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(54) **MAGNETIC DRIVE VANE PUMP**

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(57) **ABSTRACT**

A magnet drive rotary vane pump has a casing with a pump cavity. A rotor carrying a plurality of vanes 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 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 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 realizing leakage free pump.

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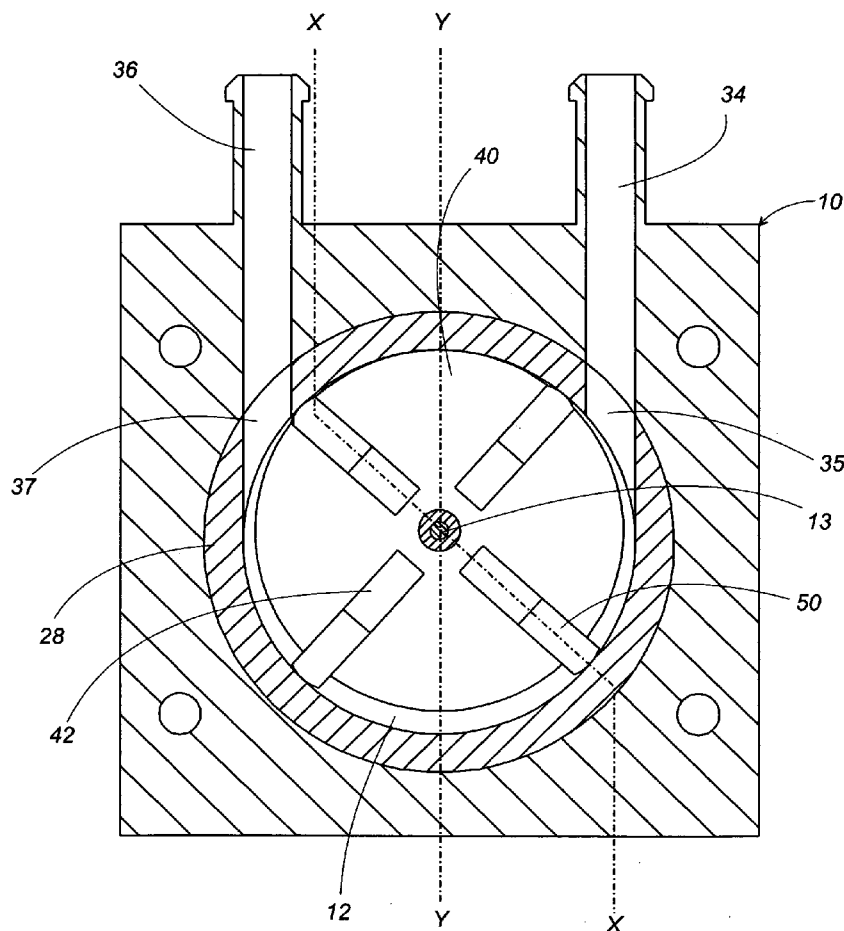


