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(72) Inventors:
• **LI, Qing**
Shanghai 201206 (CN)
• **WU, Zhongyu**
Shanghai 201206 (CN)
• **ZHU, Yin**
Shanghai 201206 (CN)
• **DONG, Haoxun**
Shanghai 201206 (CN)

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(74) Representative: **Dauncey, Mark Peter**
Marks & Clerk LLP
1 New York Street
Manchester M1 4HD (GB)

(71) Applicant: **United Automotive Electronic Systems Co., Ltd.**
Pudong New Area
Shanghai 201206 (CN)

(54) **HIGH-PRESSURE PUMP**

(57) A high-pressure pump, comprising: a pressure chamber, a plunger sleeve (3) disposed in the pressure chamber, and a protruding member (8) disposed at an outer side of the plunger sleeve (3) and in interference fit to the wall of the pressure chamber. The plunger sleeve (3) comprises a first section (31) and a second section (32) connected to the first section (31). The protruding member (8) is disposed on an outer side of the second section (32) close to the first section (31). The protruding member (8) divides the pressure chamber into a first pressure chamber (1) and a second pressure chamber (2), and the first section (31) is located in the first pressure chamber (1). By lowering the protruding member (8), under the premise of the same volumetric efficiency, the high-pressure pump has a larger plunger clearance in the oil sucking stage, less wear to the plunger set, and a longer service life.

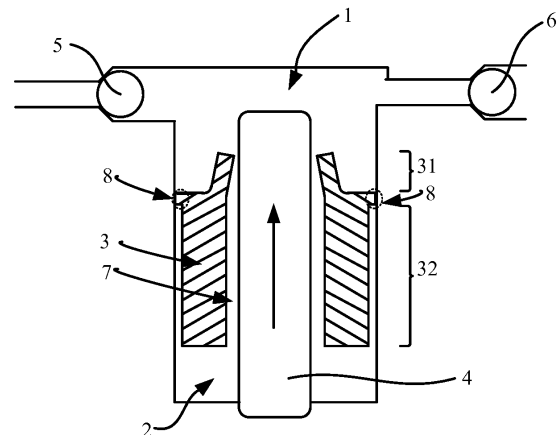


FIG. 2

Description

TECHNICAL FIELD

[0001] The present invention relates to the technical field of fuel injection pumps, and in particular, to a high-pressure pump.

BACKGROUND

[0002] A high-pressure pump is a critical part of a direct fuel injection engine. As shown in FIG. 1, the high-pressure pump includes a filling valve 5', a delivery valve 6', a pressure chamber 1' disposed between the filling valve 5' and the delivery valve 6', a plunger sleeve 3' disposed in the pressure chamber 1', a protruding member 8' disposed at one end of the plunger sleeve and at its outer side, and in interference fit to the pressure chamber 1', and a plunger 4' disposed inside the plunger sleeve 3'. Pressure is generated by the movement of the plunger 4' in the pressure chamber 1' to convert low-pressure fuel into high-pressure fuel (having a pressure up to 150 bar or higher).

[0003] With the continuous improvement of energy conservation and emission reduction requirements, the design and manufacture of high-pressure pumps also face new challenges: it is required to further increase the oil pumping pressure (up to 350 bar or higher) in the case of lightweight. However, with the increase of pressure, in the oil pumping stage, the high-pressure oil is likely to return to low-pressure areas through plunger clearances (which are the sealing clearances between the plunger and the plunger sleeve). As a result, the volumetric efficiency may be reduced. Such problem is especially obvious in low rev conditions, and thus, the oil supply capacity in low rev condition has become a choke point to oil pumps to be designed with higher pressure.

[0004] To solve the foregoing problem, the following schemes are adopted currently:

1. a larger oil pumping volume is selected to compensate for the decrease of volumetric efficiency;
2. the length of the plunger clearance is increased to counteract the influence of backflow; and
3. the machining clearance (see the reference sign 7' in FIG. 1) in the plunger set (comprising the plunger and the plunger sleeve) is reduced, to counteract the influence of backflow.

[0005] The above schemes 1 and 2 are accompanied by the increase in weight and cost, and the above scheme 3 is accompanied by the risks of accelerated wear to the plunger set and a significant decrease in the service life, and it is required to use the material having better performance in wear resistance or to perform a surface treatment process to acquire a better wear resistance. However, the cost will be increased.

