(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 967 733 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.09.2008 Bulletin 2008/37

(51) Int Cl.:
F04C 2/344 *(2006.01)* ***F04C 15/00*** *(2006.01)*

(21) Application number: **08003181.8**

(22) Date of filing: **21.02.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **06.03.2007 JP 2007056122**

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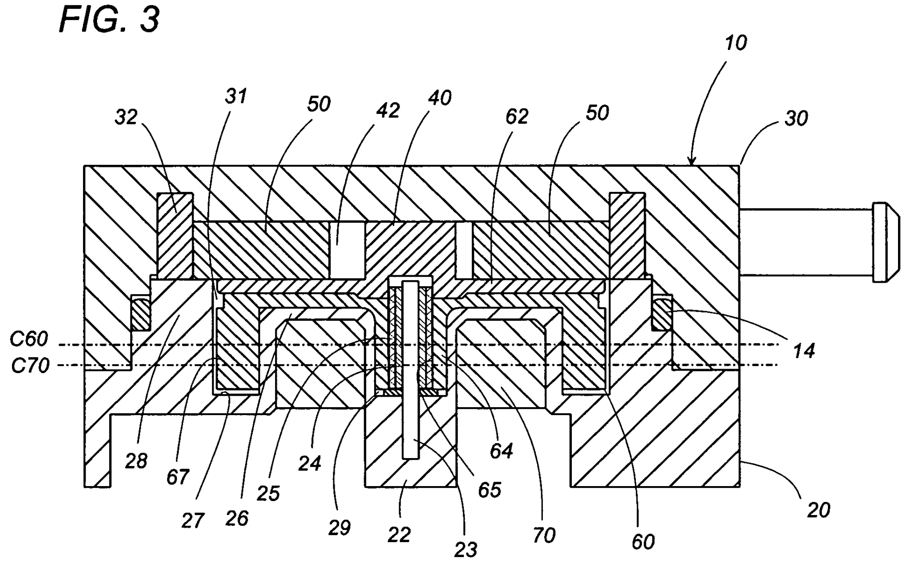
(54) **Magnet driven vane pump**

(57) A magnet drive rotary vane pump has a casing (10) with a pump cavity (12). A rotor (40) carrying a plurality of vanes (50) is disposed within the pump cavity to be rotatable about an eccentric axis with respect to the pump cavity for drawing the fluid into the pump cavity and expelling it out of the pump cavity. The rotor (40) is configured to have a rotor magnet (60) which is magnetically coupled to a stator magnet (70) mounted on the casing outwardly of the pump cavity for driving the rotor. The rotor magnet (60) is configured to have its major portion disposed in an overlapping relation with the stator magnet (70). Thus, the rotor magnet (60) can be mechanically isolated from the stator magnet (70) disposed outside of the casing to establish a sealless coupling therebetween for realizing leakage free pump.

FIG. 3



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Description

TECHNICAL FIELD

[0001] The present invention is directed to a magnetic drive vane pump.

BACKGROUND ART

[0002] Vane pumps are widely known in the art, for example, as disclosed in Japanese patent publication No. 53-2704 A. Generally, the vane pump includes a casing with a pump cavity and a rotor rotatable about an eccentric axis within the pump cavity. The rotor carries a plurality of vanes which moves radially so as to have their outer ends kept in sealed contact with an interior wall of the pump cavity as the rotor rotates, thereby drawing a fluid into the pump cavity, compressing and expelling it out of the pump cavity. The rotor is coupled to an external motor to be driven thereby to rotate. For this purpose, the rotor is provided with a shaft which extends outwardly of the casing for coupling with the motor. Therefore, a sealing is between the shaft and the casing. However, as the shaft is a constantly moving part, there is always a problem that the sealing may become deteriorated during an extended period of use to result in an unintended lead of the fluid.

DISCLOSURE OF THE INVENTION

[0003] In view of the above problem, the present invention has been achieved to provide a magnetic drive vane pump with a leakage free structure. The vane pump in accordance with the present invention includes a casing with a pump cavity, an inlet for introducing a fluid into the pump cavity, and an outlet for discharging the fluid out of the pump cavity. A rotor is disposed within the pump cavity to be rotatable about an eccentric axis with respect to the pump cavity. A plurality of vanes are carried on the rotor and are radially movable so as to be kept into sealed contact with an interior wall of the pump cavity as the rotor is driven to rotate for drawing the fluid into the pump cavity and expelling it out of the pump cavity. The rotor is configured to have a rotor magnet which is magnetically coupled to a stator magnet mounted on the casing outwardly of the pump cavity for driving the rotor. The feature of the present invention resides in that the rotor magnet is configured to have its major portion disposed in an overlapping relation with the stator magnet. Thus, the rotor magnet can be mechanically isolated from the stator magnet disposed outside of the casing to establish a sealless coupling therebetween for making the pump leakage free, yet requiring only a minimum thickness of the pump in the axial direction thereof.

[0004] Preferably, the rotor magnet is disposed radially outwardly of the stator magnet so that the stator magnet can be arranged within a radial dimension of the stator, which assures to give a compact structure to the pump with respect to the radial direction.