FIG. 1

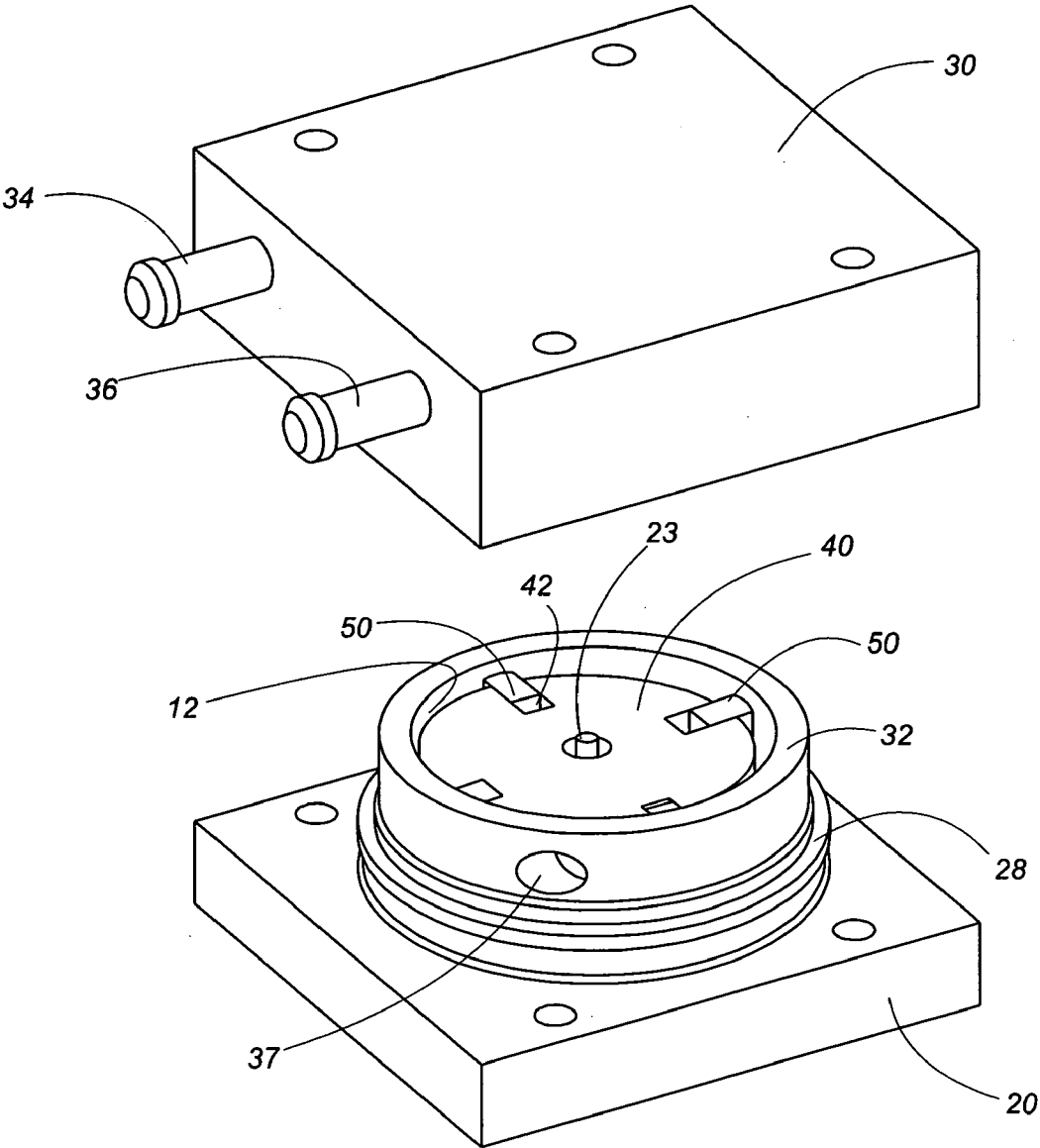


FIG. 2

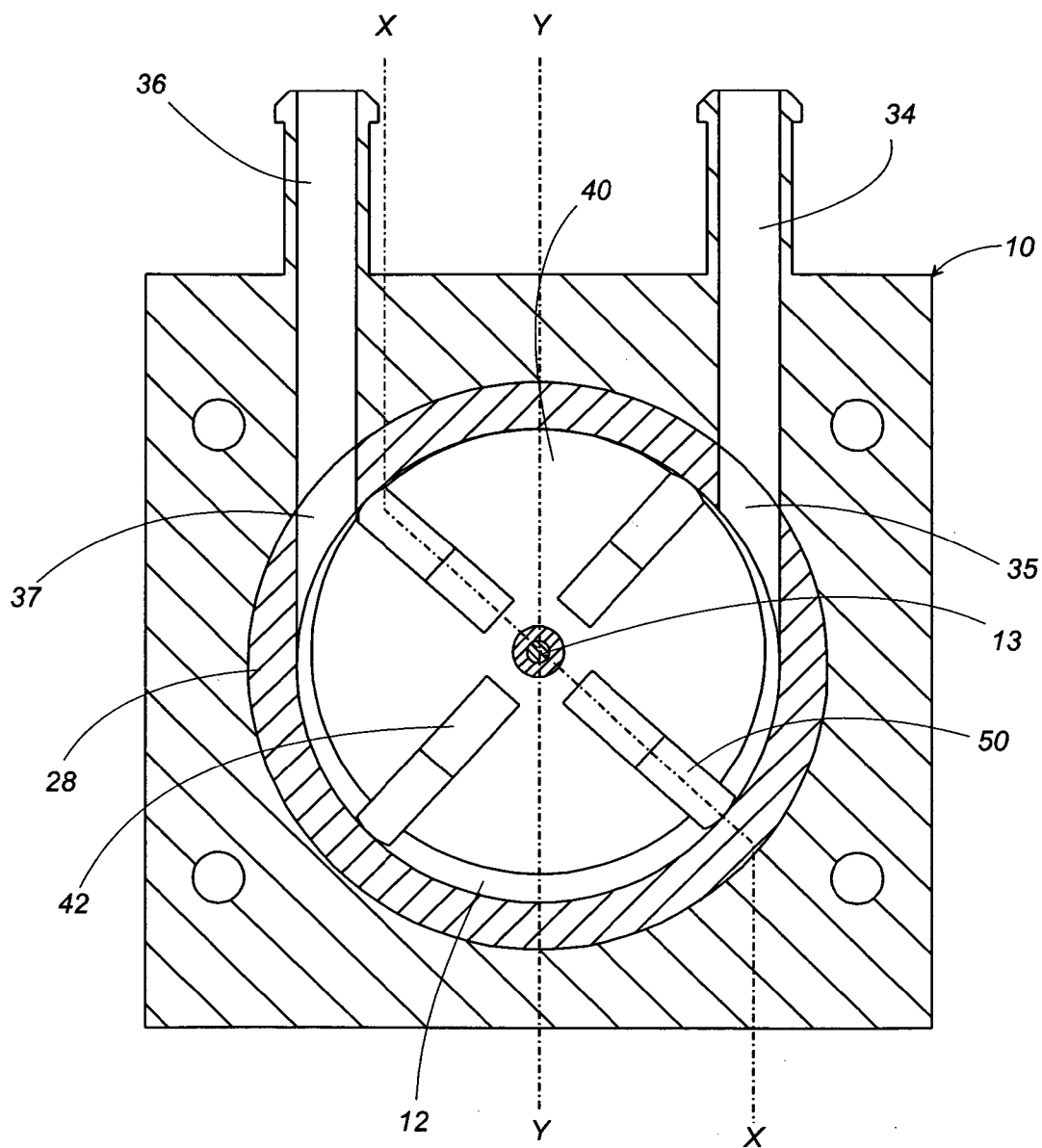


FIG. 3

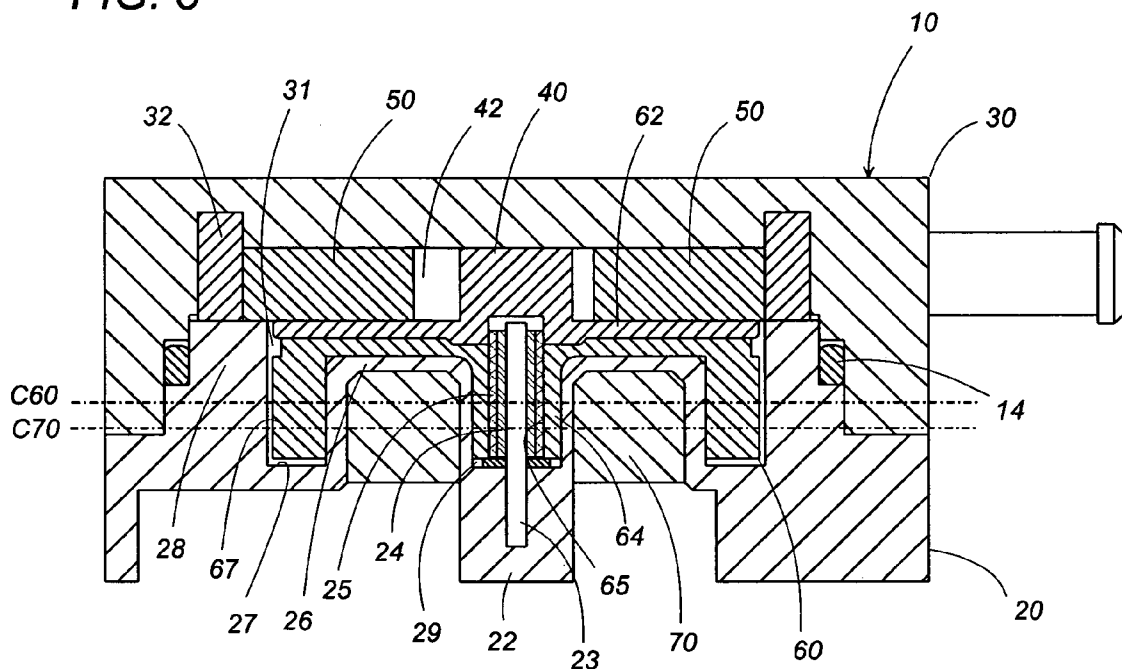


FIG. 4

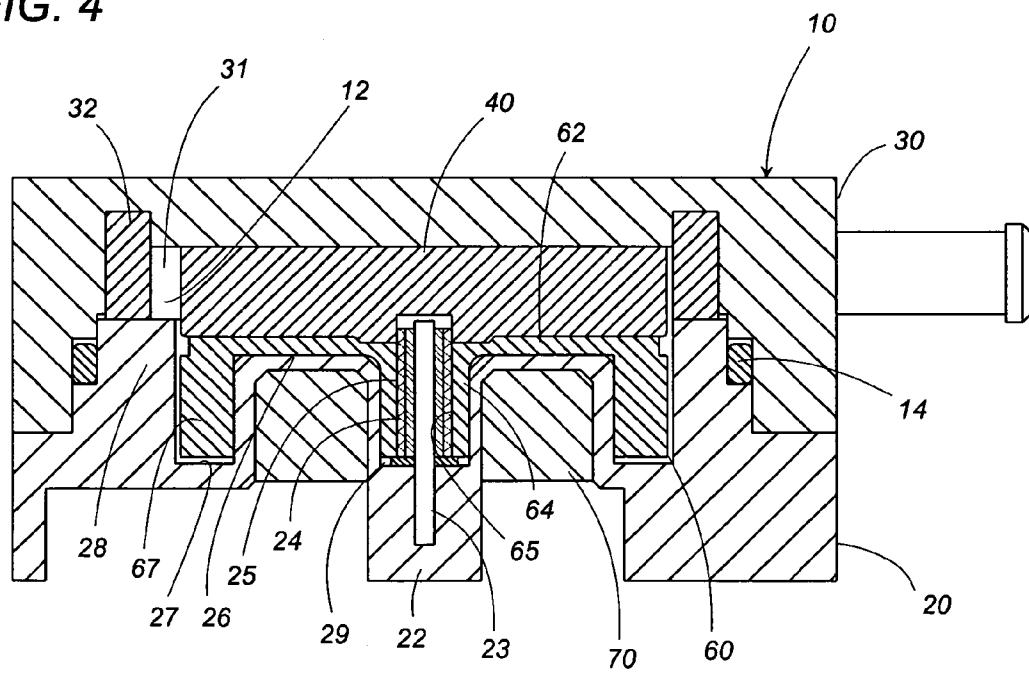


FIG. 5

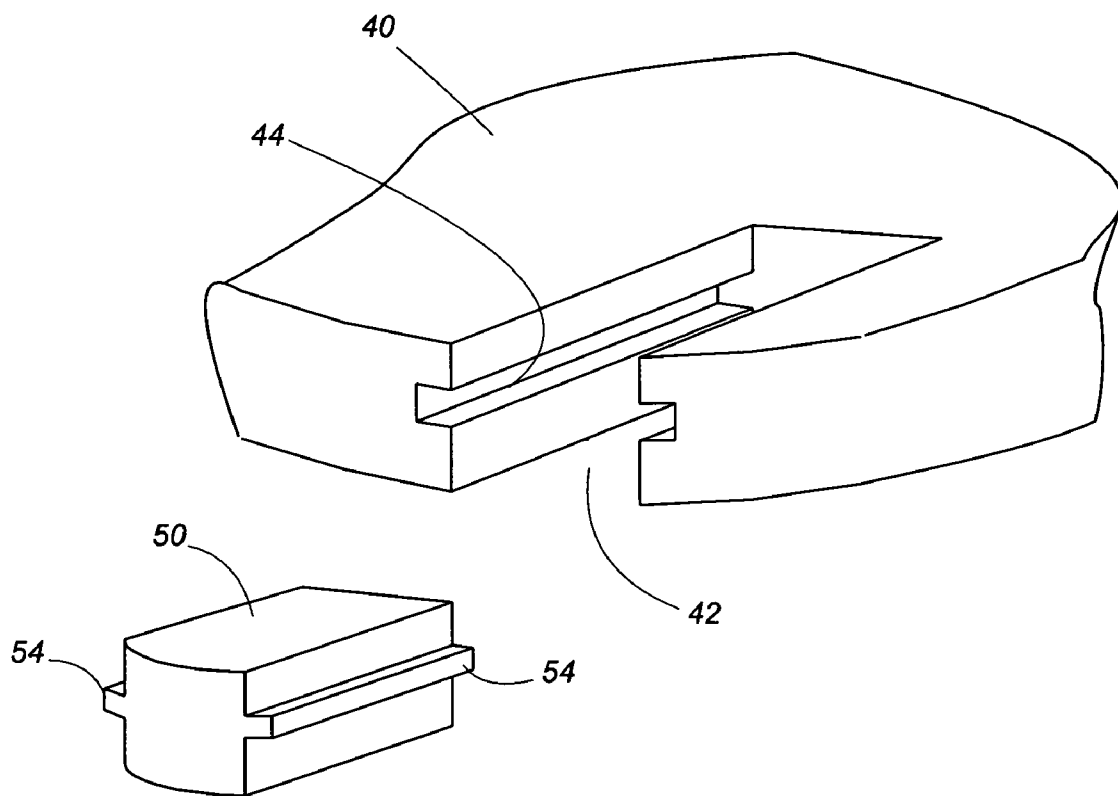


FIG. 6

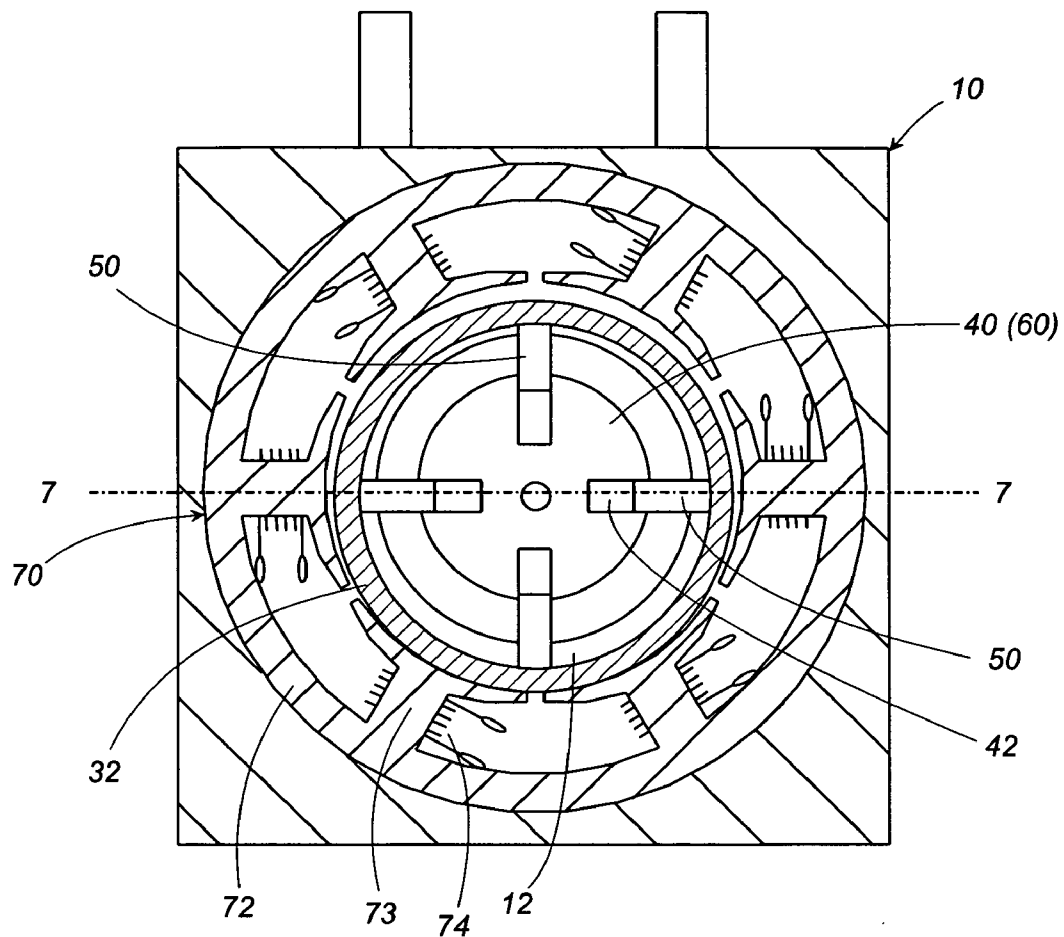


FIG. 7

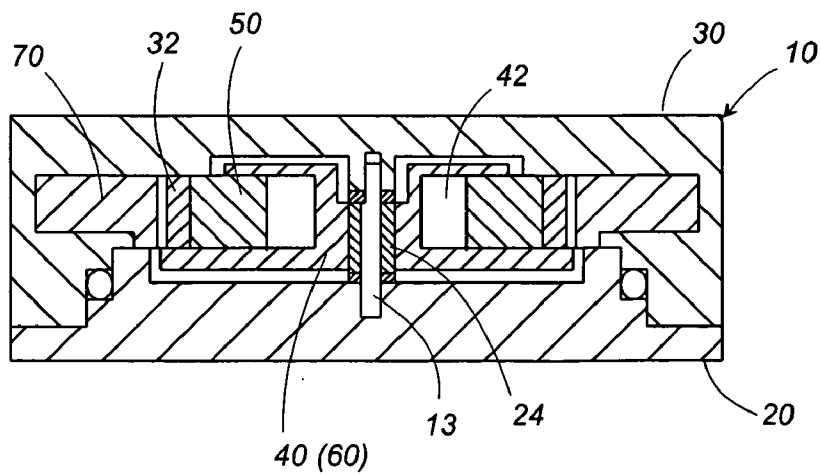


FIG. 8

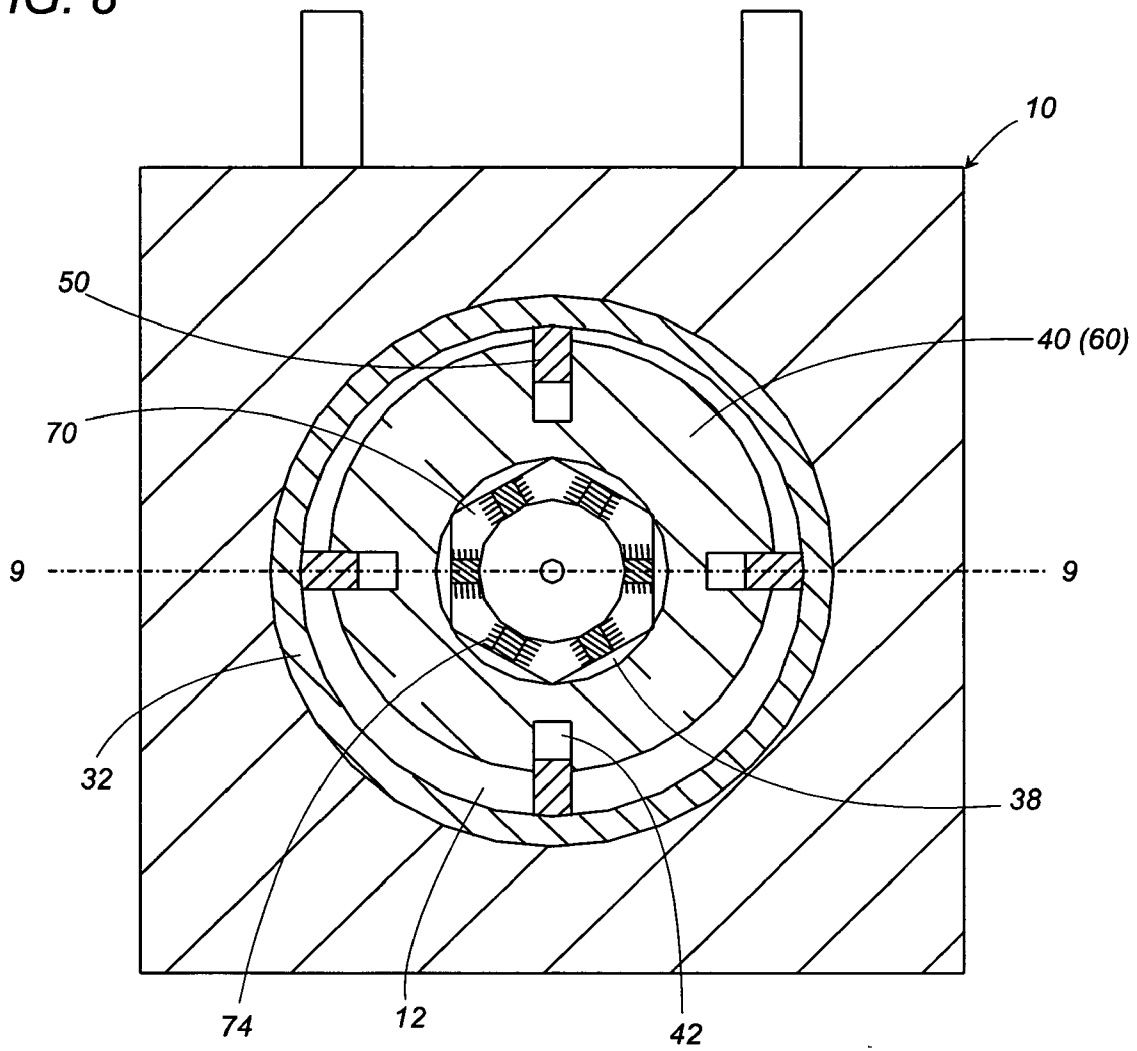
