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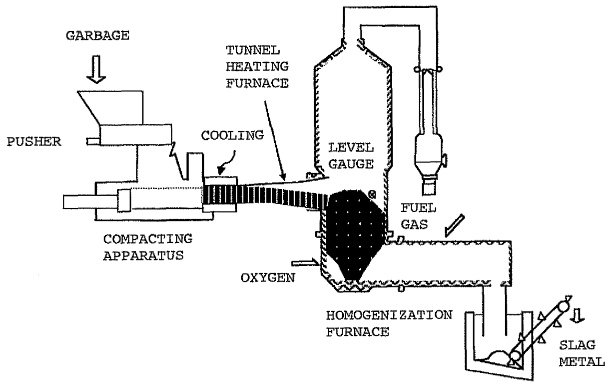
(54) METHOD AND APPARATUS FOR SUPPLYING WASTE TO GASIFICATION MELTING FURNACE

(57) To provide a method for supplying waste material that prevents a compacted block from breaking up and scattering when introducing the waste material into a melting furnace, and prevents the backflow of CO, which is a toxic gas.

In a method for supplying waste material to a body of a furnace in the interior of which waste material is heated and melted, the waste material is compacted by a compacting apparatus into a block so that the density of the waste material is at least two times and not more than 20 times the density prior to compaction, and the compacted block is supplied into the furnace from a introducing port provided in the furnace wall lower than a reforming section of the furnace body, either such that the drop distance within the furnace is not more than 3 m, or without being dropped.

FIG. 4



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Description

TECHNICAL FIELD

[0001] This invention relates to a method for supplying waste material to a melting furnace, using waste treatment equipment with which waste material is melted and gasified in a melting furnace, and particularly in a gasifying and melting furnace or a gasifying, melting and reforming furnace.

BACKGROUND ART

[0002] The lack of waste disposal sites and so forth has become a more prominent problem of late, and most industrial and general waste materials are ultimately disposed in the form generated as it is, or are buried after some kind of preliminary treatment and then incinerated to reduce their volume. There are many different ways to accomplish this incineration, but in recent years dealing with the dioxins and other harmful substances contained in the gases generated at incineration plants has become a problem, and there is now a need for a treatment method that can decompose harmful substances in a high-temperature oxidative atmosphere.

[0003] One such waste treatment method with which high-temperature treatment is possible is waste gasifying and melting, in which waste material is put into a pyrolyzing and melting furnace, dried, preheated, pyrolyzed, combusted, and taken out as slag or metal.

[0004] An example of the waste material gasifying and melting method will be described through reference to FIG. 1. The gasifying and reforming method illustrated in FIG. 1 comprises the following processes.

1. Pressing and degassing channel

   (1) Compaction of waste material, (2) Drying and pyrolysis

2. High-temperature reaction furnace, homogenizing furnace

   (3) Gasifying and melting, (4) Slag homogenization,
   (5) Gas reforming

3. Gas refining

   (6) Quenching (quenching and acid washing, acid washing), (7) Gas refining (alkali washing, desulfurization, dehumidification)

4. Water treatment

   (8) Water treatment (precipitation, desalting, etc.)

[0005] The basic constitution of this method involves the following flow.
Waste material, such as city garbage or industrial waste, that has piled up in a pit is compacted in a press, then heated and dry-distilled by indirect heating in a dry pyrolysis step, and sent to a high-temperature reaction furnace. A lance is placed at the bottom of the high-temperature reaction furnace, high-concentration oxygen is introduced into the furnace by the lance, this oxygen gas gasifies the carbon in the dry-distilled material, and this produces carbon monoxide and carbon dioxide. Also, since high-temperature water vapor is present, the carbon and water vapor bring an aqueous gas reaction that produces hydrogen and carbon monoxide. Organic compounds (such as hydrocarbons) also react with the water vapor and produce hydrogen and carbon monoxide.
As the result of the above reactions, a crude synthetic gas is recovered from the column top of the high-temperature reaction furnace.

[0006] Meanwhile, the melt produced at the bottom part of the high-temperature reaction furnace flows out from the high-temperature reaction furnace to a homogenization furnace. The melt contains carbon, trace amounts of heavy metals and so forth, and in the homogenization furnace these are gasified by sufficient oxygen or water vapor to produce hydrogen, carbon monoxide, and carbon dioxide. Because the metal melt has a higher specific gravity, it pools at the bottom of the slag in the homogenization furnace. The melt flow drops down into a water granulation system, where it is cooled and solidified, and a mixture of metal and slag is magnetically separated into metal and slag.

[0007] For the crude synthetic gas produced from the high-temperature reaction furnace, the temperature of the gas is rapidly lowered from about 1200°C to about 70°C by spraying acidic water from a quenching apparatus in order to prevent dioxins from being synthesized again. At this point the gas is washed with acidic water, and the chlorine and any heavy metal components such as lead contained in the crude synthetic gas are dissolved out during the washing.

[0008] The synthetic gas that was washed with acid is subjected to further acid washing as needed, and then to alkali washing, so that any remaining hydrogen chloride or other such acidic gas is neutralized and removed. Then, the hydrogen sulfide in the gas is converted into sulfur in a desulfurizing and washing apparatus, and this is recovered as a sulfur cake. The moisture is then removed from the synthetic gas in a low-temperature dehumidification step, after which the gas is utilized as a refined fuel gas.

[0009] FIG. 2 illustrates a known method to supply waste material to a gasifying and melting furnace.
In FIG. 2, 1 is a compacting apparatus to press and compact waste material in batches (batch-like steps), 2 is a compacting cylinder, 3 is a compaction support base, 4 is a tunnel type of heating furnace to dry, pyrolyze, and carbonize the waste material obtained from the compact-

ing apparatus 1 (hereinafter also referred to as compacted block), 4a is the drying zone for the compacted block, 4b is the pyrolysis and carbonization zone for the compacted block, 4_E is an inlet to the tunnel heating furnace 4, 5 is a high-temperature reactor, 10a and 10i are compacted blocks, 11_i and 11_n are carbonized compacted blocks (hereinafter also referred to as carbonized products), 12 is a mixture of the carbonized products and combustion residue, 13 is a port to blow in oxygen-containing gas, 14 is a melt, 14H is a melt discharge outlet, 15 is a port to blow in a combustible gas and oxygen-containing gas, 16 is a port to blow in oxygen, 20 is a waste material throw port, 21 is a lid to the waste material throw port, 22 is a port to push the carbonized product out of the tunnel heating furnace 4 (or, a port to put the carbonized product into the high-temperature reactor 5), 23 is an apparatus to quench the exhaust gas discharged from the high-temperature reactor 5 (hereinafter also referred to as generated gas), 24 is a gas refining apparatus, 25 is a gas discharge port for the high-temperature reactor 5, 26 is refined gas, f_1 is the direction of conveying the compacted blocks 10_a and 10_i, f_2 is the direction of conveying the carbonized products 11_i and 11_n, f_3 is the direction of flow of the pyrolyzed gas produced in the tunnel type of heating furnace 4, f_4 is the direction in which the oxygen-containing gas is blown into the high-temperature reactor 5, f_5 is the direction of movement of the compacting cylinder 2, f_6 is the direction of movement of the compaction support base 3, f_7 is the rotational direction of the lid 21 of the waste material throw port 20, f_8 is the direction in which the combustible gas and the oxygen-containing gas are blown in, and f_9 is the direction in which the oxygen is blown in.

[0010] In the waste treatment equipment shown in FIG. 2, first, a predetermined amount of waste material is supplied from the waste material throw port 20 to the compacting apparatus 1, and is then compacted in batches by the compacting apparatus 1 to obtain a dense compacted block 10a. Next, this compacted block 10a is pushed into a slender tunnel type of heating furnace 4 that has been heated from the outside (hereinafter referred to as the tunnel heating furnace).

[0011] Water contained in the waste material is squeezed out in the above-mentioned compaction step, and is pushed along with the waste material into the tunnel heating furnace 4. A cross section of the compacted block 10a has the same shape and size as a cross section of the inner walls of the inlet 4_E of the tunnel heating furnace 4, then, when the compacted block 10a is pushed in, it maintains its state of contact with the inner walls of the tunnel heating furnace 4, so the atmosphere inside the heating furnace can be sealed at the inlet to the tunnel heating furnace.

[0012] Every time a new block of compacted block is pushed in, the compacted block 10_i slides farther along through the tunnel heating furnace 4. The tunnel heating furnace 4 is heated from the outside as mentioned above, with the interior temperature rising to about 600°C, so the compacted block 10_i is dried, pyrolyzed, and carbonized during its conveyance and this temperature elevation processes.

[0013] The gas component generated by pyrolysis and the carbonized product 11n are introduced and blown into the high-temperature reactor 5, which is held at 1000°C or higher. After this, any combustible material in the carbonized product including mineral components and metal components is combusted and pyrolyzed by an oxygen-containing gas and then gasified. Here, the generated gas which is discharged from the high-temperature reactor 5 can be recovered as fuel gas containing carbon monoxide and hydrogen (hereinafter also referred to as fuel gas) by adjusting the oxygen content in the oxygen-containing gas.

[0014] The residual portion (non-combustible) which does not gasified by combustion and pyrolysis is melted in the high-temperature reactor 5, becoming the melt 14 composed of molten metal and molten slag, which is recovered from the melt discharge outlet 14H at the bottom of the high-temperature reactor 5.

[0015] In the conventional method described above, however, the compacted block is prone to breaking up and forming a bridge in the furnace when the waste material is thrown into the high-temperature reaction furnace, so a problem has been that the treatment could not be carried out efficiently.

[0016] Various methods have been proposed for introducing waste material into a furnace.

Patent Document 1 discloses a pellet forming apparatus used in a method to pelletize waste material such as chopped garbage, to dry and pyrolyze this in a vertical furnace, to pyrolyze the combustible portion of the waste material and recover it as a fuel gas, and to recover the non-combustible portion of the waste as molten metal and slag, wherein this pellet forming apparatus yields waste material pellets that are tough enough to hold their shape, without falling apart, while falling through the drying and pyrolysis zones of the furnace.

[0017] With an actual apparatus in which the above-mentioned pellet forming apparatus is adopted, a waste supply hole is located about 8000 mm from the bottom of a furnace, garbage is compacted into pellets by alternating hydraulic pistons in two pipes with an inside diameter of 200 mm, and these pellets are supplied into the furnace. For wet waste material, however, the material cannot be pelletized merely by compaction, so in actual practice the waste material is not pelletized. Also, even if the material is compacted and pelletized, because there is a large difference between the height of the waste supply hole and the layer height inside the furnace, the pellet will fall apart during introducing, and the garbage will be scattered inside the furnace and can get into the gas combustion chamber.

[0018] Patent Document 2 discloses a push-in feed apparatus to feed waste material into an incineration furnace, wherein a waste material retaining tank is provided above a push-in device that has a push-out port at its front end and a feed port at the front part of its upper wall, the front part of the bottom wall of the retaining tank communicates with the feed port, a suitable amount at a time of waste material in the retaining tank is fed into the push-in device by the movement of a conveyance plate, and the waste material that has been fed in is pushed through the push-out port by a push-in plate provided to this push-in device, and further pushed from there into an incinerating furnace that is contiguous with this port.

However, even though the use of this push-in feed apparatus is disclosed in Patent Document 2, there is no discussion whatsoever regarding the use for a reductive heat treatment furnace, nor is there any discussion about using the push-in feed apparatus to compact waste material into a block.

[0019] Patent Documents 3 and 4 disclose that, to supply waste material to a gasifying and melting furnace of waste material that has been fed into a supply hopper is compacted a first stage in just one direction at the bottom of the hopper as first, and then the waste material is subjected to a second stage of compaction in a direction perpendicular to the first stage of compaction, thereby producing a block that is supplied to a melting furnace.

[0020] Patent Document 5 discloses a method to treat waste material, in which the drying and pyrolysis of waste material are carried out continuously, after which the material is combusted and melted, wherein, in light of the fact that a large burden is imposed on the heat treatment system because the water contained in the waste material (waste material generally contains 25 to 50% water) becomes water vapor and is entrained during heat treatment and exhaust gas treatment, waste material that has been divided into large chunks or undivided and that includes an attendant liquid portion is compacted in batches to form a dense waste material (a compact), while maintaining its mixed and compounded structure; and then the dense compact is put into a channel that is heated to at least 100°C, so as to be in close contact with the inner walls of the channel; the channel is sealed so that the water vapor or pyrolyzed gases do not leak from the waste material inlet by regurgitation; the compact is slid along by a pushing force; the compact is dried in a drying section while maintaining frictional contact with the inner walls of the channel; the water (water vapor) is removed in the latter half of the drying section where pyrolysis does not occur very strongly (the portion with a temperature of 120 to 250°C); and then pyrolysis is performed in the pyrolysis section; after that, the material directly enters a high-temperature reaction furnace, where combustion, gas reforming, and melting are carried out.

[0021] Patent Document 6 discloses a waste material supply apparatus, to supply waste material to a gasifying and melting furnace, comprising a screw compaction conveyor having a compacting section which includes a screw and whose inside diameter gradually decreases toward the distal end, a parallel section formed at the distal end of the compacting section, and a sealed section whose inside diameter increases toward the distal end and which is continuous from the parallel section and communicates with the main part of the furnace.

However, what Patent Document 6 describes is an introducing by screw, and does not involve the compaction of waste material and the introducing of said waste material, simultaneously.

[0022] Patent Document 7 discloses waste material treatment equipment with which waste material is melted and gasified, wherein said equipment comprises a compacting apparatus to compact waste material, a heating furnace to dry, pyrolyze, and carbonize the compacted block obtained from the compacting apparatus, and a high-temperature reactor that produces fuel gas and a melt from the carbonized product obtained from said heating furnace, with a plurality of said heating furnaces being provided to a single high-temperature reactor. Also, it is described in the paragraph [0006] that the cross section of compacted block has the same shape and dimension as the cross section of inner walls of the inlet to a tunnel heating furnace, and that when the compacted block is pushed in, it maintains its state of contact with the inner walls of the tunnel heating furnace, so the atmosphere in the heating furnace can be sealed at the inlet to the tunnel heating furnace.

[0023] Patent Document 8 discloses a waste material treatment method with which waste material is melted and gasified, said method comprising a step of compacting waste material, a step of heating the compacted block thus obtained and drying, pyrolyzing and carbonizing the material while removing the gas generated in the drying, and a step of generating a melt and fuel gas by heating the obtained, carbonized product. Also disclosed is a waste material treatment method comprising a step of drying beforehand a waste material of a low calorific content to remove all or part of the water, and then compacting this product along with a waste material with a high calorific content, a step of heating the compacted block obtained in the above step drying, pyrolyzing, and carbonizing the material, and a step of heating the carbonized product obtained in the above step to produce a melt and fuel gas. Also, it is described in the paragraph [0006] that the cross section of compacted block has the same shape and dimensions as the cross section of inner walls of the inlet to a tunnel heating furnace, and that when the compacted block is pushed in, it maintains its state of contact with the inner walls of the tunnel heating furnace, so the atmosphere in the heating furnace can be sealed at the inlet to the tunnel heating furnace.

[0024] Patent Document 9 disclosed a waste material treatment method aimed at safely and environmentally friendly treating gaseous waste material, powdered waste material, or liquid waste material that is prone to scattering, without causing any scattering of the material around the waste material treatment plant, comprising a step of pressing and compacting the waste material in batches, a step of introducing the compacted block thus obtained into a tunnel heating furnace and drying, pyrolyzing, and carbonizing it, and a step of introducing the carbonized product thus obtained into a high-temperature reactor and combusting the material and melting the non-combustibles, wherein one or more types of waste material selected from gaseous waste material, powdered waste material, and liquid waste material are blown into the zone where the compacted block is pyrolyzed and carbonized in the high-temperature reactor or the tunnel heating furnace. Also, it is described in the paragraph [0005] that the cross section of compacted block has the same shape and dimensions as the cross section of inner walls of the inlet to the channel, and that when the compacted block is pushed in, it maintains its state of contact with the inner walls of the channel, so the system is sealed at the channel inlet.