SUMMARY OF THE INVENTION

[0006] An objective of the present invention is to provide a high-pressure pump to solve the problem in the prior art that in the oil pumping stage of the high-pressure pump, the high-pressure oil is likely to return to low-pressure areas through a plunger clearance, and the volumetric efficiency is reduced.

[0007] To solve the foregoing technical problem, the present invention provides a high-pressure pump, comprising: a pressure chamber, a plunger sleeve disposed in the pressure chamber, a protruding member disposed at an outer side of the plunger sleeve and in interference fit to a wall of the pressure chamber, a plunger disposed in the plunger sleeve, a filling valve, and a delivery valve, wherein the plunger sleeve comprises a first section and a second section connected to the first section; the protruding member is disposed on an outer side of the second section close to the first section; the protruding member divides the pressure chamber into a first pressure chamber and a second pressure chamber, the first section is located in the first pressure chamber, and the filling valve and the delivery valve are disposed at the first pressure chamber.

[0008] Alternatively, in the high-pressure pump, in an oil pumping stage of the high-pressure pump, the plunger moves from the second pressure chamber towards the first pressure chamber.

[0009] Alternatively, in the high-pressure pump, in the oil pumping stage of the high-pressure pump, the first pressure chamber has a pressure higher than a pressure of the second pressure chamber.

[0010] Alternatively, in the high-pressure pump, in the oil pumping stage of the high-pressure pump, the first section of the plunger sleeve deforms to contract inwards, and a clearance between the first section of the plunger sleeve and the plunger is smaller than a machining clearance of a plunger set.

[0011] Alternatively, in the high-pressure pump, in the oil pumping stage of the high-pressure pump, the pressure in the first pressure chamber is progressively decreased along a direction towards the second pressure chamber.

[0012] Alternatively, in the high-pressure pump, in an oil sucking stage of the high-pressure pump, the plunger moves from the first pressure chamber towards the second pressure chamber.

[0013] Alternatively, in the high-pressure pump, in the oil sucking stage of the high-pressure pump, the first pressure chamber has a pressure equal to a pressure of the second pressure chamber.

[0014] Alternatively, in the high-pressure pump, in the oil sucking stage of the high-pressure pump, a clearance between the first section of the plunger sleeve and the plunger is equal to a clearance between the second section of the plunger sleeve and the plunger, and the clearance between the second section of the plunger sleeve and the plunger is a machining clearance of a plunger set.

[0015] Alternatively, in the high-pressure pump, the first section of the plunger sleeve has an inner diameter same as an inner diameter of the second section of the plunger sleeve, and the first section of the plunger sleeve has an outer diameter same as an outer diameter of the second section of the plunger sleeve.

[0016] Alternatively, in the high-pressure pump, the first section of the plunger sleeve has an inner diameter same as an inner diameter of the second section of the plunger sleeve, and the first section of the plunger sleeve has an outer diameter different from an outer diameter of the second section of the plunger sleeve.

[0017] Alternatively, in the high-pressure pump, the first section of the plunger sleeve has a length satisfying a relationship with a total length of the plunger sleeve as follows:

$$3\left(\frac{L2}{L1}\right) < 8,$$

wherein L2 represents the total length of the plunger sleeve, and L1 represents the length of the first section of the plunger sleeve.

[0018] Alternatively, in the high-pressure pump, the inner diameter of the first section of the plunger sleeve, the outer diameter of the first section of the plunger sleeve, and the outer diameter of the second section of the plunger sleeve satisfy the following relationship:

$$\frac{D2 - D1}{D3 - D1} > 1.2,$$

wherein D1 represents the inner diameter of the first section of the plunger sleeve, D2 represents the outer diameter of the second section of the plunger sleeve, and D3 represents the outer diameter of the first section of the plunger sleeve.

[0019] Alternatively, in the high-pressure pump, the first section is connected to the second section through a transition section, and a cross section of the transition section is shaped with one of a rounded angle, a right angle, an oblique angle, a multi-section curve, and a multi-section line, or a combination of the multi-section curve and the multi-section line.

