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(54) **WASTE-GASIFIED FUSION FURNACE AND METHOD OF OPERATING THE FUSION FURNACE**

(57) A waste gasification-melting furnace comprises a gasifying furnace body 2 of a shaft furnace type, for drying and thermally decomposing waste sequentially supplied from above into the furnace 1 by using a high-temperature gas; and a melting chamber furnace 3 provided integrally with a lower end discharge port 2b of the gasifying furnace body 2, for receiving residue of the waste A resulting from pyrolysis, the melting chamber furnace 3 being provided with a heating and melting burner directed toward a slope of the residue, wherein the melting chamber furnace 3 is provided with a discharge port 6 through which molten substances containing molten slag and molten metal are discharged, and a gas feeding pipe 8 connected to a header duct 9, for feeding the high-temperature gas generated during heating and melting the residue inside the melting chamber furnace 3 to the gasifying furnace body 2.

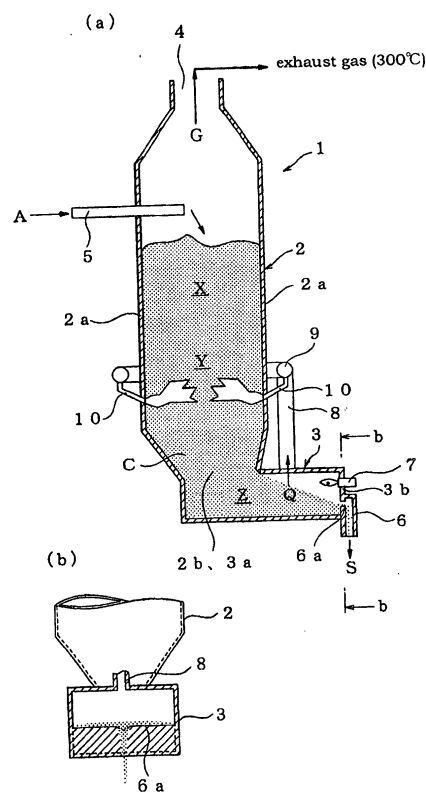


Fig. 1

Description**[Technical Field]**

5 **[0001]** The present invention relates to a waste gasification-melting furnace in which municipal waste, industrial waste, and the like are heated, dried, and thermally decomposed to allow incombustible matter to be discharged as slag, and a pyrolysis gas generated inside the furnace is treated by an exhaust gas treating device and discharged, and a method of operating the gasification-melting furnace. More particularly, the present invention relates to a waste
 10 gasification-melting furnace capable of improving fluctuation and instability in a system due to variation in waste in melting ash generated by drying and thermally decomposing the waste in a single furnace, and a method of operating the gasification-melting furnace.

[Background Art]

15 **[0002]** In general, a shaft furnace is used as a gasification-melting furnace of this type, as well as a rotary kiln or a fluidized bed furnace. There are two types of shaft furnaces. In one type, as shown in Fig. 12, waste A is fed into a furnace 51, and fuel R and oxygen-enriched air P are introduced from a bottom portion of the furnace 51 into the furnace through burners 52 or the like, thereby heating and melting the waste A. The waste A being heated and melted is balanced by a pressure of a high-temperature (e.g., 1700 °C) combustion gas Q containing large amount of oxygen
 20 gas introduced from the bottom of the furnace, thereby causing a melting zone at a boundary between the combustion gas Q and the waste A to be dome-shaped 53. The molten slag S flows downward and is discharged outside the furnace 51. Meanwhile, the combustion gas Q flows upward through a void in the waste A bed in the furnace 51. The combustion gas Q dries the waste A in an upper portion inside the furnace 51, and thermally decomposes the dried waste A in an intermediate portion inside the furnace 51, and during this time, a pyrolysis gas G is generated from
 25 combustible component. The pyrolysis gas G is discharged through an exhaust port 55. The waste A inside the furnace 51 go through a dry step and a pyrolysis step and residue resulting from pyrolysis gradually moves downward to a vicinity of the bottom of the furnace 51 by gravity. As described above, the residue including carbon is heated, reacted with oxygen, and melted by the high-temperature combustion gas and the resulting slag S is taken out from the furnace 51.

30 **[0003]** In general, one feature of the shaft furnace is that it can efficiently achieve a high-temperature condition. Specifically, the waste supplied into the shaft furnace moves downward while being combusted, and the generated gas flows upward while heating the supplied waste. The waste, i.e., solid waste, moves downward by gravity, whereas the lightweight gas moves upward. Direct heat exchange between the waste and the gas can be achieved very efficiently. In addition, large retention time of the waste in the furnace reduces bad effect to the process due to variation
 35 in properties of the waste.

[0004] As shown in Fig. 14(a), the melting zone 53 is kept dome-shaped while a balance between a load of the waste A inside the furnace body and a pressure of the combustion gas (high-temperature gas) Q being introduced from the bottom portion of the furnace and moving upward is maintained. In such state, there are small holes in the dome zone and the combustion gas passes through the holes. Then, the combustion gas pressure is maintained due to the pressure
 40 loss of the gas passing through the holes. However, as shown in Fig. 14(b), depending on the shape of incombustible matter contained in the waste A or properties of the waste A, the dome zone 53 becomes deformed accompanying large hole and part of the combustion gas Q goes up by through the large hole of the dome zone 53.

[0005] In addition to the above, the waste has various variation factors. For example, when highly moist waste is supplied, water vapor is generated vigorously. In the case of plastic waste, the amount of generated gas is greatly
 45 increased in a short time, or the melted waste adheres to a furnace wall. In the case of waste including sheet-shaped or plate-shaped waste, a gas flows unevenly in a furnace. Difference in properties of waste (difference in heating value) causes an increase or decrease in the generated pyrolysis gas or difference in temperature of the generated pyrolysis gas, which leads to an unstable reaction. As a result, waste adheres to a portion of the furnace and the waste layer located above hangs without moving downward. In the meantime, the hanging waste becomes unsupportable because
 50 a hollow space is formed in a lower part of the waste layer and then slips abruptly, which is called a "slip". Under these influences, the dome-shaped melting zone 53 is sometimes broken.

[0006] Thus, the reaction between the waste A inside the furnace 51 and the combustion gas Q moving upward from the bottom portion of the furnace 51 becomes unstable, and as a result, the amount or composition of the exhaust pyrolysis gas (hereinafter referred to as "exhaust gas") G discharged from the furnace fluctuates.

55 **[0007]** As shown in Fig. 13, in a shaft furnace 61 of the other type, the waste A, limestone M and coke N are fed thereinto through a supplying shoot 64 and dried and thermally decomposed, and thereafter an oxygen gas O and air P are introduced from a vicinity of a bottom portion of the furnace 61 into the furnace 61 for continuous combustion. In the case of the supplied waste A containing a large quantity of water (e.g., 30 to 50%), water is evaporated from the

waste A and dried by a combustion gas Q moving upward in an upper portion inside the furnace 61, and thereafter, the waste A is thermally decomposed in an intermediate portion under the upper portion to cause combustible matter in the waste to be gasified. On the other hand, the coke is combusted by oxygen O and air P introduced through tuyers 62 and 63. Then, residue resulting from the pyrolysis, with combustible matter in the coke are actively heated, melted and converted to a molten slag in a lower portion of the furnace 61, and the resulting slag is taken out by a slag discharge machine 65 and a combustible pyrolysis gas G mainly generated during pyrolysis is discharged through an exhaust port 66. The combustible pyrolysis gas is used as a fuel for generating a steam by a boiler or the like and generating a power in a generator by a steam turbine.

[0008] In the above-mentioned gasification-melting method of the rotary kiln type or fluidized-bed type, drying and pyrolysis are performed in the rotary kiln or the fluidized bed to produce uncombustible and incombustible matter, and the generated uncombustible matter and incombustible matter are heated up to a high temperature to be melted.

[0009] In addition to the above gasification-melting furnace method, there is also a waste incinerator of a stoker furnace type. In this stoker furnace type, residue remains as main ash after waste is combusted. The main ash is typically disposed to a final disposal site for landfilling. In recent years, to meet strict pollution control regulation, it is considered that the main ash should be melted in another ash melting furnace to be reduced in volume, to be reused as a material and should be converted into slag for preventing heavy metal from elution. Despite an advantage of stably melting the ash, the ash melting furnace cannot effectively use the high-temperature gas generated during melting for treating the waste. On the other hand, the shaft furnace is more advantageous than ash melting furnace in that melting and gasification are performed by the heat resulting from combustion of the waste in the single furnace.

[0010] There have been disclosed prior arts as follows. These prior arts also have disadvantages described below.

1) Japanese Laid-Open Patent Application Publication No. Hei. 11-218313 discloses that waste is heated and thermally decomposed at about 600°C in a tunnel type heating and thermal decomposition furnace, and the resulting residue (including combustible matter) is supplied into the melting furnace of the shaft furnace type and combusted and melted by introducing an oxygen gas into the residue. Since this melting furnace uses an indirect heating system with small thermal conductivity, and thereby equipment cost is tremendous. For example, when a tunnel type heating furnace using the indirect heating system treats 150 ton/day, its size must be very large (e.g., width of 1.5 meters, height of 0.5 meter, and length between 10 and 20 meters). Also, since the speed at which heat transfers through such a thick waste layer in the tunnel type heating furnace is much lower than that of the shaft furnace using a direct heating system and therefore, heat efficiency in the tunnel furnace is much lower than that of the shaft furnace, so that a large amount of heating fuel is needed. Besides, the problem associated with the melting reaction zone described above also arises in the melting furnace of the shaft furnace type. Specifically, the portion of the residue moving downward to the lower portion inside the melting furnace 61 contacts a large amount of gas blown into the residue through the tuyeres 62, 63, and is melted, thereby forming a melted film 68 as shown in Fig. 15 (a). But, a melting reaction zone 67 becomes disordered as shown in Fig. 15 (b) due to change in properties of the residue in the vicinity of the melted film 68, for example, in the presence of a broken piece of china ware. This causes unstable combustion and melting, which leads to large fluctuation in the amount or composition of the exhaust gas.

2) Japanese Laid-Open Patent Application Publication No. Hei. 11 - 132432 discloses that residue resulting from heating and pyrolysis inside the melting furnace is caused to contact an oxygen gas to be combusted and melted in a dome-shaped melting zone formed at a small-diameter portion located on lower side of the furnace. This device has been operated normally for a long period of time. In this device, as described above, when substances with a high melting point in the residue, for example, the large broken piece of china ware reaches the dome-shaped melting zone 53, as shown in Fig. 14(b), the melting zone 53 is partially broken and the combustion gas Q being blown from under side flows into the uncombusted layer located on upper side through the broken portion, which causes unstable operation inside the entire furnace. Consequently, unstable operation, including fluctuation in the flow rate or properties of the exhaust gas being discharged from a top portion of the furnace, occurs.

As should be appreciated from the foregoing, in either shaft furnace type, unstable condition caused by the properties of waste occurs, thereby resulting in fluctuation in the flow rate or properties of the exhaust gas. This brings about various problems. For example, in the case where the exhaust gas is combusted to obtain a high-temperature gas to be used to generate a steam in a boiler, and the steam is introduced into a steam turbine power generator to generate a power, the amount of steam to be delivered into the steam turbine would rapidly change by the fluctuation in the flow rate or properties of the exhaust gas. Large fluctuation in the steam causes mechanical damage to the turbine, or otherwise, the amount of generated power rapidly changes with the fluctuation in the steam, and such power fluctuation adversely affects a power net. To avoid this, extra steam is directly sent into a steam condenser, where heat is removed from the steam without reuse. This is uneconomical. Meanwhile, harmful substances of the exhaust gas, for example, dioxin, nitrogen oxide, chlorine, or sulfur oxide, are removed from the gas by supplying chemicals into the gas. If the amount of the exhaust gas rapidly changes, the amount of chemicals

more than a regular value needs to be supplied, which increases a final waste as well as chemicals. Under the circumstances in which it has become difficult to ensure landfill site, this is problematic. In general, the furnace gas is combustible, and so, when the gas mixed with air is combusted, uncombusted CO might exceed an environmental regulation value due to the fluctuation in the amount of the gas under the condition of less air. Therefore, a large amount of air needs to be mixed in advance. This increases an exhaust gas and equipment cost. Besides, waste heat going out during heat recovery in the boiler increases and consequently, heat recovery rate decreases. Further, NO_x is generated under unstable combustion, and a great quantity of chemicals such as urea water to remove NO_x are needed. Moreover, equipment capacity sufficient to deal with fluctuation in the amount of the exhaust gas needs to be ensured, and consequently, equipment cost is increased. Thus, the prior arts are incapable of stabilizing a process in waste treating equipment.

3) In the melting furnaces of the shaft furnace type disclosed in the above publications, a high-temperature (about 1400 to 1600 °C) region is formed inside the furnace and heating and melting are conducted. If this region becomes disordered and unstable, then melted portion of the residue resulting from thermal decomposition adheres to an inner wall of the furnace, which impedes continuous operation. Consequently, the rate of operation is reduced.

4) For the reason described in 3), refractory inside the furnace is susceptible to damage because it is contact with the molten slag or the high-temperature gas. To repair refractory wall damaged by the molten slag and the high-temperature gas, it is necessary to stop operation and to remove the waste inside the furnace and then to lower temperature inside the furnace. It takes a long time. Then, this reduces the rate of operation of the incinerator. To avoid the above disadvantages, another method is applied. In such method, a water-cooled wall is used as a furnace wall and instead of refractory, thin self-coated layer made of cooled slag is formed on the water-cooled wall. But, huge heat loss is generated.

5) Fig. 16 shows an ash melting furnace in which main ash D generated by the above stoker furnace type waste incinerator is supplied into a furnace 71 through a supplying shoot 73 and heated and melted while a burner 72 is introducing fuel together with oxygen-enriched air. In this ash melting furnace, the main ash D is stably melted and converted into slag, but the high-temperature gas Q which has been used for melting is directly discharged from the furnace and therefore, there is no other utilization method except heat recovery by the boiler or the like. In other words, since the high-temperature gas Q cannot be used for drying or pyrolysis of waste or preheating the combusted ash, heat efficiency is low. Instead of the burner, there is a method of melting the main ash by an electric arc or plasma, but this method is uneconomical because a large amount of expensive power is consumed.

[0011] The present invention has been developed in view of the above problems, and an object of the present invention is to provide a waste gasification-melting furnace (process) that has high heat efficiency and is stably operated, by organically and integrally combining two furnaces (processes) comprised of the conventional melting furnace of the shaft furnace type and the conventional ash melting furnace, by melting char (residue resulting from pyrolysis, composed of carbon or and incombustible ash) generated in the conventional melting furnace portion in the ash melting furnace portion, and by introducing (feeding) a high-temperature gas (hereinafter also referred to as a high-temperature gas) generated in the ash melting furnace portion into the melting furnace portion to cause waste to be heated and thermally decomposed, and a method of operating the waste gasification-melting furnace that uses an inexpensive oil as a fuel instead of an expensive gas fuel used in the conventional melting furnace.

