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(54) **LF REFINING LADLE MICROPOROUS CERAMIC ROD AIR-PERMEABLE UPPER NOZZLE WELL BLOCK, AND ARGON BLOWING CONTROL METHOD THEREFOR**

LUFTDURCHLÄSSIGER OBERER DÜSENBOHRLOCHBLOCK FÜR EINE
LF-RAFFINATIONS PFANNE UND ARGONBLASSTEUERUNGSVERFAHREN DAFÜR

BLOC DE Puits DE BUSE SUPÉRIEURE PERMÉABLE À L'AIR À TIGES EN CÉRAMIQUE
MICROPOREUSES POUR POCHÉ D'AFFINAGE LF, ET PROCÉDÉ DE COMMANDE DE
SOUFFLAGE D'ARGON ASSOCIÉ

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Description**Field of the Invention**

- 5 **[0001]** The present invention relates to a Ladle Furnace (LF) refined ladle gas-permeable upper nozzle pocket block with microporous ceramic rods, and an argon blowing control method thereof.

Background of the Invention

- 10 **[0002]** Bottom argon blowing for a ladle furnace (LF) refined ladle is a simple and efficient out-of-furnace refining technology. It is generally divided into two stages: blowing argon at a large flow rate for stirring and uniform mixing at the early stage, and performing small-flow-rate soft blowing for removal of inclusions at the later stage. At present, for domestic LF refined ladles of more than 100 tons, two bottom blowing ventilation bricks are generally used. The treatment time of high-quality steel is generally longer than 40 min, of which soft blowing is 8-12 min. At present, there are the following problems or deficiencies in production practice: (1) insufficient soft blowing time, which affects the inclusion removal effect; (2) excessive LF refining time, which causes mismatch between the furnace and the machine and becomes a restrictive procedure for increasing the productivity and improving the efficiency; (3) inaccurate soft blowing flow control: an extremely low flow affects the inclusion removal effect of soft blowing, and an extremely high flow causes the problems of an exposed molten liquid level, entrapped slag, great molten steel temperature drop, and the like.

- 20 **[0003]** Chinese patent document CN104028739A (patent number: 201410274221.8) discloses a ladle gas-permeable upper nozzle pocket block, and a method for controlling ladle slag entrapment. The ladle gas-permeable upper nozzle pocket block includes an upper nozzle pocket block body, a gas-permeable ceramic rod, a gas chamber box, and a gas inlet pipe, and a nozzle block. A steel flowing hole and an upper nozzle mounting hole are formed in the middle of the upper nozzle pocket block body from top to bottom; the circular-ring-shaped uniformly disposed microporous ceramic rod and the annular gas chamber box are arranged in the upper nozzle pocket block body; a bottom of the gas chamber box is connected with the gas inlet pipe; and when molten steel in a ladle is at a low liquid level, argon is blown from the gas inlet pipe to control the problem of vortex slag entrapment at the upper nozzle of the ladle. This patent is mainly aimed at suppressing the problem of slag entrapment at the upper nozzle of the ladle at the end of ladle pouring. This patent has the following shortcomings: a single gas-permeable ceramic rod has a small diameter, a small gas permeation area, and a small distribution density of pores, and the number of argon bubbles formed by argon blowing is small, which is not conducive to the metallurgical effect of inclusion removal. The single gas-permeable ceramic rod is high and is difficult to mold; argon is only blown at the later stage of the ladle pouring; there is no metallurgical function for removing inclusions by blowing argon at a small flow rate; and at the same time, the argon blowing flow rate is not correspondingly decreased according to the reduction of the molten steel level in the ladle, so that it is prone to the problems of an exposed molten steel level, entrapped slag, great molten steel temperature drop, and the like.

- 35 **[0004]** Chinese patent document CN109719290A (application number: 2019101296742.1) discloses a ladle circumferential weld type gas-permeable upper nozzle block and a metallurgical argon blowing method thereof. The circumferential weld type gas-permeable upper nozzle block includes a ladle upper nozzle pocket block body, a circumferential weld, a gas chamber box, and a gas inlet pipe; a steel flowing hole, a connecting hole, and an upper nozzle mounting hole which run through the ladle upper nozzle pocket block body from top to bottom are formed in the middle of the ladle upper nozzle pocket block body; in a pouring process of a continuous casting ladle, argon is blown in the whole process; the argon flow rate is automatically adjusted according to a change of the net weight of the molten steel in a ladle; the argon is formed into tiny argon bubbles through the circumferential weld; most of the argon moves up to form a ringlike gas curtain barrier around the ladle upper nozzle, and the molten steel that is going to enter the ladle upper nozzle is washed with gas; furthermore, a stable and continuous ringlike air flow is formed in the upper nozzle to suppress nodulation at the upper nozzle; and at the later stage of pouring of the ladle, the ladle slag entrapment caused by a confluence vortex and a drainage pit is effectively suppressed. This patent has the following shortcomings: A ventilation channel is a circumferential weld; a small number of large argon bubbles are formed by argon blowing, which affects the metallurgical effect of argon blowing. According to different control requirements for inclusions in steel, different argon blowing control methods are selected. Blowing argon throughout the process results in a great temperature drop in molten steel, and affects popularization and application. Furthermore, the ladle gas-permeable upper nozzle pocket block is not manually blown before automatic argon blowing, so that the ventilation channel is easily blocked by the infiltrating molten steel and steel slag, which causes that the flow rate at the early stage of argon blowing for the gas-permeable upper nozzle pocket block is small or bottom blowing is incomplete, so that the metallurgical effect of argon blowing is seriously affected.

- 55 **[0005]** Chinese patent document CN106041044A (patent number: 201610634268.X) discloses a continuous casting tundish gas-permeable ceramic pipe upper nozzle pocket block, including an upper nozzle pocket block body, a ceramic pipe, a gas chamber, and a gas inlet pipe; a plurality of ceramic pipes uniformly disposed in a circular ring shape and

one circular-ring-shaped gas chamber; a plurality of jacks uniformly disposed in a circular ring shape; top ends of the ceramic pipes extend out of an upper surface of the upper nozzle pocket block body, and lower ends of the ceramic pipes are fixed in the jacks on the gas chamber and are communicated with the gas chamber; side portions of the ceramic pipes are connected with the gas inlet pipe and are communicated with an external argon source through metal connecting pipe fittings; after being blown, argon is upwards formed into a ringlike gas curtain barrier to wash the molten steel entering an upper nozzle; there is a certain number of argon bubbles entering the upper nozzle along with the molten steel to form a stable and continuous ringlike gas flow, so that the nodulation at the nozzle is suppressed; and furthermore, the technical problem of subsurface bubbles of a cast slab caused by the fact that protective argon bubbles enter the steel is solved. This patent has the following shortcomings: the inner diameter of ventilation holes in the ceramic pipes is large; the number of the ventilation holes in the ceramic pipes is small; a small number of relatively large argon bubbles are formed by argon blowing, which affects the metallurgical effect of argon blowing; and the ventilation holes are easily blocked by infiltrating steel and are hardly blown through.

[0006] CN206047077 discloses another example of gas-permeable upper nozzle pocket block, missing a protective ring.

Summary of the Invention

[0007] For the shortcomings in the prior art, the present invention provides an LF refined ladle gas-permeable upper nozzle pocket block with microporous ceramic rods, and an argon blowing control method thereof.

[0008] The technical solution of the present invention solves the following problems in the Chinese patent document CN104028739A: the ceramic rod has poor molding quality due to its large height, and the ceramic rod is hard to position and easy to block in a pouring process of the ladle nozzle pocket block body; an argon blowing flow rate is accurately controlled; the oxygen burning-free blowing rate of a gas-permeable upper nozzle pocket block for a ladle is increased; and the service life of the gas-permeable upper nozzle pocket block for a ladle is prolonged.

[0009] The burning-free oxygen blowing rate of the ladle gas-permeable upper nozzle pocket block refers to a permeation volume of the ladle gas-permeable upper nozzle pocket block that is measured off line after pouring of a ladle is completed. When the permeation volume meets a process requirement, oxygen burning-free blowing is performed, the oxygen burning-free blowing rate = the number of batches subjected to the oxygen burning-free blowing $\div$ the total number of batches $\times 100\%$.

[0010] Technical solution of the present invention:

An LF refined ladle gas-permeable upper nozzle pocket block with microporous ceramic rods is provided, including a ladle nozzle pocket block body (1), microporous ceramic rods (2), a gas chamber box (3), a gas inlet pipe (4), a steel flowing hole (5), and an upper nozzle mounting hole (6).

[0011] The steel flowing hole (5) and the upper nozzle mounting hole (6) run through, and are mounted in the middle of the ladle nozzle pocket block body (1);

[0012] the gas chamber box (3) is buried in a surface layer of an upper portion of the ladle nozzle pocket block body (1); a plurality of jacks (8) are formed in the gas chamber box (3); the jacks (8) are used for fixing the microporous ceramic rods (2);

a plurality of microporous ceramic rods (2) are annularly uniformly distributed in the ladle nozzle pocket block body (1); a top end of each microporous ceramic rod (2) extends out of an upper surface of the ladle nozzle pocket block body (1); a bottom end of each microporous ceramic rod (2) extends into the gas chamber box (3); the shapes, number, and positions of the jacks (8) correspond to the shapes, number and positions of the microporous ceramic rods (2);

one end of the gas inlet pipe (4) is communicated to a side portion of the gas chamber box (3), and the other end of the gas inlet pipe extends out from a side portion of the ladle nozzle pocket block body (1).

[0013] The microporous ceramic rods (2) are cylindrical, a diameter d of which is 35-45 mm; and a height h of each ceramic rod is 140-180 mm. 60-120 ventilation holes are formed in the microporous ceramic rods (2) along an axial directions of the microporous ceramic rods; the ventilation holes are uniformly distributed on cross sections of the microporous ceramic rods; an inner diameter of each ventilation hole is 0.075-0.1 mm; and the ventilation holes longitudinally run through upper end faces and lower end faces of the microporous rods.

[0014] The microporous ceramic rods (2) are fired at a high temperature in an extrusion-forming manner, and adopt zirconium oxide toughened corundum or zirconium oxide toughened corundum mullite.

[0015] Preferably, in the present invention, six to ten microporous ceramic rods (2) are uniformly disposed in a circular ring shape, and a diameter Φ of the circular ring formed by the microporous ceramic rods (2) is 300-320 mm on the basis of the centers of the microporous ceramic rods (2).

[0016] Preferably, in the present invention, a height m of the upper end of each microporous ceramic rod (2) extending out from the upper surface of the ladle nozzle pocket block body (1) is 5-10 mm, and a height n of the bottom end of each microporous ceramic rod (2) extending into the gas chamber box is 5-10 mm.

[0017] The gas-permeable upper nozzle pocket block with the microporous ceramic rods includes an iron ring (7); and the iron ring (7) is buried in a surface layer of a lower portion of the ladle upper nozzle pocket block body (1).

[0018] The iron ring (7) is buried in the surface layer of the lower portion of the ladle nozzle pocket block body (1), which effectively suppresses the problem of cracks caused by a thermal stress of the ladle upper nozzle pocket block body.

[0019] Preferably, in the present invention, the entire iron ring (7) is circular-ring-shaped, a height L of which is 40-50 mm; a distance a between a lower end of the iron ring and a lower end of the ladle upper nozzle pocket block body (1) is 50-60 mm; and a depth z of the iron ring (7) buried in the surface layer of the ladle nozzle pocket block body (1) is 10-20 mm.

[0020] Preferably, in the present invention, the iron ring (7) is formed by welding an iron sheet with a thickness of 1 mm; and an overlap length of a joint is 40-50 mm, and full welding is adopted.

[0021] Preferably, in the present invention, the entire gas chamber box (3) is of a circular ring shape; the gas chamber box adopts a metal box manufactured by a steel plate with a thickness of 1.5-2.0 mm; a longitudinal section of the metal box is a rectangle with a width x of 50-60 mm and a height y of 30-40 mm; a cross section of the metal box is a circular ring; and the plurality of jacks (8) are uniformly distributed on the circular ring.

[0022] Preferably, in the present invention, the ladle nozzle pocket block body (1) is cast and formed from a chrome corundum castable, with a bulk density ≥ 3.0 g/cm³, a high-temperature flexural strength ≥ 12 Mpa, a high-temperature compressive strength ≥ 80 Mpa, and an AL₂O₃ content $\geq 92\%$, and a Cr₂O₃ content $\geq 3\%$.

[0023] Preferably, in the present invention, longitudinal center lines of the steel flowing hole (5) and the upper nozzle mounting hole (6) and a longitudinal center line of the ladle nozzle pocket block body (1) are on one straight line; an upper portion of the steel flowing hole (5) is truncated cone shaped; a diameter d1 of an upper port of the truncated cone is 190-210 mm, and a diameter d2 of a lower port is 140-160 mm; the truncated cone has a height c of 55-80 mm; a lower portion of the steel flowing hole (5) is a cylindrical channel; a diameter of the lower cylindrical channel is consistent with the diameter of the lower port of the upper truncated cone; and the cylinder has a height b of 250-270 mm.

[0024] Preferably, in the present invention, an upper portion of the upper nozzle mounting hole (6) is truncated cone shaped, and a fitting size of the upper nozzle mounting hole is designed according to an outline size of an upper nozzle.

[0025] Preferably, in the present invention, the ladle nozzle pocket block body (1) is cylindrical; and the cylindrical shape has an outer diameter D of 380-400 mm and a height H of 470-490 mm.

[0026] The gas inlet pipe (4) of the present invention is made of a heat-resistant stainless steel round pipe, an end portion of which is provided with a connecting thread, and the dimension is M16 $\times$ 1.5.

[0027] In the LF refined ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods in the present invention, 60-120 ventilation holes are formed in the microporous ceramic rods (2) along the axial directions of the microporous ceramic rods; the ventilation holes are uniformly distributed on cross sections of the microporous ceramic rods; the inner diameter of each ventilation hole is 0.075-0.1 mm; the height h of each ceramic rod is 140-180 mm; the iron ring is buried in the surface layer of the lower portion of the ladle nozzle pocket block body; and the ladle nozzle pocket block body is cylindrical. These designs are essentially technological innovations for the problems in the existing technology and are obtained via lots of researches and production tests: First, based on lots of researches on laboratory mathematical and physical simulation, by means of reducing the inner diameter of the ventilation hole in the ceramic rod and increasing the number of the ventilation holes in the ceramic rods, argon bubbles that are more and smaller than those formed in the ceramic pipe in the Chinese patent document CN106041044B (patent number: 201610634268.X) are formed by argon blowing, so that the capabilities of capturing the argon bubbles and removing inclusions are improved, and the function of suppressing the ladle slag entrapment caused by a confluence vortex and a drainage pit at the end of pouring is enhanced; and furthermore, the ventilation holes are not prone to steel infiltration and are easy to blow through after the inner diameter of the ventilation hole is reduced. Second, the height of the microporous ceramic rod is reduced as much as possible according to an erosion residual height, so that the problems that the ceramic rod in the Chinese patent document CN104028739B has poor molding quality due to its large height, and the ceramic rod is hard to position in a pouring process of the ladle nozzle pocket block body. Third, lots of production and application tests show that the iron ring is buried in the surface layer of the lower portion of the ladle nozzle pocket block body, so that the problem of cracks caused by a thermal stress on the ladle nozzle pocket block body, and the service life of the ladle gas-permeable nozzle pocket block with the microporous ceramic rods.

