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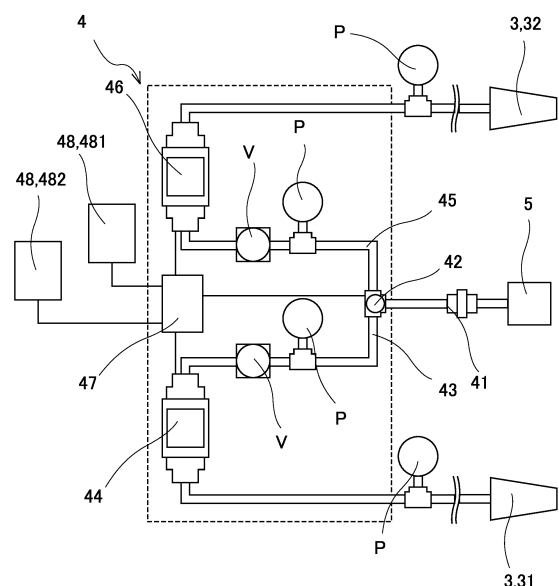
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(54) **GAS BLOWING DEVICE**

(57) A gas injection device includes: a storage container 2; a first injection plug 31; a second injection plug 32; and a gas supply circuit 4 configured to receive supply of the gas and supply the gas to the first injection plug 31 or the second injection plug 32. When each injection plug 31, 32 is cleaned, gas is jetted from each injection plug 31, 32. The gas supply circuit 4 includes: a first gas passage 43; a second gas passage 45; a switching device 42; a first gas flowmeter 44; a second gas flowmeter 46; and a control device 47 configured to switch a flow of gas, when a flow rate of gas flowing through the first gas passage 43 or the second gas passage 45 reaches a predetermined flow rate or higher, and to operate a reporting device 48 to report the switching to an outside.

Fig. 2



Description

Technical Field

[0001] The present invention relates to a gas injection device.

Background Art

[0002] Conventionally, molten metal (e.g., molten steel) is stored in a storage container to be treated. For example, in a continuous casting machine, molten steel from an outlet is poured into the storage container (e.g., ladle), the stored molten steel is discharged into a tundish, and the molten steel in the tundish is poured into a mold. After the stored molten steel is discharged from the ladle to the tundish, the ladle is conveyed to a predetermined position (original position) and molten steel is again poured into the ladle. Then, the stored and placed molten steel is processed, conveyed, and discharged. In the continuous casting machine, these steps are repeatedly performed.

[0003] The ladle is provided with a gas injection plug (hereinafter, also referred to as an injection plug) for injecting gas (stirring gas) into the stored or placed molten steel. The injection plug is disposed in a bottom of a tank-shaped ladle, and stirring gas such as argon or nitrogen is injected through the injection plug into the molten steel. With the injected stirring gas, processes, such as stirring of molten steel, temperature regulation, and acceleration of a reaction for removing non-metal components are progressed.

[0004] Examples of the injection plug include a porous plug having a shaped porous refractory with continuous micropores, and a slit plug having a shaped non-porous (compact) refractory with a formed slit (slit-shaped through hole). With the injection plug, stirring gas, which has passed through the continuous micropores of the porous plug or the slit-shaped through hole of the slit plug, is injected into molten steel.

[0005] When molten steel is stored in the ladle and stirring gas is not being injected into the molten steel, molten steel occasionally enters the through hole (or micropores) of an injection plug (also referred to as insertion). If the insertion occurs, the inserted molten steel is solidified inside the through hole, and stirring gas does not smoothly pass through the through hole. In other words, the amount of the jetted stirring gas decreases, and thus stirring or processing of molten steel is not sufficiently performed. To solve the problem, treatment for removing the inserted molten steel (cleaning of the injection plug) is performed. The ladle is reused after cleaning of the injection plug.

[0006] In cleaning of the injection plug, oxygen gas is sprayed on an inner surface of the injection plug from an inner periphery side of the ladle while cleaning gas is being jetted from the micropores of the injection plug, as disclosed in Patent Literature 1. The cleaning gas is non-

reactive gas such as Ar gas or N₂ gas. The cleaning of the injection plug is also referred to as oxygen cleaning.

[0007] For the oxygen cleaning, the ladle is conveyed to a predetermined position for the oxygen cleaning to be performed, and the injection plug is connected to a cleaning gas supply source for supplying the cleaning gas, so that the cleaning gas is jetted from the injection plug.

[0008] In the oxygen cleaning, the oxygen gas is sprayed until the cleaning gas is jetted from the injection plug at a predetermined flow rate. In other words, when the flow rate of the cleaning gas jetted from the injection plug reaches a predetermined flow rate, the oxygen cleaning of the injection plug finishes.

[0009] Some ladles are each provided with a plurality of injection plugs. The ladle provided with the plurality of injection plugs has a supply path for the cleaning gas to be injected into molten steel, for each injection plug. The oxygen cleaning (oxygen spray) of such a ladle is performed for each injection plug. Specifically, the oxygen cleaning of a primary injection plug (first injection plug) is performed by spraying the oxygen gas on the first injection plug while supplying the cleaning gas to the first injection plug. After the oxygen cleaning of the first injection plug finishes, the first injection plug is disconnected from the cleaning gas supply source and a next injection plug (second injection plug) is connected to the cleaning gas supply source. Then, the oxygen cleaning is performed by spraying the oxygen gas on the second injection plug while supplying the cleaning gas to the second injection plug. As described above, when a plurality of the injection plugs are cleaned, connection and disconnection between each injection plug and the cleaning gas supply source are performed, every time the injection plug on which the oxygen gas is sprayed is changed. Extra time and labor for operation involved in connection and disconnection between each injection plug and the cleaning gas supply source have been required to clean the plurality of injection plugs.

[0010] In the ladle provided with the plurality of injection plugs, such connection and disconnection is manually performed by an operator. An ambient temperature of the ladle is high, due to heat of the ladle itself and the molten metal remaining inside the ladle (particularly, radiant heat on the ladle side). Therefore, the increased number of connection and disconnection leads to the increased frequency and time when the operator is exposed to intense heat. That is, deterioration in safety of the operator has arisen.

Citation List

[Patent Literature]

[0011] Patent Literature 1: JP5516393 (B)

Summary of Invention

Technical Problem

[0012] The present invention has been made in view of the above circumstances, and an object of the present invention is to provide a gas injection device that includes a storage container having a plurality of injection plugs and that smoothly and safely cleans the injection plugs.

