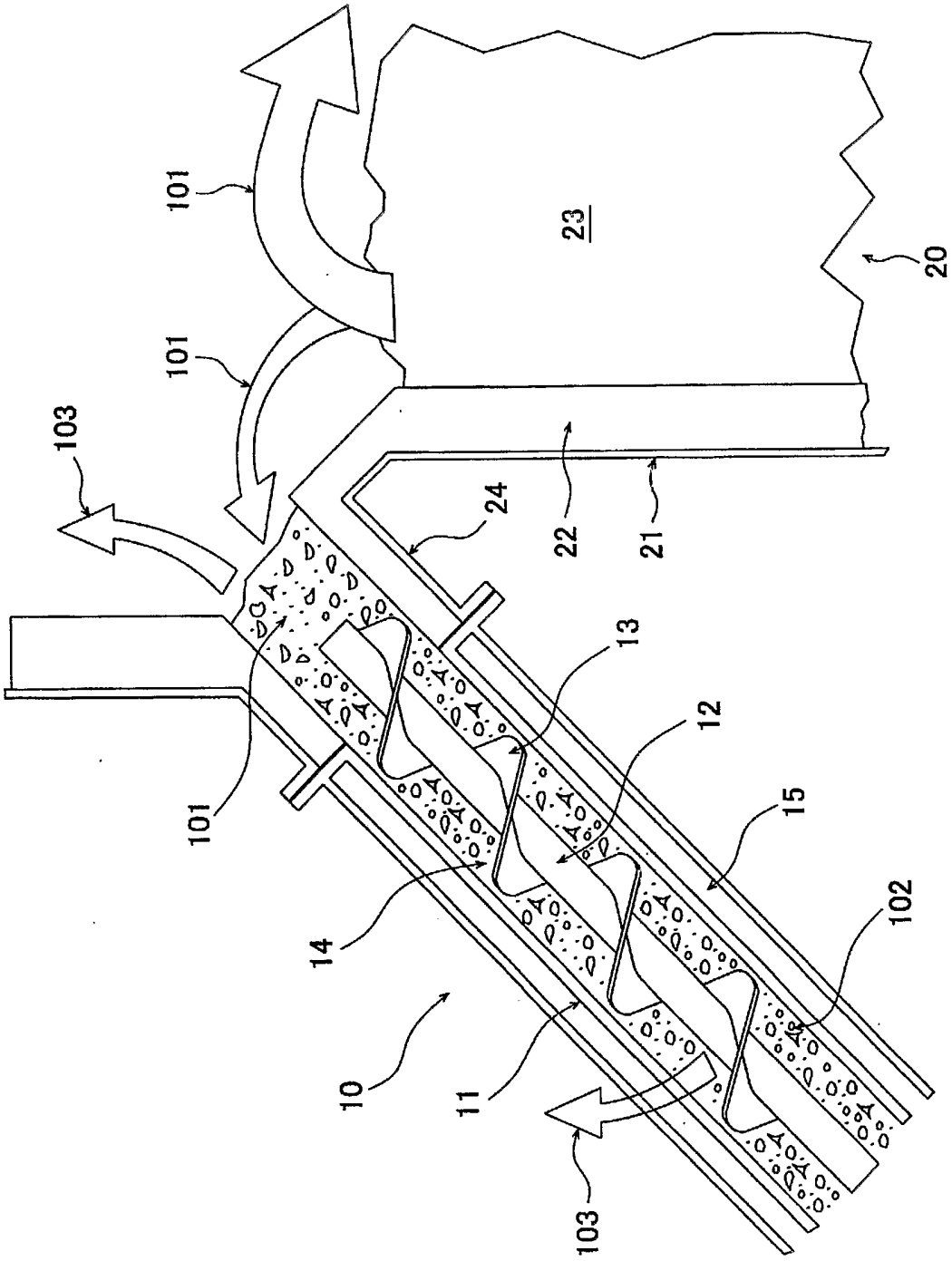


FIG.2

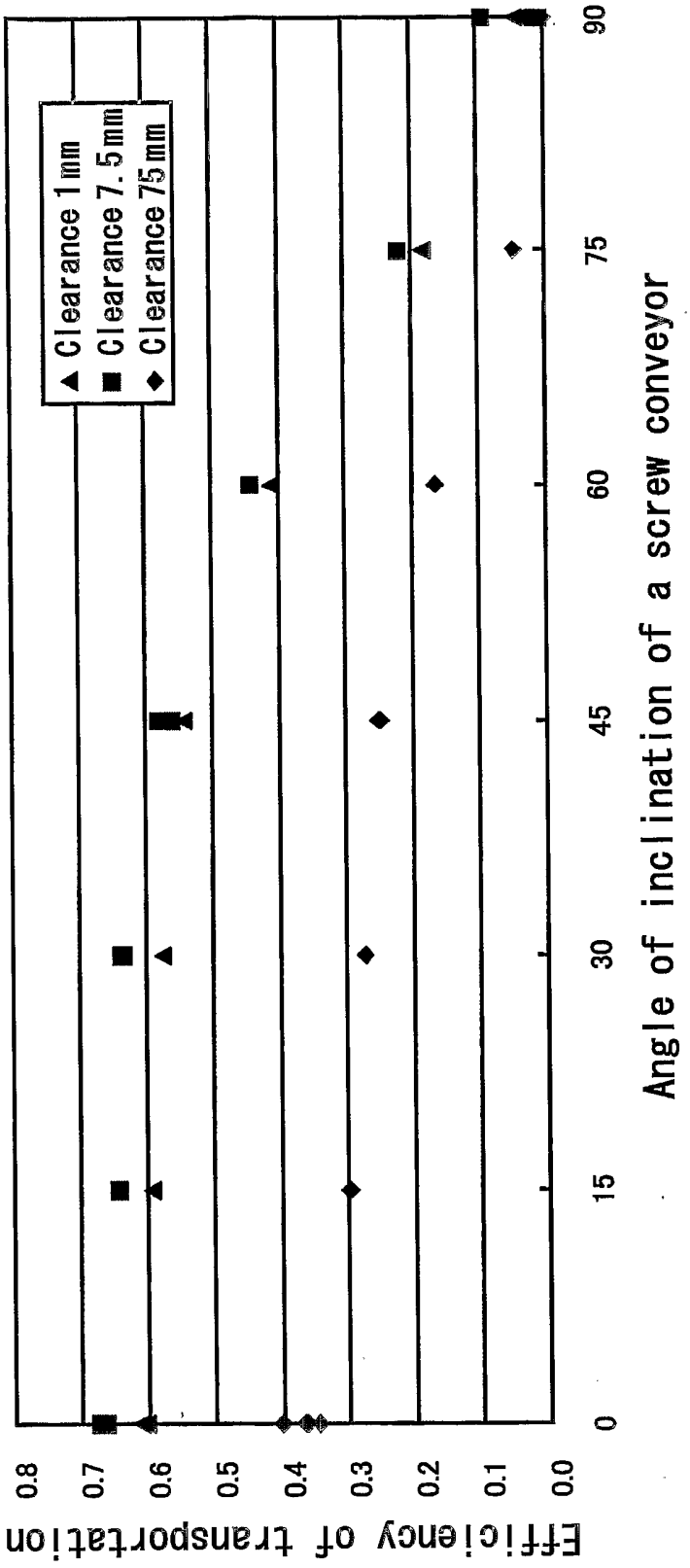

Clearance 1mm
Clearance 7.5mm
Clearance 75mm
Efficiency of transportation
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
15
30
45
60
75
90
Angle of inclination of a screw conveyor

