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(54) **PLUNGER PUMP POWER CONTROL DEVICE AND CONTROL METHOD THEREOF**

(57) A plunger pump power control device and a control method thereof. The device comprises a valve body, a valve core, a valve sleeve, a stop plug, a spring pre-loaded mechanism, a feedback mechanism and a slide valve. The slide valve is provided within one end of the valve core. The stop plug is provided at one end of the valve body, and the spring pre-loaded mechanism is provided at the other end of. The valve sleeve, the valve

core, and the slide valve are provided between the stop plug and the spring pre-loaded mechanism, and the feedback mechanism is hinged on the valve body. The device enables the hydraulic plunger pump to control the output power, the pump power output is simulated by two broken lines, and the error is less. It is flexible to load variable by the valve core through the pressure of the C-cavity.

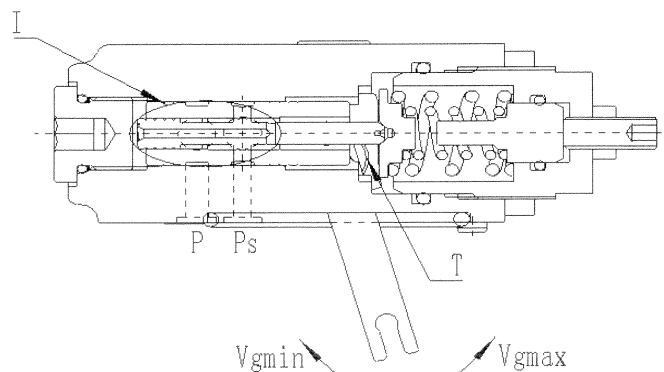


FIG. 1

Description

FIELD OF THE INVENTION

[0001] The present disclosure generally relates to the technical field of machine manufacturing, and more particularly, to a plunger pump power control device and a control method thereof.

BACKGROUND OF THE INVENTION

[0002] Power control is a common control mode for hydraulic pumps, through which the output power of the pump can remain constant (i.e., $W=PQ$) within a certain working pressure range. The power control is to adjust and input oil at a pump outlet pressure into a variable piston by means of a power control device or to drain the pressure oil from the variable piston by means of the power control device so as to drive the servo piston to move and thereby achieve variation of the pump output. Meanwhile, the movement of the variable piston drives a feedback rod of the power control device to move in the opposite direction, and after the power control device stops the adjusting process, the variable process of the pump is completed.

[0003] FIG. 1 shows a power control device available on the market, which is under the intelligent property protection. The power control device comprises a valve core and a valve sleeve that have the function of a 3-position two-way valve structure. The connection between an inlet P and an outlet Ps or between the inlet P and an oil drain port T in the power control device is controlled by the movement of the valve core and the valve sleeve. Referring to the detailed view I, the valve core is formed to be a step structure which has different diameters at points A and B (i.e., ϕ and ϕD), a pressure cavity is formed between the points A and B, and due to the area difference between the two cross sections having the aforesaid two diameters, a force acting on the valve core is $F=p\pi(D^2-d^2)/4$. The other end of the valve core is provided with a spring loaded mechanism for reversely applying a pre-loading force. The feedback rod is fixedly hinged on the valve body to rotate, with one end of the feedback rod being linked to the valve sleeve and the other end thereof being opened to be connected with the variable piston. The feedback rod functions according to the lever principle so that the moving direction of the variable piston is opposite to that of the valve sleeve, thereby achieving mechanical feedback.

[0004] Because the 3-position two-way valve formed of the valve sleeve and the valve core of the aforesaid structures has two different diameters, higher requirements are imposed on the cylindricity of the valve sleeve and the valve core and the coaxiality of the two step diameters, which represents great difficulty in manufacturing and results in higher mass production cost. Moreover, because of the objective existence of coaxiality errors between the two step diameters of each of the valve

sleeve and the valve core, sticking may be caused.

SUMMARY OF THE INVENTION

[0005] An objective of the present disclosure is to provide a plunger pump power control device and a control method thereof, which has a simple structure, parts that are easy to be manufactured, a low mass production cost, a relatively small error and flexible variables, thereby overcoming the drawbacks of the prior art.