[0028] The present invention further provides an argon blowing control device for an LF refined ladle gas-permeable upper nozzle pocket block, which is characterized in that an argon pipeline system and an electrical control system are provided, having a function of selecting a manual blowing mode for a gas-permeable upper nozzle pocket block and an automatic soft blowing mode. Furthermore, by means of introducing a weighing signal for molten steel in a ladle, an argon flow rate is synchronously adjusted according to a change in a net weight of the molten steel in the ladle, and the argon blowing flow rate for the gas-permeable upper nozzle pocket block is accurately controlled.

[0029] Preferably, in the present invention, the argon pipeline system is divided into a gas source main path, an automatic branch, a manual bypass, and a release branch; the gas source main path, the automatic branch, and the manual bypass are communicated through a gas confluence bar 18; the gas source main path includes a gas source main path first ball valve 9a, a first pressure gauge 10a, a first gas filter 11 a1, a second gas filter 11 a2, a pressure adjuster 12, and a first pressure sensor 15a in sequence; the automatic branch includes an automatic branch second ball valve 9b1, a first electromagnetic valve 13b, a special metallurgical mass flow rate controller 14, a second pressure sensor 15b, a second pressure gauge 10b, and an automatic branch third ball valve 9b2 in sequence; the manual bypass includes a manual bypass fourth ball valve 9c and a manual adjustment valve 16 in sequence; and the manual bypass is connected in parallel with the second ball valve 9b1, the second electromagnetic valve 13b, and the special metallurgical mass flow rate controller 14 to perform manual operation and application after the automatic branch fails. The argon pipeline system in the present invention is further used for high-pressure blowing through before automatic argon blowing of the LF refined ladle gas-permeable upper nozzle pocket block. In the present invention, the release branch is also arranged at a rear end of the manual adjustment valve 16, and includes a second electromagnetic valve 13c and an exhaust throttle valve 17 in sequence to discharge gas and release pressure when a gas inlet metal hose connected to the gas-permeable upper nozzle pocket block needs to be plugged.

[0030] Preferably, in the present invention, the electrical control system adopts the existing technology, including a network switch, an argon blowing control system PLC, a touch screen, and a continuous casting basic automation system; the argon blowing control system PLC and the touch screen are arranged in a control box; the argon blowing control system PLC, the touch screen, and the continuous casting basic automation system are all connected to the network switch through Ethernet communication; a weighing system for molten steel in a ladle collects and sends a weight of the molten steel in the ladle to the continuous casting basic automation system, and uploads the weight to the argon blowing control system PLC through the Ethernet communication and the network switch, as shown in FIG. 5. The continuous casting basic automation system receives weight data of the molten steel in the ladle of the molten steel weighing system, and uploads the data to the argon blowing control system PLC through Ethernet communication and the network switch. The argon blowing control system PLC receives the weight data of the molten steel in the ladle, and controls gas feeding and gas discharging of the ladle.

[0031] The gas-permeable upper nozzle pocket block in the above-mentioned argon blowing control device is the gas-permeable upper nozzle pocket block in the present invention.

[0032] The present invention further provides an argon blowing control method, which is characterized by including the following steps:

in a first step, applying the argon blowing control device of the present invention for the first time to measure an initial flow rate value of soft blowing of a full-ladle gas-permeable upper nozzle pocket block;

in a second step, communicating, after the ladle is at a pouring position on a continuous casting ladle turntable, the gas inlet pipe (4) of the above-mentioned gas-permeable upper nozzle pocket block to a gas source outlet of an argon control device using a metal hose; transferring the ladle to the pouring position for pouring and flowing, and then blowing through the above-mentioned gas-permeable upper nozzle pocket block immediately using the manual bypass in the argon pipeline system: gradually increasing the pressure by 1-10 mbar at each time by adjusting the pressure adjuster 12 of the gas source main path in the argon pipeline system until the above-mentioned gas-permeable upper nozzle pocket block is blown through;

in a third step, enabling, according to different control requirements for inclusions in steel, different automatic soft blowing modes immediately after the gas-permeable upper nozzle pocket block is blown through; blowing argon using the automatic main path in the argon pipeline system, and linearly adjusting an argon flow rate according to the change of the net weight of the molten steel in the ladle, a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle $\div$ the net weight of the molten steel in the full ladle $\times$ the initial flow rate value during soft blowing of the full ladle in the step I + (2-5) NL/min; blowing argon at the flow rate of 2-5 NL/min after the pouring volume of the molten steel reaches 30-100% of the total volume of the molten steel in the ladle; and stopping the argon blowing after the pouring of the ladle is completed and the ladle is transferred back to the pouring position of the continuous casting turntable.

[0033] Preferably, according to the present invention, the step III of selecting different automatic soft blowing modes according to different control requirements for the inclusions in the steel includes:

(1) selecting automatic soft blowing mode A for a low-end steel grade without an inclusion control requirement: enabling the automatic soft blowing mode immediately after the gas-permeable upper nozzle pocket block is blown through; blowing argon using the automatic main path in the argon pipeline system, and linearly adjusting an argon flow rate according to the change of the net weight of the molten steel in the ladle, a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle $\div$ the net weight of the

molten steel in the full ladle $\times$ the initial flow rate value during soft blowing of the full ladle in the step I + (2-5) NL/min; blowing argon at the flow rate of 2-5 NL/min after the pouring volume of the molten steel reaches 30-40% of the total volume of the molten steel in the ladle; and stopping the argon blowing after the pouring of the ladle is completed and the ladle is transferred back to the pouring position of the continuous casting turntable;

(2) selecting automatic soft blowing mode B for a medium-end steel grade with an inclusion control requirement: enabling the automatic soft blowing mode immediately after the gas-permeable upper nozzle pocket block is blown through; blowing argon using the automatic main path in the argon pipeline system, and linearly adjusting an argon flow rate according to the change of the net weight of the molten steel in the ladle, a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle $\div$ the net weight of the molten steel in the full ladle $\times$ the initial flow rate value during soft blowing of the full ladle in the step II + (2-5) NL/min; blowing argon at the flow rate of 2-5 NL/min after the pouring volume of the molten steel reaches 50-60% of the total volume of the molten steel in the ladle; and stopping the argon blowing after the pouring of the ladle is completed and the ladle is transferred back to the pouring position of the continuous casting turntable;

(3) selecting automatic soft blowing mode C for a high-end steel grade with strict inclusion control: enabling the automatic soft blowing mode immediately after the gas-permeable upper nozzle pocket block is blown through; blowing argon using the automatic main path in the argon pipeline system, and linearly adjusting an argon flow rate according to the change of the net weight of the molten steel in the ladle and the following formula:

a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle $\div$ the net weight of the molten steel in the full ladle $\times$ the initial flow rate value during soft blowing of the full ladle in the step II + (2-5) NL/min;

blowing argon at the flow rate of 2-5 NL/min after it is found that the ladle has slag entrapment or a slag entrapment detection system sounds an alarm; and stopping the argon blowing after the ladle is transferred back to the pouring position of the continuous casting turntable.

[0034] Preferably, in the present invention, the step I of measuring an initial flow rate value of soft blowing of a full-ladle gas-permeable upper nozzle pocket block includes: during soft blowing of the full ladle at the later stage of LF refining in the existing technology, shutting off argon of an original ladle bottom-blowing gas-permeable block, connecting argon to the gas-permeable upper nozzle pocket block, gradually increasing the argon flow rate, and observing that the molten steel level in the ladle slightly fluctuates, wherein an argon blowing flow rate value when the molten liquid level is not exposed is the initial flow rate value of the soft blowing of the full ladle.

[0035] The above gas-permeable upper nozzle pocket block in the above-mentioned argon blowing control method is the gas-permeable upper nozzle pocket block in the present invention.

[0036] The net weight of the molten steel when the ladle is full comes from the weighing system for molten steel in a ladle which is arranged on the continuous casting turntable. When the full ladle is disposed on the continuous casting turntable, the system automatically subtracts a calibrated tare weight of the ladle by the total weight of a weighed tare weight of the ladle and the net weight of the molten steel in the ladle to obtain the net weight of the molten steel in the full ladle. The tare weight of the ladle refers to a weight of an empty ladle.

[0037] The net weight of the remaining molten steel in the ladle comes from the weighing system for molten steel in a ladle which is arranged on the continuous casting turntable. In the ladle pouring process, the system automatically subtracts a calibrated tare weight of the ladle by the total weight of a weighed tare weight of the ladle and the net weight of the remaining molten steel in the ladle to obtain the net weight of the remaining molten steel in the full ladle. The tare weight of the ladle refers to a weight of an empty ladle.

The present disclosure has the beneficial effects:

[0038]

1. The diameter d of the ceramic rod in the ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods in the present invention is 35-45 mm; 60-120 ventilation holes are formed in the microporous ceramic rods along the axial directions of the microporous ceramic rods; the ventilation holes are uniformly distributed on cross sections of the microporous ceramic rods; and the inner diameter of each ventilation hole is 0.075-0.1 mm. Based on lots of researches on laboratory mathematical and physical simulation, by means of reducing the inner diameter of the ventilation hole in the ceramic rod and increasing the number of the ventilation holes in the ceramic rods, argon bubbles that are more and smaller than those formed in the ceramic pipe in the Chinese patent document

CN106041044B (patent number: 201610634268.X) are formed by argon blowing, so that the capabilities of capturing the argon bubbles and removing inclusions are improved, and the function of suppressing the ladle slag entrapment caused by a confluence vortex and a drainage pit at the end of pouring is enhanced; and furthermore, the ventilation holes are not prone to steel infiltration and are easy to blow through after the inner diameter of the ventilation hole is reduced. The present invention is applied to a dual-flow slab continuous casting machine to produce ultralow-carbon aluminum killed steel DC04. Automatic soft blowing mode C is selected; the weight of electrolytic inclusions of a continuous casting slab test sample is reduced by 20% or above on year-on-year basis, and the pouring remain of the molten steel in the ladle is reduced by 20% or above on year-on-year basis. Meanwhile, the height of the microporous ceramic rod is reduced according to an erosion residual height of the LF refined ladle gas-permeable upper nozzle pocket block of the present invention; the height h of the microporous ceramic rod is designed to be 140-180 mm, so that the problems that the ceramic rod in the Chinese patent document CN104028739B in the existing technology has poor molding quality due to its large height, and the ceramic rod is hard to position in the pouring process of the ladle nozzle pocket block body.

2. According to the LF refined ladle gas-permeable upper nozzle pocket block and the argon blowing control method thereof of the present invention, by means of the actual initial flow rate value of the soft blowing of the full ladle, the set value of the argon flow rate in the ladle pouring process = the net weight of the remaining molten steel in the ladle $\div$ the net weight of the molten steel in the full ladle $\times$ the initial flow rate value during soft blowing of the full ladle $\div$ (2-5) NL/min; and furthermore, different soft blowing modes are selected according to different control requirements for the inclusions in the steel, so that the problems of an exposed molten liquid level, entrapped slag, great molten steel temperature drop, and the like are effectively solved, which are caused by the fact that the argon blowing flow rate in the comparative example CN104028739B (patent number: 201410274221.8) is not correspondingly reduced according to the lowering of the molten steel level in the ladle; and the average temperature drop of the molten steel in the ladle is reduced by 0.1 °C/min or above on year-on-year basis.

3. The ladle nozzle pocket block body of the present invention is designed to be cylindrical, not the traditional square; the iron is buried in the surface layer of the lower portion of the ladle nozzle pocket block body, which effectively suppresses the problem of cracks caused by a thermal stress of the ladle upper nozzle pocket block body, and the service life of the ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods is prolonged. Compared with the average service life of the comparative example CN104028739A (patent number: 201410274221.8), the average service life is prolonged by four batches on year-on-year basis.

4. Compared with the ladle circumferential weld type gas-permeable upper nozzle block and the metallurgical argon blowing method thereof described in Chinese patent document CN109719290A (application number: 2019101296742.1), the LF refined ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods and the argon blowing control method thereof described in the present invention have essential differences. First, the ventilation channels are different; the sizes and quantities of bubbles formed by argon blowing are different; and the metallurgical effects of argon blowing are different. The gas channels of the present invention are the ventilation holes in the ceramic rods; 60-120 ventilation holes are formed in the microporous ceramic rods along the axial directions of the microporous ceramic rods; the ventilation holes are uniformly distributed on cross sections of the microporous ceramic rods; and the inner diameter of each ventilation hole is 0.075-0.1 mm. The diameter, measured in a water phantom experiment, of the bubbles near the ceramic rods is less than 1.8 mm, and the inclusion removal rate obtained by a digital model is 54-67%; the gas channel of CN109719290A (application number: 2019101296742.1) is a circumferential weld with a width a of 1.3-1.7 mm; the diameter, measured in the water phantom experiment, of bubbles of the circumferential weld is less than 2 mm, and the inclusion removal rate obtained by the digital model is 37-48%. The metallurgical effect of argon blowing of the ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods of the present invention is outstanding. Second, the argon blowing control methods are different. In the present invention, before the automatic soft blowing mode is selected, the manual bypass in the argon pipeline system is first used to blow through the gas-permeable upper nozzle pocket block; the one-time blow-through rate of the gas-permeable upper nozzle pocket block is 99% or above; the flow rate is maintained at 2-5 NL/min at the later stage of ladle pouring, so that the molten steel and steel slag are prevented from infiltrating into the ventilation channels of the gas-permeable upper nozzle pocket block, and the oxygen burning-free blowing rate of the ladle gas-permeable upper nozzle pocket block is increased. Furthermore, different automatic soft blowing modes are selected according to different control requirements for the inclusions in the steel. In automatic soft blowing modes A and B, the argon is not blown in the whole process. When the molten steel pouring volume reaches 30-40% and 50-60% of the total volume of the molten steel in the ladle, the argon is blown at the flow rate of 2-5 NL/min. Results of a comparison test on the dual-flow slab continuous casting machine to produce ultralow-carbon aluminum killed steel SPHC in a certain steel works show that compared with the argon

blowing control method for the ladle gas-permeable upper nozzle pocket block in the comparative example CN109719290A (application number: 2019101296742.1), the argon blowing control method applied to the ladle gas-permeable upper nozzle pocket block of the present invention has the advantages that the average temperature drop of the molten steel in the ladle is reduced by 0.06 °C/min on year-on-year basis; the one-time blow-through rate of the ladle gas-permeable upper nozzle pocket block is increased by 11% on year-on-year basis; and the oxygen burning-free blowing rate of the ladle gas-permeable upper nozzle pocket block is increased by 13% on year-on-year basis. The advantages of the argon blowing control method of the ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods of the present invention are outstanding.

Brief Description of the Drawings

[0039]

FIG. 1 is a structural front view of an LF refined ladle gas-permeable upper nozzle pocket block in an embodiment of the present invention; in the drawing: 1: ladle nozzle pocket block body; 2: microporous ceramic rod; 3: gas chamber box; 4: gas inlet pipe; 5: steel flowing hole; 6: upper nozzle mounting hole; and 7: iron ring.

FIG. 2 is a top view of an LF refined ladle gas-permeable upper nozzle pocket block in an embodiment of the present invention; in the drawing: 1: ladle nozzle pocket block body; 2: microporous ceramic rod; 3: gas chamber box; 4: gas inlet pipe; and 7: iron ring.