[0025] Patent Document 10 discloses a waste material treatment method in which waste material is compacted and molded, then dried, pyrolyzed, and carbonized, and the carbide thus produced is melted and gasified to obtain a fuel gas, wherein, when general waste materials of various properties, such as water and ash components, are collected for treatment, and varying of the water content of the waste material and so forth result in insufficient carbonization in the carbonization step, or there is not enough carbon component, which serves as fuel, in the high-temperature reactor, there will not be enough heat in the high-temperature reactor to melt the minerals, metals, and other such residue in the carbonized product, so stable operation is impossible, and in light of this problem, either waste material in which the weight ratio of the ash and the carbon contained is at or below a specific value is supplied to a waste material compacting step, or the specific gravity of the ash and the carbon contained in the resulting waste material is adjusted to be not more than a specific value by mixing two or more types of waste material, and the resulting waste material is supplied to a compacting step. Also, it is described in the paragraph [0006] that the cross section of compacted block has the same shape and dimensions as the cross section of inner walls of the inlet to a tunnel heating furnace, and that when the compacted block 1 is pushed in, it maintains its state of contact with the inner walls of the tunnel heating furnace, so the atmosphere in the heating furnace can be sealed at the inlet to the tunnel heating furnace.

[0026] Patent Document 11 discloses a waste material treatment method in which waste material is compacted and molded, the compacted block is dried, pyrolyzed, and carbonized, the carbonized product thus obtained is combusted, and the ash is melted, wherein, when various waste materials are successively treated, the atmosphere temperature inside the high-temperature reactor varies depending on the type of waste material put into, and the amount of fuel gas supplied and the amount of waste material treated should be changed, which inevitably leads to problems of an increase in the amount of fuel gas used and a reduction in the amount of waste material treated due to lower thermal efficiency, in light of this situation, in order to achieve stable combustion of waste material and melt of its ash without using extra fuel for thermal compensation and without reducing the amount of waste material, the waste material to be compacted and molded is made into a blend of a plurality of types of waste material with different water contents, and the ratio of the plurality of types of waste material with different water contents is controlled so that the temperature of the compacted block is within a specific range in the step of drying, pyrolyzing, and carbonizing. Also, it is described in the paragraph [0006] that the cross section of compacted block has the same shape and dimensions as the cross section of inner walls of the inlet to a tunnel heating furnace, and that when the compacted block 1 is pushed in, it maintains its state of contact with the inner walls of the tunnel heating furnace, so the atmosphere in the heating furnace can be sealed at the inlet to the tunnel heating furnace.

[0027] Patent Document 12 discloses a waste material treatment method in which waste material containing plastics is compacted, the compacted waste material thus obtained is dry-distilled and carbonized, and the dry-distilled and carbonized product thus obtained is partially oxidized and gasified in a high-temperature reaction furnace in the presence of an oxygen-containing gas, wherein the compacted block is pushed into a slender tunnel heating furnace that is heated from the outside, the cross section of the compacted block has the same shape and dimensions as a cross section of the inner walls of the inlet to the heating zone of a tunnel heating furnace, and when the compacted block is pushed in, it maintains its state of contact with the inner walls of the tunnel heating furnace, so the gas in the heating furnace can be sealed at the inlet to the tunnel heating furnace. However, if the heating temperature of the tunnel heating furnace is raised, the plastics in the compacted block softens and melts or is pyrolyzed into a powder, and the gaps through which the gas flows can become clogged by the softened plastics or powder while the material slides through the tunnel heating furnace, and this prevents the gas from flowing from the tunnel heating furnace near the high-temperature reaction furnace inlet side, into the high-temperature reaction furnace. Consequently, the pressure rises inside the tunnel heating furnace, and at a certain point this pressure causes the dry-distilled and carbonized product near the high-temperature reaction furnace inlet side to suddenly pushed out and into the high-temperature reaction furnace, and a large quantity of gas is blown into the high-temperature reaction furnace all at once, as a result, the gas produced in the tunnel heating furnace can not spend enough time in the high-temperature reaction furnace, then the gas is discharged from the high-temperature reaction furnace without being fully decomposed, the result of which is that the gas contains dioxins and the amount of carbon sludge increases, among other problems. To solve these problems, it is described that the temperature in the dry-distillation and carbonization step is controlled according to the amount of plastics contained in the waste material.

[0028] Patent Document 13 discloses an apparatus for treating waste material in a gasifying and melting furnace, wherein the furnace is operated at a negative internal pressure, the feed apparatus to feed the waste material into the gasifying and melting furnace is provided with a combination of a pusher, a damper and a rotary valve or other such mechanical separating means so that excess air does not enter the furnace from the hopper, and gas sealing is accomplished by the layer thickness of the waste material itself and the separating means. When a gasifying and melting furnace is operated at positive pressure, however, by the seal of the layer thickness of the waste material itself and a separating means such as a damper or rotary valve, there is still a certain amount of gap, therefore gas from inside the furnace can leak into the hopper opening of the waste material feeder. To solve these problems, when the waste material is supplied to the main part of the gasifying and melting furnace via a feeder apparatus equipped with a hopper and a pusher, water vapor generated from the waste material between the outlet of the feeder and the main part of the gasifying and melting furnace is cooled and condensed, the voids in the waste material are filled in by this condensate, and gas is thereby prevented from leaking out from the waste material feeder of the gasifying and melting furnace.

[0029] Patent Document 14 discloses a method in which, in a waste material melting furnace that gasifies and melts waste material, when the waste material inside a waste material feed hopper provided to supply waste material to a melting furnace is pushed out and into the melting furnace by a waste material pusher provided at the bottom of the waste material feed hopper, the waste material is compacted, thereby enhancing the seal. With this method, however, in the case of waste material that contains no water, such as waste plastics, even though the material is compacted, it returns to its original condition then gaps form between blocks of adjacent waste material until it is supplied to the melting furnace, and gas inside the furnace blows out from these portions, or conversely air is sucked in from outside the furnace, which causes sealing problems. To solve these problems, the waste material supply apparatus comprises a waste material feed hopper, a waste material compacting apparatus provided at the bottom of said waste material feed hopper, and a humidification apparatus to humidify the compacted waste material. The waste material compacting apparatus is equipped with a gate provided between the bottom of the waste material feed hopper and said humidification apparatus, a waste material pusher to push the waste material out toward said gate and to compact the waste material, and means for scraping the waste material fed to the bottom of the waste material feed hopper from both sides of the feed hopper and for pressing over the waste material when the waste material is pushed out by said waste material pusher.

[0030] Patent Document 15 discloses that when gasifying and melting waste material, the treated product that has been divided into large chunks or is undivided and includes an attendant liquid portion is compacted in batches while maintaining its mixed and compounded structure, thereby forming a compact, and then the compact is put into a channel heated to at least 100°C by forced pushing under pressure, the compact maintains the state of contact with the channel walls produced by the forced pushing while sliding, until the liquid present at the outset is evaporated and the mechanical restitutive force had by the various treated material components is eliminated, and until the entrained organic components at least partly assume a binder function. This block of solid conglomerate is pushed out of the channel while maintaining its shape and structurally stable state, and is put into a high-temperature reactor whose entire volume is held at 1000°C or higher.

The above Patent Documents 3 to 15, make no mention whatsoever regarding any way to prevent the waste material from falling apart when it is put into the furnace after compacted and molded, nor do they discuss the relationship between the location where the waste material is supplied and the layer height level inside the furnace.

Patent Document 1: Japanese Patent Publication No. S52-124776

Patent Document 2: Japanese Patent Publication No. S54-123271

Patent Document 3: Japanese Patent Publication No. H9-89230

Patent Document 4: Japanese Patent Publication No. H9-89231

Patent Document 5: Japanese Patent Publication No. 2000-93917

Patent Document 6: Japanese Patent Publication No. 2003-185113

Patent Document 7: Japanese Patent Publication No. H11-270823

Patent Document 8: Japanese Patent Publication No. H11-270824

Patent Document 9: Japanese Patent Publication No. H11-281032

Patent Document 10: Japanese Patent Publication No. H11-316007

Patent Document 11: Japanese Patent Publication No. H11-337037

Patent Document 12: Japanese Patent Publication No. 2001-115165

Patent Document 13: Japanese Patent Publication No. 2004-3823

Patent Document 14: Japanese Patent Publication No. 2004-11954

Patent Document 15: Japanese Patent Publication No. H6-79252

DISCLOSURE OF THE INVENTION

[0031] It is an object of the present invention to provide a method for supplying waste material, with which waste material that has been compacted (hereinafter referred to as a "compacted block") is prevented from falling apart and scattering when it is put into a gasifying and melting furnace, and the backflow of CO, which is a toxic gas, is also prevented.

[0032] The inventors perfected the present invention upon discovering that a compacted block falls apart when the distance the compacted block falls within the furnace is too large when introducing a waste material into a gasifying and melting furnace.

Specifically, the present invention is as follows.

[0033]

(1) A method for supplying a waste material to a body of a furnace in an interior of which the waste material is heated and melted, wherein said waste material is compacted by a compacting apparatus into a compacted block so that a density of the waste material is at least two times and not more than 20 times a density prior to compaction, and the compacted block is supplied into the furnace from an introducing port provided in a wall of the furnace lower than a reforming section of said body of the furnace, either such that a drop distance within the furnace is not more than 3 m, or without the waste material being dropped.

(2) A method for supplying waste material according to (1) above, wherein a layer height level of the waste material inside the furnace is measured and/or calculated, and a supply of the waste material is controlled such that the drop distance within the furnace is not more than 3 m.

(3) A method for supplying waste material according to (1) above, wherein the waste material is supplied without being dropped within the furnace while it is confirmed by a pressure of a pusher that the layer height level of the waste material inside the furnace is at least a level that at least partially covers the introducing port, and/or the layer height level is calculated.

(4) A method for supplying waste material according to any of (1) to (3) above, wherein a highest point of the layer height level of the waste material inside the furnace is 6 m or less from a bottom of the furnace.

(5) A method for supplying waste material according to any of (1) to (4) above, wherein the compacted material is put into when a predetermined layer level is not detected after an elapse of a predetermined time beyond a time calculated by diving an amount of the compacted material by a set processing speed.

[0034]

(6) A method for supplying waste material according to any of (1) to (5) above, wherein a transmitter and a receiver of electromagnetic waves are installed on a side wall of the body of the furnace, and the layer height level of the waste material is measured by determining presence or absence of the material put into the furnace by a strength of electromagnetic wave signals transmitted through the furnace.

(7) A method for supplying waste material according to any of (1) to (6) above, wherein a position of said measurement level, at which the layer height level of the waste material is measured by determining presence or absence of the material put into the furnace by the strength of electromagnetic wave signals transmitted through the furnace, is a position between a level 3 m under an introducing port level and the introducing port level.

(8) A method for supplying waste material according to (6) or (7) above, wherein the transmitter and the receiver are provided across from each other on side walls of the body of the furnace.

(9) A method for supplying waste material according to (6) or (7), wherein a transceiver comprising an integrated transmitter and receiver is used as said transmitter and said receiver.

(10) A method for supplying waste material according to any of (6) to (9) above, wherein an electromagnetic waveguide that also serves as a burner gas introduction pipe is provided to said side wall of the body of the furnace, an electromagnetic wave transmitter and receiver are connected to said waveguide, a transmission and a reception of electromagnetic waves are performed by said waveguide, and admixture and deposition of foreign matter to the waveguide are prevented by a burner flame and the burner gas introduction through said waveguide.

[0035]

(11) A method for supplying waste material according to (10) above, wherein a plug whose function is to block off gas but transmit electromagnetic waves is inserted between the electromagnetic wave transmitter or receiver and a burner gas inlet of the waveguide, and the burner gas is prevented from entering the electromagnetic wave transmitter or receiver.

(12) A method for supplying waste material according to any of (1) to (11) above, wherein a size of the compacted block of waste material is such that a height is at least 0.1 m and not more than 1 m, and a width is at least 0.1 m and less than an inside diameter of the furnace.

(13) A method for supplying waste material according to any of (1) to (12) above, wherein one or more of waste water, process wastewater, and moisture are added in order to adjust a water content of the compacted block during production of the compacted block, or after production thereof and before the compacted block is supplied into the furnace.

(14) A method for supplying waste material according to any of (1) to (13) above, wherein the compacted block is supplied into the furnace after having

passed at least 0.3 m and not more than 5 m through a tunnel zone that is subjected to radiant heat inside the furnace, prior to being supplied into the furnace.
(15) A method for supplying waste material according to (14) above, wherein the tunnel zone subjected to radiant heat slopes downward at a drop port inside the furnace.
(16) A method for supplying waste material according to (14) or (15) above, wherein said tunnel zone subjected to radiant heat expands so as to be exposed readily to radiant heat in front of the drop port inside the furnace.

[0036]

(17) A method for supplying waste material according to any of (1) to (16) above, wherein the apparatus for supplying waste material comprises at least a compacting apparatus for compacting waste material, and a supply hopper that is provided to an upper part of the compacting apparatus and supplies the waste material to the compacting apparatus.
(18) A method for supplying waste material according to (17) above, wherein a pusher that pushes the waste material from the supply hopper provided to the upper part of the compacting apparatus and drops into the compacting apparatus is provided in between the compacting apparatus and the supply hopper.
(19) A method for supplying waste material according to (17) or (18) above, wherein an exhaust pipe is provided to the compacting apparatus or between said compacting apparatus and the supply hopper, and a gas containing carbon monoxide that has accumulated between the compacting apparatus and the supply hopper is exhausted through said exhaust pipe.
(20) a method for supplying waste material according to any of (17) to (19) above, wherein a backflow of the gas containing carbon monoxide in the furnace is prevented by separating the compacting apparatus and the supply hopper with a double damper.

[0037]

(21) A method for supplying waste material according to any of (1) to (20) above, wherein the compacted block is heated by providing, between the compacting apparatus and the furnace, a tunnel furnace in which an upper face and left and right faces are tapered, expanding toward a waste material introducing port provided on a wall of the furnace, so that the waste material does not come into close contact with inner walls.
(22) A method for supplying waste material according to (21) above, wherein the backflow of the gas containing carbon monoxide in the furnace is prevented by introducing water vapor into said tunnel furnace.
(23) A method for supplying waste material according to any of (1) to (22) above, wherein said melting furnace is a gasifying and melting furnace or a gasifying, melting and reforming furnace for the waste material.
(24) A waste material supply apparatus for introducing a waste material to a melting furnace, said apparatus comprising:

> a compacting apparatus for compacting the waste material into a block so that a density of the waste material is at least two times and not more than 20 times a density prior to compaction;
> a supply hopper for supplying the waste material to the compacting apparatus, provided on an upper part of the compacting apparatus;
> a pipeline for supplying the compacted block compacted by the compacting apparatus to a high-temperature heating furnace; and
> a means for measuring and/or calculating the layer height level of the waste material inside the furnace, and controlling an amount of the waste material supplied such that a drop distance of the compacted block within the furnace is not more than 3 m.

