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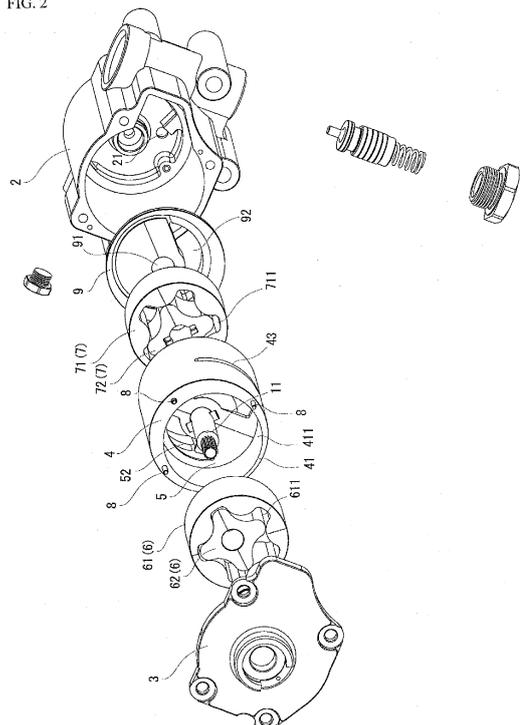
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(54) **MULTISTAGE OIL PUMP**

(57) Conventional multistage oil pumps could not have been used in an application where the pressure and the temperature are high. With a multistage oil pump 1 in the present disclosure, two rotors 6, 7 are connected in series in the direction of the rotation axis. The respective rotors 6, 7 are accommodated in a rotor case 4 separately across a spacer 5, the inside thereof being partitioned by the spacer part 5. The rotor case 4 is in the form of an integral cylindrical part, and the spacer 5 is integral with the rotor case 4. The rotors 6, 7 and the rotor case 4 are made of a ferrous material, and the rotor case 4 is fixed to a housing 2 by positioning pins.

FIG. 2



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Description

Brief Description of the Drawings

Technical Field

[0010]

[0001] The present invention relates to a multistage oil pump which is used particularly for automobiles, and the like.

5 Figure 1 is a perspective view of a multistage oil pump in one embodiment of the present invention; Figure 2 is an exploded perspective view of the multistage oil pump in Figure 1 when viewed from the cover side;

Background Art

10 Figure 3 is an exploded perspective view of the multistage oil pump in Figure 1 when viewed from the housing side;

[0002] Conventionally, there have been proposed multistage oil pumps in which a plurality of rotors are connected in series (for example, refer to Patent Document 1). As shown in Figure 1 in Patent Document 1, trochoid pumps (rotors) 4, 5 are directly accommodated in a housing main body 1 which is bottomed and cylindrical.

Figure 4 is a sectional view taken in the direction of the arrows of the line A-A in Figure 1; and

[0003] Patent Document 1: Japanese Patent Application Laid-open No. 2006-161614

15 Figure 5 is another sectional view taken in the direction of the arrows of the line A-A in Figure 1.

Disclosure of the Invention

Best Mode for Carrying Out the Invention

Problems to be Solved by the Invention

20 **[0011]** Hereinbelow, with reference to the drawings, the best mode for carrying out the present invention will be explained.

[0004] However, with the above-mentioned structure, the trochoid pumps are not cased, and therefore the multistage oil pump disclosed in Patent Document 1 could not have been used in an application where the pressure or the temperature is high.

[0012] A multistage oil pump 1 includes a housing 2; a cover 3, which closes the housing 2; a rotor case 4, which is accommodated in the housing 2; and first and second rotors 6, 7, which are accommodated in the rotor case 4, being connected in series.

[0005] It is an object of the present invention to provide a multistage oil pump which can solve the above-mentioned problem.

25 **[0013]** The housing 2 is bottomed and cylindrical, having a pump discharge port 21. The rotor case 4 is in the form of an integral cylindrical part, and the central part in the longitudinal direction thereof is partitioned by a spacer 5. The rotor case 4 provides a first rotor case 41 on one end side and a second rotor case 42 on the other end side, being partitioned by the spacer 5. From the one face and the other face of the rotor case 4, positioning pins 8 are protruded, respectively. In a side face of the rotor case 4, a first rotor suction port 43 is provided.

