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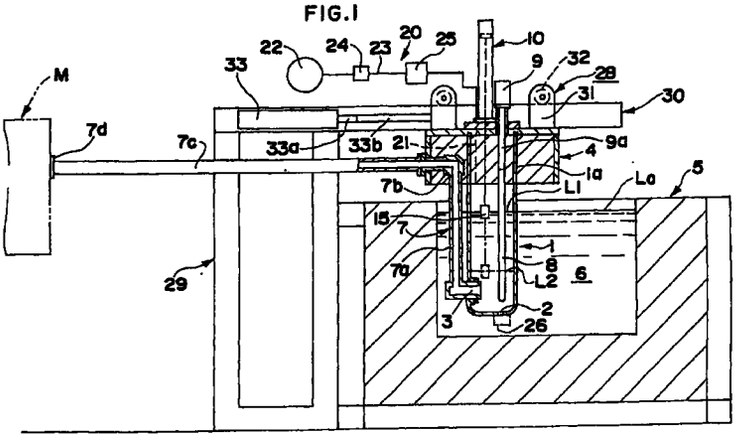
(54) APPARATUS FOR SUPPLYING MOLTEN METAL AT PREDETERMINED RATE

(57) A system for feeding molten metal in constant quantity to a die casting machine comprises a sealed pot 1 having an ingress port 2 and an egress port 3 and arranged in the inside of a molten metal holding furnace 5; a molten metal delivery tube 7 having one end communicated with the egress port 3; a pair of valves 8, 38 for opening and closing the ingress port 2 and the egress port 3 of the pot 1 due to the perpendicular motion; a level detecting mechanism 10 for detecting the upper limit level L1 and the lower limit level L2 of the molten metal in the inside of the pot; an inside pressure controller system 20 adapted for increasing an inside pressure in the pot by charging an inactive gas and for decreasing the inside pressure in the pot by discharging the once compression-charged inactive gas to the open air or by sucking the once compression-charged inactive gas forcibly from the pot; wherein the molten metal let in through the ingress port 2 into the inside of the pot 1 is depressed from an upper limit level L1 to a lower limit level L2 by the pressure of the charged gas and so is delivered from the inside of the pot through the egress port 3 with the delivery tube 7.

FIG.1



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Description

Technical Field

[0001] The present invention relates to a molten metal feeding system for feeding molten metal in constant quantity at each time, such as aluminum alloy or the others, from a molten metal holding furnace to a die casting machine in which the molten metal is replenished and stored in the holding furnace after being melted in a metal melting furnace.

Background Art

[0002] A conventional molten metal feeding system is so constructed that molten metal kept in a holding furnace is forced onwards through a molten metal delivery tube into a die casting machine by the aid of an electromagnetic pump set in the half way of the delivery tube which is extended from the holding furnace and connected to the die casting machine.

[0003] Where the molten metal is of nonferrous metal such as aluminum alloy and the like and undesiredly gets mixed with magnetic material such as iron and the like, the conventional feeding system has the electromagnetic pump clogged with the ingredient of magnetic material which is attracted to the inside of the electromagnetic pump, and results in a breakdown. Further problems are raised in quantity and constant feed of the delivered molten metal and in cost of production, since the molten metal flowing in the delivery tube cannot be halted at once when the pump stops and the electromagnetic pump is expensive.

[0004] In view of the above-described problems, it is an objective of the present invention to provide a molten metal feeding system capable of steadily feeding the molten metal in constant quantity at each time to the die casting machine without trouble and of being produced in a reduced cost.

Disclosure of the Invention

[0005] As defined in claim 1, the system for feeding molten metal in constant quantity of the invention comprises : a sealed pot 1 having an ingress port 2 and an egress port 3 on the bottom side thereof and arranged at a predetermined level in the inside of a molten metal holding furnace 5; a molten metal delivery tube 7 having one end communicated with the egress port 3 and the other end communicated with a pouring gate of a die casting machine M; a valve 8 for opening and closing the ingress port 2 of the pot 1 due to the perpendicular motion exerted by a valve actuating means interconnected with the valve; a level detecting mechanism 10 for detecting an upper limit level L1 and a lower limit level L2 of the molten metal in the inside of the pot 1; and an inside pressure controller system 20 adapted for increasing an inside pressure in the pot by charging an inactive gas (,i.e. a nitrogen gas or a dry air difficult to react to the molten metal) and for decreasing the inside pressure in the pot by discharging the once compression-charged inactive gas to the open air; wherein the molten metal let in through the ingress port 2 into the inside of the pot is depressed from the upper limit level L1 to the lower limit level L2 by the pressure of the charged gas and is thereby delivered from the inside of the pot through the egress port 3 with the delivery tube 7.

[0006] According to the system for feeding molten metal in constant quantity to a die casting machine of claim 1, the sealed pot having an ingress port and an egress port on the bottom side is arranged at a predetermined level in the inside of a molten metal holding furnace so that the molten metal let in through the ingress port into the inside of the pot is depressed from the upper limit level L1 to the lower limit level L2 by the pressure of the charged gas and is thereby delivered from the inside of the pot through the egress port with the delivery tube. Therefore, the molten metal in the inside of the molten metal holding furnace can be automatically delivered steadily in constant quantity at each time to the die casting machine. Where the molten metal is of nonferrous metal such as aluminium alloy and the like and undesiredly gets mixed with magnetic material, there is no likelihood that the inside of the delivery tube is clogged with the ingredient of magnetic material as in the case of using the electromagnetic pump and the system falls into a breakdown, since the inside pressure system is incorporated for letting the molten metal in and out with the aid of the inactive gas. This enables the production in a relative reduced cost.

[0007] As defined in claim 2, the system for feeding molten metal in constant quantity to a die casting machine of the invention comprises: a sealed pot 1 having an ingress port 2 and an egress port 3 on the bottom side thereof and arranged at a predetermined level in the inside of a molten metal holding furnace 5; a molten metal delivery tube 7 having one end communicated with the egress port 3 and the other end communicated with a pouring gate of a die casting machine M; a pair of valves 8, 38 for each opening and closing the ingress port 2 and the egress port 3 of the pot due to the perpendicular motion exerted by a valve actuating means interconnected with each of the valves, respectively; a level detecting mechanism 10 for detecting an upper limit level L1 and a lower limit level L2 of the molten metal in the inside of the pot 1; ad an inside pressure controller system 40 adapted for increasing an inside pressure in the pot by charging an inactive gas (,i.e. a nitrogen gas or a dry air difficult to react to the molten metal) and for decreasing the inside pressure in the pot by discharging the once compression-charged inactive gas to the open air; wherein the molten metal let in through the ingress port 2 into the inside of the pot is depressed from the upper limit level L1 to the lower limit level L2 by the pressure of the charged gas and is

thereby delivered from the inside of the pot through the egress port 3 with the delivery tube 7.

[0008] According to the system for feeding molten metal in constant quantity of claim 2, a pair of the valves for each opening and closing the ingress port and the egress port of the pot are provided in juxtaposition and the inside pressure controller system is provided for decreasing the inside pressure in the pot by discharging the once compression-charged inactive gas to the open air so that, when the pressure controller system performs the discharge of the inactive gas from the pot with the switching of the switch valve, the molten metal in the holding furnace is forced to flow through the ingress port into the pot in a state where the valve for the egress port closes due to the downward motion. Therefore, the flowing quantity of the molten metal from the holding furnace 5 into the pot 1 can be regulated quantitatively in a constant amount, and thus the delivered quantity from the pot at each time can be kept to a constant quantity.