Solution to Problem

[0013] A gas injection device of the present invention achieving the above object includes: a first injection plug disposed in a bottom of a storage container for storing molten metal, and configured to inject gas into the molten metal; a second injection plug disposed in the bottom of the storage container and at a position separated from the first injection plug at an interval, and configured to inject the gas into the molten metal; and a gas supply circuit including a gas receiving aperture for receiving supply of the gas, and configured to receive the supply of the gas and supply the gas to the first injection plug or the second injection plug. When each injection plug is cleaned, the gas injection device causes predetermined gas to be jetted from each injection plug. The gas supply circuit includes: a first gas passage through which the gas supplied from the gas receiving aperture flows toward the first injection plug; a second gas passage through which the gas supplied from the gas receiving aperture flows toward the second injection plug; a switching device disposed downstream of the gas receiving aperture and configured to switch a flow of the gas between the first gas passage and the second gas passage; a first gas flowmeter disposed in the first gas passage and configured to measure a flow rate of the gas flowing through the first gas passage; a second gas flowmeter disposed in the second gas passage and configured to measure a flow rate of the gas flowing through the second gas passage; and a control device connected to the first gas flowmeter and the second gas flowmeter, configured to operate the switching device to switch the flow of the gas, when the flow rate of the gas flowing through the first gas passage or the flow rate of the gas flowing through the second gas passage reaches a predetermined flow rate or higher, and configured to operate a reporting device to report the switching to an outside.

[0014] The gas injection device according to the present invention switches a flow of gas supplied from the gas receiving aperture by the switching device, and sends the gas to the first injection plug (first gas passage) or the second injection plug (second gas passage). In this configuration, the gases jetted from a plurality of the injection plugs are supplied from one gas receiving aperture, so that the number of connecting points with a gas source is one. The configuration reduces the number of times and time when an operator approaches the storage container for switching of connection. That is, the

injection plugs are safely cleaned.

[0015] The gas injection device according to the present invention preferably operates when the first injection plug and the second injection plug are cleaned.

This configuration reduces the number of connecting points with a gas source for each injection plug, for cleaning of each injection plug. That is, the operator cleans the injection plugs more safely.

Brief Description of Drawings

[0016]

Fig. 1 schematically illustrates a configuration of a ladle according to embodiment 1;

Fig. 2 schematically illustrates a configuration of a gas supply circuit of the ladle according to the embodiment 1;

Fig. 3 schematically illustrates a configuration of a continuous casting machine using the ladle according to the embodiment 1; and

Fig. 4 schematically illustrates oxygen cleaning of the ladle according to the embodiment 1.

Description of Embodiments

[0017] The present invention will be specifically described below based on embodiments. Each embodiment is an example in which a gas injection device according to the present invention is applied to a ladle for processing molten steel. The molten steel corresponds to molten metal. Each embodiment below is an example of specific embodiments for carrying out the present invention, and the present invention is not limited to the embodiments. Each configuration of the embodiments may be used in combination as appropriate.

[Embodiment 1]

(Ladle)

[0018] As shown in Fig. 1 to Fig. 3, a ladle 1 according to embodiment 1 includes a ladle body 2, injection plugs 3, a cleaning gas supply circuit 4, and a cleaning gas supply device 5. Fig. 1 schematically illustrates a configuration of the ladle 1. Fig. 2 schematically illustrates a configuration of the cleaning gas supply circuit 4. Fig. 3 schematically illustrates a configuration of a continuous casting machine 6 using the ladle 1.

(Ladle body)

[0019] The ladle body 2 corresponds to a storage container and is a tank-shaped container for storing molten steel (corresponding to molten metal). The ladle body 2 is provided with the injection plug 3 disposed in a bottom of the container. The ladle body 2 includes a nozzle 21 for discharging the stored molten steel, and the nozzle

21 is disposed in the bottom of the container. The nozzle 21 includes a molten steel outflow hole for discharging the stored molten steel. The configuration of the ladle body 2 is not limited, and thus a conventional ladle is available. The ladle body 2 according to the present embodiment includes a tank-shaped iron shell, and a refractory disposed on an inner peripheral side of the iron shell.

(Injection plug)

[0020] The injection plugs 3 include a first injection plug 31 and a second injection plug 32. The first injection plug 31 is a member that is disposed in a bottom of the ladle body 2, and is used for injecting gas (cleaning gas and stirring gas) into molten steel (molten metal). The second injection plug 32 is a member that is disposed in the bottom of the ladle body 2 and at a position separated from the first injection plug at an interval, and is used for injecting gas into molten steel (molten metal). The injection plugs 3 (the first injection plug 31 and the second injection plug 32) are disposed so as to be embedded in the refractory on an inner peripheral side of the ladle body 2.

[0021] The configuration of the injection plugs 3 (the first injection plug 31 and the second injection plug 32) is not limited, and thus a conventional injection plug is available. Examples of the injection plug 3 include a porous plug and a slit plug.

(Cleaning gas supply circuit)

[0022] The cleaning gas supply circuit 4 includes a gas receiving aperture 41 for receiving supply of cleaning gas from the cleaning gas supply device 5. The cleaning gas supply circuit 4 receives the supply of the cleaning gas through the gas receiving aperture 41 to supply the cleaning gas to the first injection plug 31 and the second injection plug 32. The cleaning gas supply circuit 4 includes a conduit line forming a passage for the cleaning gas.

[0023] The cleaning gas supply circuit 4 includes a valve 42, a first gas passage 43, a first gas flowmeter 44, a second gas passage 45, a second gas flowmeter 46, a control device 47, and a reporting device 48. The cleaning gas supply circuit 4 further includes a pressure regulating valve V and a gas pressure gauge P.

[0024] The cleaning gas supply circuit 4 includes the valve 42 disposed downstream of the gas receiving aperture 41.

[0025] The gas receiving aperture 41 forms a connection portion between the ladle 1 and the cleaning gas supply device 5 according to the present embodiment.

[0026] The valve 42 corresponds to gas switching means, and switches a flow of gas such that the gas supplied from the gas receiving aperture 41 flows through the first gas passage 43 or the second gas passage 45. The valve 42 is not limited, as long as the valve 42 is a member or a device that switches a flow of gas between the gas passage 43 and the gas passage 45 such that the cleaning gas flows through one of the gas passage

43 and the gas passage 45. In the present embodiment, a solenoid valve allowing the cleaning gas to flow through only one of the first gas passage 43 and the second gas passage 45 is used as the valve 42.

