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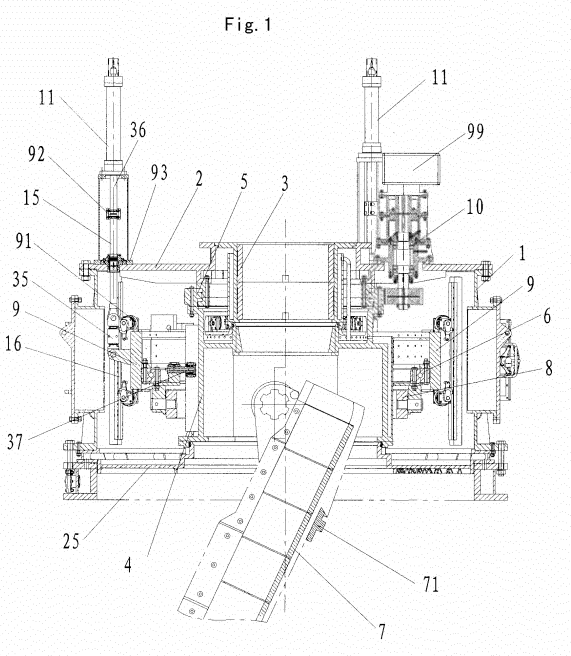
(54) FURNACE TOP CHUTE FEEDER FOR BLAST FURNACE

(57) The present invention discloses a furnace top chute distributor for a blast furnace, including an airtight case, a choke, an upper slewing bearing, a rotating sleeve, a chute, a universal frame, a lower slewing bearing, a dial wheel assembly, a cylinder and a horizontal driving apparatus for driving the upper slewing bearing to rotate. The choke extends through a top cover provided on top of the airtight case and into the airtight case. An inner ring of the upper slewing bearing is connected with the top cover. The rotating sleeve on which a lug is provided is connected with an outer ring of the upper slewing bearing, and the chute is hung within the rotating sleeve via the lug. The lug is connected to one end of a crank, while the other end of the crank is positioned within a slideway of the universal frame. An inner ring of the lower slewing bearing is connected with the universal frame. One end of the dial wheel assembly is connected with the inner ring of the lower slewing bearing, while the other end thereof is positioned within a runner of the rotating sleeve. The cylinder is used for drawing the lower slewing bearing to move up and down. The furnace top chute distributor for a blast furnace according to the present invention has advantages, such as reasonable structure, long lifetime, the shortest gearing chain, more stable operation, and no lateral force to the guide rail.

Fig. 1



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Description

Field of the Invention

[0001] The present invention relates to a furnace top charging device for a smelting blast furnace, more particularly to a furnace top chute distributor for a blast furnace.

Background of the Invention

[0002] A furnace top charging device for a blast furnace is the significant device for blast furnace ironmaking. Whether the device can meet the processing requirements will directly limit the output of blast furnace. Since the blast furnace ironmaking presents, the furnace top charging device for a blast furnace comes through the three following generations: the first generation is a bell top charging device; the second generation is a bell top charging device with a movable throat armor; and the third generation is a top charging device without bell system. Over the past twenty years, especially the past decade, with the development and improvement of the steel industry, for the furnace top charging device for a blast furnace, the bell top is gradually replaced by the top charging device without bell, which has changed the conditions, such as inflexible charging, low processing performance and operation controlling performance, and inconvenient maintenance and inspection, achieved the precise distribution, and improved the technology level and efficiency of blast furnace smelting.

[0003] The driving means for a chute of the current top charging device without bell distributor includes the planet differential transmission, the combined transmission by single cylinder with steel cable, the combined transmission by servomotor with steel cable, and the lever actuating mechanism. However, problems exist in the distributor with the planet differential transmission, such as complicated structure, high price of the device, high maintenance and repair cost, difficulty in manufacturing the device, and low performance of processing and resistance to high temperature at the furnace top. For the distributor with the combined transmission by single cylinder with steel cable, or by servomotor with steel cable, the steel cable system is complicated and the steel cable is liable to crack due to fatigue, and since the movement of the chute relies on the counterweight of a translational backing ring, the structure is limited to some extent so as to be hardly applied for those huge blast furnace. The distributor with lever actuating includes two-suspension-points form and four suspension-points form and both of them has the problems such as mechanical over-constraint and the desynchrony of processing and assembling, which causes shorter lifetime of the distributor, and therefore the requirement of furnace lifetime of one generation cannot be met.

Summary of the Invention

[0004] In view of the above-mentioned problems in the prior art, one aspect of the present invention is to provide a furnace top chute distributor for a blast furnace, which has reasonable structure, long lifetime, the shortest gearing chain, more stable operation, and no lateral force to a guide rail.

[0005] To solve the said technical problems, the technical solution of the present invention is to provide a furnace top chute distributor for a blast furnace, comprising:

an airtight case having a top cover provided on a top portion thereof;

a choke configured to communicate with exterior through the top cover and extend into the airtight case;

an upper slewing bearing having an inner ring connected with the top cover in a fixed manner;

a rotating sleeve located inside the airtight case and having an upper end fixed-connected with an outer ring of the upper slewing bearing; two lug holes provided facing each other along a diameter of the rotating sleeve and each lug hole having a lug therein, and each lug having an end extending out of the rotating sleeve to connect with an end of a crank;

a chute having two upper ends connected with the other end of each lug respectively to enable the chute to be hung within the rotating sleeve;

a universal frame telescopic coupled outside the rotating sleeve, on which two symmetrical slideways are opened, and each crank tail wheel on the other end of each crank provided within the slideway;

a lower slewing bearing having an inner ring fixed-connected with the universal frame;

a dial wheel assembly having one end fixed-connected with the inner ring of the lower slewing bearing, and a dial wheel on the other end that is positioned and rolled within a runner opened on the rotating sleeve;

a cylinder for drawing an outer ring of the lower slewing bearing to move up and down; and

a horizontal driving apparatus for driving the outer ring of the upper slewing bearing to rotate.

[0006] As preferred, a large flange on an outer edge of the top cover is fixed-connected with the airtight case while a small flange on an inner edge of the top cover is fixed-connected with the inner ring of the upper slewing bearing;

a chute bracket is fixed-connected at the outer side of the chute, and the two upper ends of the chute bracket are connected with said other end of each lug by a spline respectively while said end of each lug is connected with the end of each crank by a spline;

a translational backing ring, telescopic coupled outside the rotating sleeve having an upper portion telescopic coupled outside the choke, has a lower portion of an inner

edge fixed-connected with the outer ring of the lower slewing bearing, and a guide wheel is provided on an outer edge of the translational backing ring while a corresponding guide rail is provided on an interior wall of the airtight case to enable the guide wheel to roll up and down along the guide rail by the cylinder;

three cylinders are provided, which are disposed evenly on the top cover with respect to a horizontal rotation center line of the chute in an axial direction, and the three cylinders are connected with the translational backing ring via a transition link respectively to cause the translational backing ring to move up and down and thus cause the universal frame to move up and down.

[0007] As preferred, the cylinder includes a cylinder body fixed on the top cover by a cylinder block, and a cylinder rod having a lower end fixed-connected with the transition link by a holding sleeve. By passing through the cylinder block and the top cover, a lower end of the transition link is connected with an adjustable link, which is inside the airtight case and connected with the translational backing ring.

[0008] As preferred, the holding sleeve is formed in a cylindrical shape with a center through hole by coupling two semi-sleeve bodies to each other. Further, the two semi-sleeve bodies are fixed together by connection bolts. In this configuration, diameter of each end portion of the center through hole is smaller than diameter of a center portion thereof, while steps are formed at diameter transitions of the center through hole. Further, opposite ends of the cylinder rod and the transition link are formed as thin portions positioned in the two ends of the center through hole, respectively. Moreover, one end of each thin portion is connected with a joint positioned in the center portion of the center through hole and against the step. As such, the opposite ends of the cylinder rod and the transition link abut against both ends of the holding sleeve.

[0009] As preferred, a positioning slot with a notch facing the guide wheel is fixed-connected to the interior wall of the airtight case corresponding to the guide wheel of the translational backing ring in a lengthwise direction. Further, the guide rail of the airtight case is removably fixed into the positioning slot in a lengthwise direction.

[0010] As preferred, the guide rail is a square steel material, which is removably fixed into the positioning slot by a plurality of fixed bolts in a spaced arrangement, wherein the positioning slot is welded onto the interior wall of the airtight case.

[0011] As preferred, the universal frame includes two opposite and parallel first rims, two opposite and parallel second rims, and third rims. The first rims are perpendicular to the second rims, and opposite ends of the first rims and the adjacent second rims are connected to two ends of the third rims respectively to form a closed annular shape. Further, center portions of the two second rims protrude outwardly to form bosses, and two slideways opposite to each other are opened in the two second rims on the same sides of the bosses respectively. The length of the slideways in a lengthwise direction of the second rims is larger than that in a width direction of the second rims. At the same time, by two symmetrical connection brackets provided on center portions of the first rims respectively, the universal frame is fixed-connected with the inner ring of the lower slewing bearing.

