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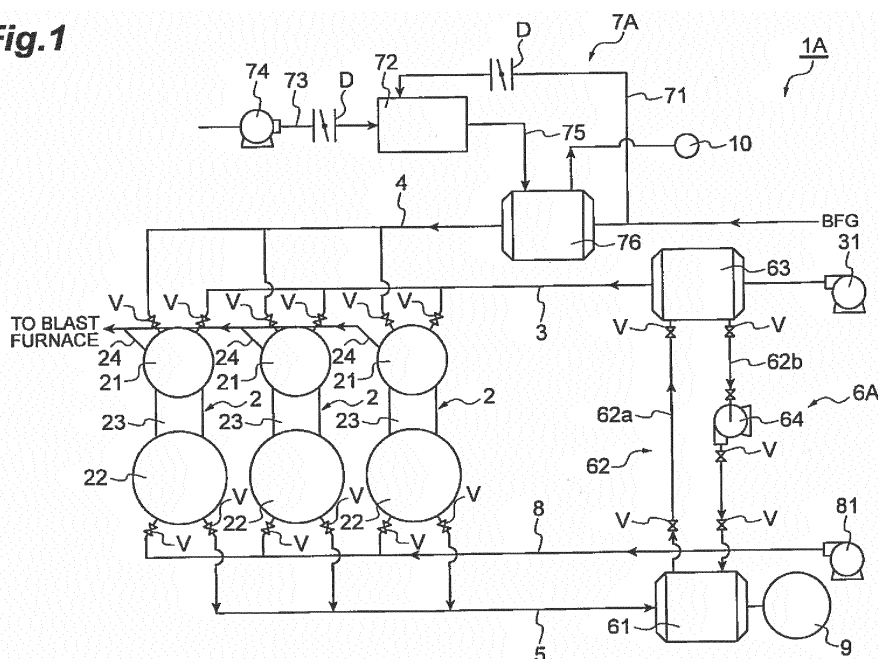
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(54) **HOT BLAST FURNACE FACILITY**

(57) There is provided a hot stove facility including: a hot stove; a combustion air pipe through which combustion air is fed to the hot stove; a fuel gas pipe through which blast furnace gas emitted from a blast furnace is fed to the hot stove, as fuel gas for the hot stove; a smoke pipe through which exhaust gas emitted from the hot stove is fed to a chimney; first preheating means that is

coupled to the smoke pipe to preheat one of the combustion air and the fuel gas by using heat recovered from the exhaust gas from the hot stove by heat exchange; and second preheating means that is provided with a first heater for burning a part of the blast furnace gas to preheat the other of the combustion air and the fuel gas by using heat generated by the first heater.

Fig.1



Description**Technical Field**

5 **[0001]** The present invention relates to a hot stove facility that heats air to be fed to a blast furnace.

Background Art

10 **[0002]** Heretofore, there has been known a hot stove facility that heats air (air for a blast furnace) to be fed to a blast furnace (refer to Patent Literature 1, for example). In a facility described in Patent Literature 1, air for a blast furnace is raised in pressure by a blower, and fed to a hot stove to be fed to a blast furnace after passing through the hot stove. A heat exchanger is coupled to piping connecting the blower and the hot stove to each other. The heat exchanger recovers heat from air raised in temperature due to pressure raised by the blower. Exhaust gas emitted from the hot stove is fed to a chimney. Another heat exchanger is also coupled to piping connecting the chimney and the hot stove to each other. This heat exchanger recovers heat from exhaust gas from the hot stove. In the facility described in Patent Literature 1, heat recovered by the heat exchanger described above preheats fuel gas and combustion air, to be supplied to the hot stove.

Citation List

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Patent Literature

[0003] [Patent Literature 1]
Japanese Unexamined Patent Publication No. H9-287013

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Summary of Invention**Technical Problem**

30 **[0004]** In a hot stove facility, such as described above, blast furnace gas (BFG) emitted from a blast furnace is sometimes supplied to a hot stove as fuel gas. The heat capacity of the blast furnace gas is relatively low, and thus if the heat capacity is insufficient, another fuel, such as liquefied petroleum gas (LPG), and coke oven gas (COG), is added to the blast furnace gas. The liquefied petroleum gas is relatively expensive, and the coke oven gas is also used in other facilities. Thus, it is preferable that the amount of another fuel to be added to the blast furnace gas is small.

35 **[0005]** In the facility described in Patent Literature 1, while heat recovered by the heat exchanger described above preheats fuel gas and combustion air to enable reducing an additive amount of another fuel, it is desired to develop a technology capable of further reducing the additive amount.

[0006] The present invention is made to solve this kind of problem, and it is an object to provide a hot stove facility capable of reducing the amount of another fuel to be added to blast furnace gas.

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Solution to Problem

45 **[0007]** A hot stove facility of one aspect of the present invention heats air for a blast furnace, and comprises: a hot stove that heats the air for a blast furnace; a combustion air pipe through which combustion air is fed to the hot stove; a fuel gas pipe through which blast furnace gas emitted from the blast furnace is fed to the hot stove as fuel gas for the hot stove; a smoke pipe through which exhaust gas emitted from the hot stove is fed to a chimney; first preheating means that is coupled to the smoke pipe, as well as to one of the combustion air pipe and the fuel gas pipe, to preheat one of the combustion air and the blast furnace gas by using heat recovered from the exhaust gas from the hot stove by heat exchange; and second preheating means that is provided with a first heater for burning a part of the blast furnace gas, and that is coupled to the other of the combustion air pipe and the fuel gas pipe to preheat the other of the combustion air and the blast furnace gas by using heat generated by the first heater.

50 **[0008]** In the hot stove facility of one aspect of the present invention, one of the combustion air and the blast furnace gas is preheated by heat recovered from the exhaust gas from the hot stove, and further the other of the combustion air and the blast furnace gas is preheated by heat generated by burning a part of the blast furnace gas. Using combustion heat generated by burning the blast furnace gas enables heating the combustion air or the blast furnace gas to a relatively high temperature. Thus, it is possible to reduce the amount of another fuel to be added to the blast furnace gas.

55 **[0009]** The first preheating means may include: a first heat exchanger coupled to the smoke pipe; a second heat exchanger coupled to the one pipe of the combustion air pipe and the fuel gas pipe; a heat medium pipe that connects

the first heat exchanger and the second heat exchanger to each other so that a liquid heat medium from which heat is recovered in the first heat exchanger is fed to the second heat exchanger through the heat medium pipe; and a second heater that is coupled to the heat medium pipe to heat the liquid heat medium by using heat generated by burning a part of the blast furnace gas. In this case, one of the combustion air and the blast furnace gas is heated not only by heat recovered from the exhaust gas from the hot stove, but also by heat generated by burning a part of the blast furnace gas. As described above, using the combustion heat generated by burning the blast furnace gas enables heating the combustion air or the fuel gas to a relatively high temperature. Thus, it is possible to reduce the amount of another fuel to be added to the blast furnace gas.

[0010] The first preheating means may be a heat exchanger of a heat pipe type that includes a high temperature section coupled to the smoke pipe, and a low temperature section coupled to the one pipe of the combustion air pipe and the fuel gas pipe, to feed a medium evaporated in the high temperature section to the low temperature section, as well as to feed the medium condensed in the low temperature section to the high temperature section. Using a heat exchanger of a heat pipe type does not need piping, and the like, for feeding a heat medium, and thus a facility can be simplified as compared with a case of circulating a liquid heat medium to exchange heat.