FIG. 3 is a schematic structural diagram of a gas chamber box in an embodiment of the present invention; in the drawing: 8: jack.

FIG. 4 is a schematic diagram of an argon pipeline system in an embodiment of the present invention; in the drawing: 1: ladle nozzle pocket block body; 4: gas inlet pipe; 9: ball valve (including a gas source main path first ball valve 9a, an automatic branch second ball valve 9b1, an automatic branch third ball valve 9b2, and a manual bypass fourth ball valve 9c); 10: pressure gauge (including a first pressure gauge 10a and a second pressure gauge 10b); 11: gas filter (including a first gas filter 11a1 and a second gas filter 11a2); 12: pressure adjuster; 13: electromagnetic valve (including an automatic main path first electromagnetic valve 13b and a manual bypass second electromagnetic valve 13c); 14: special metallurgical mass flow rate controller; 15: pressure sensor (including a gas source main path first pressure sensor 15a and an automatic branch second pressure sensor 15b); 16: manual adjustment valve; 17: exhaust throttle valve; and 18: gas confluence bar.

FIG. 5 is a schematic diagram of an electrical control system in an embodiment of the present invention.

Detailed Description of the Embodiments

[0040] The present invention is further described below in combination with the accompanying drawings and embodiments, but the protection scope is not limited to this, as it is defined by the claims.

Embodiment 1

[0041] An LF refined ladle gas-permeable upper nozzle pocket block with microporous ceramic rods is provided, as shown in FIG. 1 to FIG. 3, including a ladle nozzle pocket block body 1, microporous ceramic rods 2, a gas chamber box 3, a gas inlet pipe 4, and an iron ring 7; a steel flowing hole 5 and an upper nozzle mounting hole 6 which run through the ladle upper nozzle pocket block body from top to bottom are formed in the middle of the ladle nozzle pocket block body; ten microporous ceramic rods 2 are annularly uniformly distributed in the ladle nozzle pocket block body 1; a top end of each microporous ceramic rod 2 extends out of an upper surface of the ladle nozzle pocket block body 1; a bottom end of each microporous ceramic rod 2 extends into the gas chamber box; ten jacks 8 for fixing the microporous ceramic rods are formed in the gas chamber box; the shapes, number, and positions of the jacks correspond to the shapes, number and positions of the microporous ceramic rods; a side portion of the gas chamber box 3 is connected with the gas inlet pipe 4; one end of the gas inlet pipe is communicated with the gas chamber box, and the other end of the gas inlet pipe extends out from a side portion of the ladle nozzle pocket block body 1; the microporous ceramic rods 2 are cylindrical, a diameter d of which is 35 mm; and a height h of each ceramic rod is 140 mm.

[0042] 60 ventilation holes are formed in the microporous ceramic rods (2) along axial directions of the microporous

ceramic rods; the ventilation holes are uniformly distributed on cross sections of the microporous ceramic rods; and an inner diameter of each ventilation hole is 0.1 mm.

[0043] Ten microporous ceramic rods 2 are uniformly disposed in a circular ring shape, and a diameter $\varnothing$ of the circular ring is 300 mm.

[0044] The entire gas chamber box 3 is of a circular ring shape; the gas chamber box adopts a metal box manufactured by a steel plate with a thickness of 2.0 mm; and a cross section of the metal box is a rectangle with a width x of 50 mm and a height y of 30 mm.

[0045] A height m of the upper end of each microporous ceramic rod 2 extending out from the upper surface of the ladle nozzle pocket block body 1 is 5 mm, and a height n of the bottom end of each microporous ceramic rod 2 extending into the gas chamber box is 10 mm.

[0046] The gas-permeable upper nozzle pocket block with the microporous ceramic rods includes the iron ring 7; the iron ring 7 is buried in a surface layer of a lower portion of the ladle nozzle pocket block body 1, which effectively suppresses the problem of cracks caused by a thermal stress of the ladle upper nozzle pocket block body.

[0047] The entire iron ring (7) is circular-ring-shaped, a height L of which is 40 mm; a distance a between a lower end of the iron ring and a lower end of the ladle upper nozzle pocket block body 1 is 50 mm; and a depth z of the iron ring 7 buried in the surface layer of the ladle upper nozzle pocket block body 1 is 10 mm.

[0048] The iron ring 7 is formed by welding an iron sheet with a thickness of 1 mm; and an overlap length of a joint is 40 mm, and full welding is adopted.

[0049] The ladle nozzle pocket block body 1 is cast and formed from a chrome corundum castable, with a bulk density $\geq 3.0 \text{ g/cm}^3$, a high-temperature flexural strength $\geq 12 \text{ Mpa}$, a high-temperature compressive strength $\geq 80 \text{ Mpa}$, and an Al_2O_3 content $\geq 92\%$, and a Cr_2O_3 content $\geq 3\%$.

[0050] The microporous ceramic rods 2 are fired at a high temperature in an extrusion-forming manner, and adopt zirconium oxide toughened corundum. Longitudinal center lines of the steel flowing hole 5 and the upper nozzle mounting hole 6 and a longitudinal center line of the ladle nozzle pocket block body 1 are on one straight line; an upper portion of the steel flowing hole 5 is truncated cone shaped; a diameter d1 of an upper port of the truncated cone is 203 mm, and a diameter d2 of a lower port is 152 mm; the truncated cone has a height c of 65 mm; a lower portion of the steel flowing hole 5 is a cylindrical channel; a diameter of the lower cylindrical channel is consistent with the diameter of the lower port of the upper truncated cone; and the cylinder has a height b of 263 mm.

[0051] An upper portion of the upper nozzle mounting hole 6 is truncated cone shaped, and a fitting size of the upper nozzle mounting hole is designed according to an outline size of an upper nozzle.

[0052] The ladle nozzle pocket block body 1 is cylindrical; and the cylindrical shape has an outer diameter D of 380 mm and a height H of 470 mm.

[0053] The gas inlet pipe 4 of the present invention is made of a heat-resistant stainless steel round pipe, an end portion of which is provided with a connecting thread, and the dimension is $\text{M16} \times 1.5$.

[0054] The present invention further provides an argon blowing control device for an LF refined ladle gas-permeable upper nozzle pocket block with microporous ceramic rods. An argon pipeline system and an electrical control system are provided, having a function of selecting a manual blowing mode for a gas-permeable upper nozzle pocket block and an automatic soft blowing mode. Furthermore, by means of introducing a weighing signal for molten steel in a ladle, an argon flow rate is synchronously adjusted according to a change in a net weight of the molten steel in the ladle, and the argon blowing flow rate for the gas-permeable upper nozzle pocket block is accurately controlled.

[0055] The argon pipeline system, as shown in FIG. 4, is divided into a gas source main path, an automatic branch, a manual bypass, and a release branch; the gas source main path, the automatic branch, and the manual bypass are communicated through a gas confluence bar 18; the gas source main path includes a gas source main path first ball valve 9a, a first pressure gauge 10a, a first gas filter 11a1, a second gas filter 11a2, a pressure adjuster 12, and a first pressure sensor 15a in sequence; the automatic branch includes an automatic branch second ball valve 9b1, a first electromagnetic valve 13b, a special metallurgical mass flow rate controller 14, a second pressure sensor 15b, a second pressure gauge 10b, and an automatic branch third ball valve 9b2 in sequence; the manual bypass includes a manual bypass fourth ball valve 9c and a manual adjustment valve 16 in sequence; and the manual bypass is connected in parallel with the second ball valve 9b1, the second electromagnetic valve 13b, and the special metallurgical mass flow rate controller 14 to perform manual operation and application after the automatic branch fails. The argon pipeline system in the present invention is further used for high-pressure blowing through before automatic argon blowing of the LF refined ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods. In the present invention, the release branch is also arranged at a rear end of the manual adjustment valve 16, and includes a second electromagnetic valve 13c and an exhaust throttle valve 17 in sequence to discharge gas and release pressure when a gas inlet metal hose connected to the gas-permeable upper nozzle pocket block needs to be plugged.

[0056] The electrical control system adopts the existing technology, including a network switch, an argon blowing control system PLC, a touch screen, and a continuous casting basic automation system; the argon blowing control

system PLC and the touch screen are arranged in a control box; the argon blowing control system PLC, the touch screen, and the continuous casting basic automation system are all connected to the network switch through Ethernet communication; a weighing system for molten steel in a ladle collects and sends a weight of the molten steel in the ladle to the continuous casting basic automation system, and uploads the weight to the argon blowing control system PLC through the Ethernet communication and the network switch, as shown in FIG. 5.

[0057] The elements in the argon pipeline system are all purchased from the market. The type specification of the ball valve 9 (including the gas source main path first ball valve 9a, the automatic branch second ball valve 9b1, the automatic branch third ball valve 9b2, and the manual bypass fourth ball valve 9c) is DN20 63bar 304SS G1; the type specification of the pressure gauge 10 (including the first pressure gauge 10a and the second pressure gauge 10b) is YT60; the type specification of the gas filter 11 (including the first gas filter 11a1 and the second gas filter 11a2) is AF60-F10, G1, with a filtering level of 5 μm and pressure bearing capability of 3.0 MPa, having a manual water drainage function; the type specification of the pressure adjuster 12 is BK201-25, with a withstand pressure of 40 bar and a pressure adjustment range of 0.5-25bar; the type specification of the electromagnetic valve 13 (including the automatic main path first electromagnetic valve 13b and the manual bypass second electromagnetic valve 13c) is DC24V, G1/2 MS; the type specification of the special metallurgical mass flow rate controller 14 is FLOX[on]62, IP65, with a flow rate of 200 NL/min; the type specification of the pressure sensor 15 (including the gas source main path first pressure sensor 15a and the automatic branch second pressure sensor 15b) is PT5403, 0-25bar G1/4, 4-20mA 316L; the type specification of the manual adjustment valve 16 is PN50; the type specification of the exhaust throttle valve 17 is G1/2 MS, 25bar; and the type specification of the gas confluence bar 18 is 3.0MPa G1/2.

[0058] The elements in the electrical control system are all purchased from the market. The type specification of the PLC control system is Siemens S7, PLC S7200-Smart, containing accessories such as AI, AO, DI, and DO; and the type specification of the touch screen is a Siemens 7-inch touch screen.

[0059] An argon blowing control method using the above-mentioned LF refined ladle gas-permeable upper nozzle pocket with the microporous ceramic rods, and the argon blowing control device includes the following steps:

This embodiment is used for pouring a 130t LF refined ladle to produce ultralow-carbon aluminum killed steel DC04.

[0060] In the first step: an initial flow rate value of soft blowing of a full ladle before initial application is measured: during soft blowing of the full ladle at the later stage of LF refining in the existing technology, argon of an original ladle bottom-blowing gas-permeable block is shut off; argon to the above gas-permeable upper nozzle pocket block is connected; the argon flow rate is gradually increased, and it is observed that the molten steel level in the ladle slightly fluctuates, wherein an argon blowing flow rate value when the molten liquid level is not exposed is the initial flow rate value of the soft blowing of the full ladle, and the initial flow rate value is 45 NL/min.

[0061] In a second step, after the ladle is at a pouring position on a continuous casting ladle turntable, the gas inlet pipe 4 of the above-mentioned gas-permeable upper nozzle pocket block is communicated to a gas source outlet of an argon control device using a metal hose; the ladle is transferred to the pouring position for pouring and flowing; the above-mentioned gas-permeable upper nozzle pocket block is blown through immediately using the manual bypass in the argon pipeline system: the pressure is gradually increased by 3 mbar at each time by adjusting the pressure adjuster 12 of the gas source main path in the argon pipeline system until the above-mentioned gas-permeable upper nozzle pocket block is blown through.

[0062] When the gas-permeable upper nozzle pocket block is blocked, a pressure displayed on the second pressure gauge 10b is greater than or equal to 1200 mbar; the pressure adjuster 12 of the gas source main path in the argon pipeline system is adjusted to gradually increase the pressure, and the pressure value displayed on the second pressure gauge 10b continuously increases until the gas-permeable nozzle pocket block is blown through, the pressure value displayed on the second pressure gauge 10b starts to gradually decrease.

[0063] In a third step, different automatic soft blowing modes are selected according to different control requirements for inclusions in steel:

if the ultralow-carbon aluminum killed steel DC04 is a high-end steel grade with strict inclusion control, automatic soft blowing mode C is selected: the automatic soft blowing mode is enabled immediately after the gas-permeable upper nozzle pocket block is blown through; argon is blown using the automatic main path in the argon pipeline system, and an argon flow rate is linearly adjusted according to the change of the net weight of the molten steel in the ladle, a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle $\div$ the net weight of the molten steel in the full ladle $\times$ the initial flow rate value 45 NL/min during soft blowing of the full ladle in the step I + 5 NL/min; argon is blown at the flow rate of 5 NL/min after it is found that the ladle has slag entrapment or a slag entrapment detection system sounds an alarm; and the argon blowing is stopped after the ladle is transferred back to the pouring position of the continuous casting turntable.

Embodiment 2

[0064] A difference from the LF refined ladle gas-permeable upper nozzle pocket block with the microporous ceramic

rods of Embodiment 1 is as follows:

The microporous ceramic rods 2 are cylindrical, a diameter d of which is 45 mm, and a height h of each ceramic rod is 180 mm. 120 ventilation holes are formed in the microporous ceramic rods 2, and an inner diameter of each ventilation

5 hole is 0.075 mm. Six microporous ceramic rods 2 are uniformly disposed in a circular ring shape, and a diameter ϕ of the circular ring is 320 mm.

[0065] The entire gas chamber box 3 is of a circular ring shape; the gas chamber box adopts a metal box manufactured by a steel plate with a thickness of 1.5 mm; and a cross section of the metal box is a rectangle with a width x of 60 mm and a height y of 40 mm.

10 **[0066]** A height m of the upper end of each microporous ceramic rod 2 extending out from the upper surface of the ladle nozzle pocket block body 1 is 10mm, and a height n of the bottom end of each microporous ceramic rod 2 extending into the gas chamber box is 5mm.

[0067] The entire iron ring (7) is circular-ring-shaped, a height L of which is 50mm; a distance a between a lower end of the iron ring and a lower end of the ladle upper nozzle pocket block body 1 is 60mm; and a depth z of the iron ring 7 buried in the surface layer of the ladle upper nozzle pocket block body 1 is 20mm.

15 **[0068]** The iron ring 7 is formed by welding an iron sheet with a thickness of 1 mm; and an overlap length of a joint is 50mm, and full welding is adopted.

[0069] The microporous ceramic rods adopt zirconium oxide toughened corundum mullite.

20 **[0070]** Longitudinal center lines of the steel flowing hole 5 and the upper nozzle mounting hole 6 and a longitudinal center line of the ladle nozzle pocket block body 1 are on one straight line; an upper portion of the steel flowing hole 5 is truncated cone shaped; a diameter d_1 of an upper port of the truncated cone is 210mm, and a diameter d_2 of a lower port is 160mm; the truncated cone has a height c of 80mm; a lower portion of the steel flowing hole 5 is a cylindrical channel; a diameter of the lower cylindrical channel is consistent with the diameter of the lower port of the upper truncated cone; and the cylinder has a height b of 270mm.

25 **[0071]** The ladle nozzle pocket block body 1 is cylindrical; and the cylindrical shape has an outer diameter D of 400mm and a height H of 490mm.

