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(54) **COMPOSITE MOLTEN IRON MANUFACTURING APPARATUS**

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(56) References cited:
WO-A1-2005/054520
WO-A1-2013/100520
CN-U- 202 279 831
KR-A- 20000 032 104
KR-A- 20100 132 005
KR-A- 20120 038 017
KR-A- 20120 054 262
KR-A- 20140 070 178
US-A1- 2009 320 647
US-A1- 2014 042 677

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Description

[Technical Field]

[0001] The present invention relates to a combined molten iron manufacturing apparatus, and more particularly, to a combined molten iron manufacturing apparatus configured by combining reactors that perform reduction, dissolution, and the like of a plurality of iron-containing materials having various forms and functions so as to directly use fuel and raw materials with various ranks and particle sizes when manufacturing molten iron by directly using fine or compacted general coals or fine iron-containing ores.

[Background Art]

[0002] Currently, about 60% of the worldwide production of iron has been produced by a blast furnace method, which has been developed from the 14th century. The blast furnace method is a method for manufacturing molten iron in which coke and the like manufactured by using iron ores and bituminous coal as raw materials which are subject to a sintering process are added in a blast furnace, and oxygen is supplied to the furnace to reduce the iron ore to iron.

[0003] As such, since the blast furnace method, which forms its majority of a molten iron producing apparatus requires a raw materials that has a strength of a predetermined level or more due to the reaction characteristic and has a particle diameter capable of ensuring ventilation in the furnace, as described above, a carbon source used as fuel and a reductant depends on the coke processed by specific coking coal and an iron source depends on sintered ore that is subjected to a series of compacting processes.

[0004] Accordingly, in the current blast furnace method, since raw material pretreatment facilities such as coke production facilities and sintering facilities are necessarily accompanied, it is necessary not only to construct additional facilities other than the blast furnace but also to install environmental pollution prevention facilities for various environmental pollutants generated in the additional facilities, and as a result, the investment cost is consumed in a large amount and the manufacturing cost is rapidly increased.

[0005] In order to solve the problem of the blast furnace method, steel mills all over the world make a lot of efforts to develop a melting reduction steelmaking method for manufacturing molten iron by directly using general coals as a fuel and a reductant and as an iron source, fine ores that occupy more than 80% of the worldwide production of ores.

[0006] As an example of the melting reduction steelmaking method, in European Patent Publication No. 1,689,892, there is disclosed an apparatus fro manufacturing molten iron directly using fine or lump coals and fine iron-containing ores and the method thereof.

[0007] In European Patent Publication No. 1,689,892, an apparatus fro manufacturing molten iron directly using fine or lump coals and fine iron-containing ores is configured by a multi-stage fluidized reduction furnace that reduces and fires fine iron-containing ores and supplementary raw materials by contacting hot reducing gas; a hot compacting device that compacts the fine reduced iron discharged from the fluidized reduction furnace to manufacture hot reduced compacted iron; and a melter-gasifier in which briquette coals compacted and manufactured from fine general coals and compacted general coals are continuously supplied to form a coal filling layer with a predetermined height therein, oxygen and a pulverized coal material are injected through a plurality of fans formed at the lower end of the outer wall of the coal filling layer, the pulverized coal material and the compacted coals in the coal filling layer are combusted by the oxygen, hot reduced compacted iron which is manufactured in the hot compacting device by sensible heat generated while hot gas formed by the combustion lifts the filling layer, charged to the upper portion of the coal filling layer, and then descends in the coal filling layer and supplementary raw materials injected to the top of the coal filling layer with the hot reduced compacted iron are heated, melted, and slagged to manufacture molten iron and slag and integrate the manufactured molten iron and slag below the coal filling layer, and then the molten iron and slag are periodically discharged to the outside, the hot gas passing through the melted coal filling layer is discharged, and the hot gas is supplied to the multi-stage fluidized reduction furnace as reducing gas required for reduction of the fine iron-containing ores.

[0008] Further, there is provided an exhaust gas reformation circulation device in which the gas discharged to the multi-stage fluidized reduction furnace is cooled through a dust collecting device, and then some of the gas is branched and compressed and mixed with the hot reducing gas discharged from the melter-gasifier after removing CO_2 to additionally supply the reducing gas to the multi-stage fluidized reduction furnace. In the exhaust gas reformation circulation device, the CO_2-removed gas is supplied to a final front end of the fluidized reduction furnace which corresponds to the lowermost portion in the multi-stage fluidized reduction furnace and to which the reducing gas is directly supplied.

[0009] In the molten iron manufacturing process, the reduction of 60 to 70% of the iron ores is performed by indirect reduction by the reducing gas supplied from the melter-gasifier in the multi-stage fluidized reduction furnace, the reduction of the rest 30 to 40% of the iron ores is performed by indirect reduction by coal combustion gas which lifts the coal filling layer in the coal filling layer in the melter-gasifier after manufacturing the iron ores to the hot reduced compacted iron and then injecting the hot reduced compacted iron to the melter-gasifier and direct reduction by a carbon component of the coal in the coal filling layer and the coal combustion gas. ,

[0010] Accordingly, in order to smoothly perform the reduction of the iron ores, it is important to smoothly contact the reducing gas/fine iron ores in the fluidized reduction furnace, the hot coal combustion gas in the melter-gasifier, and the hot reduced compacted iron.

[0011] It is determined that the gas/fine ore contact in the fluidized reduction furnace has no matter when considering high mixing efficiency of the fluidized reduction furnace, but the contact of the gas/hot reduced compacted iron in the coal filling layer of the melter-gasifier is influenced by the gas flow distribution in the coal filling layer, and a factor determining the gas flow distribution is a pore distribution in the coal filling layer.

[0012] Further, the pore distribution in the coal filling layer acts as a crucial factor even when molten iron and slag generated by heating, melting, and slagging the hot reduced compacted iron and the supplementary raw materials in the coal filling layer pass through the coal filling layer and are discharged to the lower portion of the coal filling layer, thereby smoothly maintaining the flow of the molten iron/slag.

[0013] The pore distribution in the coal filling layer is largely influenced by a high-temperature property of the coals forming the coal filling layer to limit a rank of the coal which is usable in the molten iron manufacturing apparatus.

[0014] Further, as described above, the molten iron and slag need to pass through the coal filling layer to be discharged to the outside of the melter-gasifier, and in the molten iron and the slag, particularly, an amount and flowability of the slag is important. The shape of the slag is determined according to an amount, a composition, and the like of the gangue in the ores used as the raw material to limit a rank of the coal which is usable in the molten iron manufacturing apparatus.

[0015] In addition, in the case of using ores containing a large amount of phosphorous component depending on a high-reducing atmosphere in the coal filling layer, there is a problem in that a large amount of phosphorous component which is difficult to refine in the produced molten iron, and thus even in order to maintain the quality of the produced molten iron, there are restrictions on the used raw ores.

[0016] When showing the published data on an actual operation result of the molten iron manufacturing apparatus disclosed in European Patent Publication No. 1,689,892, the molten iron manufacturing apparatus is very stably operated and a rank of usable ores and a rank range of coals are gradually expanded compared with an existing blast furnace method, but it is reported that the rank of ores and the rank of coals usable in the molten iron manufacturing apparatus are significantly limited.

[0017] Meanwhile, another example of the melting reduction steelmaking method is disclosed in US Patent Registration Nos. 6332745B1, US 6379422B1 and US 6602321B1.

[0018] In US Patent Registration Nos. 6332745B1, US 6379422B1 and US 6602321B1, the molten iron manufacturing apparatus is configured by a molten-bath type reactor constituted by a molten iron layer, a slag layer formed on the molten iron layer, and a gas layer formed on the slag layer; a secondary combustion lance configured to inject hot blast which is formed from the upper portion of the molten-bath type reactor to the upper portion of the slag layer and in which oxygen is enriched to the upper portion of the slag layer; a fine coal injection lance and a fine ore injection lance configured to inject fine coals and fine ores from the outside at a boundary point, which is formed up to the upper portion of the molten iron layer of the lower portion of the slag layer, that is, the boundary point of the slag layer/molten iron layer by passing through the side of the molten-bath type reactor and passing through the slag layer in the molten-bath type reactor; a preliminary reduction furnace formed to preheat/preliminarily reduce the fine ores injected to the molten-bath type reactor by using some of the hot gas discharged from the molten-bath type reactor; a scrubber for cooling/cleaning the exhaust gas to the molten-bath type reactor other than the gas supplied to the preliminary reducing furnace; a scrubber for cooling/cleaning the exhaust gas to the molten-bath type reactor other than the gas supplied to the preheating furnace; and a hot blast furnace provided for forming hot blast supplied through the secondary combustion lance.

[0019] In the molten iron manufacturing apparatus, the reduction of iron ores is performed in a molten state in the molten bath formed in the molten-bath type reactor. To this end, coal as a reductant required for the reduction is supplied into the molten bath, heat required for the reduction is supplied as heat generated in combustion, that is, secondary combustion generated by combusting gas generated by a reduction of the iron ore and the coal in the molten bath with an oxygen-enriched hot blast supplied from the secondary combustion lance.

[0020] The reducibility of the hot gas which is discharged from the molten-bath type reactor and supplied to the preliminary reducing furnace by using the hot blast as the combustion and oxidizing gas is very low, and the reduction of the ores that proceeds in the preliminary reducing furnace is limited to 20% or less. The ores and the coals are pulverized with 1 mm or less and injected so that rapid melting and reaction in the molten bath are performed. The molten iron and the slag generated by the reaction are continuously or periodically discharged through respective outlets.

[0021] In the molten iron manufacturing apparatus, all reactions and molten iron/slag discharge are performed in a molten state, and compared with the molten iron manufacturing apparatus disclosed in European Patent Publication No. 1,689,892, limitation on the ranks of usable coals and ores is very low, and as described above, it is determined that heat efficiency is very high by simultaneously performing melting and reduction and actively using the secondary combustion.

[0022] However, when showing the published data on an actual operation result of the molten iron manufacturing apparatus disclosed in US Patent Registration No. US 6332745B1 and the like, various equipment problems and operational problems are reported.

[0023] In the problems, a problem that has the greatest effect on utilization and productivity is that the operation of connecting the molten-bath type reactor with the preliminary reducing furnace connected thereto is not smoothly performed. It is reported that in the molten-bath type reactor, the temperature and the shape of the gas generated after secondary combustion are instable, and thus, the fluctuation of the heating and reduction reaction of the ores in the preliminary reduction furnace using the gas becomes severe, the shape of the preliminary reducing ore supplied to the molten-bath type reactor from the preliminary reducing furnace is changed, and as a result, a vicious cycle in which the melting reduction reaction and the secondary combustion reaction of the ores in the molten-bath type reactor become unstable occurs.

[0024] Further, it is reported that there are problems in that even when the linked operation is temporarily smooth, the reduction rate of the preliminary reducing ore supplied to the molten-bath type reactor from the preliminary reducing furnace is too low and thus the consumption of the coal required for the melting reduction of the preliminary reducing ore is too high compared with a target, and further, the concentration of slag oxidized iron in the molten-bath type reactor is too high and thus, the refractory material in the molten-bath type reactor is excessively eroded.

[0025] Various methods for solving the problems are applied, but it is reported that an improvement effect is slight and further, the thermal efficiency and the reaction efficiency are gradually decreased due to the above methods and the economical efficiency is lowered.

[0026] Further iron manufacturing apparatuses with iron reducing furnaces are described in WO 2005/054520 A1, WO 2013/100520 A1, US 2014/042677 A1, US 2009/320647 A1 and CN 202 279 831 U.

[0027] As described above, development of various melting reduction steelmaking methods for replacing the blast furnace is independently performed and operation results of the molten iron manufacturing apparatuses according to the respective melting reduction steelmaking methods have been reported and have reached the level capable of grasping the merits, drawbacks, and technical performance of each of the respective melting reduction steelmaking methods.

[0028] Accordingly, at present, in order to maximize merits of the molten iron manufacturing apparatuses, a combined molten iron manufacturing process (apparatus) configured by combining a plurality of molten iron manufacturing processes (apparatuses) by applying a new mediation process (apparatus).

[DISCLOSURE]

[Technical Problem]

[0029] The present invention has been made in an effort to provide a new molten iron manufacturing apparatus configured by combining two molten iron manufacturing apparatuses through a fluidized reduction furnace which is additionally configured in a molten iron manufacturing apparatus based on the fluidized reduction furnace and a coal filling-type melter-gasifier and a molten iron manufacturing apparatus based on a molten-bath type melting reduction furnace, and more particularly, to provide a combined molten iron manufacturing apparatus configured by combining two molten iron manufacturing apparatuses through a separate fluidized reduction furnace which is additionally configured in a molten iron manufacturing apparatus based on the fluidized reduction furnace and a coal filling-type melter-gasifier and a molten iron manufacturing apparatus based on a molten-bath type melting reduction furnace, thereby stably producing molten iron by using conventional metallurgical fuel and raw materials in the molten iron manufacturing apparatus based on the fluidized reduction furnace and the coal filling-type melter-gasifier and stably producing molten iron by using conventional metallurgical unsuitable low-grade fuel and raw materials in the molten iron manufacturing apparatus based on the molten-bath type melting reduction furnace connected thereto.

[Technical Solution]

[0030] Further, the present invention has been made in an effort to provide a new molten iron manufacturing apparatus configured by combining two molten iron manufacturing apparatuses through a fluidized reduction furnace which is additionally configured in a molten iron manufacturing apparatus based on the fluidized reduction furnace and a coal filling-type melter-gasifier and a molten iron manufacturing apparatus based on a molten-bath type melting reduction furnace, and more particularly, to a combined molten iron manufacturing apparatus configured to stably operate the molten-bath type melting reduction furnace by partially extracting and removing a CO_2 component included in final by-product gas of the molten iron manufacturing apparatus in the molten iron manufacturing apparatus based on the fluidized reduction furnace and the coal filling-type melter-gasifier, heating the CO_2 component, manufacture hot reducing gas, and then supplying the hot reducing gas to a separate multi-stage type fluidized reduction furnace, reducing and firing fine ores and supplementary raw materials in the multi-stage type fluidized reduction furnace at a predetermined to manufacture a fine reductant, and supplying the fine reductant to the molten iron manufacturing apparatus based on the molten-bath type melting reduction furnace, thereby stably producing molten iron by using high-grade fuel and raw materials in the molten iron manufacturing apparatus based on the fluidized reduction furnace and the coal filling-type melter-gasifier and stably producing molten iron by using low-grade fuel and raw materials in the molten iron manufacturing apparatus based on the molten-bath type melting reduction furnace connected thereto.

[0031] An exemplary embodiment of the present invention provides a combined molten iron manufacturing apparatus including: a first molten iron manufacturing apparatus including a first fluidized reduction furnace constituted in multiple stages that reduces fine ore to convert the reduced fine ore to fine reduced iron, a plurality of hot compacting devices that manufactures the fine reduced iron emitted from the first fluidized reduction furnace to hot reduced compacted iron, a conveying device that conveys the hot reduced compacted iron crushed with a predetermined size, a compacted iron charging device for continuously supplying the hot reduced compacted iron conveyed by the conveying device to a melter-gasifier and a compacted general coal charging device for continuously supplying compacted general coal to the melter-gasifier, a melter-gasifier that melts the hot reduced compacted iron supplied from the compacted iron charging device by using hot combust gas generated by combusting the compacted general coal supplied from the compacted general coal charging device and a pulverized coal material injected from the lower portion with oxygen and supplies reducing gas required in fine ore reduction in the first fluidized reduction furnace, a CO_2 removing device that removes CO_2 by branching some of exhaust gas of the first fluidized reduction furnace and then supplies the reducing gas to the first fluidized reduction furnace in addition to the reducing gas supplied from the melter-gasifier, a dust circulation device that separates dust included in the reducing gas generated from the melter-gasifier to re-inject the dust to the melter-gasifier, a pressure control device that uniformly maintains pressure in the melter-gasifier by branching and cooling some of gases generated from the melter-gasifier according to a pressure change of the melter-gasifier and then discharging some of gases to a by-product gas line, a first sensible heat recovery device that recovers sensible heat of the exhaust gas discharged from the first fluidized reduction furnace, a first dry dust collecting device that separates scattering dust included in the exhaust gas discharged from the first fluidized reduction furnace, and a first gas cooling device that cools the exhaust gas discharged from the first fluidized reduction furnace;

a second molten iron manufacturing apparatus including an iron-bath type melting reduction furnace that is adapted to process fine iron-containing material and pulverized coal which are injected to the inner portion to produce molten iron and slag through reactions such as dissolution, combustion, and melting reduction therein, and that is adapted to discharge the manufactured molten iron and slag to the outside, a hot blast furnace that manufactures hot blast which is injected to the melting reduction furnace a as a secondary combustion oxidant, and a cleaning device that cools and cleans the gas discharged from the melting reduction furnace; and

a third molten iron manufacturing apparatus that is provided between the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus to connect the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus, branch some of the reducing gas generated from the melter-gasifier of the first molten iron manufacturing apparatus and supplied to the first fluidized reduction furnace, and reduces a fine ore at a predetermined level by using the branched reducing gas to supply the reduced fine ore as an iron source of the second molten iron manufacturing apparatus.