[0011] The second preheating means may include a third heat exchanger coupled to the other pipe of the combustion air pipe and the fuel gas pipe, and a heating gas pipe that connects the first heater and the third heat exchanger to each other so that gas generated by burning a part of the blast furnace gas in the first heater is fed to the third heat exchanger through the heating gas pipe. This configuration allows heat exchange between gas generated in the first heater, and combustion air or blast furnace gas, in the third heat exchanger. This case allows combustion air or blast furnace gas to be preheated to high temperature, as compared with a case of using a heat medium, such as petroleum hydrocarbon, for heat exchange, for example.

Advantageous Effects of Invention

[0012] The present invention enables providing a hot stove facility capable of reducing the amount of another fuel to be added to blast furnace gas.

Brief Description of Drawings

[0013]

[Figure 1] Figure 1 is a configuration diagram showing a hot stove facility in accordance with a first embodiment.
 [Figure 2] Figure 2 is a configuration diagram showing a hot stove facility in accordance with a second embodiment.
 [Figure 3] Figure 3 is a configuration diagram showing a hot stove facility in accordance with a third embodiment.
 [Figure 4] Figure 4 is a configuration diagram showing a hot stove facility in accordance with a fourth embodiment.
 [Figure 5] Figure 5 is a configuration diagram showing a hot stove facility in accordance with a fifth embodiment.
 [Figure 6] Figure 6 is a configuration diagram showing a hot stove facility in accordance with a comparative example.

Description of Embodiments

[0014] Embodiments will be described below in detail with reference to the accompanying drawings. In description of the drawings, the same or equivalent element is designated by the same reference numeral to avoid duplicated description of the element.

[First Embodiment]

[0015] Figure 1 is a configuration diagram showing a hot stove facility in accordance with a first embodiment. A hot stove facility 1A heats air (air for a blast furnace) to be fed to a blast furnace (not shown). The hot stove facility 1A comprises a plurality of hot stoves 2 (here three hot stoves), a combustion air pipe 3, a fuel gas pipe 4, a smoke pipe 5, a first preheating means 6A, second preheating means 7A, and an air pipe 8 for a blast furnace.

[0016] The hot stove 2 heats air for a blast furnace. The hot stove 2 includes a combustion chamber 21, a checker chamber 22, and a connecting pipe 23. The combustion chamber 21 is adapted to burn fuel gas. The combustion chamber 21 connects with the combustion air pipe 3 and the fuel gas pipe 4. The checker chamber 22 is adapted to recover heat from exhaust gas generated in the combustion chamber 21 to accumulate the heat. The checker chamber 22 connects with the combustion chamber 21 through the connecting pipe 23 to allow the exhaust gas generated in the combustion chamber 21 to be guided into the checker chamber 22 from the connecting pipe 23. The hot stove 2 is provided with piping 24 through which air for a blast furnace is fed to the blast furnace. Combustion temperature in the hot stove 2 is about 1450°C, for example.

[0017] The combustion air pipe 3 is adapted to feed combustion air to each of the hot stoves 2 through the combustion air pipe 3. A combustion air blower 31 for blowing combustion air is connected to the combustion air pipe 3. The combustion air pipe 3 branches into a plurality of pipes (here three pipes) corresponding to the number of the hot stoves 2. Each of the pipes branching from the combustion air pipe 3 is connected to the combustion chamber 21 so that air blown from the combustion air blower 31 is fed to the combustion chamber 21 as combustion air through each of the pipes. Each of the pipes branching from the combustion air pipe 3 is provided with a valve V. Temperature of combustion air guided into the combustion air pipe 3 from the combustion air blower 31 (temperature of the combustion air before preheating) is different depending on a region, and is about 10°C to 50°C, for example.

[0018] The fuel gas pipe 4 is adapted to feed blast furnace gas (BFG) emitted from the blast furnace to each of the hot stoves 2 through the fuel gas pipe 4, as fuel gas. The fuel gas pipe 4 is connected to the blast furnace. The fuel gas pipe 4 branches into a plurality of pipes (here three pipes) corresponding to the number of the hot stoves 2. Each of the pipes branching from the fuel gas pipe 4 is connected to the combustion chamber 21 so that the blast furnace gas is fed to the combustion chamber 21 through each of the pipes. Each of the pipes branching from the fuel gas pipe 4 is provided with the valve V.

[0019] The heat capacity of the blast furnace gas is about 2.93 MJ/m³ to 3.56 MJ/m³, for example. Temperature of the blast furnace gas guided into the fuel gas pipe 4 from the blast furnace (temperature of the blast furnace gas before preheating) is about 10°C to 50°C, for example. In the present invention, the heat capacity is a higher heating value.

[0020] The smoke pipe 5 is adapted to feed exhaust gas emitted from the hot stove 2 to the chimney 9 through the smoke pipe 5. The smoke pipe 5 is connected to the chimney 9. The smoke pipe 5 branches into a plurality of pipes (here three pipes) corresponding to the number of the hot stoves 2, which is connected to the corresponding checker chamber 22. Each of the pipes branching from the smoke pipe 5 is provided with the valve V.

[0021] The first preheating means 6A preheats combustion air by using heat recovered from exhaust gas from the hot stove 2 by heat exchange. The first preheating means 6A includes a first heat exchanger 61, a heat medium pipe 62, a second heat exchanger 63, and a pump 64.

[0022] The first heat exchanger 61 is coupled to the smoke pipe 5. The second heat exchanger 63 is coupled to the combustion air pipe 3. The heat medium pipe 62 connects the first heat exchanger 61 and the second heat exchanger 63 to each other so that a liquid heat medium (such as petroleum hydrocarbon) is circulated between the first heat exchanger 61 and the second heat exchanger 63. The heat medium pipe 62 includes an outward-path heat medium pipe 62a through which the heat medium is fed to the second heat exchanger 63 from the first heat exchanger 61, and a return-path heat medium pipe 62b through which the heat medium is fed to the first heat exchanger 61 from the second heat exchanger 63. The pump 64 pumps the heat medium. The pump 64 is coupled to the return-path heat medium pipe 62b.

[0023] The outward-path heat medium pipe 62a is provided with the valve V at a position between the first heat exchanger 61 and the second heat exchanger 63. The return-path heat medium pipe 62b is provided with a plurality of valves V and V at respective positions between the first heat exchanger 61 and the pump 64. The return-path heat medium pipe 62b is also provided with a plurality of valves V and V at respective positions between the pump 64 and the second heat exchanger 63.

[0024] In the first heat exchanger 61, heat is exchanged between exhaust gas from the hot stove 2, flowing through the smoke pipe 5, and the heat medium flowing through the heat medium pipe 62. Accordingly, the heat of the exhaust gas from the hot stove 2, flowing through the smoke pipe 5, is recovered by the heat medium flowing through the medium pipe 62. In the second heat exchanger 63, heat is exchanged between the heat medium flowing through the heat medium pipe 62, and combustion air flowing through the combustion air pipe 3, to preheat the combustion air flowing through the combustion air pipe 3 by using heat of the heat medium flowing through the heat medium pipe 62 (heat recovered from the exhaust gas from the hot stove 2).

[0025] The second preheating means 7A preheats blast furnace gas by using heat generated by burning a part of the blast furnace gas (combustion heat). The second preheating means 7A includes a fuel gas distribution pipe 71, a burner (first heater) 72, an air pipe 73 for a burner, an air blower 74 for a burner, a heating gas pipe 75, and a third heat exchanger 76.