Means for Solving the Problems

[0006] In order to solve such a problem, the multistage oil pump of the present invention is a multistage oil pump, two rotors being connected in series in the direction of the rotation axis, the respective rotors being accommodated in a rotor case separately across a spacer, the inside thereof being partitioned by the spacer part, the rotor case being in the form of an integral cylindrical part, and the spacer part being integral with the rotor case.

30 **[0014]** In the first rotor case 41, the first rotor 6 is accommodated, while, in the second rotor case 42, the second rotor 7 is accommodated. In the first rotor case 41, a circular first rotor accommodating bore 411, the axis of which is made eccentric with respect to the first rotor case 41, is formed. In the second rotor case 42, a circular second rotor accommodating bore 421, the axis of which is made eccentric with respect to the second rotor case 42, is formed. The first rotor case 41 and the second rotor case 42 are provided, the axis of the first rotor accommodating bore 411 and that of the second rotor accommodating bore 421 being offset from each other.

[0007] Further, the present invention features that the rotors and the rotor case are made of a ferrous material.

[0008] Further, the present invention features that the rotor case is fixed to a housing by positioning pins.

35 **[0015]** The spacer 5 is formed of a ferrous material. As the ferrous material, specifically, an iron-copper-carbon based material, SMF4030 (JPMA standard), or the like, can be used.

Advantages of the Invention

[0009] In accordance with the present invention, the rotors are not accommodated directly in the housing, but the rotors are accommodated in the rotor case, the rotor case being accommodated in the housing, whereby the multistage oil pump of the present invention can also be used in an application where the pressure and the temperature are high.

40 **[0016]** The spacer 5 is provided with an insertion hole 51 for the drive shaft 11, a first rotor discharge port 52, and a second rotor suction port 53. The first rotor discharge port 52 is formed in one face of the spacer 5, while the second rotor suction port 53 being formed in

the other face of the spacer 5, the first rotor discharge port 52 and the second rotor suction port 53 being communicated to each other.

[0017] Between the second rotor case 42 and the housing 2, a side plate 9 is disposed. With the side plate 9, an insertion hole 91 for the drive shaft 11, and a second rotor discharge port 92 are provided in a disk, which has the same outside diameter as that of the rotor case 4.

[0018] The positioning pins 8, which are protruded from the one face of the rotor case 4, are fitted to the housing 2, thereby jointing the rotor case 4 to the housing 2 as shown in Figure 4 or 5. The positioning pins 8, which are protruded from the other face of the rotor case 4, are fitted to the cover 3, thereby jointing the rotor case 4 to the cover 3.

[0019] With the first rotor 6, a first inner rotor 62 is disposed inside of a first outer rotor 61, the first rotor 6 being formed of a ferrous material. As the ferrous material, specifically, an iron-copper-carbon based material, SMF4030 (JPMA standard), or the like, can be used. With the first outer rotor 61, an oil filling hole 611 is provided in a disk, which has an outside diameter substantially equal to the inside diameter of the first rotor accommodating bore 411, the first outer rotor 61 being rotatably disposed in the first rotor accommodating bore 411. The oil filling hole 611 is provided, the axis thereof being aligned to the axis of the first outer rotor 61.

[0020] Between the first outer rotor 61 and the first inner rotor 62, there are formed four oil accommodating chambers which are partitioned by the inner peripheral part of the oil filling hole 611, the outer peripheral part of the first inner rotor 62, the spacer 5, and the cover 3.

[0021] The first inner rotor 62 is fixed to the drive shaft 11, being disposed in the first outer rotor 61 with the axis of the drive shaft 11 being aligned to the axis of the first rotor case 41.

[0022] With the second rotor 7, the second inner rotor 72 is disposed inside of the second outer rotor 71. With the second outer rotor 71, an oil filling hole 711 is provided in a disk, which has the same shape as that of the first outer rotor 61, the second outer rotor 71 being rotatably disposed in the second rotor accommodating bore 421. The second inner rotor 72 has the same shape as that of the first inner rotor 62, being disposed in the second outer rotor 71 with the axis of the drive shaft 11 being aligned to the axis of the second rotor case 42.

[0023] Between the second outer rotor 71 and the second inner rotor 72, there are formed four oil accommodating chambers which are partitioned by the inner peripheral part of the oil filling hole 711, the outer peripheral part of the second inner rotor 72, and the side plate 9.