[0009] As defined in claim 3, the system for feeding molten metal in constant quantity to a die casting machine of the invention comprises: a sealed pot 1 having an ingress port 2 and an egress port 3 on the bottom side thereof and arranged at a predetermined level in the inside of a molten metal holding furnace 5; a molten metal delivery tube 7 having one end communicated with the egress port 3 and the other end communicated with a pouring gate of a die casting machine M; a pair of valves 8, 38 for each opening and closing the ingress port 2 and the egress port 3 of the pot due to the perpendicular motion exerted by a valve actuating means interconnected with each of the valves, respectively; a level detecting mechanism 10 for detecting an upper limit level L1 and a lower limit level L2 of the molten metal in the inside of the pot 1; and an inside pressure controller system 40 adapted for increasing an inside pressure in the pot by charging an inactive gas (,i.e. a nitrogen gas or a dry air difficult to react to the molten metal) and for decreasing the inside pressure in the pot by sucking the once compression-charged inactive gas forcibly from the pot; wherein the molten metal let in through the ingress port 2 into the inside of the pot is depressed from the upper limit level L1 to the lower limit level L2 by the pressure of the charged gas and is thereby delivered from the inside of the pot through the egress port 3 with the delivery tube 7.

[0010] According to the system for feeding molten metal in constant quantity of claim 3, a pair of the valves for each opening and closing the ingress port and egress port of the pot are provided in juxtaposition and the inside pressure controller system is provided for decreasing the inside pressure in the pot by sucking the once compression-charged inactive gas forcibly from the pot. therefore, in addition to the effects of the claim 2, where the surface of a body of the molten metal stored in the holding furnace is lessened and thus lowered by the delivery of the molten metal from the pot, the upper limit level L1 in the inside of the pot 1 can be always kept to a fixed position, so that is no need of the frequent replenishment of the molten metal holding furnace with supplemental molten metal, resulting in feasibility of the supplement work of the molten metal and delivery in more constant quantity.

[0011] As defined in claim 4, in the system for feeding molten metal in constant quantity to a die casting machine according to any one of claims 1 to 3, the valve actuating means comprises a fluid pressure actuator 9, 39 erected on an upper side of the pot with a piston rod 9a, 39a thereof joined to the valve 8, 38, which valve is shaped like a bar.

[0012] According to the system for feeding molten metal in constant quantity of claim 4, the fluid pressure actuator is used in a condition of being erected on the upper side of the pot as a driving means of the valve and is joined to the bar-shaped valve, so that the driving means of the valve can be simplified and made compact.

[0013] As defined in claim 5, in the system for feeding molten metal in constant quantity according to any one of claims 1 to 3, the pot 1, the valve 8 and the molten metal delivery tube 7 each are made out of ceramics.

[0014] According to the system for feeding molten metal in constant quantity of claim 5, since the pot, the valve and the molten metal delivery tube each are made out of ceramics, these is superior in heat resistance and can be produced in a reduced cost.

[0015] As defined in claim 6, in the system for feeding molten metal in constant quantity according to any one of claims 1 to 3, the ingress port 2 of the pot 1 is provided on the outside thereof with a filter 26 of ceramics for removing impure materials.

[0016] According to the system for feeding molten metal in constant quantity of claim 6, the mounting of the filter on the ingress port at the outer side of the pot enables the removing of oxides, dust and the other contained in the molten metal in the holding furnace, the delivery of the molten metal of a good quality to the die casting machine.

Brief Description of the Drawings

[0017]

Fig. 1 is an elevational side view, in longitudinal section, of the molten metal feeding system of the first specific form of the invention;

Fig. 2 is a plan view of the molten metal feeding system shown in Fig. 1;

Fig. 3 is an enlarged section of a part of the molten metal feeding system shown in Fig. 1;

Fig. 4 is an elevational side view, in longitudinal section, of the molten metal feeding system of the second specific form of the invention;

Fig. 5 is an enlarged section of a part of the molten metal feeding system shown in Fig. 4;

Fig. 6 is an elevational side view, in longitudinal

section, of the molten metal feeding system of the third specific form of the invention; and

Fig. 7 is an enlarged section of one embodiment of a level detecting mechanism.

Best Mode for Carrying Out the invention

[0018] The first specific form of the molten metal feeding system of the invention shown in Fig. 1 is a particular application to a case in which molten metal especially of aluminum alloy is fed to a die casting machine. Figs. 2 shows the plan view and Fig. 3 shows the enlarged section of a part of the first specific form. In these figures, the numeral 1 indicates a pot of hollow cylinder closed at the bottom, which has a molten metal ingress port 2 and a molten metal egress port 3 at the position related to the bottom. The pot 1 is made out of ceramics and is arranged perpendicularly at a predetermined level in the inside of an open type molten metal holding furnace 5 while the upper end 1a of the pot 1 is supported in a sealed condition by a support block 4 of heat-resistant material meeting the requirement and the remainings of the pot 1 is suspended from the support block 4. The holding furnace 5 contains a body of molten metal 6 of aluminum alloy stored substantially fully in the inside thereof, which molten metal is supplied from a metal melting furnace. In this manner, the pot 1 is immersed, as shown in Fig. 1, in the body of molten metal 6.

[0019] The numeral 7 indicates a molten metal delivery tube of ceramics, of which one end is communicated with the egress 3 of the pot 1 and the other end is adapted to be communicated with a pouring gate (not shown) of a die casting machine M. The delivery tube 7 has three sections, i.e. a vertical section 7a extending vertically from the egress 3 along the outside of the pot 1, a bend section 7b passing through the support block 4 and supported therein, and a horizontal section 7c running horizontally from the bend section to the die casting machine M. A free end 7d of the horizontal section 7c is adapted to be pressed on the pouring gate of the casting machine M. Incidentally, a heater (omitted in the drawing) is set to the delivery tube 7 so that the molten metal from the pot 1 can be fed keeping appropriate temperature.

[0020] The numeral 8 indicates a valve for opening and closing the ingress port 2 of the pot 1 due to the perpendicular motion in stroke exerted by a fluid pressure actuator 9 serving as a means of actuating the valve 1. The valve 8 is of ceramics and comprises, as shown in Fig. 3, a valve proper 8a rounded in the lower end and a valve bar 8b hollow in the inside. The fluid pressure actuator 9 is erected on the support block 4 and its piston rod 9a is inserted into the support block 4 capably of sliding in a sealed manner, and is joined to the valve bar 8b in the inside of the support block 4. In this manner, the elongating action of the actuator 9 causes the downward motion of the valve bar 8b, and then brings about the tight engagement of the valve proper 8a with the ingress port 2, resulting in closing the ingress port 2. On the other hand, the shortening action of the actuator 9 causes the upward motion of the valve bar 8b, and then brings about the release of the valve proper 8a from the ingress port 2, resulting in opening the ingress port 2.

[0021] In the embodiments illustrated in the drawings, the ingress port 2 on the bottom side of the pot 1 is configured in a downwardly open manner, while the valve 8 for opening and closing the ingress port 2 is arranged perpendicularly on the inside of the pot 1. However, in a modification (not shown in the drawings), it is allowed that the ingress port 2 is configured in such a manner as to open upwardly at a hollow projection expanded laterally from a part of the bottom of the pot 1, while the valve 8 for opening and closing the ingress port 2 is arranged perpendicularly on the outside of the pot 1.