[0027] The first gas passage 43 is connected to the first injection plug 31, and is formed such that gas supplied from the gas receiving aperture 41 flows toward the first injection plug 31. The first gas passage 43 includes the first gas flowmeter 44 disposed therein.

[0028] The second gas passage 45 is connected to the second injection plug 32, and is formed such that gas supplied from the gas receiving aperture 41 flows toward the second injection plug 32. The second gas passage 45 includes the second gas flowmeter 46 disposed therein.

[0029] The first gas flowmeter 44 and the second gas flowmeter 46 are not limited, as long as the first gas flowmeter 44 and the second gas flowmeter 46 measure a flow rate of gas flowing through the gas passage 43 and a flow rate of gas flowing through the gas passage 45, respectively. In the present embodiment, gas flowmeters to be used for a conventional ladle are used.

[0030] The valve 42, the first gas flowmeter 44, the second gas flowmeter 46, and the reporting device 48 are connected to the control device 47.

[0031] Connection between the control device 47, and each of the valve 42, the first gas flowmeter 44, the second gas flowmeter 46, and the reporting device 48 is not limited, as long as the connection method allows a necessary signal (information) to be transmitted/received. Examples of the connection method include a wired connection for transmitting/receiving an electrical signal, a mechanical connection (physical connection) by an actuator or the like, and a wireless connection or the like by an electromagnetic wave or the like.

[0032] A measurement result of each of the gas flowmeters 44 and 46 is inputted to the control device 47, and the control device 47 compares a flow rate of gas flowing through a gas passage selected by the valve 42 between the gas passages 43 and 45, with a preset flow rate (predetermined flow rate) of gas. Then, when the flow rate of gas reaches the predetermined flow rate or higher, the control device 47 determines to finish the oxygen cleaning.

[0033] Upon determining the oxygen cleaning to be finished, the control device 47 operates the valve 42 to switch a flow of the cleaning gas.

[0034] Upon determining the oxygen cleaning to be finished, the control device 47 operates the reporting device 48 to report the switching of the flow of gas to the outside (particularly, an operator of the oxygen cleaning). The control device 47 operates the reporting device 48, that is, performs the reporting, for a predetermined period of time. The reporting device 48 stops its operation after the predetermined period of time has elapsed. The control device 47 according to the present embodiment controls the start and stop of the operation (ON and OFF control).

[0035] The reporting device 48 may have a timer. The timer stops the operation of the reporting device 48 (controls only OFF), after a predetermined period of time set to the timer has elapsed. In this configuration, the control device 47 controls only the start of the operation of the reporting device 48 (controls only ON).

[0036] The reporting device 48 is not limited, as long as the reporting device 48 is a device that reports switching of a flow of gas to the outside (particularly, an operator around the ladle 1). In the present embodiment, a buzzer 481 and a light 482 are used. The buzzer 481 refers to a device for making an auditory report to the outside by audible sound (acoustic effect), and examples of the buzzer 481 include devices such as a loudspeaker and a bell. The light 482 refers to means for making a visual report to the outside by visible light, and examples of the light 482 include a device for making a light flicker, such as a rotating lamp or a flashlight, and a device such as a display for displaying information such as a letter and a mark.

[0037] When the control device 47 determines that the oxygen cleaning has finished, the reporting device 48 according to the present embodiment turns on the light 482 while sounding the buzzer 481 for a predetermined period of time to make a report to the outside.

[0038] The pressure regulating valve V is disposed in each of the first gas passage 43 and the second gas passage 45, and regulates pressure of the cleaning gas flowing through each of the passages 43 and 45.

[0039] The gas pressure gauge P is disposed in each of the first gas passage 43 and the second gas passage 45, and measures pressure of the cleaning gas flowing through each of the passages 43 and 45. The pressure regulating valve V regulates pressure of the cleaning gas on the basis of a measurement result of the gas pressure gauge P. The measurement result of the gas pressure gauge P is transmitted to the control device 47, and the transmitted measurement result of the gas pressure may be used for determination of whether or not to switch a flow of gas.

(Cleaning gas supply device)

[0040] The cleaning gas supply device 5 is connected to the gas receiving aperture 41, and supplies gas (cleaning gas) into the gas receiving aperture 41. A configuration of the cleaning gas supply device 5 is not limited, as long as the cleaning gas supply device 5 is a device that supplies the cleaning gas into the gas receiving aperture 41. The cleaning gas supply device 5 may be, for example, a device including: a gas cylinder for storing the cleaning gas; a conduit line that connects the gas cylinder to the gas receiving aperture 41 and through which the cleaning gas flows; and a control valve that is disposed in the conduit line and controls a flow rate of gas.

[0041] The cleaning gas supplied by the cleaning gas supply device 5 is not limited, and is gas to be used in conventional oxygen cleaning. Examples of the cleaning

gas includes non-reactive gases such as Ar gas and N₂ gas.

[Operation and effect]

(Operation of Ladle)

[0042] The ladle 1 according to the present embodiment is used in the continuous casting machine 6. As shown in Fig. 3, the continuous casting machine 6 includes the ladle 1, a tundish 61, and a mold 62.

[0043] In the continuous casting machine 6, molten steel from an outlet (not shown) is poured into the ladle 1 (ladle body 2). The poured molten steel is stored in the ladle 1 (ladle body 2). At this time, the injection plug 3 is connected to a stirring gas supply device (not shown) for supplying stirring gas. In the present embodiment, the injection plug 3 and the stirring gas supply device are connected to each other through a pipe (conduit line, path) different from that of the cleaning gas supply circuit 4.

[0044] In the ladle 1, the stirring gas supplied from the stirring gas supply device is jetted from the injection plug 3, while molten steel is stored. This jetted stirring gas is used in processes such as stirring of molten steel, temperature regulation, and acceleration of a reaction for removing non-metal components.

[0045] When the process such as stirring of molten steel finishes, the supply of the stirring gas into the injection plug 3 is stopped, and the injection plug 3 is disconnected from the stirring gas supply device. Then, the ladle 1 is conveyed to a predetermined position (e.g., position shown in Fig. 3) above the tundish 61. The molten steel is discharged to the tundish 61 through the nozzle 21. The molten steel discharged to the tundish 61 is poured into the mold 62 to be continuously cast (molded). The ladle 1 is conveyed to a predetermined position (original position where pouring of molten steel through the outlet is allowed), and molten steel is again poured. In the continuous casting machine 6, storing of molten steel, processing of molten steel, conveying, and discharging are repeatedly performed.