[0038]

(25) A waste material supply apparatus according to (24) above, wherein a pusher that drops the waste material into the compacting apparatus from the supply hopper is further provided between the compacting apparatus and the supply hopper.
(26) A waste material supply apparatus according to (24) or (25) above, wherein the means for controlling the amount of the waste material supplied includes a means for detecting a level of a deposited surface of the waste material inside a melting furnace by measuring an amount of attenuation of microwaves.
(27) An apparatus for heating and melting a waste material, wherein a waste material supply apparatus according to any of (24) to (26) is provided as an apparatus for supplying the waste material to a melting furnace.
(28) An apparatus for heating and melting a waste material according to (27) above, wherein the melting furnace is a waste material gasifying and melting furnace or a gasifying, melting and reforming furnace.
With the waste material supply method of the present invention, a block of compacted waste material is put into a furnace only after the layer height level of the waste material in the furnace has been adjusted, the effect of which is that the compact is less likely to break apart. Also, the breaking apart of the compact during furnace introducing is further prevented

by heat treating the surface of the compact by heating with radiant heat or the like after compaction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039]

FIG. 1 is a schematic diagram of a waste material treatment process by gasification reforming;
FIG. 2 is a diagram of a conventional method to supply waste material to a gasifying and melting furnace;
FIG. 3 is a graph of the relationship between compaction density and amount of dust generated with drop distance varied when a compacted block was dropped;
FIG. 4 is a diagram illustrating Example of the present invention;
FIG. 5 is a diagram illustrating Example of the present invention;
FIG. 6 is a detail diagram of the pusher and the supply hopper in the present invention;
FIG. 7 is a diagram illustrating Example of the present invention;
FIG. 8 is a diagram illustrating Example of the present invention;
FIG. 9 is a diagram illustrating Example of the present invention;
FIG. 10 is a diagram illustrating Example of the present invention;
FIG. 11 is a diagram illustrating Example of the present invention;
FIG. 12 is a diagram illustrating Example of the present invention;
FIG. 13 is a diagram illustrating Example of the present invention;
FIG. 14 is a diagram illustrating Example of the present invention;
FIG. 15 is a diagram illustrating Example of the present invention;
FIG. 16 is a diagram illustrating Example of the present invention;
FIG. 17 is a diagram illustrating Example of the present invention;
FIG. 18 is a diagram illustrating a method to calculate the layer height level employed in Example;
FIG. 19 is a diagram illustrating a method to calculate the layer height level employed in Example; and
FIG. 20 is a diagram illustrating a method to calculate the layer height level employed in Example.

EXPLANATION OF REFERENCE NUMERALS

[0040]

1	compacting apparatus to press and compact waste material in batches
2	compacting cylinder
3	compaction support base
4	tunnel type of heating furnace to dry, pyrolyze and carbonize compacted waste material (compacted block)
4a	drying zone for compacted block
4b	pyrolyzing and carbonizing zones for compacted block
4_E	inlet to tunnel heating furnace
5	high-temperature reaction furnace
10_a, 10_i	compacted block
11_i, 11_n	carbonized compacted block (or carbonized product)
12	mixture of carbonized product and combustion residue
13	port to blow in oxygen-containing gas
14	melt
14H	melt discharge outlet
15	port to blow in combustible gas and oxygen-containing gas
20	waste material throw port
21	lid of waste material throw port
22	port of tunnel heating furnace to push carbonized product out (introducing port to high-temperature reactor for carbonized product)
23	quenching apparatus for generated gas which is discharged from high-temperature reactor (exhaust gas)
24	gas refining apparatus
25	gas discharge port of high-temperature reactor
26	refined gas
31	furnace body
32	refractory material
33	furnace casing (iron shell)
34	measurement seat
35	measurement nozzle
36	electromagnetic wave transmitter
37	electromagnetic wave receiver
41	microwave transmitter
42	waveguide
43	waveguide guide pipe
44	water-cooled pipe
45	gas sealing mechanism
46	ball valve
47	furnace brick
48	iron shell
49	heatproofing brick
50	position at waveguide slag removal
51	measurement position
60	compacting apparatus
61	supply hopper
62	pusher
63	waste material pit
64	waste material crane
65	cooling zone
66	tunnel furnace
67	electric heater
70	melting furnace
f_1	direction of conveying compacted block

f_2 direction of conveying carbonized product
f_3 direction of flow of pyrolyzed gas generated in high-temperature reactor
f_4 direction in which oxygen-containing gas is blown into high-temperature reactor
f_5 direction of movement of compacting cylinder
f_6 direction of movement of compaction support base
f_7 rotational direction of lid of waste material throw port
f_8 direction in which combustible gas and oxygen-containing gas are blown into high-temperature reactor
f_9 direction in which oxygen is blown in

BEST MODE FOR CARRYING OUT THE INVENTION

[0041] In the present invention, density of the waste material is adjusted to at least two times and not more than 20 times the density prior to compaction by a compacting apparatus. Compacting the waste material into a block prevents the scattering of waste material to the upper part. If the material is not compacted into a block, waste material especially paper-thin waste material tends to be entrained by gas to the upper part of the furnace. This compaction also ensures good gas flow at the lower part of the furnace, and prevents uneven flow or blow-by. Particularly when the melting furnace is a gasification reforming furnace, if the solid waste material scatters into the reforming furnace, the gas reforming is prone to be inadequate, and the gas is more apt to be conveyed out of the furnace without being reformed.

[0042] In the present invention, scattering of the waste material within the furnace is prevented either by supplying the compacted block of waste material into the furnace from a introducing port provided in the furnace wall lower than a reforming section of the furnace body, either such that the drop distance within the furnace is not more than 3 m, or without being dropped.

More specifically, one of the following (1) and (2) is done.

(1) Scattering is prevented by adjusting the packed bed level within the furnace so that the packed bed level does not exceed 3 m from the introducing port on the furnace wall. The term "drop distance" here refers to the vertical distance between the lower end of the waste material just prior to its fall through the furnace, and the waste material introducing plane position.

(2) Scattering is prevented by adjusting the packed bed level within the furnace so that part of the packed bed level is higher than the bottom of the introducing port.

Since the compacted shape can be maintained during the introducing of the waste material into the furnace by controlling the density and the drop distance as discussed above, not only is there less bridge formation, but there is also less unevenness and less blow-by.

The packed bed level can be detected as follows.

a. The packed bed level can be detected directly with a level gauge that makes use of microwaves or the like.

b. The packed bed level can be sensed by the pusher pressure during insertion into the furnace.

c. The packed bed level can be found by calculation.

[0043] The following is the reason behind compacting the waste material and thereby adjusting the density of the waste material to at least two times and not more than 20 times its density prior to compaction, and adjusting the drop distance within the furnace to not more than 3 m, and preferably not more than 1 m.

FIG. 3 shows the results of a test involving the measurement of the amount of dust generated when a 150 t/d scale gasification reforming furnace was operated at various drop distances and waste material compaction densities. The waste material used in this test was a mixture of general waste material having a water content of 51%, a combustible content of 42%, an ash content of 7%, a lower calorific value of 9.2 MJ/kg, and a bulk density of 150 to 300 kg/m^3, and industrial waste material such as waste plastics and ASR (Auto Shredder Residue) having a bulk density of 10 to 150 kg/m^3, with the mixing ratio of the industrial waste material of 0 to 60%. The pressure applied by the press in the test was 10 to 100 kg/cm^2 (0.98 to 9.8 MPa).

The term "compaction density" here is a value obtained by dividing the length of the waste material prior to compaction along the compaction direction by its length after compaction along the compaction direction. "Drop distance" is the vertical distance between the lower end of the waste material just prior to its fall through the furnace, and the waste material introducing plane position. The nondimensional dust quantity is a value obtained by nondimensionalizing the amount of generated dust with the maximum amount of dust that is operationally permissible.

The maximum amount of dust that is operationally permissible varies depending on the purpose and the dust recovery apparatus, but is preferably not more than 5% of the waste material to be treated.

[0044] From FIG. 3, a nondimensional dust quantity of 1 or less is achieved in the case of a compaction density of at least 2 times, and a drop distance of 3 m or less. No additional effect was obtained by having the compaction density higher than 20 times.

Based on the above results, in the present invention, the waste material is compacted to a density of at least two times and not more than 20 times, and its drop distance through the furnace is set at not more than 3 m.

Furthermore, when the drop distance is 1 m or less, the nondimensional dust quantity is 0.5 or less, and the reduction in dust generation is even better. It is therefore preferable for the drop distance to be 1 m or less.

Also, since bridge formation often occurs by fusing together of waste materials, it is preferable to prevent the compacts from fusing together by raising the surface temperature of the compacted blocks beforehand and effecting a phenomenon such as surface carbonization.

[0045] The method to compact the waste material preferably involves batch compaction by extrusion.

If the compacting apparatus is a continuous type such as screw compaction, the size of the compacted blocks will be smaller and the compacted blocks will be weaker in strength. Batch compaction is preferable in order to increase the form of the compacted blocks. Also, directly pushing out the material and introducing it into the melting furnace are a good way to put the material into while keeping the compacted state. The gas sealing by the compacted blocks is enhanced by arranging the direction of compaction to be the same as the direction of pushing out the waste material.

[0046] The size of the compacted block of waste material is preferably such that the height is at least 0.1 m and not more than 1 m, the width is at least 0.1 m, preferably at least 0.3 m and not more than the width of the inside of the furnace, and the length is preferably 0.1 to 1 m.

The compacted shape is not limited to rectangular but is preferably planar when its size is increased in order to improve the processing capacity. It is not favorable to excessively increase the size of the block when put into the melting furnace, in terms of ventilation.

[0047] More dust will be scattered if the height of the compacted block is less than 0.1 m. Also, the upper portion of the compacted block will fall apart during introducing if the height of the compacted block is over 1 m. More dust will also be scattered if the width of the compacted block is less than 0.1 m. The width, unlike height, poses less problem of the waste material falling apart when it drops during introducing, then at least 0.3 m is preferable. If the width of the compacted block is larger than the inside diameter of the furnace, the compacted block will fall apart during introducing.

[0048] The compacted blocks preferably move on an incline so that they can maintain their shape as much as possible until they are put into the furnace. It is also preferable for them to be little level difference in the layer height and the compacted block inside the furnace. The level can be preferably measured either continuously or intermittently with longer intervals than regular intervals of introducing, but can also be calculated. The level may be calculated, for example, by a method in which the level deviation is found from the stagnation volume, which is calculated by deriving a deviation of the level by use of the stagnation density in the furnace and the surface area in the furnace with the amount of stagnation calculated, for example: the total introduced amount (waste material + gas amount) - the generated amount (amount of generated gas, amount of generated water, amount of generated melt).

[0049] The compacted blocks are preferably put into the heating furnace through an introducing port provided on the furnace wall portion between the reforming section of the furnace and the upper part of the deposited layer in the furnace. This is because the drop distance is large by introducing the material from the upper part of the furnace, then, the block formed by compaction will tend to fall apart during its fall.

The highest point of the layer height level of the waste material inside the furnace is preferably 6 m or less from the bottom of the furnace. This is because a higher layer height makes it more likely that bridging (shelf-like situation) occurs. A lower layer height allows the material to be melted and gasified in less time, so there is less breaking apart of the material, in addition, the packed bed pressure is lower and there is less crumpling, which also leads to less breaking apart.

[0050] FIG. 4 illustrates an example in which the compacted blocks of waste material do not drop through the furnace. As shown in FIG. 4, the tunnel heating furnace is designed such that the floor of the furnace slopes downward toward the waste material introducing port side of the furnace, and the packed bed level is adjusted so that part of the packed bed level in the furnace is above the bottom part of the introducing port, accordingly the compacted blocks are supplied into the furnace without dropping.

[0051] If the highest point of the layer height level in a steady state of the waste material in the furnace is more than 6 m from the furnace bottom, it will be difficult for the non-steady state that reaches to the level control position in the furnace to be restored to a steady state. Furthermore, as the deposited layer becomes higher, a part of severe pressure loss due to the carbonized and melted waste material is longer, which causes abnormal descent (shelf-like situation) of the waste material and blow-by, and this in turn leads to disintegration of the compacted blocks and an increase in dust scattering.

[0052] An example of the waste material supply apparatus used to implement the method of the present invention will now be described through reference to the drawings.

FIG. 5 shows an apparatus comprising a compacting apparatus 60 and a supply hopper 61 that is provided to the upper part of the compacting apparatus 60. The compactor 60 and a melting furnace 70 are connected via a cooling zone. A pusher 62 is preferably provided in between the compacting apparatus 60 and the supply hopper 61. The waste material is put into the supply hopper 61 from a waste material pit 63 by a waste material crane 64, then put into the compacting apparatus 60 by the pusher 62, where it is compacted and formed to be massive then a compacted block is made. A cooling zone 65 is provided along the piping between the compacting apparatus 60 and the melting furnace 70.

[0053] FIG. 6 shows the details of the supply hopper 61 and the pusher 62.

Gas sealing is also enhanced by the combination of the supply hopper 61 and the pusher 62, and in addition the amount supplied to the compacting apparatus 60 can be kept constant, which affords a consistent size of the compacted blocks and achieves sealing difference reduced. FIG. 7 illustrates an example of providing a tunnel furnace (tunnel zone, or heating zone) 66 in between the compacting apparatus 60 and the melting furnace 70. The tunnel furnace 66 is heated by hot air.

[0054] With the present invention, preheating between the compacting apparatus 60 and the melting furnace 70 is not necessarily required, but preheating is preferable for the following reasons.

Maintaining the waste material in a block shape is preferable in order to improve gas flow in the melting furnace and enhance smooth movement. Bridge formation often occurs by the fusing together of waste materials, but if the compacted blocks are heat treated at 800°C or lower in their compacted state prior to entering the melting furnace, the outer part of the blocks will solidify, then, the block shape will be better kept in the melting furnace, and the compacted blocks can be prevented from fusing together. Particularly for paper or plastic films, if they are not in the form of a block, they will scatter in the melting furnace with their film form, and the generated gas can clog the piping, or lead to clogging of the cooling apparatus. FIG. 7 shows an example in which compacted blocks are heated in a tunnel furnace provided with a hot air inlet and outlet. The length of the heating zone is preferably longer than the thickness of the compact, and preferably at least 0.3 m and not more than 5 m.

[0055] The tunnel furnace may be formed such that it slopes downward at a drop port inside the furnace. Using a downward slope prevents the compacted block from breaking apart while falling at introducing. Also, using a downward slope opens up a gap above the compacted block, which facilitates exposure to heat radiation and improves the flow of gas produced by drying or pyrolysis.

[0056] As shown in FIGS. 8a and 8b, the upper face and the left and right faces of the tunnel furnace 66 may have a taper that expands toward the outlet, so that the compacted blocks do not come into close contact with the inner walls, thereby, a gap is opened above and to the left and right of the compacted blocks, which facilitates exposure to heat radiation and also improves the flow of gas produced by drying or pyrolysis.

As shown in FIG. 9, the slope of the inside introducing port of the melting furnace 70 may also be tapered, which allows the compacted blocks to undergo heat radiation better and also improves the flow of gas produced by drying or pyrolysis.

[0057] The compacted blocks may be heated by indirect heating instead of direct heating such as in a tunnel furnace. However, a method involving indirect heating with hot air entails more complicated equipment such as a hot air generator and a heated gas circulation apparatus, accordingly, heating with an electric heater or a liquid heat medium is preferable as the indirect heating method. FIG. 10 shows an example of heating with an electric heater 67.

[0058] Toxic gas such as CO is generated in a tunnel furnace or melting furnace, and the CO generated must be prevented from flowing back into the supply hopper in order to prevent this toxic gas from causing accidents. The following are ways to prevent CO backflow.