[0022] The numeral 10 indicates a level detecting mechanism for detecting the upper limit level L1 and the lower limit level L2 of molten metal in the inside of the pot 1. The upper limit level L1 refers to a surface of molten metal in the inside of the pot 1 at the time of the start of the feeding of the molten metal to the die casting machine, and is inclined to become identical to the surface level Lo of the body of molten metal inside the holding furnace 5 and outside the pot 1. On the other hand, the lower limit level L2 refers to a surface of molten metal in the inside of the pot 1 at the time of ending of the feeding of the molten metal to the die casting machine. In the level detecting mechanism 10 particularly shown as an example in Fig. 7, a flange member 12 is fixed on the support block 4 by way of a plate piece 11 located just above the pot 1, a guide sleeve 13 being arranged uprightly and fixed in the support block 4, the plate piece 11 and the flange member 12 in a piercing manner, and an elongated floating shaft 14 being so arranged as to extend through the guide sleeve 13 while the lower and upper ends of the floating shaft 14 are provided with a float 15 and a detection member 16, respectively. Further, a transparent cylindrical cover 17 with an upper end thereof closed is arranged uprightly and fixed on the flange member 12 so as to accommodate the upwardly extending portion of the floating shaft 14 as well as the detection member 16. In the outer side of the cylindrical cover 17, there are provided photoelectric switches 18, 19 as a detecting means of the detection member 16 at the upper and lower level levels so as to be adjustable in their own level positions, which switches comprises a pair of a light projector 18a, 19a and a light receiver 18b, 19b. In this manner, the upper side photoelectric switch 18 can detect the upper limit level L1 of the molten metal in the inside of the pot by way of the detection member 16, and the lower side photoelectric switch 19 can detect the lower limit level L2 by way of the detection member 16.

[0023] The above-described plate piece 11, flange member 12, guide sleeve 13, float shaft 14, float 14,

detection member and cylindrical cover 17 each are made out of ceramics. The detecting means of the detection member 16 is not limited to the photoelectric switch, but can use the other switches such as a proximity switch. Incidentally, the above-described level detecting mechanism 10 is of a float type, but also can be of the other type to directly measure the surface of the molten metal 6 in the pot 1 by way of laser beams, or be of a capacitance type level gauge.

[0024] The numeral 20 in Fig. 1 indicates an inside pressure controller system adapted for increasing the inside pressure in the pot 1 by charging an inactive gas (a nitrogen gas or a dry air difficult to react to the molten metal), and for decreasing the inside pressure in the pot 1 by discharging the once compression-charged inactive gas to the open air. The inside pressure controller system 20 comprises a gas charging source 22 which includes a tank for accommodating an inactive gas and a gas charging pump and is connected by a way of a guide line 23 to a gas passing pipe 21 (see Figs. 1 and 2) which is arranged in the plate piece 11 and the support block 4 so as to communicate with the inside of the pot 1. In the guide line 23, there are interposed a pressure adjusting valve 24 and an electromagnetic switch valve 25. The electromagnetic switch valve 25 is electrically connected with a control unit of the fluid pressure actuator 9 (not shown in the drawing) and the photoelectric switches 18, 19 of the level detecting mechanism 10. As for the pressure adjusting valve 24, an electric control type pressure control valve can be used for altering the inside pressure in the pot 1 desiredly.

[0025] In this manner, for increasing the inside pressure in the pot 1 by charging the inactive gas, the switch valve 25 is so operated as to let the gas to flow from the gas charging source 22 to the gas passing pipe 21. On the other hand, for decreasing the inside pressure in the pot 1, the switch valve 25 is so operated as to stop the gas flowing from the gas charging source 22 and make the gas passing pipe 21 to communicate with the open air through a gas discharging route. The adjustment of the inside pressure in the pot is performed by the pressure adjusting valve 24. Incidentally, for the gas charging source 22, a high pressure cylinder filled with the inactive gas also can be used.

[0026] In the ingress port 2 of the pot 1, there is mounted on the outside thereof a filter 26 of ceramics for removing impure materials such as oxides, dust and the others contained in the molten metal 6 in the holding furnace 5. The filter 26 is formed into a shape like a box as shown in Fig. 3, a semisphere or the other desired shapes, and is porous with about 10 to 60 meshes. The mounting of the filter 26 is performed by engaging an upper collar portion 26a of the filter 26 with a bent projection 27 provided on the outside of the bottom of the pot 1. The filter 26 is not essential, but is used if need be.

[0027] The above-described delivery tube 7 is communicated with a horizontal displacement mechanism 28 of a fluid pressure actuator type so as to move in a horizontal direction together with the pot 1. Particularly, the horizontal displacement mechanism 28 is so constructed, as shown in Figs. 1 and 2, that pairs of right and left wheels 32, installed by way of brackets 31 on the support block 4, can roll on right and left horizontal guide rails 30a which are formed on support frames 30 at the right and left sides extended horizontally from both the lateral sides of the upper end of a base frame 29 standing upright close to the holding furnace 5, and that a fluid pressure actuator 33 installed on the base frame 29 is connected by a piston rod 33a and a connecting rod 33b to the support block 4. The telescopic action of the fluid pressure actuator 33 enables the pot 1 and the delivery tube 7 integral with the support block 4 to move longitudinally in a horizontal direction and thereby can ensure the engagement of the free end 7d of the delivery tube 7 with the pouring gate (not shown) of the die casting machine M in a pressing manner.

[0028] The operations of the molten metal feeding system constructed above are as follows:

[0029] At the first stage where the inside of the pot 1 is communicated with the open air and the ingress port 2 of the pot is put openly due to the upward motion of the valve 8, the molten metal 6 in the holding furnace 5 flow through the ingress port 2 into the inside of the pot 1 and rises up to the upper limit level L1, which is detected by the level detecting mechanism 10. Particularly, with the rise of the molten metal in the inside of pot 1, the float 15 on the surface of the molten metal rises up to the upper limit level L1 and at the same time the floating shaft 14 and the detection member 16 also rise. When the detection member 16 rises to a position related to the upper limit level L1, the detection member 16 is sensed by the photoelectric switch 18. At this time, the sensing signal from the photoelectric switch 18 activates the fluid pressure actuator 9 into an elongating motion so that the valve 8 moves downwardly and then closes the ingress port 2. At the same time, the inside pressure controller system 20 activates so as to charge the inactive gas through the gas passing pipe 21 into the inside of the pot 1. Thereby, the molten metal in the inside of the pot 1 undergoes the pressure and is caused to flow through the egress port 7 into the delivery tube 7. At the second stage where the molten metal surface in the inside of the pot 1 then drops down to the lowest level L2 , the detection member 16 also drops to a position related to the lower limit level L2, which is sensed by the photoelectric switch 19. At this time, the sensing signal from the photoelectric switch 19 activates the fluid pressure actuator 9 into a shortening motion so that the valve 8 moves upwardly and then opens the ingress port 2. At the same time, the inside pressure controller system 20 activates so as to discharge the once compression-charged inactive gas in the inside of the pot 1 to the open air through the gas discharging route formed by the switch valve 25.

Thereby, the molten metal in the holding furnace 5 flows in the inside of the pot 1. Sequentially, those stages are repeated.

[0030] The inside molten metal in the pot 1, which, as described above, undergoes the pressure due to the inactive gas charged into the pot 1 and drops from the upper limit level L1 to the lower limit level L2, is fed through the delivery tube 7 by a specified quantity equivalent to the product of the interval between both the limit levels L1 and L2 by the sectional area of the inside of the pot 1. As a result, as long as the interval between both the limit levels L1 and L2 is kept to a specified value, repetition of the above two stages enables the feeding of the molten metal of a quantity proportional to the repetition. The fed quantity of the molten metal is desiredly adjustable by altering perpendicularly the position of the lower side photoelectric switch 19 of the level detecting mechanism.

[0031] Incidentally, on the use of the present molten metal feeding system, the molten metal 6 stored in the holding furnace 5 is lessened by a quantity of the melted metal fed through the delivery tube 7 from the pot 1 each time, so that the surface level Lo of the molten metal 6 in the holding furnace 5 is lowered step by step. Therefore, for the purpose of keeping the interval between the upper limit level L1 and the lower limit level L2 to a specified value, it is required to make the capacity of the holding furnace 5 as large as possible. In addition, for the purpose of keeping the surface of the molten metal in the holding furnace 5 from dropping, it is required to replenish the holding furnace 5 with a supplemental molten metal under constant detection of the surface level Lo in the holding furnace 5.