[0024] Next, the operation of the multistage oil pump 1 will be explained.

[0025] Let's assume that, to the respective oil accommodating chambers in the first rotor 6, oil has already been supplied from the first rotor suction port 43. When the drive shaft 11 is rotated, the first outer rotor 61 is rotated by the first inner rotor 62 in the direction of rotation

of the drive shaft 11, the respective oil accommodating chambers being also moved around the drive shaft 11. The respective oil accommodating chambers increase their volumes as they are moved away from the drive shaft 11, sucking the oil from the first rotor suction port 43 by the amount equal to the respective volumes increased. Further, the respective oil accommodating chambers decrease their volumes as they approaches the drive shaft 11, discharging the oil from the first rotor discharge port 52 by the amount equal to the respective volumes decreased.

[0026] Let's assume that, to the respective oil accommodating chambers of the second outer rotor 71, oil has already been supplied from the second rotor suction port 53. When the drive shaft 11 is rotated, the second outer rotor 71 is rotated by the second inner rotor 72 in the direction of rotation of the drive shaft 11, the respective oil accommodating chambers being also moved around the drive shaft 11. The respective oil accommodating chambers increase their volumes as they are moved away from the drive shaft 11, sucking the oil from the second rotor suction port 53 by the amount equal to the respective volumes increased. Further, the respective oil accommodating chambers decrease their volumes as they approach the drive shaft 11, discharging the oil from the oil discharge port 92 by the amount equal to the respective volumes decreased.

[0027] The oil discharged from the first rotor discharge port 52 by the respective oil accommodating chambers of the first rotor 6 is sucked from the second rotor suction port 53 into the respective oil accommodating chambers of the second rotor 7. The first rotor accommodating bore 411 is offset with respect to the second rotor accommodating bore 421, and therefore, as the respective oil accommodating chambers of the first rotor 6 increase their volumes, the respective oil accommodating chambers of the second rotor 7 decrease their volumes. Thus, the oil discharged from the first rotor discharge port 52 is sucked from the second rotor suction port 53 in its entirety by the respective oil accommodating chambers of the second rotor 7 that are increasing their volumes.

[0028] According to the present embodiment, the rotors 6, 7 are not accommodated directly in the housing 2, but the rotors 6, 7 are accommodated in the rotor case 4, the rotor case 4 being accommodated in the housing 2, whereby the multistage oil pump of the present invention can also be used in an application where the pressure and the temperature are high.

[0029] Further, according to the present embodiment, the rotors 6, 7 and the rotor case 4 are made of a ferrous material, whereby the thermal expansion can be suppressed for providing an improved accuracy of oil flow rate.

[0030] In the above-described embodiment, the application where the rotors 6, 7 and the rotor case 4 are formed of a ferrous material has been explained, however, only either of the rotors 6, 7 and the rotor case 4 may be formed of a ferrous material. Further, the method

of jointing the rotor case 4 is optional, and is not limited to that which uses the positioning pins 8.

[0031] Further, in the above-described embodiment, the application where the oil is supplied from the spacer 5 side in the rotor case 4 to the respective oil accommodating chambers in the first outer rotor 61 has been explained, however, there may be a configuration in which the oil is supplied from the cover 3 side. Further, there may be a configuration in which the oil is supplied to the respective oil accommodating chambers from the cover 3 through the housing 2.

Description of Symbols

[0032] The symbol 1 denotes a multistage oil pump; 11 a drive shaft; 12 a sealing material; 2 a housing; 21 a pump discharge port; 22 a fitting hole; 3 a cover; 31 a fitting hole; 4 a rotor case; 41 a first rotor case; 411 a first rotor accommodating bore; 412 a fitting hole; 42 a second rotor case; 421 a second rotor accommodating bore; 422 a fitting hole; 43 a first rotor suction port; 5 a spacer; 51 an insertion hole; 52 a first rotor discharge port; 53 a second rotor suction port; 6 a first rotor; 61 a first outer rotor; 611 an oil filling hole; 62 a first inner rotor; 7 a second rotor; 71 a second outer rotor; 711 an oil filling hole; 72 a second inner rotor; 8 a positioning pin; 9 a side plate; 91 an insertion hole; 92 a second rotor discharge port; and 94 a fitting hole.

