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(54) **MECHANISM FOR ADJUSTING CAMSHAFT OF INTERNAL COMBUSTION ENGINE**

(57) A mechanism for adjusting a camshaft of an internal combustion engine comprises a camshaft (1), a cam sleeve (2) and an electromagnetic valve (3). A guide boss portion (7) is provided on the cam sleeve (2). A valve core of the electromagnetic valve (3) is in fit with the guide boss portion (7) to drive the cam sleeve (2) to perform reciprocating movement in an axial direction of the camshaft (1). An automatic return device is provided on the valve core. After the electromagnetic valve (3) is deenergized, the valve core returns to an initial position under the action of an automatic reset device.

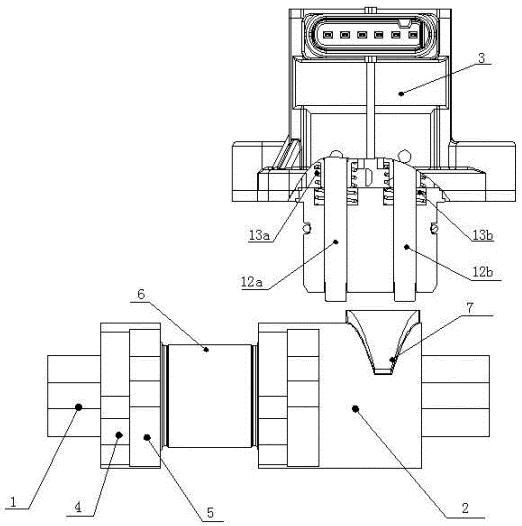

FIG. 1

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Description

Technical Field

[0001] The present invention relates to the field of designing a mechanism for adjusting a camshaft, in particular to a mechanism for adjusting a camshaft of an internal combustion engine.

Background of the Invention

[0002] With the development of the automobile industry and the shortage of petroleum resources, the oil price has raised continuously, increasingly strict environmental protection standards have been formulated, and it is more urgent to improve fuel consumption and environmental protection performance of engines. Hence, various automobile manufacturers have focused on improving the engine performance by virtue of the variable valve stroke technology.

[0003] At present, the cam movement mode is applied for the current mainstream variable valve stroke technologies. However, for the current cam movement mode, the cam sleeve is of an integrated spiral groove structure, and spiral grooves have different semi-diameters on the circumference and are provided with slopes for pushing back valve cores of a solenoid valve, and the solenoid valve does not have a function of taking back automatically after the cam is switched in place. This structure will accelerate wear of the valve cores, and the manufacturing cost of the camshaft sleeve will increase greatly due to the fact that it is very difficult to process the camshaft and guarantee the size thereof easily.

Summary of the Invention

[0004] The technical problem to be solved by the present invention is, with respect to the problems in the prior art, to provide a mechanism for adjusting a camshaft of an internal combustion engine with simple structure, high reliability, low manufacturing cost and no need of providing a valve core ejection structure on a cam sleeve.

[0005] The technical problem to be solved by the present invention is realized by the following technical solution: A mechanism for adjusting a camshaft of an internal combustion engine, comprises a camshaft, a cam sleeve and a solenoid valve, wherein guide boss portions are provided on the cam sleeve, valve cores of the solenoid valve are in fit with the guide boss portions to drive the cam sleeve to perform reciprocating movement in an axial direction of the camshaft, and an automatic return device is provided on each of the valve core for connection; and after the solenoid valve is deenergized, the valve cores return to initial positions under the action of the automatic return devices.

[0006] Preferably, a valve core A and a valve core B of the solenoid valve are respectively in corresponding fit with a side guide groove face A and a guide groove face B of each guide boss portion, and the valve core A and the valve core B are connected with a valve core return mechanism A and a valve core return mechanism B, respectively.

[0007] Preferably, the cam sleeve is of an integral structure, and high cams and low cams on the cam sleeve move integrally in an axial direction along with the cam sleeve, and are limited axially through limit mechanisms after moving in place.

[0008] Preferably, the cam sleeve is of a combined structure and comprises the high cams, the low cams, a sleeve and the guide boss portions, and the high cams, the low cams and the guide boss portions are fixed on the sleeve by means of riveting or interference press-fitting, move integrally in an axial direction along with the guide boss portions, and are axially limited through the limit mechanisms after moving in place.

[0009] Preferably, the cam sleeve is of a split structure, and comprises the sleeve in the middle, high and low cam sets arranged at both ends of the sleeve and the guide boss portions at both ends of the cam sleeve; the guide boss portions are respectively in fit with the corresponding valve core of the solenoid valve, all parts in the cam sleeve of the split structure are propped against each other, and integrally move in an axial direction of the camshaft under the action of the solenoid valve, and the guide boss portions at both ends of the cam sleeve are axially limited by the corresponding limit mechanisms.