[Disclosure of the Invention]

[0012] To achieve the above objective, according to the invention of Claim 1 of the present invention, there is provided a waste gasification-melting furnace comprising a gasifying furnace body of a shaft furnace type or a fluidized bed type, for drying and pyrolysis of waste sequentially supplied from above into the furnace by using a high-temperature gas; and a melting chamber furnace provided continuously with a lower end discharge port of the gasifying furnace body, for receiving residue of the waste resulting from pyrolysis, the melting chamber furnace being provided with a heating and melting burner directed toward a slope of the residue, wherein the melting chamber furnace is provided with a discharge port through which molten substances containing molten slag and molten metal are discharged, and a mechanism inside thereof, for feeding a high-temperature pyrolysis gas generated during heating and melting of the residue to the gasifying furnace body.

[0013] In accordance with the above-constituted waste gasification-melting furnace, oxygen containing gas and a fuel are introduced into the furnace through burners to heat and melt the residue resulting from pyrolysis inside the melting furnace and is combusted with carbon remaining in the residue. Under the resulting high-temperature of about 1650 °C, incombustible matter in the residue is melted and converted into slag. Oxygen more than a theoretical combustion amount to be equivalent for fuel is fed. Chloride metal in the residue is oxidized. For example, iron is converted into iron oxide and copper is converted into copper oxide, and these oxides are discharged in a melted and mixed state

with the slag. In general, when the amount of oxygen to be fed is insufficient, reducing flame is produced and the molten metal without oxidizing is discharged with slag. But, the present invention basically uses an oxygen atmosphere and therefore almost all of metal is oxidized and is well combined with slag. Therefore, it is not necessary to separate the metal from the slag for reuse. For example, the melted metal oxide and the slag may be used for roadbed paving, after being cooled.

[0014] After being used for melting the residue inside the melting chamber furnace, the high-temperature gas is fed to the furnace body to be used for drying or thermally decomposing the waste. Therefore, most of sensible heat owned by the high-temperature gas is used for reaction with the waste and temperature of the exhaust gas discharged from the furnace is reduced to, for example about 300°C. In contrast with the conventional furnace exclusive for melting (see Fig. 16), the gasification-melting furnace of the present invention has high efficiency like a general shaft furnace type melting furnace without large energy loss, and as a result, fuel consumption, power consumption, and oxygen gas consumption are all reduced, which leads to a reduced running cost.

[0015] By feeding the gas that has been used for melting and contains some oxygen, to the gasifying furnace body so that temperature of the exhaust gas becomes to be not high, like about 300°C, and also the temperature of the residue can be kept to be not high, like around 800°C, at which melting and adhesion of the residue hardly occur. Since melting is not conducted inside the gasifying furnace body, adhesion, hanging, and the like of the residue, which tended to occur in a conventional shaft furnace type melting furnace, do not occur, and operation is stabilized. In particular, life of refractory inside the gasifying furnace body is dramatically extended and the rate of operation of the furnace is high. In addition, since the melting chamber furnace is independent of the gasifying furnace body and only the refractory in the space inside the melting chamber furnace is damaged, therefore, maintenance is easily accomplished by spraying mud, made of wet refractory powder onto the damaged refractory wall, and as a result, the rate of operation is very high. Further, since the furnace has a simple structure, the furnace is easily handled and operation and maintenance are easy.

[0016] As a result, the furnace is operated stably regardless of larger variation in the amount of feeding waste per unit time. Since the flow rate and properties of the exhaust gas discharged from the top portion of the furnace are stable, the exhaust gas can be treated properly. In other words, since the flow rate, composition and temperature of the generated gas, which are important factors in operating the gasification melting furnace, are stable, excess air for dealing with sudden change in the amount of the gas can be minimized. This suppresses generation of carbon monoxide, generation of dioxin, NO_x, and SO_x, and correspondingly reduces the amount of spent gas cleaning chemicals such as urea, activated carbon and slaked lime, and the amount of flying ash. Further, because of the stable flow rate and properties of the exhaust gas, a stable and high-quality power can be gained in power generating equipment such as a boiler and a steam turbine. Moreover, since the amount of excess air for combustion to be mixed can be reduced, the heat loss in a waste heat boiler to generate steam for powder generation can be reduced. This results in high-efficient power generation. A plasma burner can be applied instead of a burner for combusting a fossil fuel or various gas fuels.

[0017] In the invention according to Claim 2, it is preferable that an oxygen or oxygen-enriched air is introduced into the high-temperature gas feed path from the melting chamber furnace to the gasifying furnace body to allow temperature of the high-temperature gas being fed into the gasifying furnace body to be lowered and concentration of oxygen to be increased by the oxygen or oxygen-enriched air.

[0018] In the melting furnace of Claim 2, the temperature of the high-temperature gas can be lowered by introducing a normal-temperature oxygen-containing gas into the high-temperature gas fed into the gasifying furnace body. As a result, it is possible to protect refractory bonded to an inner wall of a gas feed pipe, a duct or a header provided in a feed path of the high-temperature gas, from damage. The normal-temperature oxygen-containing gas introduced from outside into the furnace body is less likely to fully react with the waste, but by introducing the oxygen-containing gas under a high-temperature condition together with the high-temperature gas, the waste reacts with oxygen and is partially combusted. If a large amount of oxygen is introduced, the temperature of a gas mixture is lowered, but heat generated from reaction between the oxygen and the waste increases temperature of the corresponding portion. By adjusting the amount of the introduced oxygen to obtain the temperature at which the residue is hardly softened (hardly start partial melting), the residue can be stably fed into the melting chamber.

[0019] In the invention according to Claim 3, a feed path may be provided at a position where the gasifying furnace body is connected to the melting chamber furnace, or a lower portion inside the gasifying furnace body may be connected to a space inside the melting chamber furnace by means of a duct to allow the high-temperature gas to be fed from the melting chamber furnace to the gasifying furnace body.

[0020] In the gasification melting furnace according to Claim 3, since the high-temperature gas generated inside the melting chamber furnace is fed to the gasifying furnace body to be used for drying or thermally decomposing the waste, energy owned by the high-temperature gas is efficiently used without loss, and therefore, heat efficiency is high.

[0021] In the invention according to Claim 4, preferably, the waste gasification-melting furnace may comprise a mechanism for delivering the residue resulting from thermal decomposition, which is a screw type, a rotating vane type, or

a pusher type, the mechanism being provided in the vicinity of a position where the gasifying furnace body is connected to the melting chamber furnace. Since the residue moves downward by gravity along a repose angle by the amount of the residue melted in the melting chamber furnace, it is continuously delivered. Desirably, large substances or abnormal condition such as hanging should be taken into account.

[0022] With this constitution, the residue generated inside the gasifying furnace body is charged quantitatively into the melting chamber furnace by the delivery mechanism, or the charging rate of the residue is adjusted depending on the melted state of the residue inside the melting chamber furnace.

[0023] In the invention according to Claim 5, the melting chamber furnace may be provided with a tuyere inside thereof through which an oxygen-containing gas is introduced into the residue resulting from thermal decomposition.

[0024] With this constitution, since the residue in the melting chamber furnace is combusted with the oxygen-containing gas such as oxygen introduced through the tuyere to be heated up to around a melting temperature, temperature of the pyrolysis region inside the gasifying furnace body can be set to around 800°C while adjusting the amount of excess oxygen.

[0025] In the invention according to Claim 6, preferably, the gasification-melting furnace may be equipped with a control device capable of adjusting temperature of the high-temperature gas being fed from the melting chamber furnace into the gasifying furnace body to be set to 1000 to 1300°C, and of heating and thermally decomposing the waste to be converted into residue at a temperature of 500 to 1000 °C.

[0026] With this constitution, since the waste dried by removing its moisture is controlled to have a temperature within a range of 500 to 1000°C, 500°C, which is, at least, required for thermally decompose combustible matter in the waste, is obtained and the residue (ash) is hardly softened (hardly start partially melting) under temperature lower than 1000°C. Further, the high-temperature gas generated inside the melting furnace chamber is very high, for example, around 1650°C, but the temperature of the high-temperature gas is reduced to 1000 to 1300°C, therefore, a quality of the refractory bonded to the inner wall of the gas feed pipe, the duct, or the header located in the feed path is well kept, and life of the refractory is extended.

[0027] In the invention according to Claim 7, it is preferable to adjust temperature and amount of the high-temperature gas so that temperature of the high-temperature gas being fed from the melting chamber furnace into the gasifying furnace body is set higher than 1000°C and the waste inside the gasifying furnace body is heated and thermally decomposed at a temperature lower than 800°C to be converted into the residue.

[0028] In the waste gasification-melting furnace according to Claim 7, since the waste inside the gasifying furnace body is heated and thermally decomposed into the residue at a temperature lower than 800°C, adhesion or hanging of the waste or the residue in the gasifying furnace body does not occur. Thereby, operation is stabilized and life of the refractory is greatly extended.

[0029] In the invention of Claim 8, the gasifying furnace body may be provided with an inlet of incombustible substances such as ash or sludge under an intermediate portion in a vertical direction of the gasifying furnace body and an extruding mechanism of a screw type, a rotating vane type, or a pusher type, or an injecting mechanism using a carrier gas in the vicinity of the inlet.

[0030] In the waste gasification-melting furnace according to Claim 8, the incombustible substances such as ash or polluted sludge are fed into the waste layer in an intermediate portion of the furnace by the feeding mechanism or the gas injecting mechanism using the carrier gas, and the waste deposited above the feeding extrusion position serves as a filter. This enables the ash to be efficiently heated by the high-temperature gas fed into the furnace body without flying out with an effluent gas. Thus, in the invention of Claim 8, various types of wastes can be efficiently treated.

[0031] In the invention according to Claim 9, the melting chamber furnace may be provided with a feeding port through which incombustible substances are fed independently or together with fuel and an oxygen-containing gas.

[0032] In the waste gasification-melting furnace according to Claim 9, the ash is directly introduced into the melting chamber furnace to be melted together with the residue and converted into slag.

[0033] In the invention according to Claim 10, the waste gasification-melting furnace may comprise a hot cyclone provided in a high-temperature gas feed path from the melting chamber furnace to the gasifying furnace body, the cyclone being provided with a supplying port of incombustible substances such as ash or sludge in an inlet portion or inside thereof, wherein a feed path of substances collected by the cyclone extends from the cyclone to the melting chamber furnace after being heated.

[0034] In the waste gasification-melting furnace according to Claim 10, after the ash or sludge fed into the hot cyclone contacts the high-temperature gas and is instantaneously heated, they are taken into the melting chamber furnace and efficiently melted, while the high-temperature gas inside the hot cyclone, whose temperature is lowered because a part of sensible heat of the gas is transferred to the ash or sludge, and in this state, the gas with a reduced temperature is fed to the furnace body. Therefore, the feed pipe or the header is hardly damaged, and damage to the refractory inside the furnace body is prevented.

[0035] In the invention according to Claim 11, the waste gasification-melting furnace may be equipped with an industrial television camera, a microwave measuring device or a radiation ray type measuring device as a level measuring

device for keeping a residue layer resulting from thermal decomposition being heated and melted by the heating and melting burner at a proper melting flow rate or level.

[0036] In the waste gasification-melting furnace according to Claim 11, since the residue layer being heated and melted inside the melting chamber furnace by the burner is kept at a proper level by the measurement using the level measuring device, the residue can be stably and properly melted and converted into slag. The television camera allows the damage or the like of the refractory inside the melting chamber furnace to be observed, as well as obtaining information on the quality (viscosity, etc), and quality of the slag. Therefore, an appropriate timing for maintenance can be known.

[0037] In the invention according to Claim 12, it is preferable that the melting chamber furnace may have an inlet hole of a mud (made of wet refractor powder) spraying device in a wall thereof to allow damaged refractory inside the melting chamber furnace to be repaired from outside.

[0038] In the waste gasification-melting furnace according to Claim 12, the damage of the refractory wall such as a ceiling portion can be detected, and wet refractory (powder) can be coated by using a gun as the spraying device. The gun is operated for about 20 minutes and is easily handled. Also, time during which operation is stopped for maintenance of the refractory is greatly reduced in contrast with the conventional melting furnace. Consequently, the rate of operation of furnace is improved.

[0039] In the invention according to Claim 13, the gasifying furnace body may be configured to have an annular space, in which no waste exists, by sharply enlarging or reducing an inner wall of the furnace in comparison with a portion located above in the vicinity of an intermediate portion in a vertical direction of the gasifying furnace body, and the high-temperature gas being fed from the melting chamber furnace to the gasifying furnace body is led into the annular space and then uniformly distributed into the waste layer.

[0040] With this constitution, instead of the header duct provided outside the furnace, the gas header may be provided inside the furnace as part of the furnace body. So, the structure of the equipment is simple and durability of the header is improved. Also, since the gas header is located inside the furnace, thermal loss of the gas is less. Further, the high-temperature gas can be introduced evenly to the waste layer.

[0041] In the invention according to Claim 14, it is preferable that the melting chamber furnace may be provided with a plurality of gas feeding ports in an inner wall in contact with the residue layer in the melting chamber furnace so as to respectively communicate with the gas feed pipe.

[0042] In accordance with the waste gasification-melting furnace according to Claim 14, since the high-temperature gas generated inside the melting chamber furnace is fed into the furnace body not from the space but through the residue layer, the high-temperature gas is utilized for preheating the residue. By setting each of the gas feeding ports to a position apart about 1000 mm under from the surface of the residue layer, the speed of the gas flowing into each suction port is made lower. This prevents the residue from flying and mixing into the high-temperature gas.

[0043] In the invention according to Claim 15, the melting chamber furnace body may be a fluidized bed furnace, a residue resulting from thermal decomposition, which is separated from fluidizing media such as sand circulating inside the furnace body, residue accompanied by a gas generated inside the gasifying furnace body, and dust recovered by the cyclone or the like are fed into the melting chamber furnace.

[0044] In the waste gasification-melting furnace according to Claim 15, by circulating char (comprised of carbon and ash) more than waste to be supplied, fluctuation in quality of the waste due to variation in moisture or incombustible component in the waste can be lessened. As a result, the combustion is stabilized.

[0045] A method of operating the waste gasification-melting furnace according to Claim 16, comprises adjusting a flow rate of oxygen and nitrogen introduced from outside into the gasifying furnace body and a flow rate of a high-temperature gas being fed from the melting chamber furnace into the gasifying furnace body to increase temperature of an exhaust gas discharged from a top portion of the furnace up to 800 to 1100°C by adding an oxygen-containing gas such as air, oxygen or oxygen-enriched air in an air ratio of 0.5 to 2.5 from outside to an upper portion inside the gasifying furnace body, thereby controlling concentration of CO₂ contained in the exhaust gas (gas being derived from the waste layer inside the gasifying furnace body) to be high.

[0046] In the gasification-melting furnace, when the temperature of residue is 800°C under a condition in which the temperature of the exhaust gas is controlled to be 300°C, the temperature of the exhaust gas can be increased by increasing the temperature of the residue by increasing oxygen. Besides, by setting the temperature of the exhaust gas to be lower than 500°C, the waste does not flame up due to injection of air or oxygen, and therefore, stable gasification is achieved. Most of the gases naturally ignite around 700°C, and it is therefore desirable to set the temperature of the exhaust gas to be lower than 500 °C as an appropriate temperature for partial combustion without flame, taking variation in properties of waste or the like into consideration. By setting the temperature of the gasification gas going out from a gasification region to be as low as 300 to 500°C, CO₂ becomes more than CO. From this, in the invention according to Claim 16, the temperature of the gasification gas is set low to reduce the amount of fuel for promoting combustion.