[0032] The third molten iron manufacturing apparatus includes an oxygen mixing furnace that is provided on a pipe supplying hot reducing gas to the first fluidized reduction furnace of the first molten iron manufacturing apparatus through the dust circulation device of the first molten iron manufacturing apparatus to inject oxygen into the hot reducing gas,

a pipe that is provided at the rear end of the oxygen mixing furnace to branch some of the reducing gas, and

a second fluidized reduction furnace that is connected to the pipe, receives some the branched reducing gas from the pipe to reduce a fine ore, and converts the reduced fine ore to a fine reductant.

[0033] The second fluidized reduction furnace may be configured in multiple stages of two stages or three stages or more.

[0034] The combined molten iron manufacturing apparatus may further include a second sensible heat recovery device that is connected to the rear end of the second fluidized reduction furnace to recover sensible heat of the exhaust gas discharged from the second fluidized reduction furnace.

[0035] The combined molten iron manufacturing apparatus may further include a second dry dust collecting device that is connected to the rear end of the second sensible heat recovery device to separate scattering dust in the exhaust gas.

[0036] The combined molten iron manufacturing apparatus may further include a second gas cooling device that is connected to the rear end of the second dry dust collecting device to cool the exhaust gas.

[0037] The second fluidized reduction furnace may include a fine reductant storage tank that is connected to the lowermost second fluidized reduction furnace to store the fine reductant discharged from the second fluidized reduction furnace through a pipe.

[0038] The second fluidized reduction furnace may include a fine reductant transporting device that is connected to the lower end of the fine reductant storage tank to inject the fine reductant into the iron-bath type melting reduction furnace of the second molten iron manufacturing apparatus through a fine reductant transporting pipe connecting the fine reductant storage tank and the iron-bath type melting reduction furnace of the second molten iron manufacturing apparatus from the fine reductant storage tank.

[0039] At the lower end of the first dry dust collecting device, a first transporting device and a first transporting pipe connecting the first transporting device and the fine reductant transporting pipe may be provided to inject dusts separated from the first dry dust collecting device into the iron-bath type melting reduction furnace of the second molten iron manufacturing apparatus together with the fine reductant discharged from the second fluidized reduction furnace.

[0040] At the lower end of the second dry dust collecting device, a second transporting device and a second transporting pipe connecting the second transporting device and the fine reductant transporting pipe may be provided to inject dusts separated from the second dry dust collecting device into the iron-bath type melting reduction furnace of the second molten iron manufacturing apparatus together with the fine reductant discharged from the second fluidized reduction furnace.

[0041] The combined molten iron manufacturing apparatus may further include a hot blast furnace fuel gas supply pipe which is connected to the hot blast furnace by combining the exhaust gases of the first fluidized reduction furnace and the second fluidized reduction furnace of the first molten iron manufacturing apparatus and then branching the exhaust gases at the line rear end branched to the by-product gas line in order to supply required fuel to the hot blast furnace.

[0042] Another exemplary embodiment of the present invention provides a combined molten iron manufacturing apparatus including: a first molten iron manufacturing apparatus including a first fluidized reduction furnace constituted in multiple stages that reduces fine ore to convert the reduced fine ore to fine reduced iron, a plurality of hot compacting devices that manufactures the fine reduced iron emitted from the first fluidized reduction furnace to hot reduced compacted iron, a conveying device that conveys the hot reduced compacted iron crushed with a predetermined size, a compacted iron charging device for continuously supplying the hot reduced compacted iron conveyed by the conveying device to a melter-gasifier and a compacted general coal charging device for continuously supplying compacted general coal to the melter-gasifier, a melter-gasifier that melts the hot reduced compacted iron supplied from the compacted iron charging device by using hot combust gas generated by combusting the compacted general coal supplied from the compacted general coal charging device and a pulverized coal material injected from the lower portion with oxygen and supplies reducing gas required in fine ore reduction in the first fluidized reduction furnace, a CO_2 removing device that removes CO_2 by branching some of exhaust gas of the first fluidized reduction furnace and then supplies the reducing gas to the first fluidized reduction furnace in addition to the reducing gas supplied from the melter-gasifier, a dust circulation device that separates dust included in the reducing gas generated from the melter-gasifier to re-inject the dust to the melter-gasifier, a pressure control device that uniformly maintains pressure in the melter-gasifier by branching and cooling some of gases generated from the melter-gasifier according to a pressure change of the melter-gasifier and then discharging some of gases to a by-product gas line, a first sensible heat recovery device that recovers sensible heat of the exhaust gas discharged from the first fluidized reduction furnace, a first dry dust collecting device that separates scattering dust included in the exhaust gas discharged from the first fluidized reduction furnace, and a first gas cooling device that cools the exhaust gas discharged from the first fluidized reduction furnace;

a second molten iron manufacturing apparatus including a iron-bath type melting reduction furnace that manufactures a fine iron-containing material and pulverized coal which are injected to the inner portion as molten iron and slag through reactions such as dissolution, combustion, and melting reduction therein to discharge the manufactured molten iron and slag to the outside; a hot blast furnace b that manufactures hot blast which is injected to the melting reduction furnace a as a secondary combustion oxidant, a second sensible heat recovery device c for recovering sensible heat of the exhaust gas discharged from the melting reduction furnace a, and a cleaning device d that cools and cleans the gas discharged from the melting reduction furnace, and

a fourth molten iron manufacturing apparatus that is provided between the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus to connect the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus, partially extracts and removes a CO_2 component included in the final by-product gas of the first molten iron manufacturing apparatus, manufactures hot reducing gas by heating the CO_2 component, and then reduces and sinters the fine ore, supplementary raw materials, and the like at a predetermined level by using the reducing gas to manufacture a fine reductant and supply the fine reductant as an iron source of the second molten iron manufacturing apparatus.

[0043] The fourth molten iron manufacturing apparatus includes a compressor that is connected with a by-product gas pipe in which by-product gas generated from the first molten iron manufacturing apparatus flows to compress the by-product gas,

a second CO_2 removing device that is connected with the compressor to remove the CO_2 component in the compressed gas from the compressor,

a heat exchanger and a gas heater which are connected with the second CO_2 removing device and provided for heating CO_2 gas from which CO_2 is removed and that is discharged from the second CO_2 removing device and manufacturing hot reducing gas,

an oxygen mixing furnace that is connected with the gas heater to inject oxygen into the hot reducing gas, and a second fluidized reduction furnace that is connected with the oxygen mixing furnace and reduces and fires the fine ore and the supplementary raw materials by supplying the hot reducing gas.

[0044] The second fluidized reduction furnace may be configured in multiple stages of two stages or three stages or more.

[0045] The combined molten iron manufacturing apparatus may further include a second dry dust collecting device that is connected to the rear end of the heat exchanger and discharged from the second fluidized reduction furnace to separate scattering dust in the exhaust gas after passing through the heat exchanger.

[0046] The combined molten iron manufacturing apparatus may further include a second gas cooling device that is connected to the rear end of the second dry dust collecting device to cool the exhaust gas.

[0047] The combined molten iron manufacturing apparatus may further include a gas pipe that is connected to the rear end of the second gas cooling device to circulate some of the exhaust gas to the second CO_2 removing device.

[0048] The combined molten iron manufacturing apparatus may further include a final exhaust gas pipe that is connected to the rear end of the second gas cooling device to discharge the rest of the exhaust gas to the outside.

[0049] The combined molten iron manufacturing apparatus may further include a gas pipe that connects the second CO_2 removing device and the final exhaust gas pipe to discharge the CO_2 separated from the second CO_2 removing device to the outside.

[0050] The second fluidized reduction furnace may include a fine reductant storage tank for storing the fine reductant discharged from the lowermost fluidized reduction furnace through the pipe.

[0051] The second fluidized reduction furnace may include a fine reductant transporting device that injects the fine reductant into the iron-bath type melting reduction furnace of the second molten iron manufacturing apparatus through a fine reductant transporting pipe connecting the fine reductant storage tank and the iron-bath type melting reduction furnace from the fine reductant storage tank.

[0052] At the lower end of the first dry dust collecting device, a first transporting device and a first transporting pipe connecting the first transporting device and the fine reductant transporting pipe may be provided to inject dusts separated from the first dry dust collecting device into the iron-bath type melting reduction furnace of the second molten iron manufacturing apparatus together with the fine reductant discharged from the second fluidized reduction furnace.

[0053] At the lower end of the second dry dust collecting device, a second transporting device and a second transporting pipe connecting the second transporting device and the fine reductant transporting pipe may be provided to inject dusts separated from the second dry dust collecting device into the iron-bath type melting reduction furnace of the second molten iron manufacturing apparatus together with the fine reductant discharged from the second fluidized reduction furnace.

[0054] In order to supply required fuel to the gas heating furnace and the hot blast furnace of the second molten iron manufacturing apparatus, the pipe may include a fuel gas supply pipe which is branched at a front end of a point where gas containing CO_2 removed from the second CO_2 removing device and gas discharged from the second molten iron manufacturing apparatus are combined and connected to the hot blast furnace b, the gas heating furnace.

[Advantageous Effects]

[0055] According to an embodiment of the present invention, in the combined molten iron manufacturing apparatus configured by the plurality of reaction furnaces directly using fine or compacted general coals and fine iron-containing ores, it is possible to manufacture molten iron stably and at high efficiency even using low-grade coals in the molten iron manufacturing apparatus based on the molten-bath type melting reduction furnace by manufacturing molten iron in the molten iron manufacturing apparatus based on the fluidized reduction furnace and the coal filling-type melter-gasifier by using conventional metallurgical ores and coals, stably reducing low-rank ores by using some of reducing gas generated stably, and using the reduced low-rank ores as an iron source.

[0056] According to another embodiment of the present invention, in the combined molten iron manufacturing apparatus configured by the plurality of reaction furnaces directly using fine or compacted general coals and fine iron-containing ores, it is possible to manufacture molten iron stably and at high efficiency even using low-grade coals in the molten iron manufacturing apparatus based on the molten-bath type melting reduction furnace by manufacturing molten iron in the molten iron manufacturing apparatus based on the fluidized reduction furnace and the coal filling-type melter-gasifier by using conventional metallurgical ores and coals, partially extracting and removing a CO_2 component included in final by-product gas, heating the CO_2 component to manufacture hot reducing gas, and then stably reducing low-rank ores by using the reducing gas, and using the reduced low-rank ores as an iron source.

[0057] Therefore, according to the combined molten iron manufacturing apparatus according to the exemplary embodiment and/or another exemplary embodiment of the present invention, it is possible to manufacture molten iron by simultaneously using conventional metallurgical ores and coals and ores and coals known to be unsuitable for metallurgy in the past.

[Description of the Drawings]

[0058]

FIG. 1 is a schematic diagram of a combined molten iron manufacturing apparatus according to an exemplary embodiment of the present invention.

FIG. 2 is a schematic process flowchart illustrating a flow of materials in the combined molten iron manufacturing apparatus as an example of the combined molten iron manufacturing apparatus according to the exemplary embodiment of the present invention.

FIG. 3 is a table illustrating property ratios of gases according to the flow of materials in the combined molten iron manufacturing apparatus as an example of the combined molten iron manufacturing apparatus according to the exemplary embodiment of the present invention.

FIG. 4 is a schematic diagram of a combined molten iron manufacturing apparatus according to another exemplary embodiment of the present invention.

FIG. 5 is a schematic process flowchart illustrating a flow of materials in the combined molten iron manufacturing apparatus as an example of the combined molten iron manufacturing apparatus according to another exemplary embodiment of the present invention.

FIG. 6 is a table illustrating property ratios of gases according to the flow of materials in the combined molten iron manufacturing apparatus as an example of the combined molten iron manufacturing apparatus according to another exemplary embodiment of the present invention.

[Mode for Invention]

[0059] Hereinafter, exemplary embodiments of the present invention will be described so as to be easily implemented by those skilled in the art, with reference to the accompanying drawings. The present invention has been described in an illustrative manner, and it is to be understood that the terminology used is intended to be in the nature of description rather than of limitation. Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, it is to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. Like reference numerals refer to like elements throughout the specification.

[0060] It is to be understood that the terminology used therein is for the purpose of describing particular embodiments only and is not intended to be limiting. It must be noted that, as used in the specification and the appended claims, the singular forms include plural references unless the context clearly dictates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated properties, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other properties, regions, integers, steps, operations, elements, and/or components thereof.

[0061] All terminologies that include technical terminologies and scientific terminologies used herein have the same meaning as that understood by those who are skilled in the art to which the present invention belongs. The terminologies that are defined previously are further understood to have the meaning that coincides with relating technical documents and the contents that are disclosed currently, but not interpreted as the ideal or very official meaning unless it is defined.

[0062] FIG. 1 is a schematic diagram of a combined molten iron manufacturing apparatus according to an exemplary embodiment of the present invention.

[0063] Referring to FIG. 1, a first molten iron manufacturing apparatus in a combined molten iron manufacturing apparatus configured by a plurality of reaction furnaces that directly uses fine or compacted general coals or fine iron-containing ores according to an exemplary embodiment of the present invention may include

a first fluidized reduction furnace constituted in multiple stages that reduces fine ore to convert the reduced fine ore to fine reduced iron, a plurality of hot compacting devices B that manufactures the fine reduced iron emitted from the first fluidized reduction furnace A to hot reduced compacted iron, a conveying device D that conveys the hot reduced compacted iron crushed with a predetermined size, a compacted iron charging device E for continuously supplying the hot reduced compacted iron conveyed by the conveying device D to a melter-gasifier G and a compacted general coal charging device F for continuously supplying compacted general coal to the melter-gasifier G, a melter-gasifier G that melts the hot reduced compacted iron supplied from the compacted iron charging device E by using hot combust gas generated by combusting the compacted general coal supplied from the compacted general coal charging device F and a pulverized coal material injected from the lower portion with oxygen and supplies reducing gas required in fine ore reduction in the first fluidized reduction furnace A, a CO_2 removing device M that removes CO_2 by branching some of exhaust gas of the first fluidized reduction furnace A and then supplies the reducing gas to the first fluidized reduction furnace A by adding the removed CO_2 to the reducing gas supplied from the melter-gasifier G, a dust circulation device H that separates dust included in the reducing gas generated from the melter-gasifier G to re-inject the dust to the melter-gasifier G, a pressure control device I that uniformly maintains pressure in the melter-gasifier G by branching and cooling some of gases generated from the melter-gasifier G according to a pressure change of the melter-gasifier G and then discharging some of gases to a by-product gas line, a first sensible heat recovery device J that recovers sensible heat of the exhaust gas discharged from the first fluidized reduction furnace A, a first dry dust collecting device K that separates scattering dust included in the exhaust gas discharged from the first fluidized reduction furnace A, and a first gas cooling device L that cools the exhaust gas discharged from the first fluidized reduction furnace A.

[0064] Further, a second molten iron manufacturing apparatus of the combined molten iron manufacturing apparatus may include

a iron-bath type melting reduction furnace a that manufactures a fine iron-containing material and pulverized coal which are injected to the inner portion as molten iron and slag through reactions such as dissolution, combustion, and melting reduction therein to discharge the manufactured molten iron and slag to the outside,

a hot blast furnace b that manufactures hot blast which is injected to the melting reduction furnace a as a secondary combustion oxidant, and

a cleaning device d that cools and cleans the gas discharged from the melting reduction furnace a.

[0065] The combined molten iron manufacturing apparatus may include a third molten iron manufacturing apparatus that is provided between the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus to connect the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus, branch some of the reducing gas generated from the melter-gasifier G of the first molten iron manufacturing apparatus and supplied to the first fluidized reduction furnace A, and reduce fine ore at a predetermined level by using the branched reducing gas to supply the reduced fine ore as an iron source of the second molten iron manufacturing apparatus.

[0066] The third molten iron manufacturing apparatus may include an oxygen mixing furnace 2 that is provided on a pipe 30 supplying hot reducing gas to the first fluidized reduction furnace A of the first molten iron manufacturing apparatus through the dust circulation device H of the first molten iron manufacturing apparatus to inject oxygen into the hot reducing gas,

a pipe 31 that is provided at the rear end of the oxygen mixing furnace 2 to branch some of the reducing gas, and

a second fluidized reduction furnace 1 that is connected to the pipe 31, receives some the branched reducing gas from the pipe to reduce a fine ore, and converts the reduced fine ore to a fine reductant.

[0067] The second fluidized reduction furnace 1 may be configured in multiple stages of two stages or three stages or more.