[0006] To achieve the aforesaid objective of the present disclosure, one technical solution is as follows: a plunger pump power control device is provided, which comprises a control valve body, a valve core, a valve sleeve, a stop screwed plug, a spring pre-loaded mechanism and a feedback mechanism; an oil inlet P, an oil outlet Ps and two oil drain ports T are provided on the control valve body; the oil outlet Ps is externally connected to a variable piston chamber of a pump body; the valve core is provided within the valve sleeve, and an E-cavity is formed between the valve sleeve and the valve core and is in constant communication with the oil inlet P; the stop screwed plug is provided at one end of the control valve body, and the spring pre-loaded mechanism is provided at the other end of the control valve body; the valve sleeve is provided between the stop screwed plug and the spring pre-loaded mechanism, and the valve sleeve and the valve core form a 3-position two-way structure valve; an E-cavity is formed between the valve sleeve and the valve core and is in constant communication with the oil inlet P; the feedback mechanism is hinged on the control valve body, with one end of the feedback mechanism being connected with the valve sleeve to drive the valve sleeve to move in an axial direction and the other end being connected to a variable piston; a slide valve is provided at the central part of one end of the valve core, a C-cavity is disposed between the slide valve and the valve core, and the slide valve is closely attached to the stop screwed plug under the action of the pressure of the C-cavity; a ball end of the slide valve contacts with the stop screwed plug; and oil between the stop screwed plug and the valve sleeve is drained via one of the oil drain ports T, and oil between the valve sleeve and the spring pre-loaded mechanism is drained via the other of the oil drain ports T.

[0007] The hydraulic pressure acting on the valve core described in the aforesaid technical solution is mainly due to the existence of the slide valve, and the value thereof is $F=p\pi d^2/4$, wherein d is the diameter of the slide valve.

[0008] The perpendicularity between the plane of the stop screwed plug described in the aforesaid technical solution that is near the valve core and an axis of the slide valve is within 0.05 mm.

[0009] In the power control device described in the aforesaid technical solution, oil between the stop screwed plug and the valve sleeve, the valve core is drained via one of the oil drain ports T, and oil between

the valve sleeve and the spring pre-loaded mechanism is drained via the other of the oil drain ports T.

[0010] The spring pre-loaded mechanism described in the aforesaid technical solution comprises a first spring seat, a large spring, a small spring, a second spring seat, a screw insert and a nut; the screw insert is formed with a groove having a cross section in the form of the inverted

character "⊥" thereon, the screw insert is screwed into the control valve body and is fixed at one end of the control valve body via the nut; the first spring seat and the second spring seat are disposed in the groove opposite to each other, the small spring and the large spring are disposed between the first spring seat and the second spring seat, and the small spring is disposed inside the large spring.

[0011] The spring pre-loaded mechanism described in the aforesaid technical solution further has an adjusting screw, and one end of the adjusting screw is screwed into the screw insert and contacts with the second spring seat.

[0012] A control method for a plunger pump power control device is provided, which comprises the following steps of:

- (1) presetting the value of a spring pre-loaded mechanism;
- (2) introducing oil at a pump outlet pressure from an oil inlet P into a C-cavity between a valve core and a slide valve through an E-cavity, wherein the oil at the pump outlet pressure drives the slide valve and the valve core to move in opposite directions, the slide valve stops at a stop screwed plug, and the valve core moves towards and compresses the spring pre-loaded mechanism; or the pressure at the oil inlet P is decreased so that the spring pre-loaded mechanism drives the valve core to overcome the pressure of the C-cavity to move in a reverse direction; and
- (3) performing binarization processing to accomplish the process of increasing or decreasing the pressure of the pump.

[0013] The step (3) described in the aforesaid technical solution is specifically as follows: when the pump outlet pressure introduced into the C-cavity increases to exceed the preset value of the spring pre-loaded mechanism 5, the valve core 2 moves in a direction in which the spring pre-loaded mechanism 5 is compressed; when the valve core 2 moves to such an extent that the oil inlet P and the E-cavity are connected with the oil outlet Ps and the oil outlet Ps is disconnected from the oil drain port T, the pressure oil enters into a variable piston chamber through the oil outlet Ps to drive the variable piston to move towards the plunger pump at a small swing angle; meanwhile, the feedback mechanism 6 drives the valve sleeve 3 to move towards the closing direction, and when the valve sleeve 3 moves to such an extent that the oil

inlet P is disconnected from the oil outlet Ps and the oil outlet Ps is connected with the oil drain port T, the pressure oil of the variable piston is drained so that the variable piston is stopped from moving in the small swing angle direction and moves towards the plunger pump at a large swing angle; and meanwhile, the feedback mechanism 6 drives the valve sleeve 3 to move in a direction opposite to the moving direction of the variable piston until the oil inlet P is again connected with the oil outlet Ps; the aforesaid two processes are performed alternately so that the variable piston experience a tiny pulsation motion; and then the process of increasing the pressure of the pump is completed; and

when the pump outlet pressure introduced into the C-cavity decreases to be below the preset value of the spring pre-loaded mechanism 5, the oil inlet P and the E-cavity are disconnected from the oil outlet Ps and the oil outlet Ps is connected with the oil drain port T, the variable piston moves towards the plunger pump at a large swing angle; meanwhile, the feedback mechanism 6 drives the valve sleeve 3 to move in the direction opposite to the moving direction of the variable piston, and when the valve sleeve 3 moves to such an extent that the oil inlet P is connected with the oil outlet Ps and the oil outlet Ps is disconnected from the oil drain port T, the pressure oil stops the variable piston from moving and reversely drives the variable piston to move towards the plunger pump at a small swing angle; the aforesaid two processes are performed alternately so that the variable piston experiences a tiny pulsation motion; and then, the process of decreasing the pressure of the pump is completed.