[0072] An argon blowing control method using the above-mentioned LF refined ladle gas-permeable upper nozzle pocket with the microporous ceramic rods, and the argon blowing control device includes the following steps:

This embodiment is used for pouring a 130t LF refined ladle to produce ultralow-carbon aluminum killed steel SPHC.

30 **[0073]** In the first step: an initial flow rate value of soft blowing of a full ladle before initial application is measured: during soft blowing of the full ladle at the later stage of LF refining in the existing technology, argon of an original ladle bottom-blowing gas-permeable block is shut off; argon to the above gas-permeable upper nozzle pocket block is connected; the argon flow rate is gradually increased, and it is observed that the molten steel level in the ladle slightly fluctuates, wherein an argon blowing flow rate value when the molten liquid level is not exposed is the initial flow rate value of the soft blowing of the full ladle, and the initial flow rate value is 42 NL/min.

35 **[0074]** In a second step, after the ladle is at a pouring position on a continuous casting ladle turntable, the gas inlet pipe 4 of the above-mentioned gas-permeable upper nozzle pocket block is communicated to a gas source outlet of an argon control device using a metal hose; the ladle is transferred to the pouring position for pouring and flowing; the above-mentioned gas-permeable upper nozzle pocket block is blown through immediately using the manual bypass in the argon pipeline system: the pressure is gradually increased by 5 mbar at each time by adjusting the pressure adjuster 12 of the gas source main path in the argon pipeline system until the above-mentioned gas-permeable upper nozzle pocket block is blown through.

[0075] In a third step, different automatic soft blowing modes are selected according to different control requirements for inclusions in steel:

45 If the low-carbon aluminum killed steel SPHC is a medium-end steel grade with an inclusion control requirement, automatic soft blowing mode B is selected: the automatic soft blowing mode is enabled immediately after the gas-permeable upper nozzle pocket block is blown through; argon is blown using the automatic main path in the argon pipeline system, and an argon flow rate is linearly adjusted according to the change of the net weight of the molten steel in the ladle, a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle $\div$ the net weight of the molten steel in the full ladle $\times$ the initial flow rate value 42 NL/min during soft blowing of the full ladle in the step I + 3 NL/min; argon is blown at the flow rate of 3 NL/min after the pouring volume of the molten steel reaches 60% of the total volume of the molten steel in the ladle; and the argon blowing is stopped after the ladle is transferred back to the pouring position of the continuous casting turntable.

Embodiment 3

55 **[0076]** A difference from the LF refined ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods of Embodiment 1 is as follows:

The microporous ceramic rods 2 are cylindrical, a diameter d of which is 40 mm, and a height h of each ceramic rod is 160 mm. 105 ventilation holes are formed in the microporous ceramic rods 2, and an inner diameter of each ventilation hole is 0.085 mm. Eight microporous ceramic rods 2 are uniformly disposed in a circular ring shape, and a diameter ϕ of the circular ring is 310 mm.

[0077] The entire gas chamber box 3 is of a circular ring shape; the gas chamber box adopts a metal box manufactured by a steel plate with a thickness of 1.8 mm; and a cross section of the metal box is a rectangle with a width x of 55mm and a height y of 35 mm.

[0078] A height m of the upper end of each microporous ceramic rod 2 extending out from the upper surface of the ladle nozzle pocket block body 1 is 7 mm, and a height n of the bottom end of each microporous ceramic rod 2 extending into the gas chamber box is 7 mm.

[0079] The entire iron ring (7) is circular-ring-shaped, a height L of which is 45 mm; a distance a between a lower end of the iron ring and a lower end of the ladle upper nozzle pocket block body 1 is 55 mm; and a depth z of the iron ring 7 buried in the surface layer of the ladle upper nozzle pocket block body 1 is 15 mm.

[0080] Longitudinal center lines of the steel flowing hole 5 and the upper nozzle mounting hole 6 and a longitudinal center line of the ladle nozzle pocket block body 1 are on one straight line; an upper portion of the steel flowing hole 5 is truncated cone shaped; a diameter d1 of an upper port of the truncated cone is 190mm, and a diameter d2 of a lower port is 140mm; the truncated cone has a height c of 55mm; a lower portion of the steel flowing hole 5 is a cylindrical channel; a diameter of the lower cylindrical channel is consistent with the diameter of the lower port of the upper truncated cone; and the cylinder has a height b of 250mm.

[0081] The ladle nozzle pocket block body 1 is cylindrical; and the cylindrical shape has an outer diameter D of 390mm and a height H of 480mm.

[0082] An argon blowing control method using the above-mentioned LF refined ladle gas-permeable upper nozzle pocket with the microporous ceramic rods, and the argon blowing control device includes the following steps:

This embodiment is used for pouring a 130t LF refined ladle to produce Q345B.

[0083] In a first step: an initial flow rate value of soft blowing of a full ladle before initial application is measured: during soft blowing of the full ladle at the later stage of LF refining in the existing technology, argon of an original ladle bottom-blowing gas-permeable block is shut off; argon to the above gas-permeable upper nozzle pocket block is connected; the argon flow rate is gradually increased, and it is observed that the molten steel level in the ladle slightly fluctuates, wherein an argon blowing flow rate value when the molten liquid level is not exposed is the initial flow rate value of the soft blowing of the full ladle, and the initial flow rate value is 40 NL/min.

[0084] In a second step, after the ladle is at a pouring position on a continuous casting ladle turntable, the gas inlet pipe 4 of the above-mentioned gas-permeable upper nozzle pocket block is communicated to a gas source outlet of an argon control device using a metal hose; the ladle is transferred to the pouring position for pouring and flowing; the above-mentioned gas-permeable upper nozzle pocket block is blown through immediately using the manual bypass in the argon pipeline system: the pressure is gradually increased by 7 mbar at each time by adjusting the pressure adjuster 12 of the gas source main path in the argon pipeline system until the above-mentioned gas-permeable upper nozzle pocket block is blown through.

[0085] In a third step, different automatic soft blowing modes are selected according to different control requirements for inclusions in steel:

If the Q345B is a low-end steel grade without an inclusion control requirement, automatic soft blowing mode A is selected: the automatic soft blowing mode is enabled immediately after the gas-permeable upper nozzle pocket block is blown through; argon is blown using the automatic main path in the argon pipeline system, and an argon flow rate is linearly adjusted according to the change of the net weight of the molten steel in the ladle, a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle $\div$ the net weight of the molten steel in the full ladle $\times$ the initial flow rate value 40 NL/min during soft blowing of the full ladle in the step 1 + 2 NL/min; argon is blown at the flow rate of 2 NL/min after the pouring volume of the molten steel reaches 30% of the total volume of the molten steel in the ladle; and the argon blowing is stopped after the ladle is transferred back to the pouring position of the continuous casting turntable.

Comparative example 1

[0086] A difference from Embodiment 1 is that the ladle gas-permeable upper nozzle pocket block disclosed in Embodiment 1 in Chinese patent document CN104028739B (patent number: 201410274221.8) is used to replace the gas-permeable upper nozzle pocket block with microporous ceramic rods in Embodiment 1, and other contents are all the same.

Comparative example 2

[0087] A difference from Embodiment 2 is that the ladle gas-permeable upper nozzle pocket block disclosed in Embodiment 2 in Chinese patent document CN104028739B (patent number: 201410274221.8) is used to replace the gas-permeable upper nozzle pocket block with microporous ceramic rods in Embodiment 2, and other contents are all the same.

Comparative example 3

[0088] A difference from Embodiment 3 is that the ladle gas-permeable upper nozzle pocket block disclosed in Embodiment 3 in Chinese patent document CN104028739B (patent number: 201410274221.8) is used to replace the gas-permeable upper nozzle pocket block with microporous ceramic rods in Embodiment 3, and other contents are all the same.

Comparative example 4

[0089] A difference from Embodiment 2 is that the argon blowing control method for the nozzle pocket block is different. The argon blowing control method using the circumferential weld type gas-permeable upper nozzle block disclosed in Embodiment 2 in Chinese patent document CN109719290 (patent number: 2019101296742.1) is used to replace the argon blowing control method using the ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods in Embodiment 2, and other contents are all the same.

Experimental case

[0090] The applications of Embodiments 1-3 to a slab continuous casting machine of a certain steel works to produce the ultralow-carbon aluminum killed steel DC04, the ultralow-carbon aluminum killed steel SPHC, and plain carbon steel Q345B are compared with the applications of the technical solutions of comparative examples 1-4. A large electrolytic test sample is taken from the 1/4 position of a cast slab and is machined into a round rod with a diameter of 60 mm and a height of 100 mm; large electrolytic inclusion detection and comparison are performed; the same slag entrapment detection system is set when the pouring remains of the molten steel for producing the ultralow-carbon aluminum killed steel DC04 are compared and measured. Comparison results are shown in the following table 1.

Table 1

Item	Steel grade	Content (mg/10kg) of large electrolytic inclusion of the cast slab	Pouring remain (ton/package) of the molten steel in the ladle	Average temperature drop (°C/min) of the molten steel in the soft blowing process	Average life(batch) of the ladle gas-permeable upper nozzle pocket block	One-time blow-through rate (%) of the ladle gas-permeable upper nozzle pocket block	Oxygen burning-free blowing rate (%) of the ladle gas-permeable upper nozzle pocket block
Embodiment 1	DC04	0.84	0.44	0.17	51	99.1	30
Embodiment 2	SPHC	1.37	/	0.14		99.2	32
Embodiment 3	Q345B	2.43	/	0.11		99.6	35
Comparative example 1	DC04	1.07	0.56	0.28	47	92.1	26
Comparative example 2	SPHC	1.72	/	0.26		93.7	28
Comparative example 3	Q345B	3.57	/	0.24		91.3	27

(continued)

Item	Steel grade	Content (mg/10kg) of large electrolytic inclusion of the cast slab	Pouring remain (ton/ package) of the molten steel in the ladle	Average temperature drop (°C/min) of the molten steel in the soft blowing process	Average life(batch) of the ladle gas-permeable upper nozzle pocket block	One-time blow-through rate (%) of the ladle gas-permeable upper nozzle pocket block	Oxygen burning-free blowing rate (%) of the ladle gas-permeable upper nozzle pocket block
Comparative example 4	SPHC	1.68	/	0.20	49	88.1	19

[0091] By means of comparing the data in the above table 1, compared with the ladle gas-permeable upper nozzle pocket block provided in the comparative example CN104028739A (patent number: 201410274221.8), the ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods in the present invention is hard to block and easy to blow through; the weight of electrolytic inclusions of a continuous casting slab test sample is reduced by 20% or above on year-on-year basis; the average temperature drop of the molten steel in the ladle is reduced by 0.1 °C/min or above on year-on-year basis; the oxygen burning-free blowing rate of the ladle gas-permeable upper nozzle pocket block is increased by 4% on year-on-year basis; the pouring remain of the molten steel is reduced by 20% or above on year-on-year basis; and the average life of the ladle nozzle pocket block is prolonged by 4 batches on year-on-year basis. Compared with the argon blowing method for the ladle gas-permeable upper nozzle pocket block provided in the comparative example CN109719290A (patent number: 2019101296742.1), the argon blowing control method for the ladle gas-permeable upper nozzle pocket block in the present invention has the advantages that the average temperature drop of the molten steel in the ladle is reduced by 0.06 °C/min on year-on-year basis; the one-time blow-through rate of the ladle gas-permeable upper nozzle pocket block is increased by 11% on year-on-year basis; and the oxygen burning-free blowing rate of the ladle gas-permeable upper nozzle pocket block is increased by 13% on year-on-year basis.

[0092] A continuous casting tundish of a slab of a certain steel works is used as an experimental research object. According to the same research method, a water phantom experiment and a mathematical model research are carried out on the ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods in the present invention and the ladle circumferential weld type gas-permeable upper nozzle block in Chinese patent document CN109719290A (application number: 2019101296742.1). Research results of the water phantom experiment show that when a simulated argon blowing volume under a normal process condition is 3 NL/min, the diameter, measured in the water phantom experiment, of the bubbles near the ceramic rods in the present invention is less than 1.8 mm, and the diameter of the bubbles near the circumferential weld in Chinese patent document CN109719290A is less than 2 mm. Results of the mathematical model research show that the inclusion removal rate of the ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods in the present invention is 54-67%, and the inclusion removal rate of the ladle circumferential weld type gas-permeable upper nozzle block in Chinese patent document CN109719290A is 37-48%.

[0093] By means of the water phantom experiment and the mathematical model research, the metallurgical effect of argon blowing of the ladle gas-permeable upper nozzle pocket block with the microporous ceramic rods in the present invention is outstanding.

Claims

1. An LF refined ladle gas-permeable upper nozzle pocket block with microporous ceramic rods, comprising a ladle nozzle pocket block body (1), microporous ceramic rods (2), a gas chamber box (3), and a gas inlet pipe (4), wherein a steel flowing hole (5) and an upper nozzle mounting hole (6) which run through are formed in the middle of the pocket block body (1); the gas chamber box (3) is buried in a surface layer of an upper portion of the ladle nozzle pocket block body (1); a plurality of microporous ceramic rods (2) are annularly uniformly distributed in the ladle nozzle pocket block body (1); a top end of each microporous ceramic rod (2) extends out of an upper surface of the ladle nozzle pocket block body (1); a bottom end of each microporous ceramic rod (2) extends into the gas chamber box (3); a plurality of jacks (8) for fixing the microporous ceramic rods (2) are formed in the gas chamber box (3); the shapes, number, and positions of the jacks (8) correspond to the shapes, number and positions of the microporous ceramic rods (2); a side portion of the gas chamber box (3) is connected with the gas inlet pipe (4); one end of the gas inlet pipe (4)

is communicated with the gas chamber box (3), and the other end of the gas inlet pipe extends out from a side portion of the ladle nozzle pocket block body (1); the microporous ceramic rods (2) are cylindrical, a diameter d of which is 35-45 mm; a height h of each ceramic rod is 140-180 mm; the gas-permeable upper nozzle pocket block with the microporous ceramic rods comprises an iron ring (7); the iron ring (7) is buried in a surface layer of a lower portion of the ladle upper nozzle pocket block body (1); the entire iron ring (7) is circular-ring-shaped, a height L of which is 40-50 mm; a distance a between a lower end of the iron ring and a lower end of the ladle upper nozzle pocket block body (1) is 50-60 mm; and a depth z of the iron ring (7) buried in the surface layer of the ladle upper nozzle pocket block body (1) is 10-20 mm; 60-120 ventilation holes are formed in the microporous ceramic rods (2) along an axial directions of the microporous ceramic rods; the ventilation holes are uniformly distributed on cross sections of the microporous ceramic rods; an inner diameter of each ventilation hole is 0.075-0.1 mm; the ventilation holes longitudinally run through upper end faces and lower end faces of the microporous rods; the microporous ceramic rods (2) are fired at a high temperature in an extrusion-forming manner, and adopt zirconium oxide toughened corundum or zirconium oxide toughened corundum mullite.

