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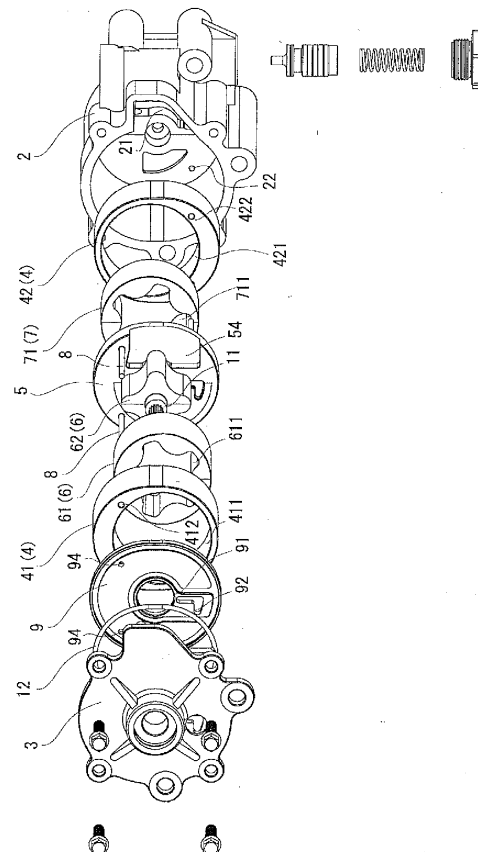
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(54) **MULTISTAGE OIL PUMP**

(57) With conventional multistage oil pumps, all the components are formed of a ferrous material, and thus there have been presented a problem that the weight is large. With a multistage oil pump 1, rotors 6, 7 are connected in series. With a rotor case 2, a first rotor case 41 and a second rotor case 42 are connected in the axial direction, and the inside thereof is partitioned by a spacer 5. The first rotor case 41 and the second rotor case 42 are jointed to the spacer 5 with dowel pins 8. The rotors 6, 7 are formed of a ferrous material, while the spacer 5 being formed of an aluminum-based material.

FIG. 3



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 a front view of the multistage oil pump in Figure 1;

Background Art

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

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

15 Figure 5 is an exploded perspective view of the multistage oil pump in Figure 1 when viewed from the cover side;

Disclosure of the Invention

20 Figure 6 is an exploded perspective view of the multistage oil pump in Figure 1 when viewed from the housing side;

Problems to be Solved by the Invention

Figure 7 is a sectional view taken in the direction of the arrows of the line A-A in Figure 2; and

Figure 8 is a figure showing the flow of oil in the multistage oil pump.

[0004] However, with the above-mentioned structure, all the components are formed of a ferrous material, therefore the multistage oil pump disclosed in Patent Document 1 has presented a problem that the weight is large.

Best Mode for Carrying Out the Invention

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

25 **[0011]** Hereinbelow, with reference to the drawings, the best mode for carrying out the present invention will be explained.

Means for Solving the Problem

30 **[0012]** As shown in Figures 1 to 6, 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.

[0006] In order to solve such a problem, the multistage oil pump of the present invention is a multistage oil pump, a plurality of rotors being connected in series in the direction of the rotation axis, the plurality of rotors being accommodated in a rotor case, the inside thereof being partitioned by a spacer, the rotor case being divided into rotor case units in the axial direction, and the spacer being made of a material having a specific gravity smaller than that for the rotor.

35 **[0013]** The housing 2 is bottomed and cylindrical, having a pump discharge port 21 and fitting holes 22. In the cover 3, fitting holes 31 are formed. The rotor case 4 is divided into a first rotor case 41 and a second rotor case 42 in the axial direction, the first rotor case 41 and the second rotor case 42 being partitioned with a spacer 5.

[0007] Further, the present invention features that the rotor is made of a ferrous material, while the spacer being made of an aluminum-based material.

40 **[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, and fitting holes 412 are 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, and fitting holes 422 are formed. The first rotor case 41 and the second rotor case 42 are disposed in the housing 2, the axis of the first rotor accommodating bore 411 and that of the second rotor accommodating bore 421 being offset from each other.

[0008] Further, the present invention features that, with the rotor case, the spacer is interposed between the rotor case units, the spacer and the respective rotor case units being jointed to each other by dowel pins.

45 **[0015]** With the spacer 5, an insertion hole 51 for the drive shaft 11, a first rotor discharge port 52, a second rotor suction port 53, and a first rotor suction port 54 are provided in a disk which has the same outside diameter

Advantages of the Invention

[0009] In accordance with the present invention, the spacer is made of a material which has a specific gravity smaller than that for the rotor, whereby weight reduction can be achieved.

as that of the first rotor case 41 and that of the second rotor case 42. 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. From the one face and the other face of the spacer 5, dowel pins 8 are protruded, respectively. The dowel pin 8 is formed of SUJ (a high carbon bearing steel).