[0012] As preferred, a center chamber is opened from the end of the lug facing the exterior of the rotating sleeve toward the interior of the lug, thereby the end of the lug is formed as an opened end provided with an end cover for covering an opening of the center chamber. Further, a through hole is opened at a center portion of the end cover, through which a water inlet tube is provided for supplying cooling water to the center chamber. Also, a plurality of overflow holes communicated with the center chamber is opened at the end cover.

[0013] As preferred, an oil hole is opened from the end of the lug facing the exterior of the rotating sleeve toward the interior of the lug, and at least one grease outlet communicated with the oil hole is opened at an exterior wall of the lug surrounded by a lug sheath. The oil hole is connected with an oil supply tube for supplying lubricant thereto.

[0014] As preferred, three grease outlets are provided, which are disposed evenly in a linear-arrangement on the exterior wall of the lug surrounded by the lug sheath.

[0015] As preferred, the lug at a location where the grease outlets are provided and the lug sheath are configured as a large clearance fit.

[0016] As preferred, an oiler connected with the oil supply tube for supplying oil thereto is secured on the crank. Further, a bumping piece is provided on the exterior wall of the rotating sleeve, the bumping piece being in contact with or separated from the oiler to start or stop fueling when the crank rotates.

[0017] Comparing to the prior art, the furnace top chute distributor for a blast furnace according to the present invention has the following advantages leastwise:

1. The furnace top chute distributor for a blast furnace according to the present invention has reasonable structure, the shortest gearing chain, more stable operation, no lateral force to the guide rail, and evenly distributing, such that various requirements of the processing operation of the top charging device without bell can be fully satisfied.
2. Since an external cylinder configuration, in which a cylinder is installed on the top cover by the cylinder block, is utilized for each of the three cylinders of the furnace top chute distributor for a blast furnace of the present invention, the requirement for replacing the cylinder rapidly during the operation of the distributor can be satisfied.
3. A removable structure is utilized for the guide rail on the airtight case of the furnace top chute distributor for a blast furnace of the present invention to enable replacement after wearing out to be very convenient to extend lifetime to match with that of the

distributor, so that the disadvantages in the prior art such as the difficulty of processing and the heat treatment for the guide rail, and impossibility of the replacement after attrition can be overcome.

4. Water-cooling and lubrication treatment are performed on the lugs according to the furnace top chute distributor for a blast furnace of the present invention so as to meet the requirement for operating the lugs under the high temperature condition and to reduce the wear, thereby lifetime of the lugs can be extended.

Brief Description of the Drawings

[0018]

Fig.1 is a schematic view of the overall structure of the furnace top chute distributor for a blast furnace according to the present invention;

Fig.2 is a schematic view of the overall structure of the furnace top chute distributor for a blast furnace in another direction according to the present invention;

Fig.3 is a top view of Fig.2;

Fig.4 is a schematic view of the connecting configuration of the universal frame, the inner ring of the lower slewing bearing and the chute bracket of the furnace top chute distributor for a blast furnace according to the present invention;

Fig.5 is a top view of the universal frame of the furnace top chute distributor for a blast furnace according to the present invention;

Fig.6 is a front view of the universal frame of the furnace top chute distributor for a blast furnace according to the present invention;

Fig.7 is a side view of the universal frame of the furnace top chute distributor for a blast furnace according to the present invention;

Fig.8 is a schematic view of the connecting configuration of one cylinder and the transition link of the furnace top chute distributor for a blast furnace according to the present invention;

Fig.9 is a sectional view of the holding sleeve of the furnace top chute distributor for a blast furnace according to the present invention;

Fig.10 is a schematic view of the connecting configuration of the guide wheel and the guide rail on the interior wall of the airtight case of the furnace top chute distributor for a blast furnace according to the present invention;

Fig.11 is a structurally schematic view of the water-cooling system of the lugs according to the furnace top chute distributor for a blast furnace of the present invention;

Fig.12 is a structurally schematic view of the lubrication system of the lugs according to the furnace top chute distributor for a blast furnace of the present invention;

Fig.13 is a schematic view of the lugs in an initial fueling condition according to the furnace top chute distributor for a blast furnace of the present invention;

Fig.14 is a schematic view of the lugs in a non-fueling condition according to the furnace top chute distributor for a blast furnace of the present invention;

Fig.15 is a schematic view of the lugs in a fueling finishing condition according to the furnace top chute distributor for a blast furnace of the present invention.

Explanation of reference numerals

[0019] I - airtight case 2 - top cover 3 - choke 4 - rotating sleeve 5 - upper slewing bearing 6 - lower slewing bearing 7 - chute 8 - universal frame 9 - translational backing ring 10 - horizontal chute driving apparatus 11 - cylinder 12 - lug 13 - lug sheath 14 - crank 15 - transition link 16 - guide rail 17 - positioning slot 18 - fixed bolt 19 - center chamber 20 - end cover 22 - overflow hole 23 - internal water tube 24 - external water tube 25- water-cooling base plate 26 - connection bolt 27 - sealing ring 28 - oil hole 29 - grease outlet 30 - oil supply tube 31 - oiler 32 - bumping piece 34 - crank tail wheel 35 - adjustable link 36-cylinder rod 37 - dial wheel assembly 71 - chute bracket 81 - slideway 82 - first rim 83 - second rim 84 - third rim 85 - boss 86 - connection bracket 91 - guide wheel 92 - holding sleeve 93 - cylinder block 94 -cylinder body 95 - semi-sleeve body 96 - center through hole 97 - connection bolt 98 - joint 99 - geared motor 100 - step 101 - thin portion

Detailed Description on the Embodiments

[0020] The detail description of the present invention will be made as following with reference to the accompanying drawings and embodiments which are not to be construed as limiting the present invention.

[0021] Fig.1 is a schematic view of the overall structure of the furnace top chute distributor for a blast furnace according to the present invention; Fig.2 is a schematic view of the overall structure of the furnace top chute distributor for a blast furnace in another direction according to the present invention; Fig.3 is a top view of Fig.2; and Fig.4 is a schematic view of the connecting configuration of the universal frame, the inner ring of the lower slewing bearing and the chute bracket of the furnace top chute distributor for a blast furnace according to the present invention. As shown in Figs.1 to 4, a furnace top chute distributor for a blast furnace according to the present invention includes an airtight case 1, a top cover 2, a choke 3, a rotating sleeve 4, an upper slewing bearing 5, a lower slewing bearing 6, a chute 7, a universal frame 8, a translational backing ring 9, a horizontal chute driving apparatus 10 and three cylinders 11. A through hole (not shown in the drawings) is provided in a middle portion of the top cover 2 to allow the choke 3 to pass therethrough. An upper end of the airtight case 1 is capped with the top cover 2 by fixed-connecting a large flange on an outer edge of the top cover 2 to the airtight case 1. In the present

invention, the upper and lower slewing bearings 5, 6 have conventional structure(s), that is, they have an inner ring and an outer ring being rotatable but not movable up and down relatively to each other, respectively. Also, a small flange on an inner edge of the top cover 2 is fixed-connected with the inner ring of the upper slewing bearing 5. Further, the choke 3 is provided inside the airtight case 1 through the through hole in the top cover 2.

[0022] As shown in Figs.1, 2 and 4, the rotating sleeve 4 having an upper portion telescopic coupled outside the choke 3 is located inside the airtight case 1. Since an upper end of the rotating sleeve 4 is fixed-connected with the outer ring of the upper slewing bearing 5 while the inner ring of the upper slewing bearing 5 is fixed-connected with the top cover 2, the rotating sleeve 4 and the top cover 2 are in a rest condition relative to each other in a vertical direction. The rotation of the outer ring of the upper slewing bearing 5 is driven by the horizontal chute driving apparatus 10 provided on the top cover 2, and causes the rotating sleeve 4 to rotate about a center line of the top cover 2 by 360 degrees. The chute 7 capable of rotating along with the rotating sleeve 4 is provided in the rotating sleeve. In particularly, the configuration of the connection between the rotating sleeve 4 and the chute 7 is described as the following. Two lug holes (not shown in the drawings) diametrically opposite to each other are opened in the wall of the rotating sleeve 4, and each lug hole is provided with a lug sheath 13 in which a lug 12 capable of rotating within the lug sheath 13 is installed. A chute bracket 71 is fixed-connected at the outer side of the chute 7. The chute bracket 71 has two upper ends respectively connected with one end of each lug 12 via a spline, such that the chute 7 is hung onto the two lugs 12 passing through the lug sheaths 13. That is, the chute 7 is hung onto the rotating sleeve 4 via the lugs. The chute bracket 71 and the chute 7 are always in a rest condition relative to each other and rotate along with the rotating sleeve 4.