[0068] Further, the combined molten iron manufacturing apparatus may sequentially provide a second sensible heat recovery device 3 that is connected to the rear end of the second fluidized reduction furnace 1 to recover sensible heat of the exhaust gas discharged from the second fluidized reduction furnace 1,

a second dry dust collecting device 4 that is connected to the rear end of the second sensible heat recovery device 3 to separate scattering dust in the exhaust gas, and

a second gas cooling device 5 that is connected to the rear end of the second dry dust collecting device 4 to cool the exhaust gas.

[0069] Further, the second fluidized reduction furnace 1 constituted in the multiple stages may include a fine reductant storage tank 20 that is connected to the lowermost second fluidized reduction furnace to store the fine reductant discharged from the second fluidized reduction furnace 1 through a pipe 19, and

a fine reductant transporting device 21 that is connected to the lower end of the fine reductant storage tank 20 to inject the fine reductant into the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus through a fine reductant transporting pipe 10 connecting the fine reductant storage tank 20 and the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus from the fine reductant storage tank 20.

[0070] Further, at the lower end of the first dry dust collecting device K, a first transporting device 6 and a first transporting pipe 7 connecting the first transporting device 6 and the fine reductant transporting pipe 10 may be provided to inject dusts separated from the first dry dust collecting device K into the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus together with the fine reductant discharged from the second fluidized reduction furnace 1.

[0071] At the lower end of the second dry dust collecting device 4, a second transporting device 8 and a second transporting pipe 9 connecting the second transporting device 8 and the fine reductant transporting pipe 10 may be provided to inject dusts separated from the second dry dust collecting device 4 into the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus together with the fine reductant discharged from the second fluidized reduction furnace 1.

[0072] Further, the second molten iron manufacturing apparatus may include a hot blast furnace fuel gas supply pipe 18 which is connected to the hot blast furnace b by combining the exhaust gases of the first fluidized reduction furnace A and the second fluidized reduction furnace 1 of the first molten iron manufacturing apparatus and then branching the exhaust gases at the line rear end branched to the by-product gas line in order to supply required fuel to the hot blast furnace b.

[0073] Hereinafter, effects of the combined molten iron manufacturing apparatus according to the exemplary of the present invention will be described with reference to FIG. 1.

[0074] The reducing gas generated from the melter-gasifier G of the first molten iron manufacturing apparatus is combined with the CO_2 removing gas supplied from the CO_2 removing device M and then passes through the dust circulation device H, and in this process, the dust in the reducing gas is removed. Some of the reducing gas from which the dust is removed is branched to the pressure control device I and the rest of the reducing gas is supplied to the first fluidized reduction furnace A of the first molten iron manufacturing apparatus through the pipe 30 as hot reducing gas.

[0075] On the pipe 30, the oxygen mixing furnace 2 is provided, and the oxygen is injected into the oxygen mixing furnace 2 to combust some of the hot reducing gas flowing into the oxygen mixing furnace 2 and increase the temperature of the hot reducing gas by the combustion heat.

[0076] In this case, the temperature of the hot reducing gas at the rear end of the oxygen mixing furnace 2 may be approximately 700 to 780°C in order to prevent adhesion of the fine ores in the first fluidized reduction furnace A and the second fluidized reduction furnace 1 of the third molten iron manufacturing apparatus to which the hot reducing gas is supplied.

[0077] At the rear end of the oxygen mixing furnace 2, the hot reducing gas heated to the temperature is branched to the pipe 31 from the pipe 30 and then supplied to the second fluidized reduction furnace 1.

[0078] The second fluidized reduction furnace 1 is constituted in the multiple stages (in FIG. 1, for example, constituted in three stages), and the fine ore and supplementary raw materials are supplied to the uppermost second fluidized reduction furnace of the multi-stage second fluidized reduction furnace 1, hot gas supplied to the lowermost second fluidized reduction furnace of the multi-stage second fluidized reduction furnace 1 and a counter flow type, that is, the fine ore and supplementary raw materials are supplied from the uppermost end to the lowermost end and the hot gas is supplied from the lowermost end to the uppermost end to cross each other and contact each other. In this process, the fine ore and supplementary raw materials are reduced and fired to be converted to the fine reductant.

[0079] The fine reductant is discharged from the lowermost second fluidized reduction furnace of the second fluidized reduction furnace 1 and stored in the fine reductant storage tank 20, injected into the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus through the fine reductant transporting pipe 10 by the transporting device 21 provided at the lower end of the fine reductant storage tank 20, dissolved in the iron-bath type melting reduction furnace a, and then converted to molten iron and slag by melting reduction, slagging reaction, and the like.

[0080] Further, a reduction rate of the fine reduced ore included in the fine reductant discharged from the lowermost end of the second fluidized reduction furnace 1 is preferably about 60 to 70%. The reason is that at the reduction rate of 60 to 70% or more, adhesion of ores occurs, and at the reduction rate of 60 to 70% or less, energy required for the melting reduction and slagging of the fine reductant in the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus is increased. In order to maintain the reduction rate, the second fluidized reduction furnace 1 may be constituted in multiple stages, for example, two to three stages.

[0081] Further, the exhaust gas discharged from the second fluidized reduction furnace 1 is cooled through the second sensible heat recovery device 3, and then the dust included in the exhaust gas is separated through the second dry dust collecting device 4, cooled up to room temperature in the second gas cooling device 5, and discharged from the first fluidized reduction furnace A of the first molten iron manufacturing apparatus. The dust is removed through the first sensible heat recovery device J, the first dry dust collecting device K and the first gas cooling device L and combined with the cooled gas. Some of the combined gas is supplied to the CO_2 removing device M and the rest of the combined gas is combined with the gas discharged through the pressure control device I to be discharged to the by-product gas line.

[0082] Further, at the lower ends of the first dry dust collecting device K and the second dry dust collecting device 4, the first transporting device 6 and the second transporting device 7 are provided, respectively. The first transporting device 6 and the second transporting device 7 are connected with the fine reductant transporting pipe 10 through the first and second transporting pipes 7 and 9 by receiving the dust separated from the exhaust gas of the first fluidized reduction furnace A and the second fluidized reduction furnace 1 from the first dry dust collecting device K and the second dry dust collecting device 4 to be mixed with the fine reductant in the fine reductant transporting pipe 10 and then injected into the iron-bath type melting reduction furnace a.

[0083] An example of manufacturing molten iron by using the combined molten iron manufacturing apparatus constituted by the plurality of reaction furnaces directly using the fine or compacted general coals and the fine iron-containing ores according to the exemplary embodiment of the present invention will be described. For purposes of the present invention, the first molten iron manufacturing apparatus is stable, and in order to produce the molten iron at high efficiency, as the used fine ores and coals, generally, high-rank ores having a relatively large iron content and metallurgy coals having a high coking property were used as illustrated in Tables 1 to 3 below.

[Table 1] Composition of used ores of first molten iron manufacturing apparatus

T.Fe	Fe	FeO	Fe2O3	SiO2	Al2O3	CaO	MgO	MnO	P2O5	S	K2O	Na2O	TiO2	ZnO	LOI
62.14	0.00	0.16	88.66	3.89	2.22	0.03	0.09	0.16	0.16	0.02	0.01	0.02	0.13	0.00	4.44

[Table 2] Composition of used coals of first molten iron manufacturing apparatus

Moisture	VM	Ash	FC
5.00	23.66	12.12	59.20

[Table 3] Composition of used supplementary raw materials of first molten iron manufacturing apparatus

Moisture	T.Fe	Fe	FeO	Fe2O3	SiO2	Al2O3	CaO	MgO	MnO
0.20	0.00	0.00	0.00	0.29	1.55	0.45	40.18	11.87	0.01

[0084] Further, unlike the first molten iron manufacturing apparatus, in the second molten iron manufacturing apparatus, low-rank ores having high gangue content and low-cost anthracites without a coking property were used as illustrated in Tables 4 to 5 below.

[Table 4] Composition of used ores of second molten iron manufacturing apparatus

T.Fe	Fe	FeO	Fe2O3	SiO2	Al2O3	CaO	MgO	MnO	P205	S	K2O	Na2O	TiO2	ZnO	Moisture	LOI
56.43	0.00	0.00	80.68	5.51	3.23	0.08	0.07	0.10	0.16	0.01	0.07	0.00	0.00	0.00	0.2	8.30

[Table 5] Composition of used coals of second molten iron manufacturing apparatus

Moisture	VM	Ash	FC
3.39	5.32	16.34	74.95

[0085] Further, the third molten iron manufacturing apparatus used supplementary raw materials having the same composition as the first molten iron manufacturing apparatus.

[0086] FIGS. 2 and 3 are a process flowchart and a table illustrating property ratios of gases as an example of a process of manufacturing molten iron of 180 ton per hour in the first molten iron manufacturing apparatus and manufacturing molten iron of 100 ton per hour in the second molten iron manufacturing apparatus by using the third molten iron manufacturing apparatus of the combined molten iron manufacturing apparatus.

[0087] Further, Tables 6 to 9 below are composition tables illustrating contents of main components of molten iron and slag produced in the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus according to the exemplary embodiment of the present invention, respectively.

[Table 6] Composition of produced molten iron of first molten iron manufacturing apparatus

C	Si	P	Mn	S
4.500	0.500	0.059	0.150	0.047

[Table 7] Composition of produced slag of first molten iron manufacturing apparatus

SiO2	Al2O3	CaO	MgO	FeO	S
30.731	17.695	36.893	10.516	0.488	1.226

[Table 8] Composition of produced molten iron of second molten iron manufacturing apparatus

C	Si	P	Mn	S
4.000	0.100	0.090	0.000	0.076

[Table 9] Composition of produced slag of second molten iron manufacturing apparatus

SiO2	Al2O3	CaO	MgO	FeO	S
32.807	18.359	42.649	2.450	2.988	0.303

[0088] In the case of the second molten iron manufacturing apparatus, as compared with the first molten iron manufacturing apparatus, low-cost fuel and raw materials were used and the impurity contents such as S and P in the molten iron are increased, but may be generally removed in a refining process.

[0089] As described above, in the first molten iron manufacturing apparatus, the molten iron is stably produced at high efficiency by using the relatively high-cost fuel and raw materials. As a result, it is shown that the hot reducing gas generated stably in the first molten iron manufacturing apparatus is used and thus, the stable fine reductant of approximately 60 to 70% is manufactured by using the low-rank fine ores and supplementary raw materials from the second fluidized reduction furnace 1.

[0090] Further, it is shown that the fine reductant is supplied as an iron source of the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus to stably produce molten iron even by using low-cost anthracite as described above in the second molten iron manufacturing apparatus.

[0091] In addition, FIG. 4 is a schematic diagram of a combined molten iron manufacturing apparatus according to another exemplary embodiment of the present invention.

[0092] Since the combined molten iron manufacturing apparatus according to another exemplary embodiment of the present invention is the same as details described in the combined molten iron manufacturing apparatus according to the exemplary embodiment of the present invention rather than specifically described details below, the detailed description thereof will be omitted.

[0093] Referring to FIG. 4, a first molten iron manufacturing apparatus in a combined molten iron manufacturing apparatus configured by a plurality of reaction furnaces that directly uses fine or compacted general coals or fine iron-containing ores according to another exemplary embodiment of the present invention may include

a first fluidized reduction furnace A constituted in multiple stages that reduces fine ore to convert the reduced fine ore to fine reduced iron, a plurality of hot compacting devices B that manufactures the fine reduced iron emitted from the first fluidized reduction furnace A to hot reduced compacted iron, a conveying device D that conveys the hot reduced compacted iron crushed with a predetermined size, a compacted iron charging device E for continuously supplying the hot reduced compacted iron conveyed by the conveying device D to a melter-gasifier G and a compacted general coal charging device F for continuously supplying compacted general coal to the melter-gasifier G, a melter-gasifier G that melts the hot reduced compacted iron supplied from the compacted iron charging device E by using hot combust gas generated by combusting the compacted general coal supplied from the compacted general coal charging device F and a pulverized coal material injected from the lower portion with oxygen and supplies reducing gas required in fine ore reduction in the first fluidized reduction furnace A, a CO_2 removing device M that removes CO_2 by branching some of exhaust gas of the first fluidized reduction furnace A and then supplies the reducing gas to the first fluidized reduction furnace A by adding the removed CO_2 to the reducing gas supplied from the melter-gasifier G, a dust circulation device that separates dust included in the reducing gas generated from the melter-gasifier G to re-inject the dust to the melter-gasifier G, a pressure control device I that uniformly maintains pressure in the melter-gasifier G by branching and cooling some of gases generated from the melter-gasifier G according to a pressure change of the melter-gasifier G and then discharging some of gases to a by-product gas line, a first sensible heat recovery device J that recovers sensible heat of the exhaust gas discharged from the first fluidized reduction furnace A, a first dry dust collecting device K that separates scattering dust included in the exhaust gas discharged from the first fluidized reduction furnace A, and a first gas cooling device L that cools the exhaust gas discharged from the first fluidized reduction furnace A.

[0094] Further, a second molten iron manufacturing apparatus of the combined molten iron manufacturing apparatus may include

a iron-bath type melting reduction furnace a that manufactures a fine iron-containing material and pulverized coal which are injected to the inner portion as molten iron and slag through reactions such as dissolution, combustion, and melting reduction therein to discharge the manufactured molten iron and slag to the outside,

a hot blast furnace b that manufactures hot blast which is injected to the melting reduction furnace a as a secondary combustion oxidant,

a second sensible heat recovery device c for recovering sensible heat of the exhaust gas discharged from the melting reduction furnace a, and

a cleaning device d that cools and cleans the gas discharged from the melting reduction furnace a.

[0095] The combined molten iron manufacturing apparatus may include a fourth molten iron manufacturing apparatus that is provided between the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus to connect the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus, partially extracts and removes a CO_2 component included in the final by-product gas of the first molten iron manufacturing apparatus, manufactures hot reducing gas by heating the CO_2 component, and then reduces and sinters the fine ore, the supplementary raw materials, and the like at a predetermined level by using the reducing gas to manufacture a fine reductant and supply the fine reductant as an iron source of the second molten iron manufacturing apparatus.

[0096] The fourth molten iron manufacturing apparatus may include a compressor 101 that is connected with a by-product gas pipe 120 in which by-product gas generated from the first molten iron manufacturing apparatus flows to compress the by-product gas, a second CO_2 removing device 102 that is connected with the compressor 101 to remove the CO_2 component in the compressed gas from the compressor 101,

a heat exchanger 104 and a gas heater 105 which are connected with the second CO_2 removing device 102 and provided for heating CO_2 removing gas discharged from the second CO_2 removing device 102 and manufacturing hot reducing gas,

an oxygen mixing furnace 106 that is connected with the gas heater 105 to inject oxygen into the hot reducing gas, and

a second fluidized reduction furnace 107 that is connected with the oxygen mixing furnace 106 and reduces and fires the fine ore and the supplementary raw materials by supplying the hot reducing gas.

[0097] The second fluidized reduction furnace 107 may be configured in multiple stages of two stages or three stages or more.

[0098] The combined molten iron manufacturing apparatus may sequentially provide a second dry dust collecting device 115 that is connected to the rear end of the heat exchanger 104 and discharged from the second fluidized reduction furnace 107 to separate scattering dust in the exhaust gas after passing through the heat exchanger 104, and a second gas cooling device 116 that is connected to the rear end of the second dry dust collecting device 115 to cool the exhaust gas.

[0099] Further, the combined molten iron manufacturing apparatus may provides a gas pipe 121 that is connected to the rear end of the second gas cooling device 116 to circulate some of the exhaust gas to the second CO_2 removing device 102,

a final exhaust gas pipe 124 that is connected to the rear end of the second gas cooling device 116 to discharge the rest of the exhaust gas to the outside, and

a gas pipe 126 that connects the second CO_2 removing device 102 and the final exhaust gas pipe 124 to discharge the CO_2 separated from the second CO_2 removing device 102 to the outside.

[0100] Further, the second fluidized reduction furnace 107 may include a fine reductant storage tank 109 for storing the fine reductant discharged from the lowermost fluidized reduction furnace through the pipe 108, and

a fine reductant transporting device 110 that injects the fine reductant into the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus through a fine reductant transporting pipe 111 connecting the fine reductant storage tank 109 and the iron-bath type melting reduction furnace a from the fine reductant storage tank 109.

[0101] Further, at the lower end of the first dry dust collecting device K, a first transporting device 113 and a first transporting pipe 114 connecting the first transporting device 113 and the fine reductant transporting pipe 111 may be provided to inject dusts separated from the first dry dust collecting device K into the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus together with the fine reductant discharged from the second fluidized reduction furnace 7.

[0102] At the lower end of the second dry dust collecting device 115, a second transporting device 117 and a second transporting pipe 118 connecting the second transporting device 117 and the fine reductant transporting pipe 111 may be provided to inject dusts separated from the second dry dust collecting device 115 into the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus together with the fine reductant discharged from the second fluidized reduction furnace 107.