[0020] In the high-pressure pump provided by the present invention, the plunger sleeve of the high-pressure pump includes a first section and a second section connected to the first section, the protruding member is disposed on the outer side of the second section close to the first section, and the first section is located in the first pressure chamber. Compared with the prior art, the position at which the protruding member is in interference fit to the pressure chamber is lower. In the oil pumping stage, the first section is deformed and shrunk inwards due to the pressure difference between the inside and the outside of the first section, and the clearance between

the first section and the plunger is reduced, which effectively reduces the likelihood of backflow through the clearance. In the oil sucking stage, no pressure difference generated between the inside and the outside of the first section, so that the first section is recovered from the contracted configuration to the shape before deformation. Therefore, under the premise of the same volumetric efficiency, the high-pressure pump of the present invention has a larger plunger clearance in the oil sucking stage, less wear to the plunger set, and a longer service life than the existing high-pressure pump. Therefore, it is possible to further reduce the machining clearance in the plunger set to increase the volumetric efficiency, without increasing the weight or using more expensive materials. The greater the oil pumping pressure is, the greater the deformation of the first section will be, and also the more significant the beneficial effects to the volumetric efficiency will be.

20 BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

FIG. 1 is a schematic structural diagram of a high-pressure pump in the prior art;

FIG. 2 is a schematic structural diagram of a high-pressure pump in an oil pumping stage according to an embodiment of the present invention;

FIG. 3 is a schematic structural diagram of a high-pressure pump in an oil sucking stage according to an embodiment of the present invention;

FIG. 4 is a schematic sectional diagram of a plunger sleeve according to an embodiment of the present invention; and

FIGs. 5a-5f are schematic sectional diagrams showing a transition section between a first section and a second section of a plunger sleeve according to an embodiment of the present invention.

[0022] In FIG. 1, 1' denotes a pressure chamber; 3' denotes a plunger sleeve; 4' denotes a plunger; 5' denotes a filling valve; 6' denotes a delivery valve; 7' denotes a machining clearance in a plunger set; 8' denotes a protruding member.

[0023] In FIGs. 2-4, 1 denotes a first pressure chamber; 2 denotes a second pressure chamber, 3 denotes a plunger sleeve; 31 denotes a first section; 32 denotes a second section; 4 denotes a plunger; 5 denotes a filling valve; 6 denotes a delivery valve; 7 denotes a machining clearance in a plunger set; 8 denotes a protruding member.

DETAILED DESCRIPTION

[0024] The high-pressure pump proposed by the present invention will be further described in detail below with reference to the accompanying drawings and specific embodiments. Advantages and features of the

present invention will be apparent from the description and appended claims below. It should be noted that the drawings are in a very simplified form and use non-precise proportions, and are only intended to conveniently and explicitly assist in describing the objectives of embodiments of the present invention.

[0025] FIGs. 2 and 4 are schematic structural diagrams of a high-pressure pump according to the present invention. As shown in FIG. 2, the high-pressure pump comprises a pressure chamber, a plunger sleeve 3 disposed in the pressure chamber, a protruding member 8 disposed at an outer side of the plunger sleeve 3 and in interference fit to the wall of the pressure chamber, a plunger 4 disposed in the plunger sleeve 3, a filling valve 5, and a delivery valve 6. The plunger sleeve 3 comprises a first section 31 and a second section 32 connected to the first section 31. The protruding member 8 is disposed on the outer side of the second section 32 close to the first section 31. The protruding member 8 divides the pressure chamber into a first pressure chamber 1 and a second pressure chamber 2. The first section 31 is located in the first pressure chamber 1, and the filling valve 5 and the delivery valve 6 are disposed at the first pressure chamber 1.

[0026] The protruding member serves as a boundary point which divides the pressure chamber into a first pressure chamber 1 and a second pressure chamber 2. As shown in FIGs. 1 and 2, the protruding member 8 shown in FIG. 2 is at a lower position than the protruding member 8' shown in FIG. 1, so that the plunger sleeve 3 is received in the first pressure chamber with a defined length (i.e., the first section). In other words, compared with the structure shown in FIG. 1, the length of the plunger sleeve received in the first pressure chamber is increased in FIG. 2, to solve the problem that in the oil pumping stage of the high-pressure pump, the high-pressure oil is likely to return to the low-pressure area through the plunger clearance, and the volumetric efficiency is reduced.