[0023] Continuing with reference to Figs.1 to 3, the three cylinders 11 axially disposed on the top cover 2 evenly with respect to a horizontal rotation center line of the chute 7 are connected with the translational backing ring 9 via a transition link 15 respectively so as to cause the translational backing ring 9 to move up and down. The translational backing ring 9 is telescopic coupled outside the rotating sleeve 4, and a lower portion of an inner edge of the translational backing ring 9 is fixed-connected with an outer ring of the lower slewing bearing 6 into one piece by means of bolts, thereby the translational backing ring 9 may cause both the inner and outer rings of the lower slewing bearing 6 to move up and down. An outer edge of the translational backing ring 9 is provided with a guide wheel 91, and a corresponding guide rail 16 is provided on an interior wall of the airtight case 1. The guide wheel 91 is provided on the guide rail 16 and caused to roll up and down along the guide rail 16 by the cylinder 11 so as to ensure an accurate moving direction of the translational backing ring 9 and the inner and outer rings of the lower slewing bearing 6. The universal frame 8 is telescopic coupled outside the rotating sleeve 4 and is fixed-connected with the inner ring of the lower slewing bearing 6. As such, the up-down movement of the translational backing ring 9 causes the inner ring of the lower slewing bearing 6 to move up and down and thus causes the universal frame 8 to move up and down. The other end of the lug 12 passing through the lug sheath 13 is connected with a crank 14 via a spline, while a crank tail wheel 34 on the other end of the crank 14 is positioned within a slideway 81 of the universal frame 8. Since the rotating sleeve 4 cannot move up and down, when the universal frame 8 moves up and down, the slideway 81 causes the crank tail wheel 34 to move up and down and along the slideway 81, such that the crank 14 causes the lug 12 to rotate within the lug sheath 13. In turn, the rotation of the lug 12 causes the swing of the chute 7 and the chute bracket 71.

[0024] The inner ring of the lower slewing bearing 6 is fixed-connected with a dial wheel assembly 37 having a dial wheel positioned within a runner (not shown in the drawings) opened on the rotating sleeve 4 in an up-down direction. When the cylinder 11 causes the lower slewing bearing 6 to move up and down via the translational backing ring 9 and thus the chute 7 is swung, the dial wheel slides up and down with respect to the rotating sleeve 4 within the runner thereof. And when the rotating sleeve 4 rotates, the dial wheel rotates along with it while sliding up and down within the runner thereof so as to cause the universal frame 8 and the inner ring of the lower slewing bearing 6 to rotate as well. Thus, the operation of the rotating and swinging of the chute 7 during the distribution is performed.

[0025] As a preferred aspect of the embodiments, the three cylinders 11 include a cylinder body 94 and a cylinder rod 36 respectively, as shown in Fig.1. The cylinder body 94 is fixed on the top cover 2 via a cylinder block 93. Through a holding sleeve 92, a lower end of the cylinder rod 36 is fixed-connected to the transition link 15. A lower end of the transition link 15 extends through the cylinder block 93 and the top cover 2 and into the airtight case 1 so as to connect to an adjustable link 35 which is within the airtight case 1 and connected with the translational backing ring 9. Thus, the up-down movement of the cylinder rod 36 causes the translational backing ring 9 to move up and down. Each of the cylinders 11 of the embodiment is arranged as an external cylinder configuration, i.e. the cylinder rod 36 is located outside the airtight case 1 or outside the furnace top chute distributor for a blast furnace of the present invention, which changes the conventional internal cylinder configuration where the cylinder rod of the cylinder has to extend into the airtight case. When failure in the cylinder 11 occurs and disassembly is needed to perform inspection and replacement, the process can be done by only releasing the holding sleeve 92 to separate the cylinder rod 36 from the transition link 15 after dismounting the cylinder 11 from the cylinder block 93, without opening the distributor

body. Under this configuration, it is not as complicated as the internal cylinder configuration where the distributor has to be opened when disassembly of the cylinder is needed, therefore, convenient and rapid disassembly can be achieved while production efficiency is increased.

[0026] As a further preferred aspect, shown in Figs.8 and 9, the holding sleeve 92 is formed in a cylindrical shape with a center through hole 96 by coupling two semi-sleeve bodies 95 to each other. Further, the two semi-sleeve bodies 95 are fixed together by connection bolts 97. In this configuration, diameter of each end portion of the center through hole 96 is smaller than diameter of a center portion thereof, while steps 100 are formed at diameter transitions of the center through hole 96. Further, opposite ends of the cylinder rod 36 and the transition link 15 are formed as thin portions 101 positioned in the two ends of the center through hole 96, respectively. Moreover, one end of each of the thin portions 101 is connected with a joint 98 positioned in the center portion of the center through hole 96 and against the step 100. Thus, the opposite ends of the cylinder rod 36 and the transition link 15 abut against both ends of the holding sleeve 92. As such, the cylinder rod 36 and the transition link 15 are fixed-connected together via the holding sleeve 92.

[0027] To overcome the disadvantages in the prior art where the guide rail is welded directly onto the interior wall of the airtight case 1, such as the difficulty of processing and the heat treatment for the guide rail, the heavy attrition of the guide rail, the short lifetime, and impossibility of the replacement after inactivation of the guide rail, as another preferred aspect of the embodiments shown in Fig.10, the removable guide rail 16 is used in the present invention. That is, a positioning slot 17 with a notch toward the guide wheel 91 is fixed-connected in a lengthwise direction to the interior wall of the airtight case 1 corresponding to the guide wheel 91 of the translational backing ring 9. The positioning slot 71 may be fixed onto the interior wall of the airtight case 1 by means of welding. The guide rail 16 (made of square steel) is removably fixed within the positioning slot 17 in a lengthwise direction by a plurality of fixed bolts 18 in a spaced arrangement. When the guide rail 16 wears out heavily, the guide rail 16 may be dismounted from the positioning slot 17 and replaced by a new one, thereby the lifetime of the guide rail is enhanced.

[0028] As a yet preferred aspect of the embodiments, shown in Figs.4 to 7, the universal frame 8 is a shaped frame by casting. The universal frame 8 includes two opposite and parallel first rims 82 and two opposite and parallel second rims 83. Also, the first rims 82 are perpendicular to the second rims 83, and opposite ends of the first rims 82 and the adjacent second rims 83 are connected to two ends of the third rims 84 respectively, i.e. the first rims 82, second rims 83 and third rims 84 are connected in an end-around manner to form a closed annular shape. Further, center portions of the two second rims 83 protrude outwardly to form bosses 85 in order to prevent the lower slewing bearing 6 from extending out of the universal frame 8 in a horizontal direction. At the same time, the configuration of the bosses 85 provides the installation space for an end cover 20 connected to the lug 12, a lower end of an external water tube 24, and an oil supply tube 30, which will be described later on. Two slideways 81 opposite to each other are opened in the two second rims 83 on the same sides of the bosses 85, respectively. In particularly, length of the slideways 81 in a lengthwise direction of the second rims 83 is larger than that in a width direction of the second rims 83. That is, the slideway 81 is a long hole, within which the crank tail wheels 34 are provided and move in a lengthwise direction of the first rims 82. By two symmetrical connection brackets 86 provided on center portions of the two first rims 82 respectively, the universal frame 8 is connected with the inner ring of the lower slewing bearing 6.

[0029] Since the lug 12 operates under the high temperature condition at all time, as a further preferred aspect of the embodiments in order to ensure the operation and lifetime of the lug 12, forced cooling is performed to the lug 12 itself to meet the functional requirement for the lug 12 operating under the high temperature condition. As shown in Fig. 11, a center chamber 19 is opened from an end of the lug 12 facing the exterior of the rotating sleeve 4 toward the interior of the lug 12 (not straight forward to the other end of the lug 12). The end of the lug 12 is formed as an opened end provided with the end cover 20 for covering an opening of the center chamber 19. The end cover 20 is removably connected with the lug 12 by connection bolts 26, and a sealing ring 27 is provided between the end cover 20 and the lug 12. A through hole (not shown in the drawings) is opened at a center portion of the end cover 20, through which a water inlet tube is provided for supplying cooling water to the center chamber 19. Also, a plurality of overflow holes 22 communicated with the center chamber 19 is opened at the end cover 20. The water inlet tube includes an internal water tube 23 located inside the center chamber 19, and the external water tube 24 located outside the center chamber 19 and communicated with the cooling water source. An end of the internal water tube 23 extends straight to be adjacent to the end of the center chamber 19 so as to fill the whole center chamber 19 with the cooling water. After cooling for the lugs 12, the cooling water within the center chamber 19 flows out through the overflow holes 22 provided on the end cover 20. Eventually, the cooling water flows into the water-cooling base plate 25 as shown in Fig.1, and then converges to the cooling water system of the distributor from the water-cooling base plate 25. Arrows in Fig. 11 indicate the flowing configuration of the cooling water within the center chamber 19 in detail.

[0030] Aiming at the case in the prior art in which dry friction exists between the lug 12 and the lug sheath 13 without any lubrication treatment, in a further preferred aspect of the embodiments, lubricant is applied to friction surfaces between the lug 12 and the lug sheath 13 to

reduce friction coefficient effectively so as to extend the lifetime of the lug 12. As a detailed structure shown in Fig.12, an oil hole 28 is opened from the end of the lug 12 facing the exterior of the rotating sleeve 4 toward the interior of the lug 12, and at least one grease outlet 29 communicated with the oil hole 28 is opened at an exterior wall of the lug 12 surrounded by the lug sheath 13. The oil hole 28 is connected with an oil supply tube 30 for supplying lubricant thereto.