[0046] During the processing of molten steel, molten steel enters the through hole (or micropores) of the injection plug 3 and solidifies inside the through hole, so that the stirring gas does not smoothly pass through the through hole. To solve this problem, the injection plug 3 of the ladle 1 is oxygen cleaned every time when the discharging of molten steel finishes.

(Oxygen cleaning)

[0047] In oxygen cleaning, first, molten steel is discharged from the ladle body 2 of the ladle 1, so that the ladle 1 (ladle body 2) is in a state in which molten steel is not stored in the ladle 1. The ladle 1 is conveyed to a predetermined position (a working position for the oxygen cleaning). The ladle body 2 of the ladle 1 is inclined and

toppled down sideways, and a furnace bottom of the ladle body 2 is set face to face to an operator (the operator who performs the oxygen cleaning). At this time, the injection plug 3 and the cleaning gas supply circuit 4 are connected, and also the gas receiving aperture 41 of the cleaning gas supply circuit 4 and the cleaning gas supply device 5 are connected.

[0048] The cleaning gas supply device 5 is operated to supply the cleaning gas into the gas receiving aperture 41. At this time, the control device 47 of the cleaning gas supply circuit 4 sets the valve 42 such that the cleaning gas supplied from the gas receiving aperture 41 flows through the first gas passage 43. Then, the cleaning gas of the cleaning gas supply device 5 is supplied into the gas receiving aperture 41. The cleaning gas flows toward the first injection plug 31 through the gas receiving aperture 41, the valve 42, and the first gas passage 43, and is jetted from the first injection plug 31.

[0049] The operator sprays the oxygen gas toward the first injection plug 31 jetting the cleaning gas. Regarding spraying of the oxygen gas, as shown in Fig. 4, the operator positioned away from the opening of the ladle body 2 toppled down sideways sprays the oxygen gas toward the first injection plug 31 by using a long tubular cleaning lance 63, for example. When the oxygen gas is sprayed, the molten steel having entered the through hole of the first injection plug 31 reacts with the oxygen gas to generate heat and melt. In addition, since the cleaning gas is supplied from the gas receiving aperture 41 to the first injection plug 31, the molten steel is jetted from the first injection plug 31 along a flow of this cleaning gas, thereby removing the molten steel.

[0050] After the molten steel is removed from the first injection plug 31, a gas flow rate of the cleaning gas flowing through the first gas passage 43 is increased. The increased gas flow rate is measured with the first gas flowmeter 44. A measurement result of the first gas flowmeter 44 is inputted to the control device 47. The control device 47 compares the flow rate of the cleaning gas flowing through the first gas passage 43, with a preset flow rate (predetermined flow rate). When the flow rate of the cleaning gas flowing through first gas passage 43 reaches the predetermined flow rate or higher, the control device 47 determines to finish the oxygen cleaning of the first injection plug 31.

[0051] Upon determining the oxygen cleaning of the first injection plug 31 to be finished, the control device 47 operates the valve 42 to switch a flow of the cleaning gas. Then, the cleaning gas flows toward the second injection plug 32 through the gas receiving aperture 41, the valve 42, and the second gas passage 45, and is jetted from the second injection plug 32.

[0052] Upon determining the oxygen cleaning of the first injection plug 31 to be finished, the control device 47 operates the buzzer 481 and the light 482 for a predetermined period of time. Reporting by the buzzer 481 and the light 482 allows the operator to know the finish time of the oxygen cleaning of the first injection plug 31, and

to perform the oxygen cleaning of the second injection plug 32 in the same manner as the oxygen cleaning of the first injection plug 31.

5 (Effect)

[0053] The ladle 1 according to the present embodiment includes two injection plugs 31 and 32. The flow of the cleaning gas supplied from the gas receiving aperture 41 is switched by the valve 42, and the cleaning gas is sent to the first injection plug 31 (first gas passage 43) or the second injection plug 32 (second gas passage 45). In other words, the cleaning gases jetted from two injection plugs 31 and 32 are supplied from one gas receiving aperture 41. Meanwhile, in a conventional ladle including two injection plugs 31 and 32, the gas receiving apertures respectively corresponding to the injection plug 31 and the injection plug 32 are formed, and, after the oxygen cleaning of the injection plug 31 finishes, the cleaning gas supply device 5 is connected to the gas receiving aperture of the injection plug 32. As described above, the ladle 1 according to the present embodiment reduces the number of connecting points between the cleaning gas supply device 5 and the cleaning gas supply circuit 4 (injection plug 3) to one, and thus the time and labor (operation cost) required for connection between the cleaning gas supply device 5 and the cleaning gas supply circuit 4 (injection plug 3) are reduced.

[0054] In addition, connection between the cleaning gas supply device 5 and the cleaning gas supply circuit 4 (injection plug 3) is performed immediately after molten steel is discharged from the ladle 1 (ladle body 2) (i.e., performed in a molten state in which molten steel is ready to be cleaned by the oxygen cleaning). When this connection is performed, the ladle 1 (ladle body 2) is substantially hot, and the operator is exposed to the heat (particularly, radiant heat) from the ladle 1 (ladle body 2). Since the ladle 1 according to the present embodiment reduces the number of connecting points to one, the time during which the operator is exposed to intense heat is reduced. Thus, the ladle 1 according to the present embodiment improves safety of the operator during the oxygen cleaning.

[0055] Furthermore, the ladle 1 according to the present embodiment measures a gas flow rate of the cleaning gas flowing through the first gas passage 43, with the first gas flowmeter 44, to determine a finish time of the oxygen cleaning. Thus, immediately after the oxygen cleaning of the first injection plug 31 finishes, the oxygen cleaning of the second injection plug 32 is started. That is, switching between the oxygen cleaning of the first injection plug 31 and oxygen cleaning of the second injection plug 32 is smoothly performed. The oxygen cleaning of the first injection plug 31 is prevented from being performed over a longer time than needed, and thus the operation time required for the oxygen cleaning is reduced. In addition, the refractory disposed on the inner periphery of the ladle body 2 is not excessively heat-

ed by excessive oxygen cleaning and thus is prevented from being damaged due to the heat.

[0056] As described above, the ladle 1 according to the present embodiment enables the operator to smoothly and safely perform the oxygen cleaning of the injection plugs 3.

[0057] In the ladle 1 of the present embodiment, a finish time of the oxygen cleaning of the first injection plug 31 is reported to the operator by operating the buzzer 481 and the light 482 for a predetermined period of time. This configuration enables the operator to surely recognize the finish time of the oxygen cleaning. As a result, the above effect is surely achieved.