[0047] Further, by injecting oxygen or air from outside into the partially combusted gas generated from the waste in

the gasifying furnace body, the exhaust gas can be re-combusted. The heating value of the partially combusted gas varies depending on the heating value of waste. In view of this, air ratio is increased when the heating value is large. Further, by circulating the exhaust gas that has been cooled, temperature of the partially combusted gas is lowered to 800 to 950 °C. For example, water may be sprayed into the gas to adjust the temperature.

[0048] Preferably, combustion is conducted in a combustion region within a range of 700 to 800 °C by injecting oxygen or air from outside in the top portion of the gasification furnace to set the re-combustion temperature to be within a range of 800 to 950°C. Thereby, oil, tar, organic matters in the gas, which easily adhere on a wall at lower temperature (ex, under 250 °C), are cracked into gas and a blockade due to tar, etc. of a leading pipe for gas analysis, a leading-pressure pipe of a pressure gauge or the like does not occur. In this case, by adjusting an air ratio, the amount of oxygen, and the amount of spray water into the exhaust gas in the subsequent re-combustion furnace, re-combustion temperature of 800 to 950°C is properly adjusted.

[0049] In accordance with this method, since the combustion temperature is controlled to be 700 to 800°C in the furnace in advance, adjustment of the subsequent reburning at a reburning temperature is facilitated. Since combustible gases such as hydro carbon, carbon monoxide, and hydrogen contained in the gasification gas have a combustion point higher than a natural ignition point and are perfectly combusted easily by adding normal-temperature air or oxygen, a complex structure of the burner becomes unnecessary. Attention should be paid to the direction in which air or oxygen is added so that adhesion or deposit of the flying ash to the furnace wall is easily avoided.

[0050] In accordance with this method, the combustion temperature is kept stable. Therefore, CO due to imperfect combustion is reduced, and increase in NOx due to too high a temperature is also reduced.

[0051] In accordance with the method of operating the waste gasification-melting furnace, since the re-combustion temperature of the exhaust gas is reduced to 850 to 900°C, a low-quality and inexpensive material may be used for pipes of the subsequent boiler or air preheater and dioxin can be reduced. As a result, since the combustion temperature of the waste layer inside the furnace body is lower than that in the conventional method, but the temperature of the residue generated in the pyrolysis region is slightly higher than that in the conventional method, the amount of LP gas used as a fuel for promoting combustion is reduced and the heating value of the exhaust gas is reduced. Since the amount of combustion air is reduced, the amount of the exhaust gas is correspondingly reduced.

[0052] The method of operating the waste gasification-melting furnace according to Claim 17 may further comprise conducting part of the high-temperature gas generated inside the melting chamber furnace to a vicinity of an upper surface of the waste layer inside the gasifying furnace body and adding an oxygen-containing gas such as air, oxygen, or oxygen-enriched air, and, mixing oxygen-containing gas with the gas exhausted from the waste layer for combustion, thereby adjusting temperature of the exhaust gas discharged from a top portion of the furnace.

[0053] In accordance with the method of operating the waste gasification-melting furnace according to Claim 17, combustion and operation can start regardless of presence/absence of the waste in the gasification furnace. Since the temperature of the exhaust gas is controlled, feeding waste rate can be applied in a wide range, or variation of the amount or blow-by (partial passing of a large amount of gas through a part of the waste layer) of the exhaust gas can be minimized.

[0054] In the invention of Claim 18, the method of operating the waste gasification-melting furnace may further comprise conducting part of a high-temperature gas generated inside the melting chamber furnace to an intermediate portion in a vertical direction of the gasifying furnace body and adding air, oxygen, or oxygen-enriched air to a vicinity of an upper surface of a waste layer inside the gasifying furnace body to combust.

[0055] In accordance with the method of operating the waste gasification-melting furnace according to Claim 18, temperature or properties of the gas used for drying or pyrolysis of the waste inside the furnace body is adjusted to be desired ones, efficient operation becomes possible, variation in the amount of supplied waste in a wide range can be dealt with, or variation of the amount or blow-by of the exhaust gas is minimized.

[0056] In the invention according to Claim 19, the method of operating the waste gasification melting chamber furnace may further comprise conducting part of the high-temperature gas generated inside the melting chamber furnace to plural positions apart in the vertical direction at the intermediate portion in the vertical direction of the gasifying furnace body and adding air, oxygen or oxygen-enriched air to a vicinity of an upper surface of the waste layer inside the gasifying furnace body to combust.

[0057] In accordance with the method of operating the waste gasification-melting furnace according to Claim 19, the same effect as that provided by the operating method according to Claim 18 are attained. Advantageously, this effect is obtained in the entire furnace body.

[0058] In the invention of Claim 20, the method of operating the waste gasification-melting furnace may further comprise controlling a flow rate of oxygen to be injected into the gasifying furnace body according to a CO/CO₂ ratio in an exhaust gas generated from a waste layer inside the gasifying furnace body. In other words, it is preferable that the flow rate of entire oxygen to be injected into the gasifying furnace body according to the CO/CO₂ ratio of the exhaust gas generated from the waste layer inside the gasifying furnace body is adjusted so that variation in the CO/CO₂ ratio is minimized.

[0059] In accordance with the invention according to Claim 20, the following function and effects are offered.

(1) Conventionally, in the case of waste with larger LHV (Lower Heating Value), the combustion temperature must be prevented from being abnormally high by increasing the air ratio. Non-uniform combustion due to variation of properties of waste causes fluctuation in temperature and flow rate of the exhaust gas.

(2) In the invention according to Claim 20, attention is focused on composition of the partially combusted gas (CO , CO_2 , H_2 , H_2O , CH_4). The results of study is as follows.

(a) It has been found out that there is a relationship between the CO/CO_2 ratio and the heating value of the partially combusted gas (i.e., gas being derived from the waste layer inside the gasifying furnace body) in which the heating value increases with an increase in the CO/CO_2 ratio, or on the other hand, the heating value decreases with a decrease in the CO/CO_2 ratio.

(b) In this process, the partially combusted gas is reburned by addition of air in the subsequent step. In view of the fact that the combustion needs to be conducted at a temperature that is not very high to suppress NO_x or high-temperature corrosion, or otherwise perfect combustion needs to be conducted at a high temperature to suppress generation of dioxin or CO , the combustion is normally conducted at temperatures within a range of 850 to 950 °C.

(c) The amount of spray water, the air ratio, and the amount of recycled exhaust gas are controlled to keep reburning temperature constant, which results in variation in the amount of the exhaust gas.

(d) It has been proved that the CO/CO_2 ratio is kept constant by adjusting the flow rate of oxygen to be injected into the gasifying furnace body.

(e) When the heating value of waste abruptly increases or waste is actively combusted due to variation in waste, the combustion temperature increases and the amount of generated gas increases. This is suppressed by reducing the amount of oxygen.

(f) On the other hand, when the heating value of waste is reduced or combustion is unstable, the amount of generated gas can be increased and the combustion temperature can be increased by increasing the amount of oxygen.

(g) The flow rate of the gas being derived from the waste layer inside the gasifying furnace body increases with an increase in the CO/CO_2 ratio, or on the other hand, the above flow rate of the gas decreases with a decrease in the CO/CO_2 ratio.

(h) It has been proved that the flow rate of the gasification gas just before reburning can be controlled by adjusting the amount of oxygen injected to the gasifying furnace body so that the CO/CO_2 ratio is constant.

(i) CO and CO_2 are measured by rapid reading by infrared ray spectrum analysis. Since the CO/CO_2 ratio, instead of CO and CO_2 compositions is applied, malfunction due to troubles hardly occurs.

(j) Since a considerable amount of waste is deposited in the gasifying furnace body in this process, the cycle of fluctuation in the gasification reaction is approximately 10 times per hour. The cycle time is sufficiently longer than a delay (about ten seconds) due to sampling of the gas of an infrared ray spectrum analysis device in (i) and is therefore applicable to control of the ratio of the gas composition (CO/CO_2 ratio) using the infrared ray spectrum analysis device by adjusting the amount of oxygen.

(k) Oxygen used for melting the residue is kept substantially constant while its melted state (flow of slag) is monitored. By doing so, the melted state is kept constant. Also, since the amount of oxygen required for melting the slag is less than the amount of oxygen fed to the gasifying furnace body, disturbance hardly occurs.

(l) Thus, the gas generated in the gasification furnace is reburned in the subsequent step while the reburning temperature and the air ratio are adjusted and the composition and the amount of the gasification gas are kept approximately constant. Finally, the flow rate of the exhaust gas can be kept substantially constant.

(m) In other words, in the present invention, incineration of waste is suppressed when the heating value of the waste is large, but the incineration rate of waste is increased when the heating value of the waste is small.

(n) In the conventional combustion furnace, there is no effective method of controlling the amount of exhaust gas and, therefore combustion has been well and evenly conducted by carefully controlling the feeding rate of waste according to variation in properties of waste. On the other hand, in accordance with the present invention, the temperature and flow rate of the exhaust gas can be eventually controlled merely by controlling the amount of injected oxygen to keep the pyrolysis gas to be constant.

(o) The variation in the amount of exhaust gas due to variation in properties of waste in the conventional incineration facility corresponds to fluctuation in the amount of treated waste in the present invention. Specifically, waste with large LHV reduces the amount of treated waste and waste with small LHV increases the amount of treated waste. It is known that combustion state of the waste varies within a certain range because the conventional incineration facility has a waste pit (refuse pit) sufficient to accommodate a large waste receiving hopper and keep long resident time. On the other hand, in the present invention, fluctuation in the

amount of treated waste occurs but, since a considerable amount of waste is deposited in the gasifying furnace body as described above, this serves as a buffer which offsets the fluctuation. A large-volume waste receiving hopper serves to buffer step-like variation in properties of waste.

(p) As should be appreciated from the foregoing, in accordance with the present invention, since the temperature and flow rate of the combustion gas after reburning can be finally constant, capacity of equipment is much higher than the amount of waste to be treated, the amount of treated waste can be well controlled, and life of the furnace is extended.

[Brief Description of the Drawings]

[0060]

Fig. 1 is a view showing a waste gasification-melting furnace according to a first embodiment of the present invention, in which Fig. 1(a) is a central longitudinal sectional view and Fig. 1(b) is a cross-sectional view along line b - b in Fig. 1(a);

Fig. 2 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a second embodiment of the present invention;

Fig. 3 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a third embodiment of the present invention;

Fig. 4 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a fourth embodiment of the present invention;

Fig. 5 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a fifth embodiment of the present invention;

Fig. 6 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a sixth embodiment of the present invention;

Fig. 7 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a seventh embodiment of the present invention;

Fig. 8 is a central longitudinal sectional view showing a waste gasification-melting furnace according to an eighth embodiment of the present invention;

Fig. 9 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a ninth embodiment of the present invention;

Fig. 10 is an enlarged central longitudinal sectional view showing another embodiment of a melting chamber furnace;

Fig. 11 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a tenth embodiment of the present invention;

Fig. 12 is a central longitudinal sectional view showing a first type of the conventional gasification-melting furnace of a shaft furnace type;

Fig. 13 is a central longitudinal sectional view showing a second type of the conventional gasification-melting furnace of the shaft furnace type;

Fig. 14 is a cross-sectional view showing an enlarged melting reaction zone of the gasification-melting zone in Fig. 12, in which Fig. 14(a) shows the zone under normal condition and Fig. 14(b) shows the zone under abnormal condition;

Fig. 15 is a cross-sectional view showing an enlarged dome-shaped melting zone of the gasification-melting zone in Fig. 13, in which Fig. 15(a) shows the zone under normal condition and Fig. 15(b) shows the condition under abnormal condition; and

Fig. 16 is a central longitudinal sectional view showing a furnace exclusive for the conventional general melting.

[Best Mode For Carrying Out the Invention]

[0061] Hereinafter, embodiments of a waste gasification-melting furnace and a method of operating the waste gasification-melting furnace according to the present invention will be described with reference to the drawings.

[0062] Fig. 1(a) is a central longitudinal sectional view showing a waste gasification-melting furnace according to a first embodiment of the present invention and Fig. 1 (b) is a cross-sectional view along line b - b in Fig. 1(a).

[0063] As shown in Fig. 1(a), a gasification-melting furnace 1 of this embodiment comprises a gasifying furnace body 2 constituted by a longitudinal shaft furnace with refractory (not shown) lined onto an inner wall thereof and a melting chamber furnace 3 adapted to heat and melt residue resulting from pyrolysis which is called char generated finally in the gasifying furnace body 2. The gasifying furnace body 2 is configured such that its upper portion has a diameter gradually decreasing toward its upper end and is provided with an exhaust port 4 of an exhaust gas at its upper end.

An end of a duct is connected to the exhaust port 4 and an exhaust gas treating device is connected to its downstream side, although this is not shown. The exhaust gas treating facility is comprised of energy recovery equipment such as a reburning chamber, a heat exchanger such as a boiler, and a steam turbine, and a dust collector, or the like.

[0064] A waste feeding chute 5 penetrates through a furnace wall 2a in an upper portion of the gasifying furnace body 2. The gasifying furnace body 2 is configured such that its lower portion has a diameter gradually decreasing downwardly and is connected integrally with the melting chamber furnace 3 at a bottom portion under a lower-end opening 2b. As shown in Fig. 1(b), the melting chamber furnace 3 is formed by a tubular body with rectangular cross-section that is laterally long. The melting chamber furnace 3 is provided with an upper-end opening 3a communicating with the lower-end opening (discharge port) 2b of the gasifying furnace body 2 and a slag discharge port 6 at a lower end portion of a side wall 3b. The slag discharge port 6 is provided with a dam 6a and slag S overflowing the dam 6a is automatically discharged. The melting chamber furnace 3 is configured to have a lateral length to permit the residue flowing into the melting chamber furnace 3 through the upper-end opening 3a so as to form a sufficient slope of repose angle inclining toward one side (rightward in Fig. 3) and have a space formed above the slope of the residue. A heating and melting burner 7 is installed on the melting chamber furnace 3 such that a part of combustion gas at its tip end is directed toward the slope of the residue. Preferably, the burner 7 is installed with an angle so that a lower end of flame of the burners 7 is distant 50 to 300 mm from an upper surface of the residue layer, but this is only illustrative. The heating and melting burner 7 uses an inexpensive fuel such as a heavy oil mixed with oxygen, air or oxygen-enriched air. Alternatively, a plasma burner may be used.

[0065] A gas feeding pipe 8 extends upward from the space inside the melting chamber furnace 3 and is connected to a header duct 9 on the periphery of the lower portion of the gasifying furnace body 2. One ends of gas introducing pipes 10 are connected to the header duct 9 at equal intervals in the circumferential direction thereof and the other ends of the gas introducing pipes 10 penetrate through the furnace wall 2a of the gasifying furnace body 2. The position where a high-temperature gas is introduced into through the gas introducing pipes 10 corresponds to a pyrolysis region Y of the waste A. In this embodiment, the high-temperature gas generated inside the melting chamber furnace 3 is led into the pyrolysis region Y while its temperature and flow rate is adjusted so that moisture of the supplied waste A is removed and the supplied waste A is dried under temperature of 300 to 400 °C in a dry region X in an upper portion inside the gasifying furnace body 2 and the waste A is thermally decomposed at a temperature within a range of 500 to 1000°C, preferably at a temperature a little higher than 800°C. The reason why the temperature of the thermal decomposition region Y is controlled to be within a range of 500 to 1000°C is that at lowest 500°C is required to thermally decompose combustible matter in the waste A and the residue (ash) starts to be partially molten at a temperature higher than 1000 °C.