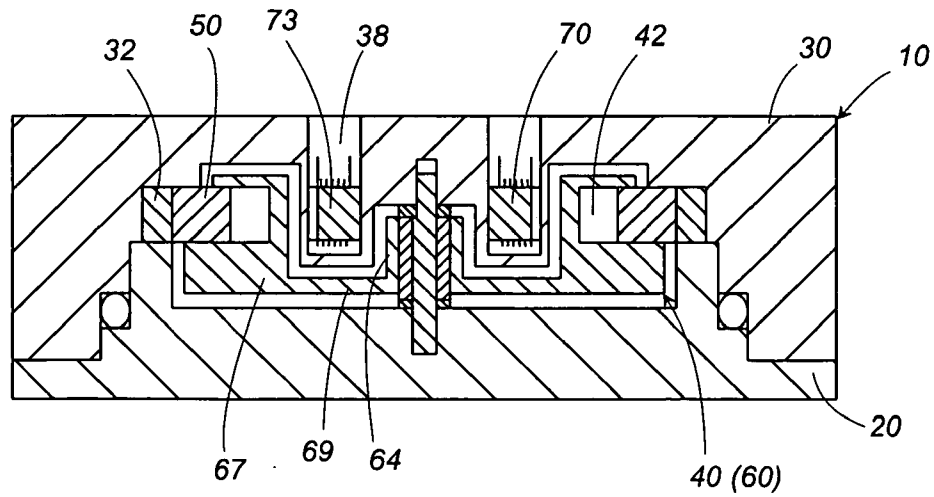


FIG. 9



## MAGNETIC DRIVE VANE PUMP

### 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 slidably 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;

**[0010]** FIG. 2 is a horizontal section of the above vane pump;

**[0011]** FIG. 3 is a cross-section taken along line X-X of FIG. 2;

**[0012]** FIG. 4 is a cross section taken along line Y-Y of FIG. 2;

**[0013]** FIG. 5 is an exploded perspective view of a portion of the above vane pump;

**[0014]** FIG. 6 is a horizontal section of a vane pump in accordance with a second embodiment of the present invention;

**[0015]** FIG. 7 is a cross section taken along line 7-7 of FIG. 6;

**[0016]** FIG. 8 is a horizontal section of a vane pump in accordance with a third embodiment of the present invention; and

**[0017]** FIG. 9 is a cross-section taken along line 9-9 of FIG. 8.

### BEST MODE FOR CARRYING OUT THE INVENTION

**[0018]** 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.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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 slidably only within the radial slit 42 without being axially displaced out of the slit.

[0024] 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.

[0025] 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.

[0026] 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.

1. A magnet drive vane pump comprising:

- a casing with a pump cavity, an inlet for introducing a fluid into said pump cavity, and an outlet for discharging the fluid out of said pump cavity;
- a rotor 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 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 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 offset from an axial center 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 defining said eccentric axis, said rotor magnet is fitted around said shaft with a vibration absorbing member interposed therebetween.

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

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