2. The nozzle pocket block according to claim 1, wherein the iron ring (7) is formed by welding an iron sheet with a thickness of 1 mm; and an overlap length of a joint is 40-50 mm, and full welding is adopted.
3. The nozzle pocket block according to claim 1, wherein six to ten microporous ceramic rods (2) are uniformly disposed in a circular ring shape, and a diameter $\varnothing$ of the circular ring is 300-320 mm.
4. The nozzle pocket block according to claim 1, wherein a height m of the upper end of each microporous ceramic rod (2) extending out from the upper surface of the ladle nozzle pocket block body (1) is 5-10 mm, and a height n of the bottom end of each microporous ceramic rod (2) extending into the gas chamber box is 5-10 mm.
5. The nozzle pocket block according to claim 1, wherein the entire gas chamber box (3) is of a circular ring shape; the gas chamber box adopts a metal box manufactured by a steel plate with a thickness of 1.5-2.0 mm; and a cross section of the metal box is a rectangle with a width x of 50-60 mm and a height y of 30-40 mm; a cross section of the metal box is a circular ring; and the plurality of jacks (8) are uniformly distributed on the circular ring.
6. The nozzle pocket block according to claim 1, wherein the ladle nozzle pocket block body (1) is cast and formed from a chrome corundum castable, with a bulk density ≥ 3.0 g/cm³, a high-temperature flexural strength ≥ 12 Mpa, a high-temperature compressive strength ≥ 80 Mpa, and an Al_2O_3 content $\geq 92\%$, and a Cr_2O_3 content $\geq 3\%$.
7. The nozzle pocket block according to claim 1, wherein longitudinal center lines of the steel flowing hole (5) and the upper nozzle mounting hole (6) and a longitudinal center line of the ladle nozzle pocket block body (1) are on one straight line; an upper portion of the steel flowing hole (5) is truncated cone shaped; a diameter d_1 of an upper port of the truncated cone is 190-210 mm, and a diameter d_2 of a lower port is 140-160 mm; the truncated cone has a height c of 55-80 mm; a lower portion of the steel flowing hole (5) is a cylindrical channel; a diameter of the lower cylindrical channel is consistent with the diameter of the lower port of the upper truncated cone; the cylinder has a height b of 250-270 mm.
8. The nozzle pocket block according to claim 1, wherein an upper portion of the upper nozzle mounting hole (6) is truncated cone shaped, and a fitting size of the upper nozzle mounting hole is designed according to an outline size of an upper nozzle.
9. The nozzle pocket block according to claim 1, wherein the ladle nozzle pocket block body (1) is cylindrical; and the cylindrical shape has an outer diameter D of 380-400 mm and a height H of 470-490 mm.
10. The nozzle pocket block according to claim 1, wherein the gas inlet pipe (4) is made of a heat-resistant stainless steel round pipe, an end portion of which is provided with a connecting thread, and the dimension is M16 $\times$ 1.5.
11. An argon blowing control device, comprising a gas-permeable upper nozzle pocket block, wherein an argon pipeline system and an electrical control system are provided, having a function of selecting a manual blowing mode for the gas-permeable upper nozzle pocket block and an automatic soft blowing mode, introducing a weighing signal for molten steel in a ladle, and synchronously adjusting an argon flow rate according to a change in a net weight of the molten steel in the ladle, and the gas-permeable upper nozzle pocket block is the gas-permeable upper nozzle pocket block with the microporous

ceramic rods according to claim 1.

12. The argon blowing control device according to claim 11, wherein the argon pipeline system is divided into a gas source main path, an automatic branch, a manual bypass, and a release branch; the gas source main path, the automatic branch, and the manual bypass are communicated through a gas confluence bar (18);

the gas source main path comprises a gas source main path first ball valve (9a), a first pressure gauge (10a), a first gas filter (11a1), a second gas filter (11a2), a pressure adjuster (12), and a first pressure sensor (15a) in sequence;

the automatic branch comprises an automatic branch second ball valve (9b1), a first electromagnetic valve (13b), a special metallurgical mass flow rate controller (14), a second pressure sensor (15b), a second pressure gauge (10b), and an automatic branch third ball valve (9b2) in sequence; the manual bypass comprises a manual bypass fourth ball valve (9c) and a manual adjustment valve (16) in sequence; the manual bypass is connected in parallel with the second ball valve automatic branch (9b1), the first electromagnetic valve (13b), and the special metallurgical mass flow rate controller (14) of the automatic branch to perform manual operation and application after the automatic branch fails;

the argon pipeline system is further used for high-pressure blowing through before automatic argon blowing of the LF refined ladle gas-permeable upper nozzle pocket block; the release branch is further arranged at a rear end of the manual adjustment valve (16), and comprises a second electromagnetic valve (13c) and an exhaust throttle valve (17) in sequence to discharge gas and release pressure when a gas inlet metal hose connected to the gas-permeable upper nozzle pocket block needs to be plugged.

13. The argon blowing control device according to claim 11, wherein the electrical control system comprises a network switch, an argon blowing control system PLC, a touch screen, and a continuous casting basic automation system; the argon blowing control system PLC and the touch screen are arranged in a control box; the argon blowing control system PLC, the touch screen, and the continuous casting basic automation system are all connected to the network switch through Ethernet communication; a weighing system for molten steel in a ladle collects and sends a weight of the molten steel in the ladle to the continuous casting basic automation system, and uploads the weight to the argon blowing control system PLC through the Ethernet communication and the network switch.

14. An argon blowing control method, comprising the following steps:

in a first step, applying the argon blowing control device of claim 11 for the first time to measure an initial flow rate value of soft blowing of a full-ladle gas-permeable upper nozzle pocket block, wherein the gas-permeable upper nozzle pocket block is the gas-permeable upper nozzle pocket block according to claim 1;

in a second step, communicating, after the ladle is at a pouring position on a continuous casting ladle turntable, the gas inlet pipe (4) of the above-mentioned gas-permeable upper nozzle pocket block to a gas source outlet of an argon control device using a metal hose; transferring the ladle to the pouring position for pouring and flowing, and then blowing through the above-mentioned gas-permeable upper nozzle pocket block immediately using the manual bypass in the argon pipeline system: gradually increasing the pressure by 1-10 mbar at each time by adjusting the pressure adjuster 12 of the gas source main path in the argon pipeline system until the above-mentioned gas-permeable upper nozzle pocket block is blown through; and

in a third step, enabling, according to different control requirements for inclusions in steel, different automatic soft blowing modes immediately after the gas-permeable upper nozzle pocket block is blown through in the second step; blowing argon using the automatic main path in the argon pipeline system, and linearly adjusting an argon flow rate according to the change of the net weight of the molten steel in the ladle,

a set value of an argon flow rate in a molten steel pouring process= the net weight of the remaining molten steel in the ladle ÷ the net weight of the molten steel in the full ladle × the initial flow rate value during soft blowing of the full ladle in the first step+ (2-5) NL/min;

blowing argon at the flow rate of 2-5 NL/min after the pouring volume of the molten steel reaches 30-100% of the total volume of the molten steel in the ladle; and stopping the argon blowing after the pouring of the ladle is completed and the ladle is transferred back to the pouring position of the continuous casting turntable.

15. The method according to claim 14, wherein the first step of measuring an initial flow rate value of soft blowing of a full-ladle gas-permeable upper nozzle pocket block comprises: during soft blowing of the full ladle at the later stage of LF refining in the existing technology, shutting off argon of an original ladle bottom-blowing gas-permeable block, connecting argon to the gas-permeable upper nozzle pocket block, gradually increasing the argon flow rate, and observing that the molten steel level in the ladle slightly fluctuates, wherein an argon blowing flow rate value when

the molten liquid level is not exposed is the initial flow rate value of the soft blowing of the full ladle.

16. The method according to claim 14, wherein the third step of selecting different automatic soft blowing modes according to different control requirements for the inclusions in the steel comprises:

(1) selecting automatic soft blowing mode A for a low-end steel grade without an inclusion control requirement: enabling the automatic soft blowing mode immediately after the gas-permeable upper nozzle pocket block is blown through; blowing argon using the automatic main path in the argon pipeline system, and linearly adjusting an argon flow rate according to the change of the net weight of the molten steel in the ladle, a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle ÷ the net weight of the molten steel in the full ladle × the initial flow rate value during soft blowing of the full ladle in the first step + (2-5) NL/min; blowing argon at the flow rate of 2-5 NL/min after the pouring volume of the molten steel reaches 30-40% of the total volume of the molten steel in the ladle; and stopping the argon blowing after the pouring of the ladle is completed and the ladle is transferred back to the pouring position of the continuous casting turntable;

(2) selecting automatic soft blowing mode B for a medium-end steel grade with an inclusion control requirement: enabling the automatic soft blowing mode immediately after the gas-permeable upper nozzle pocket block is blown through; blowing argon using the automatic main path in the argon pipeline system, and linearly adjusting an argon flow rate according to the change of the net weight of the molten steel in the ladle, a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle ÷ the net weight of the molten steel in the full ladle × the initial flow rate value during soft blowing of the full ladle in the second step + (2-5) NL/min; blowing argon at the flow rate of 2-5 NL/min after the pouring volume of the molten steel reaches 50-60% of the total volume of the molten steel in the ladle; and stopping the argon blowing after the pouring of the ladle is completed and the ladle is transferred back to the pouring position of the continuous casting turntable;

(3) selecting automatic soft blowing mode C for a high-end steel grade with strict inclusion control: enabling the automatic soft blowing mode immediately after the gas-permeable upper nozzle pocket block is blown through; blowing argon using the automatic main path in the argon pipeline system, and linearly adjusting an argon flow rate according to the change of the net weight of the molten steel in the ladle, a set value of an argon flow rate in a molten steel pouring process = the net weight of the remaining molten steel in the ladle ÷ the net weight of the molten steel in the full ladle × the initial flow rate value during soft blowing of the full ladle in the second step + (2-5) NL/min; blowing argon at the flow rate of 2-5 NL/min after it is found that the ladle has slag entrapment or a slag entrapment detection system sounds an alarm; and stopping the argon blowing after the ladle is transferred back to the pouring position of the continuous casting turntable.

Patentansprüche

1. Ein LF-verfeinerter, gasdurchlässiger oberer Pfannendüsen-Taschenblock mit mikroporösen Keramikstäben, umfassend einen Pfannendüsen-Taschenblockkörper (1), mikroporöse Keramikstäbe (2), einen Gaskammerkasten (3) und ein Gaseinlassrohr (4), wobei in der Mitte des Taschenblockkörpers (1) ein Stahlflussloch (5) und ein hindurchgehendes oberes Düsenmontageloch (6) ausgebildet sind; der Gaskammerkasten (3) ist in einer Oberflächenschicht eines oberen Abschnitts des Pfannendüsen-Taschenblockkörpers (1) eingebettet; eine Vielzahl von mikroporösen Keramikstäben (2) ist ringförmig gleichmäßig im Pfannendüsen-Taschenblockkörper (1) verteilt; ein oberes Ende jedes mikroporösen Keramikstabs (2) ragt aus einer oberen Oberfläche des Pfannendüsen-Taschenblockkörpers (1) heraus; ein unteres Ende jedes mikroporösen Keramikstabs (2) ragt in den Gaskammerkasten (3) hinein; eine Vielzahl von Hebern (8) zum Befestigen der mikroporösen Keramikstäbe (2) ist im Gaskammerkasten (3) ausgebildet; die Formen, Anzahl und Positionen der Heber (8) entsprechen den Formen, Anzahl und Positionen der mikroporösen Keramikstäbe (2); ein Seitenabschnitt des Gaskammerkastens (3) ist mit dem Gaseinlassrohr (4) verbunden; ein Ende des Gaseinlassrohrs (4) ist mit dem Gaskammerkasten (3) verbunden, und das andere Ende des Gaseinlassrohrs ragt aus einem Seitenabschnitt des Pfannendüsen-Taschenblockkörpers (1) heraus; die mikroporösen Keramikstäbe (2) sind zylindrisch, ihr Durchmesser d beträgt 35-45 mm; die Höhe h jedes Keramikstabs beträgt 140-180 mm; der gasdurchlässige obere Düsentaschenblock mit den mikroporösen Keramikstäben umfasst einen Eisenring (7); der Eisenring (7) ist in einer Oberflächenschicht eines unteren Abschnitts oberen Pfannendüsen-Taschenblockkörpers (1) eingebettet; der gesamte Eisenring (7) ist kreisringförmig, seine Höhe L beträgt 40-50 mm; ein Abstand a zwischen einem unteren Ende des Eisenrings und einem unteren Ende des oberen Pfannendüsen-Taschenblockkörpers (1) beträgt 50-60 mm; und eine Tiefe z des in der Oberflächenschicht des oberen Pfannendüsen-Taschenblockkörpers (1) eingebet-

teten Eisenrings (7) beträgt 10-20 mm; 60-120 Belüftungslöcher sind in den mikroporösen Keramikstäben (2) entlang einer axialen Richtung der mikroporösen Keramikstäbe ausgebildet; die Belüftungslöcher sind gleichmäßig auf den Querschnitten der mikroporösen Keramikstäbe verteilt; der Innendurchmesser jedes Belüftungslochs beträgt 0,075-0,1 mm; die Belüftungslöcher verlaufen in Längsrichtung durch die oberen und unteren Endflächen der mikroporösen Stäbe; die mikroporösen Keramikstäbe (2) werden bei hoher Temperatur im Extrusionsverfahren gebrannt und bestehen aus mit Zirkonoxid gehärtetem Korund oder mit Zirkonoxid gehärtetem Korundmullit.

2. Der Düsentaschenblock nach Anspruch 1, wobei der Eisenring (7) durch Schweißen eines Eisenblechs mit einer Dicke von 1 mm gebildet ist, eine Überlappungslänge einer Verbindung 40-50 mm beträgt und eine Vollschweißung angewendet wird.

3. Der Düsentaschenblock nach Anspruch 1, wobei sechs bis zehn mikroporöse Keramikstäbe (2) gleichmäßig in einer kreisförmigen Ringform angeordnet sind und ein Durchmesser ϕ des Kreisringes 300-320 mm beträgt.

4. Der Düsentaschenblock nach Anspruch 1, wobei eine Höhe m des oberen Endes jedes mikroporösen Keramikstabs (2), der aus der oberen Oberfläche des Pfannendüsen-Taschenblockkörpers (1) herausragt, 5-10 mm beträgt, und eine Höhe n des unteren Endes jedes mikroporösen Keramikstabs (2), der in den Gaskammerkasten hineinragt, 5-10 mm beträgt.

5. Der Düsentaschenblock nach Anspruch 1, wobei der gesamte Gaskammerkasten (3) eine kreisringförmige Gestalt aufweist; der Gaskammerkasten ein aus einer Stahlplatte mit einer Dicke von 1,5-2,0 mm hergestellter Metallkasten ist; und ein Querschnitt des Metallkastens ein Rechteck mit einer Breite x von 50-60 mm und einer Höhe y von 30-40 mm ist; ein Querschnitt des Metallkastens ein kreisringförmiger Ring ist; und die Vielzahl von Hebern (8) gleichmäßig auf dem kreisringförmigen Ring verteilt sind.

6. Der Düsentaschenblock nach Anspruch 1, wobei der Pfannendüsen-Taschenblockkörper (1) aus einem Chromkorund-Gussmaterial gegossen und geformt ist, mit einer Schüttdichte $\geq 3,0 \text{ g/cm}^3$, einer Hochtemperatur-Biegefestigkeit $\geq 12 \text{ Mpa}$, einer Hochtemperatur-Druckfestigkeit $\geq 80 \text{ Mpa}$, einem Al_2O_3 -Gehalt $\geq 92\%$ und einem Cr_2O_3 -Gehalt $\geq 3\%$.