[0014] By adopting the aforesaid technical solution, the present disclosure has the following benefits:

- (1) the power control method and device of the present disclosure allow the hydraulic plunger pump to control the output power, the pump power output is simulated by two broken lines, and the error is less. The device has a simple structure, parts that are easy to be manufactured and a low mass production cost. It is flexible to change the variables of the valve, and a high control stability on the variable is achieved.
- (2) the perpendicularity between the plane of the stop screwed plug that is near the valve core and the axis of the slide valve is controlled in the present disclosure so as to prevent the slide valve from being affected by a radial force.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Hereinafter, the present disclosure will be further detailed according to specific embodiments and with reference to attached drawings so that the contents of the present disclosure is more readily and clearly appreciated.

FIG. 1 is a schematic structural view of a conventional power control device;

FIG. 2 is a schematic enlarged view of part I in FIG. 1;

FIG. 3 is a schematic structural view of the present disclosure;

FIG. 4 is a schematic enlarged view of part II in FIG. 3;

FIG. 5 is a functional view of the present disclosure; and

FIG. 6 is a graph illustrating the practical power output of the present disclosure.

[0016] Reference numerals in the attached drawings are: control valve body 1, valve core 2, valve sleeve 3, stop screwed plug 4, spring pre-loaded mechanism 5, first spring seat 51, large spring 52, small spring 53, second spring seat 54, screw insert 55, nut 56, adjusting screw 57, feedback mechanism 6, slide valve 7

DETAILED DESCRIPTION OF THE INVENTION

(Embodiment 1, a plunger pump power control device)

[0017] Referring to FIG. 2 to FIG. 5, a plunger pump power control device comprises a control valve body 1, a valve core 2, a valve sleeve 3, a stop screwed plug 4, a spring pre-loaded mechanism 5, a feedback mechanism 6, and a slide valve 7; an oil inlet P, an oil outlet Ps and two oil drain ports T are provided on the control valve body 1; the oil outlet Ps is externally connected to a variable piston chamber of a pump body; the valve core 2 is provided within the valve sleeve 3, the valve sleeve 3 and the valve core 2 form a 3-position two-way structure valve and an E-cavity is formed between the valve sleeve 3 and the valve core 2; the slide valve 7 is provided at the central part of one end of the valve core 2, a C-cavity is formed along a radial direction of the valve core 2 between the slide valve 7 and the valve core 2, and a ball end of the slide valve 7 contacts with the stop screwed plug 4; the stop screwed plug 4 is provided at one end of the control valve body 1, and the spring pre-loaded mechanism 5 is provided at the other end of the control valve body 1; the valve sleeve 3, the valve core 2, and the slide valve 7 are provided between the stop screwed plug 4 and the spring pre-loaded mechanism 5; the feedback mechanism 6 is hinged on the control valve body 1 to rotate around a hinge pin, with one end of the feedback mechanism 6 being connected to the valve sleeve 3 via a sliding pair structure to drive the valve sleeve 3 to move along an axis and the other end being linked to a variable piston via the sliding pair structure so as to be moved along the axis together with the variable piston.

[0018] The perpendicularity between the plane of the stop screwed plus 4 that is near the valve core 2 and an axis of the slide valve 7 is within 0.05 mm so as to prevent the slide valve 7 from being affected by a radial force.

[0019] The power control device comprises two oil drain ports T, one of the oil drain ports T is disposed between the stop screwed plug and the valve sleeve, and

the other of the oil drain ports T is disposed between the valve sleeve and the spring pre-loaded mechanism.

[0020] The spring pre-loaded mechanism 5 is used to adjust the output power and comprises a first spring seat 51, a large spring 52, a small spring 53, a second spring seat 54, a screw insert 55 and a nut 56; the screw insert 55 is formed with a groove having a cross section in the

form of the inverted character "U" thereon, the screw insert 55 is screwed into the control valve body 1 and is fixed at one end of the control valve body 1 via the nut 56; the first spring seat 51 and the second spring seat 54 are disposed in the groove opposite to each other, the small spring 53 and the large spring 54 are disposed between the first spring seat 51 and the second spring seat 54, and the small spring 53 is disposed inside the large spring 52.

[0021] The spring pre-loaded mechanism 5 further has an adjusting screw 57, and one end of the adjusting screw 57 is screwed into the screw insert 55 and contacts with the second spring seat 54.