FIG. 3A

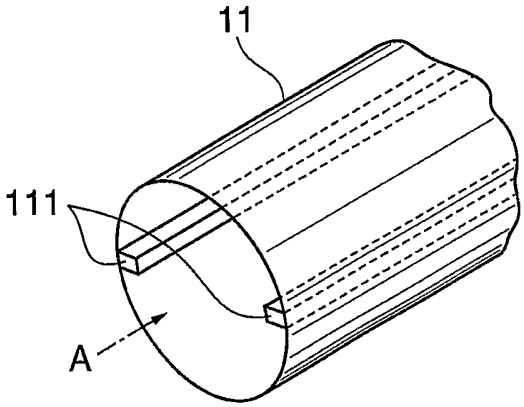


FIG. 3B

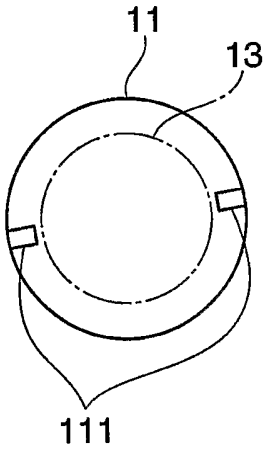


FIG.4

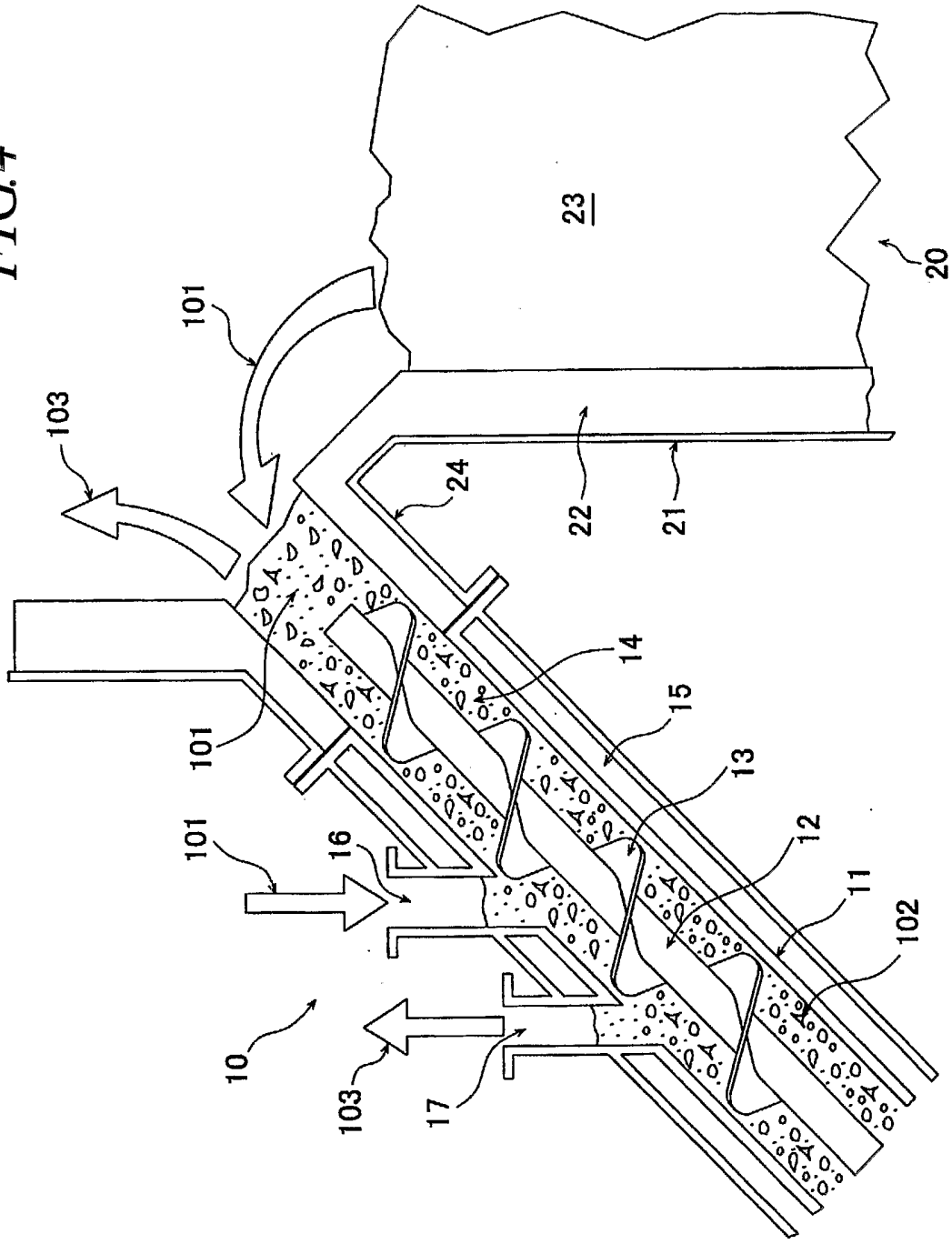


FIG.5

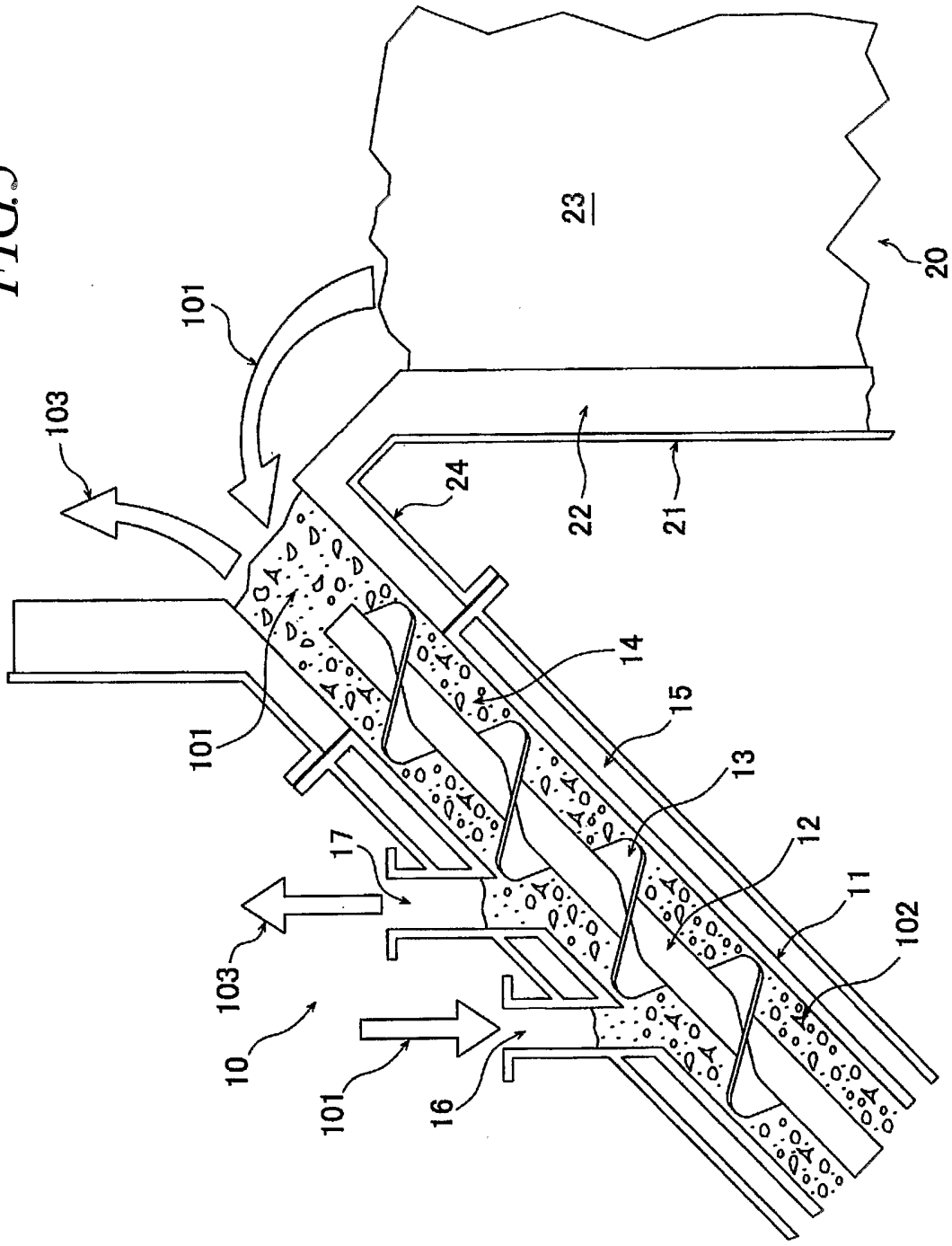


FIG.6

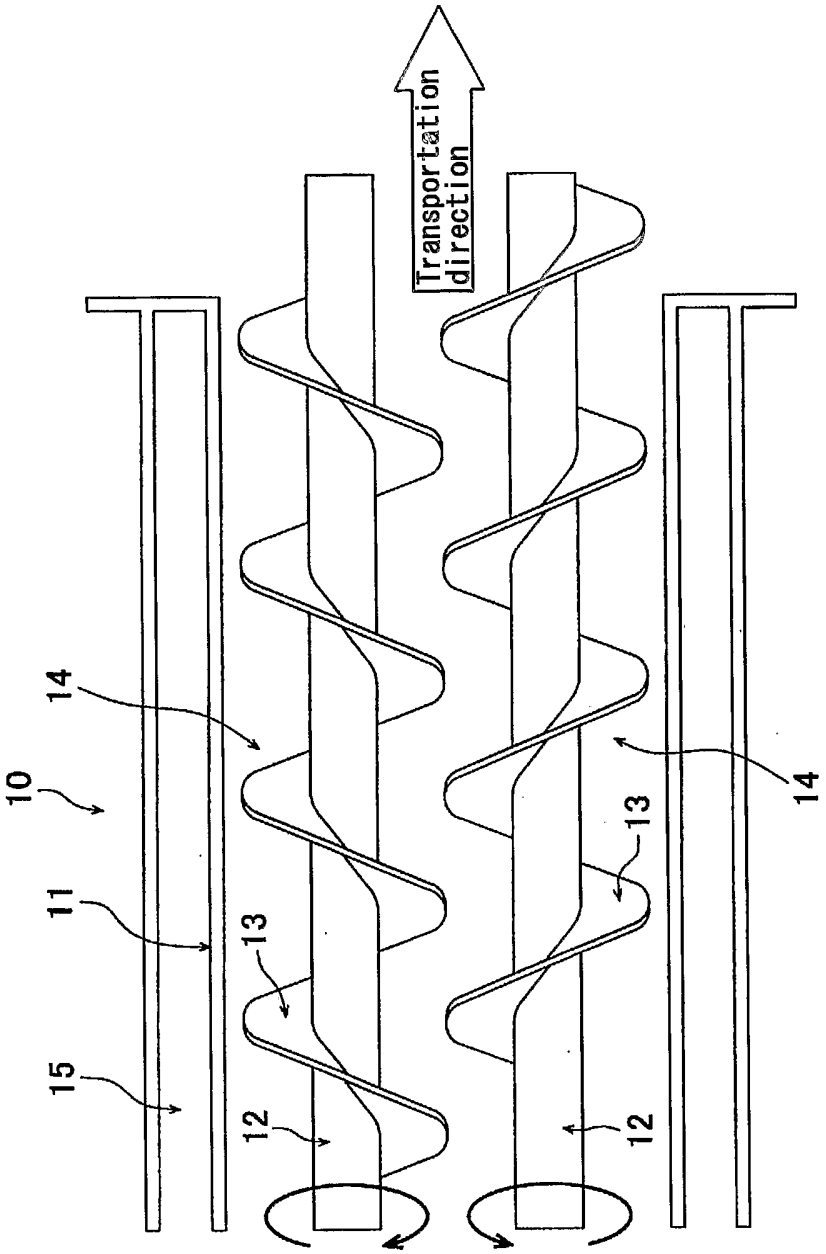


FIG.7

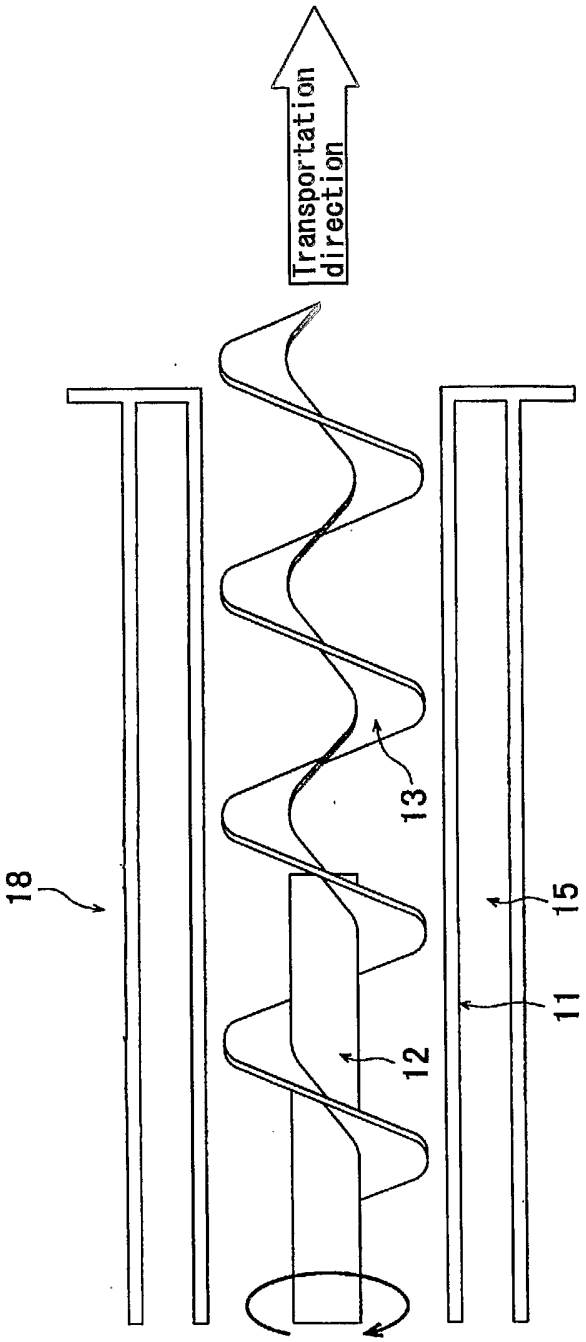


FIG. 8

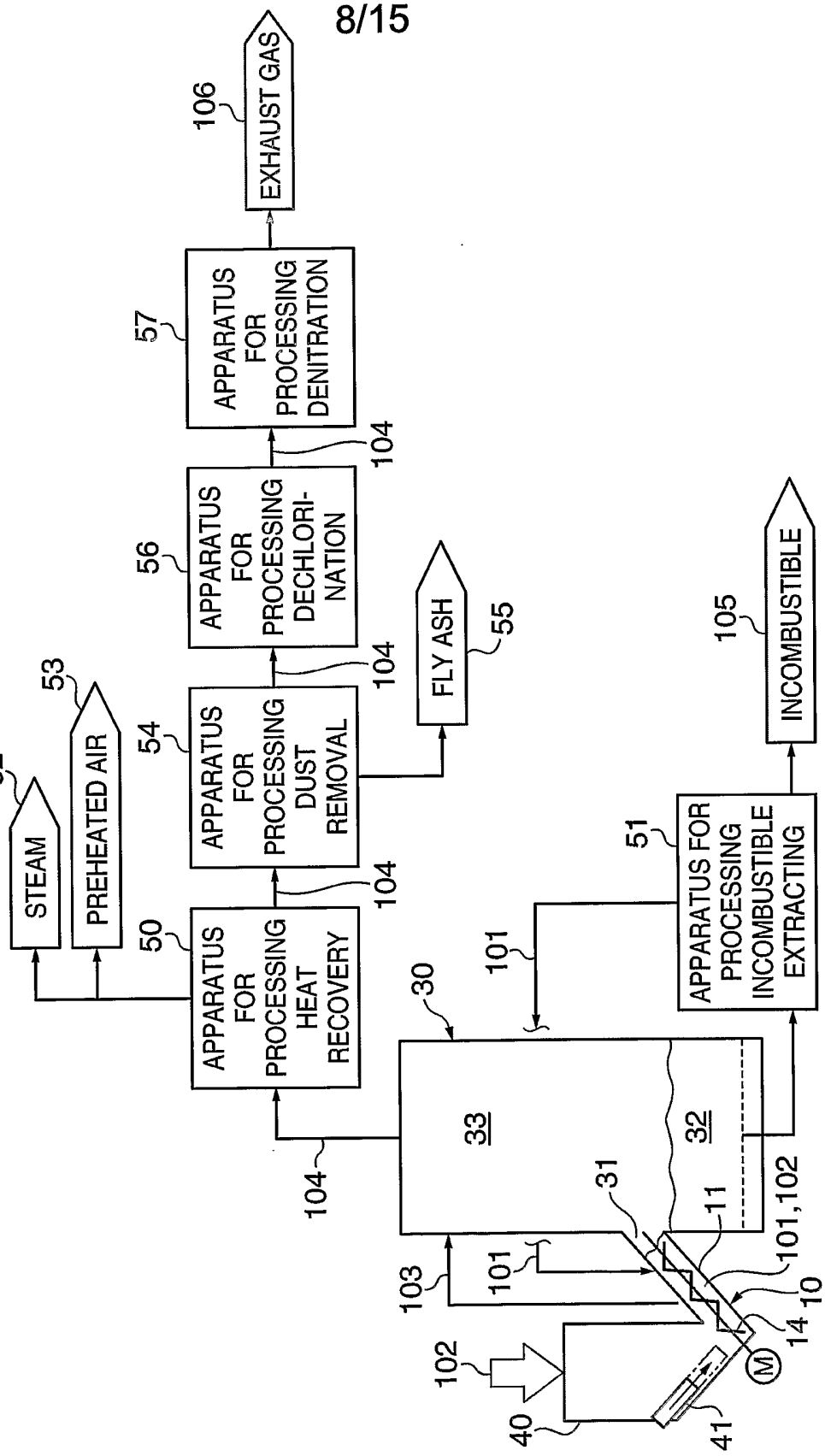

106
EXHAUST GAS
57
APPARATUS FOR PROCESSING DENITRATION
56
APPARATUS FOR PROCESSING DECHLORI-NATION
55
FLY ASH
54
APPARATUS FOR PROCESSING DUST REMOVAL
53
PREHEATED AIR
52
STEAM
50
APPARATUS FOR PROCESSING HEAT RECOVERY
104
104
104
104
105
INCOMBUSTIBLE
51
APPARATUS FOR PROCESSING INCOMBUSTIBLE EXTRACTING
101
30
33
32
31
11
101,102
10
14
M
103
101
102
40
41