[0103] Further, in order to supply required fuel to the gas heating furnace 105 and the hot blast furnace b of the second molten iron manufacturing apparatus, the pipe 120 may include a fuel gas supply pipe 119 which is branched at a front end of a point where gas containing CO_2 removed from the second CO_2 removing device 102 and gas discharged from the second molten iron manufacturing apparatus are combined and connected to the hot blast furnace b, the gas heating furnace 105, and the like.

[0104] Hereinafter, effects of the combined molten iron manufacturing apparatus according to another exemplary of the present invention will be described with reference to FIG. 4.

[0105] The by-product gas generated from the first molten iron manufacturing apparatus flows through the pipe 20, and is combined with some of the exhaust gas of the second fluidized reduction furnace 107 flowing through the pipe 121, supplied to the compressor 101, and supplied to the second CO_2 removing device 102 connected with the compressor 101 after boosting to remove CO_2 in the gas.

[0106] The CO_2 concentration in the CO_2 removing gas discharged from the second CO_2 removing device 102 may be approximately 3 to 15%. The reason is that in order to make the CO_2 concentration to be 3% or less, costs required for installation and operation of the second CO_2 removing device 102 is too high, and further, when the CO_2 concentration is 15% or more, reducibility of the CO_2 removing gas is excessively deteriorated and thus, reduction of the ores in the second fluidized reduction furnace 107 is not smoothly performed.

[0107] Further, the CO_2 removed from the by-product gas of the first molten iron manufacturing apparatus and the exhaust gas of the second fluidized reduction furnace 107 in the CO_2 removing device 102 is discharged to the outside through a separate gas pipe 126.

[0108] The CO_2 removing gas discharged from the second CO_2 removing device 102 is heated by contacting the hot gas discharged from the second fluidized reduction furnace 107 through a heat exchange tube provided in the heat exchanger 104 while passing through the heat exchanger 104, and then heated by contacting hot combustion gas generated by combusting the exhaust gas supplied through the gas pipe 119 in the gas heater 105 through a heat exchange tube provided in the gas heater 105.

[0109] The gas heating temperature in the gas heater 105 may be approximately 400 to 450°C. The reason is that since a large amount of CO gas is included in the CO_2 removing gas, at the temperature or more, metal dusting occurs by the CO gas and thus, damage to the heat exchange tube provided in the gas heater 105 is caused.

[0110] The gas heated to approximately 400 to 450°C in the gas heater 105 is partially combusted in the oxygen mixing furnace 106 by oxygen injected from the outside of the oxygen mixing furnace 106 and heated as the combustion heat. In this case, the temperature of the gas discharged from the oxygen mixing furnace 106 may be approximately 700 to 780°C in order to prevent coherence of the fine ores in the second fluidized reduction furnace 107 from which the gas is supplied. The hot gas heated at the temperature is supplied to the second fluidized reduction furnace 107 at the rear end of the oxygen mixing furnace 106.

[0111] The second fluidized reduction furnace 107 is constituted in the multiple stages (in FIG. 1, for example, constituted in three stages), and the fine ore and the supplementary raw materials are supplied to the uppermost second fluidized reduction furnace of the multi-stage second fluidized reduction furnace 107, hot gas supplied to the lowermost second fluidized reduction furnace of the multi-stage second fluidized reduction furnace 107 and a counter flow type, that is, the fine ore and supplementary raw materials are supplied from the uppermost end to the lowermost end and the hot gas is supplied from the lowermost end to the uppermost end to cross each other and contact each other. In this process, the fine ore and supplementary raw materials are reduced and fired to be converted to the fine reductant.

[0112] The fine reductant is discharged from the lowermost second fluidized reduction furnace of the second fluidized reduction furnace 107 and conveyed and stored to the fine reductant storage tank 109, injected into the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus through the fine reductant transporting pipe 111 by the transporting device 110 provided at the lower end of the fine reductant storage tank 108, dissolved in the iron-bath type melting reduction furnace a, and then converted to molten iron and slag by melting reduction, slagging reaction, and the like.

[0113] Further, a reduction rate of the fine reduced ore included in the fine reductant discharged from the lowermost end of the second fluidized reduction furnace 107 is preferably about 60 to 70%. The reason is that at the reduction rate of 60 to 70% or more, adhesion of ores occurs, and at the reduction rate of 60 to 70% or less, energy required for the melting reduction and slagging of the fine reductant in the iron-bath type melting reduction furnace a in the second molten iron manufacturing apparatus is excessively increased. In order to maintain the reduction rate, the second fluidized reduction furnace 107 may be constituted in multiple stages, for example, two to three stages.

[0114] Meanwhile, the exhaust gas discharged from the second fluidized reduction furnace 107 is cooled by heat exchange with the CO_2 removing gas while passing through the heat exchanger 104 as described above, the dust included in the exhaust gas is separated through the second dry dust collecting device 115, some of the exhaust gas after cooling to room temperature in the second gas cooling device 116 is branched, combined with the by-product gas of the first molten iron manufacturing apparatus through the pipe 121 as described above to be re-supplied to the second CO_2 removing device 102, the rest of the exhaust gas is discharged to the outside through the pipe 124, and then some of the gas flowing in the pipe 124 is supplied as the fuel of the gas heater 105 and the hot blast furnace b of the second molten iron manufacturing apparatus through the pipe 119.

[0115] Further, at the lower ends of the first dry dust collecting device K and the second dry dust collecting device 115, the first transporting device 113 and the second transporting device 117 are provided, respectively. The first transporting device 113 and the second transporting device 117 are connected with the fine reductant transporting pipe 111 through the first and second transporting pipes 114 and 118 by receiving the dust separated from the exhaust gas of the first fluidized reduction furnace A and the second fluidized reduction furnace 7 from the first dry dust collecting device K and the second dry dust collecting device 115 to be mixed with the fine reductant in the fine reductant transporting pipe 11 and then injected into the iron-bath type melting reduction furnace a.

[0116] An example of manufacturing molten iron by using the combined molten iron manufacturing apparatus constituted by the plurality of reaction furnaces directly using the fine or compacted general coals and the fine iron-containing ores according to another exemplary embodiment of the present invention will be described. For purposes of the present invention, the first molten iron manufacturing apparatus is stable, and in order to produce the molten iron at high efficiency, as the used fine ores and coals, generally, high-rank ores having a relatively large iron content and metallurgy coals having a high coking property were used as illustrated in Tables 11 to 13 below.

[Table 11] Composition of used ores of first molten iron manufacturing apparatus

Moisture	T.Fe	Fe	FeO	Fe2O3	SiO2	Al2O3	CaO	MeO	MnO	P2O5	S	K2O	Na2O	TiO2	ZnO	LOI
0.20	62.1 4	0.0 0	0.1 6	88,66	3.89	2.22	0.0 3	0.0 9	0.1 6	0.16	0.0 2	0.0 1	0.02	0.1 3	0.0 0	4.4 4

[Table 12] Composition of used coals of first molten iron manufacturing apparatus

Moisture	VM	Ash	FC
5.00	23.66	12.12	59.20

[Table 13] Composition of used supplementary raw materials of first molten iron manufacturing apparatus

Moisture	T.Fe	Fe	FeO	Fe2O3	SiO2	Al2O3	CaO	MgO	MnO
0.20	0.00	0.00	0.00	0.29	1.55	0.45	40.18	11.87	0.01

[0117] Further, unlike the first molten iron manufacturing apparatus, in the second molten iron manufacturing apparatus, low-rank ores having high gangue contents and low-cost anthracites without a coking property were used as illustrated in Tables 14 to 15 below.

[Table 14] Composition of used ores of second molten iron manufacturing apparatus

T.Fe	Fe	FeO	Fe2O3	SiO2	Al2O3	CaO	MgO	MnO	P2O5	S	K2O	Na2O	TiO2	ZnO	Moisture	LOI
56.43	0.00	0.00	80.68	5.51	3.23	0.08	0.07	0.10	0.16	0.01	0.07	0.00	0.00	0.00	0.2	8.30

[Table 15] Composition of used coals of second molten iron manufacturing apparatus

Moisture	VM	Ash	FC
3.39	5.32	16.34	74.95

[0118] Further, the fourth molten iron manufacturing apparatus used supplementary raw materials having the same composition as the first molten iron manufacturing apparatus.

[0119] FIG. 5 is a process flowchart according to a material flow and a table illustrating property ratios of gases as an example of a process of manufacturing molten iron of 100 ton per hour in the second molten iron manufacturing apparatus by using the fourth molten iron manufacturing apparatus according to another exemplary embodiment of the present invention using the exhaust gas of the first molten iron manufacturing apparatus that manufactures molten iron of 180 ton per hour.

[0120] Further, Tables 16 to 19 below are composition tables illustrating contents of main components of molten iron and slag produced in the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus according to another exemplary embodiment of the present invention, respectively.

[Table 16] Composition of produced molten iron of first molten iron manufacturing apparatus

C	Si	P	Mn	S
4.500	0.500	0.059	0.150	0.047

[Table 17] Composition of produced slag of first molten iron manufacturing apparatus

SiO2	Al2O3	CaO	MgO	FeO	S
30.731	17.695	36.893	10.516	0.488	1.226

[Table 18] Composition of produced molten iron of second molten iron manufacturing apparatus

C	Si	P	Mn	S
4.000	0.100	0.090	0.000	0.076

[Table 19] Composition of produced slag of second molten iron manufacturing apparatus

SiO2	Al2O3	CaO	MgO	FeO	S
32.807	18.359	42.649	2.450	2.988	0.303

[0121] In the case of the second molten iron manufacturing apparatus, as compared with the first molten iron manufacturing apparatus, low-cost fuel and raw materials were used and the impurity contents such as S and P in the molten iron are increased, but may be generally removed in a refining process.

[0122] As described above, in the first molten iron manufacturing apparatus, the molten iron is stably produced at high efficiency by using the relatively high-cost fuel and raw materials. As a result, it is shown that the hot reducing gas generated stably in the first molten iron manufacturing apparatus is used and thus, the stable fine reductant of approximately 60 to 70% is manufactured by using the low-rank fine ores and supplementary raw materials from the second fluidized reduction furnace 1.

[0123] Further, it is shown that the fine reductant is supplied as an iron source of the iron-bath type melting reduction furnace a of the second molten iron manufacturing apparatus to stably produce molten iron even by using low-cost anthracite as described above in the second molten iron manufacturing apparatus.

<Description of symbols>

A: First fluidized reduction furnace
B: Hot compacting apparatus
D: Conveying device
E: Compacted iron charging device
F: Compacted general coal charging device
G: Melter-gasifier
H: Dust circulation device
I: Pressure control device
J: First sensible heat recovery device
K: First dry dust collecting device
L: First gas cooling device
a: Iron-bath type melting reduction furnace
b: Hot blast furnace
c: Second sensible heat recovery device
d: Cleaning device

(continued)

1: Second fluidized reduction furnace	2: Oxygen mixing furnace
3: Second sensible heat recovery device	
4: Second dry dust collecting device	
5: Second gas cooling device	
6, 8: First, second transporting device	
7, 9: First, second transporting pipes	
10: Fine reductant transporting pipe	
19, 30, 31: Pipe	20: Fine reductant storage tank
21: Fine reductant transporting pipe	
101: Compressor	102: Second CO_2 removing device
104: Heat exchanger	105: Gas heater
106: Oxygen mixing furnace	
107: Second fluidized reduction furnace	
108: Pipe	109: Fine reductant storage tank
110: Fine reductant transporting device	
111: Fine reductant transporting pipe	
113, 117: First, second transporting devices	
114, 118: First, second transporting pipes	
115, 116: First, second cooling devices	119: Fuel gas supply pipe
120: By-product gas pipe	121, 126: Gas pipe
124: Final exhaust gas pipe	

Claims

1. A combined molten iron manufacturing apparatus comprising:

a first molten iron manufacturing apparatus including a first fluidized reduction furnace (A) constituted in multiple stages that reduces fine ore to convert the reduced fine ore to fine reduced iron, a plurality of hot compacting devices (B) that manufactures the fine reduced iron emitted from the first fluidized reduction furnace (A) to hot reduced compacted iron, a conveying device (D) that conveys the hot reduced compacted iron crushed with a predetermined size, a compacted iron charging device (E) for continuously supplying the hot reduced compacted iron conveyed by the conveying device (D) to a melter-gasifier (G) and a compacted general coal charging device (F) for continuously supplying compacted general coal to the melter-gasifier (G), a melter-gasifier (G) that melts the hot reduced compacted iron supplied from the compacted iron charging device (E) by using hot combust gas generated by combusting the compacted general coal supplied from the compacted general coal charging device (F) and a pulverized coal material injected from the lower portion with oxygen and supplies reducing gas required in fine ore reduction in the first fluidized reduction furnace (A), a CO_2 removing device (M) that removes CO_2 by branching some of exhaust gas of the first fluidized reduction furnace (A) and then supplies the reducing gas to the first fluidized reduction furnace (A) in addition to the reducing gas supplied from the melter-gasifier (G), a dust circulation device (H) that separates dust included in the reducing gas generated from the melter-gasifier (G) to re-inject the dust to the melter-gasifier (G), a pressure control device (I) that uniformly maintains pressure in the melter-gasifier (G) by branching and cooling some of gases generated from the melter-gasifier (G) according to a pressure change of the melter-gasifier (G) and then discharging some of gases to a by-product gas line, a first sensible heat recovery device (J) that recovers sensible heat of the exhaust gas discharged from the first fluidized reduction furnace (A), a first dry dust collecting device (K) that separates scattering dust included in the exhaust gas discharged from the first fluidized reduction furnace (A), and a first gas cooling device (L) that cools the exhaust gas discharged from the first fluidized reduction furnace (A);
a second molten iron manufacturing apparatus including an iron-bath type melting reduction furnace (a) that is adapted to process fine iron-containing material and pulverized coal which are injected to the inner portion to produce molten iron and slag through reactions such as dissolution, combustion, and melting reduction therein, and that is adapted to discharge the manufactured molten iron and slag to the outside, a hot blast furnace (b) that manufactures hot blast which is injected to the melting reduction furnace (a) as a secondary combustion

oxidant, and a cleaning device (d) that cools and cleans the gas discharged from the melting reduction furnace (a); and
a third molten iron manufacturing apparatus that is provided between the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus to connect the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus, branch some of the reducing gas generated from the melter-gasifier (G) of the first molten iron manufacturing apparatus and supplied to the first fluidized reduction furnace (A), and reduces a fine ore at a predetermined level by using the branched reducing gas to supply the reduced fine ore as an iron source of the second molten iron manufacturing apparatus, wherein:

the third molten iron manufacturing apparatus includes an oxygen mixing furnace (2) that is provided on a pipe supplying hot reducing gas to the first fluidized reduction furnace (A) of the first molten iron manufacturing apparatus through the dust circulation device (H) of the first molten iron manufacturing apparatus to inject oxygen into the hot reducing gas,
a pipe that is provided at the rear end of the oxygen mixing furnace (2) to branch some of the reducing gas, and a second fluidized reduction furnace (1) that is connected to the pipe, receives some of the branched reducing gas from the pipe to reduce a fine ore, and converts the reduced fine ore to a fine reductant.

2. The combined molten iron manufacturing apparatus of claim 1, wherein:
the second fluidized reduction furnace (1) is configured in multiple stages of two stages or three stages or more.

3. The combined molten iron manufacturing apparatus of claim 2, comprising: a second sensible heat recovery device (3) that is connected to the rear end of the second fluidized reduction furnace (1) to recover sensible heat of the exhaust gas discharged from the second fluidized reduction furnace (1).

4. The combined molten iron manufacturing apparatus of claim 3, comprising:
a second dry dust collecting device (4) that is connected to the rear end of the second sensible heat recovery device (3) to separate scattering dust in the exhaust gas.

5. The combined molten iron manufacturing apparatus of claim 4, comprising:
a second gas cooling device (5) that is connected to the rear end of the second dry dust collecting device (4) to cool the exhaust gas.

6. The combined molten iron manufacturing apparatus of claim 5, wherein:
the second fluidized reduction furnace (1) includes a fine reductant storage tank (20) that is connected to the lowermost second fluidized reduction furnace (1) to store the fine reductant discharged from the second fluidized reduction furnace (1) through a pipe.

7. The combined molten iron manufacturing apparatus of claim 6, wherein:
the second fluidized reduction furnace (1) includes a fine reductant transporting device (21) that is connected to the lower end of the fine reductant storage tank (20) to inject the fine reductant into the iron-bath type melting reduction furnace (a) through a fine reductant transporting pipe (10) connecting the fine reductant storage tank (20) and the iron-bath type melting reduction furnace (a) from the fine reductant storage tank (20).