7. Der Düsentaschenblock nach Anspruch 1, wobei die Längsmittellinien des Stahlflusslochs (5) und des oberen Düsenmontagelochs (6) sowie eine Längsmittellinie des Pfannendüsen-Taschenblockkörpers (1) auf einer geraden Linie liegen; ein oberer Teil des Stahlflusslochs (5) kegelstumpfförmig ist; ein Durchmesser d1 einer oberen Öffnung des Kegelstumpfs 190 - 210 mm und ein Durchmesser d2 einer unteren Öffnung 140 - 160 mm beträgt; der Kegelstumpf eine Höhe c von 55 - 80 mm aufweist; ein unterer Abschnitt des Stahlflusslochs (5) ein zylindrischer Kanal ist; ein Durchmesser des unteren zylindrischen Kanals dem Durchmesser der unteren Öffnung des oberen Kegelstumpfs entspricht; und der Zylinder eine Höhe b von 250-270 mm aufweist.

8. Der Düsentaschenblock nach Anspruch 1, wobei ein oberer Abschnitt des oberen Düsenmontagelochs (6) kegelstumpfförmig ist und eine Passgröße des oberen Düsenmontagelochs entsprechend einer Umrissgröße einer oberen Düse ausgelegt ist.

9. Der Düsentaschenblock nach Anspruch 1, wobei der Pfannendüsen-Taschenblockkörper (1) zylindrisch ist; und die zylindrische Form einen Außendurchmesser D von 380-400 mm und eine Höhe H von 470-490 mm aufweist.

10. Der Düsenstockblock nach Anspruch 1, wobei das Gaseinlassrohr (4) aus einem hitzebeständigen Edelstahlrundrohr besteht, dessen Endabschnitt mit einem Anschlussgewinde versehen ist und die Abmessung M16x1,5 beträgt.

11. Eine Argon-Blassteuervorrichtung, die einen gasdurchlässigen oberen Düsentaschenblock umfasst, wobei ein Argon-Rohrleitungssystem und ein elektrisches Steuersystem vorgesehen sind, mit einer Funktion zum Auswählen eines manuellen Einblasmodus für den gasdurchlässigen oberen Düsentaschenblock und eines automatischen sanften Einblasmodus, zum Einführen eines Wiegesignals für geschmolzenen Stahl in einer Pfanne und zum synchronen Anpassen einer Argon-Durchflussmenge entsprechend einer Änderung eines Nettogewichts des geschmolzenen Stahls in der Pfanne, und der gasdurchlässige obere Düsentaschenblock der gasdurchlässige obere Düsentaschenblock mit den mikroporösen Keramikstäben nach Anspruch 1 ist.

12. Die Argon-Einblassteuervorrichtung nach Anspruch 11, wobei das Argon-Rohrleitungssystem in einen Gasquellen-

Hauptpfad, einen automatischen Zweig, eine manuelle Umleitung und einen Freigabezweig unterteilt ist; wobei der Gasquellen-Hauptpfad, der automatische Zweig und der manuelle Bypass über eine Gaszusammenflusssange (18) miteinander verbunden sind;

der Gasquellen-Hauptweg umfasst in dieser Abfolge ein erstes Kugelventil (9a) des Gasquellen-Hauptwegs, ein erstes Druckmessgerät (10a), einen ersten Gasfilter (11a1), einen zweiten Gasfilter (11a2), einen Druckregler (12) und einen ersten Drucksensor (15a);

der automatische Zweig umfasst nacheinander einen zweiten Kugelhahn (9b1) des automatischen Zweigs, ein erstes elektromagnetisches Ventil (13b), einen speziellen metallurgischen Massendurchflussregler (14), einen zweiten Drucksensor (15b), ein zweites Druckmessgerät (10b) und einen dritten Kugelhahn (9b2) des automatischen Zweigs; die manuelle Umleitung umfasst nacheinander einen vierten Kugelhahn (9c) der manuellen Umleitung und ein manuelles Einstellventil (16); die manuelle Umleitung ist parallel mit dem zweiten Kugelhahn des automatischen Zweigs (9b1), dem ersten elektromagnetischen Ventil (13b) und dem speziellen metallurgischen Massendurchflussregler (14) des automatischen Zweigs geschaltet, um nach einem Ausfall des automatischen Zweigs einen manuellen Betrieb und eine manuelle Anwendung durchzuführen;

das Argon-Rohrleitungssystem wird ferner zum Durchblasen mit hohem Druck vor dem automatischen Argon-Einblasvorgang des gasdurchlässigen oberen Düsentaschenblocks der LF-Raffinationspfanne verwendet; der Ablasszweig ist ferner an einem hinteren Ende des manuellen Einstellventils (16) angeordnet und umfasst ein zweites elektromagnetisches Ventil (13c) und ein Abluftdrosselventil (17) in Folge, um Gas abzulassen und Druck zu reduzieren, wenn ein mit dem gasdurchlässigen oberen Düsentaschenblock verbundener Gaseinlass-Metallschlauch verschlossen werden muss.

13. Die Argon-Blassteuervorrichtung nach Anspruch 11, wobei das elektrische Steuersystem einen Netzwerkschalter, eine Argon-Blassteuersystem-SPS, einen Touchscreen und ein Strangguss-Basisautomatisierungssystem umfasst; die SPS des Argon-Einblassteuersystems und der Touchscreen sind in einem Steuerkasten angeordnet; die SPS des Argon-Blassteuersystems, der Touchscreen und das Strangguss-Basisautomatisierungssystem sind alle über Ethernet-Kommunikation mit dem Netzwerkschalter verbunden; ein Wiegesystem für geschmolzenen Stahl in einer Pfanne erfasst und sendet das Gewicht des geschmolzenen Stahls in der Pfanne an das Strangguss-Basisautomatisierungssystem und lädt das Gewicht über die Ethernet-Kommunikation und den Netzwerkschalter auf die SPS des Argon-Blassteuersystems hoch.

14. Ein Argon-Blassteuerverfahren, das die folgenden Schritte umfasst:

in einem ersten Schritt, erstmaliges Anwenden der Argon-Blassteuervorrichtung von Anspruch 11, um einen anfänglichen Durchflusswert des sanften Blasens eines gasdurchlässigen oberen Düsentaschenblocks einer vollen Pfanne zu messen, wobei der gasdurchlässige obere Düsentaschenblock der gasdurchlässige obere Düsentaschenblock nach Anspruch 1 ist;

in einem zweiten Schritt, nachdem sich die Pfanne in einer Gießposition auf einem Drehtisch für Stranggusspfannen befindet, Verbinden des Gaseinlassrohrs (4) des oben genannten gasdurchlässigen oberen Düsentaschenblocks mit einem Gasquellenauslass einer Argon-Steuervorrichtung unter Verwendung eines Metallschlauchs; Übertragen der Pfanne in die Gussposition zum Gießen und Fließen und anschließendes sofortiges Durchblasen des oben genannten gasdurchlässigen oberen Düsentaschenblocks unter Verwendung der manuellen Umleitung im Argon-Rohrleitungssystem; schrittweises Erhöhen des Drucks jedes Mal um 1-10 mbar durch Einstellen des Druckreglers 12 des Gasquellen-Hauptpfads im Argon-Rohrleitungssystem, bis der oben genannte gasdurchlässige obere Düsentaschenblock durchgeblasen ist; und

in einem dritten Schritt, Aktivieren unterschiedlicher automatischer sanfter Einblasmodi, unmittelbar nachdem der gasdurchlässige obere Düsentaschenblock im zweiten Schritt durchgeblasen wurde, entsprechend unterschiedlichen Kontrollanforderungen für Einschlüsse im Stahl; Einblasen von Argon unter Verwendung des automatischen Hauptpfads im Argon-Rohrleitungssystem und lineares Anpassen einer Argon-Durchflussmenge entsprechend der Änderung des Nettogewichts des geschmolzenen Stahls in der Pfanne,

ein eingestellter Wert der Argon-Durchflussmenge bei einem Gießvorgang für geschmolzenen Stahl = das Nettogewicht der verbleibenden Stahlschmelze in der Pfanne * das Nettogewicht der Stahlschmelze in der vollen Pfanne x der anfängliche Durchflusswert während des sanften Blasens der vollen Pfanne im ersten Schritt + (2 - 5) NL/min;

Einblasen von Argon mit einer Durchflussmenge von 2-5 NL/min, nachdem das Gießvolumen des geschmolzenen Stahls 30-100 % des Gesamtvolumens des geschmolzenen Stahls in der Pfanne erreicht hat; und Beenden des Argon-Einblasens, nachdem das Gießen der Pfanne abgeschlossen ist und die Pfanne zurück in die Gießposition des Strangguss-Drehtisches bewegt wurde.

15. Das Verfahren nach Anspruch 14, wobei der erste Schritt des Messens eines anfänglichen Durchflusswertes des sanften Blasens eines gasdurchlässigen oberen Düsentaschenblocks einer vollen Pfanne Folgendes umfasst: wäh-
 5 während des sanften Blasens der vollen Pfanne im späteren Stadium der LF-Raffination bei der bestehenden Technologie Absperrern von Argon von einem ursprünglichen gasdurchlässigen Block zum Bodenblasen der Pfanne, Verbinden
 von Argon mit dem gasdurchlässigen oberen Düsentaschenblock, das allmähliche Erhöhen der Argon-Durchfluss-
 menge, und Beobachten, dass der Pegel der geschmolzenen Stahlflüssigkeit in der Pfanne leicht schwankt, wobei
 ein Argon-Einblasdurchflusswert, wenn der Pegel der geschmolzenen Flüssigkeit nicht freiliegt, der anfängliche d
 Durchflusswert des sanften Blasens der vollen Pfanne ist.

16. Das Verfahren nach Anspruch 14, wobei der dritte Schritt des Auswählens unterschiedlicher automatischer sanfter
 Einblasmodi gemäß unterschiedlicher Kontrollanforderungen für die Einschlüsse im Stahl Folgendes umfasst:

(1) Auswählen des automatischen sanften Einblasmodus A für eine Stahlsorte niedriger Qualität ohne Ein-
 schlusskontrollanforderung: Aktivieren des automatischen sanften Einblasmodus unmittelbar nachdem der gas-
 15 durchlässige obere Düsentaschenblock durchgeblasen wurde; Einblasen von Argon unter Verwendung des
 automatischen Hauptpfads im Argon-Leitungssystem und lineares Anpassen einer Argon-Durchflussmenge
 entsprechend der Änderung des Nettogewichts des geschmolzenen Stahls in der Pfanne, ein eingestellter Wert
 einer Argon-Durchflussmenge in einem Gießprozess für geschmolzenen Stahl = das Nettogewicht des verblei-
 benden geschmolzenen Stahls in der Pfanne * das Nettogewicht des geschmolzenen Stahls in der vollen Pfanne
 20 x der anfängliche Durchflusswert während des sanften Blasens der vollen Pfanne im ersten Schritt + (2 - 5)
 NL/min; Einblasen von Argon mit einer Durchflussmenge von 2 - 5 NL/min, nachdem das Gießvolumen des
 geschmolzenen Stahls 30 - 40 % des Gesamtvolumens des geschmolzenen Stahls in der Pfanne erreicht hat;
 und Beenden des Argon-Einblasens, nachdem das Gießen der Pfanne abgeschlossen ist und die Pfanne zurück
 in die Gießposition des Strangguss-Drehtisches bewegt wurde;

(2) Auswählen des automatischen sanften Einblasmodus B für eine mittelfeste Stahlsorte mit einer Einschluss-
 kontrollanforderung: Aktivieren des automatischen sanften Einblasmodus unmittelbar nachdem der gasdurch-
 25 lässige obere Düsentaschenblock durchgeblasen wurde; Einblasen von Argon unter Verwendung des automa-
 tischen Hauptpfads im Argon-Leitungssystem und lineares Anpassen einer Argon-Durchflussmenge entspre-
 chend der Änderung des Nettogewichts des geschmolzenen Stahls in der Pfanne, ein eingestellter Wert einer
 Argon-Durchflussmenge in einem Gießprozess für geschmolzenen Stahl = das Nettogewicht des verbleibenden
 geschmolzenen Stahls in der Pfanne + Nettogewicht der Stahlschmelze in der vollen Pfanne x Anfangswert
 30 der Durchflussmenge beim sanften Blasens der vollen Pfanne im zweiten Schritt + (2 - 5) NL/min; Einblasen von
 Argon mit einer Durchflussmenge von 2 - 5 NL/min, nachdem das Gießvolumen der Stahlschmelze 50 - 60 %
 des Gesamtvolumens der Stahlschmelze in der Pfanne erreicht hat; und Beenden des Argon-Einblasens, nach-
 35 dem das Gießen der Pfanne abgeschlossen ist und die Pfanne zurück in die Gießposition des Strangguss-
 Drehtisches bewegt wurde;

(3) Auswählen des automatischen sanften Einblasmodus C für eine hochwertige Stahlsorte mit strenger Ein-
 schlusskontrolle: Aktivieren des automatischen sanften Einblasmodus unmittelbar nachdem der gasdurchläs-
 40 sige obere Düsentaschenblock durchgeblasen wurde; Einblasen von Argon unter Verwendung des automati-
 schen Hauptpfads im Argon-Rohrleitungssystem und lineares Anpassen einer Argon-Flussrate entsprechend
 der Änderung des Nettogewichts der Stahlschmelze in der Pfanne, ein eingestellter Wert einer Argon-Flussrate
 in einem Stahlschmelzgießprozess = Nettogewicht der verbleibenden Stahlschmelze in der Pfanne * Netto-
 gewicht der Stahlschmelze in der vollen Pfanne x anfänglicher Flussratenwert während des sanften Einblasens
 45 der vollen Pfanne im zweiten Schritt + (2 - 5) NL/min; Einblasen von Argon mit einer Durchflussmenge von 2 -
 5 NL/min, nachdem festgestellt wurde, dass in der Pfanne Schlacke eingeschlossen ist oder ein Schlackeein-
 schluss-Erkennungssystem einen Alarm auslöst; und Stoppen des Argon-Einblasens, nachdem die Pfanne
 zurück zur Gießposition des Strangguss-Drehtisches bewegt wurde.