[0066] The gasification-melting furnace 1 according to the first embodiment of the present invention is constituted as described above. In the gasification-melting furnace 1, the waste A slowly moves downward to the pyrolysis region Y in the lower portion while being dried in the dry region X in the upper portion inside the furnace. The waste A is thermally decomposed and the combustible matter in the waste A is gasified in the pyrolysis region Y. The resulting gas is led from the melting chamber furnace 3 to the gasifying furnace body 2 to be used for drying the waste A in the dry region X together with the high-temperature gas and is thereafter discharged through the exhaust port 4 to be sent a gas treating facility including a power generating equipment or the like. After recovery of energy in the power generating equipment, the gas is treated in a bag filter or the like and is then discharged outside. The residue generated in the gasifying furnace body 2 flows into the melting chamber furnace 3, and the surface layer of the slope of the residue layer is sequentially melted by the flame from the heating and melting burner 7 and converted into slag, which is melted together with alumina, silica, and the like contained in the waste A, and is discharged from the slag discharge port 6. The discharged molten slag is abruptly cooled and solidified by water spray-cooling and disposed for land filling or reused as a material for road bed for land filling. It should be appreciated that the residue deposited on the bottom surface inside the melting chamber furnace 3 protect the refractory on the bottom surface. In Fig. 1, Z represents a heating and melting region where the residue C is deposited.

[0067] Fig. 2 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a second embodiment of the present invention.

[0068] A melting furnace 1 - 2 of the second embodiment differs from the melting furnace 1 in that a gas header 11 is provided as part of the gasifying furnace body 2 inside the furnace instead of the header duct 9 provided outside the furnace. Specifically, the gas header 11 is configured such that the furnace wall 2a of the gasifying furnace body 2 is radially outwardly and circumferentially annularly protruded to have a triangular cross-section, and has an inner annular space in which no waste exists without a waste layer B. The other constitution and function are identical to those of the first embodiment, and therefore, the same components as those in the first embodiment are identified by the same reference numerals and will not be further described.

[0069] Fig. 3 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a third embodiment of the present invention.

[0070] A melting furnace 1 - 3 of the third embodiment differs from the melting furnace 1 in that an oxygen introducing

pipe 12 is connected to the gas feeding pipe 8 to allow an oxygen-containing gas such as oxygen, air, or oxygen-enriched air to be introduced therethrough.

[0071] With this constitution, the function and effects described below are provided. Heat required for melting the residue inside the melting furnace 3 is basically proportional to the amount of the residue led from the gasifying furnace body 2 into the melting chamber furnace 3. In fact, when much moisture and combustible matter are contained in the waste A, the high-temperature gas generated inside the melting chamber furnace 3 is insufficient to completely dry and thermally decompose the waste A. To achieve this, it is necessary to blow oxygen into the waster layer B inside the gasifying furnace body 2 to cause combustible matter to be combusted to thereby generate heat. It is desirable to convert the combustible component in the waste A into a lightweight gas in exhaust gas treating equipment. To convert the combustible matter into a hydro carbon gas such as CO, H₂, or CH₄, rather than tar or oil, heat and oxygen need to be added. To this end, it becomes necessary to introduce oxygen into the gasifying furnace body 2.

[0072] Further, a normal-temperature oxygen-containing gas is introduced through the oxygen introducing pipe 12 serves to lower the temperature of the high-temperature gas being fed into the gasifying furnace body 2. Specifically, the high-temperature gas generated inside the melting furnace chamber 3 is extremely high, for example, about 1650 °C. If such a high-temperature gas is directly fed into the gasifying furnace body 2, this damages refractory lined on an inner wall of the gas feeding pipe 8, or the header in a feed path of the gas. But, addition of the oxygen-containing gas lowers the temperature of the gas to, for example, 1300°C. Thereby, the damage to the refractory is lessened. Also, the normal-temperature oxygen-containing gas being independently introduced from outside into the gasifying furnace body 2 is less likely to fully react with the waste A, but when the oxygen-containing gas is introduced under a high-temperature condition of , for example, 1300 °C together with the high-temperature gas, the waste A reacts with oxygen and is reliably combusted.

[0073] The other constitution and function are identical to those of the first embodiment, and therefore, the same components as those in the first embodiment are identified by the same reference numerals and will not be further described.

[0074] Fig. 4 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a fourth embodiment of the present invention.

[0075] A melting furnace 1 - 4 of the fourth embodiment differs from the melting furnace 1 - 3 in that a screw type feeder 13 is provided just under the openings (discharge ports) 2b, 3a where the gasifying furnace body 2 is connected to the melting chamber furnace 3.

[0076] With this constitution, the following function and effects are provided. By rotating the screw shaft 13a by a drive device 14 inside the melting chamber furnace 3, the residue generated inside the gasifying furnace body 2 is quantitatively and gradually extruded toward the burner 7 in the melting chamber furnace 3. A main part of the screw shaft 13a (including a screw) has a water-cooled structure for cooling (not shown). In this embodiment, the temperature of the residue is relatively low, i.e., 800 to 1000°C or less. Therefore, various types of feeders including pusher-type extruder is applied, as well as the screw-type extruder. In particular, an extruder used for a direct reduction iron making furnace of a shaft furnace type, or an iron making furnace of a rotary furnace type may be used.

[0077] The other constitution and function are identical to those of the third embodiment, and therefore, the same components as those in the third embodiment are identified by the same reference numerals and will not be further described.

[0078] Fig. 5 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a fifth embodiment of the present invention.

[0079] A melting furnace 1 - 5 of the fifth embodiment differs from the melting furnace 1 - 4 of the fourth embodiment. In the fifth embodiment, the high-temperature gas Q generated inside the melting chamber furnace 3 is led into the gasifying furnace body 2 through the residue layer resulting from pyrolysis inside the melting chamber furnace 3 from the openings 2b, 3a connecting with the gasifying furnace body 2, without the use of the gas feeding pipe 8 or the header duct 9. Although the screw type extruder 13 is illustrated as being located slightly under the openings 2b, 3a, it is more preferable in this embodiment that the extruder 13 is located slightly above the openings 2b, 3a, i.e., on the gasifying furnace body 2 side.

[0080] With this constitution, the following function and effects are provided.

1) Since the high-temperature gas Q is led into the gasifying furnace body 2 through the residue layer, the residue C is efficiently heated. In other words, in the first to fourth embodiments, heat transfer through the residue layer inside the melting chamber furnace 3 is conducted by radiation, efficiency is lower than that of the fifth embodiment.

2) Since oxygen contained in the high-temperature gas reacts with combustible substances (mainly, carbon) remaining in the residue and is combusted, temperature of the residue layer can be increased. This reduces the fuel used in the burner 7.

3) The melting furnace 1 - 5 of this embodiment has a structure simpler than those of the melting furnaces of the other embodiments. While melting is conducted in the unstable dome-shaped melting zone in the above-mentioned

prior art (Japanese Laid-Open Patent Application Publication No. Hei. 11 - 132432), melting is conducted in the surface layer of the slope of the residue layer inside the melting chamber furnace 3 in the melting furnace 1 - 5, and therefore operation is stably carried out.

In the melting furnace 1 - 5, control is executed so that temperature of the residue in the vicinity of the extruder 13 is set to 1000 °C or less. Also, the height of the waste layer B deposited inside the gasifying furnace body 2 is set low so that the residue resulting from thermal decomposition in the vicinity of the extruder 13 contains not only char but also relatively more combustible component resulting from imperfect thermal decomposition.

The other constitution and function are identical to those of the fourth embodiment, and therefore, the same components as those in the fourth embodiment are identified by the same reference numerals and will not be further described.

Fig. 6 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a sixth embodiment of the present invention.

A melting furnace 1 - 6 of the sixth embodiment differs from the melting furnace 1 - 4 of the fourth embodiment in the following two respects.

[0081] First, like the second embodiment, a gas header 16 is provided inside the furnace as part of the gasifying furnace body 2. Specifically, the gas header 16 is configured such that a furnace wall 2a of the gasifying furnace body 2 is radially inwardly and circumferentially annularly protruded to have a triangular cross-section, and has an inner annular space in which no waste exists.

[0082] Second, the high-temperature gas generated inside the melting chamber furnace 3 is fed into the gasifying furnace body 2 not from the space but through the residue layer resulting from thermal composition. Specifically, a plurality of gas suction ports 17 are provided on the inner wall in contact with the residue layer deposited inside the melting chamber furnace 3 so as to connect with the gas feeding pipe 8. Each of the suction ports 17 is apart about 1000 mm (as represented by L in Fig. 6) from the surface of the slope of the residue layer, and the speed of the gas flowing into each suction port 17 is set very low, for example, 0.1m/sec, for the purpose of preventing the residue from flying and mixing into the high-temperature gas.

[0083] With this structure, the same function and effects as described in 1) and 2) associated with the fifth embodiment are provided. The other constitution and function are identical to those of the above embodiments, and therefore, the same components as those in the above embodiments are identified by the same reference numerals and will not be further described.

[0084] Fig. 7 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a seventh embodiment of the present invention.

[0085] A melting furnace 1 - 7 of the seventh embodiment differs from the melting furnace 1 - 4 of the fourth embodiment in that two types of oxygen-containing gases, i.e., oxygen and air, are introduced into the gas feed pipe 8, and a flow rate of oxygen and a flow rate of air are controlled by using controllers 18, 19 and control valves 20, 21 so that measured temperature of the residue in the lower portion inside the furnace body 2 is 800 °C and measured temperature of the high-temperature gas being fed into the gas feeding pipe 8 is 1300°C. The temperature of the high-temperature gas to be fed into the furnace body 2 is adjusted by the flow rate of oxygen and the flow rate of air, and the temperature of the residue is adjusted by a ratio between oxygen and air. In the case where heat in the gasification-melting furnace 1 - 7 is insufficient, the fuel being fed by the burner 7 is increased and the amount of air and the amount of oxygen being fed into the melting chamber furnace 3 are increased. In this case, oxygen and air may be introduced through the burner 7.

[0086] Fig. 8 is a central longitudinal sectional view showing a waste gasification-melting furnace according to an eighth embodiment of the present invention.

[0087] A melting furnace 1 - 8 of the eighth embodiment differs from the melting furnace 1 - 4 of the fourth embodiment. In the eighth embodiment, ash is charged from outside into the furnace body 2. As shown in Fig. 8, an ash charging chute 22 is provided at a position slightly above the high-temperature gas introducing port of the gasifying furnace body 2, and a screw feeder 23 is provided with an upper end portion of the ash charging chute 22 so that ash C is charged into the furnace body 2 from outside and treated in the furnace.

[0088] With this constitution, it is advantageous that the ash C does not fly with gas because the waste A deposited above the position from where the ash is charged serves as a kind of filter in this embodiment, although upon supplying the ash C into the upper portion of the gasifying furnace body 2, the ash C flies away with the flow of the exhaust gas Q. The other constitution and function are identical to those of the fourth embodiment, and therefore, the same components as those in the above embodiments are identified by the same reference numerals and will not be further described.

[0089] Fig. 9 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a ninth embodiment of the present invention.

[0090] A melting furnace 1 - 9 of the ninth embodiment differs from the melting furnace 1 - 4 of the fourth embodiment.

In the ninth embodiment, a cyclone type suspended preheater 24 is provided in the gas feeding pipe 8 and an ash supplying port 25 is provided upstream of the cyclone type suspended preheater 24.

[0091] With this constitution, the high-temperature gas Q being fed from the melting chamber furnace 3 into the gasifying furnace body 2 is led into the cyclone type suspended preheater 24, while the ash being supplied from the supplying port 25 into the gas feeding pipe 8 is instantaneously heated by being mixed with the high-temperature gas flowing into the cyclone suspended preheater 24 and falls into the melting chamber furnace 3 to be melted. Meanwhile, temperature of the high-temperature gas Q is reduced to an appropriate value because the gas Q has been used for heating the ash C and is fed into the gasifying furnace body 2. The ash may be supplied from the inside of the cyclone type suspended preheater 24 into the inside of the melting furnace chamber 3 through an introducing port 26 as shown in Fig. 9 or through the burner 7 together with fuel, air, and the like.

[0092] Fig. 10 is an enlarged central longitudinal sectional view showing another embodiment of a melting chamber furnace. A melting chamber furnace 3' of this embodiment is provided with an insertion hole 28 on a side wall 3c through which a spraying gun 27 for spraying mud made of wet refractory powder E is installed. The gun 27 is installed through the insertion hole 28 to be movable in longitudinal and lateral directions. Measurement instruments such as a television camera (not shown) or a thermometer (not shown) are provided in a space U inside the melting chamber furnace 3', for inspecting the refractory wall such as a ceiling portion, and the sprayed wet refractory powder E is sprayed by using the gun 27. The gun 27 is operated for about 20 minutes, and its operation is easy. With this structure, time for stopping operation to maintenance the refractory is greatly reduced, and operation efficiency of the melting furnace 1 is improved.

[0093] Fig. 11 is a central longitudinal sectional view showing a waste gasification-melting furnace according to a tenth embodiment of the present invention.

[0094] A melting furnace 1 - 10 of this embodiment differs from each of the above embodiments as follows. The melting furnace 1 - 10 is configured such that the gasifying furnace body 2 is connected to the melting chamber furnace 3 through the connecting openings 2b, 3a which are equal in diameter to the gasifying furnace body 2 and a side wall 3d (left in Fig. 11) of the melting chamber furnace 3 is configured to have a slope near a repose angle of the residue C. A steel-made slate belt conveyor 29 (with bars) as a heat-resistant carrying device is mounted along the slope 3d. A slag reservoir 30 is installed under a slag discharge port 6 to open upward. A steel-made conveyor 31 is installed inside the slag reservoir 30 to allow the cooled molten matter such as the slag to be continuously carried out. Three burners 7 are installed in the space inside the melting chamber furnace 3 and an LP gas or an oil is injected as oxygen-enriched air and a fuel for promoting combustion from each of the burners 7.

[0095] Specifically, like the second embodiment, a furnace wall 1a in an intermediate portion (dry region X) and a lower portion (thermal decomposition region Y) in the vertical direction of the gasifying furnace body 2 is radially outwardly and circumferentially annularly protruded to have a triangle cross-section, and an annular space, in which no waste exists, is formed above the slope of the waste A with a repose angle as upper and lower gas headers 32, 33. Pipes 34, 35 branching from the gas feeding pipe 8 are connected to the upper and lower gas headers 32, 33, respectively, and a pipe 36 branching from the gas feeding pipe 8 is connected to a top space portion T inside the furnace body 2. Dampers 37, 38, 39 are internally provided in the branching pipes 34, 35, 36, respectively. Introducing pipes 40, 41, 42 for introducing oxygen-containing gas such as oxygen or nitrogen are connected to the top space portion T and the gas headers 32, 33, and valves 43, 44, 45 are provided in the introducing pipes 40, 41, 42, respectively. A supplying port 46 of the waste A opens in the upper furnace wall 2a of the furnace body 2 and a pusher 48 provided with a feeding hopper 47 of the waste A is provided continuously with the supplying port 46. The other constitution and function are identical to those of the first embodiment, and therefore, the same components as those in the first embodiment are identified by the same reference numerals and will not be further described. As the gasification furnace, a rotary kiln may be used instead of the shaft furnace or the fluidized bed furnace.