[0059] (1) (In the case of comprising a compacting apparatus and a supply hopper) Safe operation can be ensured by providing an exhaust pipe to the compacting apparatus or in between the compacting apparatus and the supply hopper, exhausting the toxic gas, and pumping this to a combustion line or the like.

FIG. 11a shows an example of employing natural exhaust, and FIG. 11b shows an example of forced exhaust by providing an exhaust fan to the exhaust pipe. Further FIG. 11c shows an example of suction exhaust in which the exhaust pipe is connected to a deodorizing and exhausting line.

[0060] (2) A double damper is provided between the compacting apparatus and the supply hopper. Safe operation can be ensured by pumping the gas between the double seals to a combustion line or the like.

FIG. 12 shows an example of providing a double damper between the compacting apparatus 60 and the pusher 62.

[0061] (3) The moisture content is adjusted by adding water (one or more of waste water, process wastewater, and moisture). Gas is sealed by the compacted blocks, but dry compacted blocks contain voids through which gas can pass, so the seal is not complete. Accordingly, the passage of gas can be prevented by adding water so that it is present in the voids of the compacted blocks.

[0062] (4) Water vapor is introduced into the tunnel furnace, from the compacting apparatus to the inside of the furnace.

Water vapor in the compacted blocks is condensed as water by introducing water vapor into the tunnel furnace, between the compacting apparatus and the inside of the furnace, and then cooling between the compacting apparatus and water vapor inlet. This reduces the gas ventilation.

FIG. 13 illustrates a specific method to add steam. FIG. 13 is a vertical cross sectional view of a tunnel furnace, in which a means to supply steam to the tapered roof of the tunnel furnace is provided. The steam supply means is composed of a steam supply header and a steam addition nozzle that branches off from the steam supply header.

[0063] FIG. 14 shows an example of providing an exhaust pipe between the compacting apparatus 60 and the supply hopper 61.

FIG. 15 shows an example of adding water or water vapor to the piping between the compacting apparatus 60 and the melting furnace 70, and also providing an exhaust pipe between the compacting apparatus 60 and the supply hopper 61.

FIG. 16 shows an example of providing an exhaust pipe between the compacting apparatus 60 and the supply hopper 61, and also providing a double damper between the compacting apparatus 60 and the pusher 62.

FIG. 17 shows an example of adding water or water vapor to the piping between the compacting apparatus 60 and the melting furnace 70, and also providing an exhaust pipe between the compacting apparatus 60 and the supply hopper 61, and further providing a double damper between the compacting apparatus 60 and the pusher 62.

[0064] In prior art (see Patent Documents 7-9 and so on), the compacted blocks have to be in close contact with the inner walls of the tunnel furnace to prevent the backflow of toxic gas, but in the present invention, the compacted block do not necessarily have to be in close contact with the inner walls of the tunnel furnace. Gas backflow can be prevented by a combination of the above backflow prevention methods, even if the blocks are not in close contact with the inner walls of the tunnel furnace.

[0065] In the present invention, as mentioned above, the distance that the waste material drops through the furnace must be not more than 3 m.

Accordingly, a level sensor is used to detect the height level of the deposited layer of waste material in the furnace, and when a predetermined layer height level is not detected after the elapse of a predetermined time beyond a time calculated by diving the amount of compacted material by a set processing speed, a decision of pushing out the compacted block is made, and the introduce amount is controlled.

If no level sensor is installed, then the same control is performed by calculating whether or not a predetermined level height has been reached. The level may be calculated, for example, by a method in which the level deviation is found from the furnace stagnation density and the surface area in the furnace with the stagnation volume, which is calculated as: the total introduced amount (waste material + gas amount) - the generated amount (amount of generated gas, amount of generated water, amount of generated melt), for instance.

[0066] It is preferable for the amount of generated gas to be kept constant, therefore the introducing rate is also preferably kept constant. For this purpose, the blocks of waste material are preferably put into the melting furnace by pushing them out from an insertion port stepwise. There will be greater fluctuation in the amount of gas generated if two or more blocks of waste material are put into all at once.

[0067] A method to keep the introducing rate constant will now be discussed.

An example will now be described is a method to keep the introducing rate constant in the case of a layer height level management method in which, basically, when it is detected that the layer height level is the layer height-managed level of the deposited layer (hereinafter referred to as the SL) by use of a level sensor to detect the SL (hereinafter this detection is referred to as SL detection), introducing is carried out one or more times, as necessary, until the SL detection state no longer holds. If we let W (kg/s) be the set amount of waste material to be treated and w (kg/iteration) be the amount of waste material in one pressing, then the average introducing interval t (sec/iteration) is defined as the quotient of dividing w by W. If T (sec) is the time elapsed since the previous introducing, then the next introducing is set to be T = a_1t to a_2t (a_1 = 0.1 to 1, a_2 = 1 to 10).

The introducing can be spaced out and continuous introducing prevented, by beginning the next introducing only after waiting until T = a_1t, even when the SL has not be exceeded in a single introducing or when the SL is detected right after an introducing. Introducing will also be performed only one time in the case that the level does not drop soon due to bridging or the like then there is no SL detection even though T = a_2t. After this, a single introducing is performed when there is still no SL detection a_2t (sec), and this process is repeated. As a result, continuous introducing of the next material can be avoided even if the bridging of put material is broken up and the level drops suddenly, therefore this in turn keeps the amount of generated gas constant.

[0068] In implementing the present invention, it is preferable for the furnace diameter in the space at the upper part of the melting furnace to be larger than the furnace diameter at the location where the waste material is put into the furnace. This lowers the superficial velocity in upper portion of the reaction furnace, so amount of scattering particles can be decreased.

[0069] The method to detect the layer height level of the put material in the melting furnace will now be described in detail.

FIG. 18 is a simplified partial cross sectional view of a furnace body provided with a layer height level detection apparatus that can be used in the present invention. In the figure, the furnace body 31 comprises a refractory material 32 and a furnace casing (iron shell) 33 that covers the refractory material. An electromagnetic wave transmitter 36 and an electromagnetic wave receiver 37 are provided across from each other on a measurement nozzle 35 mounted on a measurement seat 34 in a side face of the furnace.

Microwaves are preferably used as the electromagnetic waves. It is desirable for the microwave output to be high, at least 0.5 kW. Preferably, the inside of the measurement nozzle 35 is filled with ceramic fiber or another such adiabatic refractory fiber or a mold made from such fiber, so that the heat inside the furnace does not affect the transmitter and receiver, and a lid is put on the measurement seat to prevent the gas from leaking out of the furnace. As needed, the transmitter and receiver may be cooled by purging with nitrogen gas or air.

[0070] The above example is of a through-type in which the receiver receives microwaves that have been transmitted by the transmitter through the furnace, but, a reflection type of transceiver in which a transmitter and receiver are integrated may be used, a measurement port provided at just one place in the furnace wall, and measurement made with this transceiver.

[0071] FIG. 18 shows a combination of an electromagnetic wave receiver and an electromagnetic wave transmitter provided in two stages in the vertical direction of the furnace, but three or more stages may be provided instead. When a plurality of stages are furnished, the upper limit to the attachment positions is preferably the highest point to which the put material is expected to piled up (the lower part of the bell, or below the bell), and the lower limit is the upper part of the main impeller opening. As long as the attachment positions are in between these two limits, they may be at any height, and any number of stages may be used.

[0072] In the example illustrated, no opening has been made in the refractory material of the attachment seat portion of the electromagnetic wave transmitter and receiver, and electromagnetic waves are to be detected through the refractory material of the furnace body. The reason for this is that if an opening is given, scattered material in the furnace will adhere to and piled up around the opening and make measurement impossible, then this is to be avoided.

[0073] If a transmitter and receiver are provided in the opening of a furnace body that has already had an opening made in it, then this opening is to be filled with an adiabatic refractory material or some other such filling material to prevent scattered material in the furnace from adhering and piled up. Doing this achieves stable detection of the layer height over a long term, increases the service life of the equipment, and greatly cuts down on maintenance work.

[0074] The electromagnetic wave transmitter is preferably one with a high output, and the electromagnetic wave receiver is preferably one with a high sensitivity. The level where the transmitter and receiver are installed as a pair (the height of the attachment seat) is determined according to a layer height control value, but these can be installed at a plurality of places (a plurality of levels), rather than just at one place (one level), in order to deal with changes in the layer height control value corresponding to the operating status, or to allow detection at a plurality of points .

[0075] In the case that microwaves are used as the electromagnetic waves, if molten slag adheres to the furnace inner surface of the brick for heat shield, this is the most significant cause of failure in ensuring enough reliability in the detected values of the waste material introducing level obtained by microwaves. To ensure the reliability, in the apparatus shown in FIG. 19, no heat shielding brick is installed to protect the microwave transmitter and microwave receiver against the high-temperature atmosphere in the furnace, and the tip portion of the waveguide of the microwave transmitter is designed to extend up to the furnace sidewall portion of the melting furnace brick.

[0076] The furnace walls comprise furnace brick 47 and an iron shell 48, and a water-cooled pipe 44 is equipped with passing through the furnace wall. Heatproofing brick 49 is provided to the end of the water-cooled pipe 44 that is inside the furnace, and a waveguide guide pipe 43 is provided inside the water-cooled pipe 44. A waveguide 42 to guide the microwaves transmitted from the microwave transmitter 41 is slidably inserted in the waveguide guide pipe 43. The microwave transmitter 41 is movably mounted so that when no measurement is performed, it is in the maintenance position shown in the drawing, and during measurement, it is in the measurement position shown.

[0077] To remove any molten slag that adheres to the tip of the waveguide 42 of the microwave transmitter 41, the microwave transmitter 41, which is linked to the rear end of the waveguide 42 used for microwave transmission, is advanced about 50 mm from the measurement position to its farthest advance position, and this removes the molten slag adhering to the tip of the waveguide.

[0078] Also, to boost the function of removing molten slag adhering to the tip of the waveguide 42 of the microwave transmitter 41, and also to cool the waveguide, the system is purged with nitrogen gas as an inert gas supplied from a purging nitrogen gas pipe linked to the waveguide 42 of the microwave transmitter 41.

[0079] Thus providing the microwave transmitter movably, and providing a cooling pipe, a purging nitrogen gas pipe, and heatproofing brick increases the heat resistance and the cooling efficiency of the microwave transmitter, and also prevents dust and gases from infiltrating the system.

[0080] Another example of the apparatus that detects the waste material level will be described through reference to FIG. 20.

A pair of electromagnetic waveguides that also serve as burner gas introduction pipes are provided so as to pass through the furnace wall composed of heat shielding brick. The electromagnetic wave transmitter and electromagnetic wave receiver are installed as a pair, facing each other, in the furnace wall below the melting furnace introducing port. A case in which electromagnetic waves are emitted horizontally is shown in the drawing, but the electromagnetic waves do no necessarily have to be emitted horizontally, and the direction may be suitably determined as dictated by the setting of the deposition level of put material to be detected, equipment restrictions, and so forth. However, to shorten the electromagnetic wave transmission distance and enhance detection accuracy, it is preferable for the electromagnetic waves to be emitted horizontally.

[0081] The combustion burner is preferably one with the multiple pipe structure shown in the drawing. The inner pipe of the multiple pipe is used as a fuel gas introduction pipe and also as an electromagnetic wave waveguide, while the outer pipe is used to introduce air or oxygen. The outer pipe has a structure that allows it to be water-cooled. The electromagnetic wave transmitter or electromagnetic wave receiver is connected to a later stage of the inner pipe, which is the combustion burner.

Employing the above structure achieves prevention of molten slag infiltrating and adhering to the tip of the waveguide (on the furnace inner wall side) by the burner flame, and prevents tip clogging.
The electromagnetic wave transmitter or electromagnetic wave receiver may be provided so as to be capable of advancing and retracting as shown in the drawing in order to facilitate maintenance.

[0082] When microwaves are used as the electromagnetic waves, a frequency of the microwaves is preferably from 8 to 30 GHz. By this frequency, detection accuracy will not be affected by interference between the microwaves and the flame plasma.
The burner flame is a plasma, and it is known that a plasma generally has a plasma oscillation frequency inherent to its type, and blocks any electromagnetic waves with a lower oscillation frequency than the plasma. The electron density ne (cm^{-3}) of a burner flame plasma is about 10^8, and the plasma oscillation frequency fp is calculated with this, as $fp = 9 \times 10^3 \times ne^{1/2}$, which works out to about 90 MHz. In contrast, when microwaves with a far higher oscillation frequency of 8 to 30 GHz are used, there will be no problems such as blockage by the flame. How much the microwave intensity was attenuated was checked experimentally using a microwave level gauge, and this revealed that a substantially constant microwave intensity (although the attenuation during burner ignition is not zero) can be ensured regardless of whether or not a burner flame exists.

[0083] The gas sealing mechanism provided in the waveguide shown in FIG. 20 is, specifically, a plug, the function of which is to block gases but transmit microwaves between the burner gas introduction port and the microwave transmitter or receiver during the introduction of burner gas. Providing the plug prevents burner gas from entering the microwave transmitter or receiver, and prevents the explosion of combustible gases inside the transmitter or receiver. A synthetic resin, for example, can be used as the material of the plug.

[0084] Numerous small holes are made around the periphery of the waveguide to ensure good gas introduction and reduce microwave loss when introducing burner gas into the waveguide. Since microwave leakage occurs if there are openings larger than the wavelength of the microwaves, these openings must be sufficiently smaller than the wavelength of the microwaves in order to prevent such loss.

[0085] The microwaves emitted from the microwave transmitter are received by the microwave receiver, and the amount of attenuation of the microwaves is measured. There is only a tiny amount of microwave attenuation when the microwaves emitted from the microwave transmitter are received by the microwave receiver without passing through compacted waste material that has been deposited in the melting furnace. On the other hand, when the microwaves are received by the microwave receiver after passing through compacted waste material, the amount of microwave attenuation changes in proportion to the distance of passage through the compacted waste material.

[0086] In other words, the longer the distance that the microwaves travel through compacted waste material, the greater their attenuation. In view of this, a threshold value is set beforehand, the measured microwave attenuation is compared with the threshold value, and it is determined that the compacted waste material inside the melting furnace has reached a certain deposition level when the measured attenuation exceeds the threshold value.

[0087] As discussed above, in the present invention, the measured value of microwave attenuation is compared to the threshold value, so the level to which compacted waste material has been deposited can be detected with just a pair of microwave transmitter and microwave receiver.

[0088] The above example is of a through-type in which the receiver receives microwaves that have been transmitted by the transmitter through the furnace, but a reflection type of transceiver in which a transmitter and receiver are integrated may be used, with a measurement port provided at just one place in the furnace wall, and measurement made with the transceiver mounted. An advantage of a through-type is that the microwave path is shorter, so there is less signal attenuation and it is unlikely to be affected by noise, but it requires that measurement ports be provided at two locations. A reflection type only needs a measurement port at one location, then it imposes fewer restrictions on the installation site than a through-type, but because the signal travels back and forth through the furnace, drawbacks include signal attenuation and more noise.

INDUSTRIAL APPLICABILITY

[0089] The method of the present invention for supplying waste material prevents compacted blocks of waste material from falling apart and scattering during introducing into the furnace, and also prevents the backflow of CO, which is a toxic gas, and therefore can be used favorably as a waste material supply method in waste material treatment equipment that is used for melting and gasifying waste material in a gasifying and melting furnace.

Claims

1. A method for supplying a waste material to a body of a furnace in an interior of which the waste material is heated and melted,
wherein said waste material is compacted by a compacting apparatus into a compacted block so that a density of the waste material is at least two times and not more than 20 times a density prior to compaction, and the compacted block is supplied into the furnace from an introducing port provided in a

wall of the furnace lower than a reforming section of said body of the furnace, either such that a drop distance within the furnace is not more than 3 m, or without the waste material being dropped.