[0016] The spacer 5 is formed of an aluminum-based material which has a specific gravity smaller than that for the first and second rotors 6, 7. As the aluminum-based material, specifically, ADC12, ADC10 and ADC14 (for die casting), AC2A and AC4B (for sand mold casting), A2014, A2017, and the like, can be used.

[0017] Between the first rotor case 41 and the cover 3, a side plate 9 and a sealing material 12 are disposed in this order from the side of the first rotor case 41. With the side plate 9, an insertion hole 91 for the drive shaft 11, a purging port 92, and fitting holes 94 are provided in a disk which has the same outside diameter with that of the first rotor case 41. The sealing material 12 seals between the cover 3 and the side plate 9.

[0018] The dowel pins 8, which are protruded from the one face of the spacer 5, are fitted to the fitting holes 422 in the second rotor case 42 and the fitting holes 22 in the housing 2, thereby jointing the second rotor case 42 and the housing 2 to the spacer 5 as shown in Figure 7. The dowel pins 8, which are protruded from the other face of the spacer 5, are fitted to the fitting holes 412 in the first rotor case 41, the fitting holes 94 in the side plate 9, and the fitting holes 31 in the cover 3, thereby jointing the first rotor case 41, the side plate 9, and the cover 3 to the spacer 5.

[0019] With the first rotor 6, a first inner rotor 62 is provided in the 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 bore 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 bore 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 bore 611, the outer peripheral part of the first inner rotor 62, the spacer 5, and the side plate 9.

[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 in the inside of the second outer rotor 71. With the second outer rotor 71, an oil filling bore 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 bore 711, the outer peripheral part of the second inner rotor 72, the spacer 5, and the housing 2.

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

[0025] First, the drive shaft 11 is inserted into the spacer 5 and positioned with a pin; the inner rotor is assembled to the drive shaft 11; and to the inner rotors 62, 72, the outer rotors 61, 71 are fitted, respectively. Then, the dowel pins 8 are mounted to the spacer 5; to the one face and the other face of the spacer 5, the rotor cases 41, 42 are assembled, respectively; and further, to the first rotor case 41, the side plate 9 is assembled. After thus making temporal assembling, the assembly is accommodated in the housing 2, and the cover 3 is mounted to the housing 2.

[0026] Next, the operation of the multistage oil pump 1 will be explained.

[0027] Let's assume that, as shown in Figure 8, to the oil accommodating chambers in the first rotor 6, oil has already been supplied from the first rotor suction port 54. 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 54 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 purging port 92 and the first rotor discharge port 52 by the amount equal to the respective volumes decreased.

[0028] 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 approaches the drive shaft 11, discharging the oil

from the oil discharge port 21 by the amount equal to the respective volumes decreased.

[0029] The oil which has been discharged by the respective oil accommodating chambers of the first rotor 6 from the first rotor discharge port 52 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 which has been 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.

[0030] According to the present embodiment, the spacer 5 is made of a material which has a specific gravity smaller than that for the rotor 6, 7, whereby weight reduction can be achieved.

[0031] Further, according to the present embodiment, the rotors 6, 7 are made of a ferrous material, and the spacer 5 is of an aluminum-based material, whereby occurrence of a seizure between any of the rotors 6, 7 and the spacer 5 can be suppressed.

[0032] In the above-described embodiment, the application where the spacer 5 is made of an aluminum-based material has been explained, however, the spacer 5 may be made of a magnesium-based material. Further, the method of jointing the spacer 5 with the rotor case 41, 42 by means of the dowel pins 8 is optional, and for example, there may be provided a configuration in which rotation stoppage between the rotor case 41, 42 and the spacer 5 is performed by making the outside diameter of the spacer 5 smaller than the outside diameter of the rotor case 41, 42, providing the inner peripheral part of the rotor case 41, 42 with a shoulder which is fitted to the outer peripheral part of the spacer 5, and fitting pins, such as the dowel pins 8, into the fitting parts of both from the outside of the rotor case 41, 42.

[0033] Further, in the above-described embodiment, the application where the oil is supplied from the side of the spacer 5 at the side of the rotor case 4 to the oil accommodating chamber in the first outer rotor 61 has been explained, however, there may be provided a configuration in which the oil is supplied from the side of the cover 3. Further, there may be a configuration in which the oil is supplied to the oil accommodating chamber from the cover 3 through the housing 2.

Description of Symbols

[0034] 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; 5 a spacer; 51 an insertion hole; 52 a first rotor discharge port; 53 a second rotor suction port; 54 a first rotor suction port; 6 a first rotor; 61 a first outer rotor; 611 an oil filling bore; 62 a first inner rotor; 7 a second rotor; 71 a second outer rotor; 711 an oil filling bore; 72 a second inner rotor; 8 a dowel pin; 9 a side plate; 91 an insertion hole; 92 a purging port; and 94 a fitting hole.