[0027] Two stages including an oil pumping stage and an oil sucking stage are involved in the operation of the high-pressure pump, which are specified as follows:

As shown in FIG. 2, in the oil pumping stage, the plunger 4 moves from the second pressure chamber 2 towards the first pressure chamber 1, so that the pressure in the first pressure chamber 1 is higher than that in the second pressure chamber 2. In this case, a pressure difference is generated between the inside and the outside of the first section 31, which means the pressure in the first pressure chamber 1 is progressively decreased along a direction towards the second pressure chamber 2. The main reason is that the outer side of the first section 31 of the plunger sleeve 3 is affected by the high and constant pressure in the first pressure chamber 1, and the inner side of the first section 31 of the plunger sleeve 3 is in communication with the second pressure chamber 2, and thus, the pressure at the inner side of the first section 31 of the plunger sleeve 3 is progressively decreased along a direction from the first pressure chamber

1 towards the second pressure chamber 2 and is less than the pressure applied to the outer side of the first section 31. Under the effect of the pressure difference, the first section 31 is deformed and contracted inwards, so that the clearance between the first section 31 of the plunger sleeve 3 and the plunger 4 is smaller than the machining clearance 7 in the plunger set (i.e., the original machining clearance between the plunger 4 and the plunger sleeve 3).

[0028] As shown in FIG. 3, in the oil sucking stage, the plunger 4 moves from the first pressure chamber 1 towards the second pressure chamber 2, so that the pressure in the first pressure chamber 1 becomes equal to that in the second pressure chamber 2. Therefore, no pressure difference is generated between the inside and the outside of the first section 31, and the first section 31 is recovered to the shape before deformation from the inwardly contracted configuration in the oil pumping stage, and the clearance between the first section 31 of the plunger sleeve 3 and the plunger 4 is equal to the clearance between the second section 32 of the plunger sleeve 3 and the plunger 4 (i.e., the initial state of the plunger sleeve 3), which are equal to the machining clearance 7 in the plunger set. Preferably, the machining clearance 7 in the plunger set has a width ranging from 1 μm to 15 μm .

[0029] Therefore, compared with an existing high-pressure plunger having a same plunger clearance in oil pumping stage (i.e., same volumetric efficiency), the high-pressure pump of the present invention can have a larger plunger clearance in the oil sucking stage, a less wear to the plunger set, and a longer service life, and can further reduce the machining clearance 7 in the plunger set to increase the volumetric efficiency. In other words, at the cost of service life, the machining clearance 7 in the plunger set can be further reduced, to reduce the likelihood of backflow through the clearance, without increasing the weight or using more expensive materials. Moreover, the greater the oil pumping pressure is, the larger the adaptive deformation is, and the more significant the beneficial effects to the volumetric efficiency is, thereby effectively improving the fuel combustion utilization rate and reducing fuel consumption.

[0030] Further, the inner diameter of the first section 31 of the plunger sleeve 3 is the same as that of the second section 32 of the plunger sleeve 3, and the outer diameter of the first section 31 of the plunger sleeve 3 is the same as or different from that of the second section 32 of the plunger sleeve 3. In this embodiment, it is preferable that the outer diameter of the first section 31 of the plunger sleeve 3 is different from that of the second section 32 of the plunger sleeve 3, so that the first section 31 is more likely to be deformed to contract in the oil pumping stage.

[0031] Referring to FIG. 4, regardless of whether the outer diameter of the first section 31 of the plunger sleeve 3 is the same as that of the second section 32 of the plunger sleeve 3, it is necessary to satisfy the following

relationship:

$$3 < \frac{L2}{L1} < 8,$$

where L2 represents the total length of the plunger sleeve 3, and L1 represents the length of the first section 31 of the plunger sleeve 3.

[0032] Still referring to FIG. 4, when the outer diameter of the first section 31 of the plunger sleeve 3 is different from that of the second section 32 of the plunger sleeve 3, it is necessary to satisfy the following relationship:

$$\frac{D2 - D1}{D3 - D1} > 1.2,$$

where D1 represents the inner diameter of the first section 31 of the plunger sleeve 3, D2 represents the outer diameter of the second section 32 of the plunger sleeve 3, and D3 represents the outer diameter of the first section 31 of the plunger sleeve 3.

[0033] Preferably, referring to FIGs. 5a-5f, the first section is connected to the second section through a transition section which facilitates in mounting the plunger sleeve in the pressure chamber, and the cross section of the transition section is shaped with one of a rounded angle, a right angle, an oblique angle, a multi-section curve, and a multi-section line, or a combination of the multi-section curve and the multi-section line.