[Embodiment 2]

[0058] The ladle 1 according to embodiment 2 is the same as the ladle 1 according to the embodiment 1, except that the ladle 1 according to the embodiment 2 further includes a third injection plug (and a third gas passage).

[0059] In the ladle 1 according to the embodiment 2, configurations of the third injection plug and the third gas passage are the same as the configurations of the first injection plug 31 and the first gas passage 43, and the configurations of the second injection plug 32 and the second gas passage 45 according to the embodiment 1, respectively. That is, the third gas passage is connected to the third injection plug and is formed such that the cleaning gas supplied from the gas receiving aperture 41 flows toward the third injection plug. The third gas passage includes a third gas flowmeter disposed therein.

[0060] The valve 42 switches a flow of gas such that the cleaning gas supplied from the gas receiving aperture 41 flows through one of the first gas passage 43, the second gas passage 45, and the third gas passage.

[0061] A measurement result of each of the gas flowmeters is inputted to the control device 47, and the control device 47 compares a flow rate of gas flowing through a gas passage selected by the valve 42 from among the gas passages, with a preset flow rate (predetermined flow rate). When the flow rate of gas reaches the predetermined flow rate or higher, the control device 47 operates the valve 42 to switch the flow of gas. In addition, the control device 47 operates the buzzer 481 and the light 482 for a predetermined period of time, when the flow of the cleaning gas is switched.

(Operation)

[0062] The ladle 1 according to the embodiment 2 is the same as the ladle 1 according to the embodiment 1, except that the number of injection plugs 3 according to the embodiment 2 is increased.

[0063] In the ladle 1 according to the embodiment 2, the first injection plug 31 and the second injection plug 32 are oxygen cleaned in the same manner as the oxygen cleaning according to the embodiment 1. When the ox-

ygen cleaning of the second injection plug 32 finishes and a flow rate of the cleaning gas flowing through the second gas passage 45 reaches a predetermined flow rate or higher, determination to finish the oxygen cleaning of the second injection plug 32 is performed. When the oxygen cleaning of the second injection plug 32 is determined to be finished, the valve 42 is operated to switch a flow of the cleaning gas. Specifically, switching of the valve 42 is performed such that the cleaning gas supplied from the gas receiving aperture 41 having flowed through the second gas passage 45 is switched to flow through the third gas passage.

[0064] Upon determining the oxygen cleaning of the second injection plug 32 to be finished, the control device 47 operates the buzzer 481 and the light 482 for a predetermined period of time. Reporting by the buzzer 481 and the light 482 allows the operator to know a finish time of the oxygen cleaning of the second injection plug 32, and to perform the oxygen cleaning of the third injection plug in the same manner as the oxygen cleaning of the first injection plug 31 and the second injection plug 32.

(Effect)

[0065] The ladle 1 according to the embodiment 2 has the same configuration as the configuration of the ladle 1 according to the embodiment 1, except that the number of injection plugs 3 according to the embodiment 2 is increased, and the same effect as the effect of the embodiment 1 is achieved. Thus, in the ladle 1 according to the embodiment 2, the time and labor (operation cost) required for connection between the cleaning gas supply device 5 and the cleaning gas supply circuit 4 (injection plug 3) are reduced. In addition, the ladle 1 according to the embodiment 2 improves safety of the operator during the oxygen cleaning.

[0066] In particular, the ladle 1 according to the embodiment 2 includes three injection plugs 3, and reduces the number of connecting points between the cleaning gas supply device 5 and the cleaning gas supply circuit 4 (injection plug 3) to one, thereby more surely achieving the above effect.

[0067] In the embodiment 2, the three injection plugs 3 are provided, but the same effect is achieved by the ladle including four or more injection plugs 3.

[Embodiment 3]

[0068] The ladle 1 according to embodiment 3 is the same as the ladle 1 according to the embodiment 1, except that the control device 47 according to the embodiment 3 has a switch that allows the operator to instruct switching of the valve 42.

[0069] The ladle 1 according to the embodiment 3 achieves an effect of selecting the injection plug 3 from which the cleaning gas is jetted, as necessary.

[Embodiment 4]

[0070] The ladle 1 according to embodiment 4 is the same as the ladle 1 according to the embodiment 1, except that the valve 42 according to the embodiment 4 lets gas flow through not only one of the first gas passage 43 and the second gas passage 45 but also both the first gas passage 43 and the second gas passage 45.

[0071] The valve 42 according to the embodiment 4 switches the gas supplied from the gas receiving aperture 41 so as to flow through the first gas passage 43, the second gas passage 45, or both the first gas passage 43 and the second gas passage 45.

[0072] According to the embodiment 4, the gas supplied in the gas receiving aperture 41 is selectively supplied into one or both of the injection plugs 31 and 32. According to the embodiment 4, the cleaning gas is jetted from one of the first injection plug 31 and the second injection plug 32 during the oxygen cleaning. Then, when a flow rate of the cleaning gas of one injection plug 3 (first injection plug 31) is determined to have exceeded a predetermined flow rate (first predetermined flow rate), the gas flow is switched such that the cleaning gas is jetted from the other injection plug 3 (second injection plug 32). Then, when a flow rate of the cleaning gas of the other injection plug 3 (second injection plug 32) is determined to have exceeded another predetermined flow rate (second predetermined flow rate), the gas flow is switched such that the cleaning gas is jetted from both of the two injection plugs 31 and 32. According to the embodiment 4, the oxygen cleaning of both of the two injection plugs 31 and 32 are simultaneously performed, thereby achieving an improvement effect in the workability of the oxygen cleaning.

[0073] When the configuration of the embodiment 4 is applied to the ladle 1 including three or more injection plugs 3 (e.g., the ladle 1 according to the embodiment 2), the valve 42 is operated such that the cleaning gas is jetted from any injection plug between the three injection plugs 3. In other words, the cleaning gas is jetted from two injection plugs 3 (a plurality of the injection plugs 3) disposed close to each other, and thus the oxygen cleaning is simultaneously performed on the two injection plugs 3, thereby achieving an improvement effect in the workability of the oxygen cleaning. At this time, the cleaning gas is not supplied to the remaining injection plug 3 on which the oxygen cleaning is not performed.

[Modification]

[0074] The ladle 1 according to a modification includes a pressure-accumulation cylinder for storing gas in a pressurized state in the circuit for supplying stirring gas into the injection plug 3. According to the modification, when the injection plug 3 is separated from the stirring gas supply source, gas (stirring gas stored in a tank) is supplied from this cylinder into the injection plug 3.