Claims

1. A multistage oil pump, a plurality of rotors being connected in series in the direction of the rotation axis, said plurality of rotors being accommodated in a rotor case, the inside thereof being partitioned by a spacer, the rotor case being divided in the axial direction, and said spacer being made of a material having a specific gravity smaller than that for the rotor.
2. The multistage oil pump according to Claim 1, wherein said rotors are made of a ferrous material, while said spacer being made of an aluminum-based material.
3. The multistage oil pump according to Claim 1 or 2, wherein, with said rotor case, said spacer is interposed between rotor case units, the spacer and said respective rotor case units being jointed to each other by dowel pins.

FIG. 1

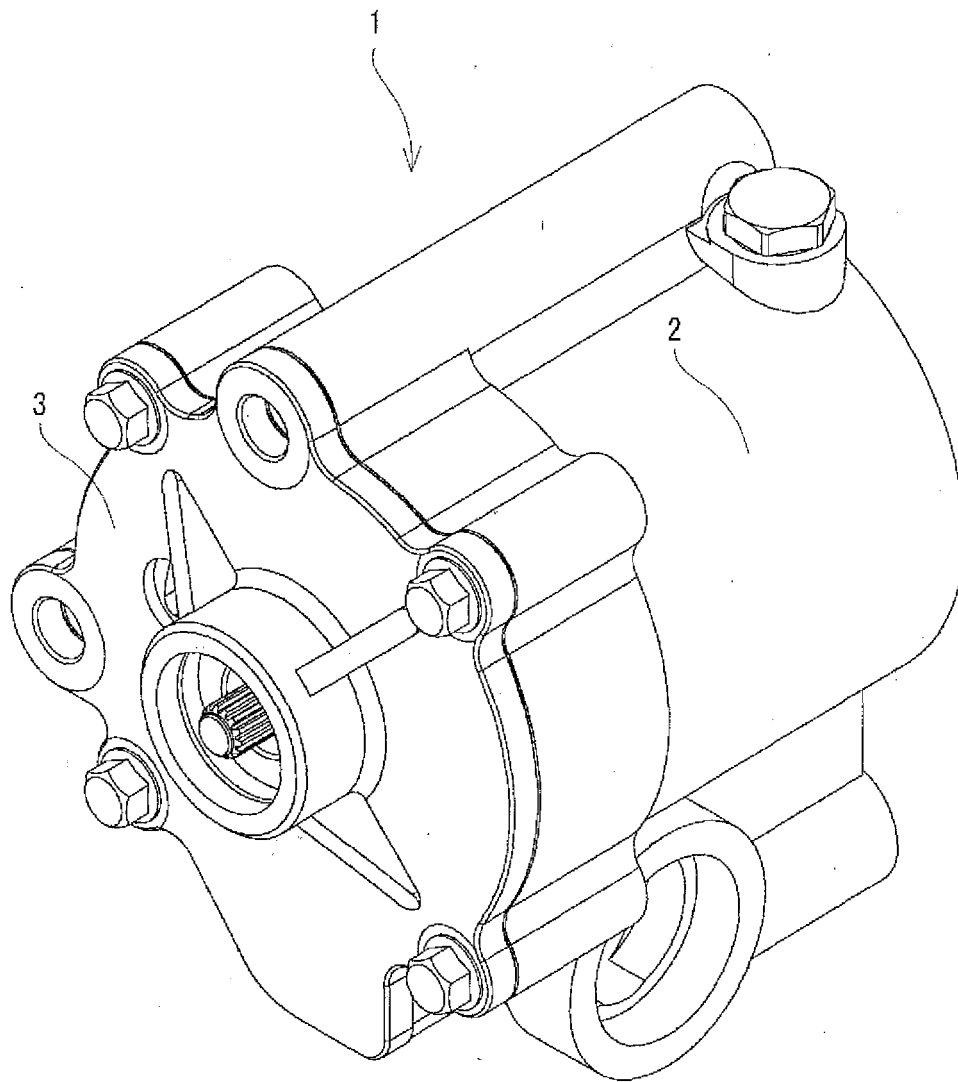


FIG. 2

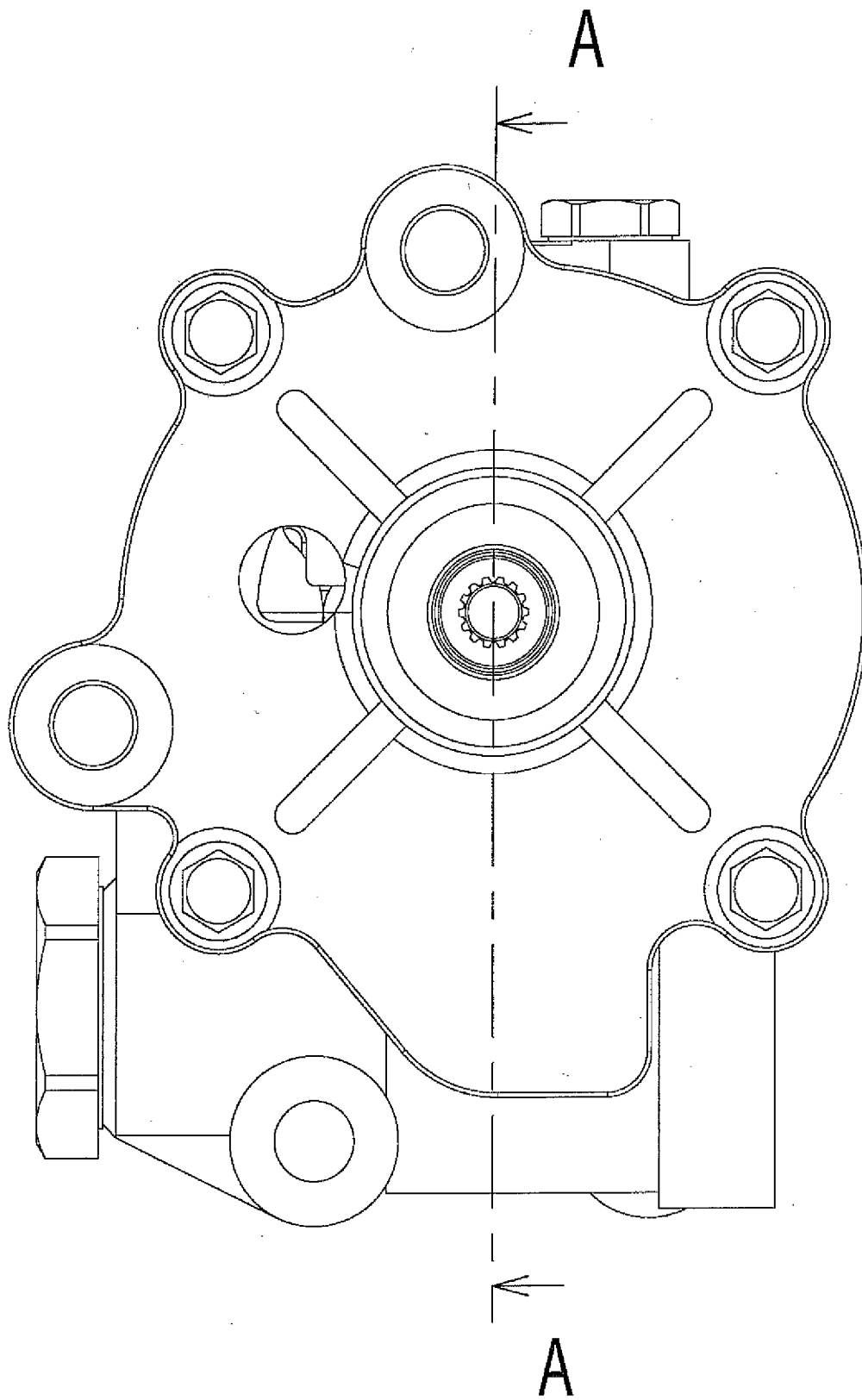


FIG. 3

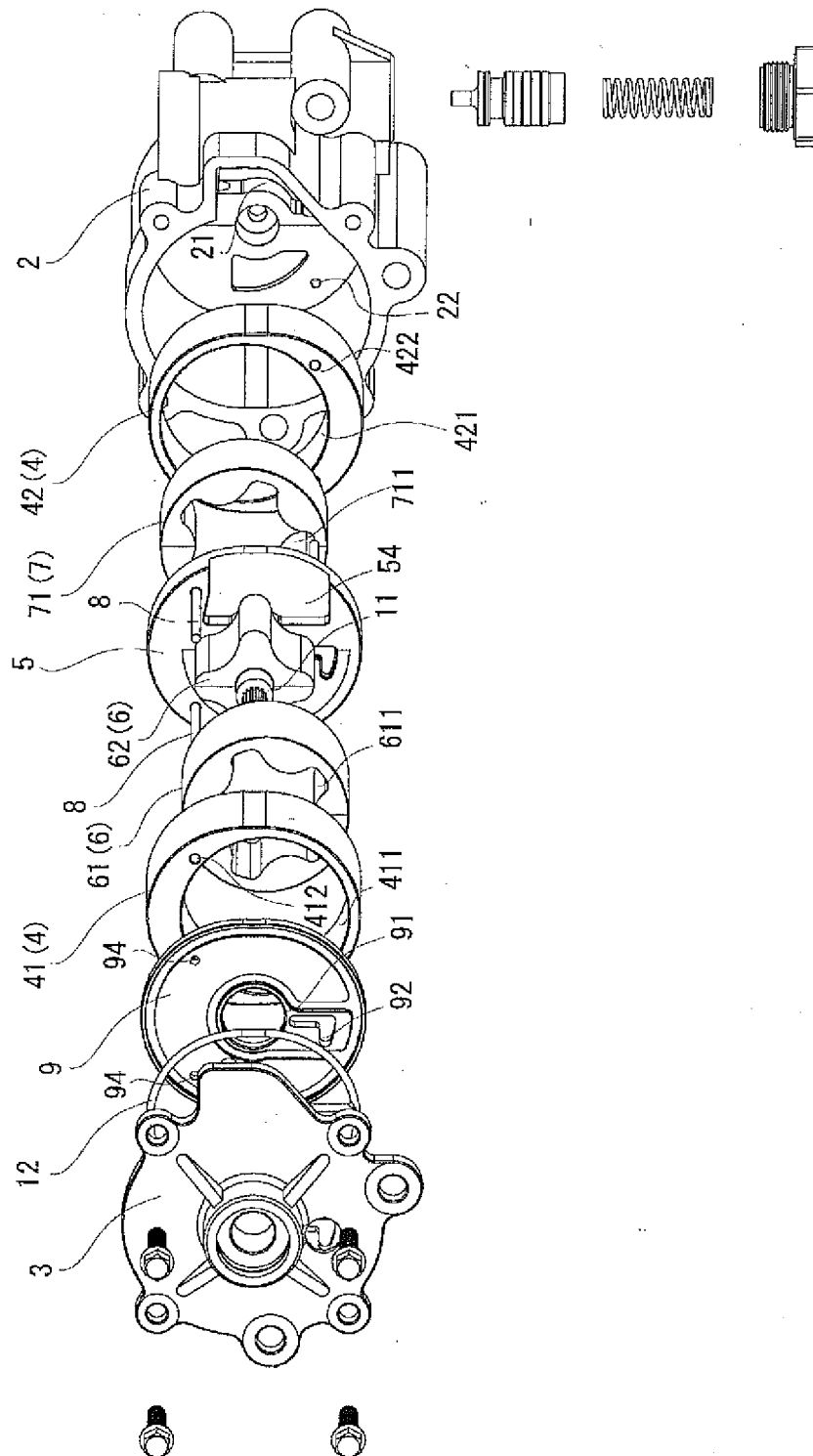


FIG. 4

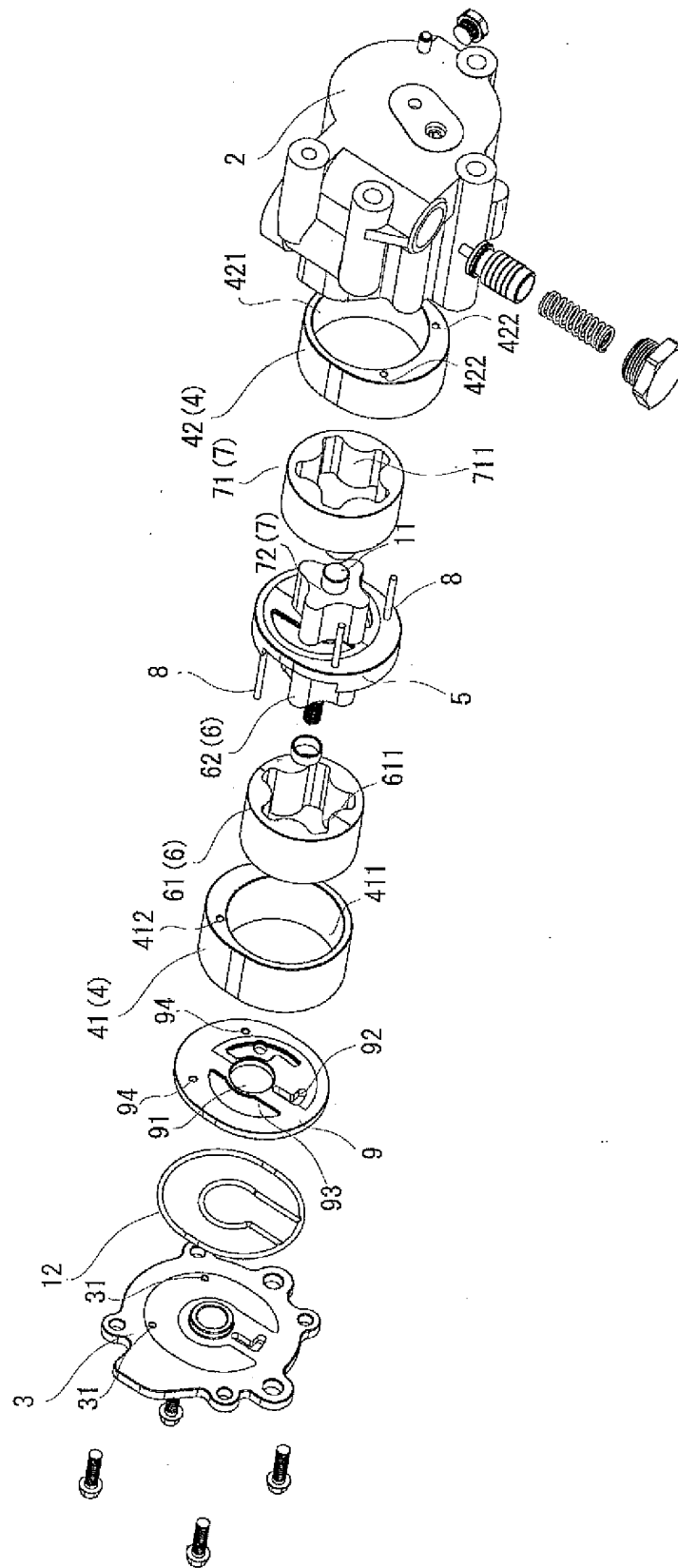


FIG. 5

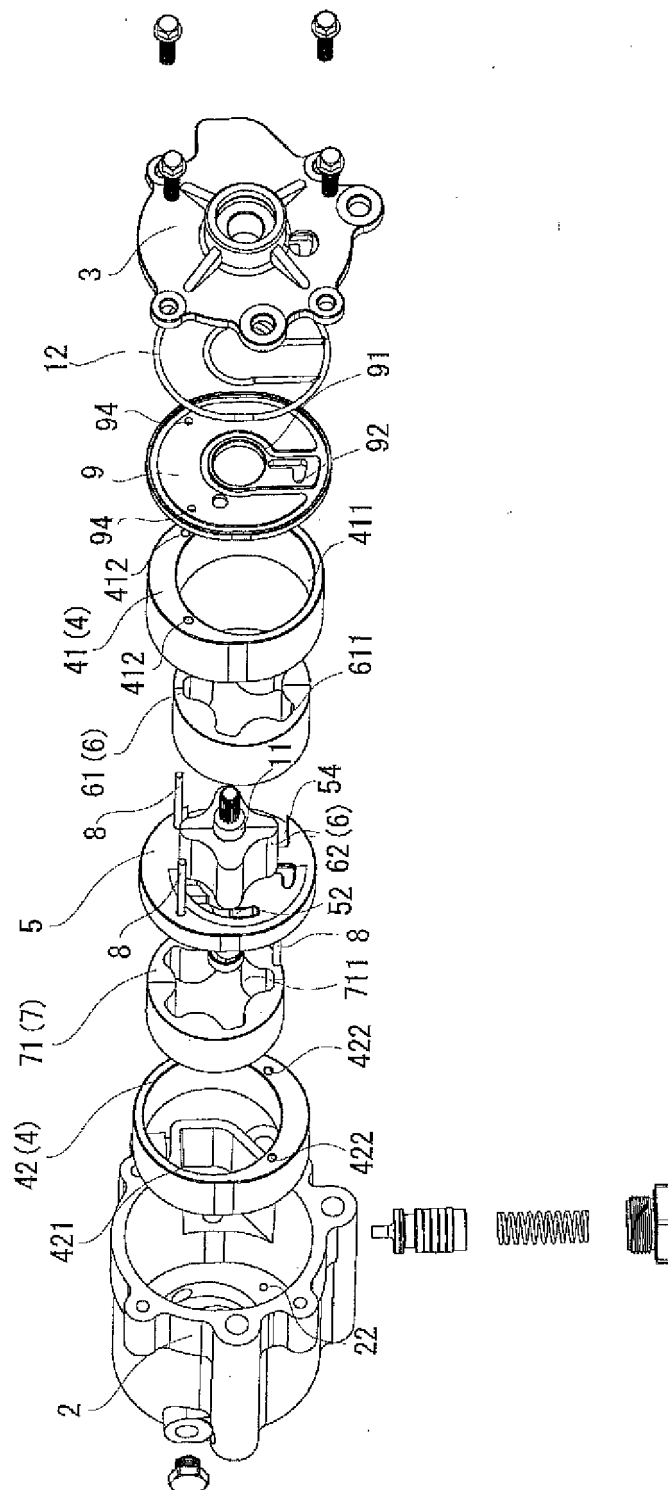


FIG. 6