(Embodiment 2, a control method for a plunger pump power control device)

[0022] A control method for a plunger pump power control device specifically comprises the following steps of:

(1) presetting the value of a spring pre-loaded mechanism 5;

(2) introducing oil at a pump outlet pressure from an oil inlet P into a C-cavity of a valve core 2 through a valve sleeve 3, wherein the oil at the pump outlet pressure drives the slide valve 7 and the valve core 2 to move in opposite directions, the slide valve stops at a stop screwed plug, and the valve core moves towards and compresses the spring pre-loaded mechanism; or the pressure at the oil inlet P is decreased so that the spring pre-loaded mechanism drives the valve core to overcome the pressure of the C-cavity to move in a reverse direction; and

(3) performing binarization processing, when the pump outlet pressure introduced into the C-cavity increases to exceed the preset value of the spring pre-loaded mechanism 5, the valve core 2 moves in a direction in which the spring pre-loaded mechanism 5 is compressed; when the valve core 2 moves to such an extent that the oil inlet P and the E-cavity are connected with the oil outlet Ps and the oil outlet Ps is disconnected from the oil drain port T, the pressure oil enters into a variable piston chamber through the oil outlet Ps to drive the variable piston to move towards the plunger pump at a small swing angle; meanwhile, the feedback mechanism 6 drives the valve sleeve 3 to move towards the closing direction, and when the valve sleeve 3 moves to such an extent that the oil inlet P is disconnected from the oil outlet Ps and the oil outlet Ps is connected with the oil drain

port T, the pressure oil of the variable piston is drained so that the variable piston is stopped from moving in the small swing angle direction and moves towards the plunger pump at a large swing angle; and meanwhile, the feedback mechanism 6 drives the valve sleeve 3 to move in a direction opposite to the moving direction of the variable piston until the oil inlet P is again connected with the oil outlet Ps; the aforesaid two processes are performed alternately so that the variable piston experiences a tiny pulsation motion; and then the process of increasing the pressure of the pump is completed; and

when the pump outlet pressure introduced into the C-cavity decreases to be below the preset value of the spring pre-loaded mechanism 5, the oil inlet P and the E-cavity are disconnected from the oil outlet Ps and the oil outlet Ps is connected with the oil drain port T, the variable piston moves towards the plunger pump at a large swing angle; meanwhile, the feedback mechanism 6 drives the valve sleeve 3 to move in the direction opposite to the moving direction of the variable piston, and when the valve sleeve 3 moves to such an extent that the oil inlet P is connected with the oil outlet Ps and the oil outlet Ps is disconnected from the oil drain port T, the pressure oil stops the variable piston from moving and reversely drives the variable piston to move towards the plunger pump at a small swing angle; the aforesaid two processes are performed alternately so that the variable piston experiences a tiny pulsation motion; and then, the process of decreasing the pressure of the pump is completed.

[0023] Referring to FIG. 6, the practical output power of the hydraulic plunger pump is represented by two broken lines instead of the theoretical curve, and the error thereof is within 3%.

[0024] What described above are only the embodiments of the present disclosure, but are not intended to limit the scope of the present disclosure. Any equivalent structures or equivalent process flow modifications that are made according to the specification and the attached drawings of the present disclosure, or any direct or indirect applications of the present disclosure in other related technical fields shall all be covered within the scope of the present disclosure.

Claims

1. A plunger pump power control device, comprising a control valve body (1), a valve core (2), a valve sleeve (3), a stop screwed plug (4), a spring pre-loaded mechanism (5) and a feedback mechanism (6); an oil inlet P, an oil outlet Ps and two oil drain ports T being provided on the control valve body (1); the oil outlet Ps being externally connected to a variable piston chamber of a pump body; the valve core (2) being provided within the valve sleeve (3), and an

E-cavity being formed between the valve sleeve (3) and the valve core (2) and being in constant communication with the oil inlet P; the stop screwed plug (4) being provided at one end of the control valve body (1), and the spring pre-loaded mechanism (5) being provided at the other end of the control valve body (1); the valve core (2) and the valve sleeve (3) being provided between the stop screwed plug (4) and the spring pre-loaded mechanism (5), and the valve sleeve (3) and the valve core (2) forming a 3-position two-way structure valve; the feedback mechanism (6) being hinged on the control valve body (1), with one end of the feedback mechanism (6) being connected with the valve sleeve (3) to drive the valve sleeve (3) to move in an axial direction and the other end being connected to a variable piston; wherein: a slide valve (7) is provided at the central part of one end of the valve core (2), a C-cavity is disposed between the slide valve (7) and the valve core (2), and the slide valve (7) is closely attached to the stop screwed plug (4) under the action of the pressure of the C-cavity; a ball end of the slide valve (7) contacts with the stop screwed plug (4); and oil between the stop screwed plug (4) and the valve sleeve (3) is drained via one of the oil drain ports T, and oil between the valve sleeve (3) and the spring pre-loaded mechanism (5) is drained via the other of the oil drain ports T.