[0026] The fuel gas distribution pipe 71 branches from the fuel gas pipe 4. The fuel gas distribution pipe 71 is connected to the burner 72. The fuel gas distribution pipe 71 feeds a part of blast furnace gas flowing through the fuel gas pipe 4 to the burner 72. The fuel gas distribution pipe 71 is provided with a flow control damper D. The burner 72 burns blast furnace gas fed through the fuel gas distribution pipe 71.

[0027] The air pipe 73 for a burner connects the burner 72 and the air blower 74 for a burner to each other. The air blower 74 for a burner blows combustion air for the burner 72. The air pipe 73 for a burner is adapted to feed air blown from the air blower 74 for a burner to the burner 72 through the air pipe 73. The air pipe 73 for a burner is provided with the flow control damper D. The heating gas pipe 75 connects the burner 72 and the third heat exchanger 76 to each other. Accordingly, the heating gas pipe 75 is adapted to feed exhaust gas generated by burning blast furnace gas in the burner 72 to the third heat exchanger 76 through the heating gas pipe 75.

[0028] The third heat exchanger 76 is coupled to the fuel gas pipe 4. In the third heat exchanger 76, heat is exchanged between exhaust gas from the burner 72, and blast furnace gas flowing through the fuel gas pipe 4. The blast furnace gas flowing through the fuel gas pipe 4 is preheated by using heat of the exhaust gas from the burner 72 (combustion heat generated by burning a part of the blast furnace gas). The third heat exchanger 76 is connected to a chimney 10 to feed the exhaust gas from the burner 72 used in the heat exchange to the chimney 10.

[0029] The air pipe 8 for a blast furnace is adapted to feed air for a blast furnace to the hot stove 2 through the air pipe 8. The air pipe 8 for a blast furnace is connected to a blower 81 for a blast furnace. The air pipe 8 for a blast furnace branches into a plurality of pipes (here three pipes) corresponding to the number of the hot stoves 2, which is connected to the corresponding checker chamber 22. Each of the pipes branching from the air pipe 8 for a blast furnace is provided with the valve V. The air pipe 8 for a blast furnace is adapted to feed air blown from the blower 81 for a blast furnace to each checker chamber 22 through the air pipe 8, as air for a blast furnace.

[0030] In the hot stove facility 1A as described above, for example, a part (two hot stoves 2, for example) of the plurality of hot stoves 2 accumulates heat, and the rest (one hot stove 2, for example) of the hot blast furnaces 2 heats air for a blast furnace.

[0031] Specifically, in the hot stove 2 where heat is accumulated, combustion air is guided into the combustion chamber 21 through the combustion air pipe 3, and blast furnace gas is also guided into the combustion chamber 21 through the fuel gas pipe 4 to be burned. Exhaust gas generated in the combustion chamber 21 is guided into the checker chamber 22 through the connecting pipe 23, and then heat of the exhaust gas is recovered in the checker chamber 22. The exhaust gas passing through the checker chamber 22 is fed to the chimney 9 through the smoke pipe 5.

[0032] In this case, in the first preheating means 6A, the first heat exchanger 61 exchanges heat between exhaust gas from the hot stove 2 and a heat medium. Accordingly, heat of the exhaust gas from the hot stove 2 is recovered. Then, the second heat exchanger 63 exchanges heat between the heat medium and the combustion air. Accordingly, the combustion air is preheated. Then, the preheated combustion air is guided into the combustion chamber 21.

[0033] In the second preheating means 7A, the burner 72 burns blast furnace gas fed through the fuel gas distribution pipe 71. The third heat exchanger 76 exchanges heat between exhaust gas from the burner 72 and the blast furnace gas. In this way, the blast furnace gas is preheated. Then, the preheated blast furnace gas is guided into the combustion chamber 21.

[0034] If the heat capacity of blast furnace gas is about 3.56 MJ/m^3 , for example, and the combustion air, as well as the blast furnace gas, is preheated to 70°C or more, no another fuel may be added to the blast furnace gas. That is, burning only BFG (solely BFG operation) enables a hot stove facility to be operated. If the heat capacity of the blast furnace gas is about 2.93 MJ/m^3 , for example, and the combustion air, as well as the blast furnace gas, is preheated to 355°C or more, no another fuel may be added to the blast furnace gas. In this way, it is thought that optimum design is performed in accordance with the heat capacity of blast furnace gas.

[0035] In the hot stove 2 where air for a blast furnace is heated, the air for a blast furnace is guided into the checker chamber 22 through the air pipe 8 for a blast furnace. Then, the air for a blast furnace heated by using heat accumulated in the checker chamber 22 is fed to a blast furnace through the piping 24. If the amount of accumulated heat in the hot stove 2 where the air for a blast furnace is heated decreases to a predetermined amount or less, the hot stove 2 where the air for a blast furnace is heated, and the hot stove 2 where heat is accumulated, are switched.

[0036] As above, in the hot stove facility 1A of the present embodiment, combustion air is preheated by using heat recovered from exhaust gas from the hot stove 2, and further blast furnace gas is preheated by using combustion heat generated by burning a part of the blast furnace gas. Using the combustion heat generated by burning the blast furnace gas enables heating the blast furnace gas to a relatively high temperature. Thus, it is possible to reduce the amount of another fuel to be added to the blast furnace gas. That is, it is possible to reduce consumption of fuel different from the blast furnace gas.

[0037] As described above, a heat medium in the first preheating means 6A is petroleum hydrocarbon or the like, for example, and thus if heated too much, the heat medium may be changed in viscosity or the like due to change in properties. For this reason, it is preferable that the heat medium in the first preheating means 6A is used at a predetermined temperature or less. Thus, in the case of preheating means for preheating both of combustion air and blast furnace gas, for example, the combustion air and the blast furnace gas can be preheated to only a relatively low temperature.

[0038] In contrast, the present embodiment comprises the first preheating means 6A for preheating combustion air, and the second preheating means 7A for preheating blast furnace gas. The second preheating means 7A includes the third heat exchanger 76 coupled to the fuel gas pipe 4, and the heating gas pipe 75 that connects the burner 72 and the third heat exchanger 76 to each other so that gas generated by burning a part of the blast furnace gas in the burner 72 is fed to the third heat exchanger 76 through the heating gas pipe 75. The second preheating means 7A of the present embodiment preheats blast furnace gas by exchanging heat between exhaust gas generated in the burner 72 and the blast furnace gas, without using a heat medium, such as petroleum hydrocarbon. Accordingly, the blast furnace gas can be preheated to a high temperature, as compared with the case of using the heat medium, such as petroleum hydrocarbon.

[Second Embodiment]

[0039] A hot stove facility of a second embodiment will be described. Figure 2 is a configuration diagram showing the hot stove facility in accordance with the second embodiment. A hot stove facility 1B in accordance with the present embodiment is different from the hot stove facility 1A in accordance with the first embodiment (refer to Figure 1) in that blast furnace gas is preheated instead of combustion air in first preheating means 6B, and in that the combustion air is preheated instead of the blast furnace gas in second preheating means 7B.

[0040] Specifically, in the hot stove facility 1B, the second heat exchanger 63 in the first preheating means 6B is coupled to the fuel gas pipe 4 instead of the combustion air pipe 3. The third heat exchanger 76 in the second preheating means 7B is coupled to the combustion air pipe 3 instead of the fuel gas pipe 4.