[0032] The second specific form of the invention shown in Figs. 4 and 5 is different from the above described first specific form in that there is provided a valve 38 for opening and closing the egress port 3 of the pot 1 due to the perpendicular motion with a fluid actuator 39, in addition to the above-described valve 8 for opening and closing the ingress port 2. Except for this respect, the second specific form has the same construction as the first specific form. Thus, the same constituent elements are indicated by the same reference numerals and the description about the same elements are omitted in the following.

[0033] Particularly, the valve 38 for the egress 3 is almost similar to the valve 8 for the ingress port 2, and is of ceramics and comprises, as shown in Fig. 5, a valve proper 38a rounded in the lower end and a valve bar 38b. The fluid pressure actuator 39 is erected on the support block 4 side by side with the fluid pressure actuator 9 for the ingress valve 8 and its piston rod 39a is inserted into the support block 4 capably of sliding in a sealed manner, and is joined to the valve bar 38b in the inside of the support block 4. In this manner, the elongating action of the actuator 39 causes the downward motion of the valve bar 38b, and then brings about the tight engagement of the valve proper 38a with the egress port 3, resulting in closing the egress port 3. On the other hand, the shortening action of the actuator 39 causes the upward motion of the valve bar 38b, and then brings about the release of the valve proper 38a from the egress port 3, resulting in opening the egress port 3.

[0034] Incidentally, an inside pressure controller system, similarly to that in the first specific form, comprises a gas charging source 22 which includes a tank for accommodating an inactive gas and a gas charging pump and is connected by a way of a guide line 23 to a gas passing pipe 21. In the guide line 23, there are interposed a pressure adjusting valve 24 and an electromagnetic switch valve 25. The electromagnetic switch valve 25 is electrically connected with a control unit of the fluid pressure actuator 9 and the photoelectric switches 18, 19 of the level detecting mechanism 10. In this manner, for increasing the inside pressure in the pot 1 by charging the inactive gas, the switch valve 25 is so operated as to let the gas to flow from the gas charging source 22 to the gas passing pipe 21. On the other hand, for decreasing the inside pressure in the pot 1, the switch valve 25 is so operated as to stop the gas flowing from the gas charging source 22 and make the gas passing pipe 21 to communicate with the open air through a gas discharging route. The adjustment of the inside pressure in the pot is performed by the pressure adjusting valve 24. Incidentally, as for the pressure adjusting valve 24, an electric control type pressure control valve can be used, similarly to the first embodiment, for altering the inside pressure in the pot 1 desiredly. As for the gas charging source 22, a high pressure cylinder filled with the inactive gas also can be used. The above-described operations are the same as in the first specific form.

[0035] On the use of the molten metal feeding system constructed above, in a situation where the ingress port 2 of the pot 1 is put in an open position due to the upward motion of the ingress valve 8 while the egress port 3 of the pot 1 is put in a closed position due to the downward motion of the egress valve 38, the inside of the pot 1 is caused to communicate with the open air by the inside pressure controller system 20, so that the molten metal 6 in the holding furnace 5 flows through the ingress port 2 into the inside of the pot 1 and rises up to the upper limit level L1, which is detected by the level detecting mechanism 10. Particularly, with the rise of the molten metal in the inside of pot 1, the float 15 on the surface of the molten metal rises and the detection member 16 by way of the floating shaft 14 also rise. When the detection member 16 rises to a position related to the upper limit level L1, the detection member 16 is sensed by the photoelectric switch 18.

[0036] At this time, the sensing signal from the photoelectric switch 18 activates the fluid pressure actuator 9 into an elongating motion to move the valve 8 downwardly and then close the ingress port 2, and also activates the fluid pressure actuator 39 into an elongating motion to move the valve 38 upwardly and then open

the egress port 3. At the same time, the inside pressure controller system 20 activates so as to charge the inactive gas through the gas passing pipe 21 into the inside of the pot 1. Thereby, the molten metal in the inside of the pot 1 undergoes the pressure and is caused to flow through the egress port 3 into the delivery tube 7. Then, the molten metal surface in the inside of the pot 1 drops down to the lower limit level L2 , and the detection member 16 also drops to a position related to the lower limit level L2, which is sensed by the photoelectric switch 19. At this time, the sensing signal from the photoelectric switch 19 activates the fluid pressure actuator 9 into a shortening motion to move the valve 8 upwardly and then open the ingress port 2, and also activates the fluid pressure actuator 39 into an elongating motion to move the valve 38 downwardly and then close the egress port 3. At the same time, the inside pressure controller system 20 activates so as to discharge the once compression-charged inactive gas in the inside of the pot 1 through the gas passing pipe 21 and the gas discharging route formed by the switch valve 25 to the open air. Thereby, the molten metal in the holding furnace 5 flows in the inside of the pot 1. Sequentially, those processes are repeated.

[0037] According to the above-described molten metal feeding system, the inside molten metal in the pot 1, which, as described above, undergoes the pressure due to the inactive gas charged into the pot 1 and drops from the upper limit level L1 to the lower limit level L2, is fed through the delivery tube 7 by a specified quantity equivalent to the product of the interval between both the limit levels L1 and L2 by the sectional area of the inside of the pot 1. As a result, the repetition of the above processes enables the feeding of the molten metal of a quantity proportional to the repetition. The fed quantity of the molten metal is desiredly adjustable by altering perpendicularly the position of the upper and lower side photoelectric switches 19 of the level detecting mechanism. In this case, either or both of the upper and lower side photoelectric switches 19 may be changed in position.

[0038] In the present molten metal feeding system, when the molten metal in the pot 1 lowers down to the lower limit level L2 and the detection signal activates the pressure controller system 20 so as to discharge from the pot 1 with the switching of the switch valve 25, the molten metal in the holding furnace 5 is forced to flow through the ingress port 2 into the pot 1 in a state where the valve 38 for the egress port 3 closes due to the downward motion. Accordingly, the flowing quantity of the molten metal from the holding furnace 5 into the pot 1 can be regulated quantitatively. For example, there is no likelihood that a part of the molten metal flown into the pot 1 escapes through the egress port 3 of the pot 1.

[0039] The third specific form of the molten metal feeding system of the invention shown in Fig. 6 is different from the above-described second form in that there is provided an inside pressure controller system 40 adapted to reduce also the inside pressure in the pot 1 by sucking the once compression-charged inactive gas forcibly from the pot 1. Except for this respect, the third specific form has the same construction as the second specific form. Thus, the same constituent elements are indicated by the same reference numerals and the description about the same elements are omitted.

[0040] Particularly, the inside pressure controller system 40 comprises, as shown in Fig. 6, a gas tank 34 for accommodating an inactive gas and a gas charging pump 35 for feeding the inactive gas in the inside of the tank 34 , which tank 34 and pump 35 both are connected by a way of a guide line 36 to the gas passing pipe 21. In the guide line 36, there are interposed a pressure adjusting valve 37 and an electromagnetic switch valve 41. Further, the electromagnetic switch valve 41 and the gas tank 37 are connected by a bypass line 42, in which there are interposed a sucking pump 43 and a pressure adjusting valve 44. The electromagnetic switch valve 41 is electrically connected with a control unit (not shown in the drawing) of each of the fluid pressure actuators 9, 39 and the photoelectric switches 18, 19 of the level detecting mechanism 10.

[0041] In this manner, for increasing the inside pressure in the pot 1 by charging the inactive gas, the switch valve 41 is so operated as to cut off the bypass line 42 and let the gas to flow from the gas charging pump 35 to the gas passing pipe 21. On the other hand, for decreasing the inside pressure in the pot 1, the switch valve 41 is so operated as to stop the gas flowing from the gas charging pump 35 to the gas passing pipe 21 and release the bypass line 42. The adjustment of the inside pressure in the pot 1 is performed by the pressure adjusting valves 37,44.