[0031] As also further preferred, shown in Fig.12, in consideration of evenness of lubricant feeding, three grease outlets 29 are provided and disposed evenly in a linear-arrangement on the exterior wall of the lug 12 surrounded by the lug sheath 13. Also, the oil hole 28 is opened preferably close to the exterior wall of the lug 12 rather than the center portion thereof, and the grease outlets 29 are also opened at the side close to the exterior wall of the lug 12 so as to reduce the difficulty of processing and the distance of the grease flowing. Additionally, the lug at a location where the grease outlets are provided and the lug sheath are configured as a large clearance fit. As such, contact relation between the lug 12 and the lug sheath 13 is initially line-contact and turns to narrow surface-contact after operating for a certain time. The friction coefficient may be reduced effectively when performing the lubrication treatment thereon, and then the lifetime is increased.

[0032] As further preferred, shown in Fig.12, since lubricant may not be supplied for said lubrication of the lugs 12 via an external lubrication apparatus, an oiler 31 is secured on the crank 14, and a bumping piece 32 is provided on the exterior wall of the rotating sleeve 4. The crank 14 rotates to make the oiler 31 move up and down, so as to allow the bumping piece 32 to be in contact with and separated from the oiler. To control the amount of fueling, the lubrication is performed in a fixed cycle during the operation of the distributor. During non-lubrication period, an operating angle of the chute 81 is controlled in a range between 7 to 45 degrees, and a non-contact condition is maintained between the oiler 31 and the bumping piece 32. When lubrication period starts, the control range of the operating angle of the chute 81 is changed. The lubrication of the lugs 12 is performed in a fixed cycle during the operation of the distributor, i.e. the lubrication is performed once every ten batches of distributing by the distributor, and a non-contact condition is maintained between the oiler 31 and the bumping piece 32 during the non-lubrication period. When lubrication period starts for the lug 12, the oiler 31 and the bumping piece 32 are hitting each other to start fueling as the operating angle of the chute 81 is 4 degrees during the rotation of the crank 14, as shown in Fig. 13. As shown in Fig.15, the fueling operation by the oiler 31 is completed as the chute 81 turns to 1 degree. Then, the bumping piece 32 and the oiler 31 are separated from each other to allow the oiler 31 to stop fueling, i.e. the condition shown in Fig.4. In turn, the chute 81 enters next cycle of fueling. The height of the universal frame 8 may be controlled by adjusting the length of the adjustable link 35, so as to change the swinging angle of the chute 81.

[0033] Next, principle of operation and working process of the furnace top chute distributor for a blast furnace of the present invention will be introduced with reference to Figs.1 to 4:

> To complete the distributing of the distributor, it is needed that the chute 7 swings while rotating to achieve the even distribution.

[0034] The swinging operation of the chute is now described as following. Each of the three cylinders 11 is connected to the translational backing ring 9 via the transition link 15 and the adjustable link 35. The outer ring of the lower slewing bearing 6 is connected with the translational backing ring 9 by bolts, and its inner ring is connected with the universal frame 8. While the cylinder rods 36 of the three cylinders 11 move up and down, the translational backing ring 9, the lower slewing bearing 6 and the universal frame 8 move up and down. During the up-down movement of the translational backing ring 9, rolling friction is presented due to the co-operation between the guide wheel 91 and the guide rail 16 of the airtight case 1 which functions to restrict the position of the guide wheel 91 when moving. The crank tail wheel 34 mounted within the slideway 81 of the universal frame 8 moves with the universal frame 8, and the crank 14 installed on the outer side of the lug 12 causes the lug 12 to rotate within the lug sheath 13 of the rotating sleeve 4 in a corresponding range. Further, the other end of the lug 12 co-operates with the chute bracket 71 by a spline, hereto, the chute 7 and the chute bracket 71 swing along with the crank 14 synchronously under dynamic action transmitted via the spline of the lug 12.

[0035] The rotating operation of the chute 7 is now described as following. The large flange of the top cover 2 is fixed-connected with the airtight case 1, while the small flange in the lower portion of the top cover 2 is connected with the inner ring of the upper slewing bearing 5 with the outer ring fixed-connected with the rotating sleeve 4. The two lugs 12 are respectively installed within the lug sheaths 13 located in the respective lug holes opened on the rotating sleeve 4. The spline at the end of the lug 12 is connected with the crank 14, while the spline at the other end of the lug 12 is connected with the chute bracket 71. That is, the chute bracket 71 is hung onto the rotating sleeve 4 via the lugs 12. A geared motor 99 may supply the power for the horizontal chute driving apparatus 10 installed on the top cover 2. When the horizontal chute driving apparatus 10 drives the outer ring of the upper slewing bearing 5 to rotate through a pinion, the rotating sleeve 4 rotates as the outer ring of the upper slewing bearing 5 rotates, and then the chute bracket 71 rotates as the rotating sleeve 4 rotates. Eventually, the chute 7 installed at the chute bracket 71 rotates thereupon.

[0036] The rotating-swinging operation of the chute 7 is now described as following. As shown in Fig.1, the dial

wheel assembly 37 installed on the inner ring of the lower slewing bearing 6 may move up and down along with the translational backing ring 9, and then the dial wheel of the dial wheel assembly 37 may roll up and down within the runner of the rotating sleeve 4. Also, when the rotating sleeve 4 rotates, the dial wheel assembly 37 rotates along with the rotating sleeve 4 so as to drive the universal frame 8 to move. At the same time, the inner ring of the lower slewing bearing 6 rotates in a circumferential direction correspondingly. The translational backing ring 9 is pulled by the cylinder 11 via the adjustable link 35 to move up and down, the outer ring of the lower slewing bearing 6 is fixed-connected with the translational backing ring 9 and maintained in a stationary condition relative to each other, and the outer and inner rings of the lower slewing bearing 6 are in a motionless condition relatively in a vertical direction, so the universal frame 8 is able to move up and down and the crank tail wheel 34 moves up and down with the universal frame 8 within the slideway 81 thereof. Since the rotating sleeve 4 cannot move up and down such that the lug 12 is rotated within the lug sheath 13 by the crank 14, the rotation of the lug 12 causes the chute 7 and the chute bracket 71 to swing in a fixed range. To this extent, the effective combination of the rotation and swing of the chute 7 with the chute bracket 71 is achieved.

[0037] The above just provides an explanation to the exemplary embodiments of this invention rather than limit the present invention, and the protecting scope of the invention is defined by the appended claims. It should be noted that a person skilled in the art may make various alterations and equivalences without departing from the spirit of this invention. These alterations and equivalences should be considered falling within the protection scope of the present invention.

Claims

1. A furnace top chute distributor for a blast furnace, **characterized in that** the chute distributor comprises:

   an airtight case having a top cover provided on a top portion thereof;
   a choke configured to communicate with exterior through the top cover and extend into the airtight case;
   an upper slewing bearing having an inner ring fixed-connected with the top cover;
   a rotating sleeve located inside the airtight case and having an upper end fixed-connected with an outer ring of the upper slewing bearing; two lug holes provided facing each other along a diameter of the rotating sleeve and each lug hole having a lug therein, and each lug having an end extending out of the rotating sleeve to connect with an end of a crank;
   a chute having two upper ends connected with the other end of each lug respectively to enable the chute to be hung within the rotating sleeve;
   a universal frame telescopic coupled outside the rotating sleeve, on which two symmetrical slideways are opened, and each crank tail wheel on the other end of each crank provided within the slideway;
   a lower slewing bearing having an inner ring fixed-connected with the universal frame;
   a dial wheel assembly having one end fixed-connected with the inner ring of the lower slewing bearing, and a dial wheel on the other end that is positioned and rolled within a runner opened on the rotating sleeve;
   a cylinder for drawing an outer ring of the lower slewing bearing to move up and down; and
   a horizontal driving apparatus for driving the outer ring of the upper slewing bearing to rotate.

2. The furnace top chute distributor for a blast furnace according to claim 1, **characterized in that** a large flange on an outer edge of the top cover is fixed-connected with the airtight case while a small flange on an inner edge of the top cover is fixed-connected with the inner ring of the upper slewing bearing;
   a chute bracket is fixed-connected at the outer side of the chute, and the two upper ends of the chute bracket are connected with said other end of each lug by a spline respectively while said end of each lug is connected with the end of each crank by a spline;
   a translational backing ring, telescopic coupled outside the rotating sleeve having an upper portion telescopic coupled outside the choke, has a lower portion of an inner edge fixed-connected with the outer ring of the lower slewing bearing, and a guide wheel is provided on an outer edge of the translational backing ring while a corresponding guide rail is provided on an interior wall of the airtight case to enable the guide wheel to roll up and down along the guide rail by the cylinder;
   three cylinders are provided, which are disposed evenly on the top cover with respect to a horizontal rotation center line of the chute in an axial direction, and the three cylinders are connected with the translational backing ring via a transition link respectively to cause the translational backing ring to move up and down and thus cause the universal frame to move up and down.

3. The furnace top chute distributor for a blast furnace according to claim 2, **characterized in that** the cylinder includes a cylinder body fixed on the top cover by a cylinder block, and a cylinder rod having a lower end fixed-connected with the transition link by a holding sleeve, and that by passing through the cylinder block and the top cover, a lower end of the transition

link is connected with an adjustable link, which is inside the airtight case and connected with the translational backing ring.