[0096] The melting furnace 1 - 10 constituted above is operated according to the subsequent procedure. The melting method (operating method) of this embodiment will be described with reference to the melting method (hereinafter referred to as the conventional method) using the conventional melting furnace (Japanese Laid-Open Patent Application Publication No. Hei. 11 - 132432, hereinafter referred to as the conventional furnace).

[0097] In the conventional method (Fig. 12), since the exhaust gas contains relatively much CO, the exhaust gas derived from the furnace is produced into hydrogen and carbon monoxide. The dome-shaped melting zone 53 (Fig. 12) has a temperature of around 1650 °C, and therefore, a composition of the exhaust gas estimated from chemical equilibrium at this temperature is CO = 17%, CO₂ = 14%, and H₂ = 14%, which almost coincide with actual operation data of the furnace. The LP gas used as the fuel for promoting combustion occupies about 20% of the total heating value of the waste A.

[0098] On the other hand, in the melting furnace 1 - 10 of this embodiment, the percentage of CO₂ in the composition of the exhaust gas is greater than that of the conventional furnace. This is because combustion temperature of the waste layer B inside the furnace body 2 is set lower than that in the conventional method. The high-temperature gas Q generated in the melting chamber furnace 3 is led into the top space portion T and the gas headers 32, 33, together with the oxygen-containing gas. The gas Q reacts with the waste layer B inside the furnace body 2 and is combusted

at a temperature lower than that in the conventional method. But, since temperature of the residue generated in the pyrolysis region Y is slightly higher than that in the conventional method, the amount of LP gas or oil used as the fuel for promoting combustion is reduced, and the heating value of the exhaust gas is reduced. Since the amount of combustion air to be fed is reduced, the amount of exhaust gas is reduced. Table 1 below shows 1) the amount of the LP gas used as the fuel for promoting combustion, 2) the amount of oxygen used in the entire melting furnace, and 3) the amount of reburning gas required for combusting the exhaust gas, between the conventional method and this operating method.

[Table 1]

Item	Operating Method of This Embodiment	Conventional Method
1) Amount of LP gas	80 x 10 ³ kcal/ton	180 X 10 ³ kcal/ton
2) Amount of Oxygen	180 kg/ton	220 kg/ton
3) Amount of Re-combustion Gas	3000 Nm ³ /ton	3500 Nm ³ /ton

[0099] In accordance with the operating method of this embodiment, the following advantages are presented. The exhaust gas containing CO₂ with a percentage higher than that in the conventional method is generated. The temperature required for melting the residue C is 1650°C that is equal to that in the conventional method. The amount of heat generated per unit of the waste A is equal in both methods, while LHV (lower heating value) of the exhaust gas is greater in the conventional method than in the operating method of this embodiment. Because reduction of hydrogen due to reduction of the LP gas used as the fuel for promoting combustion regardless of equal amount of carbon contained in the exhaust gas, the gas volume is greater in the conventional method than in the operating method of this embodiment.

[0100] Because the temperature in reburning of the exhaust gas G is reduced to 850 to 1100°C, an inexpensive and low-quality material can be used for pipes of the boiler or air preheater in the subsequent gas treating facility. Besides, dioxin can be reduced. In addition, the dampers 37, 38 adjust the amount of the high-temperature gas Q being fed into the gas headers 32, 33 so that concentration of carbon dioxide contained in the exhaust gas G is kept constant, and the amount of oxygen-containing gas from the introducing pipes 41, 42 is set so that the drying region X and the pyrolysis region Y have desired temperatures. By introducing the oxygen-containing gas into the furnace body 2, the amount of carbon dioxide is increased.

[0101] Further, to keep the temperature of the exhaust gas G constant, the high-temperature gas Q and the oxygen-containing gas are led into the top space portion T from the branch pipe 36 and from the introducing pipe 40, respectively, and mixed. Thereby, variation in the amount of supplied waste A within a wide range can be dealt with, or fluctuation in the quality or blow-by of the exhaust gas G is minimized. Moreover, at the beginning of combustion of the waste A, by introducing the high-temperature gas Q from the branch pipe 36 into the top space portion T, combustion is started and the furnace is operated regardless of presence/absence of the waste A.

[0102] As should be appreciated from the foregoing description, in accordance with the present invention, the waste gasification-melting furnace and the method of operating the furnace offers advantages described below.

(1) High heat efficiency is gained and the amount of gas generation is averaged like the waste gasification-melting furnace of the shaft furnace type. More specifically, the high-temperature gas that has been used for melting the residue is delivered into the furnace body to be used for drying and thermally decomposing the waste, and most of sensible heat owned by the high-temperature gas is used for reaction with the waste, thereby rendering temperature of the exhaust gas to, for example, about 300 °C. Consequently, the amount of fuel consumption, the amount of power consumption, and the amount of oxygen consumption are all reduced.

2) Handling and equipment are simple and operation and maintenance are easy. The amount of waste to be melted per time can be steadily varied within a wide range.

3) The exhaust gas is treated properly because of stable flow rate and properties of the exhaust gas from the melting furnace. As a result, the amount of air to be mixed for reburning in downstream gas treating facility is minimized, and generation of CO and dioxin or NO_x is suppressed. Further, the amount of chemicals for gas cleaning such as urea, activated carbon, or slaked lime is reduced, and the amount of flying ash is reduced.

4) Since the amount and properties of the exhaust gas are stabilized, a steady and high-quality power can be obtained by reburning the exhaust gas in power generating equipment such as the boiler and the steam turbine. Further, since the amount of combustion air to be mixed can be reduced as described above, waste heat in the boiler is reduced and thermal loss is very small because all the generated steam is effectively delivered into the steam turbine without being dumped directly into a steam condenser.

5) Very small amount of supplied waste can be dealt with, for example, waste equal to 1/10 of regular amount,

can be gasified and melted stably.

6) Sludge, combusted ash, or flying ash can be treated, and heat of the exhaust gas obtained by combustion is efficiently recovered.

7) Since the waste is not melted inside the furnace body, temperature of the waste layer inside the furnace body is much lower than that of the melting furnace in the prior art, and lower than 1000°C corresponding to the temperature at which the ash starts to be melted (softened). As a result, without adhesion of the residue or hanging residue inside the furnace body, the operation is stabilized. Also, life of refractory is greatly extended and operation efficiency is increased.

8) Since the melting chamber furnace is located outside of the furnace body, and the exhaustive refractory is located in the gas space, maintenance is easily carried out by spraying wet refractory powder. This significantly increases the rate of operation of the facility.

[Industrial Applicability]

[0103] The present invention is constituted as described above, and is suitable as a waste gasification-melting furnace that has high-heat efficiency and is stable, comprising an integrated melting furnace and ash melting furnace, capable of melting char generated in the melting furnace in the ash melting furnace, and heating and thermally decomposing the waste by leading a high-temperature combustion gas generated in the ash melting furnace into the melting furnace.

Claims

1. A waste gasification-melting furnace comprising a gasifying furnace body of a shaft furnace type or a fluidized bed type, for drying and pyrolysis of waste sequentially supplied from above into the furnace by using a high-temperature gas; and a melting chamber furnace provided continuously with a lower end discharge port of the gasifying furnace body, for receiving residue of the waste resulting from pyrolysis, the melting chamber furnace being provided with a heating and melting burner directed toward a slope of the residue, wherein
the melting chamber furnace is provided with a discharge port through which molten substances containing molten slag and molten metal are discharged, and a mechanism inside thereof, for feeding a high-temperature pyrolysis gas generated during heating and melting of the residue to the gasifying furnace body.
2. The waste gasification-melting furnace according to claim 1, wherein an introducing path of oxygen or oxygen-enriched air is connected to a high-temperature gas feed path from the melting chamber furnace to the gasifying furnace body to allow temperature of the high-temperature gas being fed into the gasifying furnace body to be lowered and concentration of oxygen to be increased by the oxygen or oxygen-enriched air.
3. The waste gasification-melting furnace according to Claim 1 or 2, wherein a feeding path is provided at a position where the gasifying furnace body is connected to the melting chamber furnace or a lower portion inside the gasifying furnace body is connected to a space inside the melting chamber furnace by means of a duct to allow the high-temperature gas to be fed from the melting chamber furnace to the gasifying furnace body.
4. The waste gasification-melting furnace according to any one of Claims 1 to 3, further comprising a mechanism for charging the residue resulting from pyrolysis, which is a screw type, a rotating vane type, or a pusher type, the mechanism being provided in the vicinity of a position where the gasifying furnace body is connected to the melting chamber furnace.
5. The waste gasification-melting furnace according to any one of Claims 1 to 3, wherein the melting chamber furnace is provided with a tuyere inside thereof through which an oxygen-containing gas is introduced into the residue resulting from pyrolysis.
6. The waste gasification-melting furnace according to any one of Claims 1 to 5, further comprising a control device capable of adjusting temperature of the high-temperature gas being fed from the melting chamber furnace into the gasifying furnace body to be set to 1000 to 1300°C and of heating and thermally decomposing the waste to be converted into residue at a temperature of 500 to 1000°C.
7. The waste gasification-melting furnace according to Claim 6, further comprising a control device capable of adjusting temperature and amount of the high-temperature gas so that temperature of the high-temperature gas

being fed from the melting chamber furnace into the gasifying furnace body is set higher than 1000°C and the waste inside the gasifying furnace body is heated and thermally decomposed at a temperature of 800°C or lower to be converted into the residue.

- 5 **8.** The waste gasification-melting furnace according to any one of Claims 1 to 5, wherein the gasifying furnace body is provided with an inlet of incombustible substances such as ash or sludge under an intermediate portion in a vertical direction of the gasifying furnace body and an extruding mechanism of a screw type, a rotating vane type, or a pusher type, or an injecting mechanism using a carrier gas in the vicinity of the inlet.
- 10 **9.** The waste gasification-melting furnace according to any one of Claims 1 to 5, wherein the melting chamber furnace is provided with a feeding port through which incombustible substances are fed independently or together with fuel and an oxygen-containing gas.
- 15 **10.** The waste gasification-melting furnace according to any one of Claims 1 to 5, further comprising a hot cyclone provided in a high-temperature gas feed path from the melting chamber furnace to the gasifying furnace body, the cyclone being provided with a supplying port of incombustible substances such as ash or sludge in an inlet portion or inside thereof, wherein a feed path of substances collected by the cyclone extends from the cyclone to the melting chamber furnace.
- 20 **11.** The waste gasification-melting furnace according to any one of Claims 1 to 5, further comprising an industrial television camera, a microwave measuring device or a radiation ray type measuring device provided as a level measuring device for keeping a residue layer resulting from pyrolysis being heated and melted by the heating and melting burner at a proper level.
- 25 **12.** The waste gasification-melting furnace according to any one of Claims 1 to 5, wherein the melting chamber furnace has an inlet hole for a wet refractory spraying device in a wall thereof to allow refractory inside the melting chamber furnace to be repaired from outside.
- 30 **13.** The waste gasification-melting furnace according to any one of Claims 1 to 5, wherein the gasifying furnace body is configured to have an annular space without waste supplied, by sharply enlarging or reducing an inner wall of the furnace in comparison with a portion located above in the vicinity of an intermediate portion in a vertical direction of the gasifying furnace body, and the high-temperature gas being fed from the melting chamber furnace to the gasifying furnace body is led into the annular space.
- 35 **14.** The waste gasification-melting furnace according to Claims 1 to 5, wherein the melting chamber furnace is provided with a plurality of gas feeding ports in an inner wall in contact with the residue layer deposited inside the melting chamber furnace so as to respectively connect with the gas feed pipe.
- 40 **15.** The waste gasification-melting furnace according to any one of Claims 1, 2, and 5, wherein the melting chamber furnace body is a fluidized bed furnace, a residue layer resulting from thermal decomposition, which is separated from a fluidizing medium such as sand circulating inside the furnace body, residue accompanied by a gas generated inside the gasifying furnace body, and dust recovered by the cyclone or the like are fed into the melting chamber furnace.
- 45 **16.** A method of operating the waste gasification-melting furnace according to any one of Claims 1 to 14, further comprising adjusting a flow rate of oxygen and nitrogen introduced from outside into the gasifying furnace body and a flow rate of a high-temperature gas being fed from the melting chamber furnace into the gasifying furnace body to increase temperature of an exhaust gas discharged from a top portion of the furnace up to 800 to 1100 °C by adding an oxygen-containing gas such as air, oxygen, or oxygen-enriched air in an air ratio of 0.5 to 2.5
50 from outside to an upper portion inside the gasifying furnace body, thereby controlling concentration of CO₂ contained in the exhaust gas to be high.
- 55 **17.** The method of operating the waste gasification-melting furnace according to any one of Claims 1 to 14, further comprising leading part of the high-temperature gas generated inside the melting chamber furnace to a vicinity of an upper surface of the waste layer inside the gasifying furnace body and adding an oxygen-containing gas such as air, oxygen or oxygen-enriched air, thereby adjusting temperature of the exhaust gas discharged from the top portion of the furnace.

18. The method of operating the waste gasification-melting furnace according to any one of Claims 1 to 14, further comprising leading part of the high-temperature gas generated inside the melting chamber furnace to an intermediate portion in a vertical direction of the gasifying furnace body and adding air, oxygen or oxygen-enriched air to a vicinity of an upper surface of the waste layer inside the gasifying furnace body to combust.

19. The method of operating the waste gasification-melting furnace according to any one of Claims 1 to 14, further comprising leading part of the high-temperature gas generated inside the melting chamber furnace to plural positions apart in the vertical direction at the intermediate portion in the vertical direction of the gasifying furnace body and adding air, oxygen or oxygen-enriched air to a vicinity of an upper surface of the waste layer inside the gasifying furnace body to combust.

20. The method of operating the waste gasification-melting furnace according to any one of Claims 16 to 19, further comprising controlling a flow rate of oxygen to be injected into the gasifying furnace body according to a CO/CO₂ ratio in an exhaust gas generated from a waste layer inside the gasifying furnace body.