[0075] When the ladle 1 according to the modification

is moved after the stirring process, the ladle 1 is disconnected from the stirring gas supply device to be moved. At this time, the stirring gas stored in the tank is supplied into the injection plug 3 to be jetted from the injection plug 3, and molten steel is prevented from entering the through hole of the injection plug 3 during moving. Therefore, the through hole of the injection plug 3 is prevented from closing, and thus a use time of the ladle 1 is prolonged in repeated use of the ladle 1.

Description of the Reference Characters

[0076]

15	1:	ladle
	2:	ladle body
	3:	injection plug
	31:	first injection plug
	32:	second injection plug
20	4:	cleaning gas supply circuit
	41:	gas receiving aperture
	42:	valve
	43:	first gas passage
	44:	first gas flowmeter
25	45:	second gas passage
	46:	second gas flowmeter
	47:	control device
	48:	reporting device
	481:	buzzer
30	482:	light
	5:	cleaning gas supply device
	6:	continuous casting machine
	61:	tundish
	62:	mold
35	63:	cleaning lance

Claims

- 40 1. A gas injection device comprising:
- 45 a first injection plug disposed in a bottom of a storage container for storing molten metal, and configured to inject gas into the molten metal;
- 50 a second injection plug disposed in the bottom of the storage container and at a position separated from the first injection plug at an interval, and configured to inject the gas into the molten metal; and
- 55 a gas supply circuit including a gas receiving aperture for receiving supply of the gas, and configured to receive the supply of the gas and supply the gas to the first injection plug or the second injection plug, wherein
- when each injection plug is cleaned, the gas injection device causes predetermined gas to be jetted from each injection plug, and the gas supply circuit comprises:

- a first gas passage through which the gas supplied from the gas receiving aperture flows toward the first injection plug;
 a second gas passage through which the gas supplied from the gas receiving aperture flows toward the second injection plug;
 a switching device disposed downstream of the gas receiving aperture and configured to switch a flow of the gas between the first gas passage and the second gas passage;
 a first gas flowmeter disposed in the first gas passage and configured to measure a flow rate of the gas flowing through the first gas passage;
 a second gas flowmeter disposed in the second gas passage and configured to measure a flow rate of the gas flowing through the second gas passage; and
 a control device connected to the first gas flowmeter and the second gas flowmeter, configured to operate the switching device to switch the flow of the gas, when the flow rate of the gas flowing through the first gas passage or the flow rate of the gas flowing through the second gas passage reaches a predetermined flow rate or higher, and configured to operate a reporting device to report the switching to an outside.
2. The gas injection device according to claim 1, wherein the reporting device has at least one of a buzzer and a light.
 3. The gas injection device according to claim 1 or 2, wherein the gas injection device is configured to operate when the first injection plug or the second injection plug is cleaned.