4. The furnace top chute distributor for a blast furnace according to claim 3, **characterized in that** the holding sleeve is formed in a cylindrical shape with a center through hole by coupling two semi-sleeve bodies to each other, and the two semi-sleeve bodies are fixed together by connection bolts;
diameter of each end portion of the center through hole is smaller than diameter of a center portion thereof while steps are formed at diameter transitions of the center through hole;
opposite ends of the cylinder rod and the transition link are formed as thin portions positioned in the two ends of the center through hole, respectively, one end of each thin portion is connected with a joint positioned in the center portion of the center through hole and against the step, and then the opposite ends of the cylinder rod and the transition link abut against both ends of the holding sleeve.

5. The furnace top chute distributor for a blast furnace according to claim 2, **characterized in that** a positioning slot with a notch facing the guide wheel is fixed-connected to the interior wall of the airtight case corresponding to the guide wheel of the translational backing ring in a lengthwise direction, and the guide rail of the airtight case is removably fixed into the positioning slot in a lengthwise direction.

6. The furnace top chute distributor for a blast furnace according to claim 5, **characterized in that** the guide rail is a square steel material, which is removably fixed into the positioning slot by a plurality of fixed bolts in a spaced arrangement, wherein the positioning slot is welded onto the interior wall of the airtight case.

7. The furnace top chute distributor for a blast furnace according to claim 1 or 2, **characterized in that** the universal frame includes two opposite and parallel first rims, two opposite and parallel second rims, and third rims;
the first rims are perpendicular to the second rims, and opposite ends of the first rims and the adjacent second rims are connected to two ends of the third rims respectively to form a closed annular shape;
center portions of the two second rims protrude outwardly to form bosses, and two slideways opposite to each other are opened in the two second rims on the same sides of the bosses respectively, wherein length of the slideways in a lengthwise direction of the second rims is larger than that in a width direction of the second rims, and then by two symmetrical connection brackets provided on center portions of the two first rims respectively, the universal frame is fixed-connected with the inner ring of the lower slewing bearing.

8. The furnace top chute distributor for a blast furnace according to claim 1 or 2, **characterized in that** a center chamber is opened from the end of the lug facing the exterior of the rotating sleeve toward the interior of the lug, thereby the end of the lug is formed as an opened end provided with an end cover for covering an opening of the center chamber, and that a through hole is opened at a center portion of the end cover, through which a water inlet tube is provided for supplying cooling water to the center chamber, and that a plurality of overflow holes communicated with the center chamber is opened at the end cover.

9. The furnace top chute distributor for a blast furnace according to claim 1 or 2, **characterized in that** an oil hole is opened from the end of the lug facing the exterior of the rotating sleeve toward the interior of the lug, and at least one grease outlet communicated with the oil hole is opened at an exterior wall of the lug surrounded by a lug sheath, wherein the oil hole is connected with an oil supply tube for supplying lubricant thereto.

10. The furnace top chute distributor for a blast furnace according to claim 9, **characterized in that** three grease outlets are provided, which are disposed evenly in a linear-arrangement on the exterior wall of the lug surrounded by the lug sheath.

11. The furnace top chute distributor for a blast furnace according to claim 10, **characterized in that** the lug at a location where the grease outlets are provided and the lug sheath are configured as a large clearance fit.

12. The furnace top chute distributor for a blast furnace according to claim 10, **characterized in that** an oiler connected with the oil supply tube for supplying oil thereto is secured on the crank, and a bumping piece is provided on the exterior wall of the rotating sleeve, the bumping piece being in contact with or separated from the oiler to start or stop fueling when the crank rotates.