8. The combined molten iron manufacturing apparatus of claim 7, wherein:
at the lower end of the first dry dust collecting device (K), a first transporting device (6) and a first transporting pipe (7) connecting the first transporting device (6) and the fine reductant transporting pipe (10) are provided to inject dusts separated from the first dry dust collecting device (K) into the iron-bath type melting reduction furnace (a) together with the fine reductant discharged from the second fluidized reduction furnace (1).

9. The combined molten iron manufacturing apparatus of claim 8, wherein:
at the lower end of the second dry dust collecting device (4), a second transporting device (8) and a second transporting pipe (9) connecting the second transporting device (8) and the fine reductant transporting pipe (10) are provided to inject dusts separated from the second dry dust collecting device (4) into the iron-bath type melting reduction furnace (a) of the second molten iron manufacturing apparatus together with the fine reductant discharged from the second fluidized reduction furnace (1).

10. The combined molten iron manufacturing apparatus of claim 9, comprising:
a hot blast furnace fuel gas supply pipe which is connected to the hot blast furnace (b) by combining the exhaust

gases of the first fluidized reduction furnace (A) and the second fluidized reduction furnace (1) of the first molten iron manufacturing apparatus and then branching the exhaust gases at the line rear end branched to the by-product gas line in order to supply required fuel to the hot blast furnace (b).

11. A combined molten iron manufacturing apparatus comprising:

a first molten iron manufacturing apparatus including a first fluidized reduction furnace (A) constituted in multiple stages that reduces fine ore to convert the reduced fine ore to fine reduced iron, a plurality of hot compacting devices (B) that manufactures the fine reduced iron emitted from the first fluidized reduction furnace (A) to hot reduced compacted iron, a conveying device (D) that conveys the hot reduced compacted iron crushed with a predetermined size, a compacted iron charging device (E) for continuously supplying the hot reduced compacted iron conveyed by the conveying device (D) to a melter-gasifier (G) and a compacted general coal charging device (F) for continuously supplying compacted general coal to the melter-gasifier (G), a melter-gasifier (G) that melts the hot reduced compacted iron supplied from the compacted iron charging device (E) by using hot combust gas generated by combusting the compacted general coal supplied from the compacted general coal charging device (F) and a pulverized coal material injected from the lower portion with oxygen and supplies reducing gas required in fine ore reduction in the first fluidized reduction furnace (A), a CO_2 removing device (M) that removes CO_2 by branching some of exhaust gas of the first fluidized reduction furnace (A) and then supplies the reducing gas to the first fluidized reduction furnace (A) in addition to the reducing gas supplied from the melter-gasifier (G), a dust circulation device (H) that separates dust included in the reducing gas generated from the melter-gasifier (G) to re-inject the dust to the melter-gasifier (G), a pressure control device (I) that uniformly maintains pressure in the melter-gasifier (G) by branching and cooling some of gases generated from the melter-gasifier (G) according to a pressure change of the melter-gasifier (G) and then discharging the gases to a by-product gas line, a first sensible heat recovery device (J) that recovers sensible heat of the exhaust gas discharged from the first fluidized reduction furnace (A), a first dry dust collecting device (K) that separates scattering dust included in the exhaust gas discharged from the first fluidized reduction furnace (A), and a first gas cooling device (L) that cools the exhaust gas discharged from the first fluidized reduction furnace (A);
a second molten iron manufacturing apparatus including an iron-bath type melting reduction furnace (a) that is adapted to processs fine iron-containing material and pulverized coal which are injected to the inner portion to produce molten iron and slag through reactions such as dissolution, combustion, and melting reduction therein, and that is adapted to discharge the manufactured molten iron and slag to the outside; a hot blast furnace (b) that manufactures hot blast which is injected to the melting reduction furnace (a) as a secondary combustion oxidant, a second sensible heat recovery device (c) for recovering sensible heat of the exhaust gas discharged from the melting reduction furnace (a), and a cleaning device (d) that cools and cleans the gas discharged from the melting reduction furnace (a), and
a fourth molten iron manufacturing apparatus that is provided between the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus to connect the first molten iron manufacturing apparatus and the second molten iron manufacturing apparatus, partially extracts and removes a CO_2 component included in the final by-product gas of the first molten iron manufacturing apparatus, manufactures hot reducing gas by heating the CO_2 component, and then reduces and sinters the fine ore, supplementary raw materials, and the like at a predetermined level by using the reducing gas to manufacture a fine reductant and supply the fine reductant as an iron source of the second molten iron manufacturing apparatus, wherein:

the fourth molten iron manufacturing apparatus includes a compressor (101) that is connected with a by-product gas pipe in which by-product gas generated from the first molten iron manufacturing apparatus flows to compress the by-product gas,
a second CO_2 removing device (102) that is connected with the compressor (101) to remove the CO_2 component in the compressed gas from the compressor (101),
a heat exchanger (104) and a gas heater (105) which are connected with the second CO_2 removing device (102) and provided for heating gas from which CO_2 is removed and that is discharged from the second CO_2 removing device (102) and manufacturing hot reducing gas,
an oxygen mixing furnace (106) that is connected with the gas heater (105) to inject oxygen into the hot reducing gas, and
a second fluidized reduction furnace (1) that is connected with the oxygen mixing furnace (106) and reduces and fires the fine ore and the supplementary raw materials by supplying the hot reducing gas.

12. The combined molten iron manufacturing apparatus of claim 11, wherein:
the second fluidized reduction furnace (107) is configured in multiple stages of two stages or three stages or more.

13. The combined molten iron manufacturing apparatus of claim 12,
comprising: a second dry dust collecting device (115) that is connected to the rear end of the heat exchanger (104) and discharged from the second fluidized reduction furnace (107) to separate scattering dust in the exhaust gas after passing through the heat exchanger (104).

14. The combined molten iron manufacturing apparatus of claim 13, comprising:
a second gas cooling device (116) that is connected to the rear end of the second dry dust collecting device (115) to cool the exhaust gas.

15. The combined molten iron manufacturing apparatus of claim 14, comprising:
a gas pipe that is connected to the rear end of the second gas cooling device (116) to circulate some of the exhaust gas to the second CO_2 removing device (102).

16. The combined molten iron manufacturing apparatus of claim 15, comprising:
a final exhaust gas pipe that is connected to the rear end of the second gas cooling device (116) to discharge the rest of the exhaust gas to the outside.

17. The combined molten iron manufacturing apparatus of claim 16, comprising:
a gas pipe that connects the second CO_2 removing device (102) and the final exhaust gas pipe to discharge CO_2 separated from the second CO_2 removing device (102) to the outside.

18. The combined molten iron manufacturing apparatus of claim 17, wherein:
the second fluidized reduction furnace (107) includes a fine reductant storage tank (109) for storing the fine reductant discharged from the lowermost fluidized reduction furnace through the pipe.

19. The combined molten iron manufacturing apparatus of claim 18, wherein:
the second fluidized reduction furnace (107) includes a fine reductant transporting device (110) that injects the fine reductant into the iron-bath type melting reduction furnace (a) through a fine reductant transporting pipe (110) connecting the fine reductant storage tank (109) and the iron-bath type melting reduction furnace (a) from the fine reductant storage tank (109).

20. The combined molten iron manufacturing apparatus of claim 19, wherein:
at the lower end of the first dry dust collecting device (K), a first transporting device (113) and a first transporting pipe (114) connecting the first transporting device (113) and the fine reductant transporting pipe (111) are provided to inject dusts separated from the first dry dust collecting device (K) into the iron-bath type melting reduction furnace (a) together with the fine reductant discharged from the second fluidized reduction furnace (107).

21. The combined molten iron manufacturing apparatus of claim 20, wherein:
at the lower end of the second dry dust collecting device (115), a second transporting device (117) and a second transporting pipe (118) connecting the second transporting device (117) and the fine reductant transporting pipe (111) are provided to inject dusts separated from the second dry dust collecting device (115) into the iron-bath type melting reduction furnace (a) together with the fine reductant discharged from the second fluidized reduction furnace (107).

22. The combined molten iron manufacturing apparatus of claim 21, wherein:
in order to supply required fuel to the gas heating furnace (105) and the hot blast furnace (b) of the second molten iron manufacturing apparatus, the pipe includes a fuel gas supply pipe which is branched at a front end of a point where gas containing CO_2 removed from the second CO_2 removing device (102) and gas discharged from the second molten iron manufacturing apparatus are combined and connected to the hot blast furnace (b) and the gas heating furnace (105).

Patentansprüche

1. Kombinierte Eisenschmelzeherstellungsvorrichtung, umfassend:

eine erste Eisenschmelzeherstellungsvorrichtung, die Folgendes beinhaltet:

einen aus mehreren Stufen bestehenden, ersten Schmelz-Reduktionsofen (A), der Feinerz reduziert, um das reduzierte Feinerz in feines, reduziertes Eisen umzuwandeln,
eine Vielzahl von Heißverdichtungsvorrichtungen (B), die das feine, reduzierte Eisen, das von dem ersten Schmelz-Reduktionsofen (A) ausgegeben wird, zu heißem, reduziertem, verdichtetem Eisen herstellen,
eine Fördervorrichtung (D), die das heiße, reduzierte, verdichtete Eisen, das mit einer vorbestimmten Größe zerkleinert wurde, fördert,
eine Beschickungsvorrichtung für verdichtetes Eisen (E) zum kontinuierlichen Zuführen des heißen, reduzierten, verdichteten Eisens, das von der Fördervorrichtung (D) gefördert wird, zu einem Einschmelzvergaser (G) und
eine Beschickungsvorrichtung für verdichtete allgemeine Kohle (F) zum kontinuierlichen Zuführen von verdichteter allgemeiner Kohle zu dem Einschmelzvergaser (G),

einen Einschmelzvergaser (G), der das heiße, reduzierte, verdichtete Eisen, das von der Beschickungsvorrichtung für verdichtetes Eisen (E) zugeführt wird, schmilzt, indem er heißes Verbrennungsgas, das durch Verbrennen der verdichteten allgemeinen Kohle, die von der Beschickungsvorrichtung für verdichtete allgemeine Kohle (F) zugeführt wird, und eines pulverisierten Kohlematerials, das von dem unteren Abschnitt zugeführt wird, mit Sauerstoff erzeugt wird, verwendet, und
reduzierendes Gas, das bei der Feinerzreduktion in dem ersten Schmelz-Reduktionsofen (A) erforderlich ist, zuführt,
eine CO_2-entfernende Vorrichtung (M), die CO_2 entfernt, indem sie einen Teil des Abgases des ersten Schmelz-Reduktionsofens (A) abzweigt und dann das reduzierende Gas zu dem ersten Schmelz-Reduktionsofen (A) zuführt, zusätzlich zu dem reduzierenden Gas, das von dem Einschmelzvergaser (G) zugeführt wird,
eine Staubzirkulationsvorrichtung (H), die in dem reduzierenden Gas, das von dem Einschmelzvergaser (G) erzeugt wird, enthaltenen Staub trennt, um den Staub dem Einschmelzvergaser (G) wieder zuzuführen,
eine Druckregelvorrichtung (I), die den Druck in dem Einschmelzvergaser (G) einheitlich hält, indem sie einen Teil der von dem Einschmelzvergaser (G) erzeugten Gase gemäß einer Druckänderung des Einschmelzvergasers (G) abzweigt und kühlt, und dann einen Teil der Gase zu einer Nebenproduktgasleitung abführt,
eine erste Rückgewinnungsvorrichtung für fühlbare Wärme (J), die fühlbare Wärme des von dem ersten Schmelz-Reduktionsofen (A) abgeführten Abgases zurückgewinnt,
eine erste Trockenstaubsammelvorrichtung (K), die in dem von dem ersten Schmelz-Reduktionsofen (A) abgeführten Abgas enthaltenen Streustaub trennt, und
eine erste Gaskühlvorrichtung (L), die das von dem ersten Schmelz-Reduktionsofen (A) abgeführte Abgas kühlt;

eine zweite Eisenschmelzeherstellungsvorrichtung, die Folgendes beinhaltet:

einen Schmelzreduktionsofen vom Eisenbadtyp (a), der dazu angepasst ist, feines Eisen enthaltendes Material und pulverisierte Kohle zu verarbeiten, die dem inneren Abschnitt zugeführt werden, um geschmolzenes Eisen und Schlacke zu erzeugen, durch Reaktionen, wie etwa Auflösung, Verbrennung und Schmelzreduktion darin, und der dazu angepasst ist, das hergestellte geschmolzen Eisen und die Schlacke nach Außen abzuführen,
einen Heißwindofen (b), der Heißwind herstellt, der dem Schmelzreduktionsofen (a) als ein sekundäres Verbrennungsoxidationsmittel zugeführt wird, und
eine Reinigungsvorrichtung (d), die das von dem Schmelzreduktionsofen (a) abgeführte Gas kühlt und reinigt; und
eine dritte Eisenschmelzeherstellungsvorrichtung, die zwischen der ersten Eisenschmelzeherstellungsvorrichtung und der zweiten Eisenschmelzeherstellungsvorrichtung bereitgestellt ist, um die erste Eisenschmelzeherstellungsvorrichtung und die zweite Eisenschmelzeherstellungsvorrichtung zu verbinden, einen Teil des reduzierenden Gases, das von dem Einschmelzvergaser (G) der ersten Eisenschmelzeherstellungsvorrichtung erzeugt wird und dem ersten Schmelz-Reduktionsofen (A) zugeführt wird, abzuzweigen, und ein Feinerz auf einem vorbestimmten Niveau reduziert, indem sie das abgezweigte reduzierende Gas verwendet, um das reduzierte Feinerz als eine Eisenquelle des der zweiten Eisenschmelzeherstellungsvorrichtung zuzuführen, wobei:
die dritte Eisenschmelzeherstellungsvorrichtung Folgendes beinhaltet:

einen Sauerstoffmischofen (2), der an einem Rohr bereitgestellt ist, das heißes reduzierendes Gas zu dem ersten Schmelz-Reduktionsofen (A) der ersten Eisenschmelzeherstellungsvorrichtung durch die Staubzirkulationsvorrichtung (H) der ersten Eisenschmelzeherstellungsvorrichtung zuführt, um dem heißen reduzierenden Gas Sauerstoff zuzuführen,
ein Rohr, das an dem hinteren Ende des Sauerstoffmischofens (2) bereitgestellt ist, um einen Teil des

reduzierenden Gases abzuzweigen, und
einen zweiten Schmelz-Reduktionsofen (1), der mit dem Rohr verbunden ist, einen Teil des abgezweigten reduzierenden Gases von dem Rohr erhält, um ein Feinerz zu reduzieren und das reduzierte Feinerz in ein feines Reduktionsmittel umwandelt.

2. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 1, wobei: der zweite Schmelz-Reduktionsofen (1) in mehreren Stufen von zwei Stufen oder drei Stufen oder mehr ausgelegt ist.

3. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 2, umfassend: eine zweite Rückgewinnungsvorrichtung für fühlbare Wärme (3), die mit dem hinteren Ende des zweiten Schmelz-Reduktionsofens (1) verbunden ist, um fühlbare Wärme des von dem zweiten Schmelz-Reduktionsofen (1) abgeführten Abgases zurückzugewinnen.

4. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 3, umfassend: eine zweite Trockenstaubsammelvorrichtung (4), die mit dem hinteren Ende der zweiten Rückgewinnungsvorrichtung für fühlbare Wärme (3) verbunden ist, um Streustaub in dem Abgas zu trennen.

5. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 4, umfassend: eine zweite Gaskühlvorrichtung (5), die mit dem hinteren Ende der zweiten Trockenstaubsammelvorrichtung (4) verbunden ist, um das Abgas zu kühlen.

6. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 5, wobei: der zweite Schmelz-Reduktionsofen (1) einen Speichertank für feines Reduktionsmittel (20) beinhaltet, der mit dem untersten zweiten Schmelz-Reduktionsofen (1) verbunden ist, um das von dem zweiten Schmelz-Reduktionsofen (1) durch ein Rohr abgeführte feine Reduktionsmittel zu speichern.

7. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 6, wobei: der zweite Schmelz-Reduktionsofen (1) eine Transportvorrichtung für feines Reduktionsmittel (21) beinhaltet, die mit dem unteren Ende des Speichertanks für feines Reduktionsmittel (20) verbunden ist, um das feine Reduktionsmittel dem Schmelzreduktionsofen vom Eisenbadtyp (a) durch ein Transportrohr für feines Reduktionsmittel (10), das den Speichertank für feines Reduktionsmittel (20) und den Schmelzreduktionsofen vom Eisenbadtyp (a) verbindet, von dem Speichertank für feines Reduktionsmittel (20) zuzuführen.

8. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 7, wobei: an dem unteren Ende der ersten Trockenstaubsammelvorrichtung (K) eine erste Transportvorrichtung (6) und ein erstes Transportrohr (7), das die erste Transportvorrichtung (6) und das Transportrohr für feines Reduktionsmittel (10) verbindet, bereitgestellt sind, um Stäube, die von der ersten Trockenstaubsammelvorrichtung (K) getrennt werden, dem Schmelzreduktionsofen vom Eisenbadtyp (a) zusammen mit dem von dem zweiten Schmelz-Reduktionsofen (1) abgeführten feinen Reduktionsmittel zuzuführen.

9. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 8, wobei: an dem unteren Ende der zweiten Trockenstaubsammelvorrichtung (4) eine zweite Transportvorrichtung (8) und ein zweites Transportrohr (9), das die zweite Transportvorrichtung (8) und das Transportrohr für feines Reduktionsmittel (10) verbindet, bereitgestellt sind, um Stäube, die von der zweiten Trockenstaubsammelvorrichtung (4) getrennt werden, dem Schmelzreduktionsofen vom Eisenbadtyp (a) der zweiten Eisenschmelzeherstellungsvorrichtung zusammen mit dem von dem zweiten Schmelz-Reduktionsofen (1) abgeführten feinen Reduktionsmittel zuzuführen.

10. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 9, umfassend: ein Zuführrohr für Heißwindofenbrenngas, das mit dem Heißwindofen (b) verbunden ist, indem es die Abgase des ersten Schmelz-Reduktionsofens (A) und des zweiten Schmelz-Reduktionsofens (1) der ersten Eisenschmelzeherstellungsvorrichtung kombiniert und dann die Abgase an dem hinteren Leitungsende, das zu der Nebenproduktgasleitung abgezweigt ist, abzweigt, um erforderlichen Brennstoff zu dem Heißwindofen (b) zuzuführen.

11. Kombinierte Eisenschmelzeherstellungsvorrichtung, umfassend: eine erste Eisenschmelzeherstellungsvorrichtung, die Folgendes beinhaltet:

einen aus mehreren Stufen bestehenden, ersten Schmelz-Reduktionsofen (A), der Feinerz reduziert, um das reduzierte Feinerz in feines, reduziertes Eisen umzuwandeln,
eine Vielzahl von Heißverdichtungsvorrichtungen (B), die das feine, reduzierte Eisen, das von dem ersten

Schmelz-Reduktionsofen (A) ausgegeben wird, zu heißem, reduziertem, verdichtetem Eisen herstellen,
eine Fördervorrichtung (D), die das heiße, reduzierte, verdichtete Eisen, das mit einer vorbestimmten Größe zerkleinert wurde, fördert,
eine Beschickungsvorrichtung für verdichtetes Eisen (E) zum kontinuierlichen Zuführen des heißen, reduzierten, verdichteten Eisens, das von der Fördervorrichtung (D) gefördert wird, zu einem Einschmelzvergaser (G) und eine Beschickungsvorrichtung für verdichtete allgemeine Kohle (F) zum kontinuierlichen Zuführen von verdichteter allgemeiner Kohle zu dem Einschmelzvergaser (G),
einen Einschmelzvergaser (G), der das heiße, reduzierte, verdichtete Eisen, das von der Beschickungsvorrichtung für verdichtetes Eisen (E) zugeführt wird, schmilzt, indem er heißes Verbrennungsgas, das durch Verbrennen der verdichteten allgemeinen Kohle, die von der Beschickungsvorrichtung für verdichtete allgemeine Kohle (F) zugeführt wird, und eines pulverisierten Kohlematerials, das von dem unteren Abschnitt zugeführt wird, mit Sauerstoff erzeugt wird, verwendet, und reduzierendes Gas, das bei der Feinerzreduktion in dem ersten Schmelz-Reduktionsofen (A) erforderlich ist, zuführt,
eine CO_2-entfernende Vorrichtung (M), die CO_2 entfernt, indem sie einen Teil des Abgases des ersten Schmelz-Reduktionsofens (A) abzweigt und dann das reduzierende Gas zu dem ersten Schmelz-Reduktionsofen (A) zuführt, zusätzlich zu dem reduzierenden Gas, das von dem Einschmelzvergaser (G) zugeführt wird,
eine Staubzirkulationsvorrichtung (H), die in dem reduzierenden Gas, das von dem Einschmelzvergaser (G) erzeugt wird, enthaltenen Staub trennt, um den Staub dem Einschmelzvergaser (G) wieder zuzuführen,
eine Druckregelvorrichtung (I), die den Druck in dem Einschmelzvergaser (G) einheitlich hält, indem sie einen Teil der von dem Einschmelzvergaser (G) erzeugten Gase gemäß einer Druckänderung des Einschmelzvergasers (G) abzweigt und kühlt, und dann die Gase zu einer Nebenproduktgasleitung abführt,
eine erste Rückgewinnungsvorrichtung für fühlbare Wärme (J), die fühlbare Wärme des von dem ersten Schmelz-Reduktionsofen (A) abgeführten Abgases zurückgewinnt,
eine erste Trockenstaubsammelvorrichtung (K), die in dem von dem ersten Schmelz-Reduktionsofen (A) abgeführten Abgas enthaltenen Streustaub trennt, und eine
erste Gaskühlvorrichtung (L), die das von dem ersten Schmelz-Reduktionsofen (A) abgeführte Abgas kühlt;
eine zweite Eisenschmelzeherstellungsvorrichtung, die Folgendes beinhaltet:

> einen Schmelzreduktionsofen vom Eisenbadtyp (a), der dazu angepasst ist, feines Eisen enthaltendes Material und pulverisierte Kohle zu verarbeiten, die dem inneren Abschnitt zugeführt werden, um geschmolzenes Eisen und Schlacke zu erzeugen, durch Reaktionen, wie etwa Auflösung, Verbrennung und Schmelzreduktion darin, und der dazu angepasst ist, das hergestellte geschmolzene Eisen und die Schlacke nach Außen abzuführen,
> einen Heißwindofen (b), der Heißwind herstellt, der dem Schmelzreduktionsofen (a) als ein sekundäres Verbrennungsoxidationsmittel zugeführt wird,
> eine zweite Rückgewinnungsvorrichtung für fühlbare Wärme (c) zum Rückgewinnen fühlbarer Wärme des von dem Schmelzreduktionsofen (a) abgeführten Abgases und
> eine Reinigungsvorrichtung (d), die das von dem Schmelzreduktionsofen (a) abgeführte Gas kühlt und reinigt; und
> eine vierte Eisenschmelzeherstellungsvorrichtung, die zwischen der ersten Eisenschmelzeherstellungsvorrichtung und der zweiten Eisenschmelzeherstellungsvorrichtung bereitgestellt ist, um die erste Eisenschmelzeherstellungsvorrichtung und die zweite Eisenschmelzeherstellungsvorrichtung zu verbinden,

eine in dem endgültigen Nebenproduktgas der ersten Eisenschmelzeherstellungsvorrichtung enthaltene CO_2-Komponente teilweise entzieht, heißes reduzierende Gas herstellt, indem sie die CO_2-Komponente erwärmt und dann das Feinerz, zusätzliche Rohmaterialien und dergleichen auf einem vorbestimmten Niveau reduziert und sintert, indem sie das reduzierende Gas verwendet, um ein feines Reduktionsmittel herzustellen und das feine Reduktionsmittel als eine Eisenquelle der zweiten Eisenschmelzeherstellungsvorrichtung zuzuführen, wobei:
die vierte Eisenschmelzeherstellungsvorrichtung Folgendes beinhaltet: einen Verdichter (101), der mit einem Nebenproduktgasrohr verbunden ist, in dem von der ersten Eisenschmelzeherstellungsvorrichtung erzeugtes Nebenproduktgas strömt, um das Nebenproduktgas zu verdichten,
eine zweite CO_2-entfernende Vorrichtung (102), die mit dem Verdichter (101) verbunden ist, um die CO_2-Komponente in dem verdichteten Gas von dem Verdichter (101) zu entfernen,
einen Wärmeaustauscher (104) und einen Gasheizer (105), die mit der zweiten CO_2-entfernenden Vorrichtung (102) verbunden sind und zum Erwärmen von Gas, aus dem CO_2 entfernt wird und das von der zweiten CO_2-entfernenden Vorrichtung (102) abgeführt wird, und Herstellen von heißem reduzierenden Gas bereitgestellt sind,

einen Sauerstoffmischofen (106), der mit dem Gasheizer (105) verbunden ist, um dem heißen reduzierenden Gas Sauerstoff zuzuführen, und
einen zweiten Schmelz-Reduktionsofen (1), der mit dem Sauerstoffmischofen (106) verbunden ist und das Feinerz und die zusätzlichen Rohmaterialien reduziert und feuert, indem er das heiße reduzierende Gas zuführt.

12. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 11, wobei: der zweite Schmelz-Reduktionsofen (107) in mehreren Stufen von zwei Stufen oder drei Stufen oder mehr ausgelegt ist.

13. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 12,umfassend:
eine zweite Trockenstaubsammelvorrichtung (115), die mit dem hinteren Ende des Wärmetauschers (104) verbunden ist und von dem zweiten Schmelz-Reduktionsofen (107) abgeführt wird, um Streustaub in dem Abgas nach dem Durchlaufen des Wärmetauschers (104) zu trennen.

14. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 13, umfassend:
eine zweite Gaskühlvorrichtung (116), die mit dem hinteren Ende der zweiten Trockenstaubsammelvorrichtung (115) verbunden ist, um das Abgas zu kühlen.

15. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 14, umfassend:
ein Gasrohr, das mit dem hinteren Ende der zweiten Gaskühlvorrichtung (116) verbunden ist, um einen Teil des Abgases zu der zweiten CO_2-entfernenden Vorrichtung (102) zu zirkulieren.

16. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 15, umfassend:
ein letztes Abgasrohr, das mit dem hinteren Ende der zweiten Gaskühlvorrichtung (116) verbunden ist, um den Rest des Abgases nach Außen abzuführen.

17. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 16, umfassend:
ein Gasrohr, das die zweite CO_2-entfernende Vorrichtung (102) und das letzte Abgasrohr verbindet, um von der zweiten CO_2-entfernenden Vorrichtung (102) getrenntes CO_2 nach Außen abzuführen.

18. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 17, wobei:
der zweite Schmelz-Reduktionsofen (107) einen Speichertank für feines Reduktionsmittel (109) zum Speichern des feinen Reduktionsmittels, das von dem untersten Schmelz-Reduktionsofen durch das Rohr abgeführt wird, beinhaltet.

19. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 18, wobei:
der zweite Schmelz-Reduktionsofen (107) eine Transportvorrichtung für feines Reduktionsmittel (110) beinhaltet, die das feine Reduktionsmittel dem Schmelzreduktionsofen vom Eisenbadtyp (a) durch ein Transportrohr für feines Reduktionsmittel (110), das den Speichertank für feines Reduktionsmittel (109) und den Schmelzreduktionsofen vom Eisenbadtyp (a) verbindet, von dem Speichertank für feines Reduktionsmittel (109) zuführt.

20. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 19, wobei:
an dem unteren Ende der ersten Trockenstaubsammelvorrichtung (K) eine erste Transportvorrichtung (113) und ein erstes Transportrohr (114), das die erste Transportvorrichtung (113) und das Transportrohr für feines Reduktionsmittel (111) verbindet, bereitgestellt sind, um Stäube, die von der ersten Trockenstaubsammelvorrichtung (K) getrennt werden, dem Schmelzreduktionsofen vom Eisenbadtyp (a) zusammen mit dem von dem zweiten Schmelz-Reduktionsofen (107) abgeführten feinen Reduktionsmittel zuzuführen.

21. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 20, wobei:
an dem unteren Ende der zweiten Trockenstaubsammelvorrichtung (115) eine zweite Transportvorrichtung (117) und ein zweites Transportrohr (118), das die zweite Transportvorrichtung (117) und das Transportrohr für feines Reduktionsmittel (111) verbindet, bereitgestellt sind, um Stäube, die von der zweiten Trockenstaubsammelvorrichtung (115) getrennt werden, dem Schmelzreduktionsofen vom Eisenbadtyp (a) zusammen mit dem von dem zweiten Schmelz-Reduktionsofen (107) abgeführten feinen Reduktionsmittel zuzuführen.

22. Kombinierte Eisenschmelzeherstellungsvorrichtung nach Anspruch 21, wobei:
um erforderlichen Brennstoff zu dem Gasheizofen (105) und dem Heißwindofen (b) der zweiten Eisenschmelzeherstellungsvorrichtung zuzuführen, das Rohr ein Brenngaszuführrohr beinhaltet, das an einem vorderen Ende eines Punkts abgezweigt ist, an dem von der zweiten CO_2-entfernenden Vorrichtung (102) entferntes CO_2-enthal-

tendes Gas und von der zweiten Eisenschmelzeherstellungsvorrichtung abgeführtes Gas mit dem Heißwindofen (b) und dem Gasheizofen (105) kombiniert und verbunden werden.

Revendications

1. Appareil de fabrication de fonte liquide combinée comprenant :

un premier appareil de fabrication de fonte liquide incluant un premier four de réduction de fusion (A) constitué en étages multiples qui réduit un minerai fin pour convertir le minerai fin réduit en fer réduit fin,
une pluralité de dispositifs de compactage à chaud (B) qui fabrique le fer réduit fin émis par le premier four de réduction de fusion (A) en fer compacté réduit à chaud,
un dispositif d'acheminement (D) qui achemine le fer compacté réduit à chaud concassé avec une taille prédéterminée,
un dispositif de chargement en fer compacté (E) pour fournir continuellement le fer compacté réduit à chaud acheminé par le dispositif d'acheminement (D) à un fondoir-gazéifieur (G) et
un dispositif de chargement en charbon général compacté (F) pour fournir continuellement du charbon général compacté au fondoir-gazéifieur (G),
un fondoir-gazéifieur (G) qui fait fondre le fer compacté réduit à chaud fourni par le dispositif de chargement en fer compacté (E) en utilisant du gaz de combustion chaud généré par combustion du charbon général compacté fourni par le dispositif de chargement en charbon général compacté (F) et un matériau de charbon pulvérisé injecté depuis la portion inférieure avec de l'oxygène et fournit un gaz réducteur requis dans la réduction de minerai fin dans le premier four de réduction de fusion (A),
un dispositif d'élimination de CO_2 (M) qui élimine le CO_2 par bifurcation d'une partie du gaz d'échappement du premier four de réduction de fusion (A) puis fournit le gaz réducteur au premier four de réduction de fusion (A) en plus du gaz réducteur fourni par le fondoir-gazéifieur (G),
un dispositif de circulation de poussière (H) qui sépare la poussière incluse dans le gaz réducteur généré par le fondoir-gazéifieur (G) pour réinjecter la poussière dans le fondoir-gazéifieur (G),
un dispositif de régulation de pression (1) qui maintient uniformément la pression dans le fondoir-gazéifieur (G) par bifurcation et refroidissement de certains des gaz générés par le fondoir-gazéifieur (G) selon un changement de pression du fondoir-gazéifieur (G) puis évacuer certain des gaz vers une ligne de sous-produit gazeux,
un premier dispositif de récupération de chaleur sensible (J) qui récupère la chaleur sensible du gaz d'échappement évacué du premier four de réduction de fusion (A),
un premier dispositif de collecte de poussière sèche (K) qui sépare la poussière de diffusion incluse dans le gaz d'échappement évacué du premier four de réduction de fusion (A), et
un premier dispositif de refroidissement de gaz (L) qui refroidit le gaz d'échappement évacué du premier four de réduction de fusion (A) ;
un deuxième appareil de fabrication de fonte liquide incluant un four de réduction par fusion de type bain de fer (a) qui est adapté pour traiter un matériau contenant du fer fin et du charbon pulvérisé qui sont injectés dans la portion interne pour produire de la fonte liquide et des scories à travers des réactions telles qu'une dissolution, une combustion, et une réduction par fusion à l'intérieur, et qui est adapté pour évacuer la fonte liquide fabriqué et les scories vers l'extérieur, un haut fourneau chaud (b) qui fabrique du vent chaud qui est injecté dans le four de réduction par fusion (a) en tant qu'oxydant de combustion secondaire, et un dispositif de nettoyage (d) qui refroidit et nettoie le gaz évacué du four de réduction par fusion (a) ; et
un troisième appareil de fabrication de fonte liquide qui est ménagé entre le premier appareil de fabrication de fonte liquide et le deuxième appareil de fabrication de fonte liquide pour relier le premier appareil de fabrication de fonte liquide et le deuxième appareil de fabrication de fonte liquide, fait bifurquer une partie du gaz réducteur généré par le fondoir-gazéifieur (G) du premier appareil de fabrication de fonte liquide et fourni au premier four de réduction de fusion (A), et réduit un minerai fin à un niveau prédéterminé par utilisation du gaz réducteur bifurqué pour le fournir le minerai fin réduit en tant que source de fer du deuxième appareil de fabrication de fonte liquide, dans lequel :

le troisième appareil de fabrication de fonte liquide inclut un four de mélange d'oxygène (2) qui est ménagé sur un tuyau fournissant du gaz réducteur chaud au premier four de réduction de fusion (A) du premier appareil de fabrication de fonte liquide par le biais du dispositif de circulation de poussière (H) du premier appareil de fabrication de fonte liquide pour injecter de l'oxygène dans le gaz réducteur chaud, un tuyau qui est ménagé à l'arrière du four de mélange d'oxygène (2) pour faire bifurquer une partie du gaz réducteur, et un second four de réduction de fusion (1) qui est relié au tuyau, reçoit une partie du gaz réducteur bifurqué depuis le tuyau pour réduire un minerai fin, et convertit le minerai fin réduit en réducteur fin.