2. A method for supplying waste material according to Claim 1, wherein a layer height level of the waste material inside the furnace is measured and/or calculated, and a supply of the waste material is controlled such that the drop distance within the furnace is not more than 3 m.

3. A method for supplying waste material according to Claim 1, wherein the waste material is supplied without being dropped within the furnace while it is confirmed by a pressure of a pusher that the layer height level of the waste material inside the furnace is at least a level that at least partially covers the introducing port, and/or the layer height level is calculated.

4. A method for supplying waste material according to any of Claims 1 to 3, wherein a highest point of the layer height level of the waste material inside the furnace is 6 m or less from a bottom of the furnace.

5. The method for supplying waste material according to any of Claims 1 to 4, wherein the compacted material is put into when a predetermined layer level is not detected after an elapse of a predetermined time beyond a time calculated by diving an amount of the compacted material by a set processing speed.

6. A method for supplying waste material according to any of Claims 1 to 5, wherein a transmitter and a receiver of electromagnetic waves are installed on a side wall of the body of the furnace, and the layer height level of the waste material is measured by determining presence or absence of the material put into the furnace by a strength of electromagnetic wave signals transmitted through the furnace.

7. A method for supplying waste material according to any of Claims 1 to 6, wherein a position of said measurement level, at which the layer height level of the waste material is measured by determining presence or absence of the material put into the furnace by the strength of electromagnetic wave signals transmitted through the furnace, is a position between a level 3 m under an introducing port level and the introducing port level.

8. A method for supplying waste material according to Claim 6 or 7, wherein the transmitter and the receiver are provided across from each other on side walls of the body of the furnace.

9. A method for supplying waste material according to Claim 6 or 7, wherein a transceiver comprising an integrated transmitter and receiver is used as said transmitter and said receiver.

10. A method for supplying waste material according to any of Claims 6 to 9, wherein an electromagnetic waveguide that also serves as a burner gas introduction pipe is provided to said side wall of the body of the furnace, an electromagnetic wave transmitter and receiver are connected to said waveguide, a transmission and a reception of electromagnetic waves are performed by said waveguide, and admixture and deposition of foreign matter to the waveguide are prevented by a burner flame and the burner gas introduction through said waveguide.

11. A method for supplying waste material according to Claim 10, wherein a plug whose function is to block off gas but transmit electromagnetic waves is inserted between the electromagnetic wave transmitter or receiver and a burner gas inlet of the waveguide, and the burner gas is prevented from entering the electromagnetic wave transmitter or receiver.

12. A method for supplying waste material according to any of Claims 1 to 11, wherein a size of the compacted block of the waste material is such that a height is at least 0.1 m and not more than 1 m, and a width is at least 0.1 m and less than an inside diameter of the furnace.

13. A method for supplying waste material according to any of Claims 1 to 12, wherein one or more of waste water, process wastewater, and moisture are added in order to adjust a water content of the compacted block during production of the compacted block, or, after production thereof and before the compacted block is supplied into the furnace.

14. A method for supplying waste material according to any of Claims 1 to 13, wherein the compacted block is supplied into the furnace after having passed at least 0.3 m and not more than 5 m through a tunnel zone that is subjected to radiant heat inside the furnace, prior to being supplied into the furnace.

15. A method for supplying waste material according to Claim 14, wherein the tunnel zone subjected to radiant heat slopes downward at a drop port inside the furnace.

16. A method for supplying waste material according to Claim 14 or 15, wherein said tunnel zone subjected to radiant heat expands so as to be exposed readily to the radiant heat in front of the drop port inside the furnace.

17. A method for supplying waste material according to any of Claims 1 to 16, wherein the apparatus for supplying waste material comprises at least a compacting apparatus for compacting waste material, and a supply hopper that is provided to an upper part of the compacting apparatus and supplies the waste material to the compacting apparatus.

18. A method for supplying waste material according to Claim 17, wherein a pusher that pushes the waste material from the supply hopper provided to the upper part of the compacting apparatus and drops into the compacting apparatus is provided in between the compacting apparatus and the supply hopper.

19. A method for supplying waste material according to Claim 17 or 18, wherein an exhaust pipe is provided to the compacting apparatus or between said compacting apparatus and the supply hopper, and a gas containing carbon monoxide that has accumulated between the compacting apparatus and the supply hopper is exhausted through said exhaust pipe.

20. A method for supplying waste material according to any of Claims 17 to 19, wherein a backflow of the gas containing carbon monoxide in the furnace is prevented by separating the compacting apparatus and the supply hopper with a double damper.

21. A method for supplying waste material according to any of Claims 1 to 20, wherein the compacted block is heated by providing, between the compacting apparatus and the furnace, a tunnel furnace in which an upper face and left and right faces are tapered, expanding toward a waste material introducing port provided on a wall of the furnace, so that the waste material does not come into close contact with inner walls.

22. A method for supplying waste material according to Claim 21, wherein the backflow of the gas containing carbon monoxide in the furnace is prevented by introducing water vapor into said tunnel furnace.

23. A method for supplying waste material according to any of Claims 1 to 22, wherein said melting furnace is a gasifying and melting furnace or a gasifying, melting and reforming furnace for the waste material.

24. A waste material supply apparatus for introducing a waste material to a melting furnace, said apparatus comprising:

a compacting apparatus for compacting the waste material into a block so that a density of the waste material is at least two times and not more than 20 times a density prior to compaction;

a supply hopper for supplying the waste material to the compacting apparatus, provided on an upper part of the compacting apparatus;

a pipeline for supplying the compacted block compacted by the compacting apparatus to a high-temperature heating furnace; and

a means for measuring and/or calculating a layer height level of the waste material inside the furnace, and controlling an amount of the waste material supplied such that a drop distance of the compacted block within the furnace is not more than 3 m.

25. A waste material supply apparatus according to Claim 24, wherein a pusher that drops the waste material into the compacting apparatus from the supply hopper is further provided between the compacting apparatus and the supply hopper.

26. A waste material supply apparatus according to Claim 24 or 25, wherein the means for controlling the amount of the waste material supplied includes a means for detecting a level of a deposited surface of the waste material inside a melting furnace by measuring an amount of attenuation of microwaves.

27. An apparatus for heating and melting a waste material, wherein a waste material supply apparatus according to any of Claims 24 to 26 is provided as an apparatus for supplying the waste material to a melting furnace.

28. An apparatus for heating and melting a waste material according to Claim 27, wherein the melting furnace is a waste material gasifying and melting furnace or a gasifying, melting and reforming furnace.

Amended claims under Art. 19.1 PCT

1. (Amended) A method for supplying a waste material to a body of a furnace in an interior of which the waste material is heated and melted,

wherein said waste material is compacted by a compacting apparatus into a compacted block so that a density of the waste material is at least two times and not more than 20 times a density prior to compaction, the compacted block is supplied into the furnace from an introducing port provided in a wall of the furnace lower than a reforming section of said body of the furnace, either such that a drop distance within the furnace is not more than 3 m, or without the waste material being dropped; when a supply of the waste material is controlled such that the drop distance within the furnace is not more than 3 m by measuring a layer height level of the waste material inside the furnace, an electromagnetic waveguide that also serves as a burner gas introduction pipe is provided to said sidewall of the body of the furnace, an electromagnetic wave transmitter and receiver are connected to said waveguide, a transmission and a reception of electromagnetic waves are performed by said waveguide, and admixture and deposition of foreign matter to the waveguide are prevented by a burner flame and the burner gas introduction through said waveguide.

2. (Amended) A method for supplying waste material according to Claim 1, wherein a plug whose function is to block off gas but transmit electromagnetic waves is inserted between the electromagnetic wave transmitter or receiver and a burner gas inlet of the waveguide, and the burner gas is prevented from entering the electromagnetic wave transmitter or receiver.

3. (Amended) A method for supplying waste material according to any of Claim 1 or 2, wherein the compacted block is heated by providing, between the compacting apparatus and the furnace, a tunnel furnace in which an upper face and left and right faces are tapered, expanding toward a waste material introducing port provided on a wall of the furnace, so that the waste material does not come into close contact with inner walls.

4. (Amended) A method for supplying waste material according to any of Claims 1 to 3, wherein a highest point of the layer height level of the waste material inside the furnace is 6 m or less from a bottom of the furnace.

5. (Amended) A method for supplying waste material according to any of Claims 1 to 4, wherein one or more of waste water, process wastewater, and moisture are added in order to adjust a water content of the compacted block during production of the compacted block, or, after production thereof and before the compacted block is supplied into the furnace.

6. (Amended) A method for supplying waste material according to any of Claims 1 to 5, wherein the compacted block is supplied into the furnace after having passed at least 0.3 m and not more than 5 m through a tunnel zone that is subjected to radiant heat inside the furnace, prior to being supplied into the furnace.

7. (Amended) A method for supplying waste material according to Claim 6, wherein the tunnel zone subjected to radiant heat slopes downward at a drop port inside the furnace.

8. (Amended) A method for supplying waste material according to Claim 6 or 7, wherein said tunnel zone subjected to radiant heat expands so as to be exposed readily to the radiant heat in front of the drop port inside the furnace.

9. (Amended) A method for supplying waste material according to any of Claims 1 to 8, wherein the apparatus for supplying waste material comprises at least a compacting apparatus for compacting waste material, and a supply hopper that is provided to an upper part of the compacting apparatus and supplies the waste material to the compacting apparatus.

10. (Amended) A method for supplying waste material according to Claim 9, wherein an exhaust pipe is provided to the compacting apparatus or between said compacting apparatus and the supply hopper, and a gas containing carbon monoxide that has accumulated between the compacting apparatus and the supply hopper is exhausted through said exhaust pipe.

11. (Amended) A method for supplying waste material according to any of Claims 1 to 10, wherein the backflow of the gas containing carbon monoxide in the furnace is prevented by introducing water vapor into said tunnel furnace.

12. (Amended) An apparatus for heating and melting a waste material according to any of Claims 1 to 11, wherein the melting furnace is a waste material gasifying and melting furnace or a gasifying, melting and reforming furnace.

13. (Canceled)

14. (Canceled)

15. (Canceled)

16. (Canceled)

17. (Canceled)

FIG. 1

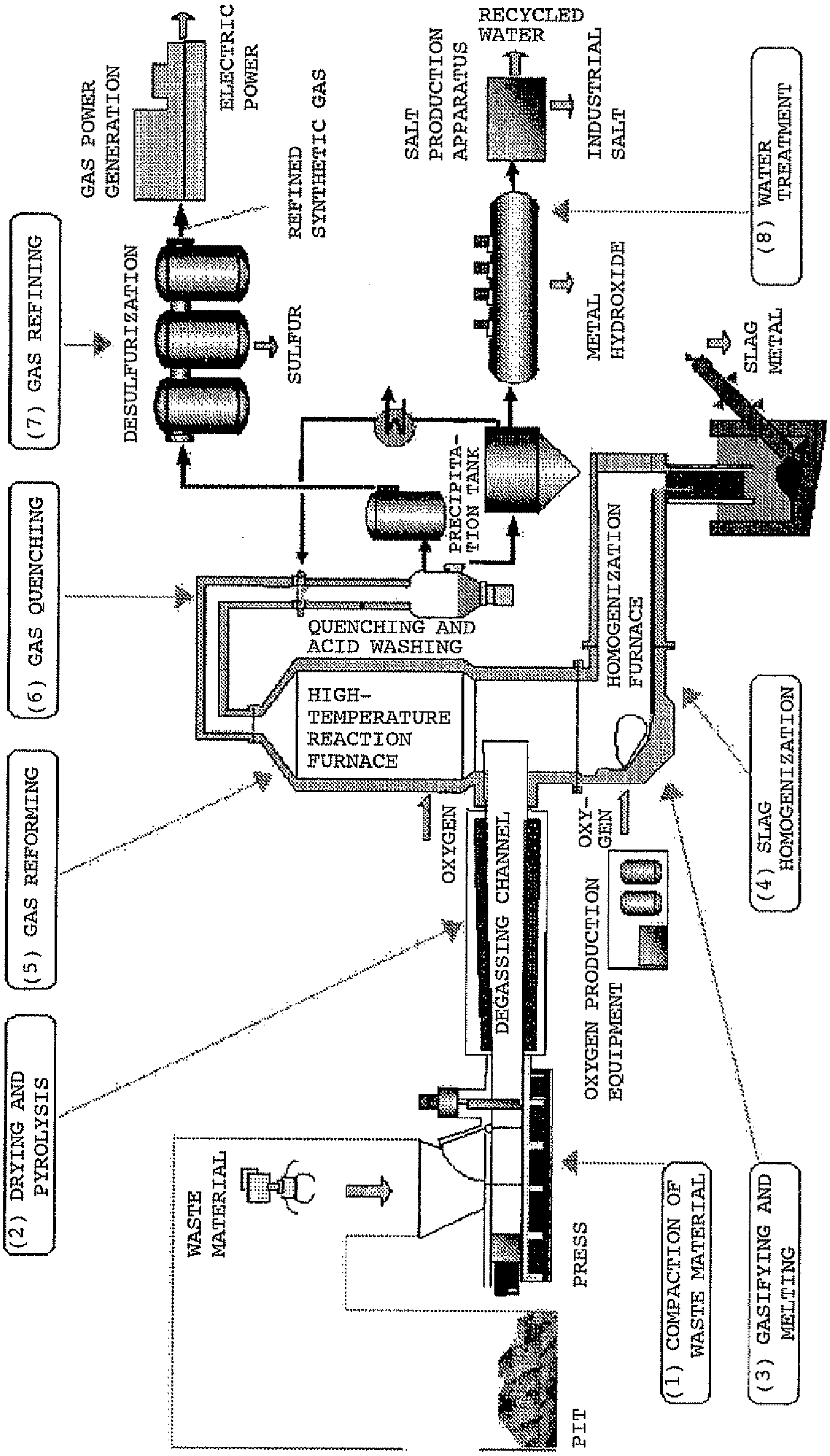

(1) COMPACTION OF WASTE MATERIAL
(2) DRYING AND PYROLYSIS
(3) GASIFYING AND MELTING
(4) SLAG HOMOGENIZATION
(5) GAS REFORMING
(6) GAS QUENCHING
(7) GAS REFINING
(8) WATER TREATMENT
PIT
WASTE MATERIAL
PRESS
DEGASSING CHANNEL
OXYGEN
OXY-GEN
OXYGEN PRODUCTION EQUIPMENT
HIGH-TEMPERATURE REACTION FURNACE
HOMOGENIZATION FURNACE
SLAG
METAL
QUENCHING AND ACID WASHING
PRECIPITA-TION TANK
METAL HYDROXIDE
SALT PRODUCTION APPARATUS
INDUSTRIAL SALT
RECYCLED WATER
DESULFURIZATION
SULFUR
REFINED SYNTHETIC GAS
GAS POWER GENERATION
ELECTRIC POWER