Fig. 1

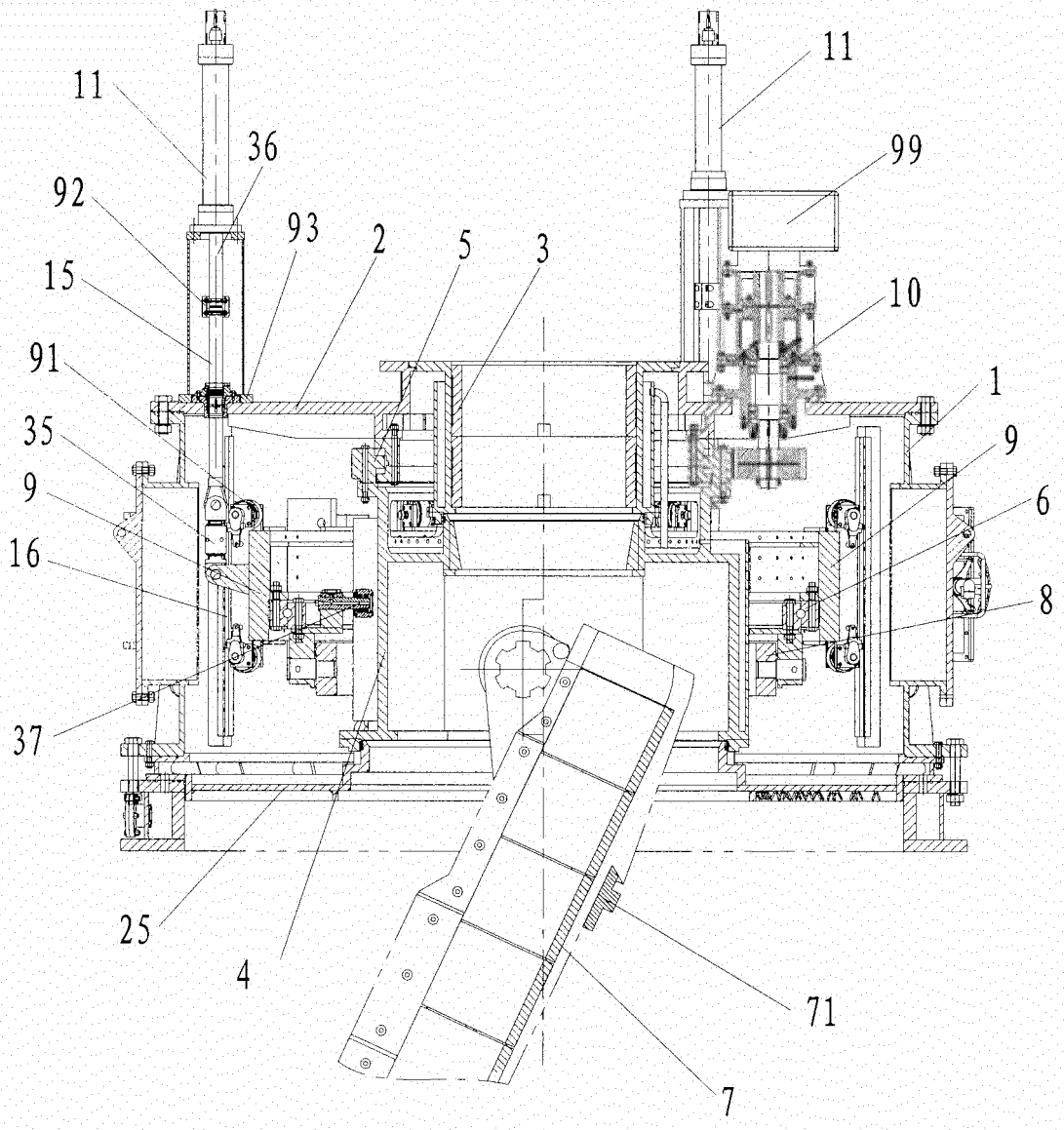


Fig. 2

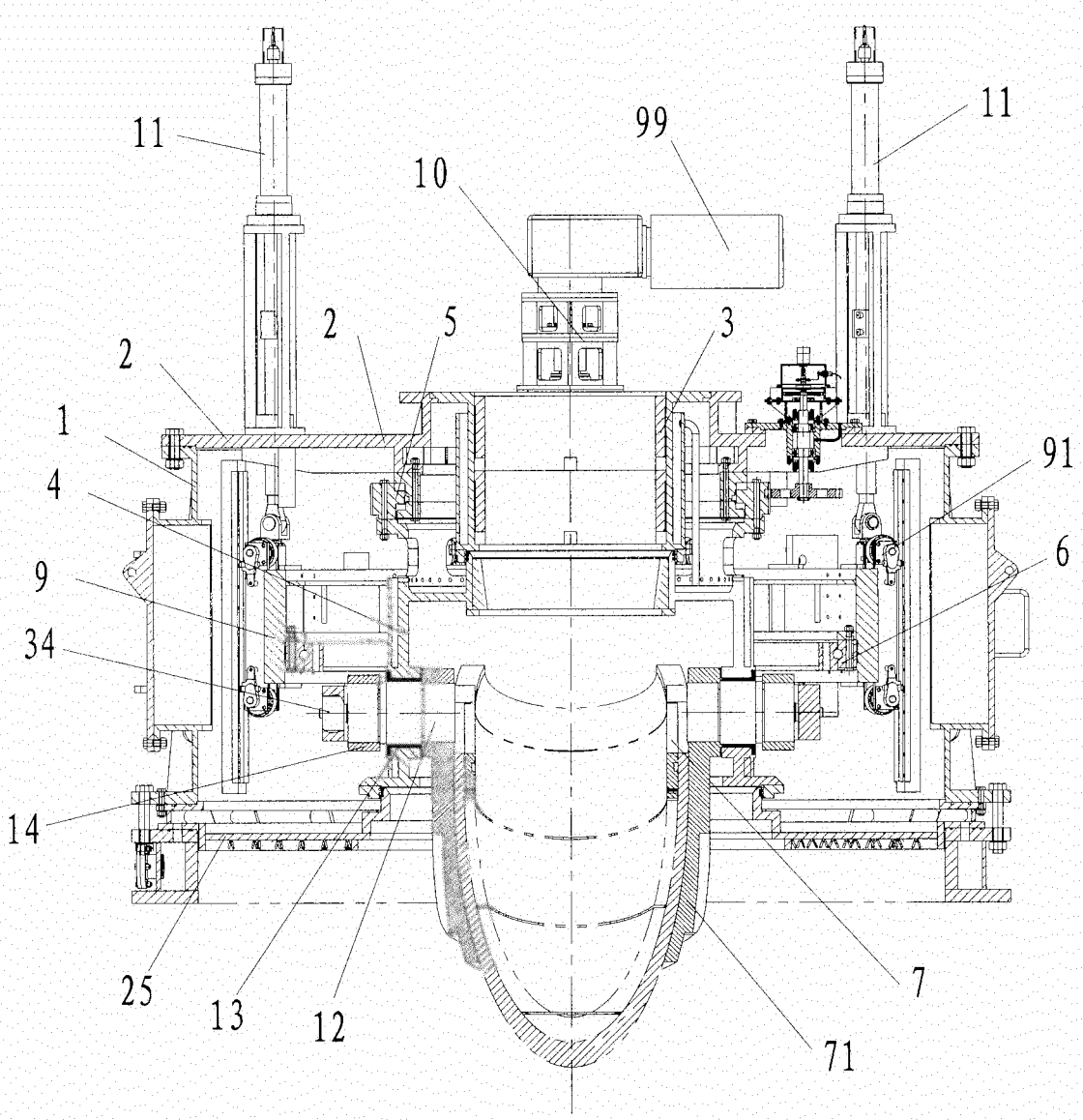


Fig. 3

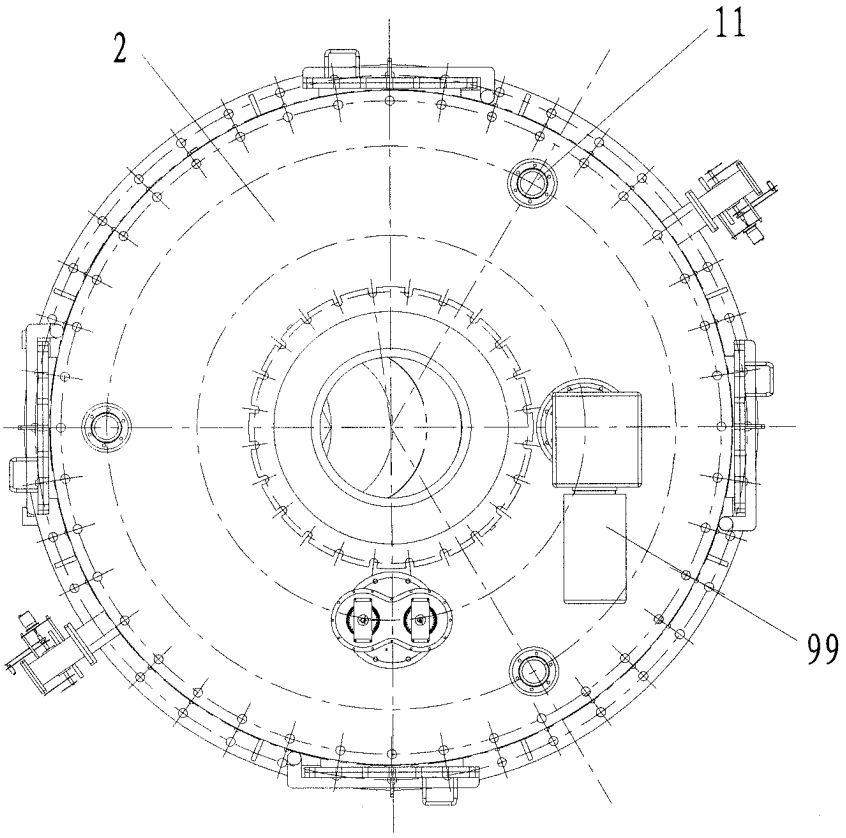


Fig. 4

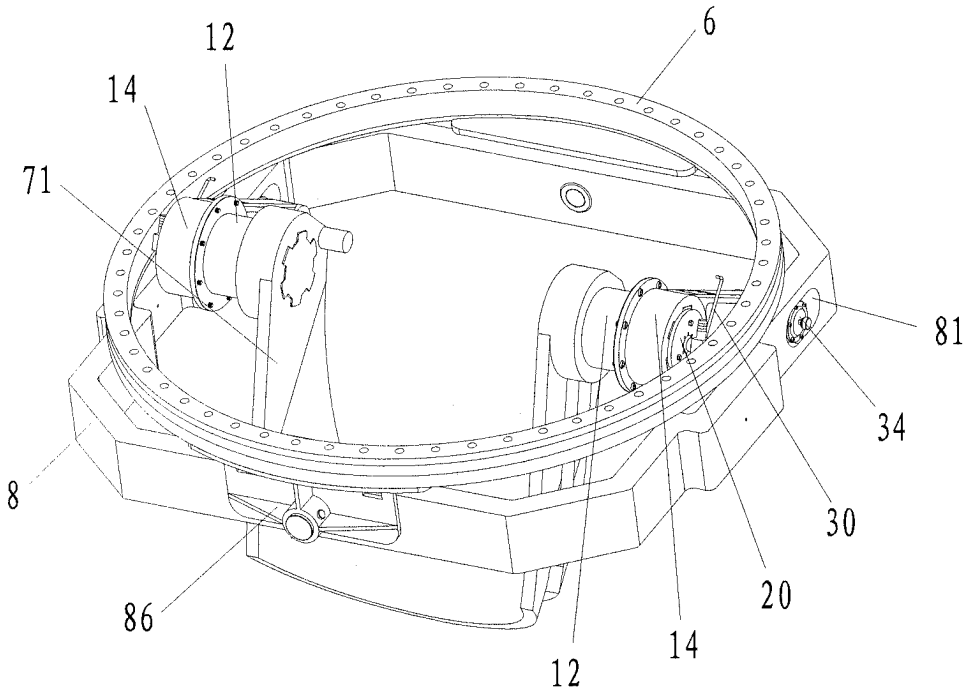


Fig. 5

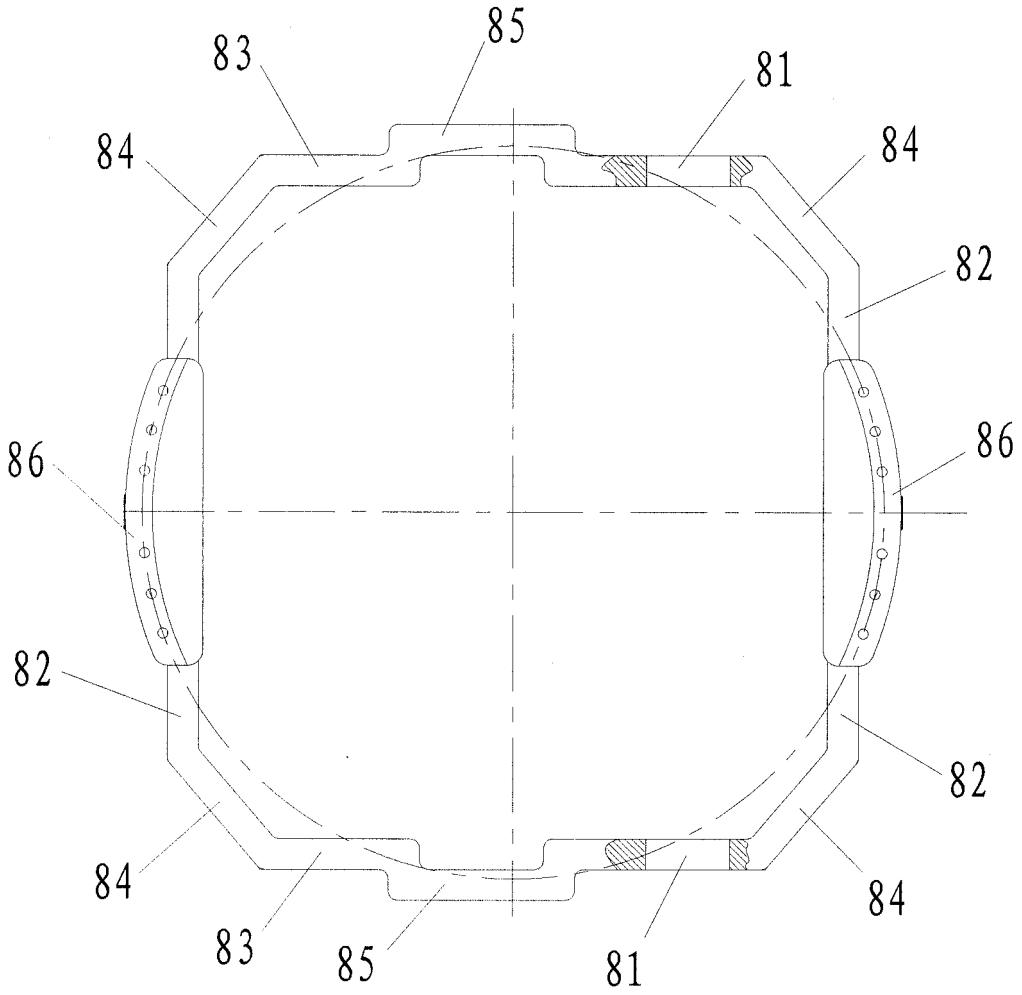


Fig. 6

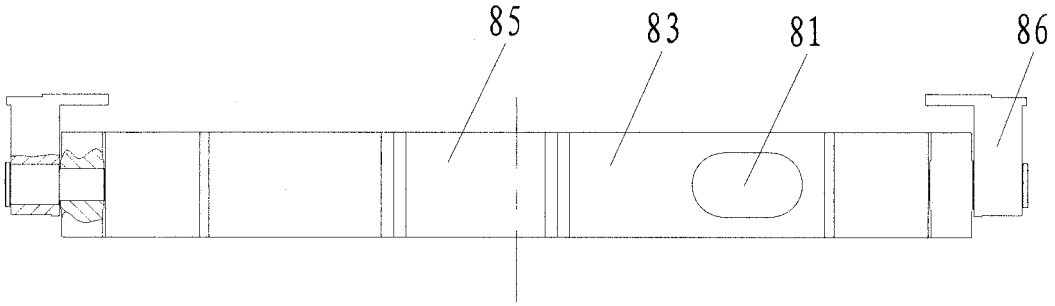


Fig. 7

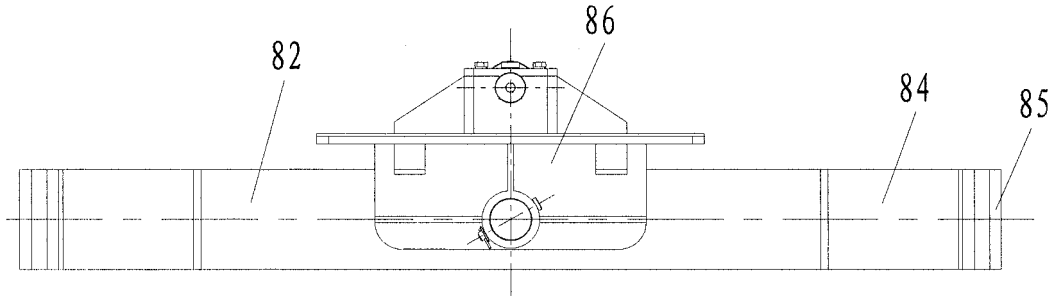


Fig. 8

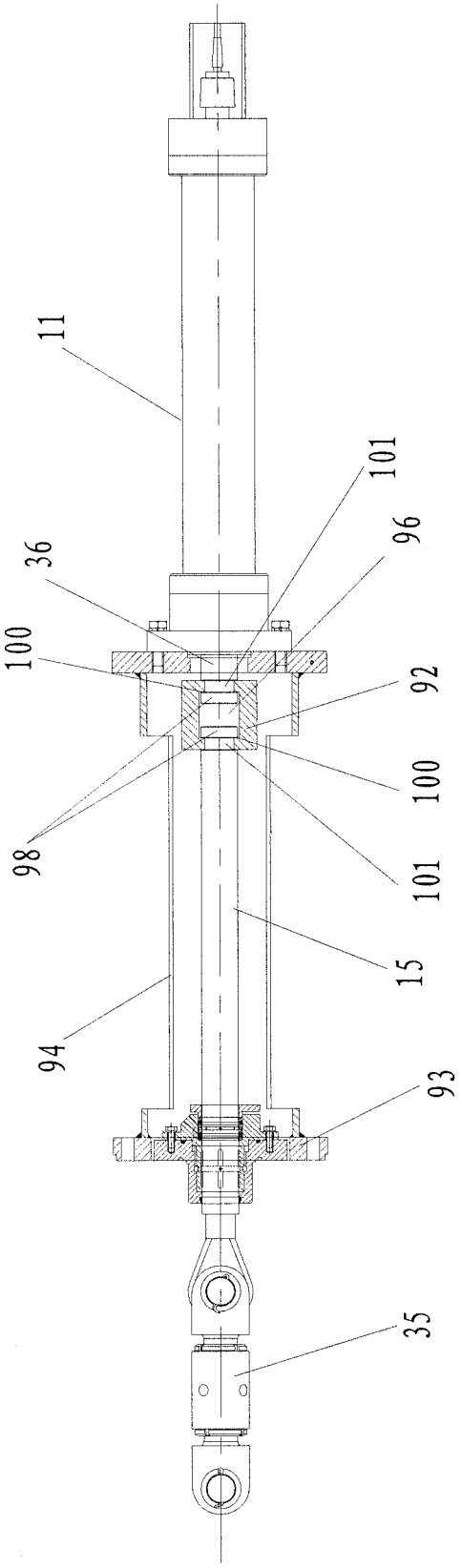


Fig. 9

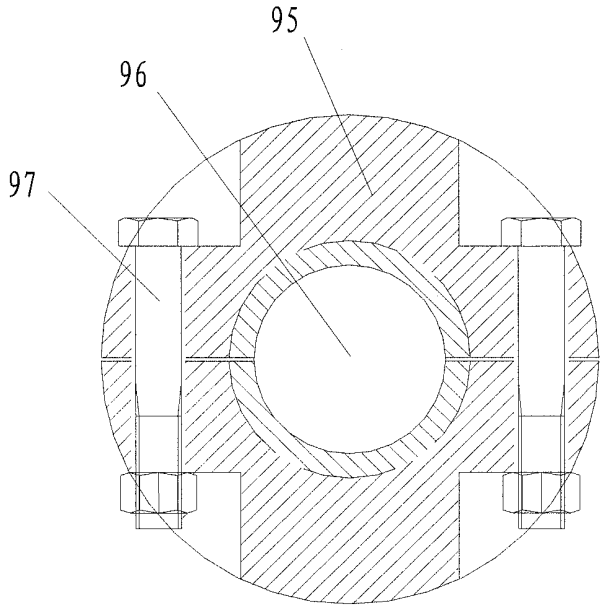


Fig. 10

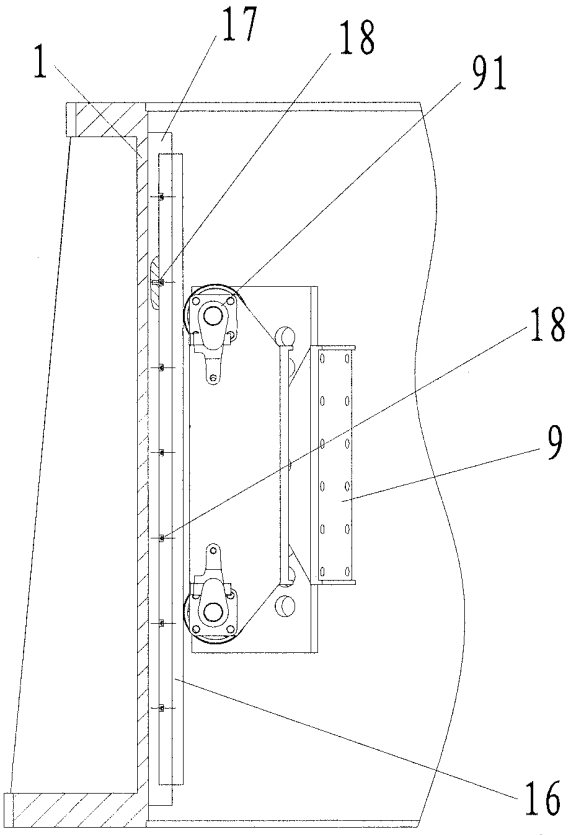


Fig. 11

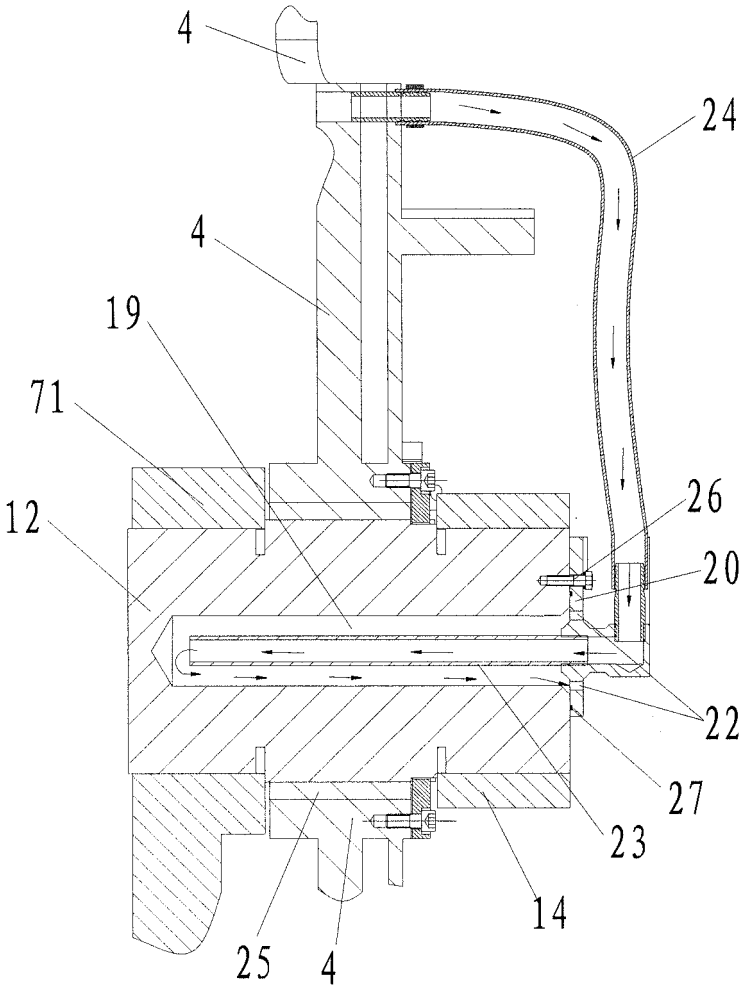


Fig. 12

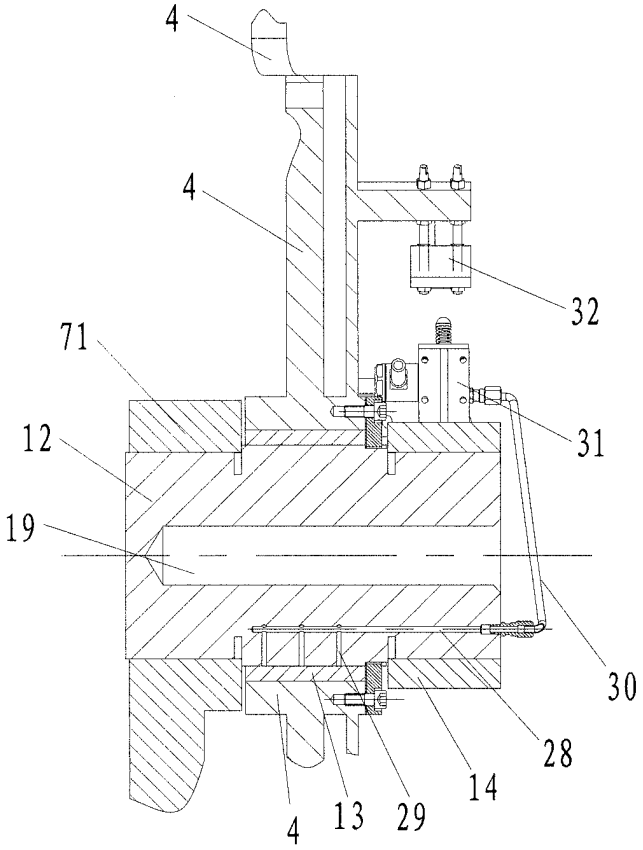


Fig. 13

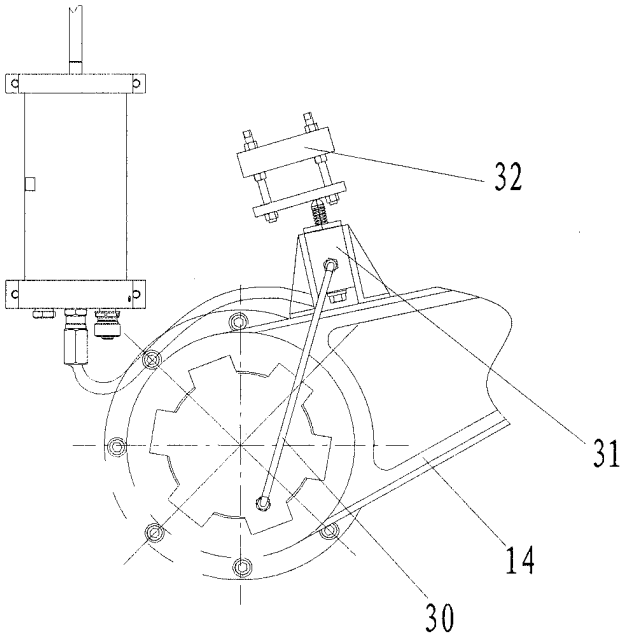


Fig. 14

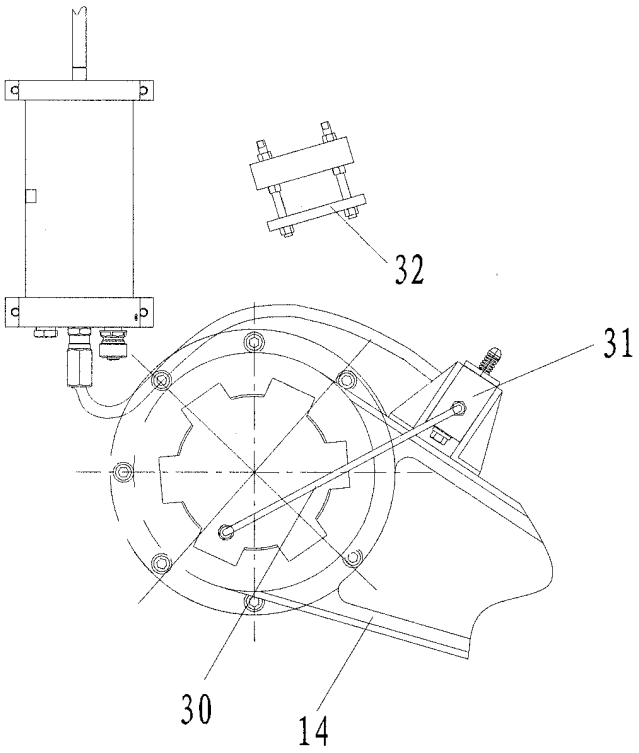
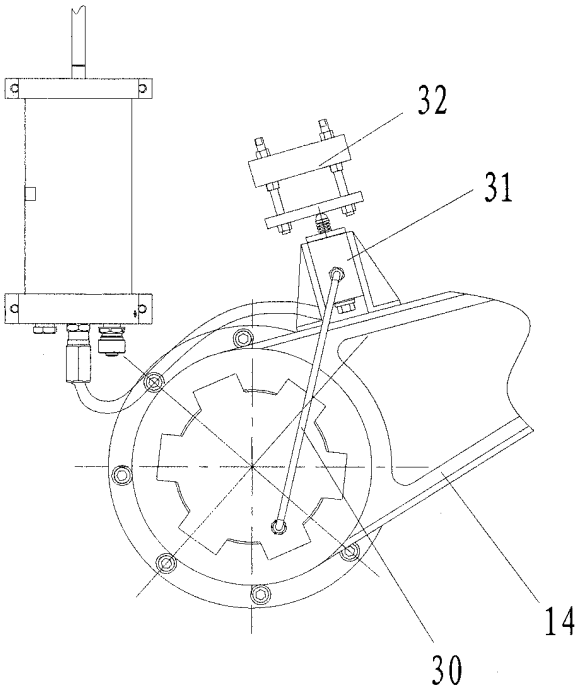


Fig. 15



INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/071989

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C21B 7/-

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

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