FIG. 9

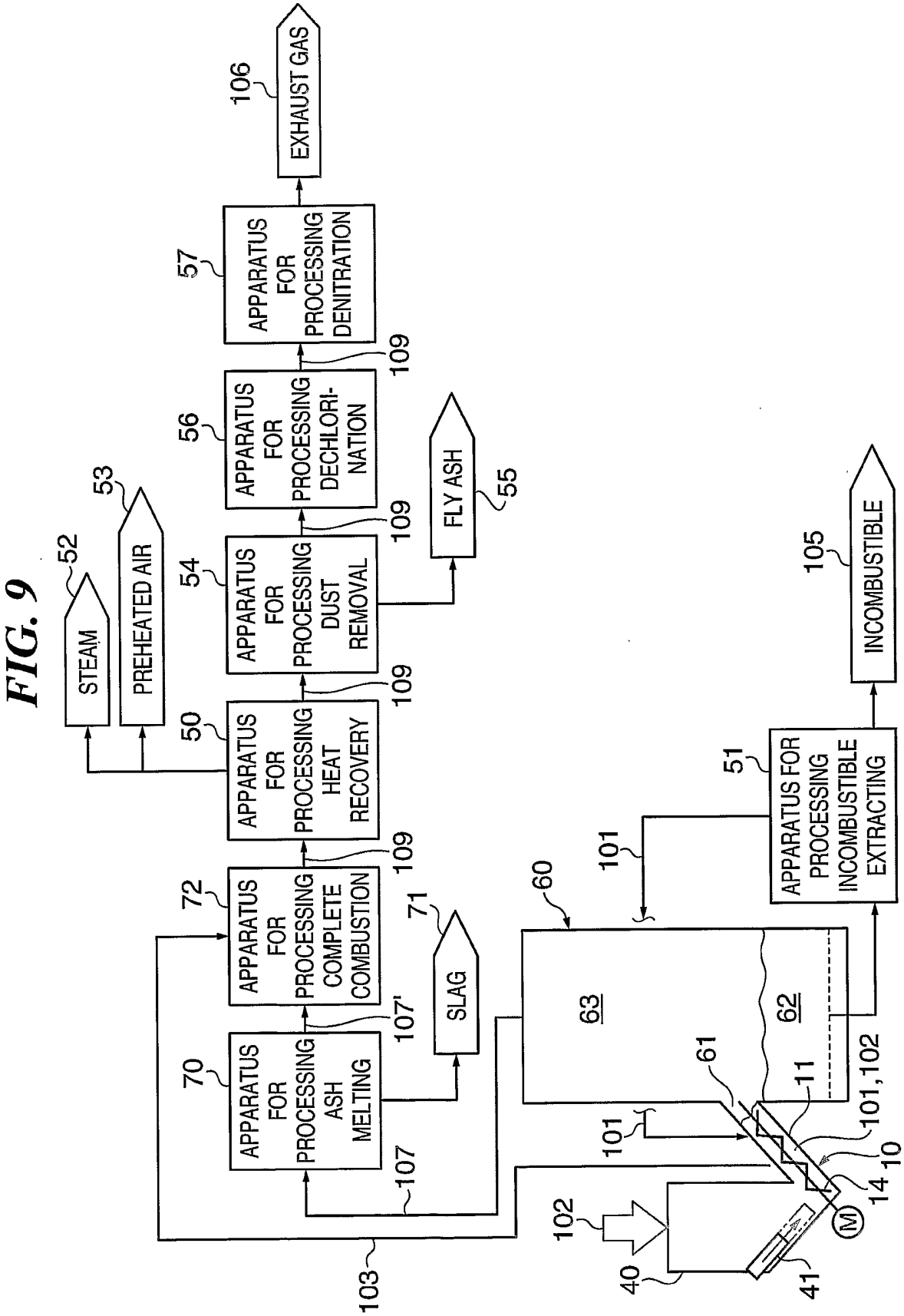

106
EXHAUST GAS
57
APPARATUS FOR PROCESSING DENITRATION
56
APPARATUS FOR PROCESSING DECHLORI-NATION
54
APPARATUS FOR PROCESSING DUST REMOVAL
FLY ASH
55
53
PREHEATED AIR
52
STEAM
50
APPARATUS FOR PROCESSING HEAT RECOVERY
72
APPARATUS FOR PROCESSING COMPLETE COMBUSTION
71
SLAG
70
APPARATUS FOR PROCESSING ASH MELTING
109
107'
107
103
60
63
62
61
11
101,102
101
10
14
M
102
40
41
51
APPARATUS FOR PROCESSING INCOMBUSTIBLE EXTRACTING
105
INCOMBUSTIBLE

FIG. 10

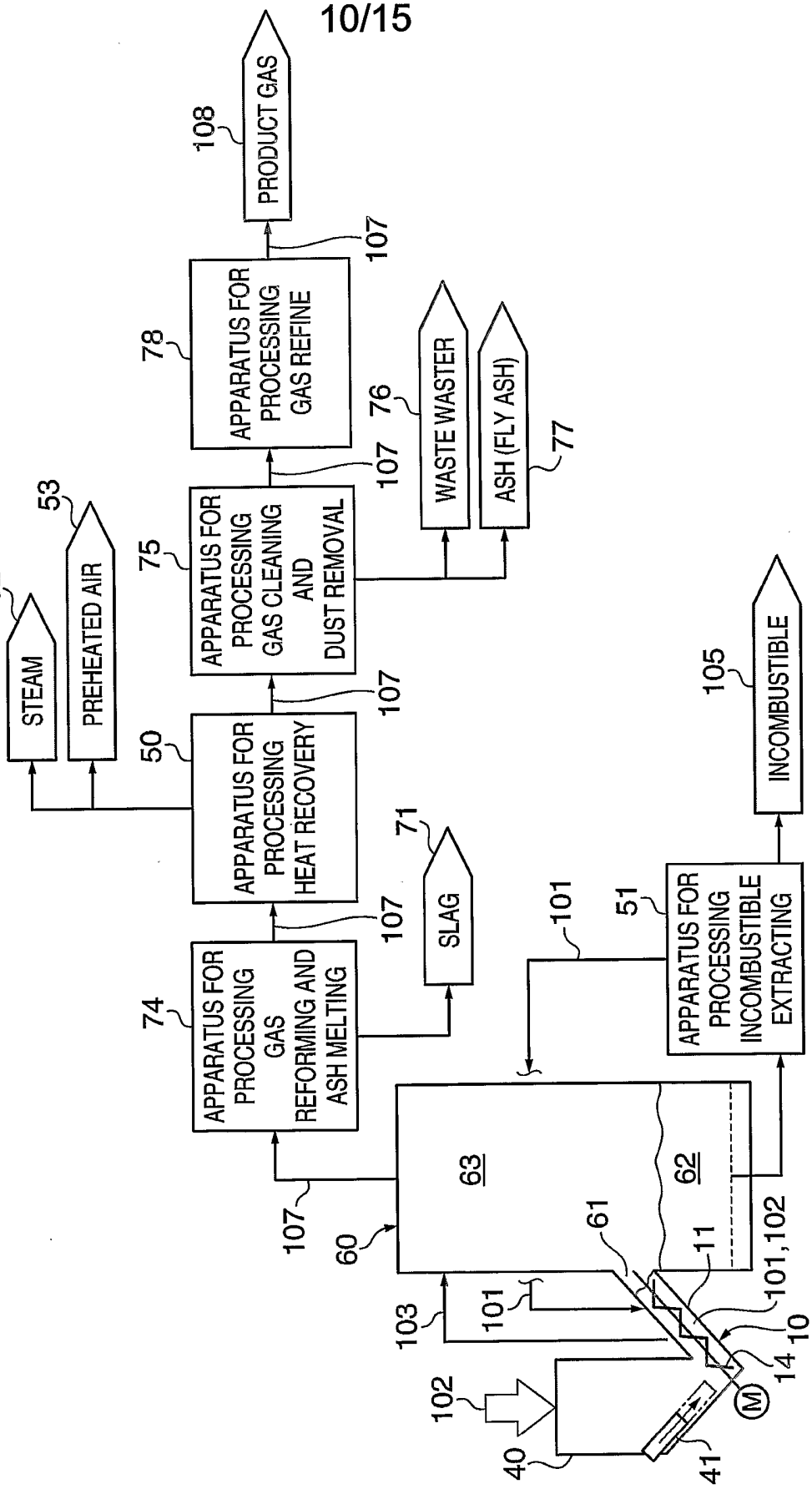

108
PRODUCT GAS
78
APPARATUS FOR PROCESSING GAS REFINE
107
76
WASTE WASTER
77
ASH (FLY ASH)
75
APPARATUS FOR PROCESSING GAS CLEANING AND DUST REMOVAL
107
53
PREHEATED AIR
52
STEAM
50
APPARATUS FOR PROCESSING HEAT RECOVERY
107
71
SLAG
74
APPARATUS FOR PROCESSING GAS REFORMING AND ASH MELTING
107
105
INCOMBUSTIBLE
101
51
APPARATUS FOR PROCESSING INCOMBUSTIBLE EXTRACTING
63
62
61
11
101,102
60
107
103
101
10
14
M
102
40
41