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Fig. 1

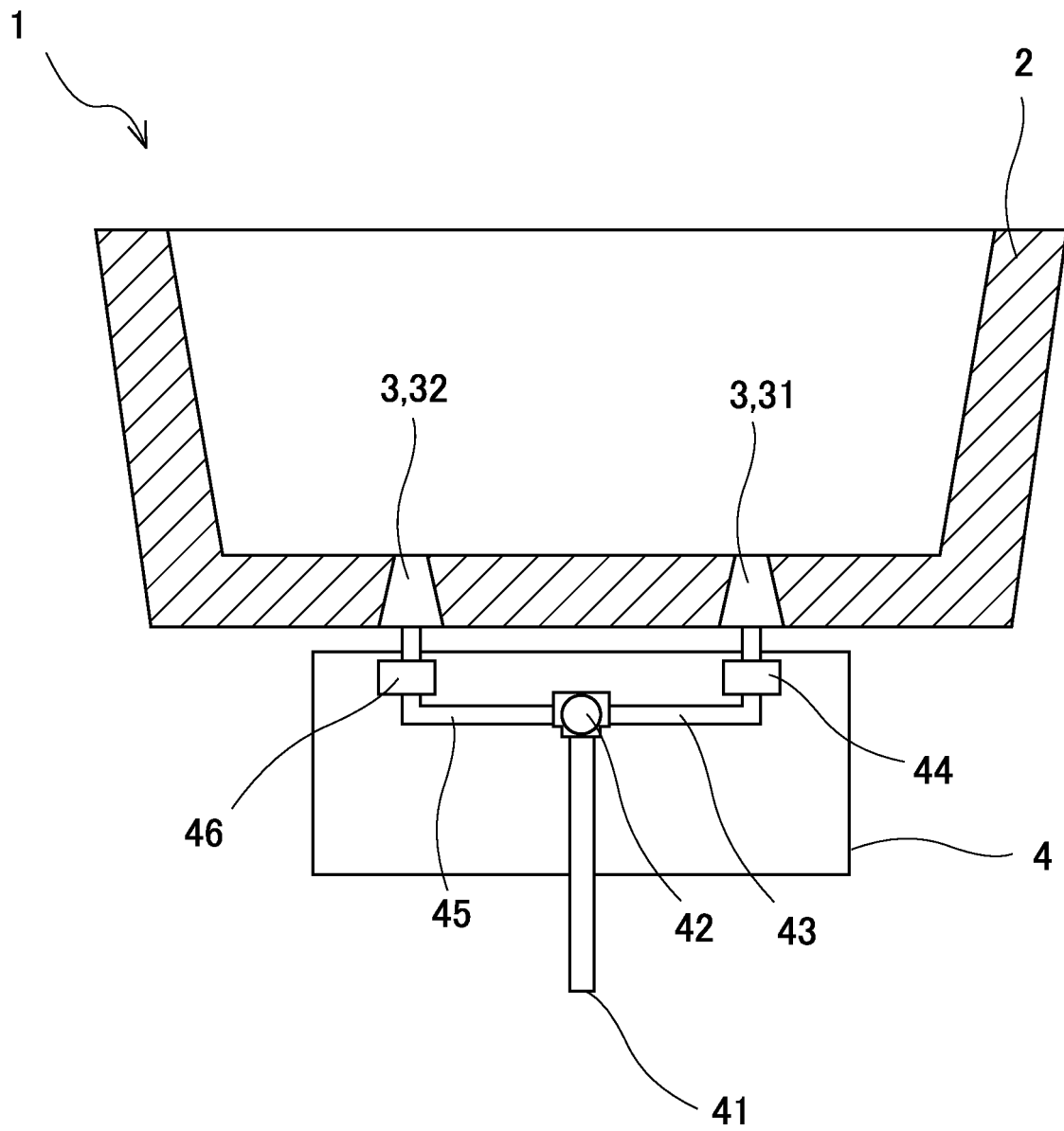


Fig. 2

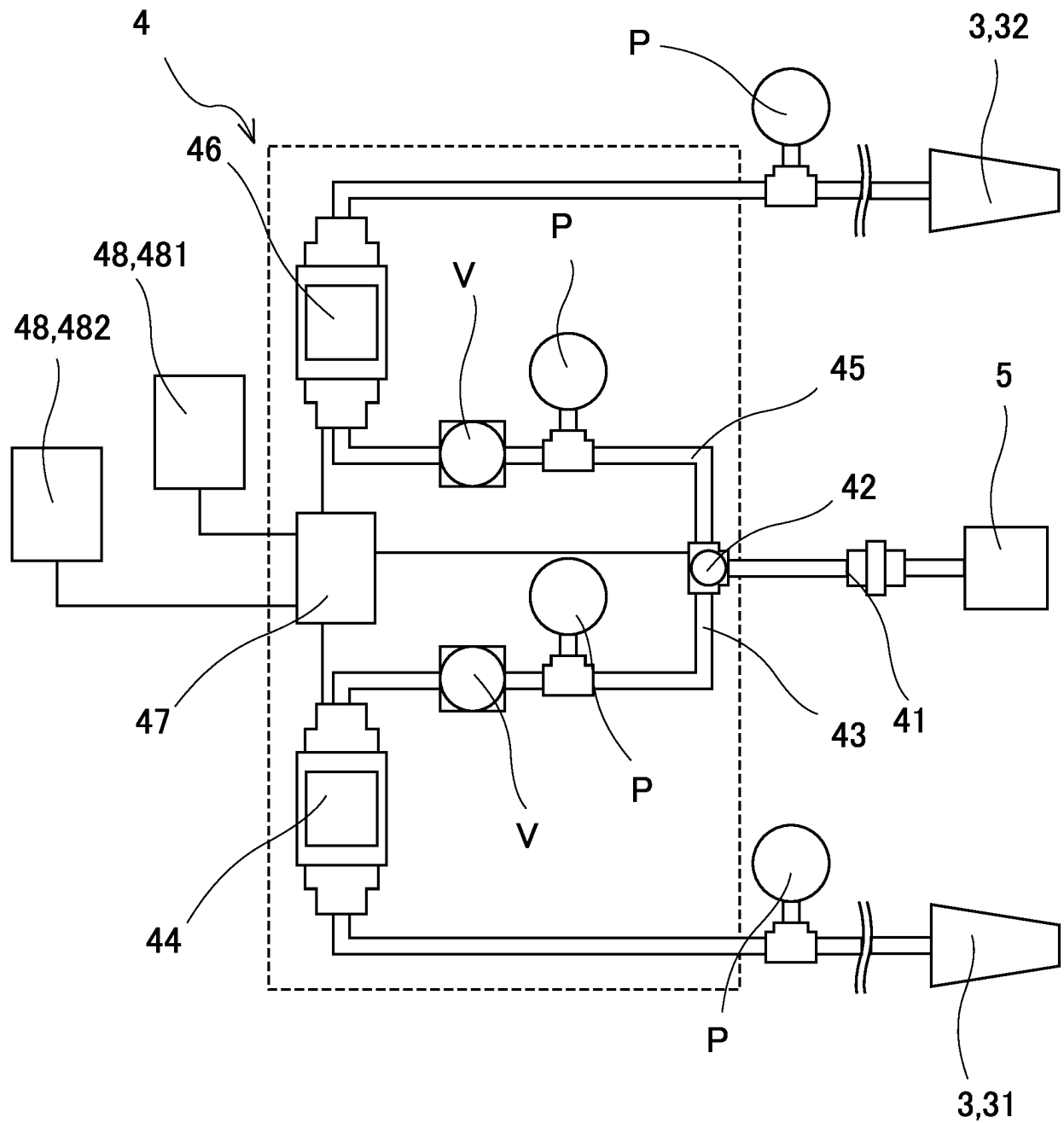
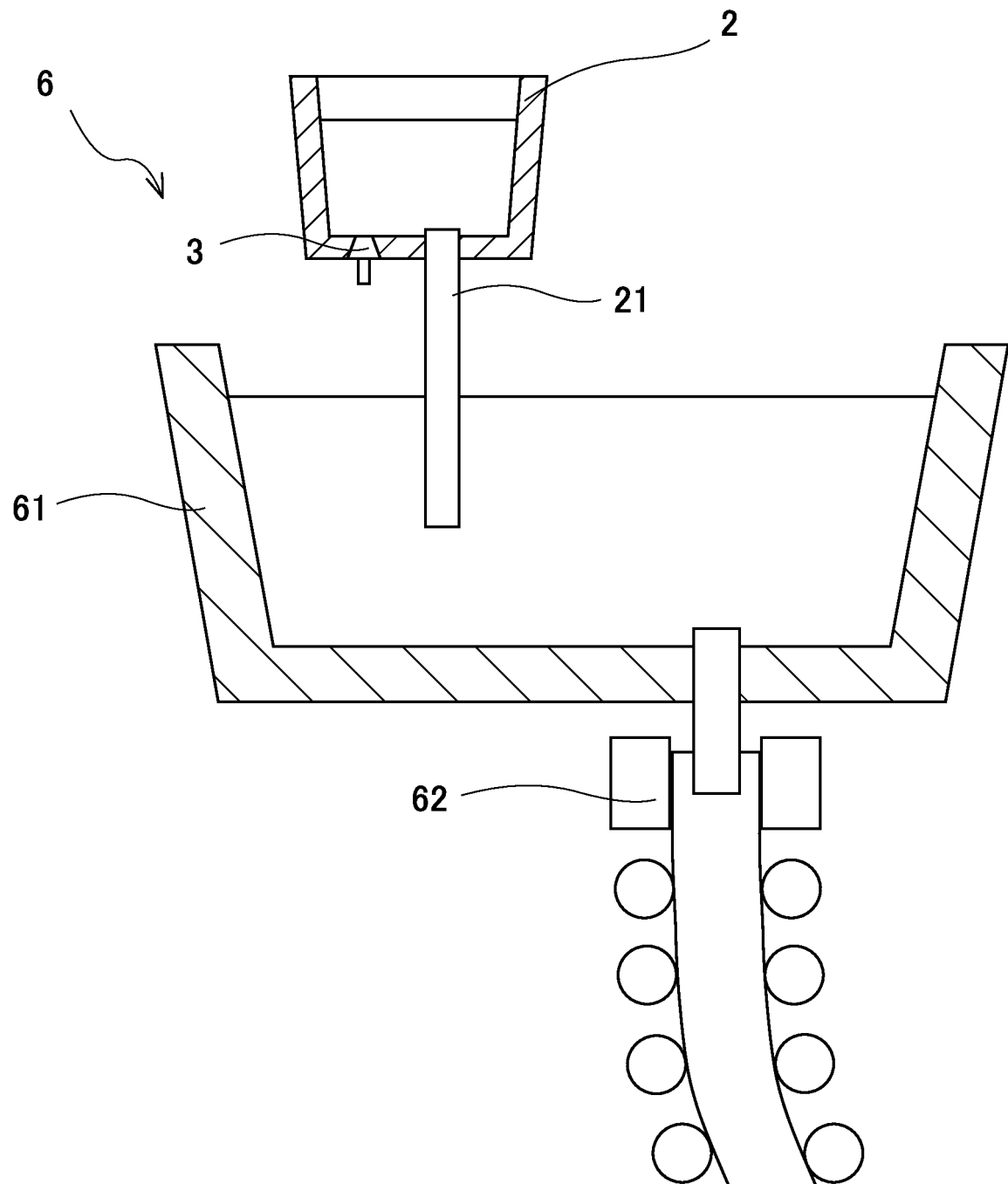