[0041] In the hot stove facility 1B, the second heat exchanger 63 in the first preheating means 6B exchanges heat between a heat medium and blast furnace gas to preheat the blast furnace gas. In addition, the third heat exchanger 76 in the second preheating means 7B exchanges heat between exhaust gas generated in the burner 72 and combustion air to preheat the combustion air.

[0042] In the hot stove facility 1B of the present embodiment, blast furnace gas is preheated by using heat recovered from exhaust gas from the hot stove 2. In addition, combustion air is preheated by using combustion heat generated by burning a part of the blast furnace gas. Using the combustion heat generated by burning the blast furnace gas enables heating the combustion air to a relatively high temperature. Thus, it is possible to reduce the amount of another fuel to be added to the blast furnace gas. That is, it is possible to reduce consumption of fuel different from the blast furnace gas.

[0043] The second preheating means 7B exchanges heat between exhaust gas from the burner 72 and combustion air to preheat the combustion air, without using a heat medium, such as petroleum hydrocarbon. Accordingly, the combustion air can be preheated to a high temperature, as compared with the case of using the heat medium, such as petroleum hydrocarbon.

[Third Embodiment]

[0044] A hot stove facility of a third embodiment will be described. Figure 3 is a configuration diagram showing the hot stove facility in accordance with the third embodiment. A hot stove facility 1C in accordance with the present embodiment is different from the hot stove facility 1A in accordance with the first embodiment (refer to Figure 1) in that first preheating means 6C includes a second heater 65.

[0045] Specifically, the second heater 65 heats a heat medium by using combustion heat generated by burning a part of blast furnace gas. The second heater 65 is coupled to the outward-path heat medium pipe 62a. The second heater 65 includes a burner 65a, and a heat exchange section 65b.

[0046] In the burner 65a, a part of the blast furnace gas as well as combustion air is guided, and the blast furnace gas is burned. In the heat exchange section 65b, heat is exchanged between gas heated by the burner 65a, and a heat medium fed from the first heat exchanger 61. In this way, the heat medium is heated by using heat of the gas heated by the burner 65a. Then, the heat medium heated is fed to the second heat exchanger 63.

[0047] In the outward-path heat medium pipe 62a, a pump 66 may be coupled upstream of the second heater 65.

[0048] The hot stove facility 1C of the present embodiment has the same effect as that of the hot stove facility 1A in accordance with the first embodiment. In addition, in the hot stove facility 1C, combustion air is heated by using not only heat recovered from exhaust gas from the hot stove 2, but also combustion heat generated by burning a part of blast furnace gas. Thus, the combustion air can be heated to a relatively high temperature so that the amount of another fuel to be added to the blast furnace gas can be reduced. That is, it is possible to reduce consumption of fuel different from the blast furnace gas.

[Fourth Embodiment]

[0049] A hot stove facility of a fourth embodiment will be described. Figure 4 is a configuration diagram showing the hot stove facility in accordance with the fourth embodiment. A hot stove facility 1D in accordance with the present embodiment is different from the hot stove facility 1B in accordance with the second embodiment (refer to Figure 2) in that first preheating means 6D includes the second heater 65. Structure of the second heater 65 is the same as that of the third embodiment (refer to Figure 3).

[0050] The hot stove facility 1D of the present embodiment has the same effect as that of the hot stove facility 1B in accordance with the second embodiment. In addition, in the hot stove facility 1D, blast furnace gas is heated by using not only heat recovered from exhaust gas from the hot stove 2, but also combustion heat generated by burning a part of the blast furnace gas. Thus, the blast furnace gas can be heated to a relatively high temperature so that the amount of another fuel to be added to the blast furnace gas can be reduced. That is, it is possible to reduce consumption of fuel different from the blast furnace gas.

[Fifth Embodiment]

[0051] A hot stove facility of a fifth embodiment will be described. Figure 5 is a configuration diagram showing the hot stove facility in accordance with the fifth embodiment. A hot stove facility 1E in accordance with the present embodiment is different from the hot stove facility 1A in accordance with the first embodiment (refer to Figure 1) in that first preheating means 6E is a heat exchanger of a heat pipe type.

[0052] Specifically, the first preheating means 6E includes a high temperature section 67, and a low temperature section 68. The high temperature section 67 is coupled to the smoke pipe 5. The low temperature section 68 is coupled to the combustion air pipe 3. Between the high temperature section 67 and the low temperature section 68, a volatile medium is circulated.

[0053] In the high temperature section 67, heat is exchanged between exhaust gas from the hot stove 2, and a liquid medium, and then the medium is evaporated by using heat of the exhaust gas from the hot stove 2. The medium evaporated is fed to the low temperature section 68. In the low temperature section 68, heat is exchanged between a gaseous medium and combustion air, and then the combustion air is preheated by using heat of the gaseous medium. The medium, from which heat is removed, is condensed, and is fed to the high temperature section 67.

[0054] In the hot stove facility 1E of the present embodiment, combustion air is preheated by using heat recovered from exhaust gas from the hot stove 2, and further blast furnace gas is preheated by using combustion heat generated by burning a part of the blast furnace gas. Thus, the blast furnace gas is heated to a relatively high temperature so that the amount of another fuel to be added to the blast furnace gas can be reduced.

[0055] The first preheating means 6E is a heat exchanger of a heat pipe type, which includes the high temperature section 67 provided in the smoke pipe 5, and the low temperature section 68 provided in the combustion air pipe 3, to feed the medium evaporated in the high temperature section 67 to the low temperature section 68, as well as the medium condensed in the low temperature section 68 to the high temperature section 67. In the first preheating means 6E, piping and the like for feeding a heat medium are unnecessary, and thus a facility can be simplified as compared with a case of circulating a liquid heat medium to exchange heat.

[0056] Although the embodiments are described above, the present invention is not always limited to the embodiments described above, and various modifications are possible within a range without departing from the essence of the present invention.

[0057] Structure, quantity, material, and the like, of each element are not limited to the structure, quantity, material, and the like, of the embodiments described above, and thus can be appropriately changed.

Examples

[0058] Although contents of the present invention will be described in detail with reference to examples and a comparative example, the present invention is not limited to the examples below.

[Evaluation Calculation]

[0059] Various temperatures were calculated with respect to the hot stove facilities 1A to 1D above, shown in Figures 1 to 4, respectively, on the basis of a precondition similar to actual operation data (Examples 1 to 4). In addition, various temperatures were calculated with respect to a hot stove facility 100 in accordance with a comparative example shown in Figure 6 (comparative example).

[0060] As shown in Figure 6, the hot stove facility 100 in accordance with the comparative example includes no preheating means (second preheating means, and a second heater) using combustion of blast furnace gas. In the hot stove facility 100, a fourth heat exchanger 69 included in first preheating means 60 is provided in the fuel gas pipe 4. The fourth heat exchanger 69 is connected to a pipe branching from the outward-path heat medium pipe 62a, and a pipe branching from the return-path heat medium pipe 62b. In the hot stove facility 100, both of combustion air and blast furnace gas are preheated by the first preheating means 60.