FIG. 11

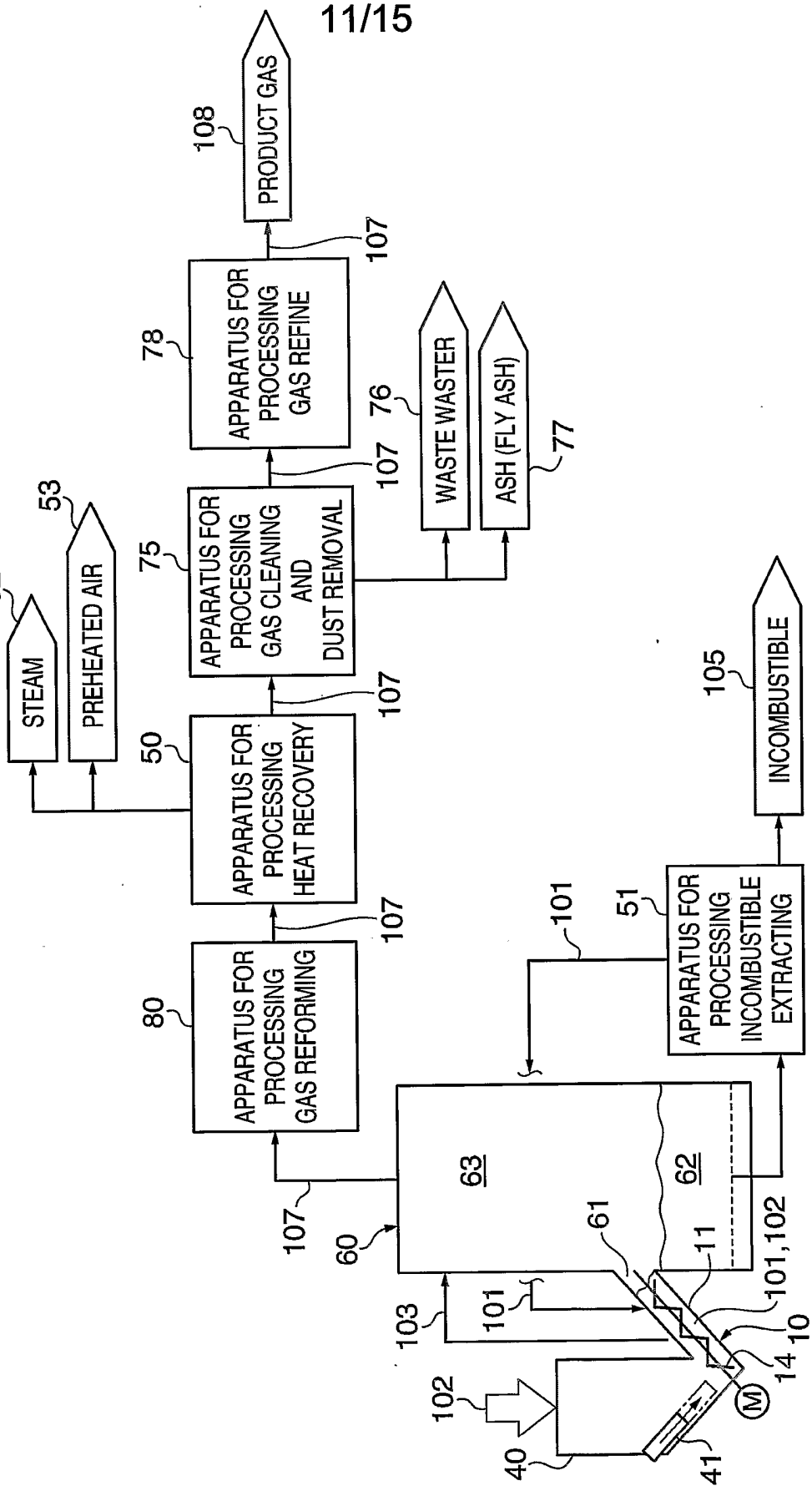

108
PRODUCT GAS
107
78
APPARATUS FOR PROCESSING GAS REFINE
76
WASTE WASTER
77
ASH (FLY ASH)
53
PREHEATED AIR
52
STEAM
75
APPARATUS FOR PROCESSING GAS CLEANING AND DUST REMOVAL
50
APPARATUS FOR PROCESSING HEAT RECOVERY