[0005] Also, it is preferred that the stator magnet is configured to have its axial center offset from an axial center of the rotor magnet so as to be disposed further away from the rotor than said rotor magnet with respect to the eccentric axis. With this arrangement, the rotor is attracted towards the stator magnet in an axial direction such that the rotor can rotate at a constant level with regard to its axial direction, causing no substantial axial fluctuation.

[0006] Further, the rotor magnet is preferred to be fitted around a shaft extending axially from a center of the casing with a vibration absorbing member interposed therebetween. The vibration absorbing member can well absorb radial vibrations possibly caused by an eccentric rotary motion of the rotor, thereby assuring a smooth and silent rotary motion.

[0007] Besides, each of the vanes, which are slidable fitted respectively in radial grooves in the rotor, is configured to be movable only radially without being caused to fluctuate in the axial direction. For this purpose, each vane is formed on its opposite sides respectively with ribs which engage into guide grooves formed in opposite faces of the rotor defining the radial groove therebetween.

[0008] These and still other advantageous features of the present invention will become more apparent from the following description of preferred embodiments of the present invention when taken in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is an exploded perspective view of a vane pump in accordance with a first embodiment of the present invention;

FIG. 2 is a horizontal section of the above vane pump;

FIG. 3 is a cross-section taken along line X-X of FIG. 2;

FIG. 4 is a cross section taken along line Y-Y of FIG. 2;

FIG. 5 is an exploded perspective view of a portion of the above vane pump;

FIG. 6 is a horizontal section of a vane pump in accordance with a second embodiment of the present invention;

FIG. 7 is a cross section taken along line 7-7 of FIG. 6;

FIG. 8 is a horizontal section of a vane pump in accordance with a third embodiment of the present invention; and

FIG. 9 is a cross-section taken along line 9-9 of FIG. 8.

BEST MODE FOR CARRYING OUT THE INVENTION

[0010] Referring now to FIGS. 1 to 4, there is shown a magnetic drive vane pump in accordance with a first embodiment of the present invention. The pump includes a casing **10** formed in its interior with a cylindrical pump cavity **12** which accommodates therein a rotor **40** having an eccentric axis offset from an axis of the pump cavity **12.** The casing **10** is composed of a lower half **20** and an upper half **30** which are secured to each other with a sealing ring **14** held therebetween. The lower and upper halves **20** and **30** are respectively formed with a lower recess **21** and an upper recess **31** which are cooperative to define the pump cavity **12.** As seen in FIGS. 3 and 4, the lower half **20** is formed to have a center stud **22** anchoring a shaft **23,** and an annular projection **26** between the center stud **22** and a peripheral wall **28.** The shaft **23** projects from the center stud **22** into a center concavity **29** of the lower half **20** to define the eccentric axis, and is surrounded by a bearing sleeve **24.** A ring **32** is fitted inside of the upper half **30** to extend around the periphery of the upper recess **31** with its one axial end resting on the peripheral wall **28** of the lower half **20.** The upper half **30** is formed with an inlet **34** for introducing a fluid into the pump cavity **12** through a port **35** in the ring **32** and an outlet **36** for expelling the fluid out of the pump cavity through a port **37** of the ring **32.**

[0011] The rotor **40** is shaped into a disc disposed within the upper recess **21** and carries a plurality of vanes **50** which are slidably received respectively in circumferentially spaced radial slits **42.** As the rotor **40** is driven to rotate, each of the vanes **50** is shifted radially outwardly by a centrifugal force to have its outer end in sealing contact with the inside of the ring **32,** thereby forming a displacement chamber confined between the adjacent vanes and between the ring **32** and the rotor. The displacement chamber undergoes expansion and contraction while the rotor **40** rotates about the eccentric axis, thereby drawing the fluid into and expelling it out of the pump cavity **12.**

[0012] The rotor **40** carries a rotor magnet **60** which is magnetically coupled to a stator magnet **70** disposed outside of the casing **10** so as to be driven thereby to rotate. The rotor magnet **60** is a permanent magnet which is integrated with the rotor **40** to form a unitary structure. The rotor magnet **60** is shaped to have a thin base **62** secured on one axial end face of the rotor **40,** a hub **64** projecting axially from the center of the base **62,** and an outer ring **67** projecting axially from the periphery of the base **62.** The hub **64** is received into the center concavity **29** in an overlapping relation with the stator magnet **70** with respect to the radial direction about the eccentric axis. The hub **64** is formed with a bearing hole **65** into which the shaft **23** extends together with the bearing sleeve **24** so that the rotor magnet **60** is freely rotatable about the shaft **23** together with the rotor **40.** The outer ring **67** projects into an annular groove **27** formed between the annular projection **26** and the peripheral wall **28** of the lower half **20** also in an overlapping relation with the stator magnet **70** with respect to the radial direction. The outer ring **67** and the hub **64** constitute a major portion of the rotor magnet **60** which are disposed radially outwardly of the stator magnet **70** in the overlapping relation therewith, which contributes to minimize the axial dimension as well as the radial dimension of the pump.