[0042] On the use of the molten metal feeding system constructed above, in a situation where the ingress port 2 of the pot 1 is put in an open position due to the upward motion of the ingress valve 8 while the egress port 3 of the pot 1 is put in a closed position due to the downward motion of the egress valve 38, the inside of the pot 1 is sucked to the outside by the inside pressure controller system 40, so that the molten metal 6 in the holding furnace 5 flows through the ingress port 2 into the inside of the pot 1 and rises up to the upper limit level L1, which is detected by the level detecting mechanism 10. Particularly, with the rise of the molten metal in the inside of pot 1, the float 15 on the surface of the molten metal rises and the detection member 16 by way of the floating shaft 14 also rise. When the detection member 16 rises to a position related to the upper limit level L1, the detection member 16 is sensed by the photoelectric switch 18.

[0043] At this time, the sensing signal from the photoelectric switch 18 activates the fluid pressure actuator 9 into an elongating motion to move the valve 8 downwardly and then close the ingress port 2, and also activates the fluid pressure actuator 39 into an elongating motion to move the valve 38 upwardly and then open

the egress port 3. At the same time, the inside pressure controller system 40 activates so as to charge the inactive gas through the gas passing pipe 21 into the inside of the pot 1. Thereby, the molten metal in the inside of the pot 1 undergoes the pressure and is caused to flow through the egress port 3 into the delivery tube 7. Then, the molten metal surface in the inside of the pot 1 drops down to the lower limit level L2 , and the detection member 16 also drops to a position related to the lower limit level L2, which is sensed by the photoelectric switch 19. At this time, the sensing signal from the photoelectric switch 19 activates the fluid pressure actuator 9 into a shortening motion to move the valve 8 upwardly and then open the ingress port 2, and also activates the fluid pressure actuator 39 into an elongating motion to move the valve 38 downwardly and then close the egress port 3. At the same time, the inside pressure controller system 40 activates so as to discharge or return the once compression-charged inactive gas in the inside of the pot 1 to the gas tank 34 through the gas passing pipe 21 and the bypass line 42 opened by the switch valve 41. Thereby, the molten metal in the holding furnace 5 flows in the inside of the pot 1. Sequentially, those processes are repeated.

[0044] According to the above-described molten metal feeding system, the inside molten metal in the pot 1, which, as described above, undergoes the pressure due to the inactive gas charged into the pot 1 and drops from the upper limit level L1 to the lower limit level L2, is fed through the delivery tube 7 by a specified quantity equivalent to the product of the interval between both the limit levels L1 and L2 by the sectional area of the inside of the pot 1. As a result, the repetition of the above processes enables the delivery of the molten metal of a quantity proportional to the repetition. Similarly to the operations in the first and second specific forms, the delivered quantity of the molten metal is desiredly adjustable by altering perpendicularly the position of the upper and lower side photoelectric switches 18, 19 of the level detecting mechanism. In this case, either or both of the upper and lower side photoelectric switches 18, 19 may be changed in position.

[0045] Especially, in the present molten metal feeding system, there are provided the valve 8 for the ingress port 2 and the valve 38 for the egress port 38 as well as the inside pressure controller system 40 adapted to reduce also the inside pressure in the pot 1 by sucking the once compression-charged inactive gas forcibly from the pot 1. Accordingly, where the surface Lo of a body of the molten metal 6 stored in the holding furnace 5 is lessened and thus lowered by the delivery of the molten metal from the pot 1, the upper limit level L1 in the inside of the pot 1 can be always kept to a fixed position, so that is no need of the frequent replenishment of the molten metal holding furnace 5 with supplemental molten metal, resulting in feasibility of the supplement work of the molten metal and feed in more constant quantity.

[0046] Incidentally, the above-described specific forms are the application mainly to the case of feeding the molten metal of aluminum, but not limited thereto. For example, it is possible to apply to another case of using magnesium or the others as molten metal. In the case of the use of molten metal of magnesium, the pot, valves and delivery tube may be made out of iron.

Industrial Applicability

[0047] As evident from the above description, according to the present invention, the molten metal in the inside of the molten metal holding furnace can be automatically fed steadily in constant quantity to the die casting machine. Where the molten metal is of nonferrous metal such as aluminium alloy and the like and undesiredly gets mixed with magnetic material, there is no likelihood that the inside of the feeding system is clogged with the ingredient of magnetic material as in the case of using the electromagnetic pump and the system falls into a breakdown, since the inside pressure controller system is incorporated for letting the molten metal in and out with the aid of the inactive gas. This enables the production in a relative reduced cost. Further, the use of the inactive gas prevents oxides from being formed on the molten metal surface. In addition, since the molten metal can be fed without suffering the decrease of the temperature, it is not required to supply the heat for maintaining the temperature of the metal melting furnace and the molten metal furnace. This serves for saving energy, and enables the casting of a good quality.

Claims

1. A system for feeding molten metal in constant quantity to die casting machine comprising : a sealed pot having an ingress port and an egress port on the bottom side thereof and arranged at a predetermined level in the inside of a molten metal holding furnace; a molten metal delivery tube having one end communicated with the egress port and the other end communicated with a pouring gate of a die casting machine; a valve for opening and closing the ingress port of the pot due to the perpendicular motion exerted by a valve actuating means interconnected with the valve; a level detecting mechanism for detecting an upper limit level L1 and a lower limit level L2 of the molten metal in the inside of the pot; and an inside pressure controller system adapted for increasing an inside pressure in the pot by charging an inactive gas (,i.e. a nitrogen gas or a dry air difficult to react to the molten metal) and for decreasing the inside pressure in the pot by discharging the once compression-charged inactive gas to the open air; wherein the molten metal let in through the ingress port into the inside of the pot is depressed from the upper limit level L1

to the lower limit level L2 by the pressure of the charged gas and is thereby fed from the inside of the pot through the egress port with the delivery tube.

2. A system for feeding molten metal in constant quantity to a die casting machine comprising : a sealed pot having an ingress port and an egress port on the bottom side thereof and arranged at a predetermined level in the inside of a molten metal holding furnace; a molten metal delivery tube having one end communicated with the egress port and the other end communicated with a pouring gate of a die casting machine; a pair of valves for each opening and closing the ingress port and the egress port of the pot due to the perpendicular motion exerted by a valve actuating means interconnected with each of the valves, respectively; a level detecting mechanism for detecting an upper limit level L1 and a lower limit level L2 of the molten metal in the inside of the pot; and an inside pressure controller system adapted for increasing an inside pressure in the pot by charging an inactive gas (,i.e. a nitrogen gas or a dry air difficult to react to the molten metal) and for decreasing the inside pressure in the pot by discharging the once compression-charged inactive gas to the open air; wherein the molten metal let in through the ingress port into the inside of the pot is depressed from the upper limit level L1 to the lower limit level L2 by the pressure of the charged gas and is thereby fed from the inside of the pot through the egress port with the delivery tube.

3. A system for feeding molten metal in constant quantity to a die casting machine comprising : a sealed pot having an ingress port and an egress port on the bottom side thereof and arranged at a predetermined level in the inside of a molten metal holding furnace; a molten metal delivery tube having one end communicated with the egress port and the other end communicated with a pouring gate of a die casting machine; a pair of valves for each opening and closing the ingress port and the egress port of the pot due to the perpendicular motion exerted by a valve actuating means interconnected with each of the valves, respectively; a level detecting mechanism for detecting an upper limit level L1 and a lower limit level L2 of the molten metal in the inside of the pot; and an inside pressure controller system adapted for increasing an inside pressure in the pot by charging an inactive gas (,i.e. a nitrogen gas or a dry air difficult to react to the molten metal) and for decreasing the inside pressure in the pot by sucking the once compression-charged inactive gas forcibly from the pot; wherein the molten metal let in through the ingress port into the inside of the pot is depressed from the upper limit level L1 to the lower limit level L2 by the pressure of the charged gas and is thereby fed from the inside of the pot through the egress port with the delivery tube.