Claims

1. A multistage oil pump, two rotors being connected in series in the direction of the rotation axis, said respective rotors being accommodated in a rotor case separately across a spacer, the inside thereof being partitioned by the spacer part, said rotor case being in the form of an integral cylindrical part, and said spacer part being integral with said rotor case.
2. The multistage oil pump according to Claim 1, wherein said rotors and said rotor case are made of a ferrous material.
3. The multistage oil pump according to Claim 1 or 2, wherein said rotor case is fixed to a housing by positioning pins.

FIG. 1

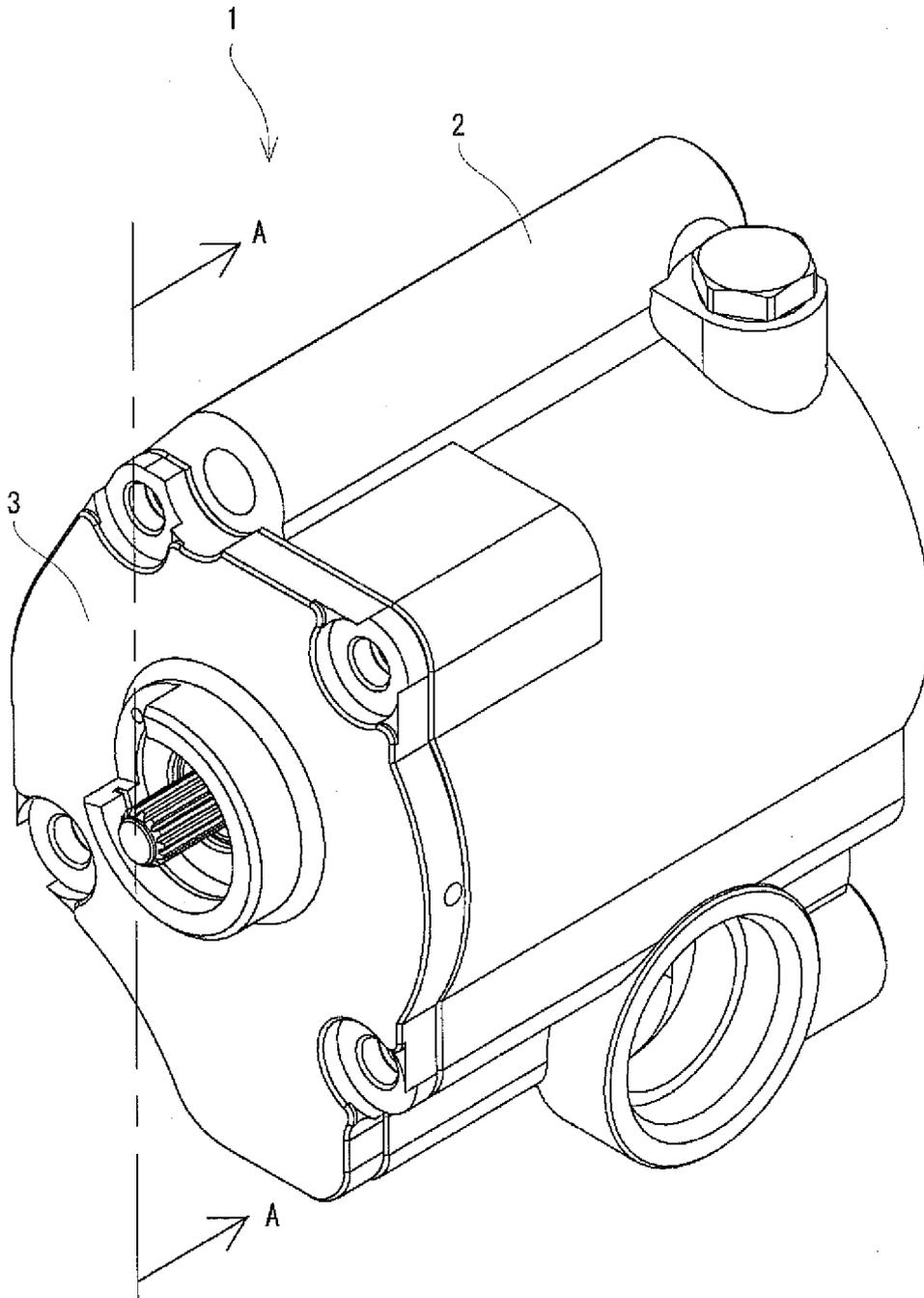


FIG. 2

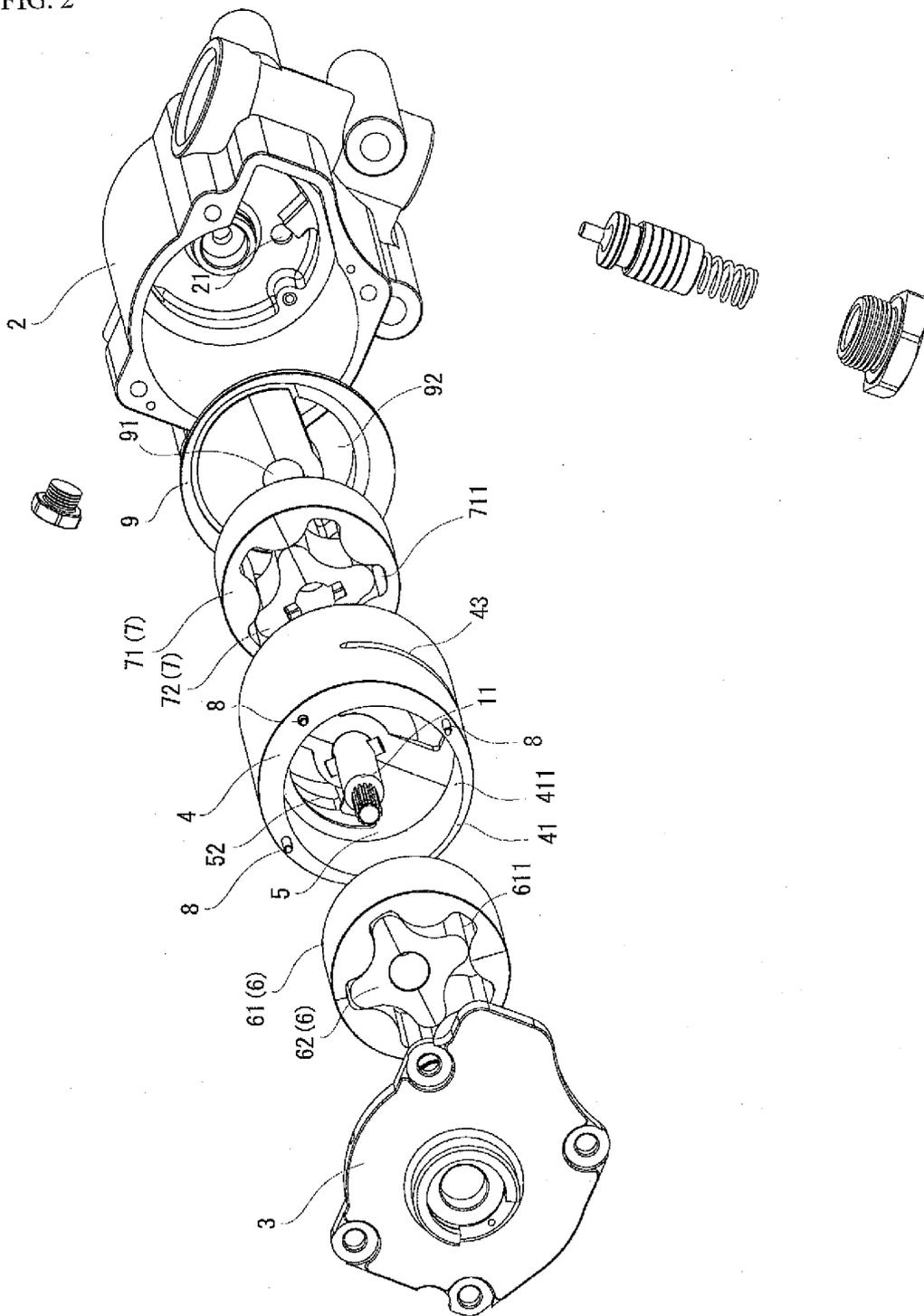


FIG. 3

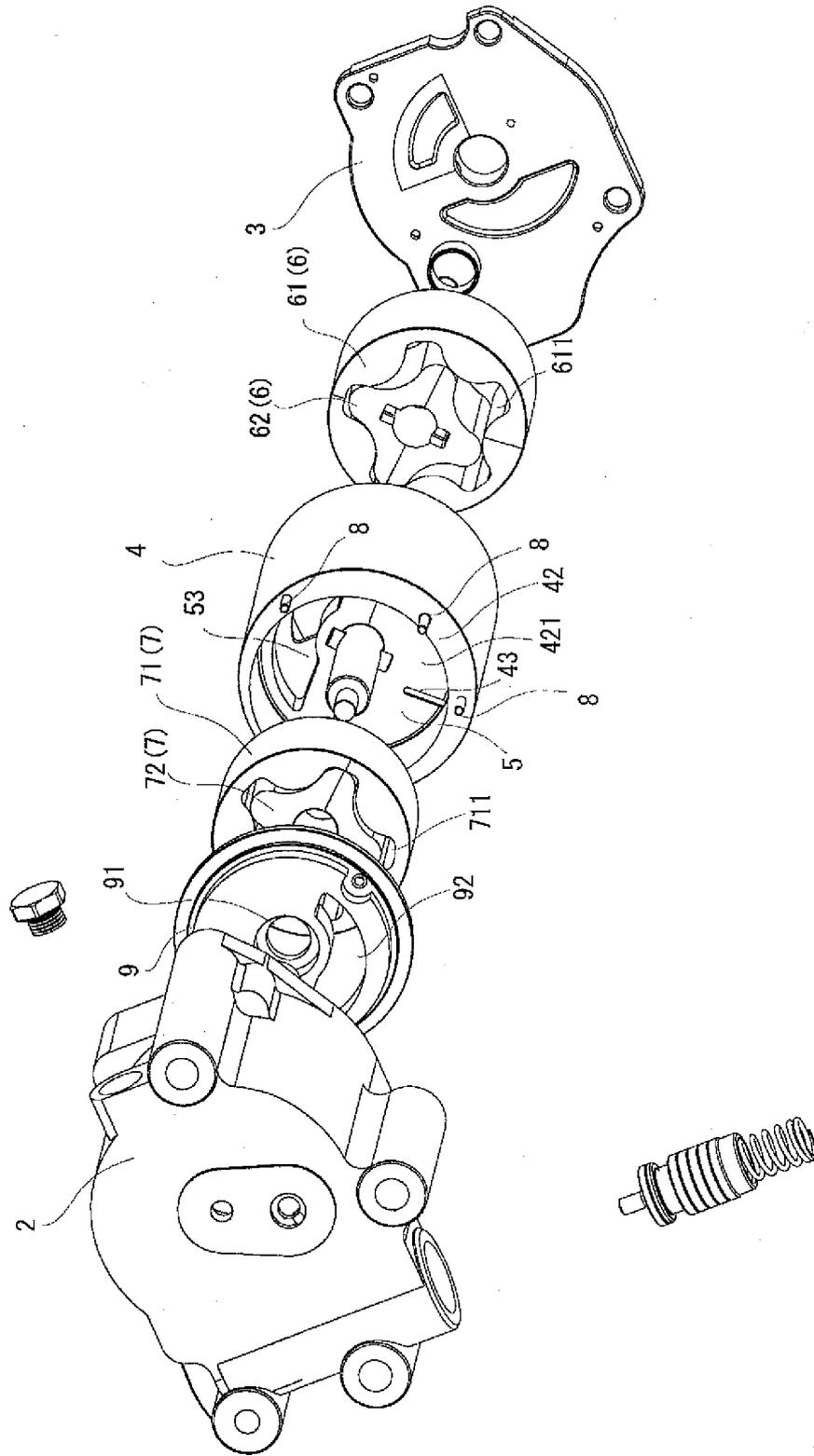


FIG. 4

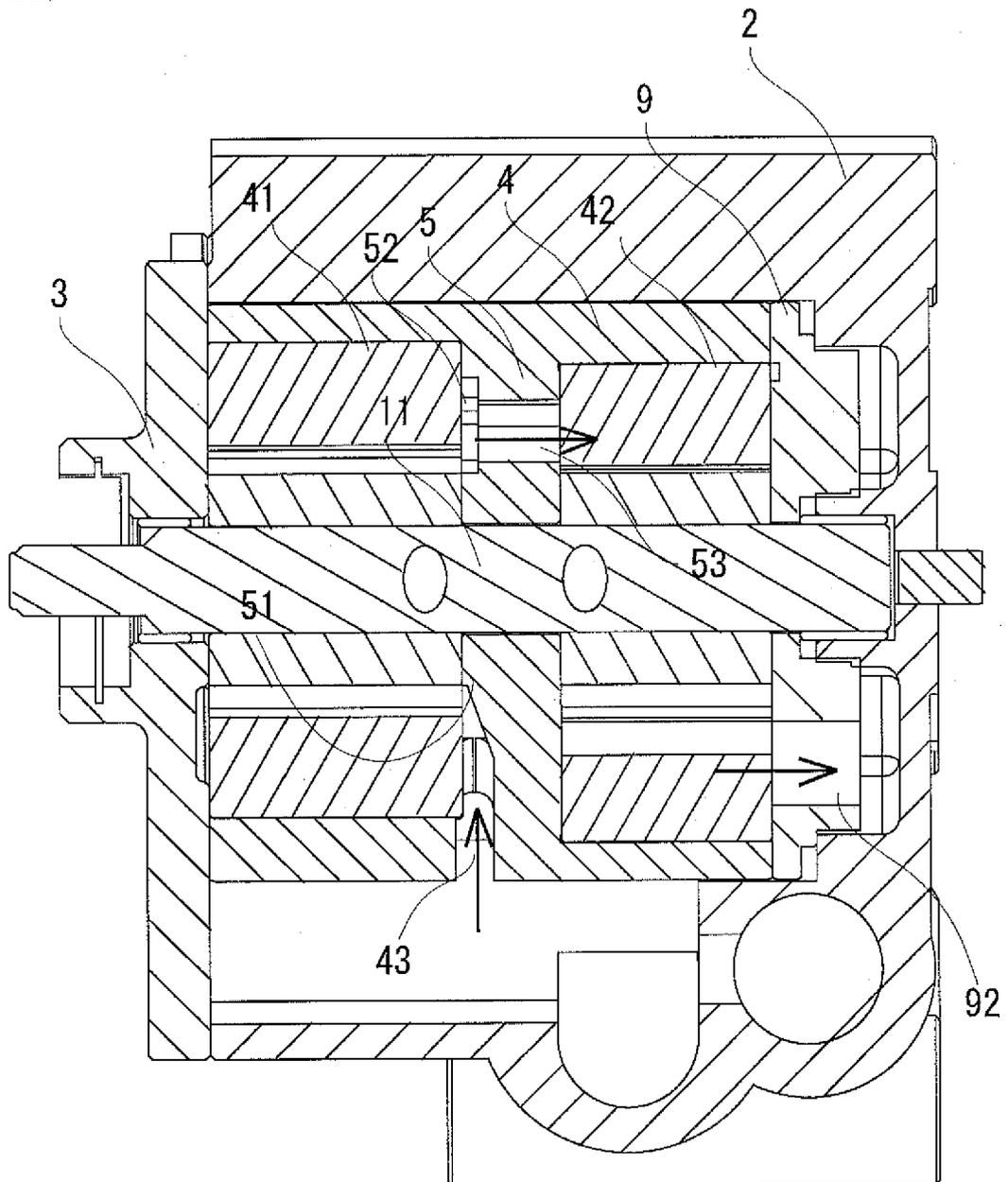
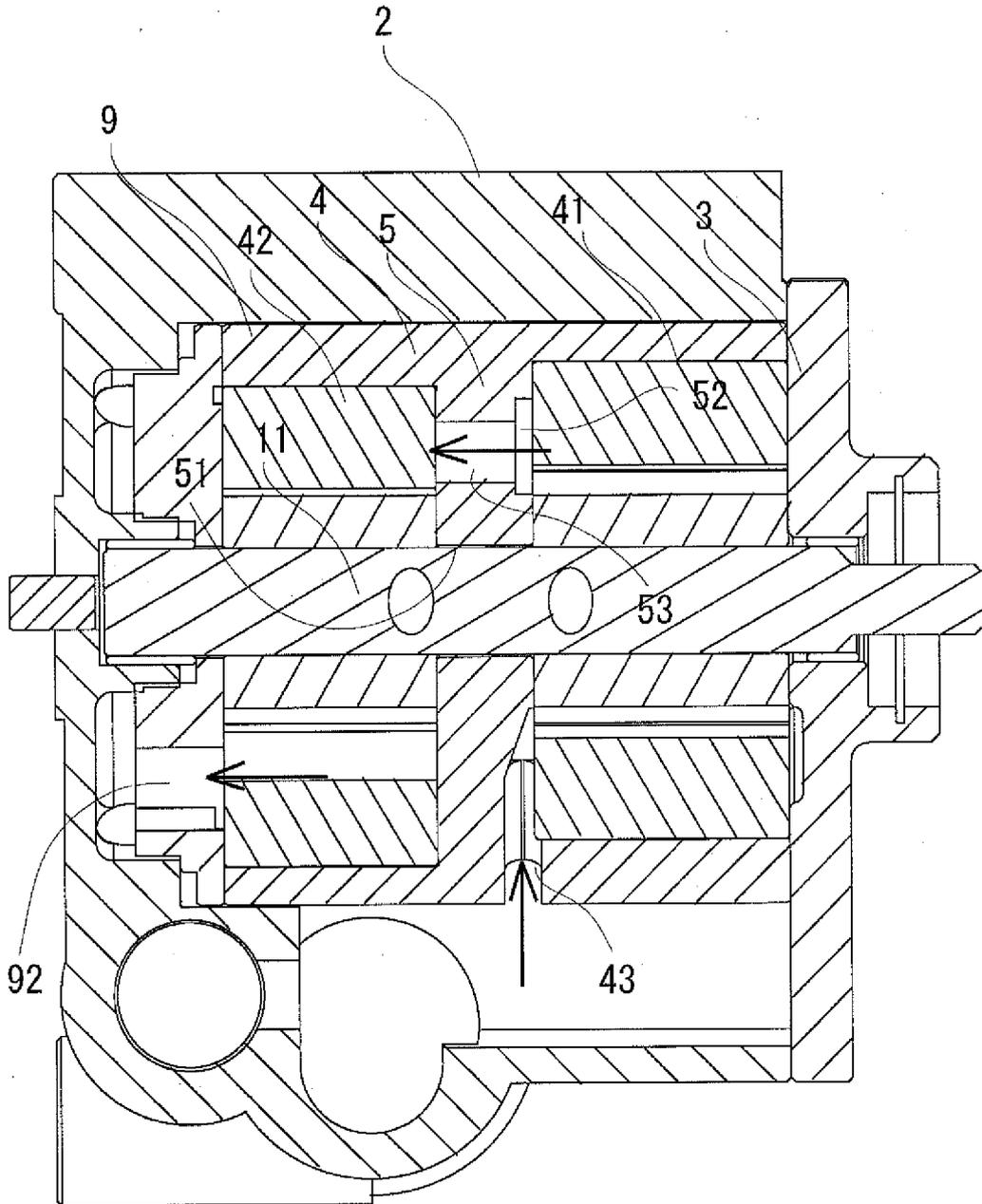