[0013] In order to reduce radial vibrations of the rotor **40** which may occur during its rotation about the eccentric axis, a vibration absorbing member **25** is interposed between the bearing hole **65** and the bearing sleeve **24** of the shaft **23.**

[0014] The stator magnet **70** is composed of a plurality of electro magnets which are mounted within an open space formed underside of the annular projection **26** and extend around the center stud **22.** As shown in FIG. 3, the stator magnet **70** has its axial center **C70** offset axially from an axial center **C60** of the rotor magnet **60** so as to be spaced further away from the rotor **40** than rotor magnet **60** with respect to the axial direction of the eccentric axis. Thus, the stator magnet **70** develops an attraction force of attracting the rotor magnet **60** and therefore the rotor **40** axially towards the stator magnet **70,** thereby keeping the rotor magnet **60** in abutment against the upper face of the annular projection **26** and therefore minimizing axial fluctuation of the rotor **40** during the rotation thereof.

[0015] As shown in FIG. 5, each of the vanes **50** is formed on its opposite sides with ribs **54** which are slidably received into guide grooves **44** formed in opposite faces defining the radial slit **42** such that the vane **50** is held slidable only within the radial slit **42** without being axially displaced out of the slit.

[0016] FIGS. 6 and 7 illustrates a vane pump in accordance with a second embodiment of the present invention which is basically identical to the first embodiment except that the rotor **40** is itself made of a permanent magnet to constitute the rotor magnet **60.** Like parts are designated by like reference numerals and no duplicate explanation is made herein for simplicity. The rotor **40** is disposed in the pump cavity **12** defined between the lower half **20** and the upper half **30** of the casing **10** and confined within the circumference of the ring **32.** The rotor **40** is shaped into a generally flat disc to have a plurality of the circumferentially spaced radial slits **42** each receiving the radially slidable vane **50,** and to have a bearing hole **65** in its center for receiving the shaft **13** and the bearing sleeve **24** so that the rotor **40** is freely rotatable about the eccentric axis defined by the shaft **13.** The stator magnet **70** is disposed between the lower and upper halves **20** and **30** radially outwardly of the ring **32,** and is composed of an electromagnet assembly having a yoke ring **72** with a plurality of circumferentially cores **73** each carrying a coil **74.**

[0017] FIGS. 8 and 9 illustrates a vane pump in accordance with a third embodiment of the present invention which is basically identical to the first embodiment except that the rotor **40** is itself made of a permanent magnet to constitute the rotor magnet **60** and the stator magnet **70** is disposed within diameter of the rotor **40.** Like parts are designated by like reference numerals and no duplicate explanation is made herein for simplicity. The rotor **40** is disposed in the pump cavity **12** defined between the lower half **20** and the upper half **30** of the casing and confined within the circumference of the ring **22.** The rotor **40** is shaped to have a hub **64** and an outer ring **67** integrally connected by means of a bridge **69.** The hub **64** has a bearing hole **65** into which the shaft **13** is fitted together with the bearing sleeve **24** so that the rotor **40** is supported to the lower half **10** to be freely rotatable about the shaft **13** or the eccentric axis defined thereby. The upper half **30** is formed with an annular groove **38** extending between the hub **64** and the outer ring **67** of the rotor **40** to receive therein the stator magnet **70.** Thus, the stator magnet **70** is arranged in an overlapping relation with the rotor magnet **60** or the rotor **40** with respect to the radial direction about the eccentric axis so as to minimize the axial dimension of the pump. The stator magnet **70** is an electromagnet assembly composed of a plurality of cores **73** each carrying a coil **74.**

[0018] Although the present invention is explained specifically with reference to the above embodiments, it should not be delimited to the embodiments and can encompass any combination of the individual features disclosed in the above embodiments.

Claims

1. A magnet drive vane pump comprising:

a casing (10) with a pump cavity (12), an inlet (34) for introducing a fluid into said pump cavity, and an outlet (36) for discharging the fluid out of said pump cavity;
a rotor (40) disposed within said pump cavity to be rotatable about an eccentric axis eccentric to an axis of said pump cavity, said rotor carrying a plurality of vanes (50) which are configured to move radially so as to be kept in sealed contact with an interior wall of said pump cavity as said rotor rotates, said rotor is configured to have a rotor magnet;
a stator magnet (70) mounted to said casing outwardly of said pump cavity and magnetically coupled to said rotor magnet for driving said rotor to rotate;

wherein
said rotor magnet is configured to have its major portion disposed in an overlapping relation with said stator magnet with respect to a radial direction about said eccentric axis.

2. The magnet drive vane pump as set forth in claim 1, wherein
said rotor magnet is disposed radially outwardly of said stator magnet.

3. The magnet drive vane pump as set forth in claim 1, wherein
said stator magnet is configured to have its axial center (C70) offset from an axial center (C60) of said rotor magnet so as to be disposed further away from said rotor than said rotor magnet with respect to said eccentric axis.

4. The magnet drive vane pump as set forth in claim 1, wherein
said casing is provided with a shaft (13) defining said eccentric axis,
said rotor magnet is fitted around said shaft (13) with a vibration absorbing member (25) interposed therebetween.

5. The magnetic drive vane pump as set forth in claim 1, wherein
said vanes are slidably fitted respectively in radial slits (42) formed in said rotor, each of said vanes is formed on its opposite sides with ribs (54) which engage respectively into guide grooves (44) formed in opposite faces of said rotor defining said radial slit therebetween.