FIG. 2

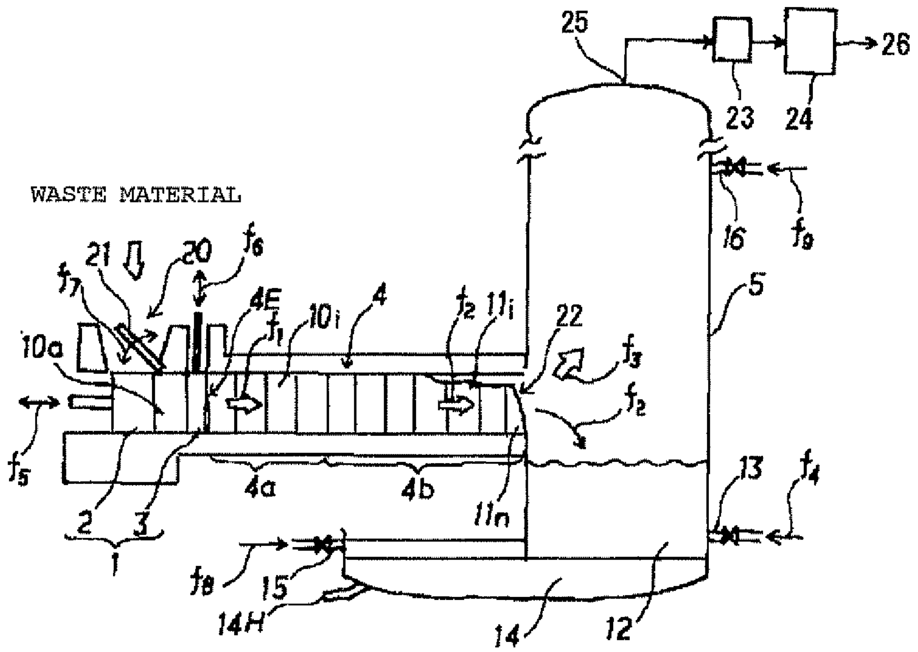

WASTE MATERIAL
25
23
24
26
16
13
15
14H
14
12
22
5
4
4a
4b
4E
10a
10i
11i
11n
20
21
1
2
3

FIG. 3

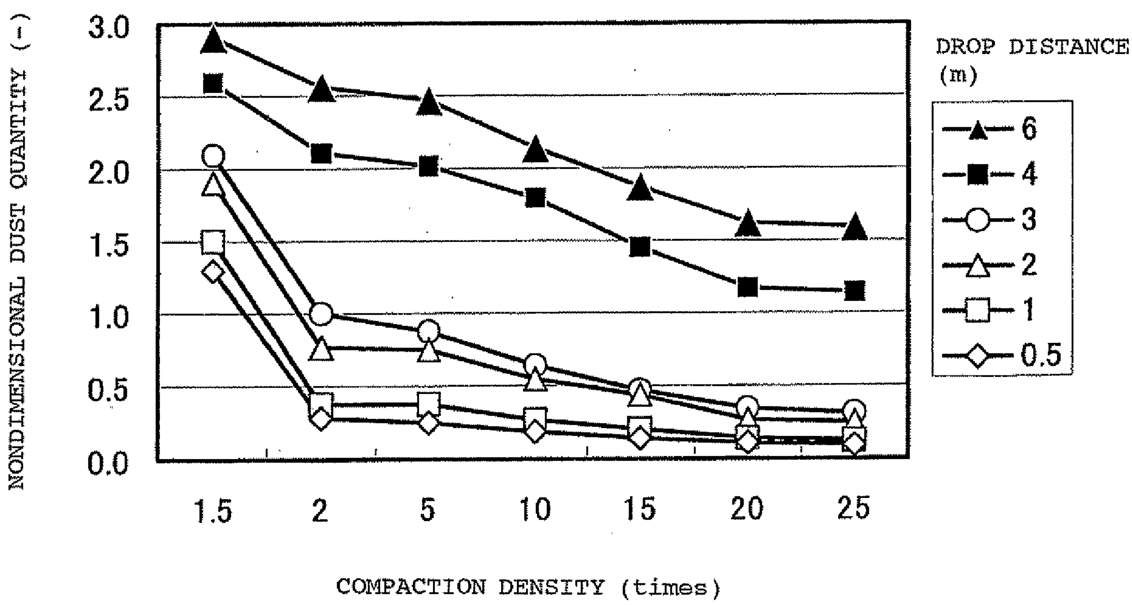

NONDIMENSIONAL DUST QUANTITY (-)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1.5
2
5
10
15
20
25
COMPACTION DENSITY (times)
DROP DISTANCE (m)
6
4
3
2
1
0.5

FIG. 4

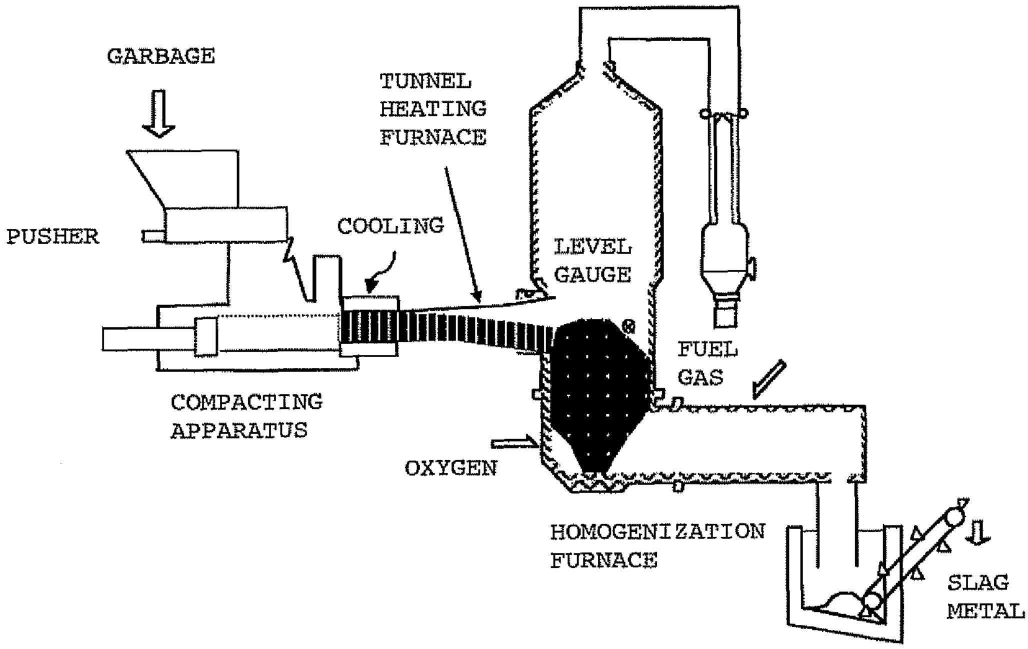

GARBAGE
TUNNEL
HEATING
FURNACE
PUSHER
COOLING
LEVEL
GAUGE
FUEL
GAS
COMPACTING
APPARATUS
OXYGEN
HOMOGENIZATION
FURNACE
SLAG
METAL

FIG. 5

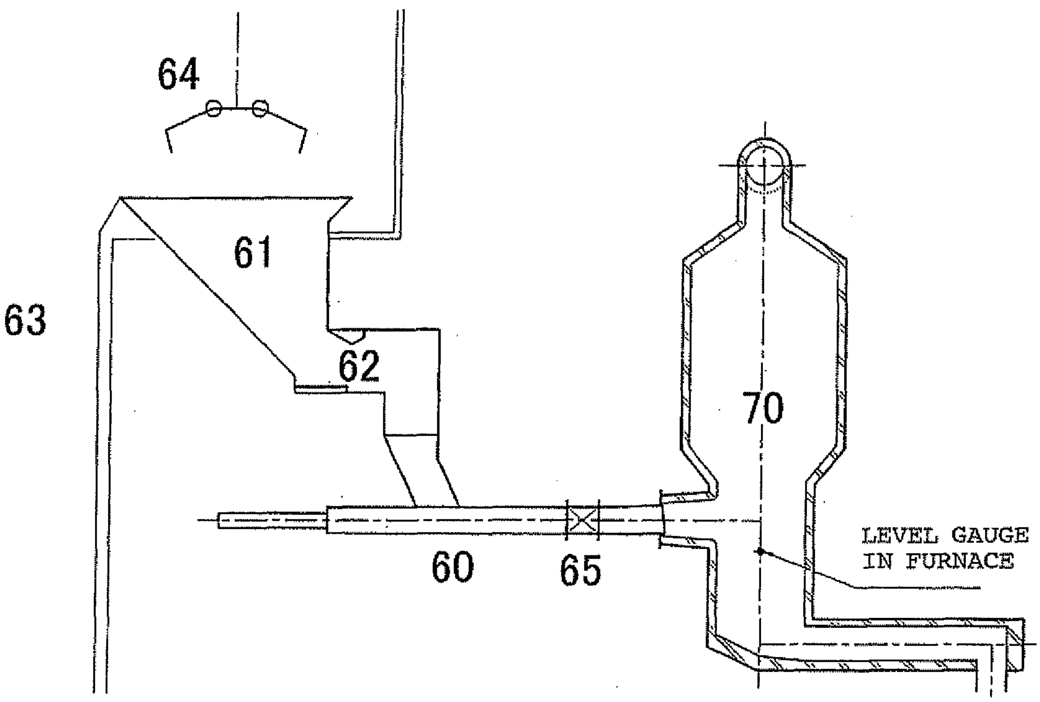
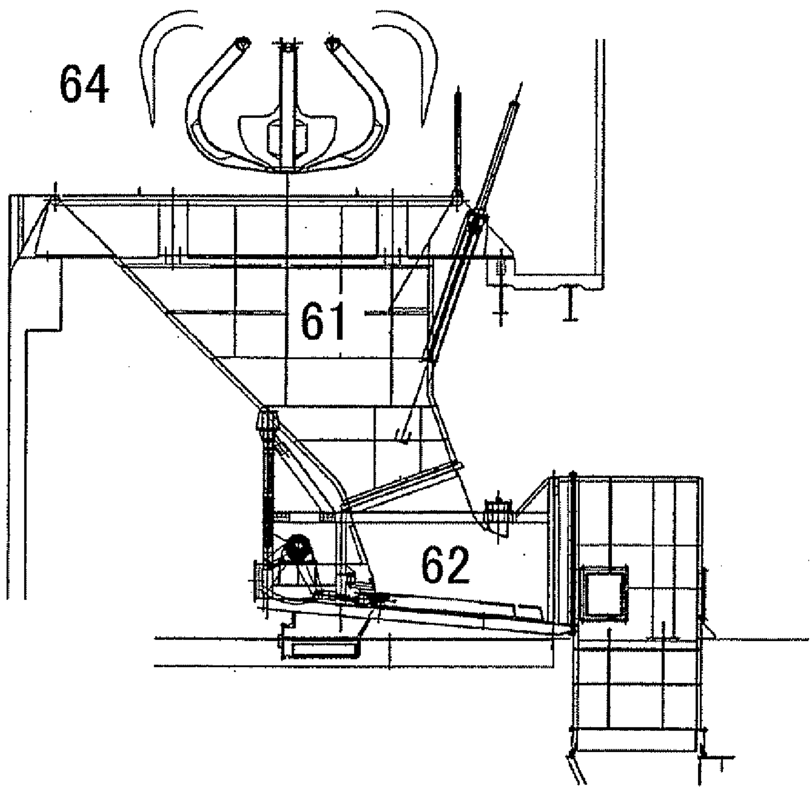

64
61
63
62
70
60
65
LEVEL GAUGE
IN FURNACE

FIG. 6



COMPACTING APPARATUS INLET

FIG. 7

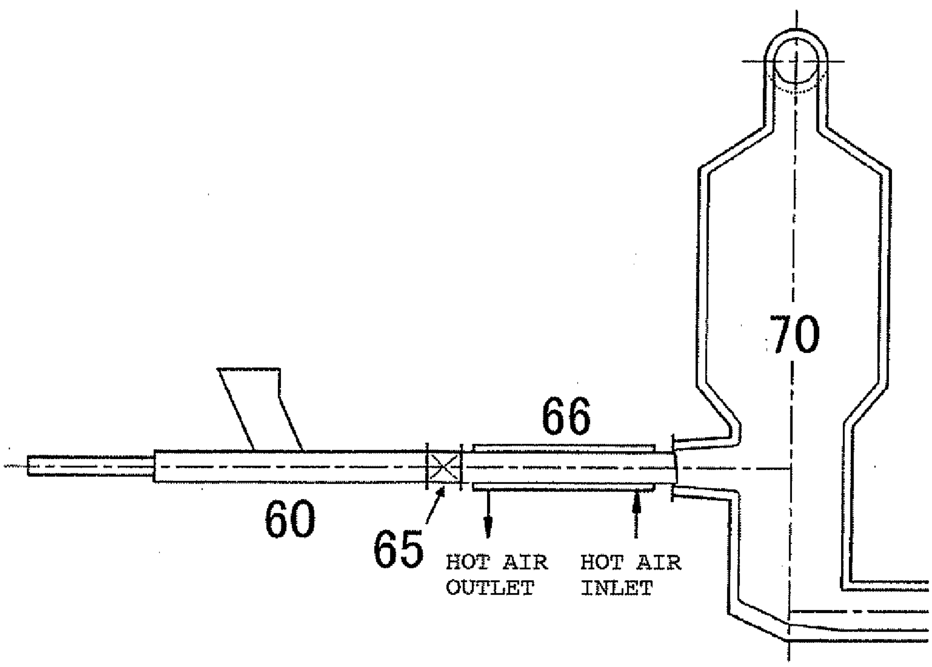


FIG. 8

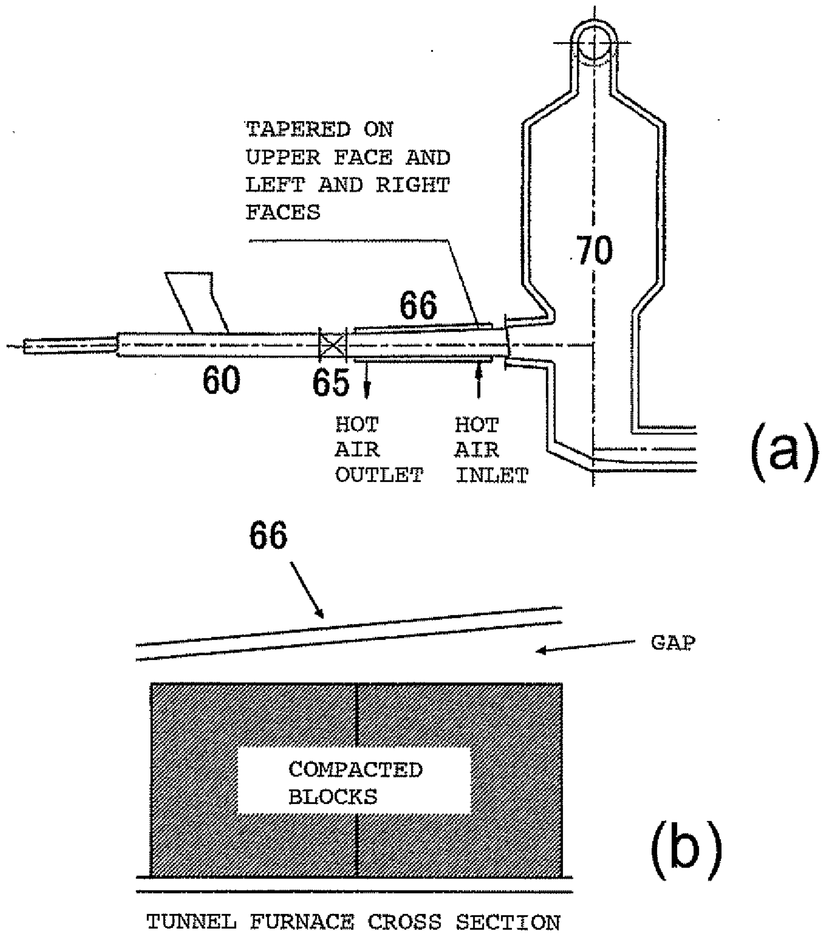

TAPERED ON
UPPER FACE AND
LEFT AND RIGHT
FACES
70
66
60
65
HOT
AIR
OUTLET
HOT
AIR
INLET
(a)
66
GAP
COMPACTED
BLOCKS
(b)
TUNNEL FURNACE CROSS SECTION