80
APPARATUS FOR PROCESSING GAS REFORMING
105
INCOMBUSTIBLE
51
APPARATUS FOR PROCESSING INCOMBUSTIBLE EXTRACTING
101
63
62
61
11
101,102
60
107
103
10
14
102
40
41
M

FIG. 12

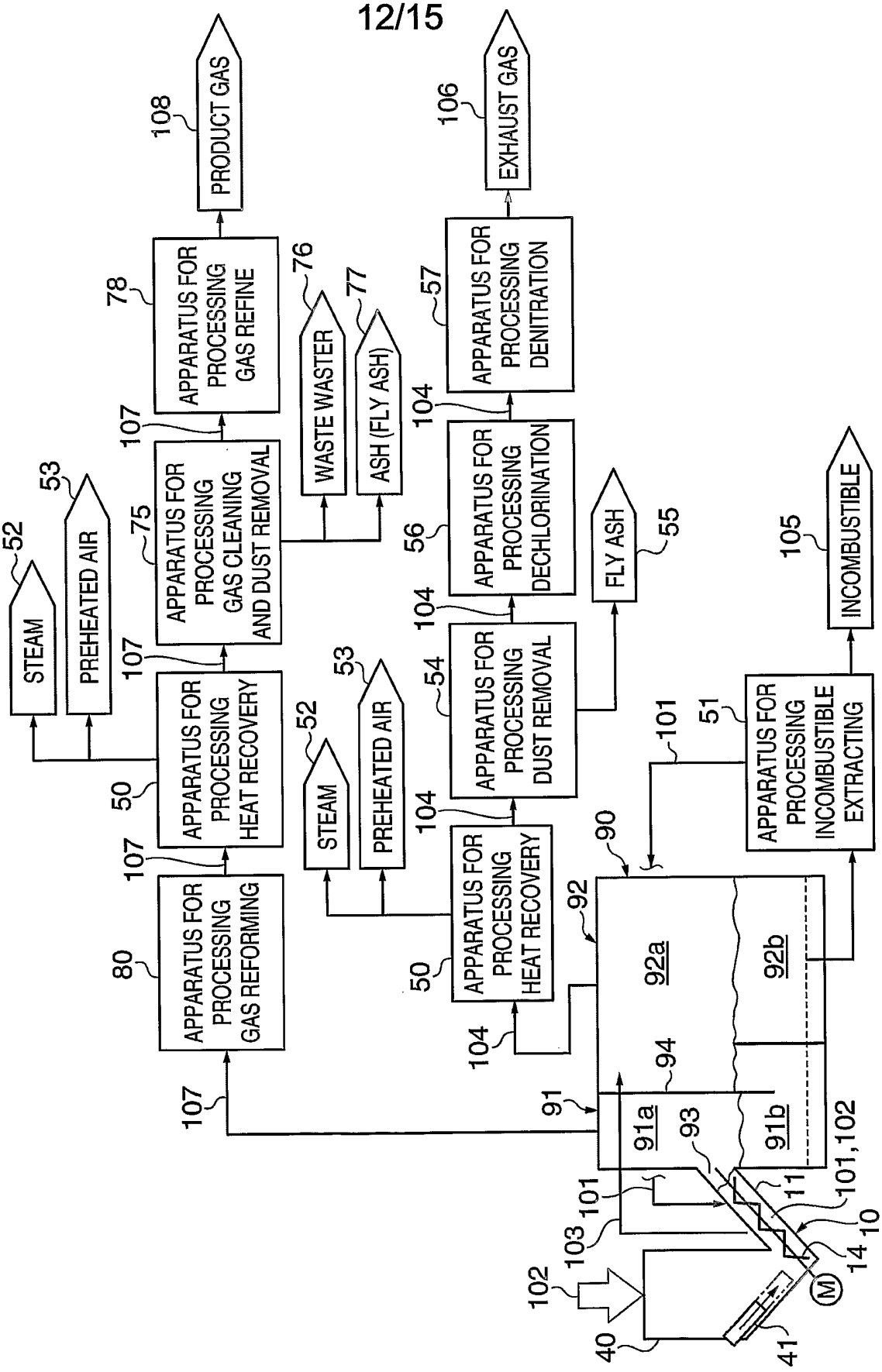
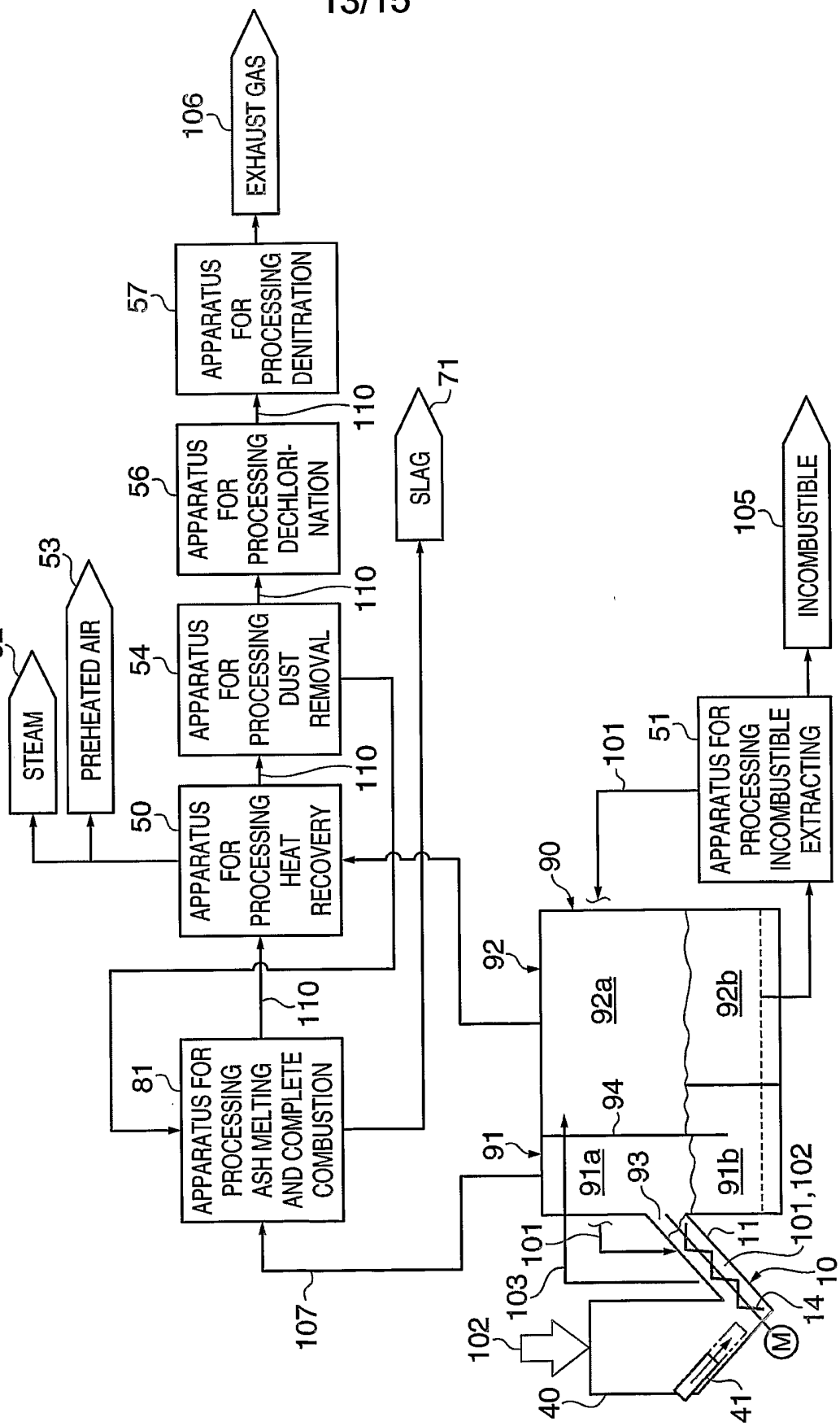