[0010] Preferably, the camshaft is in fit with the cam sleeve in a polygon mode, and the number of sides of the camshaft in fit with the cam sleeve is an integral multiple of the number of the corresponding engine cylinders.

[0011] Preferably, the number of sides of the camshaft in fit with the cam sleeve is 3, or 6, or 9, or 12.

[0012] Preferably, the automatic return device is of a spring or electromagnet or permanent magnet.

[0013] Compared with the prior art, the present invention has the beneficial effects: By means of the guide groove that is arranged on the cam sleeve and guides the cam sleeve to move in the axial direction, valve core ejection grooves are not required; the valve cores of the solenoid valve can return to initial positions under the action of the automatic return devices; the cam guide groove is in fit with the solenoid valve to adjust the position of the camshaft, thereby changing the valve stroke; and the mechanism has simple structure, good reliability and low cost.

Brief description of the Drawings

[0014]

Fig. 1 illustrates a structure diagram of Embodiment 1 of the present invention.

Fig. 2 illustrates a structure diagram in which the valve cores of a solenoid valve are in fit with guide grooves in Embodiment 1 of the present invention.

Fig. 3 illustrates a structure diagram of a cam sleeve

in Embodiment 1 of the present invention.

Fig. 4 illustrates a section view of an integrated cam sleeve in Embodiment 1 of the present invention.

Fig. 5 illustrates a section view of a combined cam sleeve in Embodiment 1 of the present invention.

Fig. 6 illustrates a structure diagram of a cam sleeve in Embodiment 2 of the present invention.

Fig. 7 illustrates a section view of the cam sleeve in Embodiment 2 of the present invention.

Fig. 8 illustrates a structure diagram of a cam sleeve fitting surface in the present invention.

Fig. 9 illustrates a structure diagram of a cam fitting surface in the present invention.

[0015] Marks in the figures: 1-camshaft; 2-cam sleeve; 3-solenoid valve; 4-high cam; 5-low cam; 6-sleeve; 7-guide boss portion; 7a-guide groove face A; 7b-guide groove face B; 8a-first groove A of limit device; 8b-first groove B of limit device; 9a-second groove A of limit device; 9b-second groove B of limit device; 10-sleeve fitting surface; 11-cam fitting surface; 12a-valve core A; 12b-valve core B; 13a-valve core return mechanism A; 13b-valve core return mechanism B.

Detailed Description of Embodiments

[0016] In order to make the purpose, technical solution and advantages of the present invention more clear, the present invention will be elaborated in combination with attached drawings and specific embodiments. It should be understood that the embodiments described herein are only used to explain the present invention rather than defining the present invention.

Embodiment 1

[0017] As shown in Figs. 1 to 4, a mechanism for adjusting a camshaft of an internal combustion engine, comprises a camshaft 1, a cam sleeve 2 and a solenoid valve 3. Guide boss portions 7 are provided on the cam sleeve 2, valve cores of the solenoid valve 3 are in fit with the guide boss portions 7 to drive the cam sleeve 2 to perform reciprocating movement in an axial direction of the camshaft 1, and each of the valve core is provided with an automatic return device for connection. When the valve cores of the solenoid valve protrude into the cam sleeve guide grooves, the cam sleeve moves in an axial direction of the camshaft under rotation of the camshaft to adjust position of the cam to switch a valve stroke. When the valve cores pass through the guide grooves, the cam sleeve and the camshaft are fixed by a limit device. When the solenoid valve 3 is deenergized, the valve cores return to initial positions under the action of the automatic return devices, without the need of providing ejection grooves on the cam shaft. The guide groove is set to have an equal unit radius and a same base circle. The automatic return devices can return by means of spring, electromagnet and permanent magnet suction, etc.

[0018] In this embodiment, a valve core A12a and a valve core B12b of the solenoid valve 3 are respectively in corresponding fit with a side guide groove face A7a and a guide groove face B7b of each guide boss portion 7; the guide groove can be a spiral groove, or can be of a sloped shape; and the valve core A12a and the valve core B12b are connected with a valve core return mechanism A13a and a valve core return mechanism B13b, respectively. The cam sleeve 2 is of an integral structure, and high cams 4 and low cams 5 on the cam sleeve 2 move in an axial direction along with the cam sleeve 2, and are limited axially through limit mechanisms after moving in place.