Fig. 3



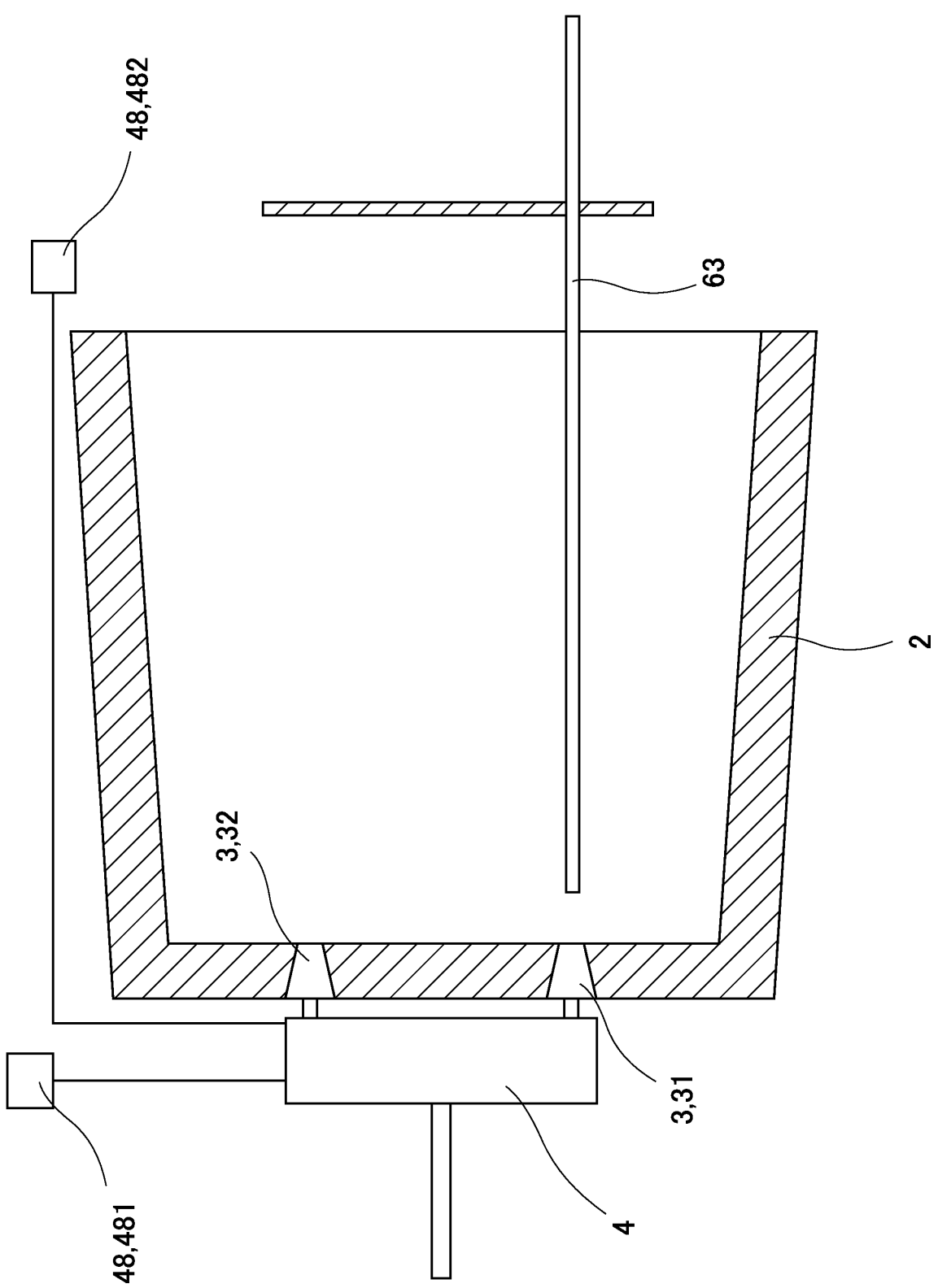


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/011103

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. B22D43/00 (2006.01) i, C21C7/072 (2006.01) i, B22D1/00 (2006.01) i,
B22D11/10 (2006.01) i, B22D41/00 (2006.01) i
FI: B22D41/00 Z, B22D43/00 F, B22D1/00 P, B22D11/10 310A, C21C7/072 P, C21C7/072 J

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. B22D43/00, C21C7/072, B22D1/00, B22D11/10, B22D41/00

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2021
Registered utility model specifications of Japan 1996-2021
Published registered utility model applications of Japan 1994-2021

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	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 112212/1991 (Laid-open No. 54533/1993) (KAWASAKI ROZAI KK) 20 July 1993, paragraphs [0008], [0009], [0012]-[0015], fig. 1	1-3
A	JP 2012-135779 A (SUMITOMO METAL INDUSTRIES, LTD.) 19 July 2012, entire text, all drawings	1-3
A	JP 2009-018321 A (TOKYO YOGYO KK) 29 January 2009, entire text, all drawings	1-3



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
30.04.2021Date of mailing of the international search report
18.05.2021

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2021/011103

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 5-54533 U1	20.07.1993	(Family: none)	
JP 2012-135779 A	19.07.2012	(Family: none)	
JP 2009-018321 A	29.01.2009	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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