[0061] In each of the examples, the precondition was as follows. In the comparative example, since combustion temperature required in a hot stove could not be acquired by using only blast furnace gas, coke oven gas (COG) was added to the blast furnace gas (details will be described later). Calculation results are shown in Table 1, where Temperature of combustion air before preheating was 20°C;

Temperature of blast furnace gas before preheating was 40°C; Combustion temperature in a hot stove was 1450°C;

Temperature of exhaust gas from the hot stove before passing through a first heat exchanger was 250°C;

Temperature of the exhaust gas from the hot stove after passing through the first heat exchanger was 150°C;

Temperature of a heat medium of first preheating means before passing through the first heat exchanger was 100°C;

Temperature of the heat medium of the first preheating means after passing through the first heat exchanger was 200°C;

Temperature of the heat medium of the first preheating means after passing through a second heater was 300°C (only

in Examples 3 and 4); The heat capacity of the blast furnace gas was 2.96 MJ/m³; and The heat capacity of coke oven gas was 16.72 MJ/m³ (only in the comparative example).

[Table 1]

	Comparative example	Example 1 (Figure 1)	Example 2 (Figure 2)	Example 3 (Figure 3)	Example 4 (Figure 4)
Temperature of combustion air after preheating (°C)	125	200	560	250	480
Temperature of blast furnace gas after preheating (°C)	125	410	200	385	250
COG Additive amount (%)	8.0	-	-	-	-

[0062] As shown in Table 1, in Examples 1 to 4, preheating at least one of combustion air and blast furnace gas by using combustion heat, generated by burning a part of blast furnace gas, enabled preheating both of the combustion air and the blast furnace gas to high temperature as compared with the comparative example.

[0063] The heat medium of the first preheating means is petroleum hydrocarbon, or the like, for example, as described above, and thus if heated too much, the heat medium may be changed in viscosity or the like due to change in properties. Thus, the heat medium of the first preheating means was used at 300°C or less. As a result, in the comparative example in which the first preheating means preheated both of combustion air and blast furnace gas, temperature of the combustion air and the blast furnace gas, after preheating, was low as compared with Examples 1 to 4. For this reason, in the comparative example, the coke oven gas with the amount of heat higher than that of the blast furnace gas needed to be added to the blast furnace gas to acquire the combustion temperature (1450°C) required at the hot stove.

Industrial Applicability

[0064] According to the present invention, it is possible to provide a hot stove facility capable of reducing the amount of another fuel to be added to blast furnace gas.

Reference Signs List

[0065] 1A to 1E ... hot stove facility, 2 ... hot stove, 3 ... combustion air pipe, 4 ... fuel gas pipe, 5 ... smoke pipe, 6A to 6E ... first preheating means, 7A, 7B ... second preheating means, 9 ... chimney, 61 ... first heat exchanger, 62 ... heat medium pipe, 63 ... second heat exchanger, 65 ... second heater, 67 ... high temperature section, 68 ... low temperature section, 72 ... burner (first heater), 75 ... heating gas pipe, 76 ... third heat exchanger.

Claims

1. A hot stove facility that heats air for a blast furnace, the hot stove facility comprising:

a hot stove that heats the air for a blast furnace;
 a combustion air pipe through which combustion air is fed to the hot stove;
 a fuel gas pipe through which blast furnace gas emitted from the blast furnace is fed to the hot stove as fuel gas for the hot stove;
 a smoke pipe through which exhaust gas emitted from the hot stove is fed to a chimney;
 first preheating means that is coupled to the smoke pipe, as well as to one of the combustion air pipe and the fuel gas pipe, to preheat one of the combustion air and the blast furnace gas by using heat recovered from the exhaust gas from the hot stove by heat exchange; and
 second preheating means that is provided with a first heater for burning a part of the blast furnace gas, and that is coupled to the other of the combustion air pipe and the fuel gas pipe to preheat the other of the combustion air and the blast furnace gas by using heat generated by the first heater.

2. The hot stove facility according to claim 1, comprising the first preheating means including:

a first heat exchanger coupled to the smoke pipe;
a second heat exchanger coupled to the one pipe of the combustion air pipe and the fuel gas pipe;
a heat medium pipe that connects the first heat exchanger and the second heat exchanger to each other so
that a liquid heat medium from which heat is recovered in the first heat exchanger is fed to the second heat
exchanger through the heat medium pipe; and
a second heater that is coupled to the heat medium pipe to heat the liquid heat medium by using heat generated
by burning a part of the blast furnace gas.

3. The hot stove facility according to claim 1, wherein the first preheating means is a heat exchanger of a heat pipe type that includes a high temperature section coupled to the smoke pipe, and a low temperature section coupled to the one pipe of the combustion air pipe and the fuel gas pipe, to feed a medium evaporated in the high temperature section to the low temperature section, as well as to feed the medium condensed in the low temperature section to the high temperature section.
4. The hot stove facility according to any one of claims 1 to 3, wherein the second preheating means includes a third heat exchanger coupled to the other pipe of the combustion air pipe and the fuel gas pipe, and a heating gas pipe that connects the first heater and the third heat exchanger to each other so that gas generated by burning a part of the blast furnace gas in the first heater is fed to the third heat exchanger through the heating gas pipe.