FIG. 1

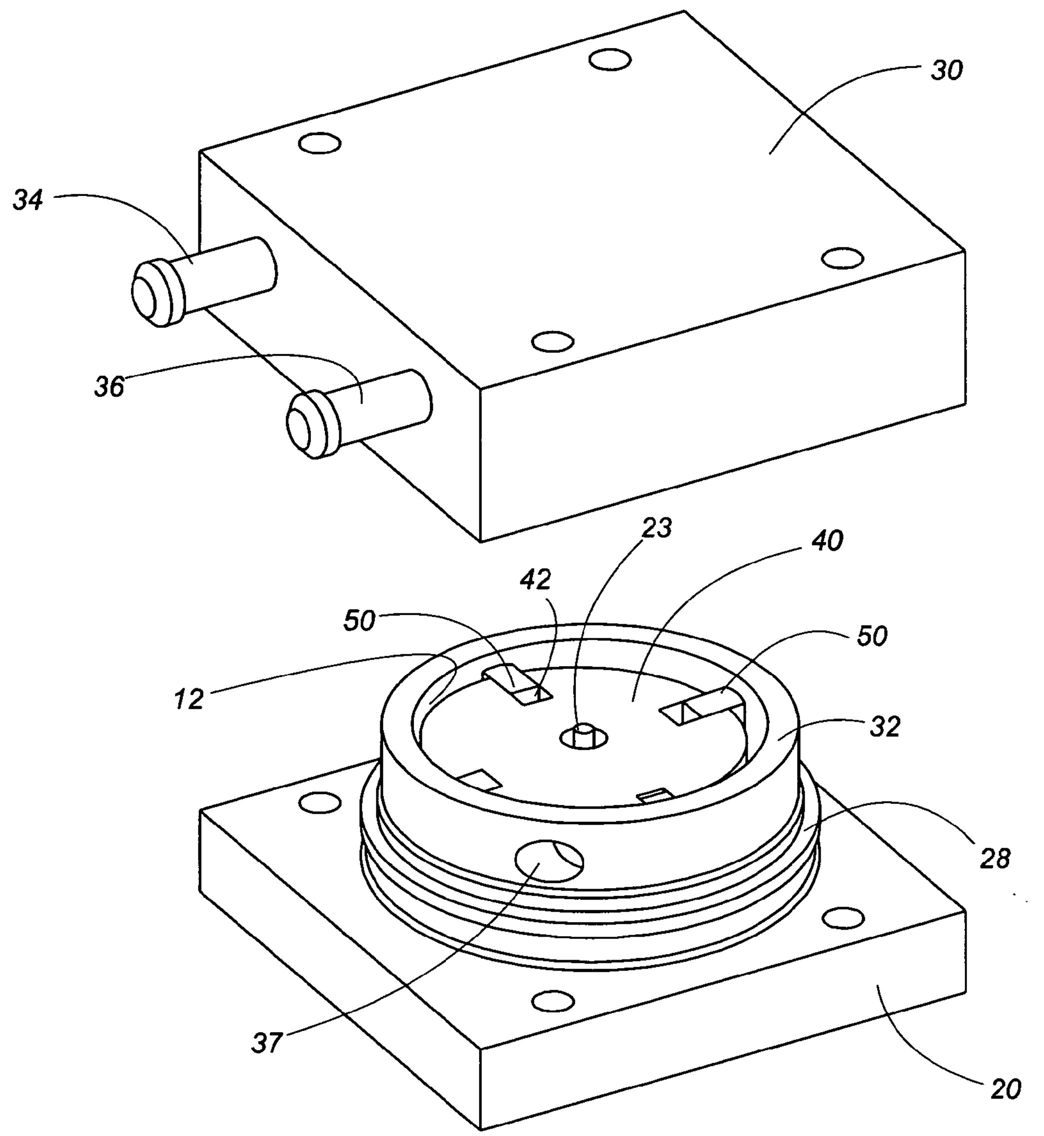


FIG. 2