4. A system for feeding molten metal in constant quantity to a die casting machine according to any one of claims 1 to 3, wherein the valve actuating means comprises a fluid pressure actuator erected on an upper side of the pot with a piston rod thereof joined to the valve, which valve is shaped like a bar.

5. A system for feeding molten metal in constant quantity to a die casting machine according to any one of claims 1 to 3, wherein the pot, the valve and the molten metal delivery tube each are made out of ceramics.

6. A system for feeding molten metal in constant quantity to a die casting machine according to any one of claims 1 to 3, wherein the ingress port of the pot is provided on the outside thereof with a filter of ceramics for removing impure materials.

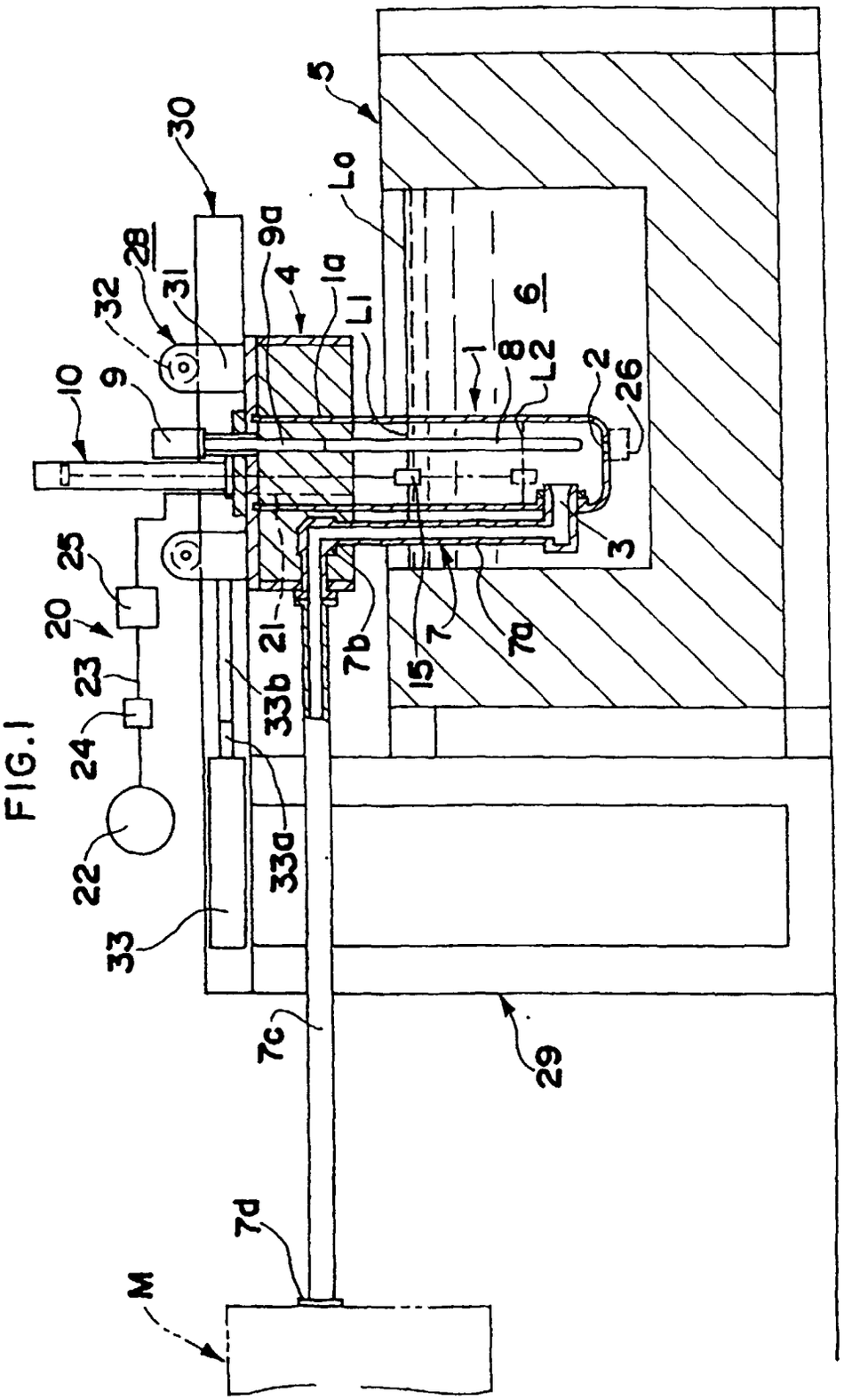
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FIG. 1

FIG.2

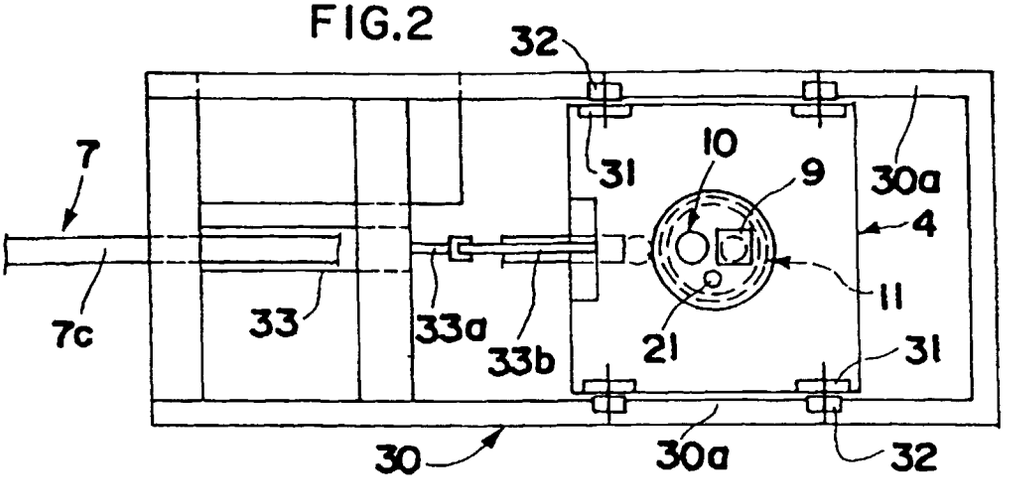
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FIG.3

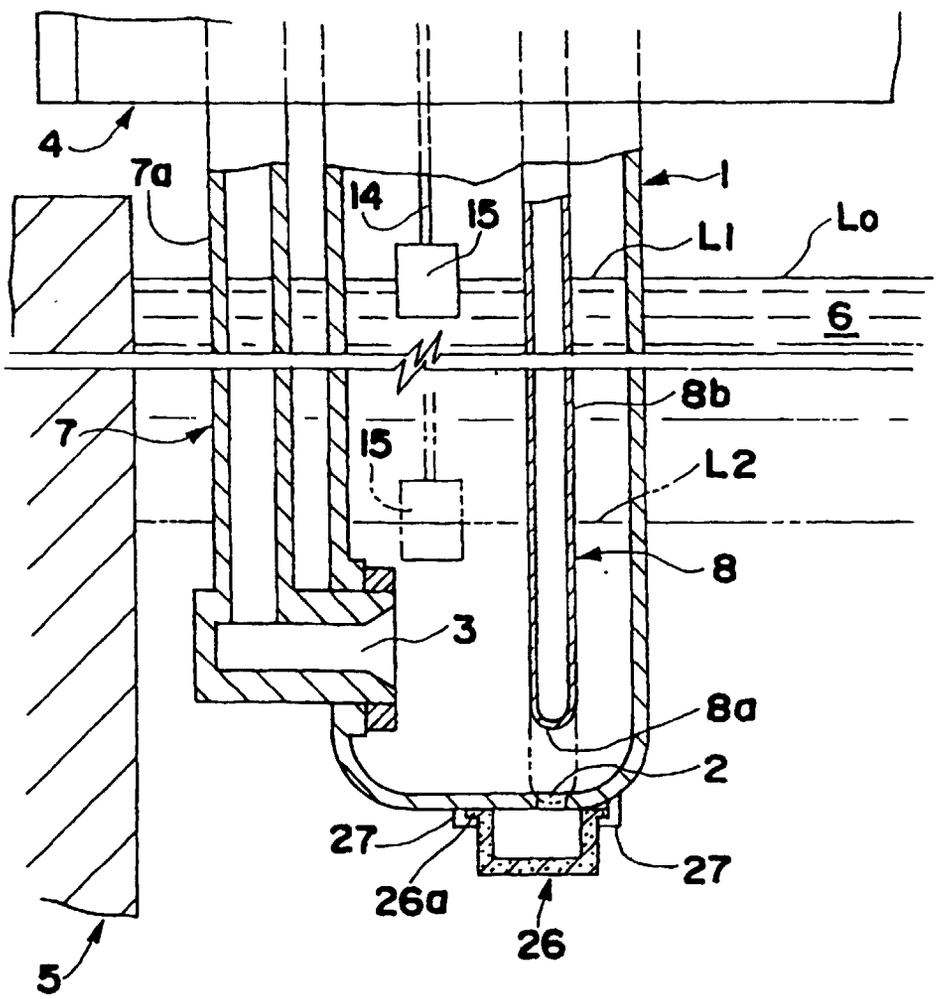
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FIG.4