2. Appareil de fabrication de fonte liquide combinée selon la revendication 1, dans lequel : le second four de réduction de fusion (1) est configuré en étages multiples de deux étages ou trois étages ou plus.

3. Appareil de fabrication de fonte liquide combinée selon la revendication 2, comprenant : un second dispositif de récupération de chaleur sensible (3) qui est relié à l'extrémité arrière du second four de réduction de fusion (1) pour récupérer la chaleur sensible du gaz d'échappement évacué du second four de réduction de fusion (1).

4. Appareil de fabrication de fonte liquide combinée selon la revendication 3, comprenant : un second dispositif de collecte de poussière sèche (4) qui est relié à l'extrémité arrière du second dispositif de récupération de chaleur sensible (3) pour séparer la poussière de diffusion dans le gaz d'échappement.

5. Appareil de fabrication de fonte liquide combinée selon la revendication 4, comprenant : un second dispositif de refroidissement de gaz (5) qui est relié à l'extrémité arrière du second dispositif de collecte de poussière sèche (4) pour refroidir le gaz d'échappement.

6. Appareil de fabrication de fonte liquide combinée selon la revendication 5, dans lequel : le second four de réduction de fusion (1) inclut un réservoir de stockage de réducteur fin (20) qui est relié au second four de réduction de fusion (1) le plus bas pour stocker le réducteur fin évacué du second four de réduction de fusion (1) par le biais d'un tuyau.

7. Appareil de fabrication de fonte liquide combinée selon la revendication 6, dans lequel : le second four de réduction de fusion (1) inclut un dispositif de transport de réducteur fin (21) qui est relié à l'extrémité inférieure du réservoir de stockage de réducteur fin (20) pour injecter le réducteur fin dans le four de réduction par fusion de type bain de fer (a) par le biais d'un tuyau de transport de réducteur fin (10) reliant le réservoir de stockage de réducteur fin (20) et le four de réduction par fusion de type bain de fer (a) depuis le réservoir de stockage de réducteur fin (20).

8. Appareil de fabrication de fonte liquide combinée selon la revendication 7, dans lequel : à l'extrémité inférieure du premier dispositif de collecte de poussière sèche (K), un premier dispositif de transport (6) et un premier tuyau de transport (7) reliant le premier dispositif de transport (6) et le tuyau de transport de réducteur fin (10) sont ménagés pour injecter des poussières séparées du premier dispositif de collecte de poussière sèche (K) dans le four de réduction par fusion de type bain de fer (a) conjointement avec le réducteur fin évacué du second four de réduction de fusion (1).

9. Appareil de fabrication de fonte liquide combinée selon la revendication 8, dans lequel : à l'extrémité inférieure du second dispositif de collecte de poussière sèche (4), un second dispositif de transport (8) et un second tuyau de transport (9) reliant le second dispositif de transport (8) et le tuyau de transport de réducteur fin (10) sont ménagés pour injecter des poussières séparées du second dispositif de collecte de poussière sèche (4) dans le four de réduction par fusion de type bain de fer (a) du deuxième appareil de fabrication de fonte liquide conjointement avec le réducteur fin évacué du second four de réduction de fusion (1).

10. Appareil de fabrication de fonte liquide combinée selon la revendication 9, comprenant : un tuyau de fourniture de gaz de combustion de haut fourneau chaud qui est relié au haut fourneau chaud (b) par combinaison des gaz d'échappement du premier four de réduction de fusion (A) et du second four de réduction de fusion (1) du premier appareil de fabrication de fonte liquide puis bifurcation des gaz d'échappement au niveau de l'extrémité arrière de ligne bifurquée sur la ligne de sous-produit gazeux afin de fournir du combustible requis au haut fourneau chaud (b).

11. Appareil de fabrication de fonte liquide combinée comprenant :

un premier appareil de fabrication de fonte liquide incluant un premier four de réduction de fusion (A) constitué en étages multiples qui réduit du minerai fin pour convertir le minerai fin réduit en fer réduit fin,
une pluralité de dispositifs de compactage à chaud (B) qui fabrique le fer réduit fin émis par le premier four de réduction de fusion (A) en fer compacté réduit chaud,
un dispositif d'acheminement (D) qui achemine le fer compacté réduit chaud concassé avec une taille prédé-

terminée,
un dispositif de chargement en fer compacté (E) pour fournir continuellement le fer compacté réduit chaud acheminé par le dispositif d'acheminement (D) vers un fondoir-gazéifieur (G) et
un dispositif de chargement en charbon général compacté (F) pour fournir continuellement du charbon général compacté au fondoir-gazéifieur (G),
un fondoir-gazéifieur (G) qui fait fondre le fer compacté réduit chaud fourni par le dispositif de chargement en fer compacté (E) en utilisant du gaz de combustion chaud généré par combustion du charbon général compacté fourni par le dispositif de chargement en charbon général compacté (F) et un matériau de charbon pulvérisé injecté depuis la portion inférieure avec de l'oxygène et fournit du gaz réducteur requis dans une réduction de minerai fin dans le premier four de réduction de fusion (A),
un dispositif d'élimination de CO_2 (M) qui élimine le CO_2 par bifurcation d'une partie du gaz d'échappement du premier four de réduction de fusion (A) puis fournit le gaz réducteur au premier four de réduction de fusion (A) en plus du gaz réducteur fourni par le fondoir-gazéifieur (G),
un dispositif de circulation de poussière (H) qui sépare la poussière incluse dans le gaz réducteur généré par le fondoir-gazéifieur (G) pour réinjecter la poussière dans le fondoir-gazéifieur (G),
un dispositif de régulation de pression (1) qui maintient uniformément la pression dans le fondoir-gazéifieur (G) par bifurcation et refroidissement de certains des gaz générés par le fondoir-gazéifieur (G) selon un changement de pression du fondoir-gazéifieur (G) puis évacuer certain des gaz vers une ligne de sous-produit gazeux,
un premier dispositif de récupération de chaleur sensible (J) qui récupère la chaleur sensible du gaz d'échappement évacué du premier four de réduction de fusion (A), un premier dispositif de collecte de poussière sèche (K) qui sépare la poussière de diffusion incluse dans le gaz d'échappement évacué du premier four de réduction de fusion (A), et
un premier dispositif de refroidissement de gaz (L) qui refroidit le gaz d'échappement évacué du premier four de réduction de fusion (A) ;
un deuxième appareil de fabrication de fonte liquide incluant un four de réduction par fusion de type bain de fer (a) qui est adapté pour traiter un matériau contenant du fer fin et du charbon pulvérisé qui sont injectés dans la portion interne pour produire de la fonte liquide et des scories à travers des réactions telles qu'une dissolution, une combustion, et une réduction par fusion à l'intérieur, et qui est adapté pour évacuer la fonte liquide fabriqué et les scories vers l'extérieur,
un haut fourneau chaud (b) qui fabrique du vent chaud qui est injecté dans le four de réduction par fusion (a) en tant qu'oxydant de combustion secondaire, un second dispositif de récupération de chaleur sensible (c) pour récupérer la chaleur sensible du gaz d'échappement évacué du four de réduction par fusion (a) et
un dispositif de nettoyage (d) qui refroidit et nettoie le gaz évacué du four de réduction par fusion (a) ; et
un quatrième appareil de fabrication de fonte liquide qui est ménagé entre le premier appareil de fabrication de fonte liquide et le deuxième appareil de fabrication de fonte liquide pour relier le premier appareil de fabrication de fonte liquide et le deuxième appareil de fabrication de fonte liquide, extrait partiellement et élimine un composant de CO_2 inclus dans le sous-produit gazeux final du premier appareil de fabrication de fonte liquide, fabrique du gaz réducteur chaud en chauffant le composant de CO_2, puis réduit et fritte le minerai fin, des matières premières supplémentaires, et similaire à un niveau prédéterminé en utilisant le gaz réducteur pour fabriquer un réducteur fin et fournir le réducteur fin comme source de fer du deuxième appareil de fabrication de fonte liquide, dans lequel :

le quatrième appareil de fabrication de fonte liquide inclut un compresseur (101) qui est relié à un tuyau de sous-produit gazeux dans lequel du sous-produit gazeux généré par le premier appareil de fabrication de fonte liquide s'écoule pour comprimer le sous-produit gazeux,
un second dispositif d'élimination de CO_2 (102) qui est relié au compresseur (101) pour éliminer le composant de CO_2 dans le gaz comprimé du compresseur (101),
un échangeur de chaleur (104) et un chauffage de gaz (105) qui sont reliés au second dispositif d'élimination de CO_2 (102) et ménagé pour chauffer le gaz duquel le CO_2 est éliminé et qui est évacué du second dispositif d'élimination de CO_2 (102) et fabriquant du gaz réducteur chaud, un four de mélange d'oxygène (106) qui est relié au chauffage de gaz (105) pour injecter de l'oxygène dans le gaz réducteur chaud, et
un second four de réduction de fusion (1) qui est relié au four de mélange d'oxygène (106) et réduit et met à feu le minerai fin et les matières premières supplémentaires en fournissant le gaz réducteur chaud.

12. Appareil de fabrication de fonte liquide combinée selon la revendication 11, dans lequel :
le second four de réduction de fusion (107) est configuré en étages multiples de deux étages ou trois étages ou plus.

13. Appareil de fabrication de fonte liquide combinée selon la revendication 12, comprenant : un second dispositif de collecte de poussière sèche (115) qui est relié à l'extrémité arrière de l'échangeur de chaleur (104) et évacué du second four de réduction de fusion (107) pour séparer la poussière de diffusion dans le gaz d'échappement après passage à travers l'échangeur de chaleur (104).

14. Appareil de fabrication de fonte liquide combinée selon la revendication 13, comprenant :
un second dispositif de refroidissement de gaz (116) qui est relié à l'extrémité arrière du second dispositif de collecte de poussière sèche (115) pour refroidir le gaz d'échappement.

15. Appareil de fabrication de fonte liquide combinée selon la revendication 14, comprenant :
un tuyau de gaz qui est relié à l'extrémité arrière du second dispositif de refroidissement de gaz (116) pour faire circuler une partie du gaz d'échappement vers le second dispositif d'élimination de CO_2 (102).

16. Appareil de fabrication de fonte liquide combinée selon la revendication 15, comprenant :
un tuyau de gaz d'échappement final qui est relié à l'extrémité arrière du second dispositif de refroidissement de gaz (116) pour évacuer le reste du gaz d'échappement vers l'extérieur.

17. Appareil de fabrication de fonte liquide combinée selon la revendication 16, comprenant :
un tuyau de gaz qui relie le second dispositif d'élimination de CO_2 (102) et le tuyau de gaz d'échappement final pour évacuer le CO_2 séparé du second dispositif d'élimination de CO_2 (102) vers l'extérieur.

18. Appareil de fabrication de fonte liquide combinée selon la revendication 17, dans lequel :
le second four de réduction de fusion (107) inclut un réservoir de stockage de réducteur fin (109) destiné à stocker le réducteur fin évacué du four de réduction de fusion le plus bas à travers le tuyau.

19. Appareil de fabrication de fonte liquide combinée selon la revendication 18, dans lequel :
le second four de réduction de fusion (107) inclut un dispositif de transport de réducteur fin (110) qui injecte le réducteur fin dans le four de réduction par fusion de type bain de fer (a) par le biais d'un tuyau de transport de réducteur fin (110) reliant le réservoir de stockage de réducteur fin (109) et le four de réduction par fusion de type bain de fer (a) à partir du réservoir de stockage de réducteur fin (109).

20. Appareil de fabrication de fonte liquide combinée selon la revendication 19, dans lequel :
à l'extrémité inférieure du premier dispositif de collecte de poussière sèche (K), un premier dispositif de transport (113) et un premier tuyau de transport (114) reliant le premier dispositif de transport (113) et le tuyau de transport de réducteur fin (111) sont ménagés pour injecter des poussières séparées du premier dispositif de collecte de poussière sèche (K) dans le four de réduction par fusion de type bain de fer (a) conjointement avec le réducteur fin évacué du second four de réduction de fusion (107).

21. Appareil de fabrication de fonte liquide combinée selon la revendication 20, dans lequel :
à l'extrémité inférieure du second dispositif de collecte de poussière sèche (115), un second dispositif de transport (117) et un second tuyau de transport (118) reliant le second dispositif de transport (117) et le tuyau de transport de réducteur fin (111) sont ménagés pour injecter des poussières séparées du second dispositif de collecte de poussière sèche (115) dans le four de réduction par fusion de type bain de fer (a) conjointement avec le réducteur fin évacué du second four de réduction de fusion (107).

22. Appareil de fabrication de fonte liquide combinée selon la revendication 21, dans lequel :
afin de fournir du combustible requis au four de chauffage de gaz (105) et au haut fourneau chaud (b) du deuxième appareil de fabrication de fonte liquide, le tuyau inclut un tuyau de fourniture de combustible gazeux qui bifurque au niveau d'une extrémité avant d'un point où un gaz contenant du CO_2 éliminé du second dispositif d'élimination de CO_2 (102) et un gaz évacué du deuxième appareil de fabrication de fonte liquide sont combinés et reliés au haut fourneau chaud (b) et au four de chauffage de gaz (105).