FIG. 9

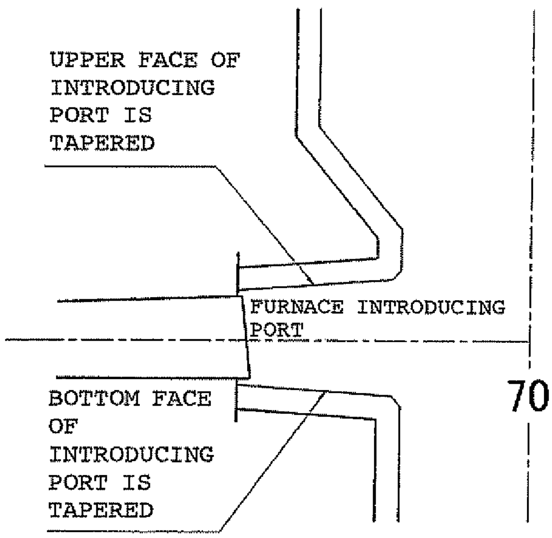

UPPER FACE OF
INTRODUCING
PORT IS
TAPERED
FURNACE INTRODUCING
PORT
70
BOTTOM FACE
OF
INTRODUCING
PORT IS
TAPERED

FIG. 10

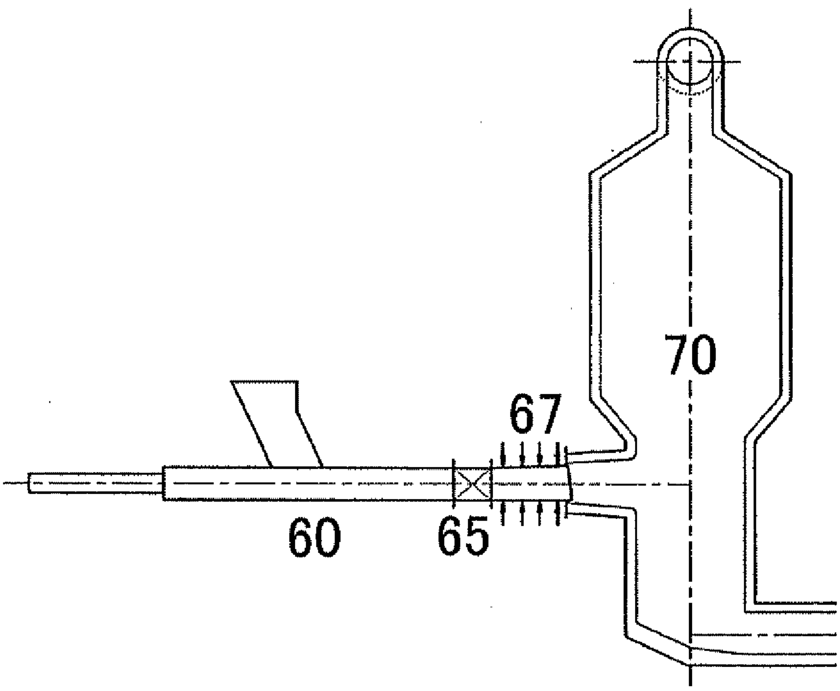


FIG. 11

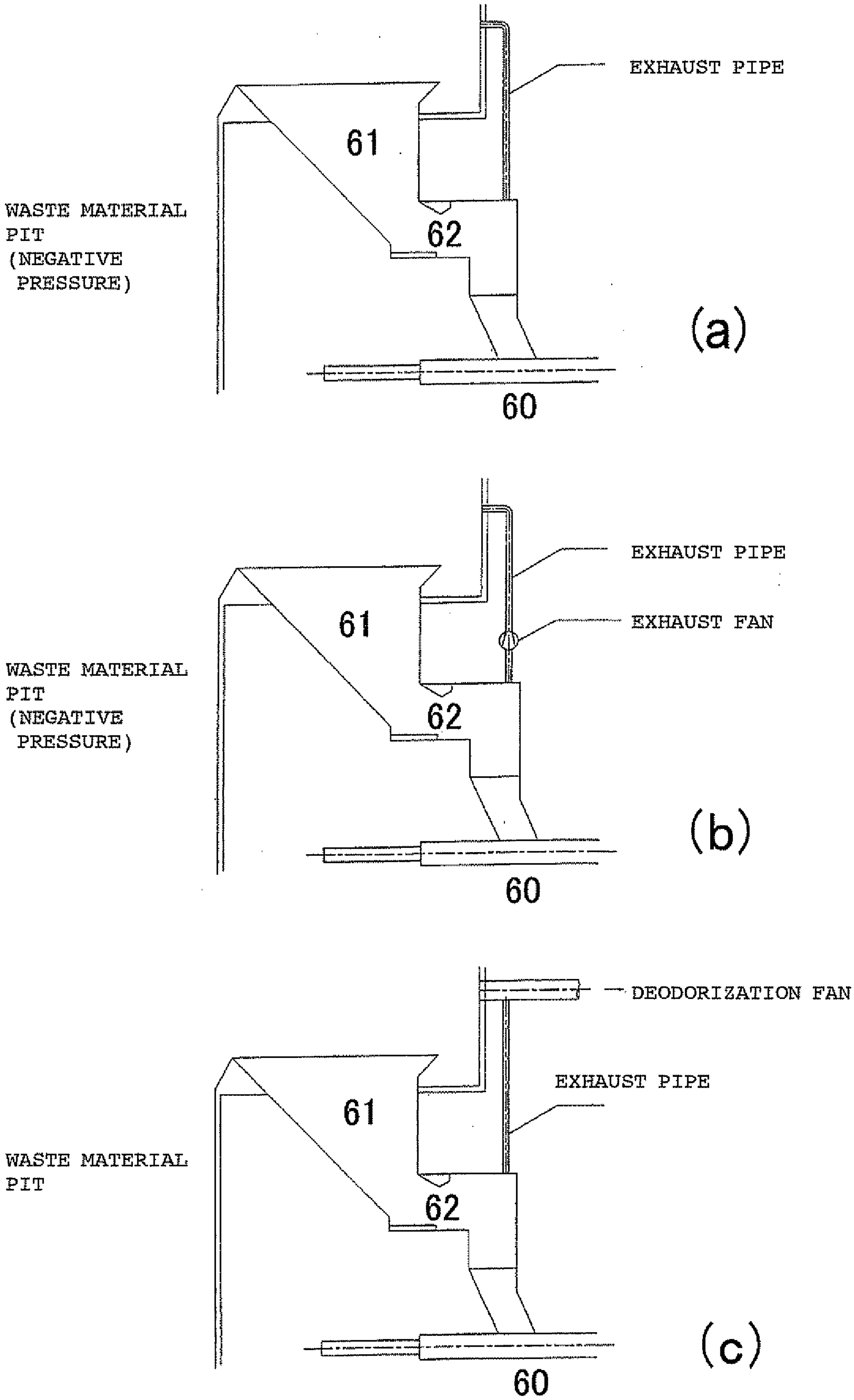

EXHAUST PIPE
61
WASTE MATERIAL PIT (NEGATIVE PRESSURE)
62
(a)
60
EXHAUST PIPE
EXHAUST FAN
61
WASTE MATERIAL PIT (NEGATIVE PRESSURE)
62
(b)
60
DEODORIZATION FAN
EXHAUST PIPE
61
WASTE MATERIAL PIT
62
(c)
60