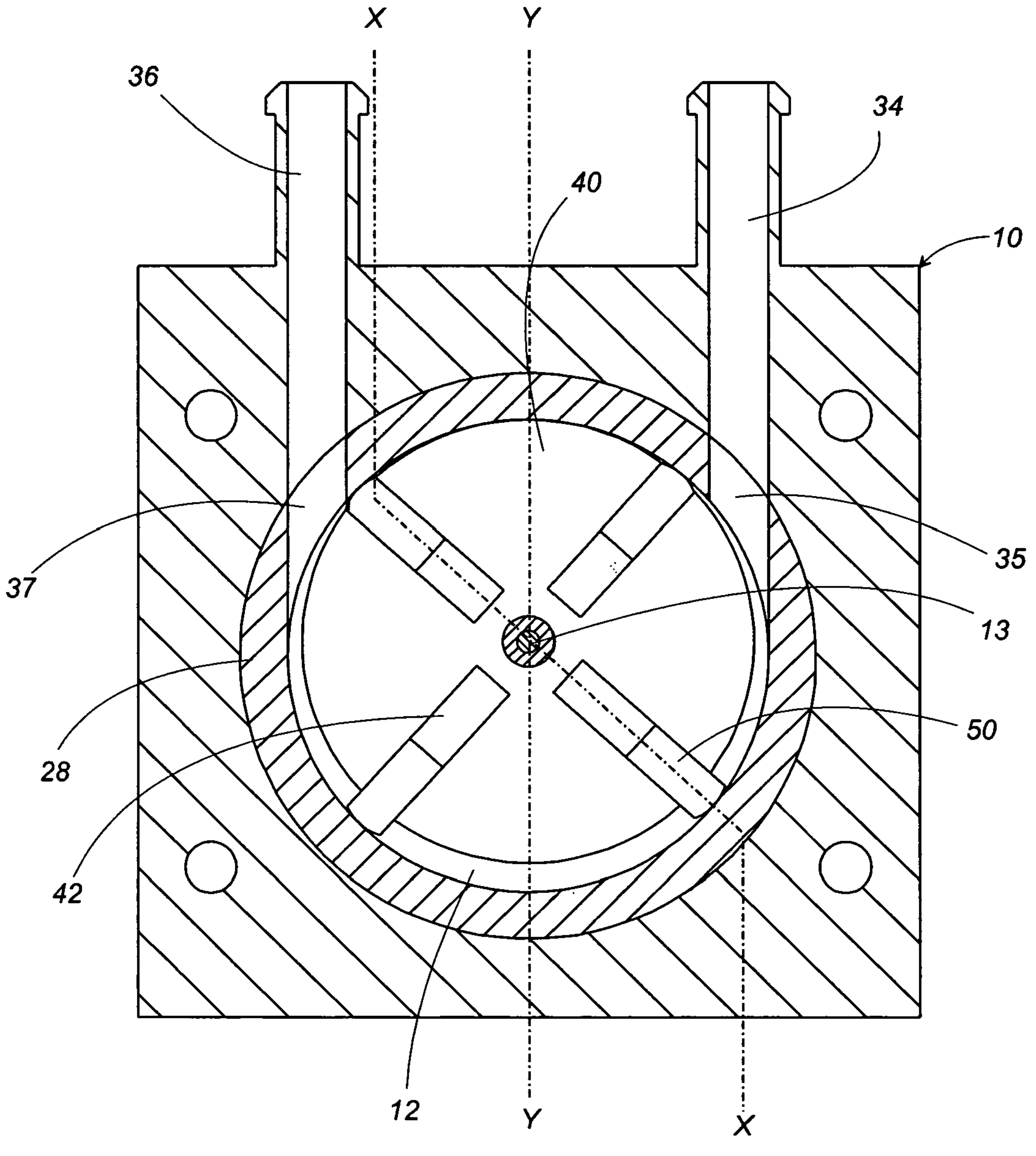
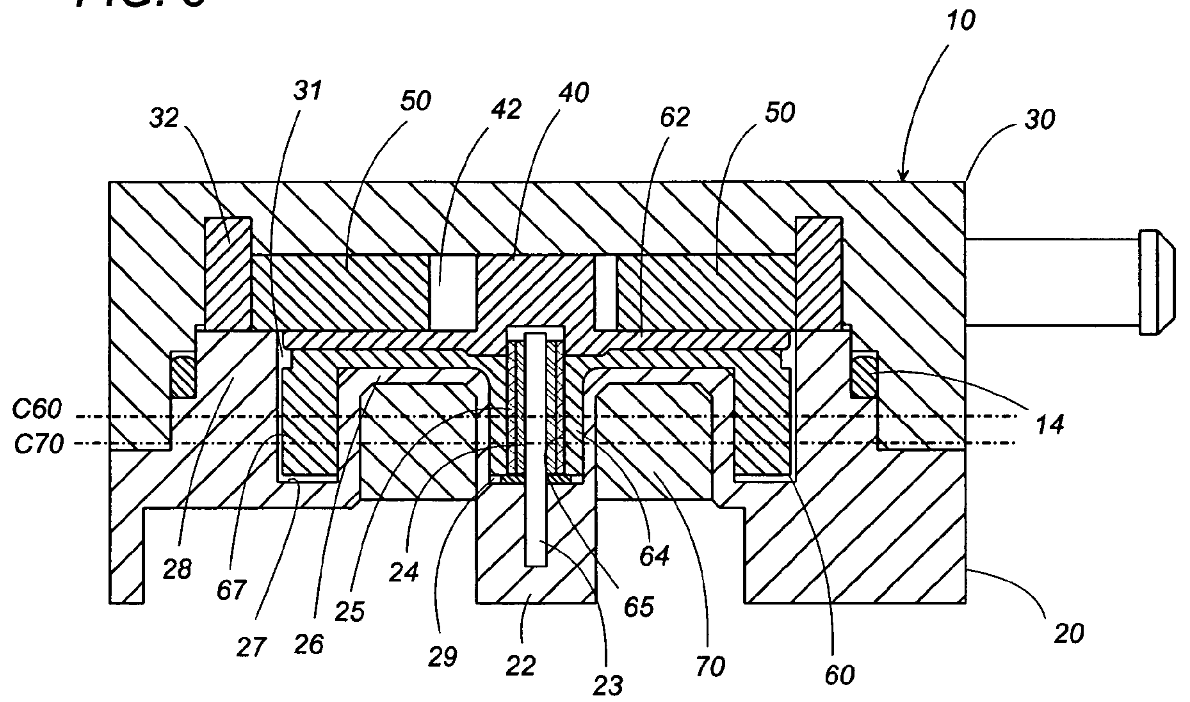