2. The plunger pump power control device of claim 1, wherein the perpendicularity between the plane of the stop screwed plug (4) that is near the valve core (2) and an axis of the slide valve (7) is within 0.05 mm.

3. The plunger pump power control device of claim 2, wherein the spring pre-loaded mechanism (5) comprises a first spring seat (51), a large spring (52), a small spring (53), a second spring seat (54), a screw insert (55) and a nut (56); the screw insert (55) is formed with a groove having a cross section in the

form of the inverted character "⊥" thereon, the screw insert (55) is screwed into the control valve body (1) and is fixed at one end of the control valve body (1) via the nut (56); the first spring seat (51) and the second spring seat (54) are disposed in the groove opposite to each other, the small spring (53) and the large spring (54) are disposed between the first spring seat (51) and the second spring seat (54), and the small spring (53) is disposed inside the large spring (52).

4. The plunger pump power control device of claim 3, wherein the spring pre-loaded mechanism (5) further has an adjusting screw (57), and one end of the adjusting screw (57) is screwed into the screw insert (55) and contacts with the second spring seat (54).

5. A control method for a plunger pump power control device, comprising the following steps of:

(1) presetting the value of a spring pre-loaded mechanism (5);
 (2) introducing oil at a pump outlet pressure from an oil inlet P into a C-cavity between a valve core (2) and a slide valve (7) through an E-cavity, wherein the oil at the pump outlet pressure drives the slide valve (7) and the valve core (2) to move in opposite directions, the slide valve (7) stops at a stop screwed plug (4), and the valve core (2) moves towards and compresses the spring pre-loaded mechanism (5); or the pressure at the oil inlet P is decreased so that the spring pre-loaded mechanism (5) drives the valve core (2) to overcome the pressure of the C-cavity to move in a reverse direction; and
 (3) performing binarization processing to accomplish the process of increasing or decreasing the pressure of the pump.

6. The control method for a plunger pump power control device of claim 5, wherein the step (3) is specifically as follows: when the pump outlet pressure introduced into the C-cavity increases to exceed the preset value of the spring pre-loaded mechanism (5), the valve core (2) moves in a direction in which the spring pre-loaded mechanism (5) is compressed; when the valve core (2) moves to such an extent that the oil inlet P and the E-cavity are connected with the oil outlet Ps and the oil outlet Ps is disconnected from the oil drain pore T, the pressure oil enters into a variable piston chamber through the oil outlet Ps to drive the variable piston to move towards the plunger pump at a small swing angle; meanwhile, the feedback mechanism (6) drives the valve sleeve (3) to move towards the closing direction, and when the valve sleeve (3) moves to such an extent that the oil inlet P is disconnected from the oil outlet Ps and the oil outlet Ps is connected with the oil drain port T, the pressure oil of the variable piston is drained so that the variable piston is stopped from moving in the small swing angle direction and moves towards the plunger pump at a large swing angle; and meanwhile, the feedback mechanism (6) drives the valve sleeve (3) to move in a direction opposite to the moving direction of the variable piston until the oil inlet P is again connected with the oil outlet Ps; the aforesaid two processes are performed alternately so that the variable piston experiences a tiny pulsation motion; and then the process of increasing the pressure of the pump is completed; and when the pump outlet pressure introduced into the C-cavity decreases to be below the preset value of the spring pre-loaded mechanism (5), the oil inlet P and the E-cavity are disconnected from the oil outlet Ps and the oil outlet Ps is connected with the oil drain port

T, the variable piston moves towards the plunger pump at a large swing angle; meanwhile, the feedback mechanism (6) drives the valve sleeve (3) to move in the direction opposite to the moving direction of the variable piston, and when the valve sleeve (3) moves to such an extent that the oil inlet P is connected with the oil outlet Ps and the oil outlet Ps is disconnected from the oil drain port T, the pressure oil stops the variable piston from moving and reversely drives the variable piston to move towards the plunger pump at a small swing angle: the aforesaid two processes are performed alternately so that the variable piston experiences a tiny pulsation motion; and then, the process of decreasing the pressure of the pump is completed.