PRODUCT GAS
108
EXHAUST GAS
106
APPARATUS FOR PROCESSING GAS REFINE
78
APPARATUS FOR PROCESSING DENITRATION
57
WASTE WASTER
76
ASH (FLY ASH)
77
STEAM
52
PREHEATED AIR
53
APPARATUS FOR PROCESSING GAS CLEANING AND DUST REMOVAL
75
APPARATUS FOR PROCESSING DECHLORINATION
56
FLY ASH
55
INCOMBUSTIBLE
105
APPARATUS FOR PROCESSING HEAT RECOVERY
50
APPARATUS FOR PROCESSING DUST REMOVAL
54
APPARATUS FOR PROCESSING INCOMBUSTIBLE EXTRACTING
51
APPARATUS FOR PROCESSING GAS REFORMING
80
92a
92b
91a
91b
90
92
94
93
91
11
10
14
40
41
101
102
103
104
107

FIG. 13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EXHAUST GAS
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APPARATUS FOR PROCESSING DENITRATION
56
APPARATUS FOR PROCESSING DECHLORI-NATION
54
APPARATUS FOR PROCESSING DUST REMOVAL
50
APPARATUS FOR PROCESSING HEAT RECOVERY
53
PREHEATED AIR
52
STEAM
71
SLAG
105
INCOMBUSTIBLE
51
APPARATUS FOR PROCESSING INCOMBUSTIBLE EXTRACTING
81
APPARATUS FOR PROCESSING ASH MELTING AND COMPLETE COMBUSTION
110
101
90
92
92a
92b
91
91a
91b
93
94
11
101,102
10
14
M
103
102
40
41
107