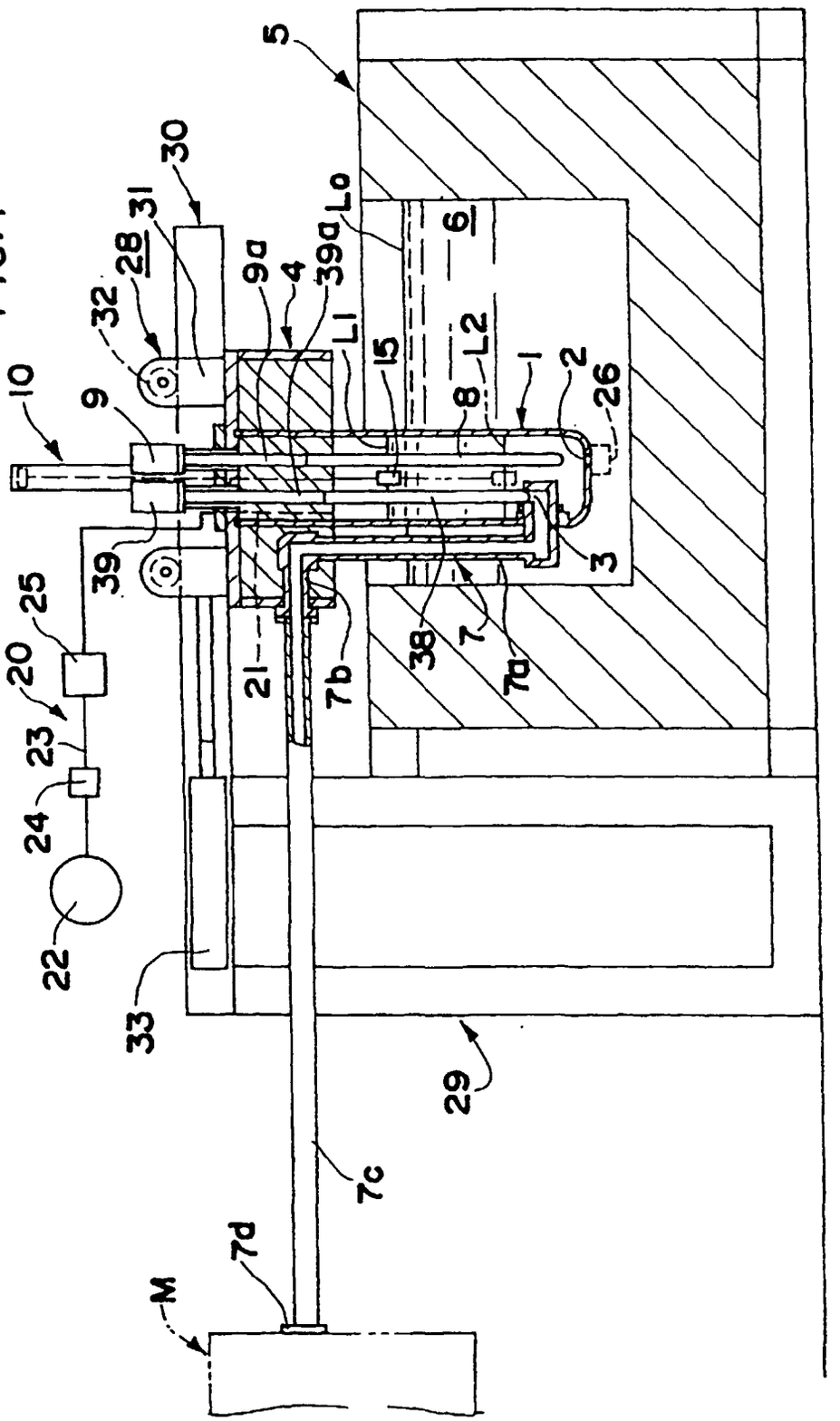
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FIG.5