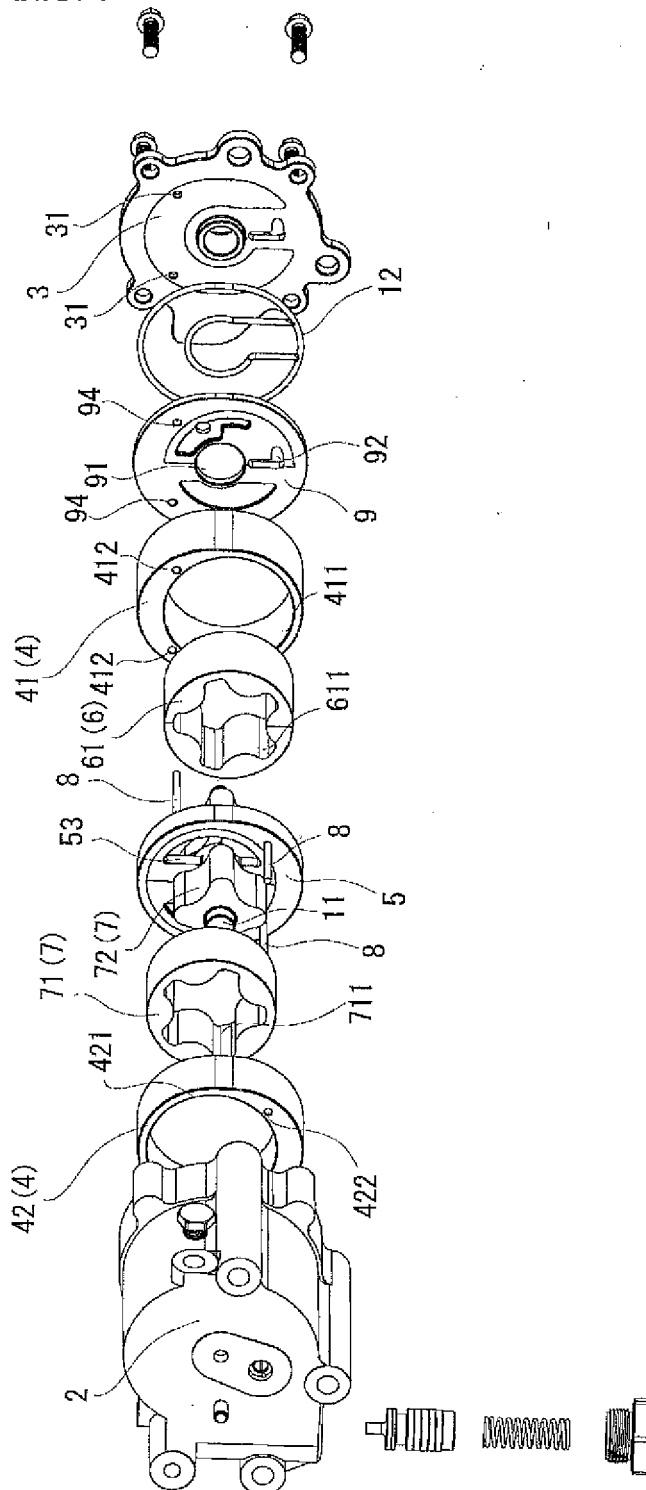


FIG. 7

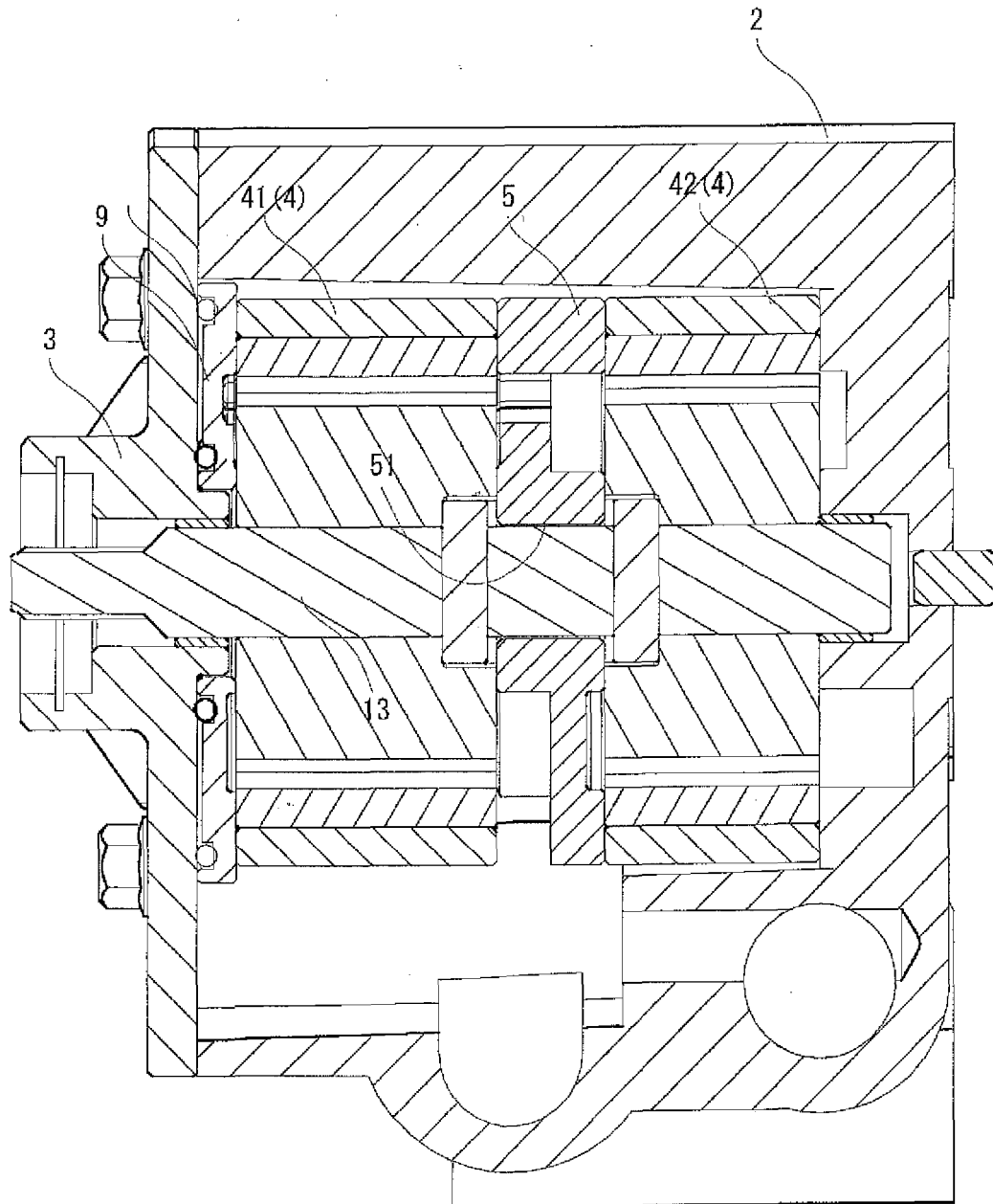
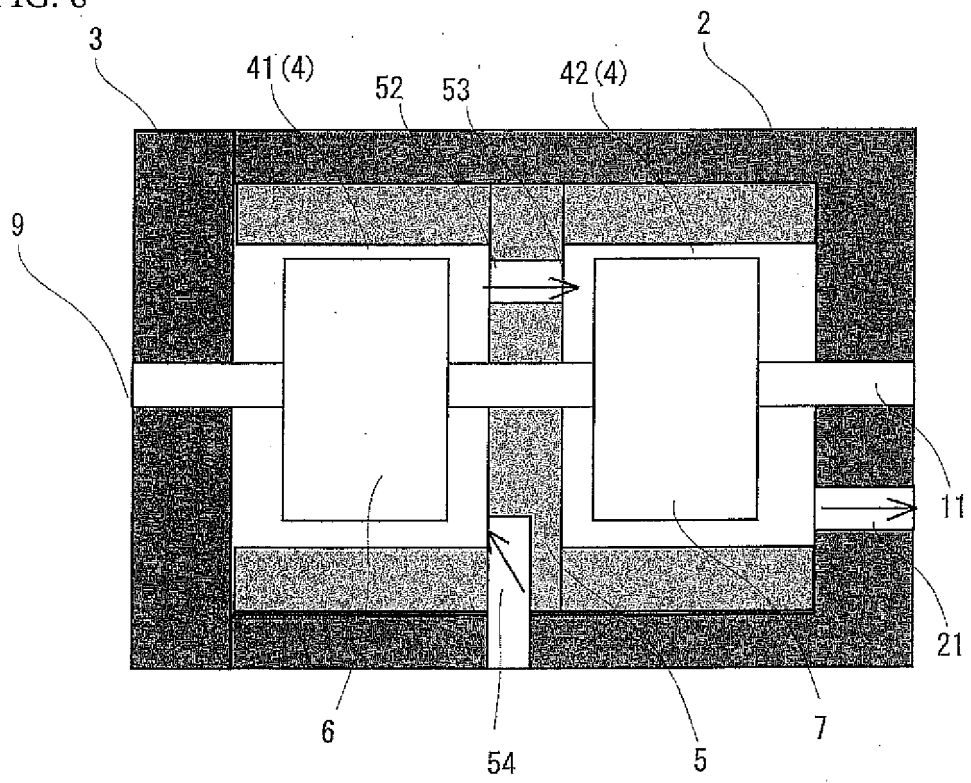


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/063649

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04C15/00, F04C2/10, F04C11/00

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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)	1-3
Y	JP 6-323261 A (Honda Motor Co., Ltd.), 22 November 1994 (22.11.1994), paragraph [0016]; fig. 1 (Family: none)	1-3
Y	JP 7-167066 A (Jidosha Kiki Co., Ltd.), 04 July 1995 (04.07.1995), fig. 12 (Family: none)	3

☒ 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
12 July, 2013 (12.07.13)Date of mailing of the international search report
23 July, 2013 (23.07.13)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/063649

C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 62-52219 A (Shimadzu Corp.), 06 March 1987 (06.03.1987), page 2, lower left column, lines 11 to 17; fig. 1 (Family: none)	1-3

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006161614 A [0003]