[0019] As shown in Fig. 5, as another structure, the cam sleeve 2 is of a combined structure, and comprises high cams 4, low cams 5, a sleeve 6 and guide boss portions 7. The high cams 4, the low cams 5 and the guide boss portions 7 are fixed on the sleeve 6 by means of riveting or interference press-fitting or other methods, move integrally in an axial direction along with the guide boss portions 7, and are axially limited through the limit mechanisms after moving in place.

[0020] The operating principle of the present invention is as follows: After the solenoid valve is energized, the electromagnetic core A protrudes, and the cam sleeve operates under rotation of the camshaft; the guide groove face A contacts with the valve core A; the cam sleeve and the camshaft slide in an axial direction under the action of the valve core A; when the guide groove face A passes through the valve core A, the camshaft enters a first groove A of the limit device for limiting through a first groove B of the limit device; the low cams and the high cams are switched; and the solenoid valve is deenergized, the valve core A returns to the initial position under the action of the valve core return mechanism A, and thus the cam position is adjusted. In a similar way, the valve core B protrudes, and the camshaft position is adjusted reversely after the solenoid valve is deenergized.

Embodiment 2

[0021] As shown in Figs. 6 and 7, the cam sleeve 2 is of a split type structure, and comprises a sleeve 6 in the middle, high and low cam sets arranged at the both ends of the sleeve 6 and guide boss portions 7 located at both ends of the cam sleeve 2; and the guide boss portions 7 are respectively in fit with the corresponding valve cores of the corresponding solenoid valve, all parts in the cam sleeve 2 of the split structure are propped against each other, and integrally move in an axial direction of the camshaft 1 under the action of the solenoid valve, and the guide boss portions 7 at both ends of the cam sleeve 2 are respectively limited by the corresponding limit mechanisms in an axial direction.

[0022] The operating principle of the present invention is as follows: After the solenoid valve is energized, the

electromagnetic core A protrudes, and the cam sleeve operates under rotation of the camshaft; the guide groove face A contacts with the valve core A; the cam sleeve and the camshaft slide in an axial direction under the action of the valve core A; when the guide groove face A passes through the valve core A, a first groove B of the limit device of the camshaft enters a first groove A of the limit device, a second groove B of the limit device of the camshaft enters a second groove of the limit device for limiting; the camshaft enters a first groove A of the limit device for limiting through a first groove B of the limit device, and the high cams and the low cams are switched; and the solenoid valve is deenergized, the valve core A returns to the initial position under the action of the valve core return mechanism A, and thus the cam position is adjusted. In a similar way, the valve core B protrudes, and the camshaft position is adjusted reversely after the solenoid valve is deenergized.

[0023] As shown in Figs. 8 and 9, the camshaft 1 is in fit with the cam sleeve 2 in a polygon mode. An inner pore surface of the cam sleeve 2 is provided with a sleeve fitting surface 10, and an outer surface of the cam shaft 1 is provided with a cam fitting surface 11. The number of sides of the cam shaft 1 in fit with the cam sleeve 2 is an integral multiple of the number of the corresponding engine cylinders. For instance, the number of sides of a three-cylinder engine camshaft in fit with the cam sleeve can be 3, 6, 9, 12, etc.

[0024] All above are only preferred embodiments of the present invention, and not used to limit the scope of the present invention. It shout be pointed out that, all alterations, equivalent replacements and improvements, without departing from the spirit and principle of the present invention, shall fall within the protection scope of the present invention.

Claims

1. A mechanism for adjusting a camshaft of an internal combustion engine, comprising a camshaft (1), a cam sleeve (2) and a solenoid valve (3), **characterized in that** guide boss portions (7) are provided on the cam sleeve (2), valve cores of the solenoid valve (3) are in fit with the guide boss portions (7) to drive the cam sleeve (2) to perform reciprocating movement in an axial direction of the camshaft (1), and an automatic return device is provided on each of the valve cores; and after the solenoid valve (3) is deenergized, the valve core returns to an initial position under the action of the automatic return device.

2. The mechanism for adjusting a camshaft of an internal combustion engine according to claim 1, **characterized in that** a valve core A (12a) and a valve core B (12b) of the solenoid valve (3) are respectively in fit with a side guide groove face A (7a) and a guide groove face B (7b) of each guide boss portion (7), and the valve core A (12a) and the valve core B (12b) are connected with a valve core return mechanism A (13a) and a valve core return mechanism B (13b), respectively.

3. The mechanism for adjusting a camshaft of an internal combustion engine according to claim 2, **characterized in that** the cam sleeve (2) is of an integral structure, and high cams (4) and low cams (5) on the cam sleeve (2) move in an axial direction along with the cam sleeve (2), and are limited axially through limit mechanisms after moving in place.