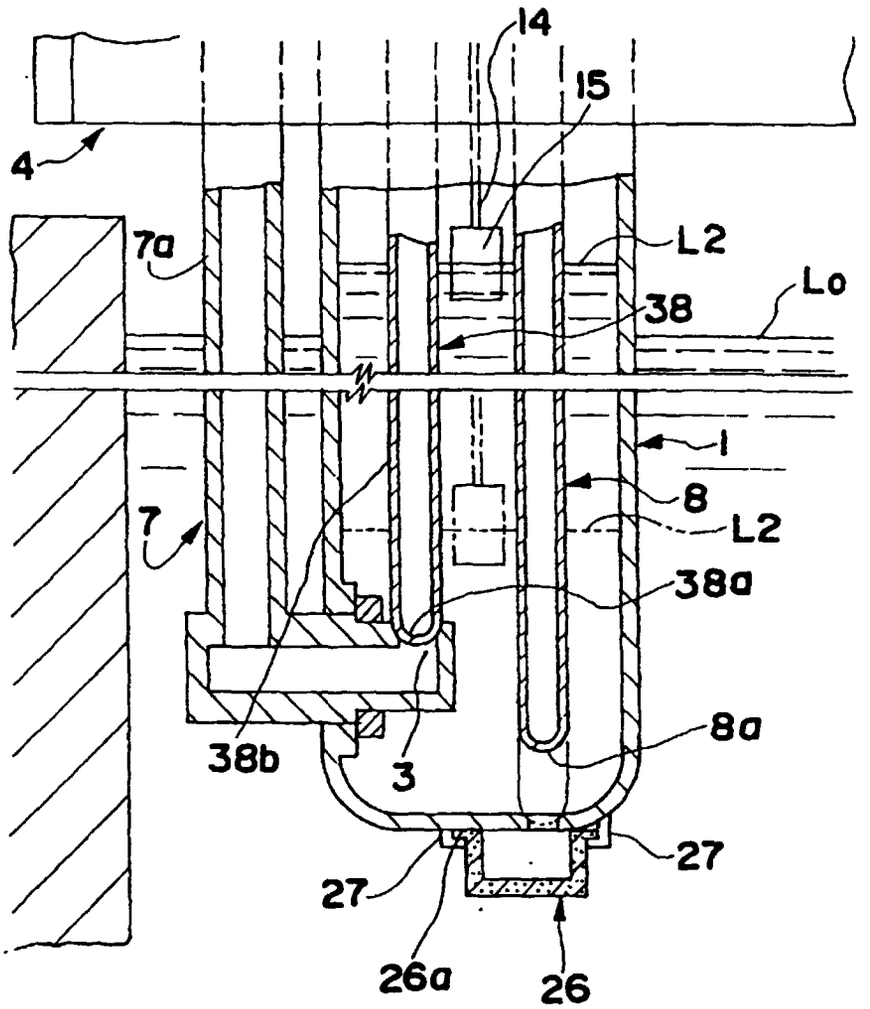

FIG.6

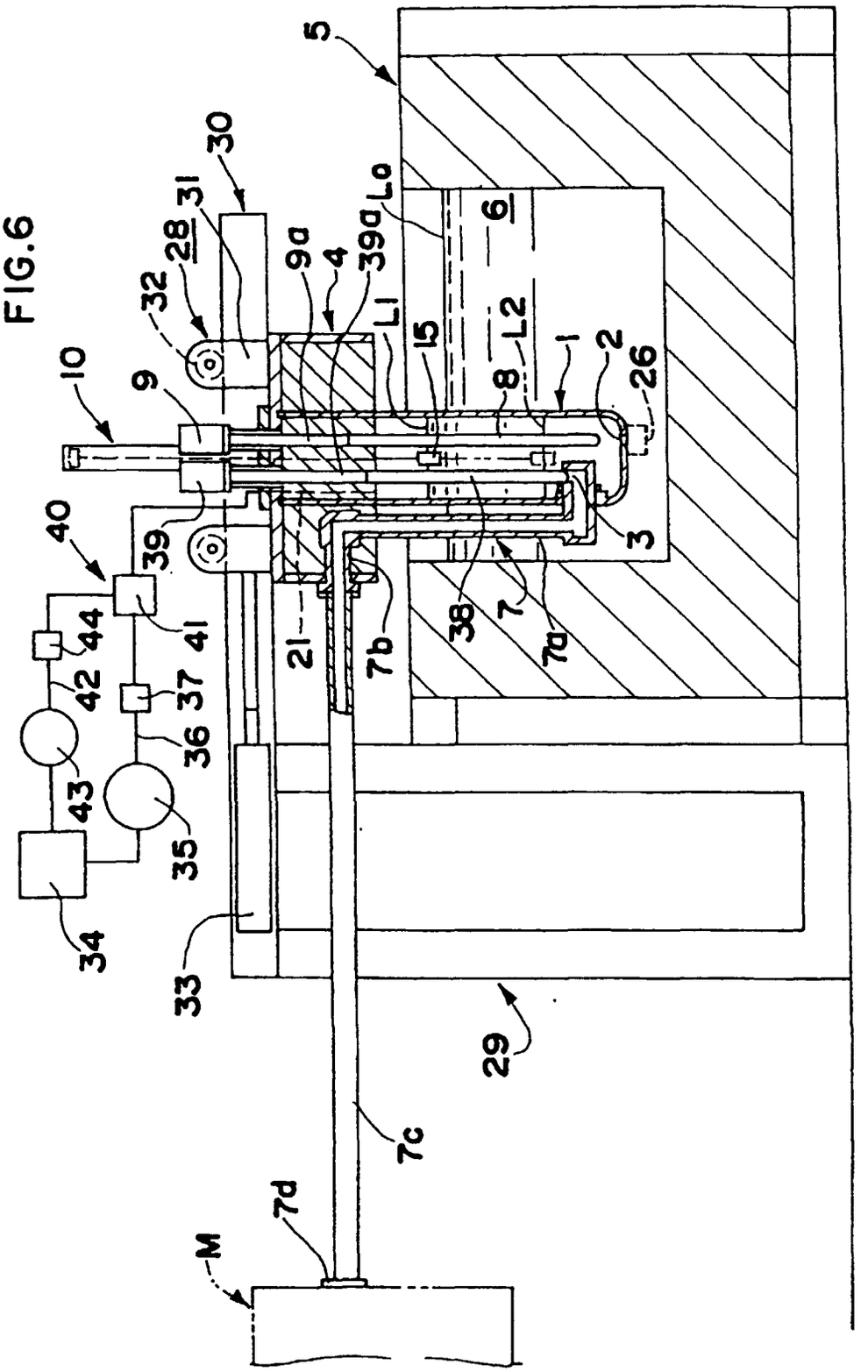
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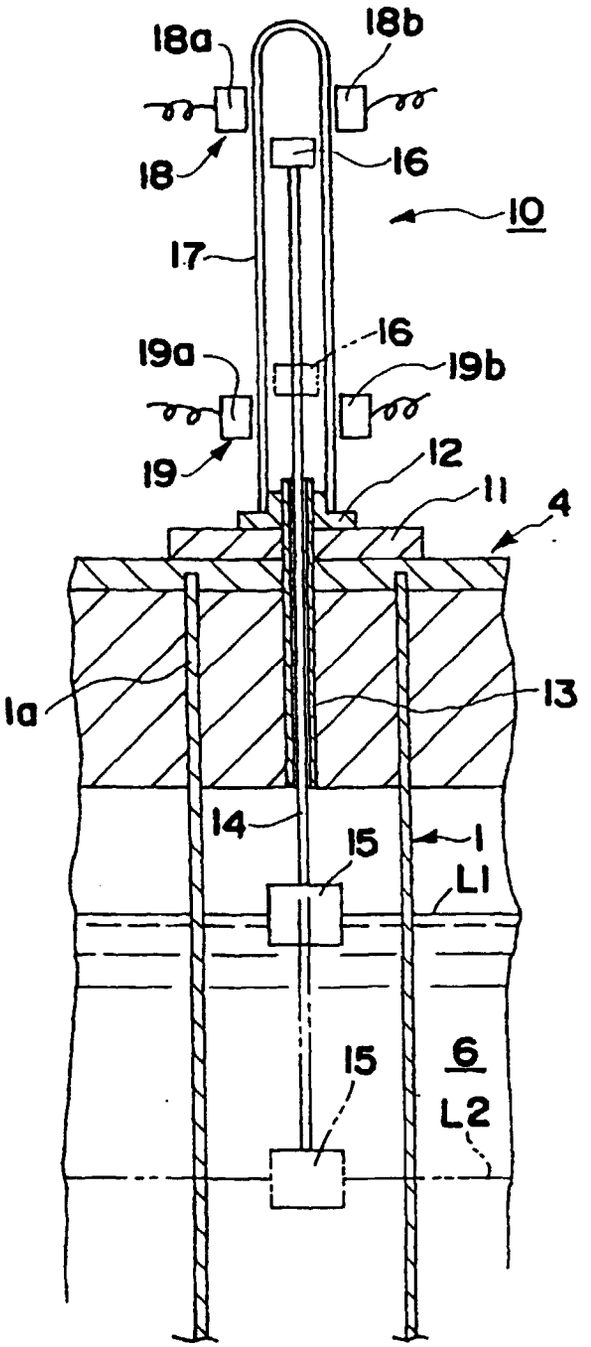
FIG.7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/00416

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[6] B22D39/06, B22D35/00

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[6] B22D39/06, B22D35/00, B22D17/02, F04F1/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-1998
Kokai Jitsuyo Shinan Koho 1971-1998 Jitsuyo Shinan Toroku Koho 1996-1998

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 8-10937, A (K.K. Hirochiku), January 16, 1996 (16. 01. 96) (Family: none)	1-6
Y	JP, 60-115357, A (Nachi-Fujikoshi Corp.), June 21, 1985 (21. 06. 85) (Family: none)	1-6
Y	JP, 7-16737, A (General Motors Corp.), January 20, 1995 (20. 01. 95) & US, 5454423, A & EP, 632244, A2	2-6
Y	JP, 63-252667, A (Meichu Seiki K.K.), October 19, 1988 (19. 10. 88) (Family: none)	5, 6
A	JP, 4-371359, A (Kobe Steel, Ltd.), December 24, 1992 (24. 12. 92) (Family: none)	1-6

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
April 1, 1998 (01. 04. 98)	April 14, 1998 (14. 04. 98)
Japanese Patent Office Facsimile No.	Authorized officer Telephone No.