FIG. 14A

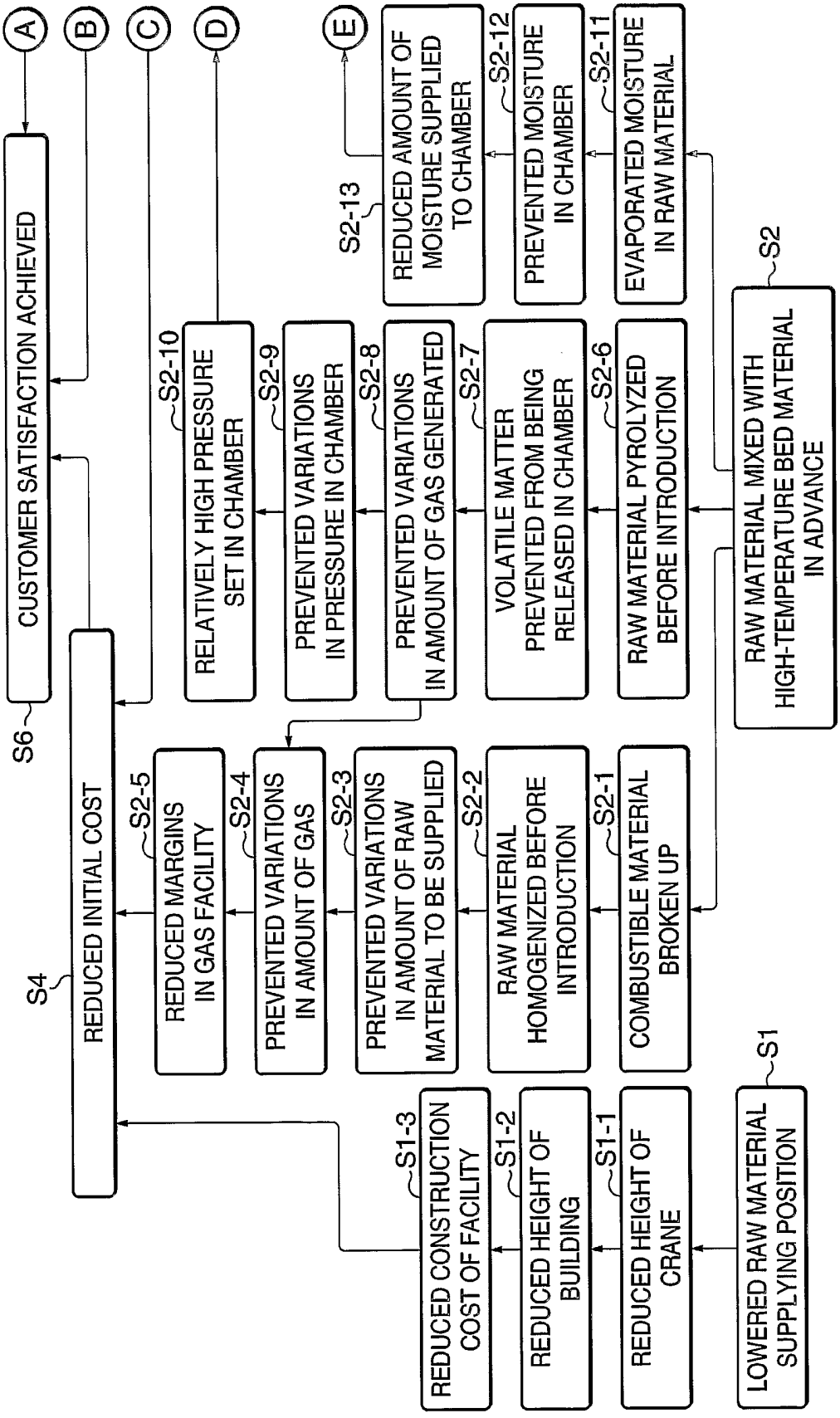
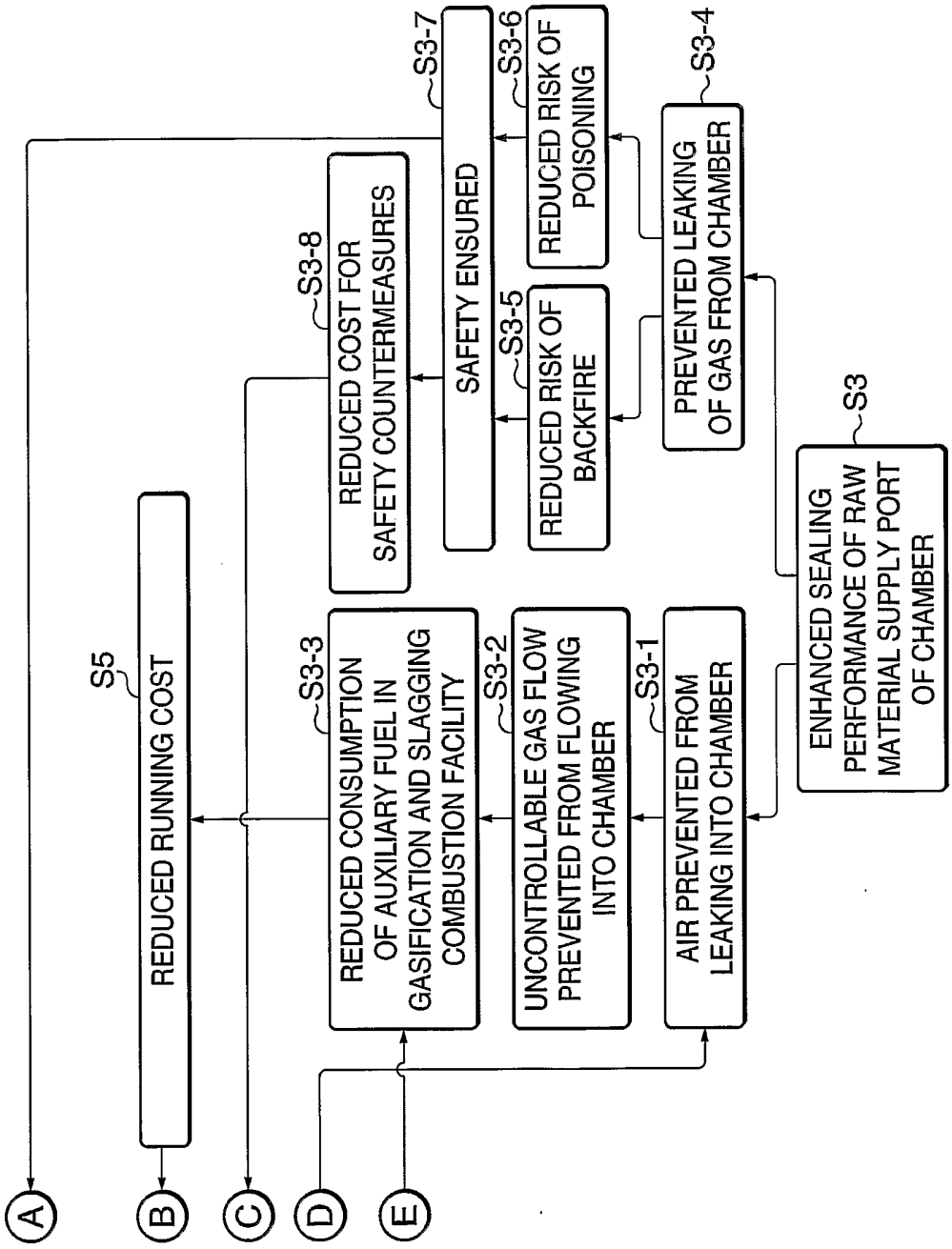

A
B
C
D
E
CUSTOMER SATISFACTION ACHIEVED
S6
REDUCED INITIAL COST
S4
S2-5
REDUCED MARGINS IN GAS FACILITY
S2-4
PREVENTED VARIATIONS IN AMOUNT OF GAS
S2-3
PREVENTED VARIATIONS IN AMOUNT OF RAW MATERIAL TO BE SUPPLIED
S2-2
RAW MATERIAL HOMOGENIZED BEFORE INTRODUCTION
S2-1
COMBUSTIBLE MATERIAL BROKEN UP
S1-3
REDUCED CONSTRUCTION COST OF FACILITY
S1-2
REDUCED HEIGHT OF BUILDING
S1-1
REDUCED HEIGHT OF CRANE
S1
LOWERED RAW MATERIAL SUPPLYING POSITION
S2-10
RELATIVELY HIGH PRESSURE SET IN CHAMBER
S2-9
PREVENTED VARIATIONS IN PRESSURE IN CHAMBER
S2-8
PREVENTED VARIATIONS IN AMOUNT OF GAS GENERATED
S2-7
VOLATILE MATTER PREVENTED FROM BEING RELEASED IN CHAMBER
S2-6
RAW MATERIAL PYROLYZED BEFORE INTRODUCTION
S2-13
REDUCED AMOUNT OF MOISTURE SUPPLIED TO CHAMBER
S2-12
PREVENTED MOISTURE IN CHAMBER
S2-11
EVAPORATED MOISTURE IN RAW MATERIAL
S2
RAW MATERIAL MIXED WITH HIGH-TEMPERATURE BED MATERIAL IN ADVANCE

FIG. 14B


A
B
C
D
E
S5
REDUCED RUNNING COST
S3-3
REDUCED CONSUMPTION OF AUXILIARY FUEL IN GASIFICATION AND SLAGGING COMBUSTION FACILITY
S3-2
UNCONTROLLABLE GAS FLOW PREVENTED FROM FLOWING INTO CHAMBER
S3-1
AIR PREVENTED FROM LEAKING INTO CHAMBER
S3-8
REDUCED COST FOR SAFETY COUNTERMEASURES
S3-7
SAFETY ENSURED
S3-5
REDUCED RISK OF BACKFIRE
S3-6
REDUCED RISK OF POISONING
S3-4
PREVENTED LEAKING OF GAS FROM CHAMBER
S3
ENHANCED SEALING PERFORMANCE OF RAW MATERIAL SUPPLY PORT OF CHAMBER