FIG. 3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42
40
62
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C60
C70
14
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67
27
26
25
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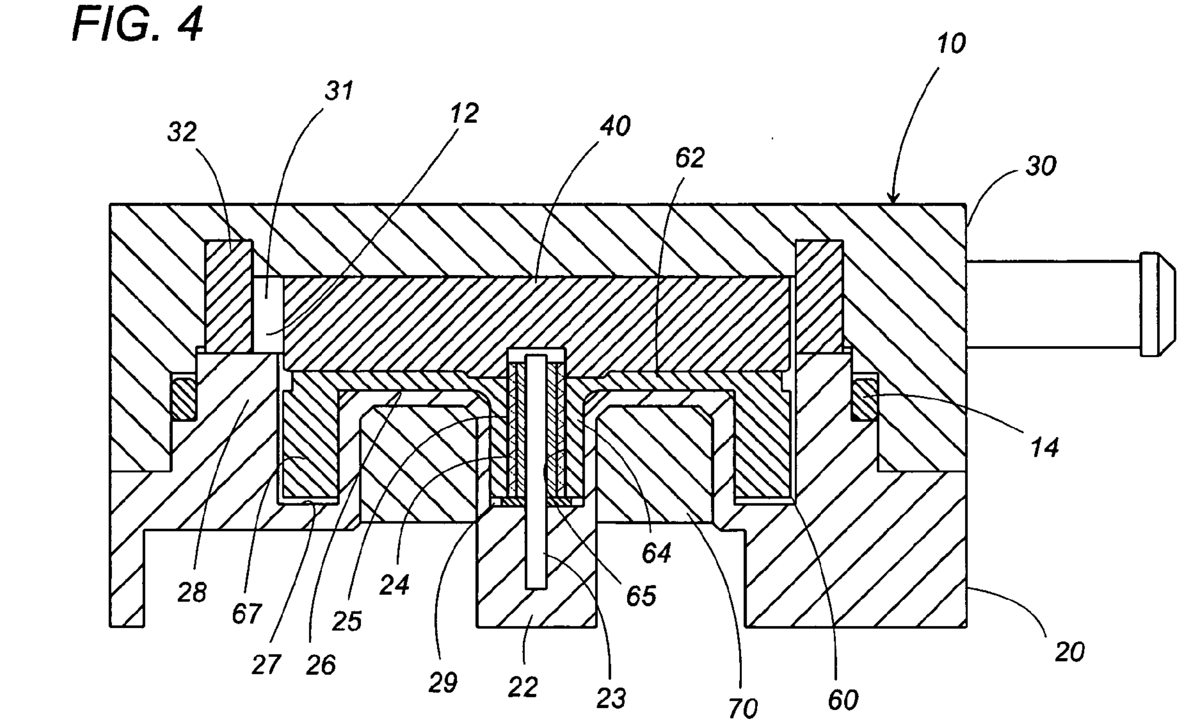
65
64
70
60
20

FIG. 4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65
64
70
60
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FIG. 5