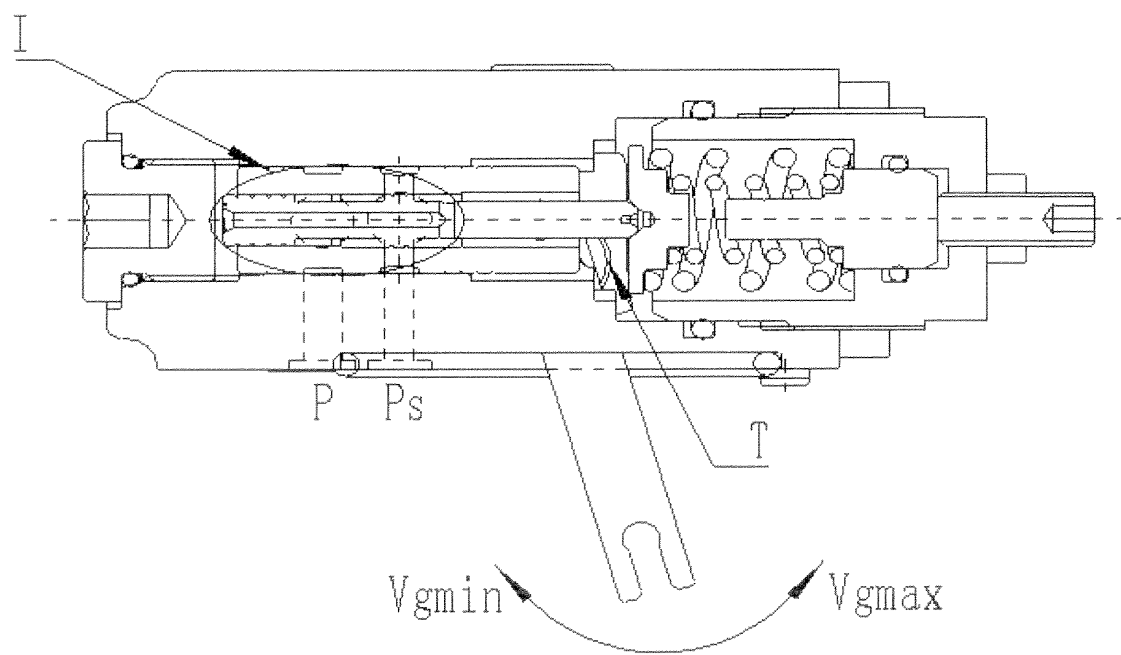


FIG. 1

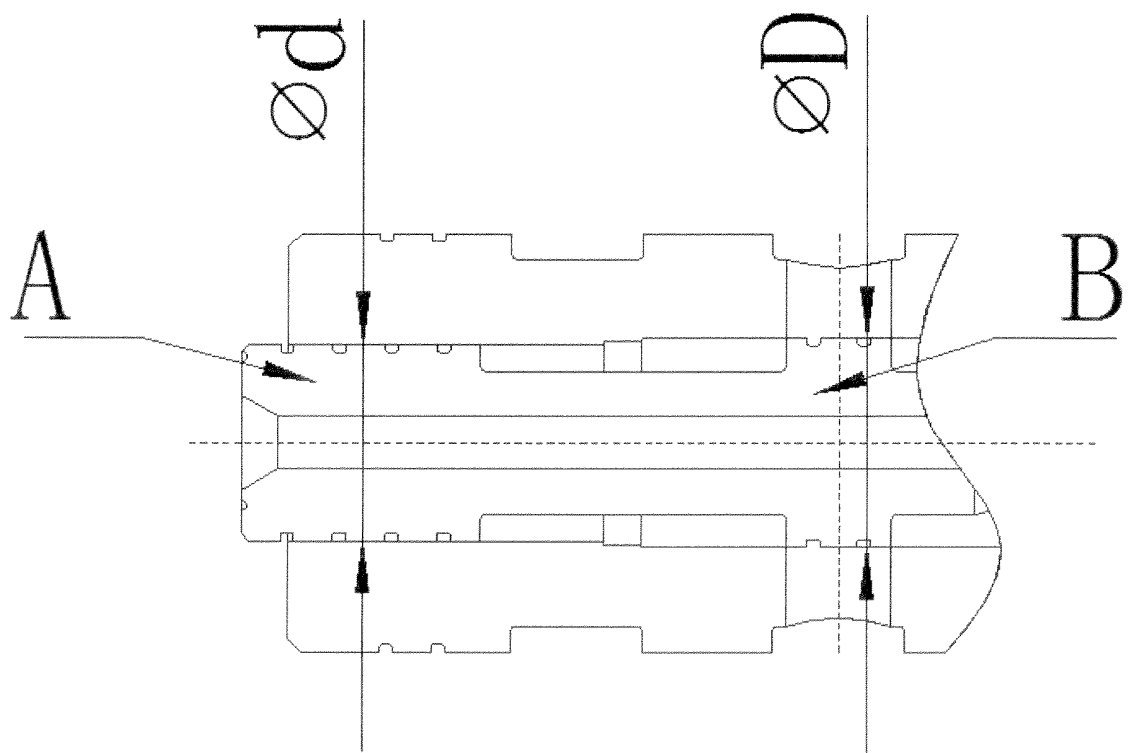


FIG. 2

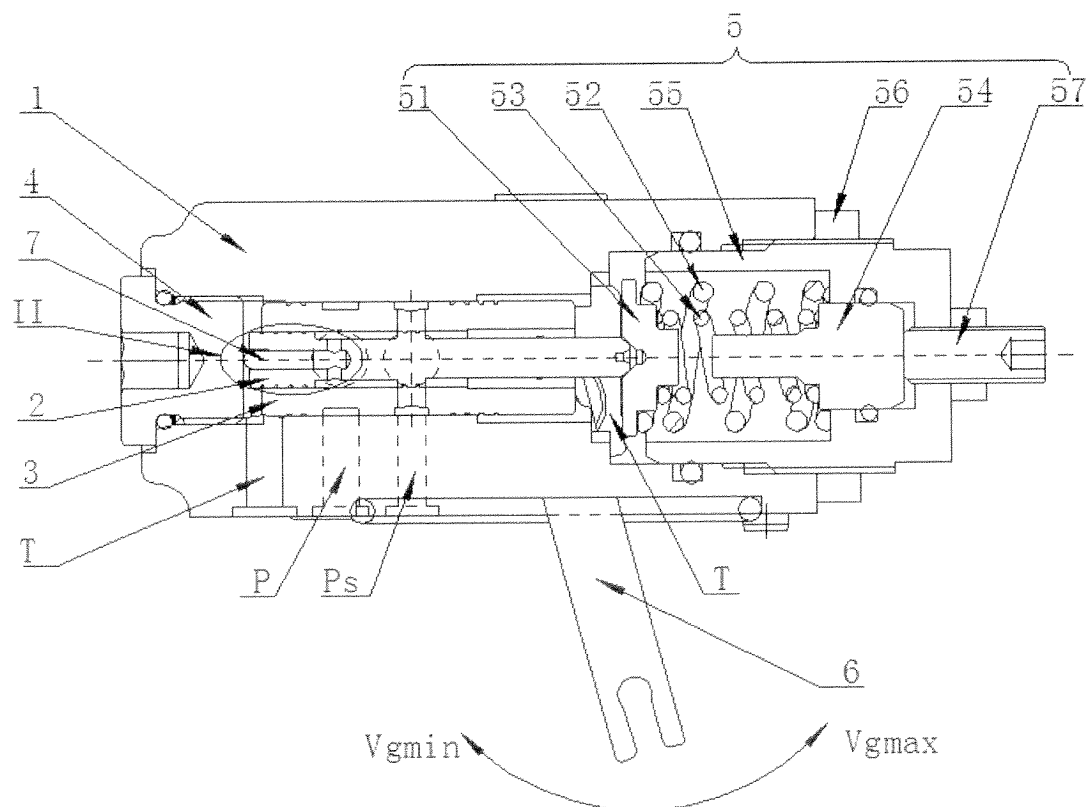


FIG. 3

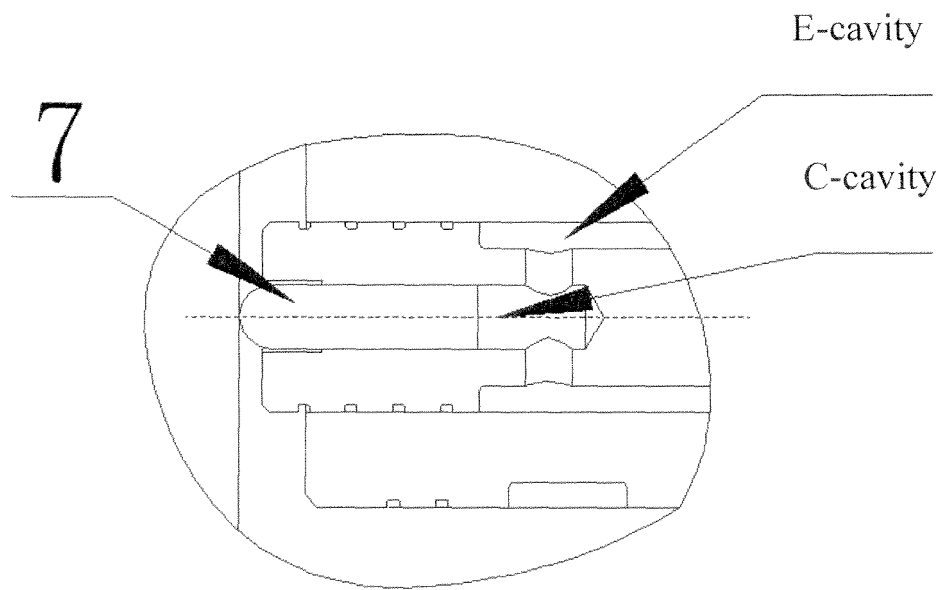


FIG. 4

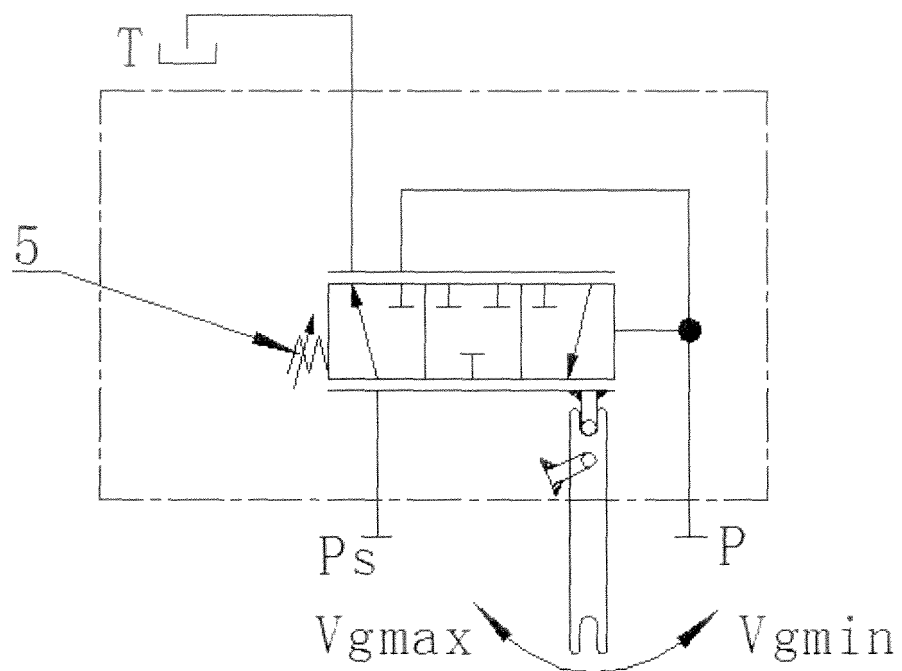


FIG. 5

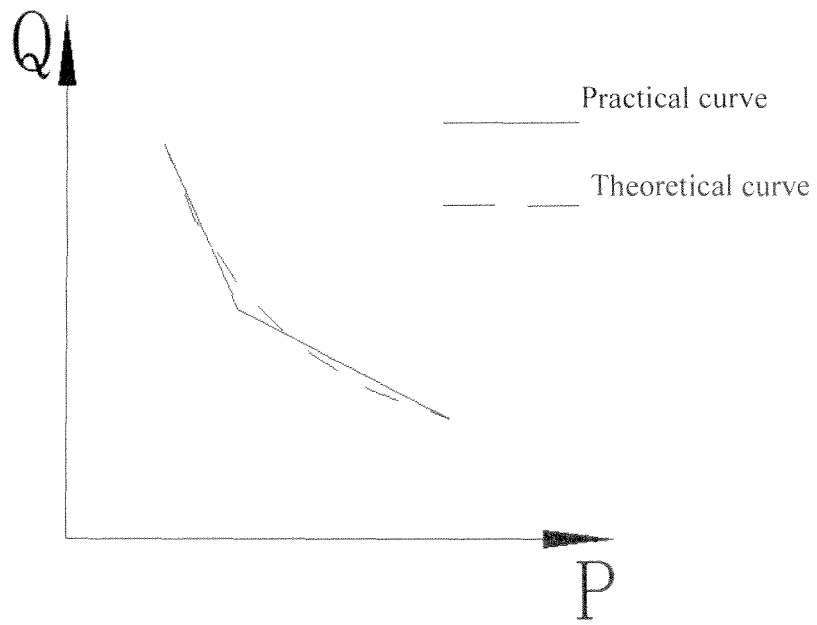


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/001488

A. CLASSIFICATION OF SUBJECT MATTER

F04B 49/22 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04B; F04C; F16K

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)

CNPAT, CNKI, WPI, EPODOC: plunger pump, power, oil port, feedback, valve, variable w displacement, pressure, hydraulic, oil, control+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 101922445 A (HANGZHOU LINON HYDRAULIC CO., LTD.), 22 December 2010 (22.12.2010), description, paragraphs [0022]-[0030], and figure 1	1-6
A	CN 201972916 U (JIANGSU HENGYUAN HYDRAULIC CO., LTD.), 14 September 2011 (14.09.2011), the whole document	1-6
A	CN 102168540 A (SUN, Maoyi), 31 August 2011 (31.08.2011), the whole document	1-6
A	US 3865514 A (SPERRY RAND CORP.), 11 February 1975 (11.02.1975), the whole document	1-6

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

* Special categories of cited documents:	"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
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Date of the actual completion of the international search
18 July 2014 (18.07.2014)Date of mailing of the international search report
30 July 2014 (30.07.2014)Name and mailing address of the ISA/CN:
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Haidian District, Beijing 100088, China
Facsimile No.: (86-10) 62019451

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 101922445 A	22 December 2010	None	
CN 201972916 U	14 September 2011	None	
CN 102168540 A	31 August 2011	None	
US 3865514 A	11 February 1975	IN 140491 A1	20 November 1976

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