WPI; EPODOC; CHINA JOURNAL FULL-TEXT DATABASE; CNPAT: hydraulic cylinder, material distribution; chute, trough, distribut???, smelt???, steel, iron, rotat???, circl???, cylinder, piston, cool???, lubricat???, grease, oil, detach????, remov???, disconnect???

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 201598300 U (QINHUANGDAO QINYE HEAVY INDUSTRY CO., LTD.), 06 October 2010 (06.10.2010), description, particular embodiments, and figures 1-2	1-2, 5-6, 9-12
Y	CN 2503073 Y (SHIJIAZHUANG SANHUAN VALVE CO., LTD.), 31 July 2002 (31.07.2002), description, particular embodiments, and figures 1-2	1-2, 5-6, 9-12
Y	CN 2685347 Y (SHIJIAZHUANG SANHUAN VALVE CO., LTD.), 16 March 2005 (16.03.2005), description, particular embodiments, and figure 1	9-12
A	CN 2560643 Y (SHIJIAZHUANG SANHUAN VALVE CO., LTD.), 16 July 2003 (16.07.2003), the whole document	1-12
A	CN 202039077 U (LIU, Xuan), 16 November 2011 (16.11.2011), the whole document	1-12
A	CN 1896285 A (SENG, Quansong), 17 January 2007 (17.01.2007), the whole document	1-12
A	FR 2692595 A1 (INT EQUIP SARL), 24 December 1993 (24.12.1993), the whole document	1-12

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

* Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 October 2012 (07.10.2012)	**22 November 2012 (22.11.2012)**
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer **SHI, Guangyi** Telephone No.: (86-10) **62413229**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/071989

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 201598300 U	06.10.2010	None	
CN 2503073 Y	31.07.2002	None	
CN 2685347 Y	16.03.2005	None	
CN 2560643 Y	16.07.2003	None	
CN 202039077 U	16.11.2011	None	
CN 1896285 A	17.01.2007	None	
FR 2692595 A1	24.12.1993	None	

Form PCT/ISA/210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/071989

CONTINUATION: A. CLASSIFICATION OF SUBJECT MATTER

C21B 7/20 (2006.01) i

C21B 7/18 (2006.01) i

Form PCT/ISA/210 (extra sheet) (July 2009)