[0034] In conclusion, in the high-pressure pump provided by the present invention, the plunger sleeve of the high-pressure pump includes a first section and a second section connected to the first section, the protruding member is disposed on the outer side of the second section close to the first section, and the first section is located in the first pressure chamber. Compared with the prior art, the position at which the protruding member is in interference fit to the pressure chamber is lower. In the oil pumping stage, the first section is deformed and contracted inwards due to the pressure difference between the inside and the outside of the first section, and the clearance between the first section and the plunger is reduced, which effectively reduces the likelihood of back-flow through the clearance. In the oil sucking stage, no pressure difference is generated between the inside and the outside of the first section, so that the first section is recovered from the contracted state to the shape before deformation. Therefore, under the premise of the same volumetric efficiency, the high-pressure pump of the present invention has a larger plunger clearance in the oil sucking stage, a less wear to the plunger set, and a longer service life than the existing high-pressure pump. Therefore, it is possible to further reduce the machining clearance in the plunger set to increase the volumetric efficiency, without increasing the weight or using more expensive materials.

[0035] The above description is only for the description of the preferred embodiments of the present invention, and is not intended to limit the scope of the present invention. Any changes and modifications made by those skilled in the art according to the above disclosure are all within the protection scope of the appended claims.

Claims

1. A high-pressure pump, comprising: a pressure chamber, a plunger sleeve disposed in the pressure chamber, a protruding member disposed at an outer side of the plunger sleeve and in interference fit to a wall of the pressure chamber, a plunger disposed in the plunger sleeve, a filling valve, and a delivery valve; wherein the plunger sleeve comprises a first section and a second section connected to the first section; the protruding member is disposed on an outer side of the second section close to the first section; the protruding member divides the pressure chamber into a first pressure chamber and a second pressure chamber, the first section is located in the first pressure chamber, and the filling valve and the delivery valve are disposed at the first pressure chamber.
2. The high-pressure pump according to claim 1, wherein in an oil pumping stage of the high-pressure pump, the plunger moves from the second pressure chamber towards the first pressure chamber.
3. The high-pressure pump according to claim 2, wherein in the oil pumping stage of the high-pressure pump, the first pressure chamber has a pressure higher than a pressure of the second pressure chamber.
4. The high-pressure pump according to claim 3, wherein in the oil pumping stage of the high-pressure pump, the first section of the plunger sleeve deforms to contract inwards, and a clearance between the first section of the plunger sleeve and the plunger is smaller than a machining clearance of a plunger set.
5. The high-pressure pump according to claim 3, wherein in the oil pumping stage of the high-pressure pump, the pressure in the first pressure chamber is progressively decreased along a direction towards the second pressure chamber.
6. The high-pressure pump according to claim 1, wherein in an oil sucking stage of the high-pressure pump, the plunger moves from the first pressure chamber towards the second pressure chamber.
7. The high-pressure pump according to claim 6, wherein in the oil sucking stage of the high-pressure

pump, the first pressure chamber has a pressure equal to a pressure of the second pressure chamber.

8. The high-pressure pump according to claim 7, wherein in the oil sucking stage of the high-pressure pump, a clearance between the first section of the plunger sleeve and the plunger is equal to a clearance between the second section of the plunger sleeve and the plunger, and the clearance between the second section of the plunger sleeve and the plunger is a machining clearance of a plunger set. 5 10
9. The high-pressure pump according to claim 1, wherein the first section of the plunger sleeve has an inner diameter same as an inner diameter of the second section of the plunger sleeve, and the first section of the plunger sleeve has an outer diameter same as an outer diameter of the second section of the plunger sleeve. 15 20
10. The high-pressure pump according to claim 1, wherein the first section of the plunger sleeve has an inner diameter same as an inner diameter of the second section of the plunger sleeve, and the first section of the plunger sleeve has an outer diameter different from an outer diameter of the second section of the plunger sleeve. 25
11. The high-pressure pump according to claim 9 or 10, wherein the first section of the plunger sleeve has a length satisfying a relationship with a total length of the plunger sleeve as follows: 30

$$3 < \frac{L2}{L1} < 8, \quad 35$$

wherein L2 represents the total length of the plunger sleeve, and L1 represents the length of the first section of the plunger sleeve. 40

12. The high-pressure pump according to claim 10, wherein the inner diameter of the first section of the plunger sleeve, the outer diameter of the first section of the plunger sleeve, and the outer diameter of the second section of the plunger sleeve satisfy the following relationship: 45

$$\frac{D2 - D1}{D3 - D1} > 1.2, \quad 50$$

wherein D1 represents the inner diameter of the first section of the plunger sleeve, D2 represents the outer diameter of the second section of the plunger sleeve, and D3 represents the outer diameter of the first section of the plunger sleeve. 55

13. The high-pressure pump according to claim 12, wherein the first section is connected to the second section through a transition section, and a cross section of the transition section is shaped with one of a rounded angle, a right angle, an oblique angle, a multi-section curve, and a multi-section line, or a combination of the multi-section curve and the multi-section line.