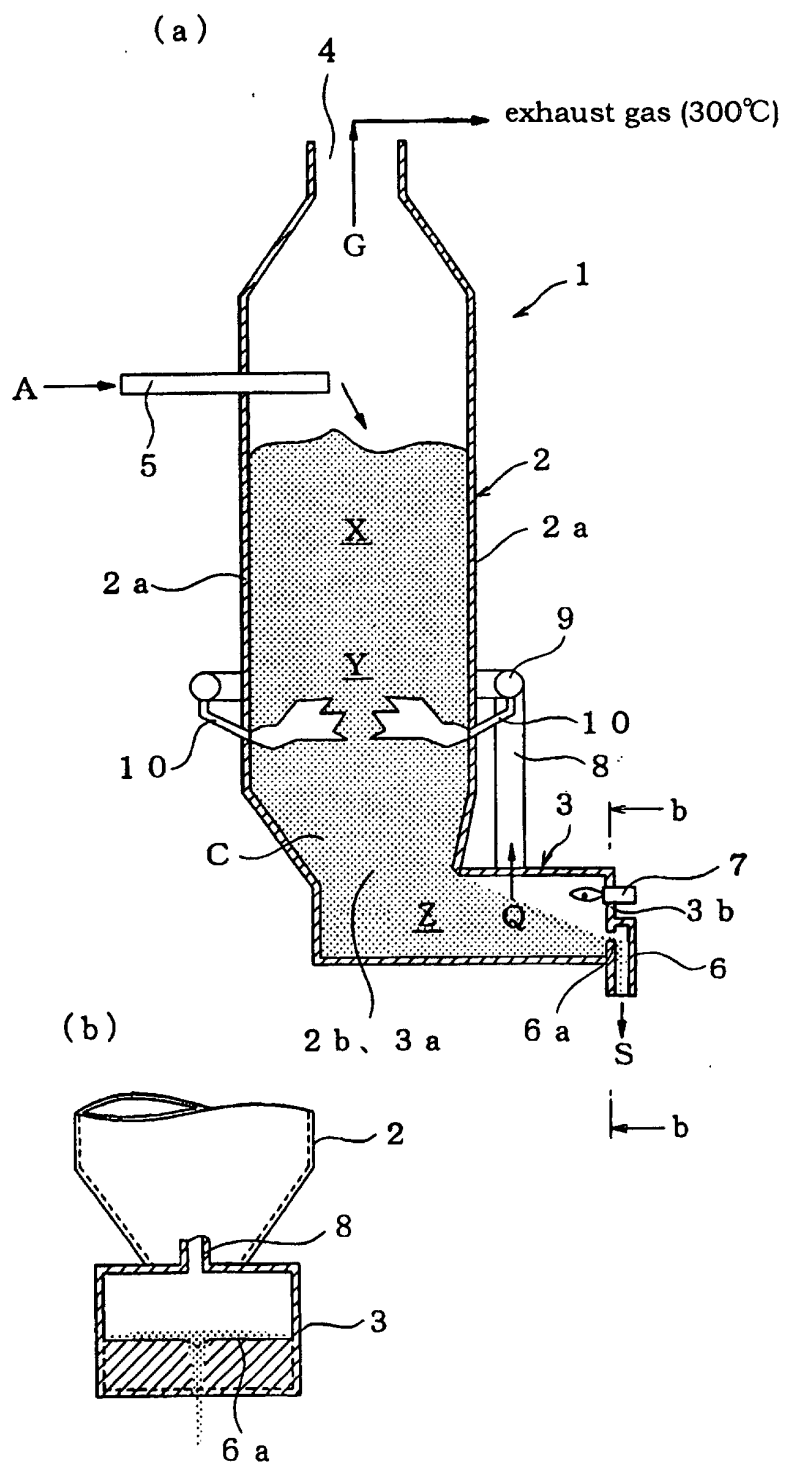


Fig. 1

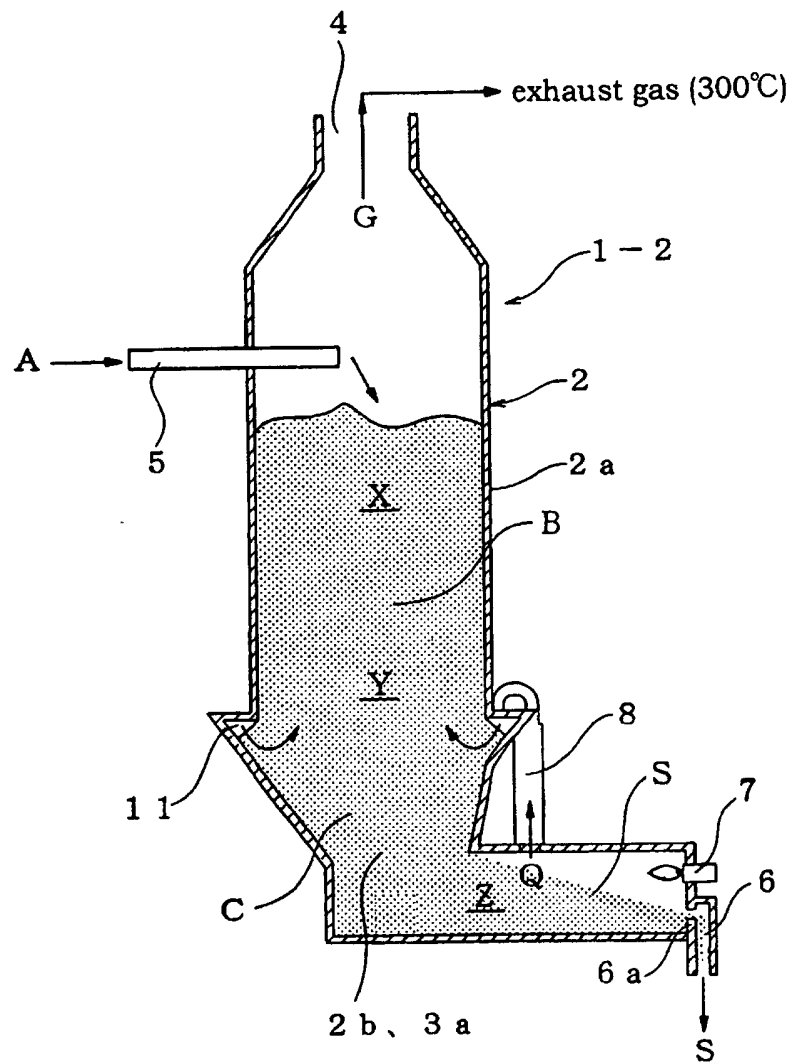


Fig. 2

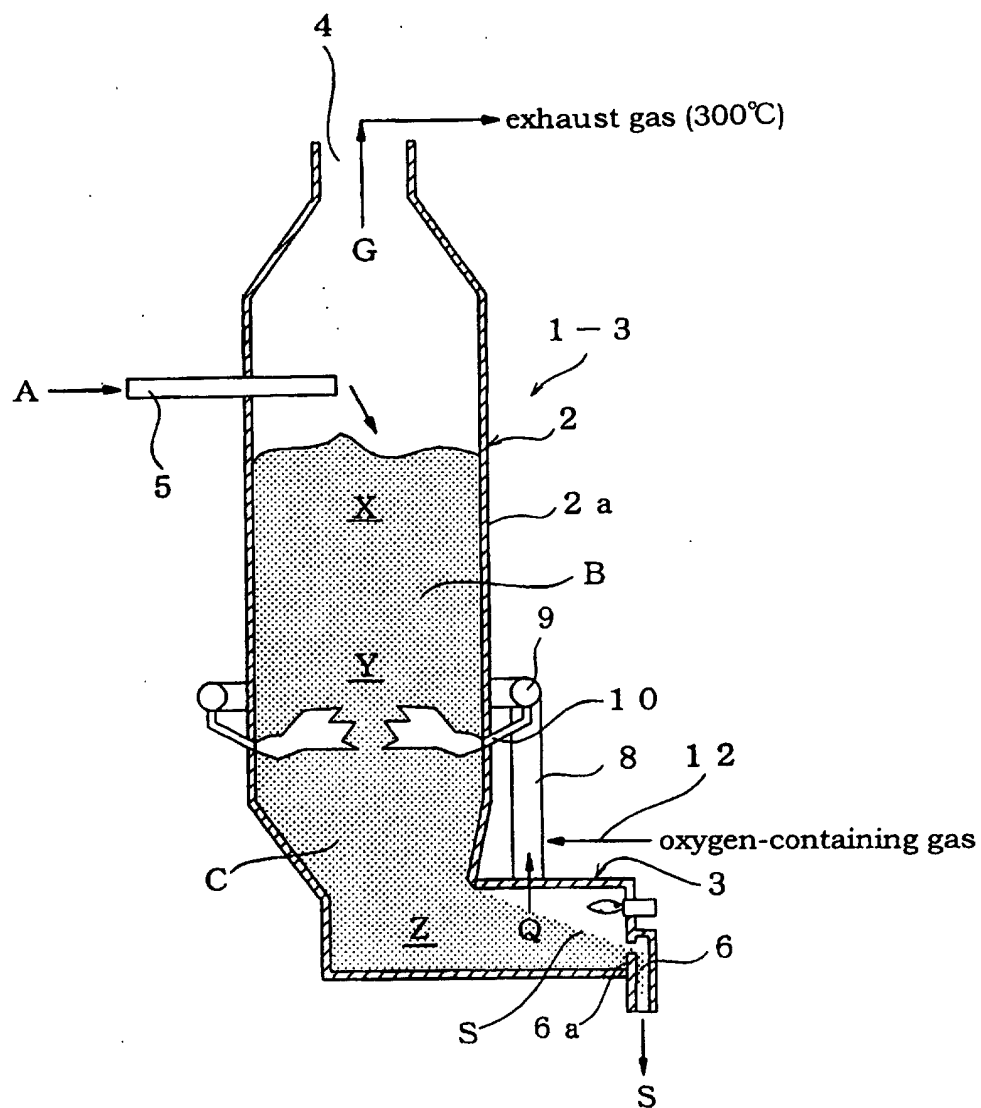


Fig. 3

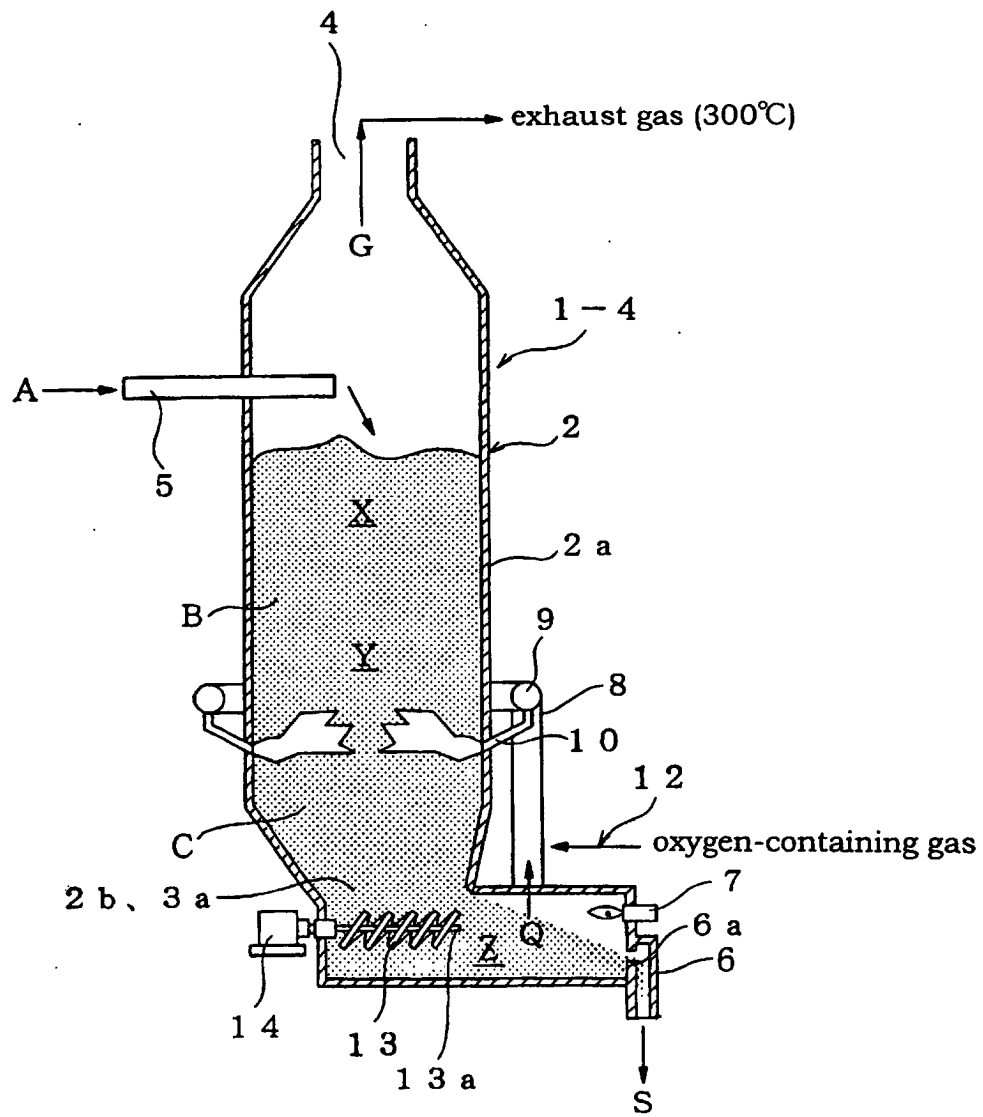


Fig. 4

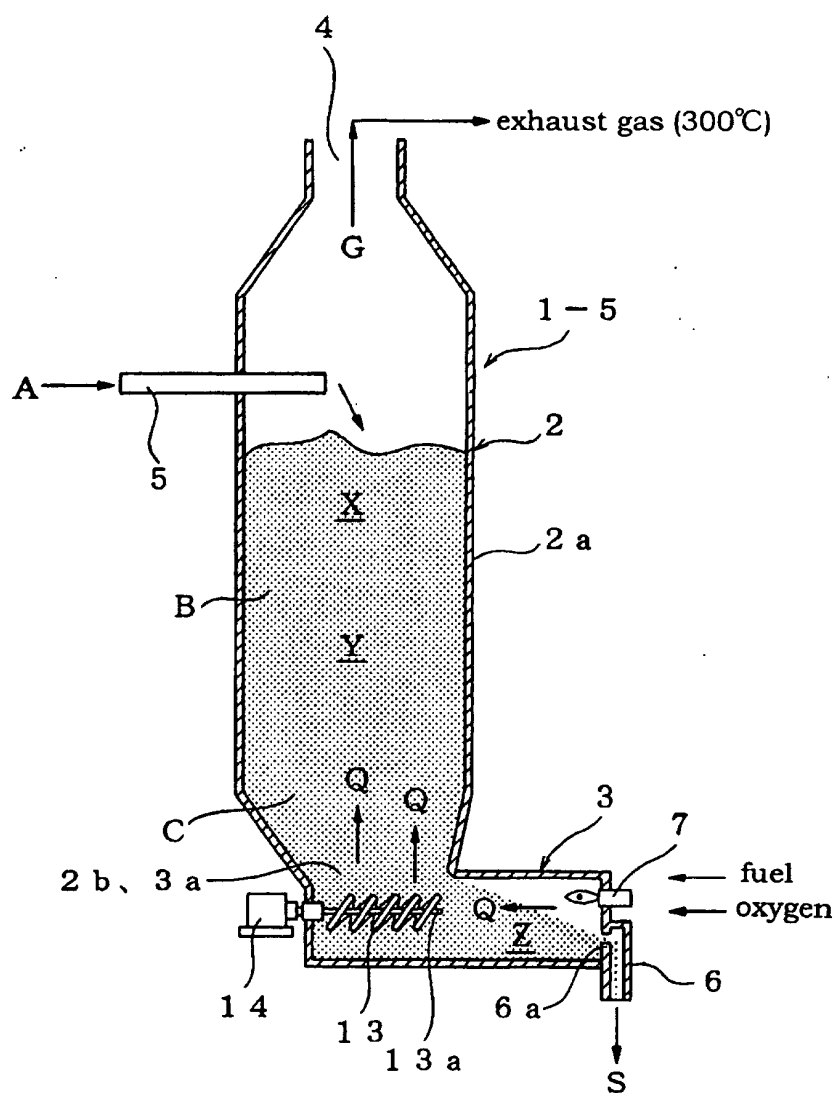


Fig. 5

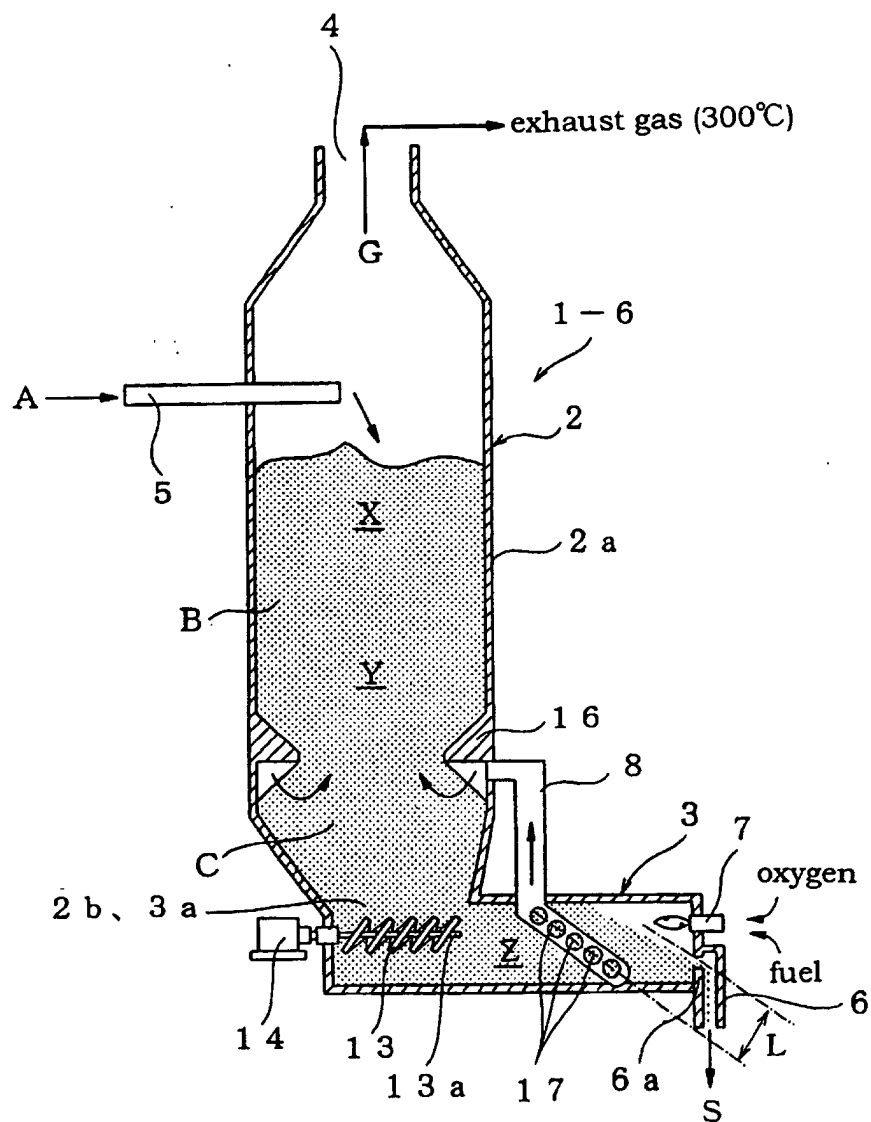


Fig. 6

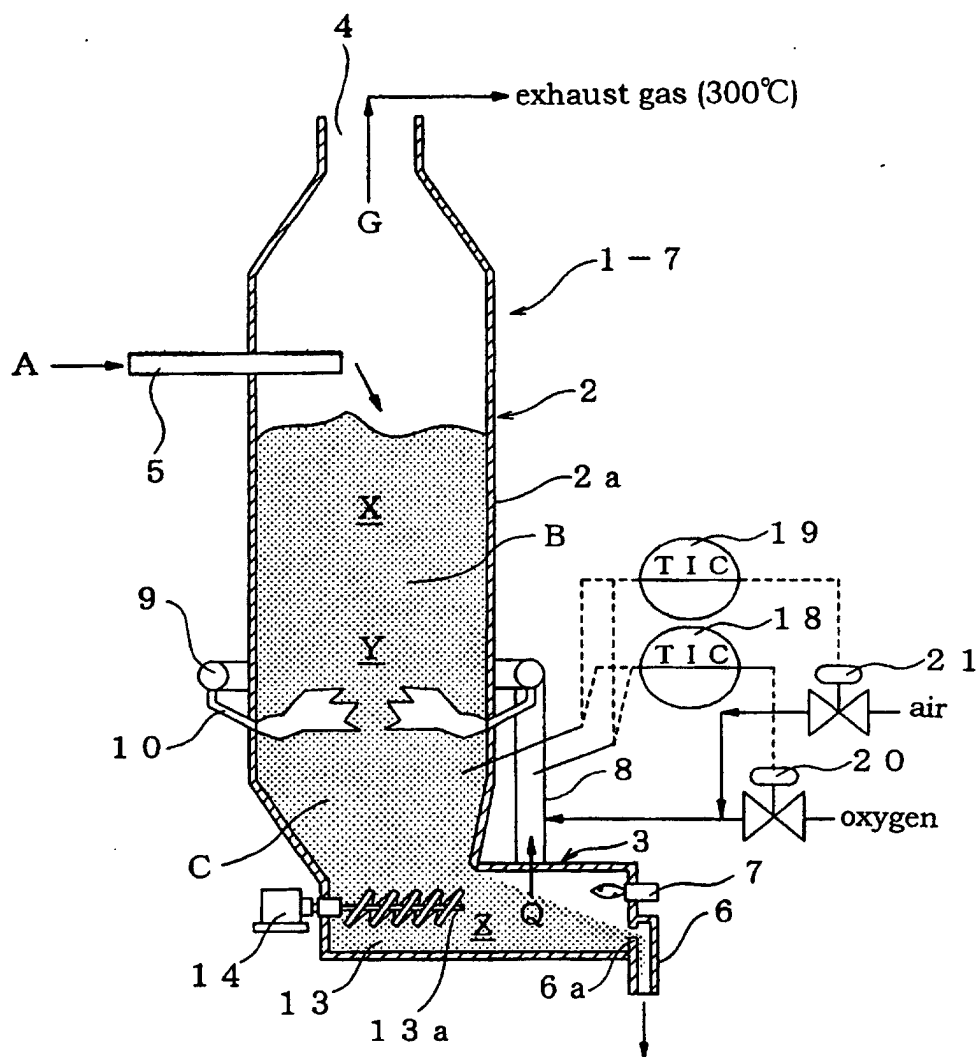


Fig. 7

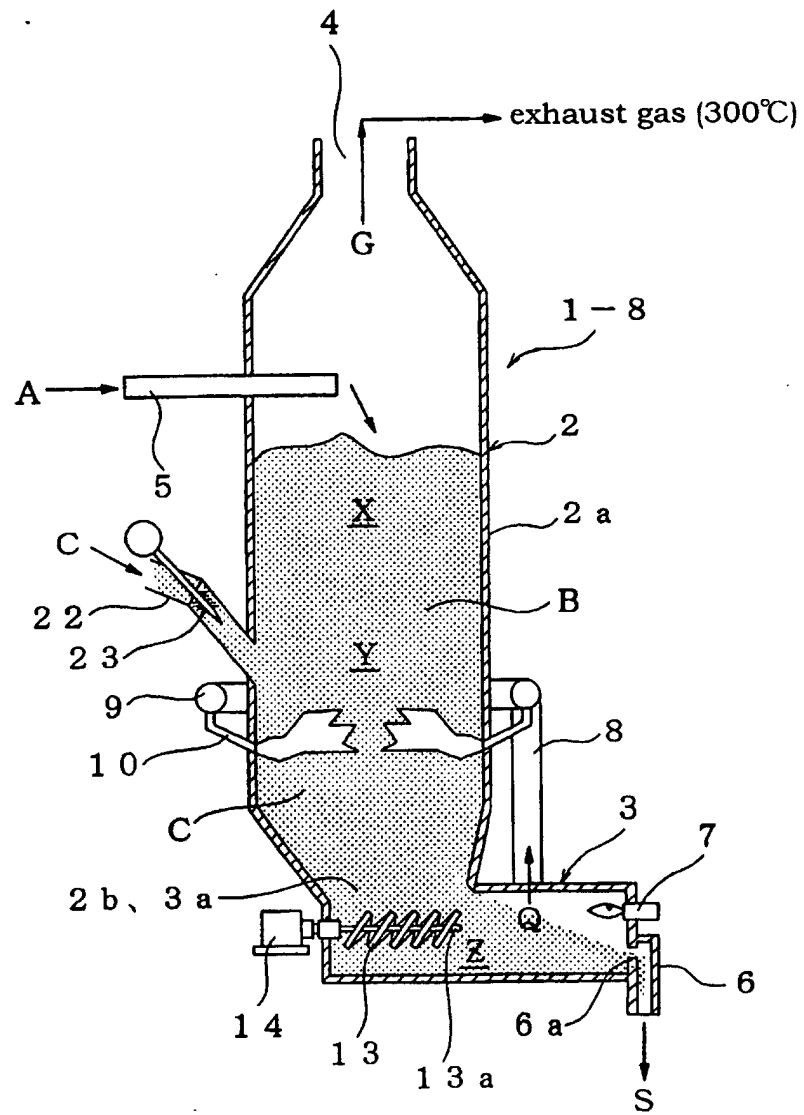


Fig. 8

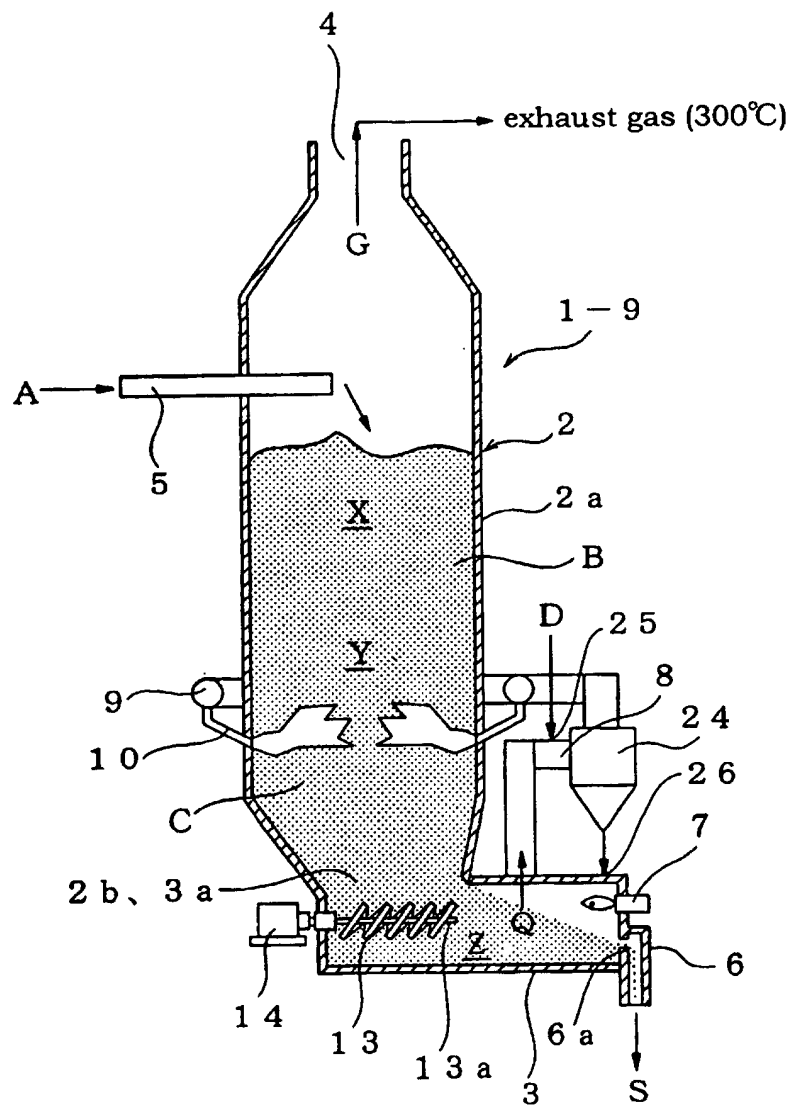


Fig. 9

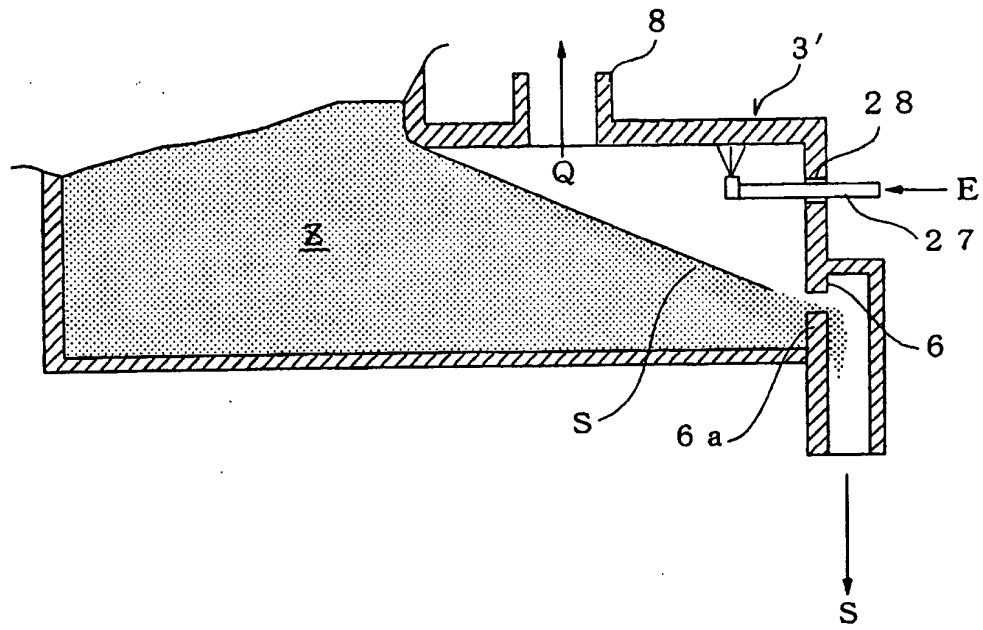


Fig. 10

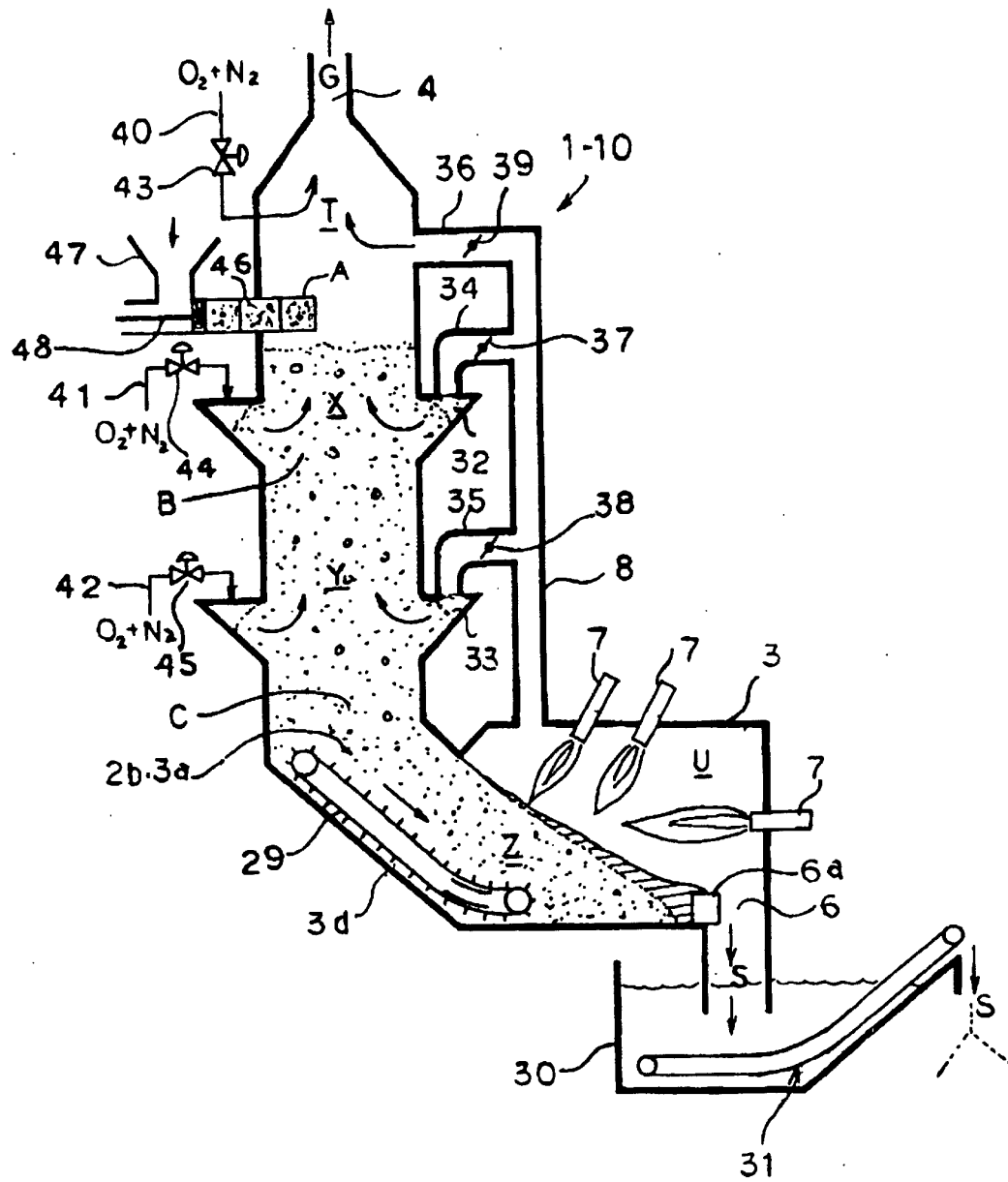


Fig. 11

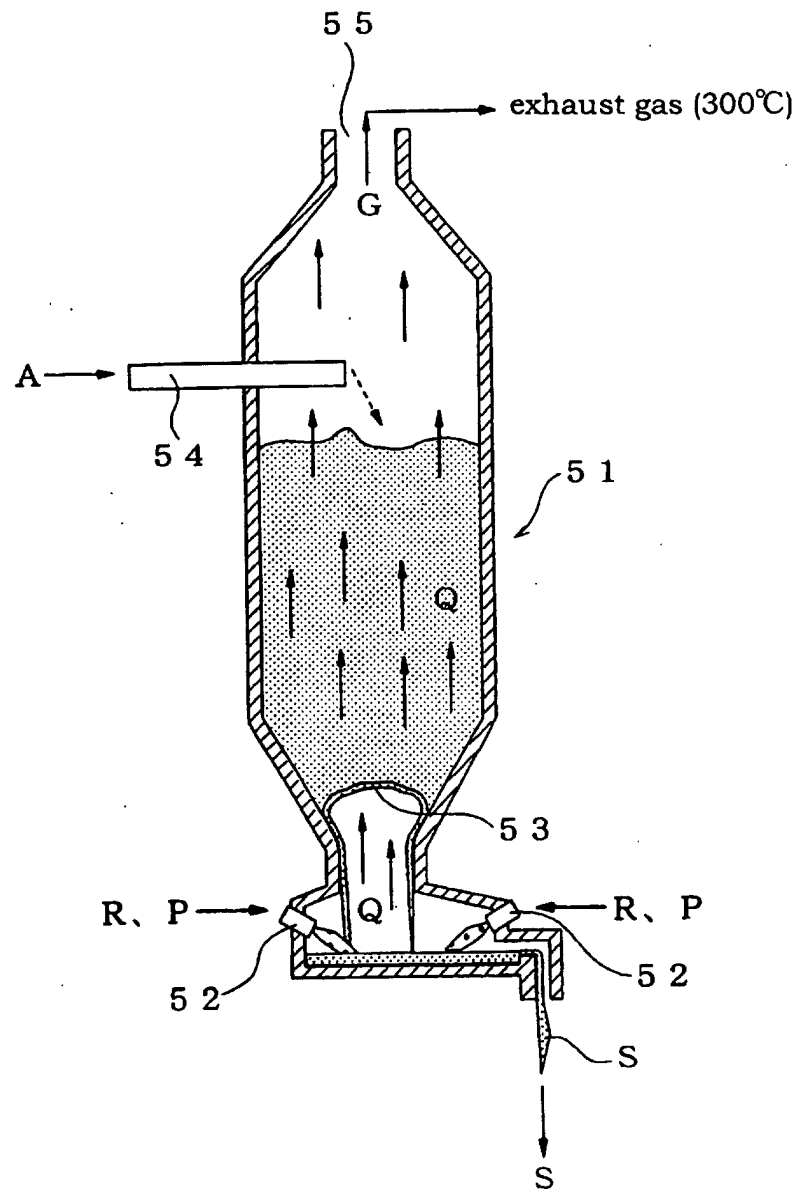


Fig. 12

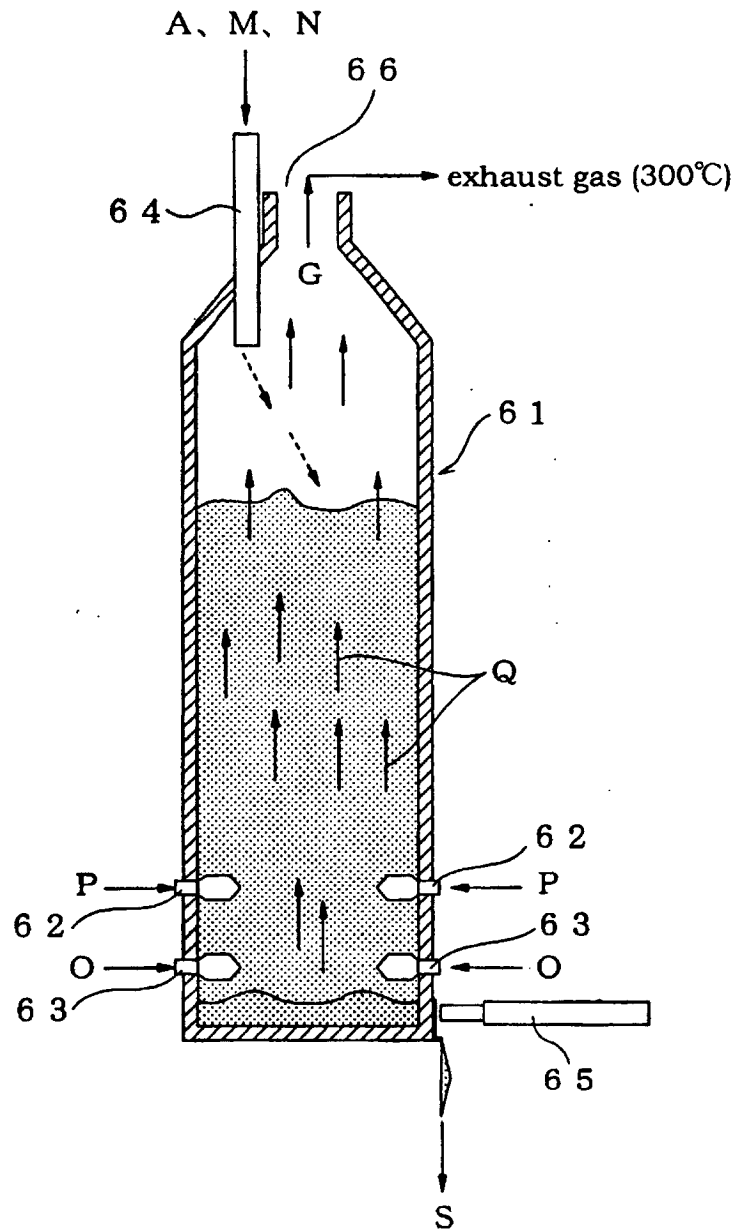


Fig. 13

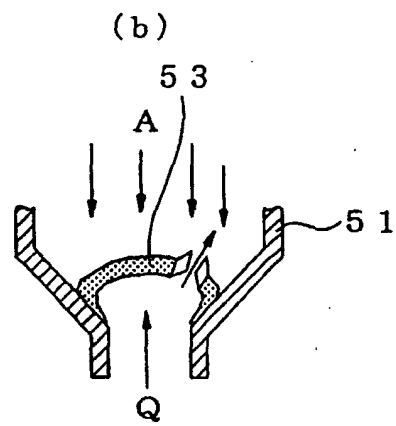
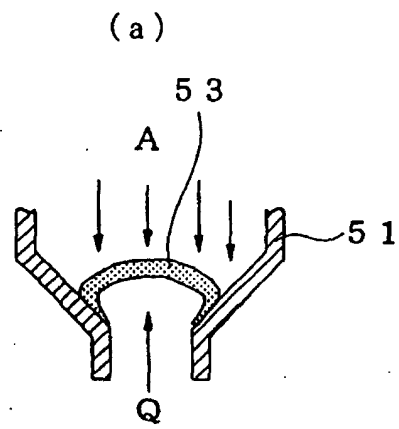


Fig. 14

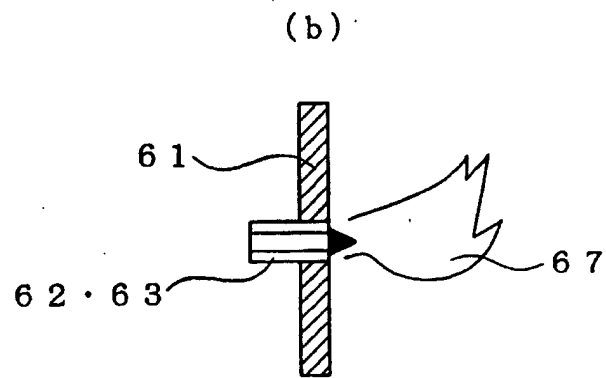
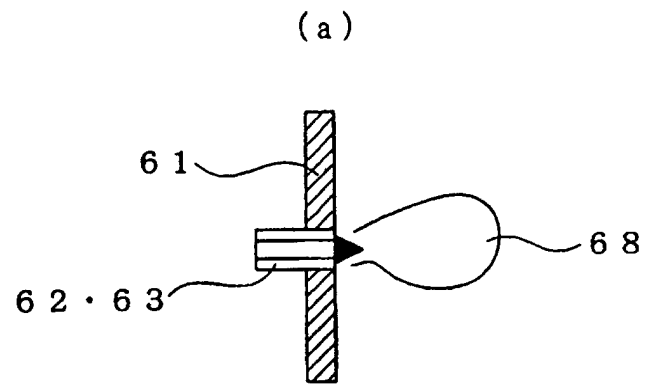


Fig. 15

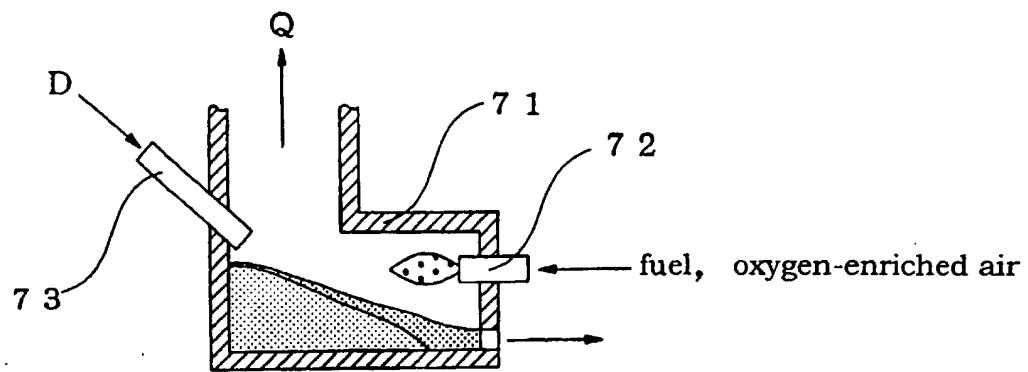


Fig. 16