【DRAWINGS】

FIG. 1

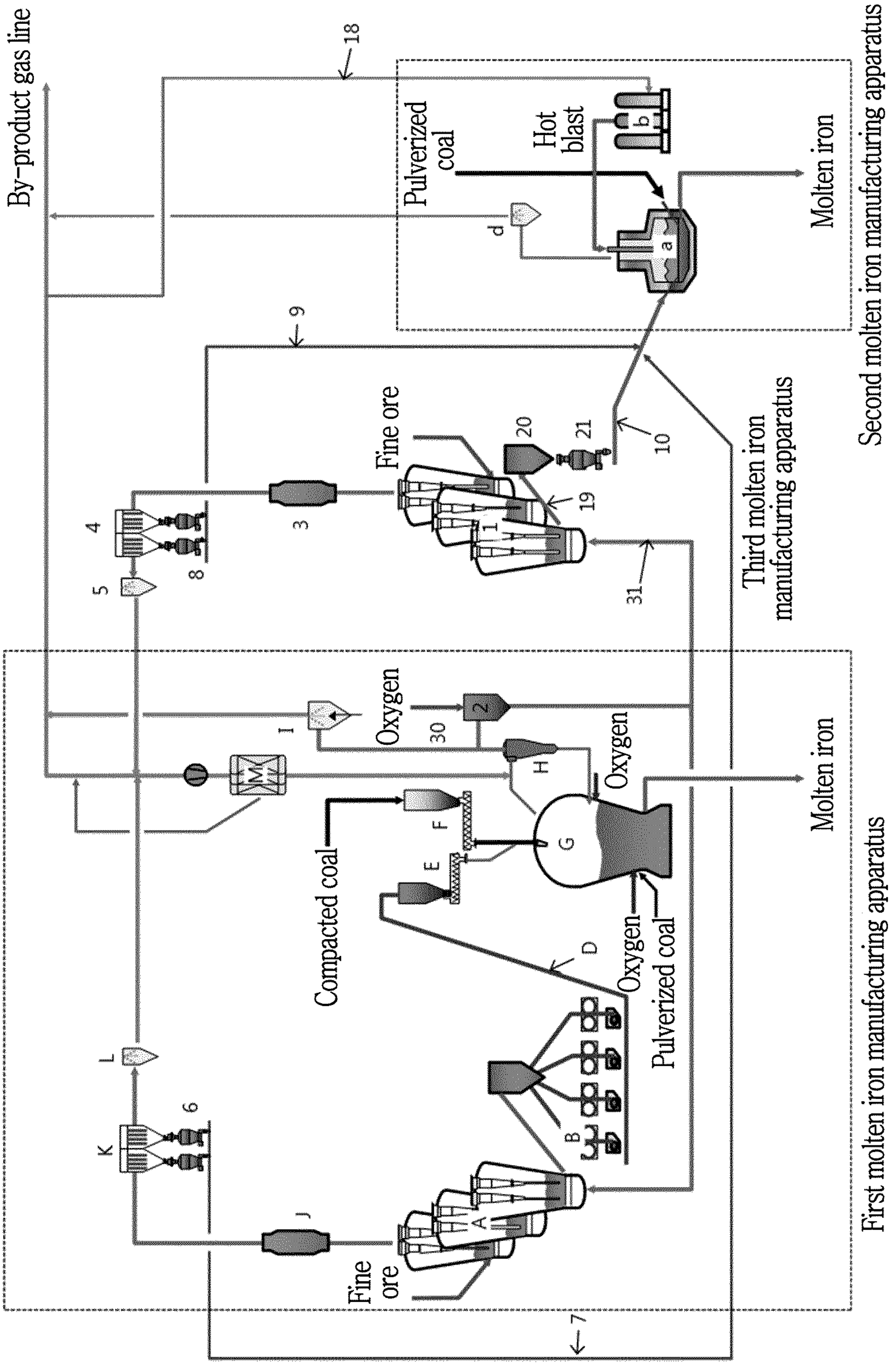

FIG. 2

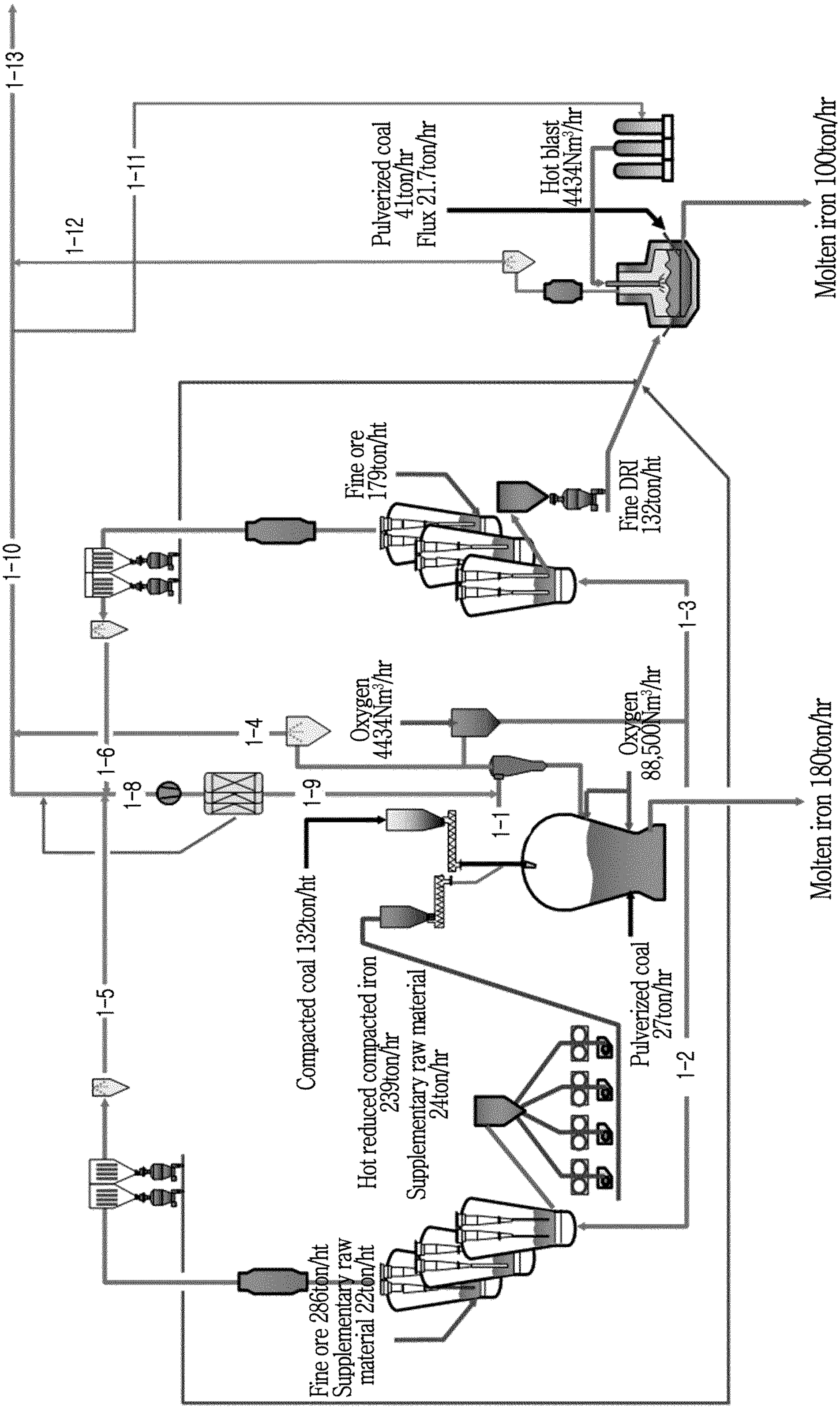
1-13
1-12
1-11
Pulverized coal
41ton/hr
Flux 21.7ton/hr
Hot blast
4434Nm^3/hr
Molten iron 100ton/hr
1-10
Fine ore
179ton/ht
Fine DRI
132ton/ht
1-3
1-6
1-4
Oxygen
4434Nm^3/hr
Oxygen
88,500Nm^3/hr
1-8
1-9
1-1
Molten iron 180ton/hr
Compacted coal 132ton/ht
Hot reduced compacted iron
239ton/hr
Supplementary raw material
24ton/hr
Pulverized coal
27ton/hr
1-5
1-2
Fine ore 286ton/ht
Supplementary raw
material 22ton/ht

FIG. 3

		Melter-gasifier generation gas(1-1)	First fluidized reduction furnace reducing gas(1-2)	Second fluidized reduction furnace reducing gas(1-3)	Pressure control gas(1-4)	First fluidized reduction furnace exhaust gas(1-5)	Second fluidized reduction furnace exhaust gas(1-6)
Flow rate(Nm^3/hr)		284685	338391	170523	15747	337652	171560
Temperature(℃)		1000	730	730	40	40	40
Pressure(bar.g)		4.30	4.10	4.10	0.15	0.70	0.70
Gas composition(%)	CO	63.78	55.78	55.78	54.72	38.24	36.64
	CO_2	8.29	7.62	7.62	5.59	25.96	26.37
	H_2	17.90	19.17	19.17	18.18	14.17	13.77
	H_2O	3.66	1.93	1.93	6.77	4.31	4.31
	CH_4	1.50	1.75	1.75	1.67	1.76	1.74
	N_2	4.87	13.75	13.75	13.08	15.55	17.16

		CO_2 supply gas(1-8)	CO_2 removing gas(1-9)	First exhaust gas(1-10)	Hot blast furnace fuel gas(1-11)	Melter-gasifier exhaust gas(1-12)	Total exhaust gas(1-13)
Flow rate(Nm^3/hr)		407369	239229	285730	53347	172075	404458
Temperature(℃)		40	40	40	40	40	40
Pressure(bar.g)		0.70	6.00	0.15	0.15	0.15	0.15
Gas composition(%)	CO	37.70	50.08	28.28	28.28	16.45	23.25
	CO_2	26.10	3.00	44.31	44.31	14.28	31.54
	H_2	14.04	20.56	8.81	8.81	0.66	5.34
	H_2O	4.31	0.00	8.05	8.05	6.35	7.33
	CH_4	1.75	2.06	1.49	1.49	0.00	0.86
	N_2	16.09	24.31	9.05	9.05	62.25	31.68

FIG. 4

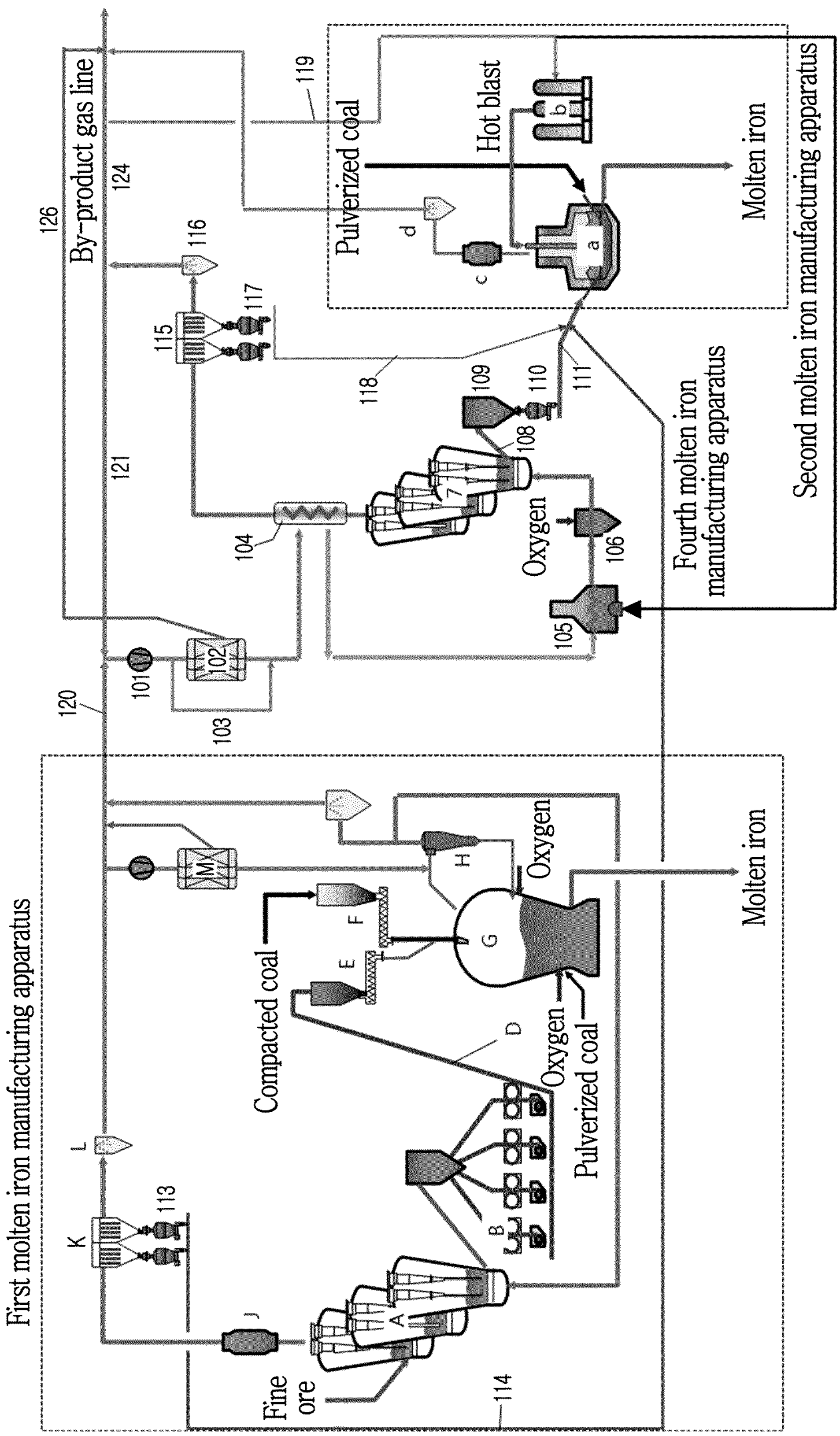
First molten iron manufacturing apparatus
Fine ore
A
B
J
K
113
L
114
D
E
F
G
H
M
Compacted coal
Oxygen
Pulverized coal
Oxygen
Molten iron
120
101
102
103
104
105
106
108
109
110
111
115
116
117
118
119
121
124
126
By-product gas line
Oxygen
Fourth molten iron manufacturing apparatus
Second molten iron manufacturing apparatus
Pulverized coal
Hot blast
Molten iron
a
b
c
d

FIG. 5

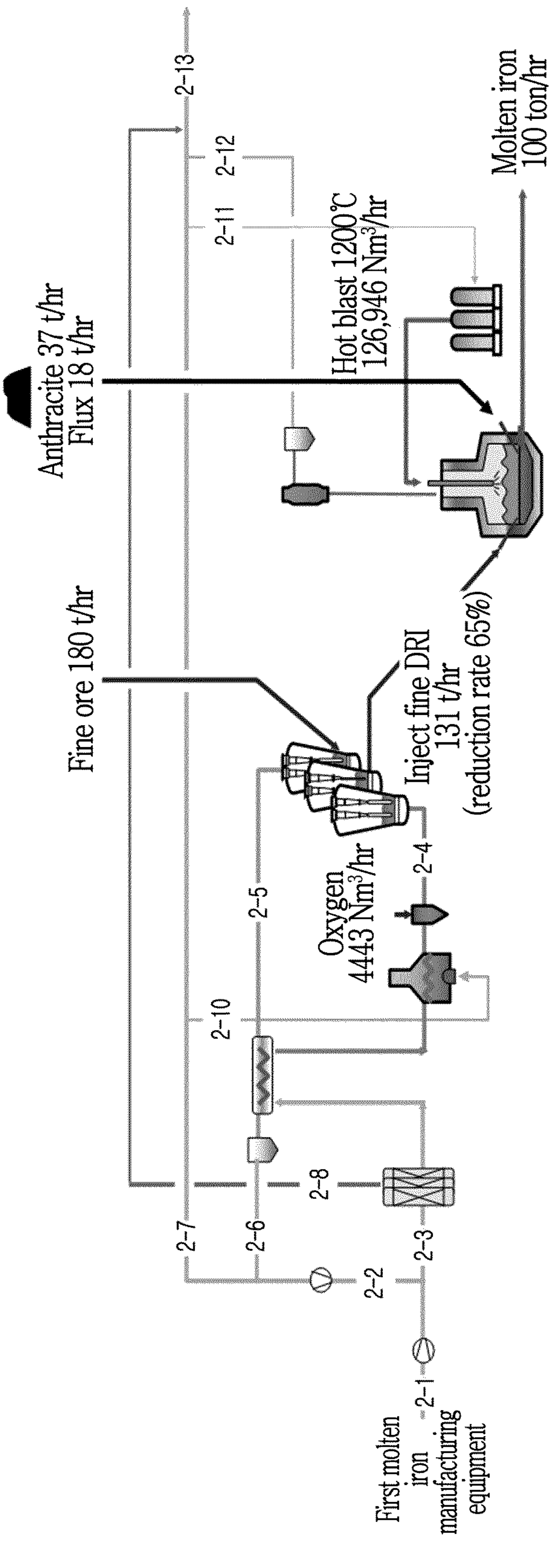
First molten iron manufacturing equipment
2-1
2-2
2-3
2-6
2-7
2-8
2-10
2-5
Oxygen 4443 Nm³/hr
2-4
Fine ore 180 t/hr
Inject fine DRI 131 t/hr (reduction rate 65%)
Anthracite 37 t/hr
Flux 18 t/hr
Hot blast 1200°C 126,946 Nm³/hr
2-11
2-12
2-13
Molten iron 100 ton/hr

FIG. 6

		Melter-gasifier generation gas(2-1)	Circulation gas(2-2)	CO_2 remover supply gas(2-3)	Second fluidized reduction furnace reducing gas(2-4)	Second fluidized reduction furnace exhaust gas(2-5)	Second fluidized reduction furnace cleaning exhaust gas(2-6)
Flow rate(Nm^3/hr)		333158	93250	426408	215754	255961	207223
Temperature(℃)		40	40	40	780	394	40
Pressure(bar.g)		0.15	6	6	6	4	3
Gas composition(%)	CO	30.60	35.34	31.64	47.61	28.61	35.34
	CO_2	44.10	19.99	38.83	5.54	16.18	19.99
	H_2	11.30	10.35	11.09	17.67	8.38	10.35
	H_2O	2.60	1.96	2.46	1.58	20.63	1.96
	CH_4	1.40	2.36	1.61	2.27	1.91	2.36
	N_2	10.10	29.99	14.45	25.33	24.28	29.99

		Second fluidized reduction furnace exhaust gas(2-7)	CO_2 remover separating gas(2-8)	Gas heater fuel gas(2-10)	Hot blast furnace fuel gas(2-11)	Melter-gasifier exhaust gas(2-12)	Total exhaust gas(2-13)
Flow rate(Nm^3/hr)		113972	210987	15348	35000	154713	429325
Temperature(℃)		40	40	40	40	40	40
Pressure(bar.g)		0	0	0	0	0	0
Gas composition(%)	CO	35.34	12.66	35.34	35.34	16.90	17.55
	CO_2	19.99	75.40	19.99	19.99	14.64	45.30
	H_2	10.35	2.73	10.35	10.35	0.69	3.12
	H_2O	1.96	4.97	1.96	1.96	2.95	3.80
	CH_4	2.36	0.94	2.36	2.36	0.00	0.81
	N_2	29.99	3.30	29.99	29.99	64.82	29.43

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1689892 A **[0006] [0007] [0016] [0021]**
- US 6332745 B1 **[0017] [0018] [0022]**
- US 6379422 B1 **[0017] [0018]**
- US 6602321 B1 **[0017] [0018]**
- WO 2005054520 A1 **[0026]**
- WO 2013100520 A1 **[0026]**
- US 2014042677 A1 **[0026]**
- US 2009320647 A1 **[0026]**
- CN 202279831 U **[0026]**