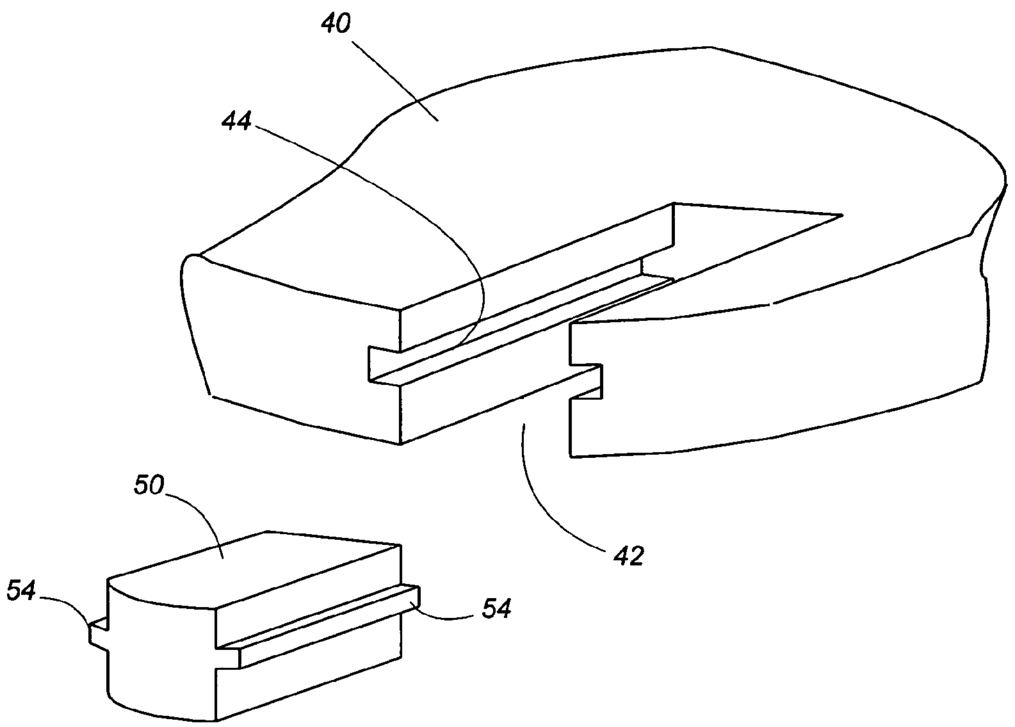


FIG. 6

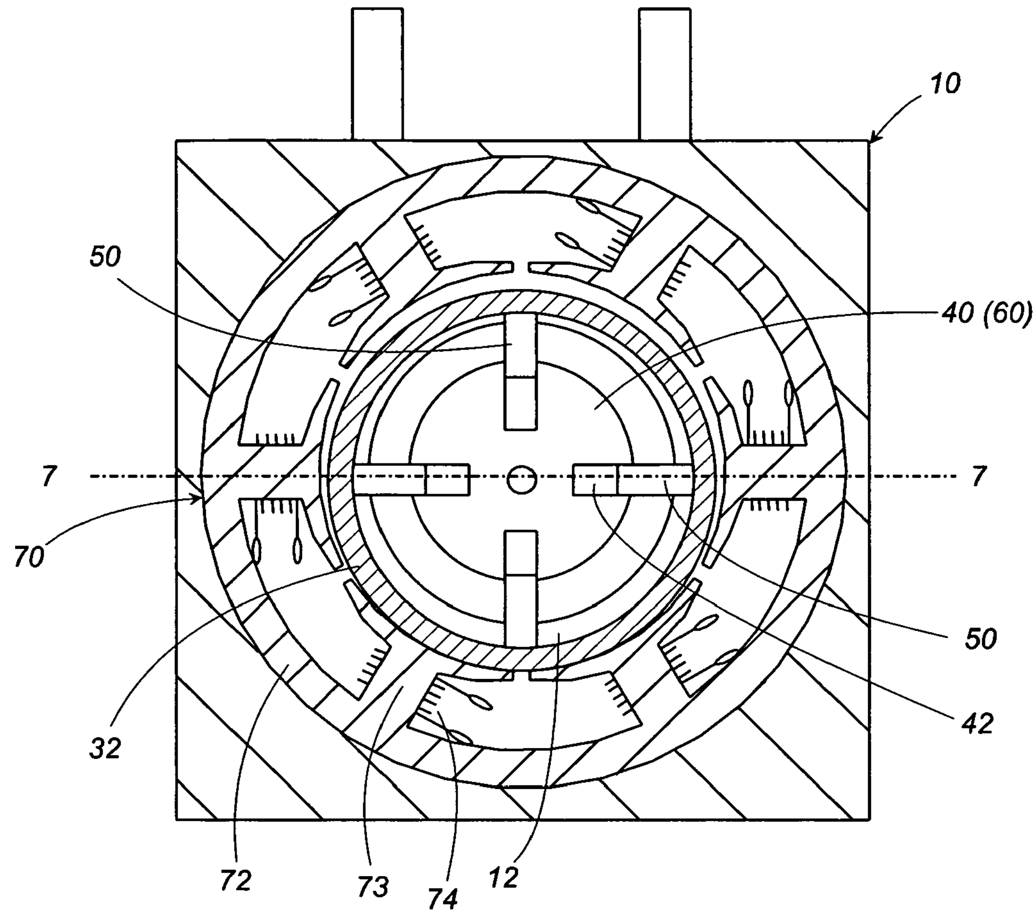


FIG. 7

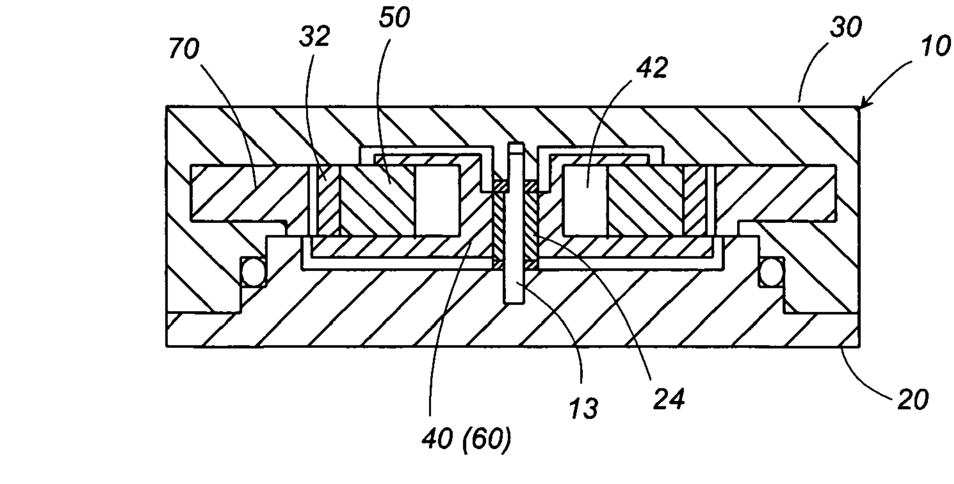


FIG. 8

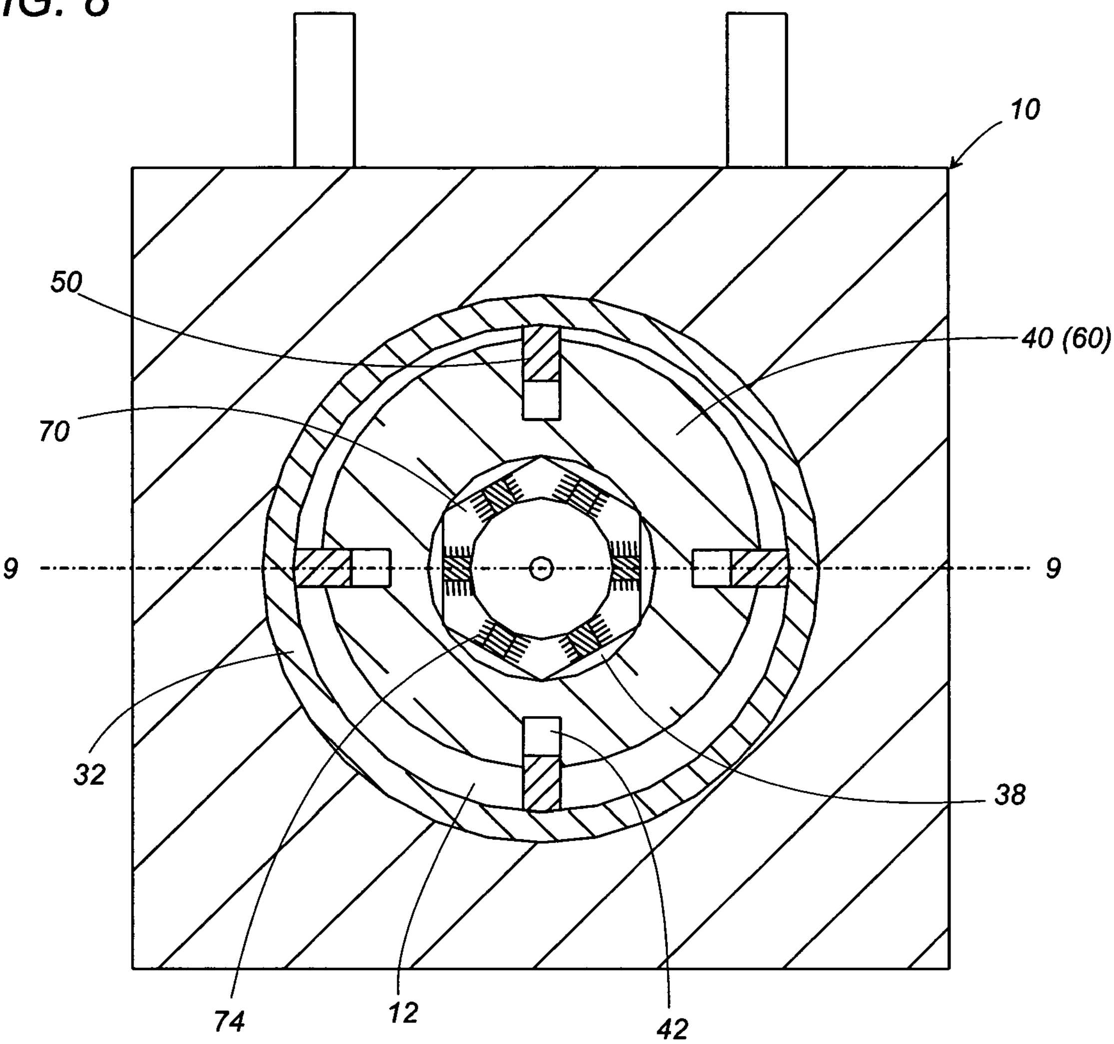
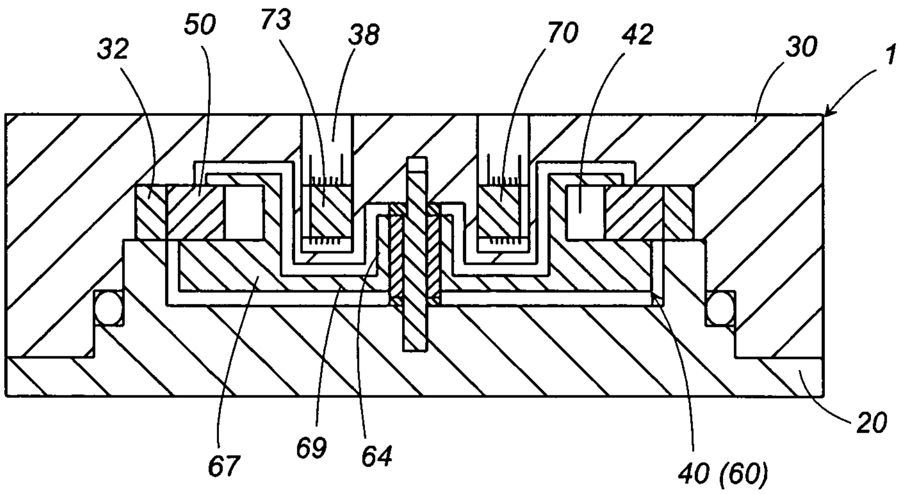

10
50
40 (60)
70
9
9
32
38
74
12
42

FIG. 9


32
50
73
38
70
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67
69
64
40 (60)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 53002704 A **[0002]**