4. The mechanism for adjusting a camshaft of an internal combustion engine according to claim 2, **characterized in that** the cam sleeve (2) is of a combined structure and comprises the high cams (4), the low cams (5), a sleeve (6) and the guide boss portions (7), and the high cams (4), the low cams (5) and the guide boss portions (7) are fixed on the sleeve (6) by means of riveting or interference press-fitting, move in an axial direction along with the guide boss portions (7), and are axially limited through the limit mechanisms after moving in place.

5. The mechanism for adjusting a camshaft of an internal combustion engine according to claim 2, **characterized in that** the cam sleeve (2) is of a split structure, and comprises the sleeve (6) in the middle, high and low cam sets arranged at both ends of the sleeve (6) and the guide boss portions (7) located at both ends of the cam sleeve (2); and the guide boss portions (7) are respectively in fit with the corresponding valve cores of the solenoid valve, all parts in the cam sleeve (2) of the split structure are propped against each other, and integrally move in an axial direction of the camshaft (1) under the action of the solenoid valve, and the guide boss portions (7) at both ends of the cam sleeve (2) are axially limited by the corresponding limit mechanisms, respectively.

6. The mechanism for adjusting a camshaft of an internal combustion engine according to any of claims 1 to 5, **characterized in that** the camshaft (1) is in fit with the cam sleeve (2) in a polygon mode, and the number of sides of the camshaft (1) in fit with the cam sleeve (2) is an integral multiple of the number of the corresponding engine cylinders.

7. The mechanism for adjusting a camshaft of an internal combustion engine according to claim 6, **characterized in that** the number of sides of the camshaft (1) in fit with the cam sleeve (2) is 3, or 6, or 9, or 12.

8. The mechanism for adjusting a camshaft of an internal combustion engine according to any of claims 1 to 5, **characterized in that** the automatic return devices is of a spring or electromagnet or permanent magnet.