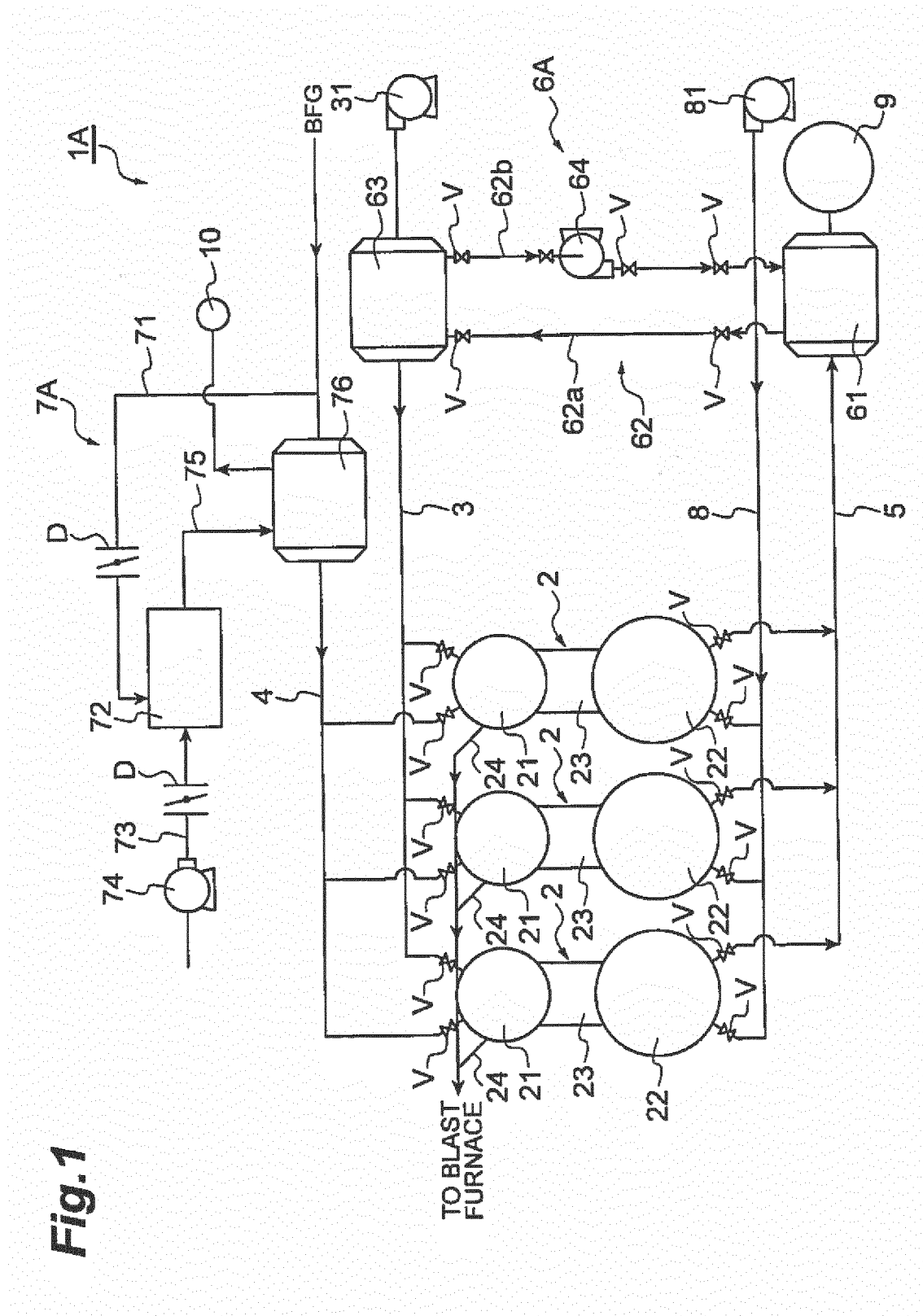


Fig.2

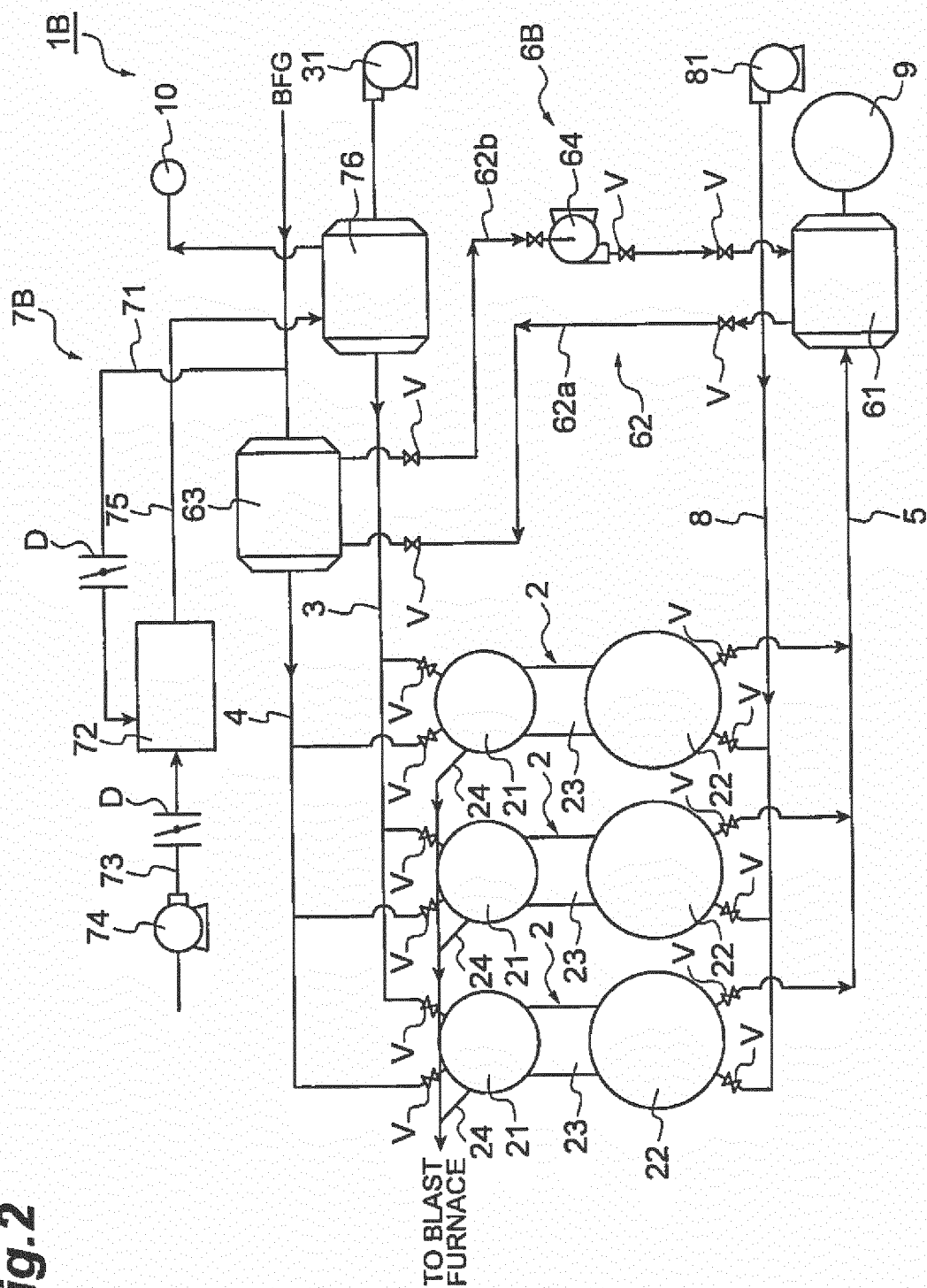
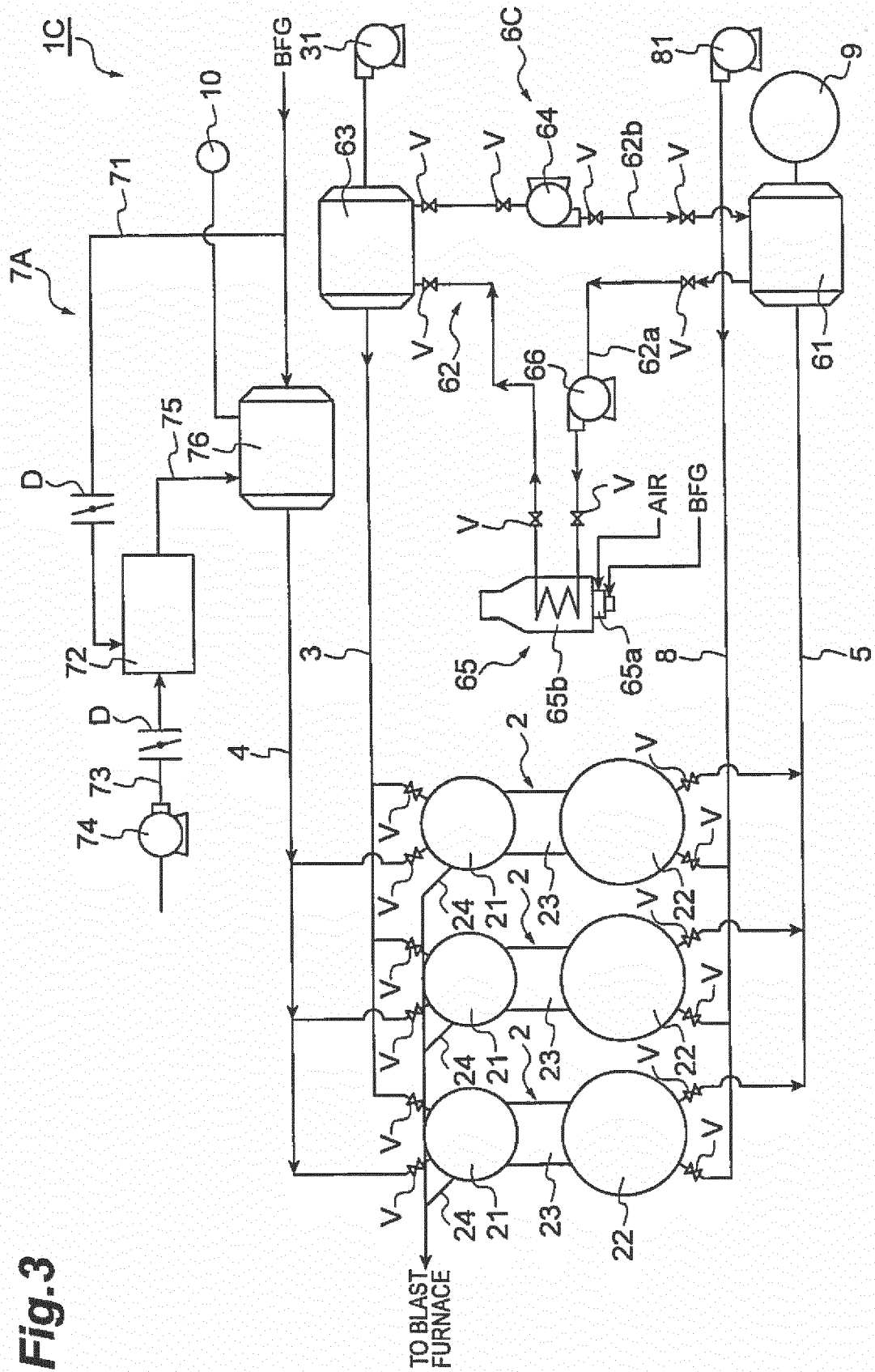