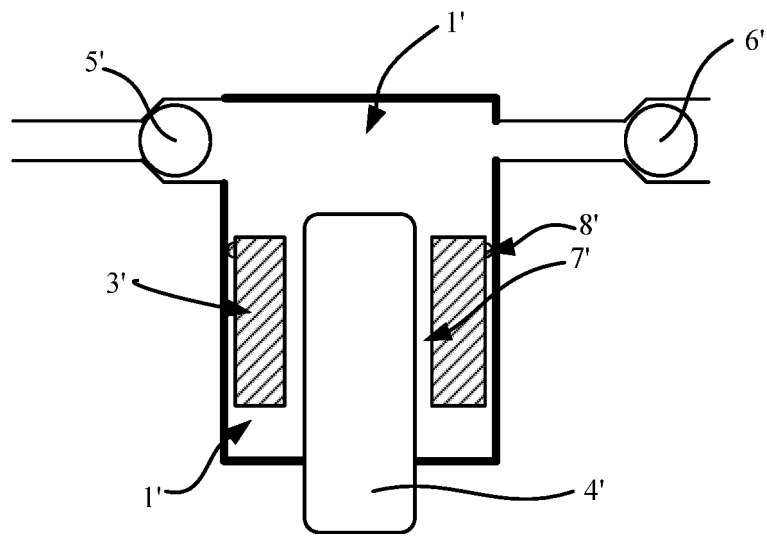


FIG. 1

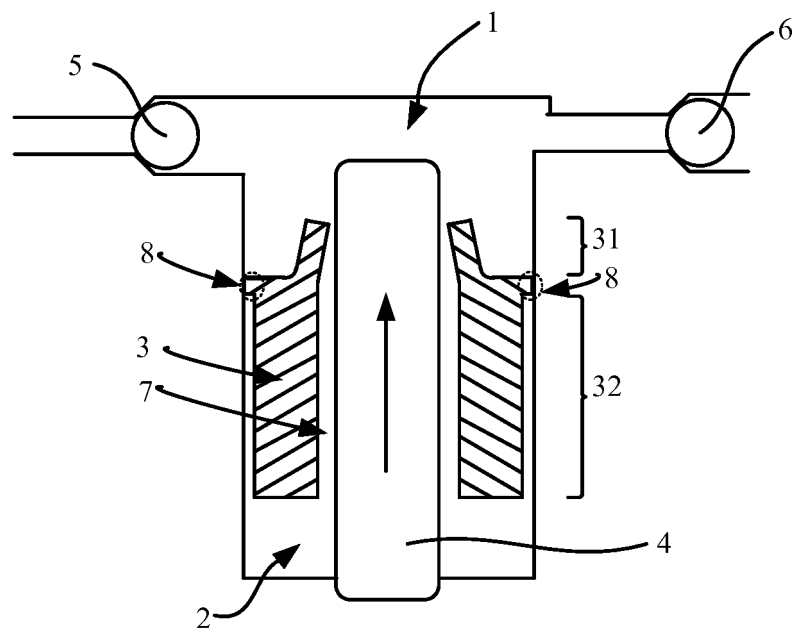


FIG. 2

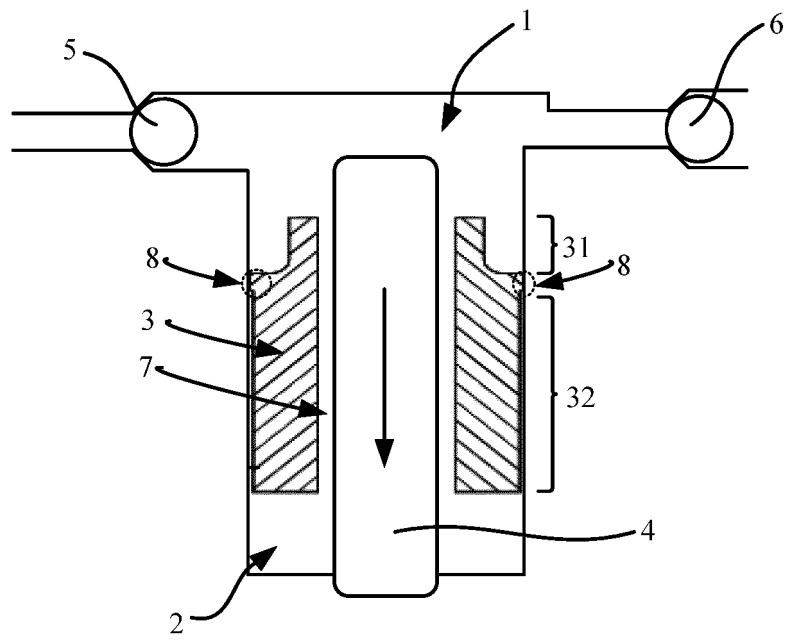


FIG. 3

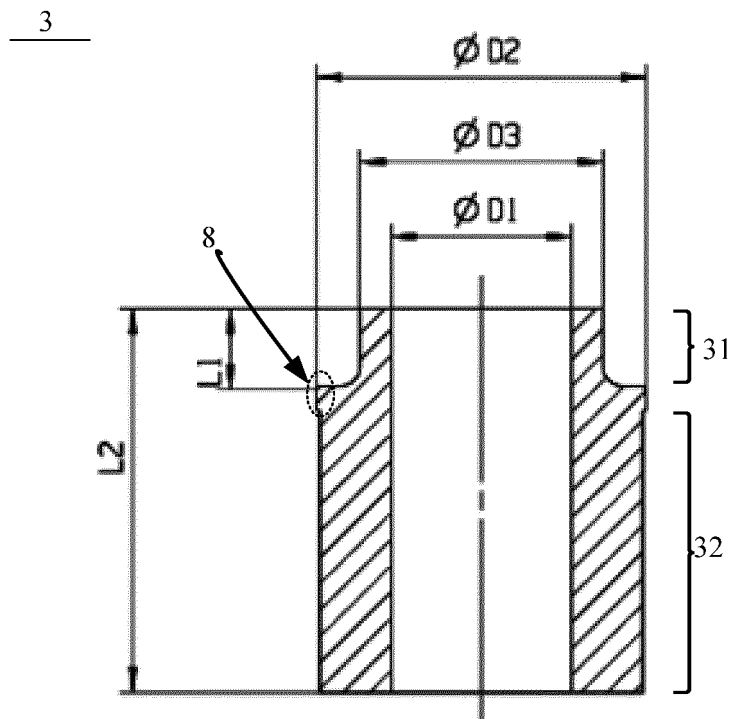


FIG. 4

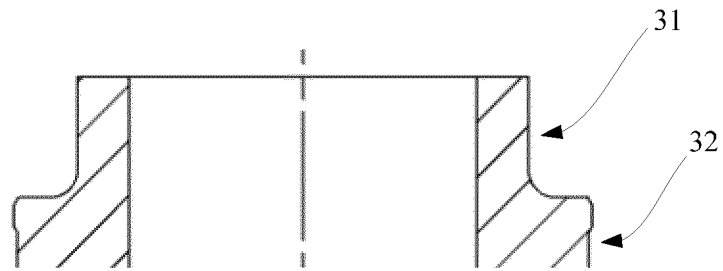


FIG. 5a

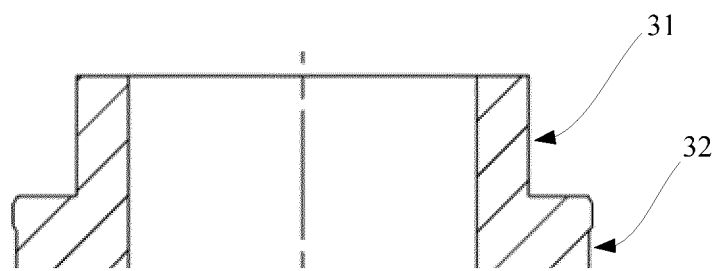


FIG. 5b

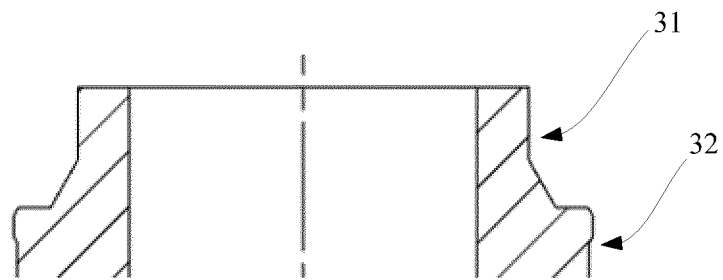


FIG. 5c

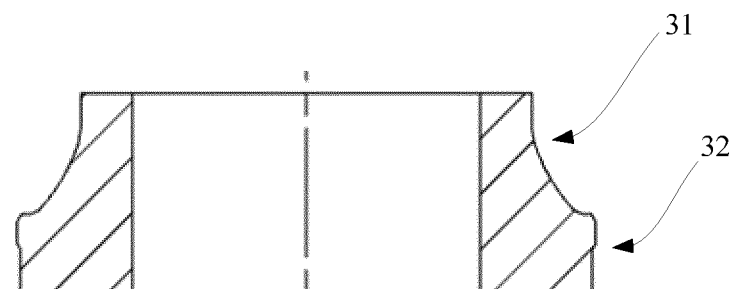


FIG. 5d

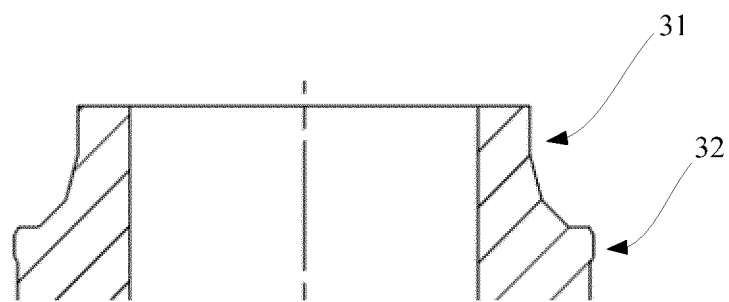


FIG. 5e

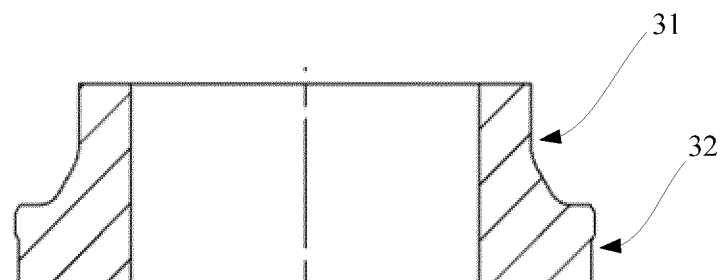


FIG. 5f

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/073787

A. CLASSIFICATION OF SUBJECT MATTER

F02M 59/44 (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)

F02M; F04B

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, CNKI, CNPAT: 泵, 柱塞, 活塞, 凸起, 凸出, 突起, 突出, 隆起, 套, 缸套, 泵套, 活塞套, 柱塞套, 间隙, PUMP,
PISTON, PLUNGER, PROJECT+, PROTRU+, BUSH+, SLEEVE, LINER, CYLINDER, GAP