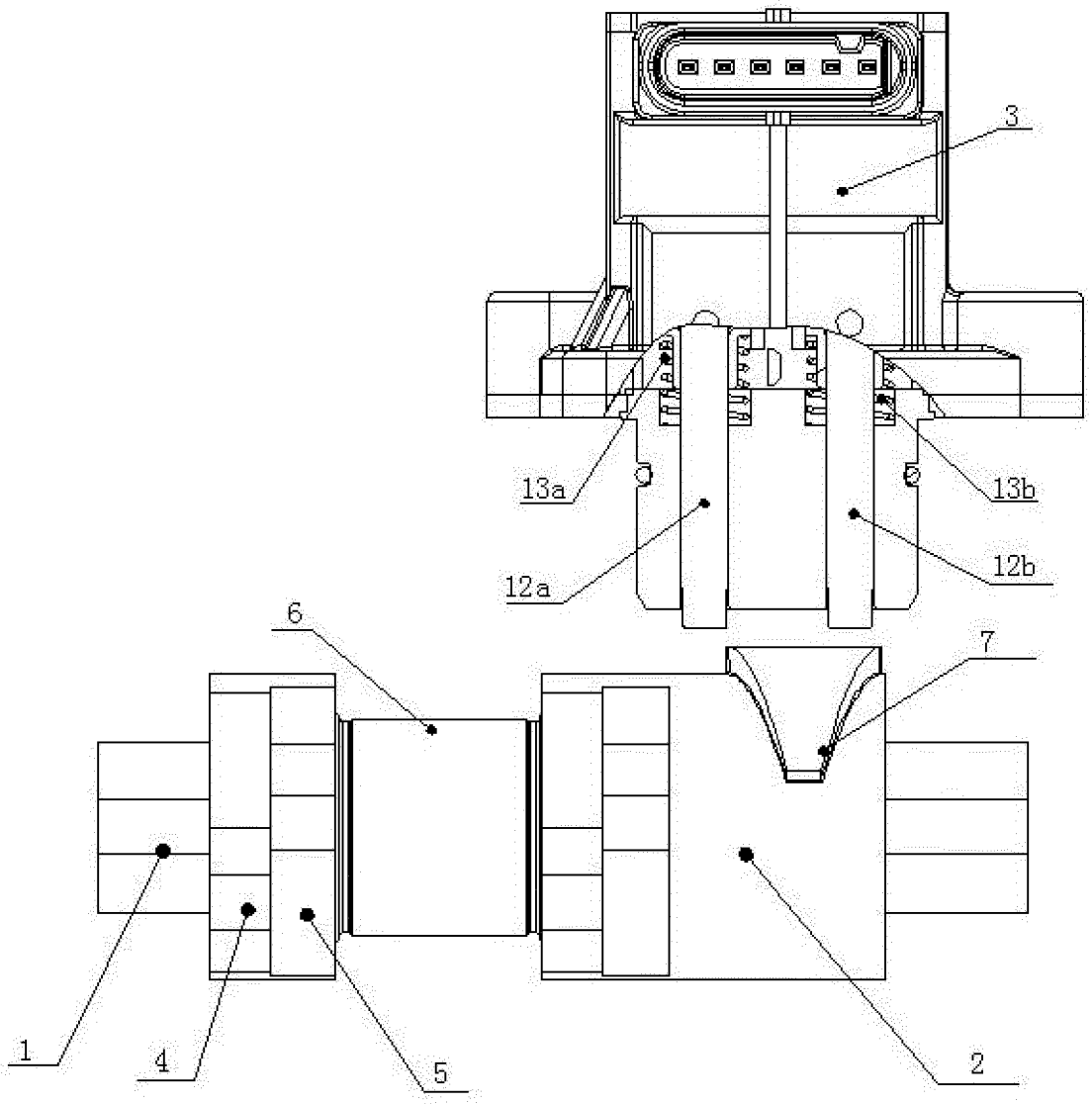

FIG. 1

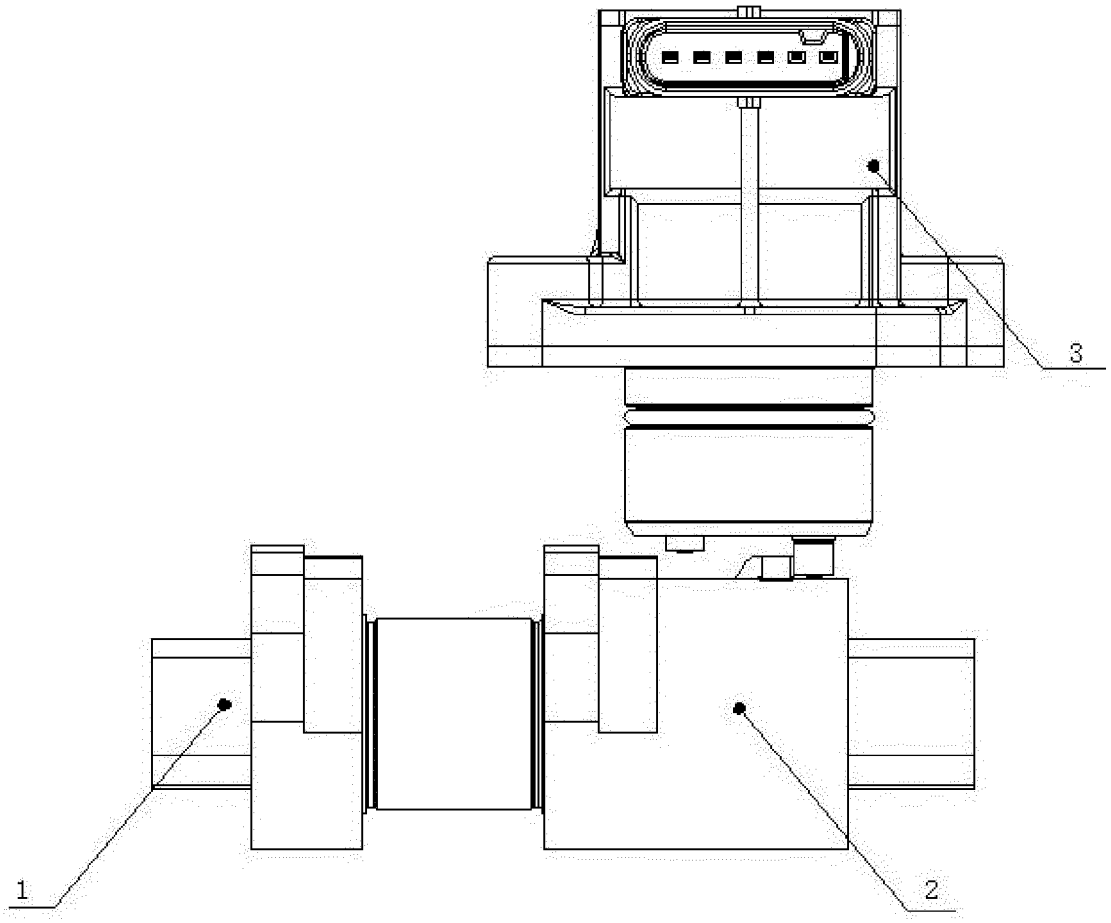

FIG. 2

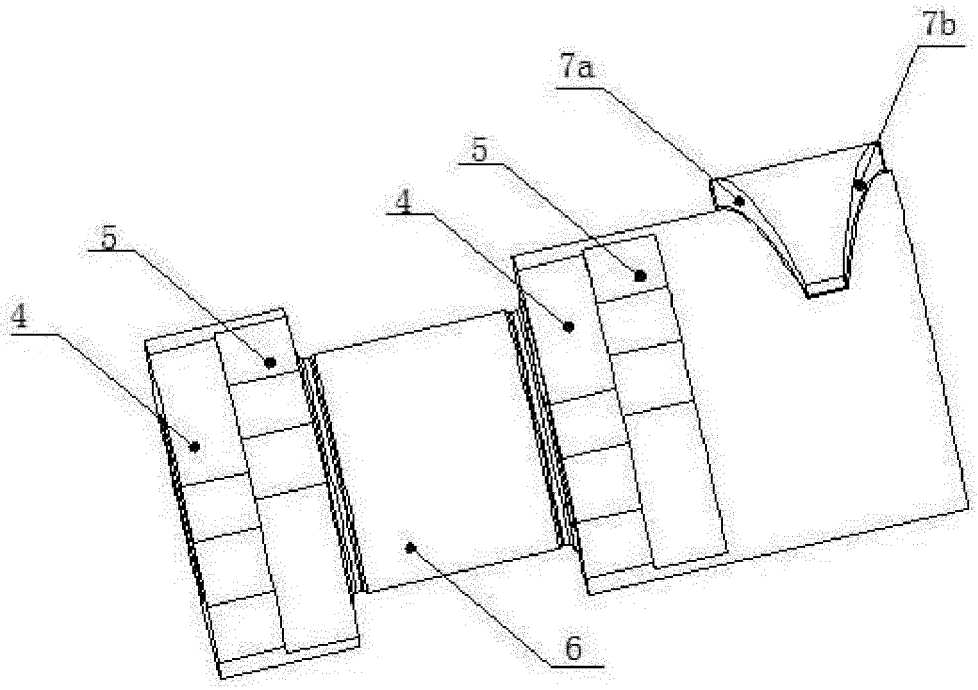

FIG. 3

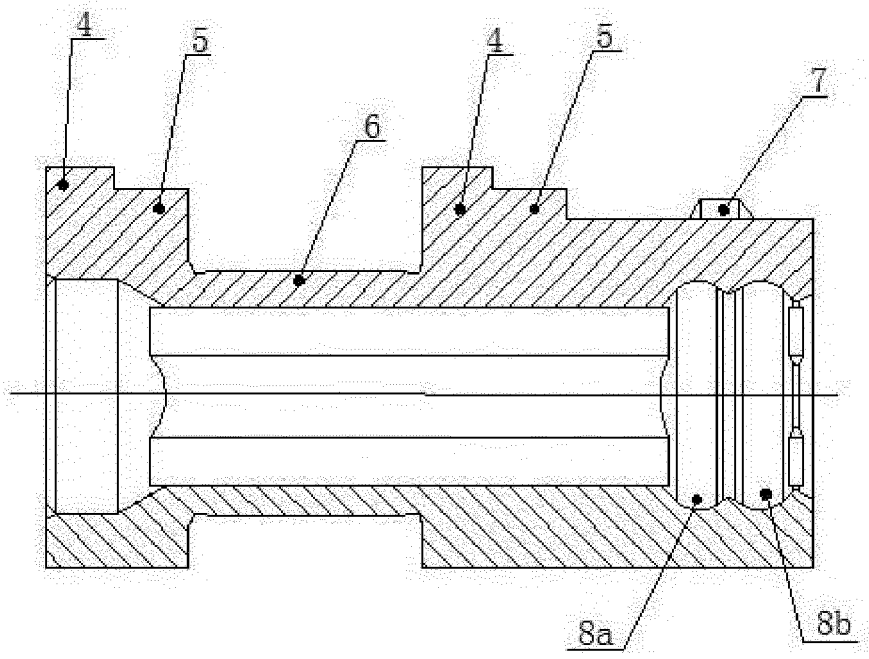

FIG. 4

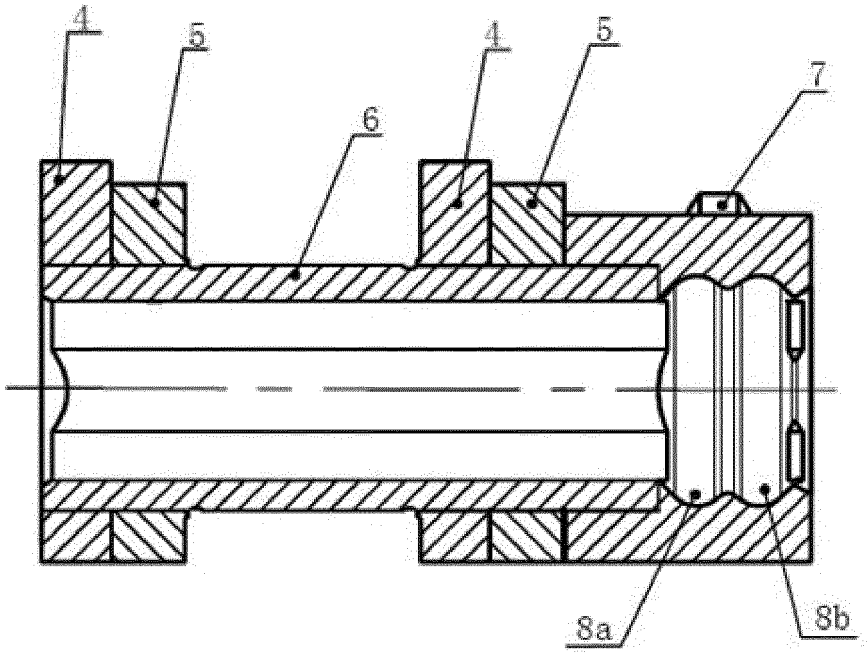

FIG. 5

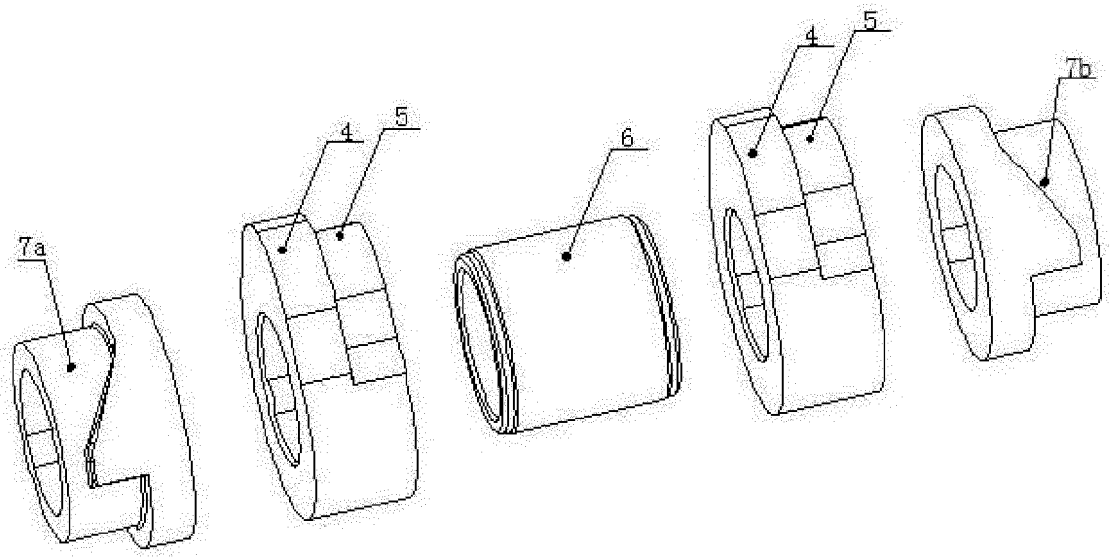

FIG. 6

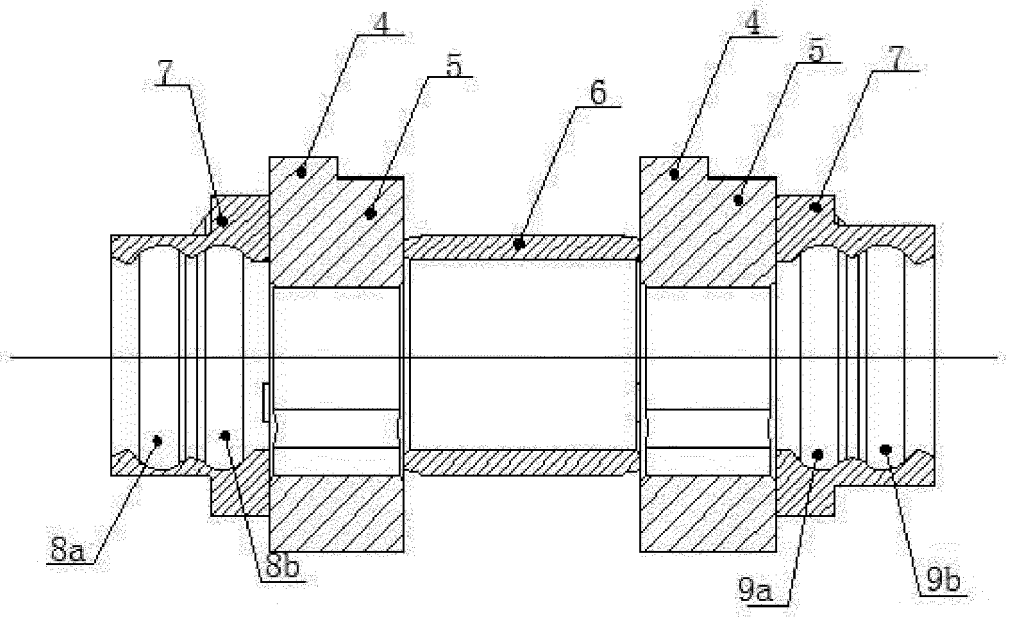

FIG. 7

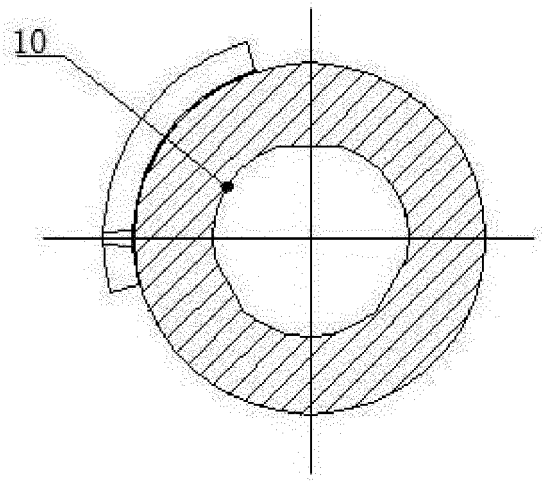

FIG. 8

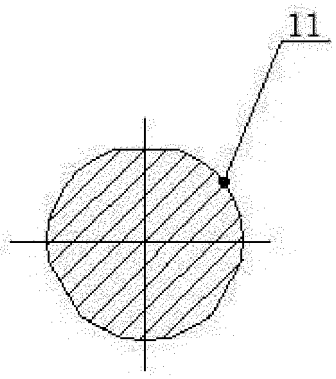

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/123443

A. CLASSIFICATION OF SUBJECT MATTER

F01L 13/00(2006.01)i; F01L 1/047(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)