Fig.3



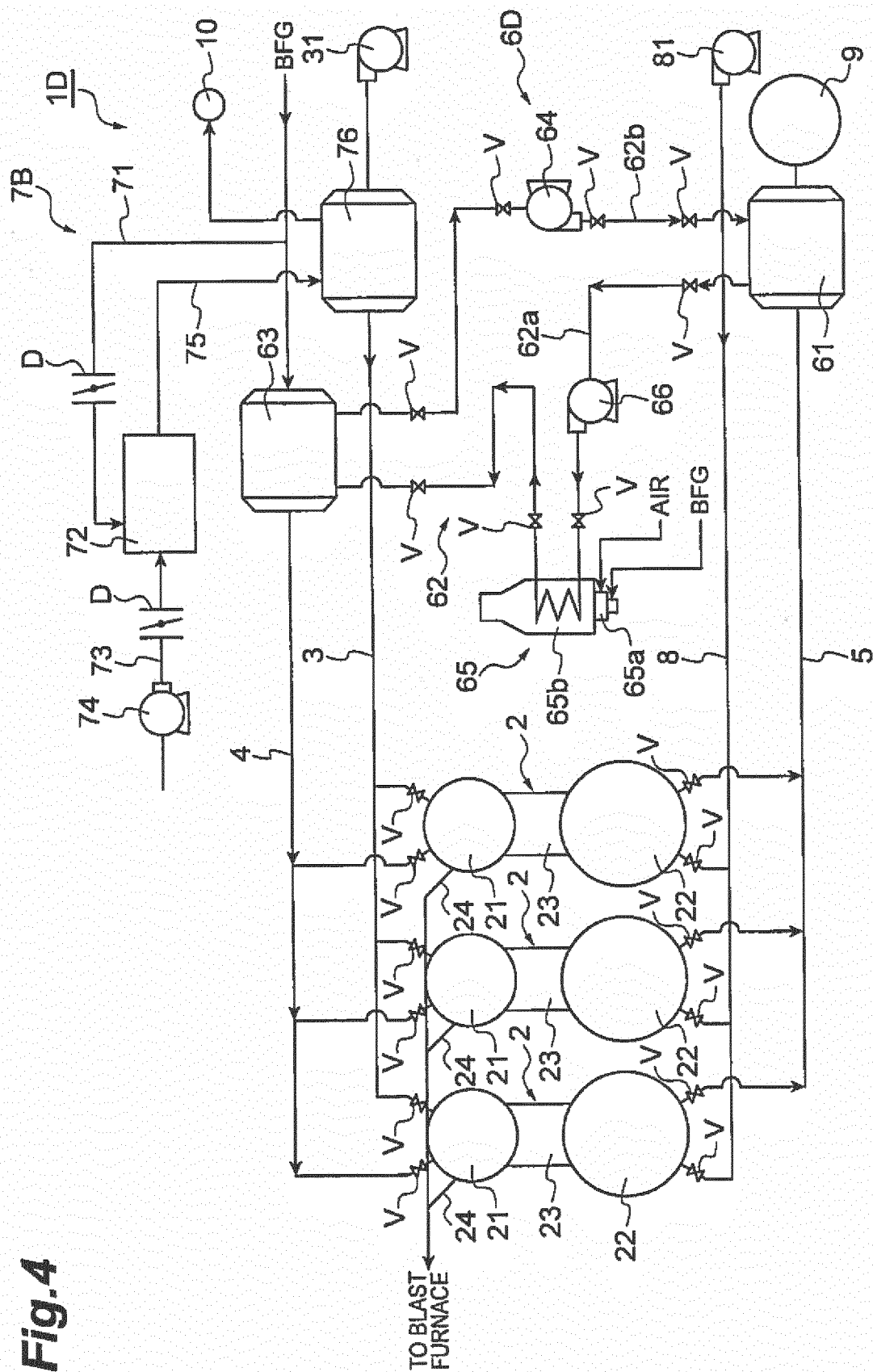


Fig. 4

Fig. 5

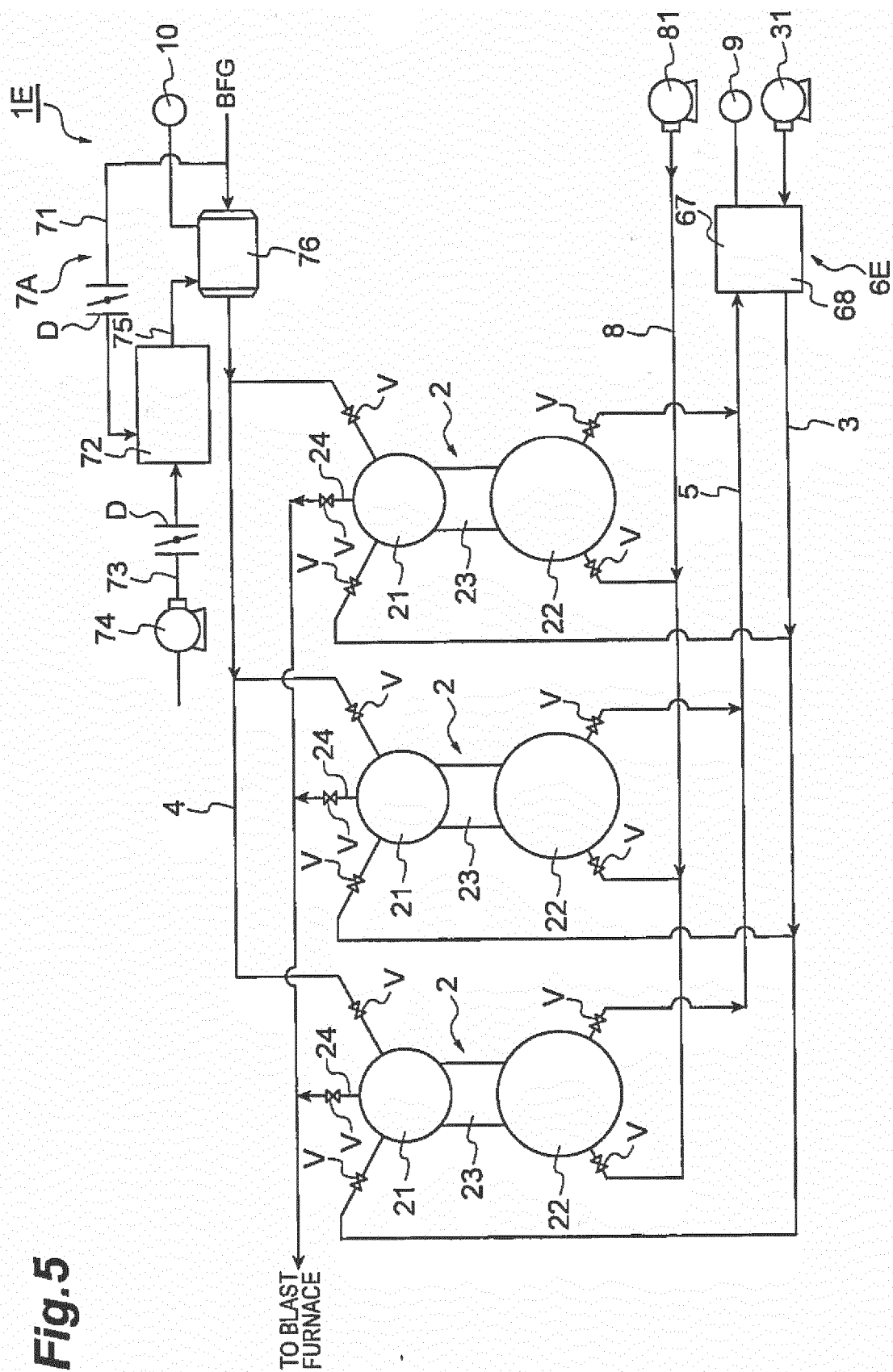
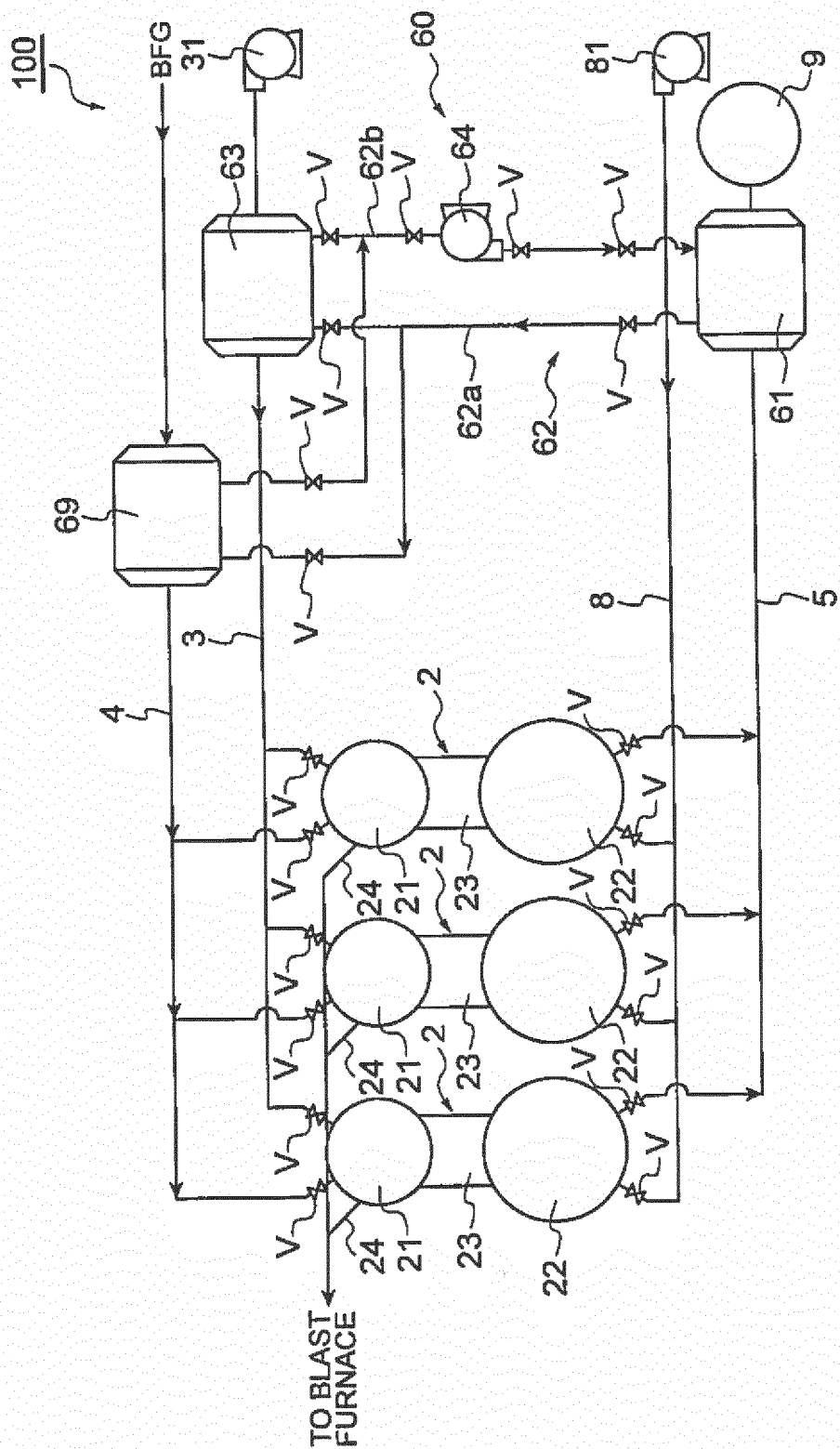


Fig.6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/077100

A. CLASSIFICATION OF SUBJECT MATTER

C21B9/14(2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C21B9/00-C21B9/16

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2002-266012 A (Nippon Steel Corp.), 18 September 2002 (18.09.2002), fig. 1 to 4; paragraphs [0002] to [0016] (Family: none)	1-4
A	JP 55-065309 A (Ishikawajima-Harima Heavy Industries Co., Ltd.), 16 May 1980 (16.05.1980), fig. 2; page 2, upper left column, line 13 to lower right column, line 17 (Family: none)	1-4
A	JP 60-005815 A (Nippon Steel Corp.), 12 January 1985 (12.01.1985), fig. 3 to 4; page 2, upper left column, line 14 to page 3, upper right column, line 3 (Family: none)	1-4

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

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Date of the actual completion of the international search

26 November, 2014 (26.11.14)

Date of mailing of the international search report

09 December, 2014 (09.12.14)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/077100

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4492568 A (DIDIER-WERKE AG), 08 January 1985 (08.01.1985), fig. 1 to 2; column 4, line 65 to column 9, line 4 & GB 2131932 A & DE 3248623 C & FR 2537605 A & SE 8306852 A & ES 527707 A	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H9287013 B [0003]