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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PX	CN 206439132 U (UNITED AUTOMOTIVE ELECTRONIC SYSTEMS CO., LTD.) 25 August 2017 (25.08.2017), claims 1-13	1-13
X	CN 106103989 A (KAYABA INDUSTRY CO., LTD.) 09 November 2016 (09.11.2016), description, paragraphs [0020]-[0063], and figures 1-3	1-3, 5-9, 11
X	JP H07217742 A (KAYABA INDUSTRY CO., LTD.) 15 August 1995 (15.08.1995), the abstract, and figure 1	1-3, 5-9, 11
X	JP H09264305 A (KAYABA INDUSTRY CO., LTD.) 07 October 1997 (07.10.1997), the abstract, and figure 8	1-3, 5-9, 11

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

* Special categories of cited documents:

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Date of the actual completion of the international search
12 March 2018

Date of mailing of the international search report
23 March 2018

Name and mailing address of the ISA
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

GUO, Xuyao

Telephone No. (86-10) 53961084

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/073787

5

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

10

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 204458157 U (BEIJING BOMANDI AUTO TECHNOLOGY CO., LTD.) 08 July 2015 (08.07.2015), entire document	1-13
A	CN 205225549 U (WUXI WEIFU MASHAN FUEL INJECTION EQUIPMENT CO., LTD.) 11 May 2016 (11.05.2016), entire document	1-13

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Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
 Information on patent family members

 International application No.
 PCT/CN2018/073787

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 106762299 A	31 May 2017	None	
CN 206439132 U	25 August 2017	None	
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