F01L

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)

CNABS; VEN; CNKI; USTXT; WOTXT; CNTXT; EPTXT: 滑动, 凸轮轴, 衬套, 轴套, 套筒, 回复, 恢复, 凸块, 凸起, 调整, 调节, slid+, shaft, sleeve, bush, revert, convex, hump, adjust

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 108266246 A (MIANYANG FULIN PRECISION MACHINING CO., LTD.) 10 July 2018 (2018-07-10) description, paragraphs [0021]-[0029], and figures 1-9	1-8
X	CN 105247176 A (MAZDA MOTOR CORPORATION) 13 January 2016 (2016-01-13) description, paragraphs [0041]-[0119], and figures 1-23	1-8
A	CN 103237962 A (SCHAEFFLER TECHNOLOGIES AG AND CO. KG) 07 August 2013 (2013-08-07) entire document	1-8
A	DE 10148178 A1 (INA SCHAEFFLER KG) 17 April 2003 (2003-04-17) entire document	1-8

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

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Date of the actual completion of the international search	Date of mailing of the international search report
20 February 2019	**08 March 2019**
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 Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2018/123443

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	108266246	A	10 July 2018	CN	207989094	U	19 October 2018
CN	105247176	A	13 January 2016	CN	105247176	B	27 October 2017
				JP	5850202	B2	03 February 2016
				DE	112014000360	T5	08 October 2015
				JP	WO2014185295	A1	23 February 2017
				US	9441510	B2	13 September 2016
				US	2015330270	A1	19 November 2015
				WO	2014185295	A1	20 November 2014
CN	103237962	A	07 August 2013	US	2013228039	A1	05 September 2013
				DE	102010053359	A1	06 June 2012
				WO	2012072305	A1	07 June 2012
				CN	103237962	B	13 January 2016
DE	10148178	A1	17 April 2003	None			

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