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/063651

5	A. CLASSIFICATION OF SUBJECT MATTER F04C15/00(2006.01)i, F04C2/10(2006.01)i, F04C11/00(2006.01)i	
	According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED	
	Minimum documentation searched (classification system followed by classification symbols) F04C15/00, F04C2/10, F04C11/00	
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013 Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013	
	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)	
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
	Category*	Citation of document, with indication, where appropriate, of the relevant passages
25	Y	JP 11-22656 A (Matsushita Electric Industrial Co., Ltd.), 26 January 1999 (26.01.1999), paragraphs [0039] to [0041]; fig. 1 to 4 (Family: none)
30	Y	JP 2011-132807 A (Hitachi Automotive Systems, Ltd.), 07 July 2011 (07.07.2011), page 6, line 6; fig. 7 (Family: none)
35	Y	JP 2010-526962 A (Robert Bosch GmbH), 05 August 2010 (05.08.2010), fig. 1 to 2 & WO 2008/138656 A1 & DE 102007022215 A1
40	<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.	
45	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "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) "O" document referring to an oral disclosure, use, exhibition or other means "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
50	Date of the actual completion of the international search 12 July, 2013 (12.07.13)	Date of mailing of the international search report 23 July, 2013 (23.07.13)
55	Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
	Facsimile No.	Telephone No.

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2013/063651
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C (Continuation). 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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Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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