50 Revendications

1. Un bloc de poche de buse supérieure perméable au gaz pour poche de raffinage LF avec barres en céramique
 microporeuse, comprenant un corps de bloc de poche de buse de coulée (1), des barres en céramique microporeuse
 55 (2), une boîte de chambre de gaz (3), et un tuyau d'arrivée de gaz (4), dans lequel un trou de flux d'acier (5) et un
 trou de montage de buse supérieure (6) qui passent à travers sont formés au milieu du corps de bloc de poche (1) ;
 la boîte de chambre de gaz (3) est enfouie dans la couche de surface de la partie supérieure du corps de bloc de
 poche de buse de coulée (1) ; une pluralité de barres en céramique microporeuse (2) est répartie uniformément de
 façon annulaire dans le corps de bloc de poche de buse de coulée (1) ; la terminaison supérieure de chaque barre

en céramique microporeuse (2) se prolonge à l'extérieur de la surface supérieure du corps de bloc de poche de buse de coulée (1) ; la terminaison inférieure de chaque barre en céramique microporeuse (2) se prolonge dans la boîte de chambre de gaz (3) ; une pluralité de connecteurs (8) pour fixer les barres en céramique microporeuse (2) est formée dans la boîte de chambre de gaz (3) ; les formes, nombres, et positions des connecteurs (8) correspondent aux formes, nombres, et positions des barres en céramique microporeuse (2) ; une partie latérale de la boîte de chambre de gaz (3) est raccordée au tuyau d'arrivée de gaz (4) ; une terminaison du tuyau d'arrivée de gaz (4) communique avec la boîte de chambre de gaz (3), et les autres terminaisons du tuyau d'arrivée de gaz se prolongent à l'extérieur depuis une partie latérale du corps de bloc de poche de buse de coulée (1) ; les barres en céramique microporeuse (2) sont cylindriques, leur diamètre est de 35-45 mm ; la hauteur de chaque barre en céramique microporeuse est de 140-180 mm ; le bloc de poche de buse supérieure perméable au gaz avec barres en céramique microporeuse comprend un anneau de fer (7) ; l'anneau de fer (7) est enfoui dans la couche de surface de la partie inférieure du corps de bloc de poche de buse de coulée (1) ; l'anneau de fer (7) est en forme d'anneau circulaire, sa hauteur L est de 40-50 mm ; la distance a entre la terminaison inférieure de l'anneau de fer et la terminaison inférieure du corps de bloc de poche de buse de coulée (1) est de 50-60 mm ; et la profondeur z de l'anneau de fer (7) enfoui dans la couche de surface de la partie supérieure du corps de bloc de poche de buse de coulée (1) est de 10-20 mm ; 60-120 trous de ventilation sont formés dans les barres en céramique microporeuse (2) dans les sens axiaux des barres en céramique microporeuse ; les trous de ventilation sont répartis uniformément sur les sections transversales des barres en céramique microporeuse ; le diamètre interne de chaque trou de ventilation est de 0,075-0,1 mm ; les trous de ventilation passent longitudinalement à travers les faces terminales supérieures et les faces terminales inférieures des barres en céramique microporeuse ; les barres en céramique microporeuse (2) sont brûlées à haute température d'une manière formant une extrusion, et du corindon renforcé à l'oxyde de zirconium ou du corindon mullite renforcé à l'oxyde de zirconium est utilisé.

2. Un bloc de poche de buse selon la revendication 1, dans lequel l'anneau de fer (7) est formé par soudure d'une feuille de fer d'une épaisseur de 1 mm ; et la longueur de recouvrement relève d'une jointure est de 40-50 mm, et une pleine soudure est employée.

3. Un bloc de poche de buse selon la revendication 1, dans lequel de six à dix barres en céramique microporeuse (2) sont placées uniformément en forme d'anneau circulaire, et le diamètre ϕ de l'anneau circulaire est de 300-320 mm.

4. Un bloc de poche de buse selon la revendication 1, dans lequel la hauteur m de la terminaison supérieure de chaque barre en céramique microporeuse (2) se prolongeant depuis la surface supérieure du corps de bloc de poche de buse de coulée (1) est de 5-10 mm, et la hauteur n de la terminaison inférieure de chaque barre en céramique microporeuse (2) se prolongeant dans la boîte de chambre de gaz est de 5-10 mm.

5. Un bloc de poche de buse selon la revendication 1, dans lequel la boîte de chambre de gaz (3) entière est en forme d'anneau circulaire ; la boîte de chambre de gaz utilise une boîte en métal fabriquée à l'aide d'une plaque d'acier de 1,5-2,0 mm d'épaisseur ; et la section transversale de la boîte en métal est un rectangle de largeur x de 50-60 mm et de hauteur y de 30-40 mm ; la section transversale de la boîte en métal est un anneau circulaire ; et la pluralité de connecteurs (8) est répartie uniformément sur l'anneau circulaire.

6. Un bloc de poche de buse selon la revendication 1, dans lequel le corps de bloc de poche de buse de coulée (1) est coulé et moulé à partir de chrome corindon coulable, avec une masse volumétrique $\geq 3,0 \text{ g/cm}^3$, une force de flexion haute température $\geq 12 \text{ Mpa}$, une force de compression haute température $\geq 80 \text{ Mpa}$, une teneur en $\text{Al}_2\text{O}_3 \geq 92\%$, et une teneur en $\text{Cr}_2\text{O}_3 \geq 3\%$.

7. Un bloc de poche de buse selon la revendication 1, dans lequel les lignes centrales longitudinales du trou de flux d'acier (5) et du trou de montage de buse supérieure (6) et la ligne centrale longitudinale du corps de bloc de poche de buse de coulée (1) sont une ligne droite ; la partie supérieure du trou de flux d'acier (5) est en forme de cône tronqué ; le diamètre d1 de l'orifice supérieur du cône tronqué est de 190-210 mm, et le diamètre d2 de l'orifice inférieur est de 140-160 mm ; la hauteur c du cône tronqué est de 55-80 mm ; la partie inférieure du trou de flux d'acier (5) est un canal cylindrique ; le diamètre du canal cylindrique inférieur correspondant au diamètre de l'orifice inférieur du cône tronqué supérieur ; le cylindre est d'une hauteur b de 250-270 mm.

8. Un bloc de poche de buse selon la revendication 1, dans lequel la partie supérieure du trou de montage de buse supérieure (6) est en forme de cône tronqué, et la taille appropriée du trou de montage de buse supérieure est conçue en fonction de la taille du contour de la buse supérieure.

9. Un bloc de poche de buse selon la revendication 1, dans lequel le corps de bloc de poche de buse de coulée (1) est cylindrique ; et la forme cylindrique est de diamètre externe D de 380-400 mm et de hauteur H de 470-490 mm.

10. Un bloc de poche de buse selon la revendication 1, dans lequel le tuyau d'arrivée de gaz (4) est fait à partir d'un tube rond en acier inoxydable résistant à la chaleur, sa partie terminale est munie d'un filetage de raccordement, de dimension M16 $\times$ 1,5.

11. Un dispositif de commande de soufflage d'argon, comprenant un bloc de poche de buse supérieure perméable au gaz, dans lequel un système de canalisation d'argon et un système de commande électrique sont fournis, doté d'une fonction de sélection de mode de soufflage manuel pour le bloc de poche de buse supérieure perméable au gaz et d'un mode de soufflage doux automatique, introduisant un signal de pesée de l'acier fondu dans une poche, et ajustant de façon synchronisée le débit d'argon en fonction du changement de poids net de l'acier fondu dans la poche, et

le bloc de poche de buse supérieure perméable au gaz est un bloc de poche de buse supérieure perméable au gaz avec barres en céramique microporeuse selon la revendication 1.

12. Un dispositif de commande de soufflage d'argon selon la revendication 11, dans lequel le système de canalisation d'argon est divisé en un chemin principal de gaz source, une section automatique, un contournement manuel, et une section de libération ; le chemin principal de gaz source, la section automatique et le contournement manuel communiquent via une barre de confluence de gaz (18) ;

le chemin principal de gaz source comprend une première vanne à boule (9a) de chemin principal de gaz, une première jauge de pression (10a), un premier filtre à gaz (11a1), un deuxième filtre à gaz (11a2), un ajusteur de pression (12), et un premier capteur de pression (15a) en séquence ;

la section automatique comprend une deuxième vanne à boule (9b1) de section automatique, une première vanne électromagnétique (13b), un contrôleur spécial de débit de masse métallurgique (14), un deuxième capteur de pression (15b), une deuxième jauge de pression (10b), et une troisième vanne à boule (9b2) de section automatique en séquence ; le contournement manuel comprend une quatrième vanne à boule (9c) de contournement manuel et une vanne d'ajustement manuel (16) en séquence ; le contournement manuel est raccordé en parallèle avec la deuxième vanne à boule (9b1) de section automatique, la première vanne électromagnétique (13b), et le contrôleur spécial de débit de masse métallurgique (14) de la section automatique pour effectuer des opérations et applications manuelles lorsque la section automatique est défectueuse ;

le système de canalisation d'argon est en outre utilisé pour un soufflage haute pression avant soufflage automatique d'argon du bloc de poche de buse supérieure perméable au gaz pour poche de raffinage LF ; la section de libération est en outre agencée à la terminaison arrière de la vanne d'ajustement manuel (16), et comprend une deuxième vanne électromagnétique (13c) et un papillon des gaz d'échappement (17) en séquence afin d'évacuer le gaz et de libérer la pression lorsqu'un tuyau en métal d'arrivée de gaz raccordé au bloc de poche de buse supérieure perméable au gaz doit être branché.

13. Un dispositif de commande de soufflage d'argon selon la revendication 11, dans lequel le système de commande électrique comprend un commutateur réseau, un système de commande PLC de soufflage d'argon, un écran tactile, et un système d'automatisation basique de coulée continue ;

le système de commande PLC de soufflage d'argon et l'écran tactile sont agencés dans un boîtier de commande ; le système de commande PLC de soufflage d'argon, l'écran tactile et le système d'automatisation basique de coulée continue sont tous raccordés au commutateur réseau via communication Ethernet ; un système de pesée pour acier fondu dans une poche collecte et envoie le poids de l'acier fondu dans la poche au système d'automatisation basique de coulée continue, et téléverse le poids vers le système de commande PLC de soufflage d'argon via communication Ethernet et le commutateur réseau.

14. Un procédé de commande de soufflage d'argon, comprenant les étapes suivantes :

dans une première étape, appliquer le dispositif de commande de soufflage d'argon selon la revendication 11 pour la première fois afin de mesurer la valeur du débit initial de soufflage doux d'un bloc de poche de buse supérieure perméable au gaz de pleine poche, dans lequel le bloc de poche de buse supérieure perméable au gaz est le bloc de poche de buse supérieure perméable au gaz selon la revendication 1 ;

dans une deuxième étape, faire communiquer, une fois que la poche est en position de coulée sur un plateau tournant à poche de coulée continue, le tuyau d'arrivée de gaz (4) du bloc de poche de buse supérieure perméable au gaz susmentionné avec la sortie de gaz source d'un dispositif de commande d'argon en utilisant

un tuyau en métal ; transférer la poche sur la position de coulée afin d'effectuer coulée et flux, puis souffler à travers le bloc de poche de buse supérieure perméable au gaz susmentionné immédiatement en utilisant le contournement manuel dans le système de canalisation d'argon : augmenter graduellement la pression de 1-10 mbar à chaque fois en ajustant l'ajusteur de pression (12) du chemin principal de gaz source dans le système de canalisation d'argon jusqu'à ce que le bloc de poche de buse supérieure perméable au gaz susmentionné soit soufflé entièrement à travers ; et

dans une troisième étape, permettre, selon diverses exigences de contrôle d'inclusion dans l'acier, différentes modes de soufflage doux automatiques immédiatement après que le bloc de poche de buse supérieure perméable au gaz ait été entièrement soufflé à travers à la deuxième étape ; souffler de l'argon en utilisant le chemin principal automatique dans le système de canalisation d'argon, et ajuster linéairement le débit d'argon en fonction des changements de poids net de l'acier fondu dans la poche,

valeur prédéfinie du débit d'argon dans le processus de coulée de l'acier fondu = le poids net de l'acier fondu résiduel dans la poche x le poids net de l'acier fondu dans la poche pleine x la valeur de débit initial durant le soufflage doux de la poche pleine dans la première étape + (2-5) NL/min ;

souffler de l'argon à un débit de 2-5 NL/min une fois que le volume de coulée de l'acier fondu atteint 30-100% du volume total de l'acier fondu dans la poche ; et cesser le soufflage d'argon une fois que la coulée de la poche est terminée et que la poche est ramenée en position de coulée du plateau tournant à poche de coulée continue.

15. Un procédé selon la revendication 14, dans lequel la première étape de mesure de la valeur du débit initial de soufflage doux d'un bloc de poche de buse supérieure perméable au gaz de pleine poche comprend : durant le soufflage doux de la pleine poche au stade ultérieur de raffinage LF dans les technologies existantes, fermer l'argon du bloc perméable au gaz soufflé par le bas de la poche originelle, raccorder l'argon au bloc de poche de buse supérieure perméable au gaz, augmenter graduellement le débit d'argon flow rate, et observer si le niveau d'acier fondu dans la poche fluctue, dans lequel la valeur de débit de soufflage d'argon lorsque le niveau de liquide fondu n'est pas exposé est la valeur de débit initial du soufflage doux de la pleine poche.

16. Un procédé selon la revendication 14, dans lequel la troisième étape de sélection de divers modes de soufflage doux automatiques selon différentes exigences de contrôle d'inclusion dans l'acier comprend :

(1) sélection automatique du mode de soufflage doux A pour acier de basse qualité sans exigence de contrôle d'inclusion : permettre le mode de soufflage doux automatique immédiatement après que le bloc de poche de buse supérieure perméable au gaz ait été entièrement soufflé à travers ; souffler de l'argon en utilisant le chemin principal automatique dans le système de canalisation d'argon, et ajuster linéairement le débit d'argon en fonction des changements de poids net de l'acier fondu dans la poche, la valeur prédéfinie du débit d'argon dans le processus de coulée de l'acier fondu = le poids net de l'acier fondu résiduel dans la poche x le poids net de l'acier fondu dans la poche pleine x la valeur de débit initial durant le soufflage doux de la poche pleine dans la première étape + (2-5) NL/min ; souffler de l'argon à un débit de 2-5 NL/min une fois que le volume de coulée de l'acier fondu atteint 30-40% du volume total de l'acier fondu dans la poche ; et cesser le soufflage d'argon une fois que la coulée de la poche est terminée et que la poche est ramenée en position de coulée du plateau tournant à poche de coulée continue ;

(2) sélection automatique du mode de soufflage doux B pour acier de moyenne qualité avec exigences de contrôle d'inclusion : permettre le mode de soufflage doux automatique immédiatement après que le bloc de poche de buse supérieure perméable au gaz ait été entièrement soufflé à travers ; souffler de l'argon en utilisant le chemin principal automatique dans le système de canalisation d'argon, et ajuster linéairement le débit d'argon en fonction des changements de poids net de l'acier fondu dans la poche, la valeur prédéfinie du débit d'argon dans le processus de coulée de l'acier fondu = le poids net de l'acier fondu résiduel dans la poche x le poids net de l'acier fondu dans la poche pleine x la valeur de débit initial durant le soufflage doux de la poche pleine dans la deuxième étape + (2-5) NL/min ; souffler de l'argon à un débit de 2-5 NL/min une fois que le volume de coulée de l'acier fondu atteint 50-60% du volume total de l'acier fondu dans la poche ; et cesser le soufflage d'argon une fois que la coulée de la poche est terminée et que la poche est ramenée en position de coulée du plateau tournant à poche de coulée continue ;

(3) sélection automatique du mode de soufflage doux C pour acier de haute qualité avec stricte contrôle d'inclusion : permettre le mode de soufflage doux automatique immédiatement après que le bloc de poche de buse supérieure perméable au gaz ait été entièrement soufflé à travers ; souffler de l'argon en utilisant le chemin principal automatique dans le système de canalisation d'argon, et ajuster linéairement le débit d'argon en fonction des changements de poids net de l'acier fondu dans la poche, la valeur prédéfinie du débit d'argon dans le processus de coulée de l'acier fondu = le poids net de l'acier fondu résiduel dans la poche x le poids net de l'acier fondu dans la poche pleine x la valeur de débit initial durant le soufflage doux de la poche pleine

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dans la deuxième étape + (2-5) NL/min ; souffler de l'argon à un débit de 2-5 NL/min une fois qu'un piégeage de scories dans la poche est constaté ou que l'alarme du système de détection de piégeage de scories retentit ; et cesser le soufflage d'argon une fois que la poche est ramenée en position de coulée du plateau tournant à poche de coulée continue.