FIG. 12

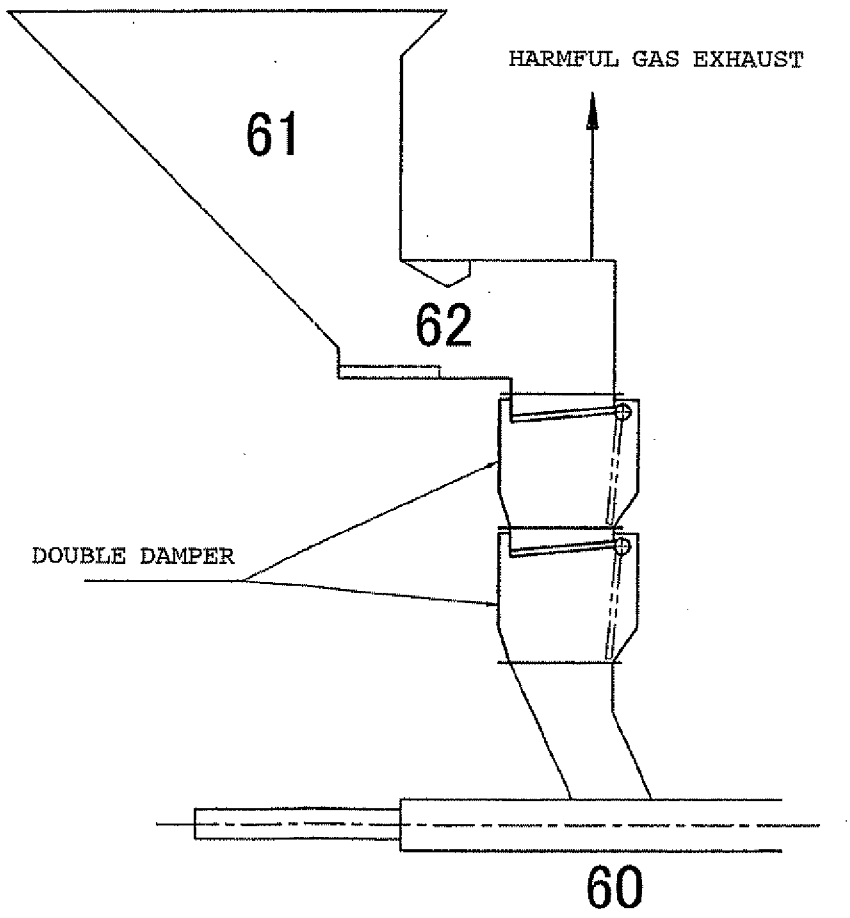

HARMFUL GAS EXHAUST
61
62
DOUBLE DAMPER
60

FIG. 13

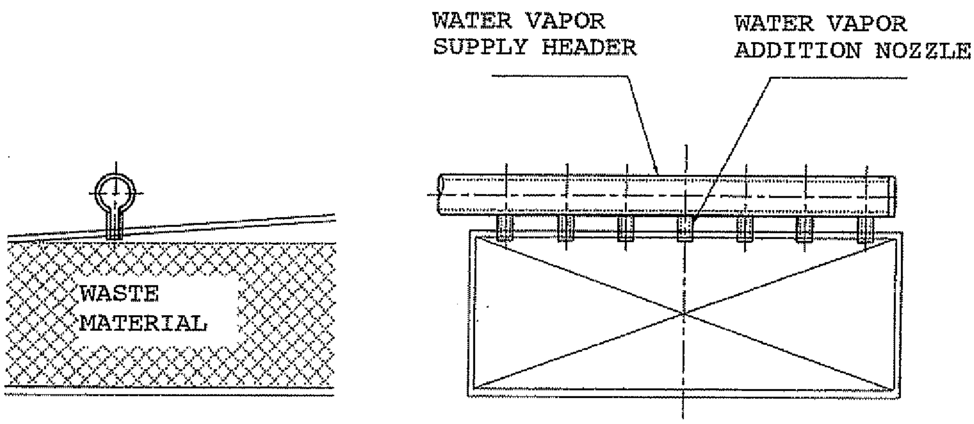

WATER VAPOR
SUPPLY HEADER
WATER VAPOR
ADDITION NOZZLE
WASTE
MATERIAL

FIG. 14

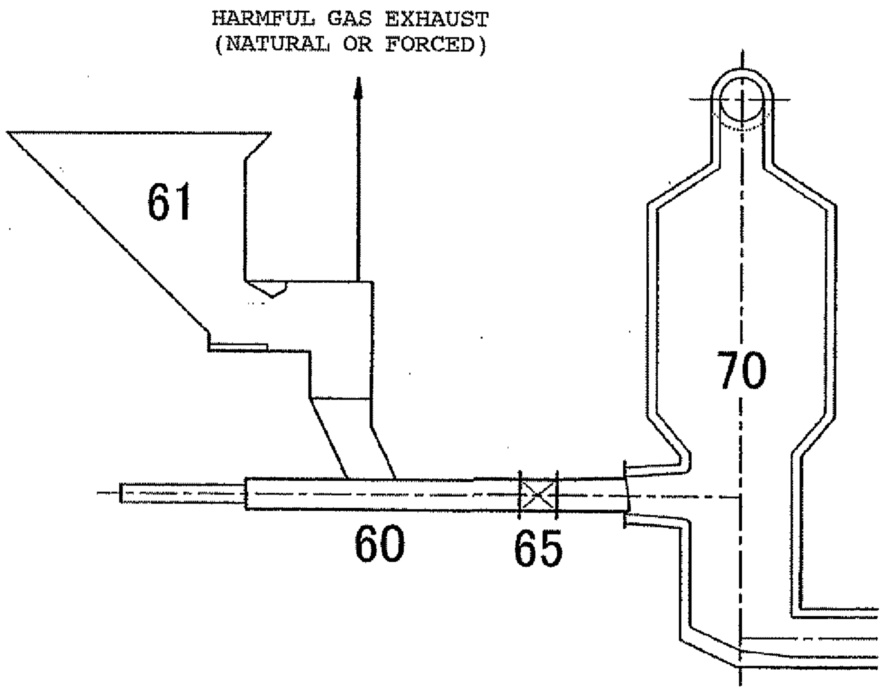

HARMFUL GAS EXHAUST
(NATURAL OR FORCED)
61
70
60
65

FIG. 15

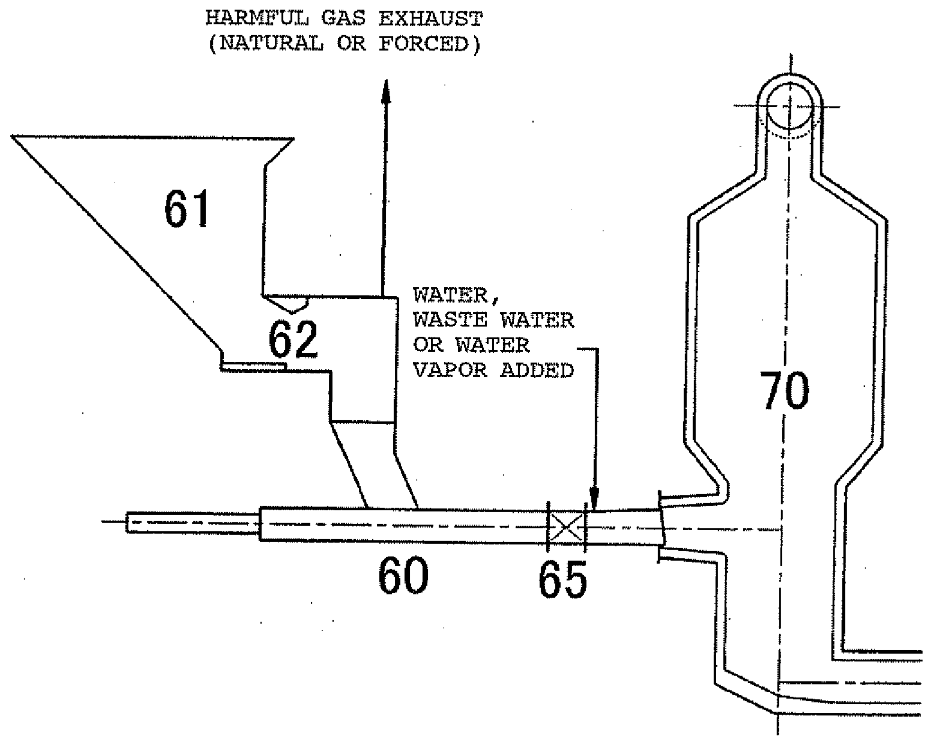

HARMFUL GAS EXHAUST
(NATURAL OR FORCED)
61
62
WATER,
WASTE WATER
OR WATER
VAPOR ADDED
70
60
65

FIG. 16

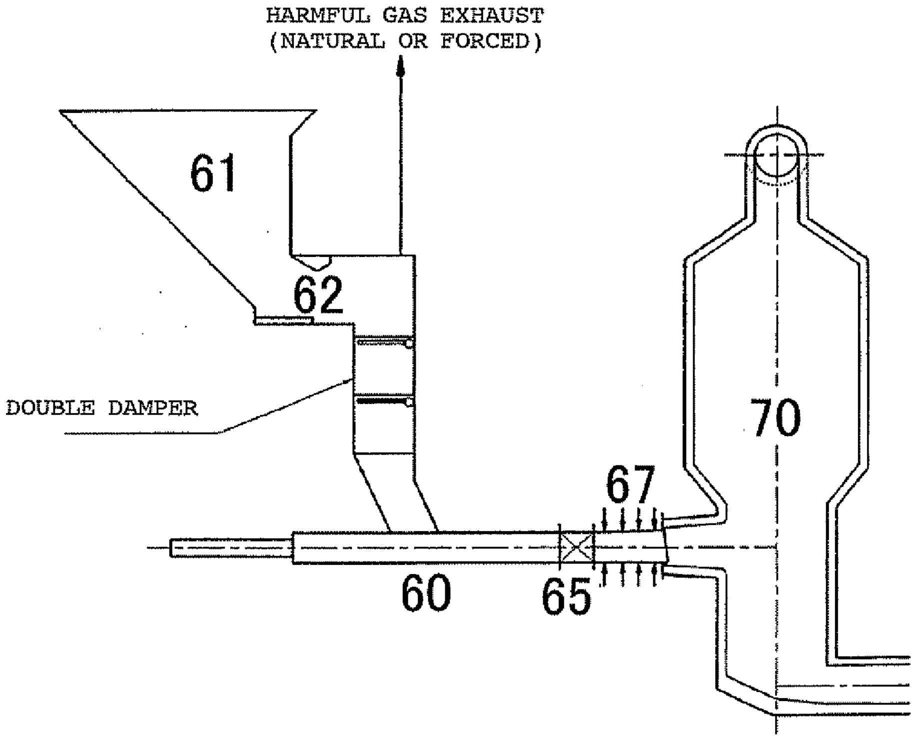

HARMFUL GAS EXHAUST
(NATURAL OR FORCED)
61
62
DOUBLE DAMPER
70
67
60
65

FIG. 17

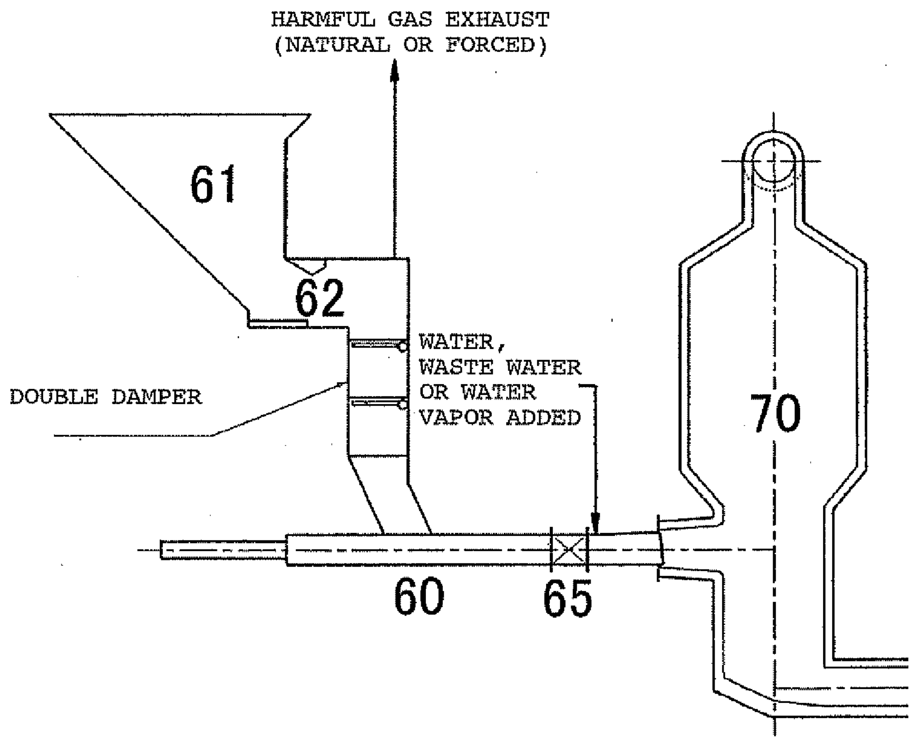

HARMFUL GAS EXHAUST
(NATURAL OR FORCED)
61
62
WATER,
WASTE WATER
OR WATER
VAPOR ADDED
DOUBLE DAMPER
70
60
65

FIG. 18

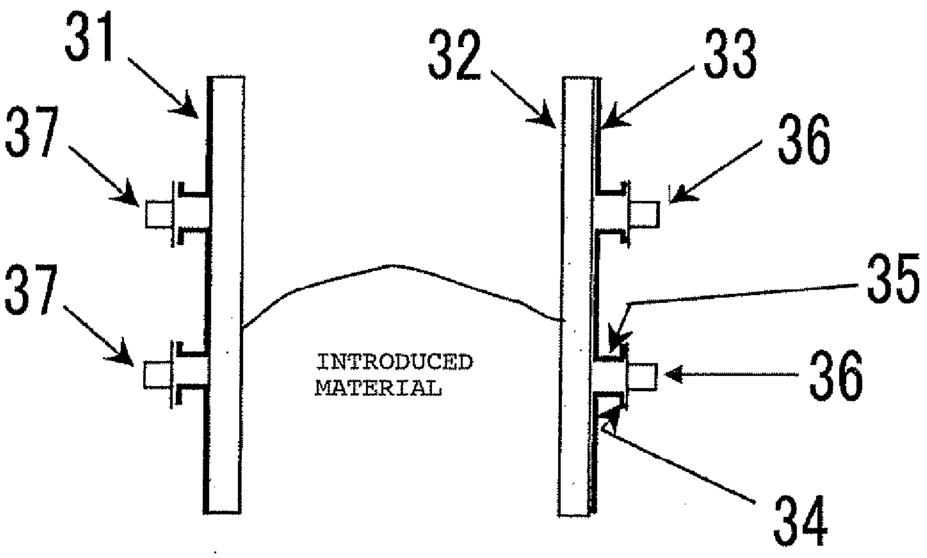

31
32
33
37
36
37
35
INTRODUCED
MATERIAL
36
34

FIG. 19

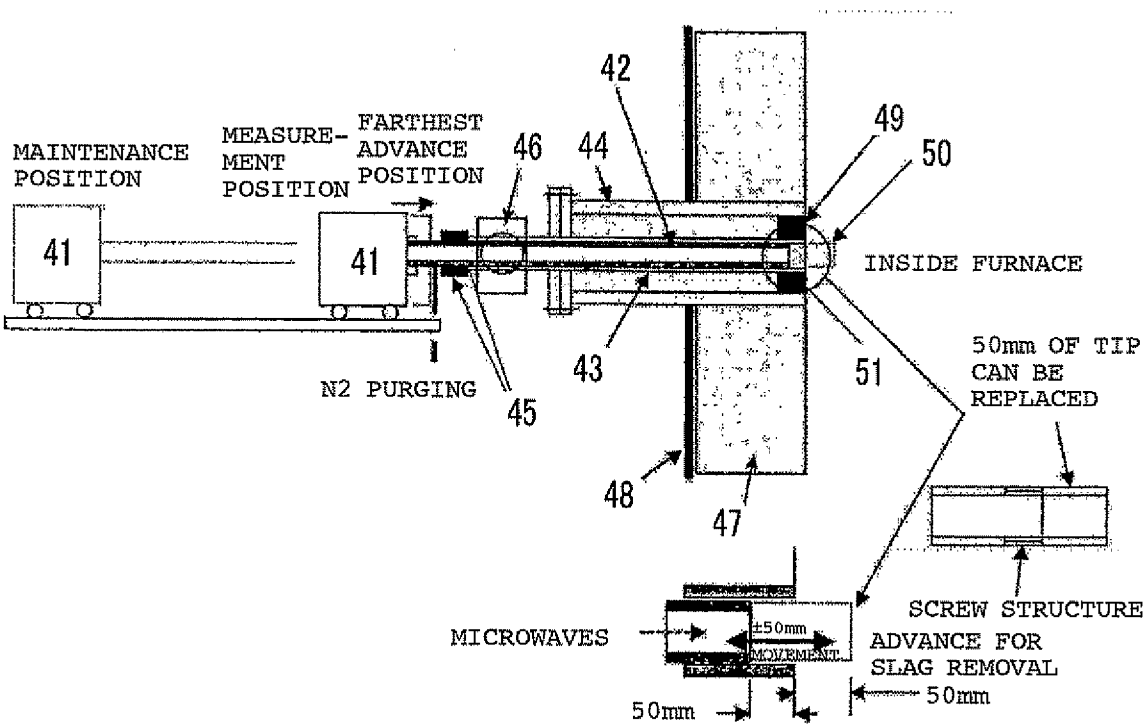
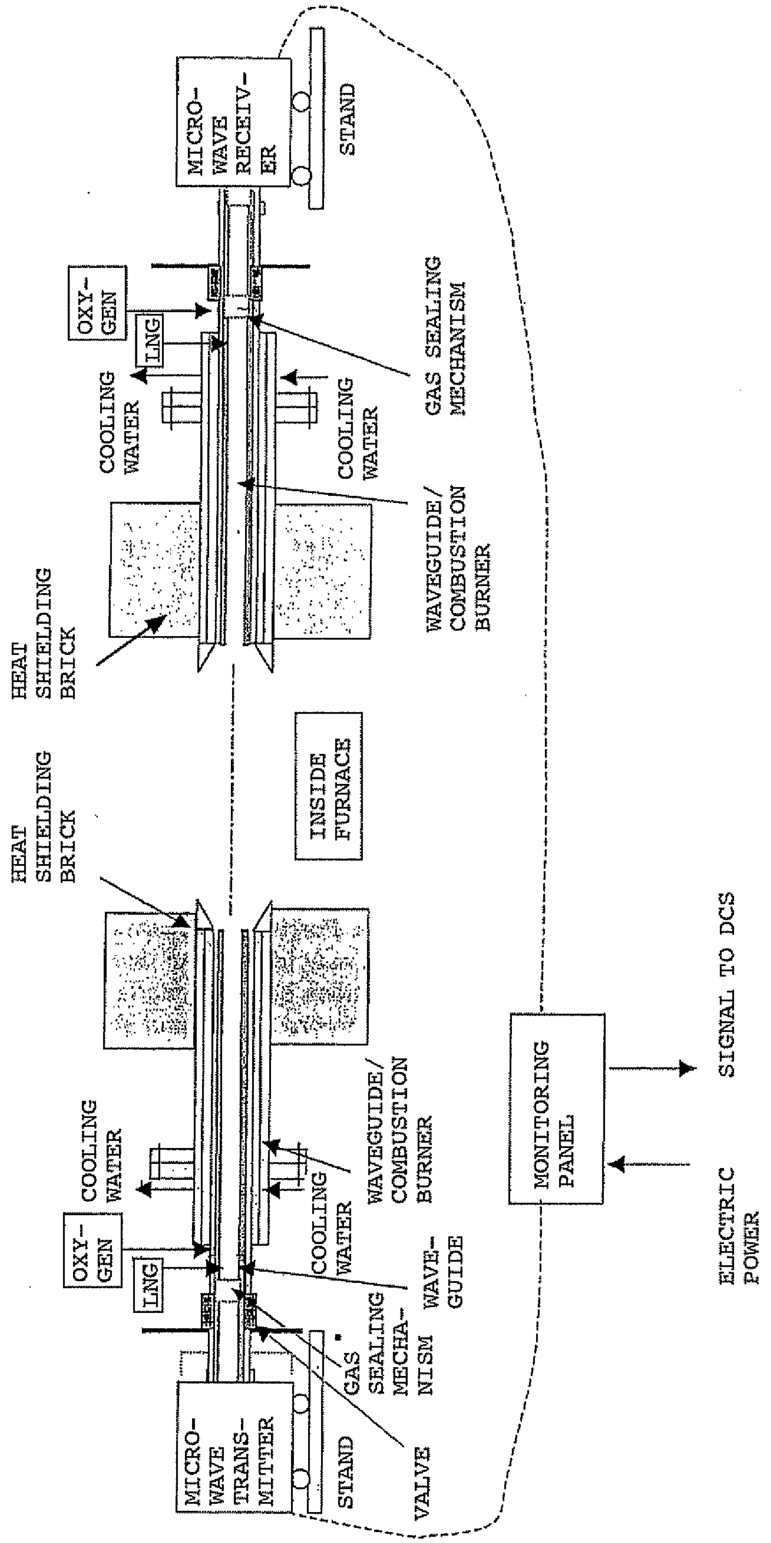

42
49
50
MAINTENANCE
POSITION
MEASURE-
MENT
POSITION
FARTHEST
ADVANCE
POSITION
46
44
41
41
INSIDE FURNACE
43
51
N2 PURGING
45
50mm OF TIP
CAN BE
REPLACED
48
47
SCREW STRUCTURE
MICROWAVES
±50mm
MOVEMENT
ADVANCE FOR
SLAG REMOVAL
50mm
50mm

FIG. 20


MICRO-WAVE RECEIV-ER
STAND
OXY-GEN
LNG
COOLING WATER
COOLING WATER
GAS SEALING MECHANISM
WAVEGUIDE/ COMBUSTION BURNER
HEAT SHIELDING BRICK
INSIDE FURNACE
HEAT SHIELDING BRICK
MONITORING PANEL
SIGNAL TO DCS
ELECTRIC POWER
WAVEGUIDE/ COMBUSTION BURNER
COOLING WATER
COOLING WATER
OXY-GEN
LNG
WAVE-GUIDE
GAS SEALING MECHA-NISM
MICRO-WAVE TRANS-MITTER
STAND
VALVE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/006482

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F23G5/44, F23G5/00, F23G5/02, F23G5/027, F23G5/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F23G5/44, F23G5/00, F23G5/02, F23G5/027, F23G5/50

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2005
Kokai Jitsuyo Shinan Koho	1971-2005	Toroku Jitsuyo Shinan Koho	1994-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004-28997 A (JFE Engineering Kabushiki Kaisha), 29 January, 2004 (29.01.04), Par. Nos. [0017] to [0035] (Family: none)	1-9,12-20, 22-28
Y	JP 11-270824 A (Kawasaki Steel Corp.), 05 October, 1999 (05.10.99), Par. No. [0065]; Fig. 3 (Family: none)	1-9,12-20, 22-28
Y	JP 2002-295817 A (Hitachi Metals, Ltd.), 09 October, 2002 (09.10.02), Par. Nos. [0012], [0057]; Fig. 3 (Family: none)	4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search 19 April, 2005 (19.04.05)	Date of mailing of the international search report 10 May, 2005 (10.05.05)
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INTERNATIONAL SEARCH REPORT

International application No.
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