1, 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, 1-9, 1-10...gasification-melting furnace, 2...gasifying furnace body, 2a...furnace wall, 2b...lower-end opening, 3, 3'...melting chamber furnace, 3a...upper-end opening, 3b...side wall, 4...exhaust port, 5...waste feeding chute, 6...slag discharge port, 6a...dam 7...heating and melting burner, 8...gas feeding pipe, 9...header duct 10...gas introducing pipe, 11...gas header, X...dry region, Y...pyrolysis region, Z...heating and melting zone, A...waste, B...waste layer, C...residue

Fig. 17

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/07523

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl⁷ F23G5/24, F23G5/44, F23J1/08

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.Cl⁷ F23G5/24, F23G5/44, F23J1/08

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

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-2001
Kokai Jitsuyo Shinan Koho	1971-2001	Jitsuyo Shinan Toroku Koho	1996-2001

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 11-125415 A (Chiyoda, Chem. Eng. & Constr. Co., Ltd.), 11 May, 1999 (11.05.99), Full text; Figs. 1, 2 (Family: none)	1-20
Y	JP 10-103635 A (Plantec K.K.), 21 April, 1998 (21.04.98), Full text; Figs. 1 to 6 (Family: none)	1-20
Y	JP 5-256584 A (Nisshin Steel Co., Ltd.), 05 October, 1993 (05.10.93), Full text; Fig. 1 (Family: none)	12
A	JP 2000-74334 A (Hitachi Zosen Corporation), 14 March, 2000 (14.03.00), Full text; Figs. 1, 2 (Family: none)	1-20

☐ 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

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"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
05 November, 2001 (05.11.01)Date of mailing of the international search report
20 November, 2001 (20.11.01)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

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Form PCT/ISA/210 (second sheet) (July 1992)