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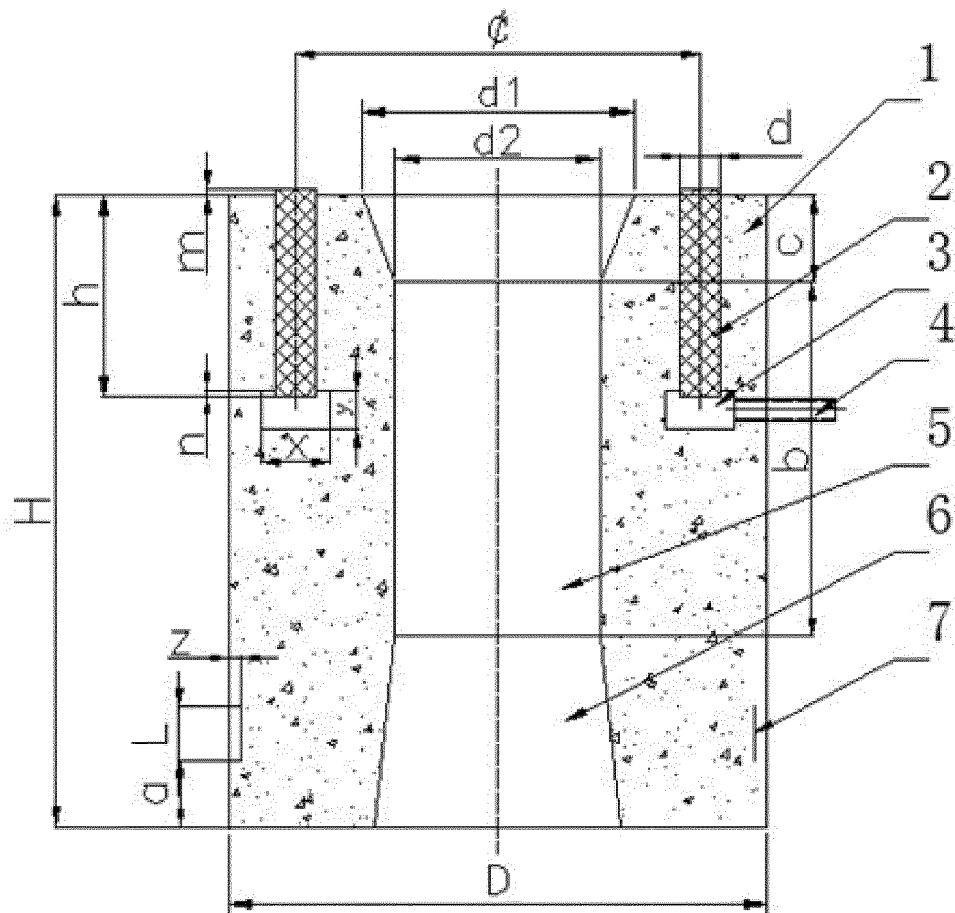


Fig. 1

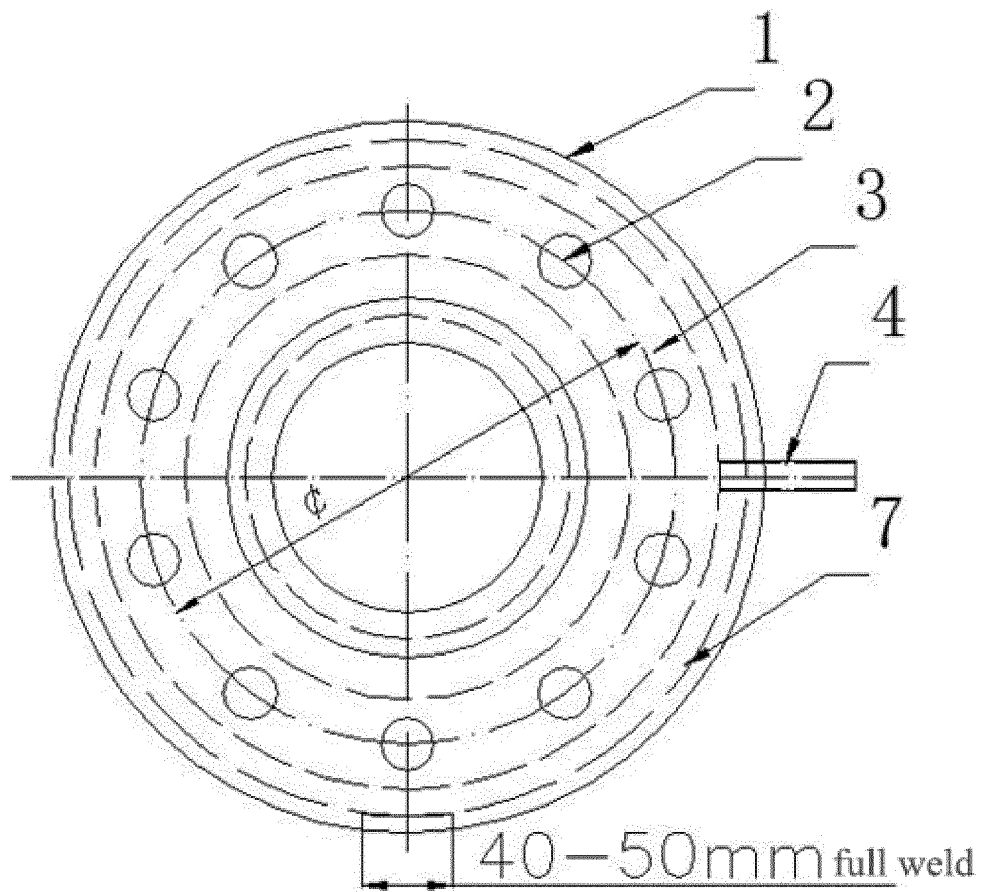


Fig. 2

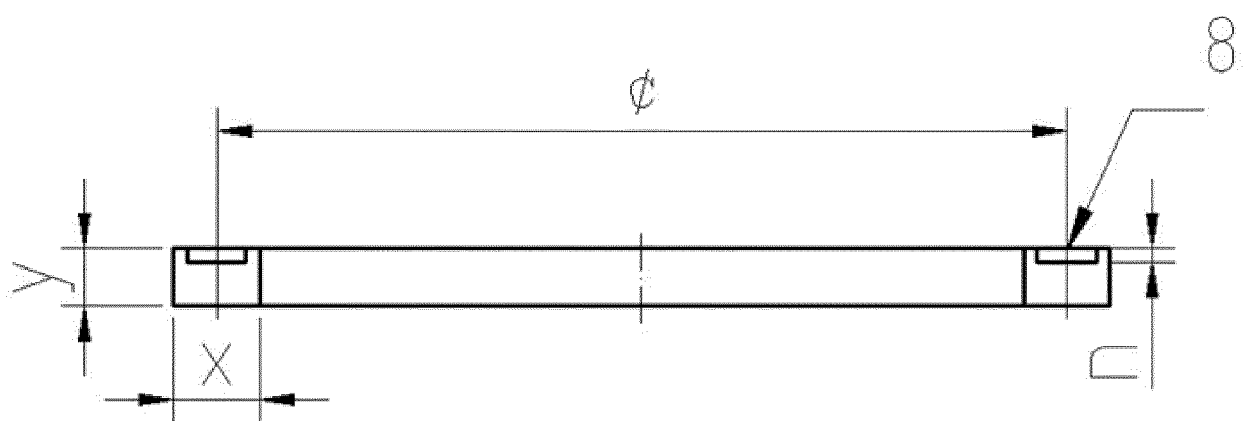


Fig. 3

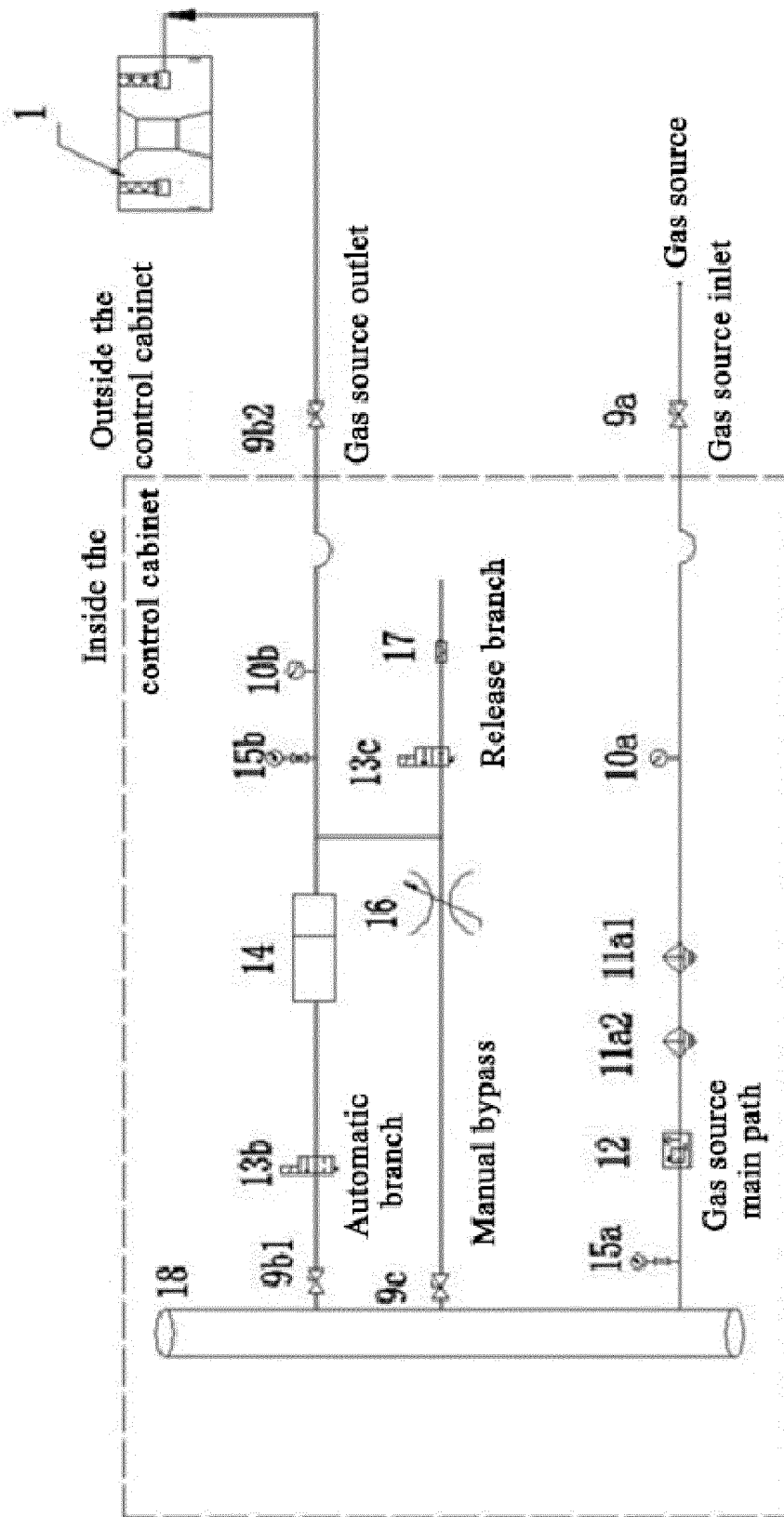


Fig. 4

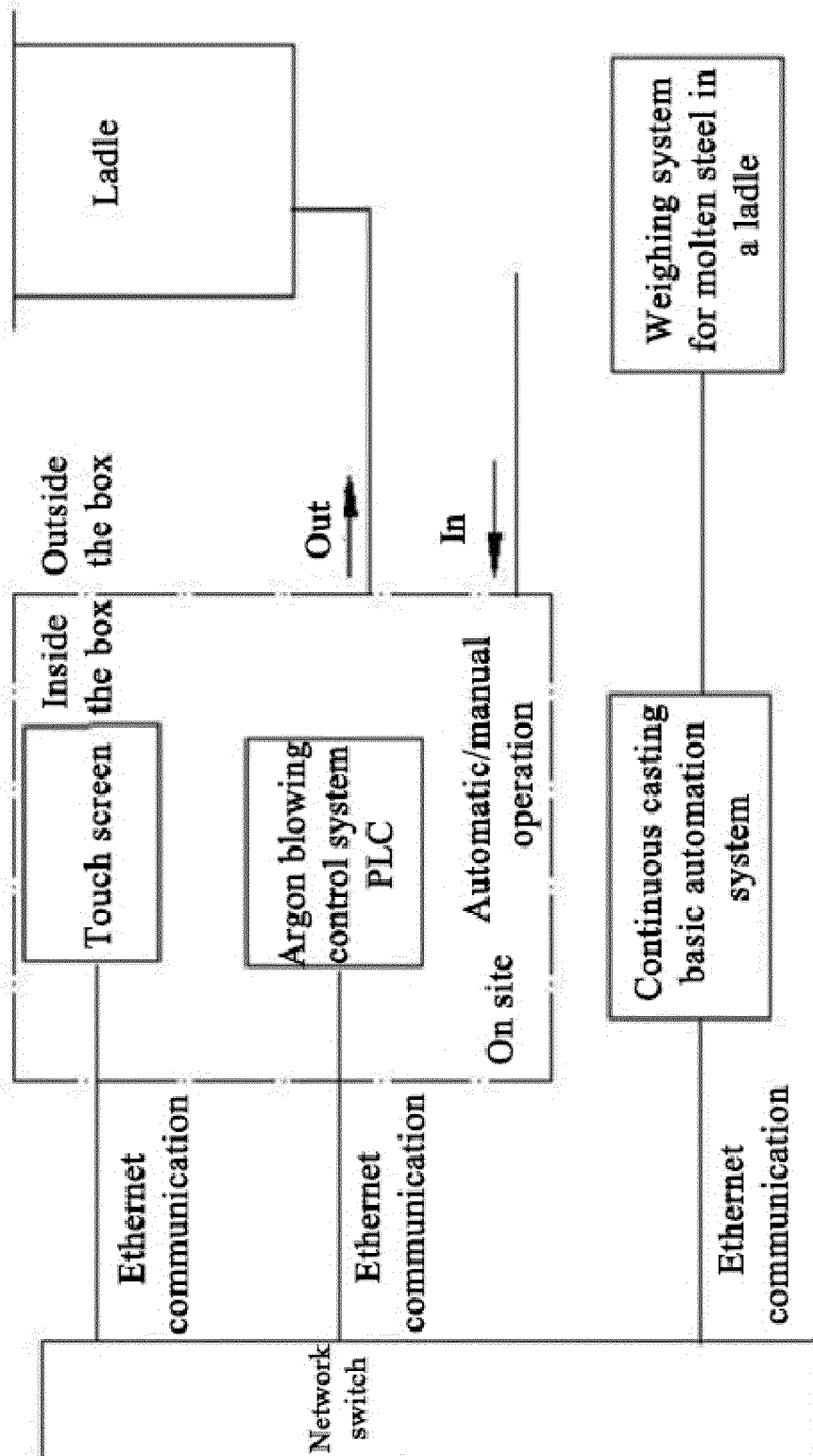


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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