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SLIDING-VANE ROTARY FLUID DISPLACEMENT MACHINE

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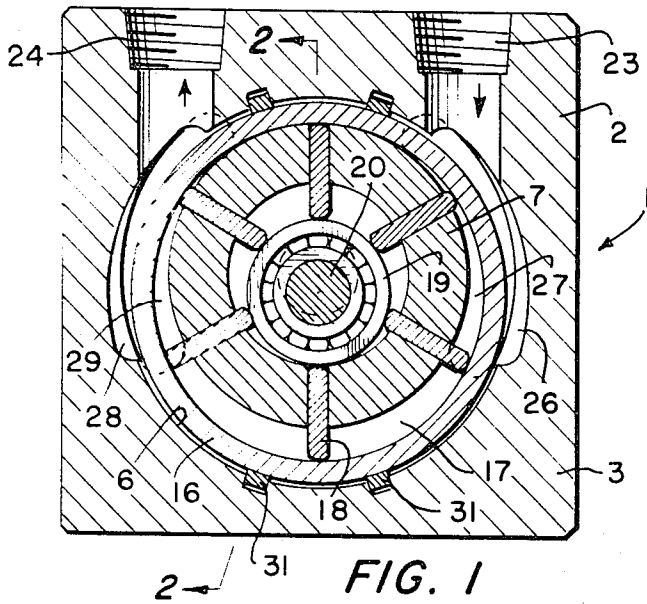


FIG. 1

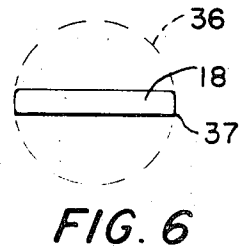


FIG. 6

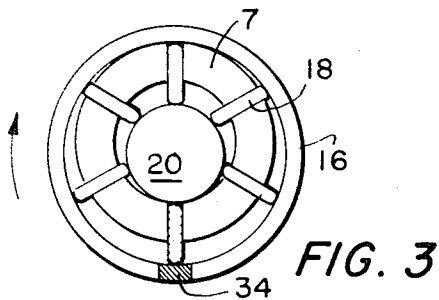


FIG. 3

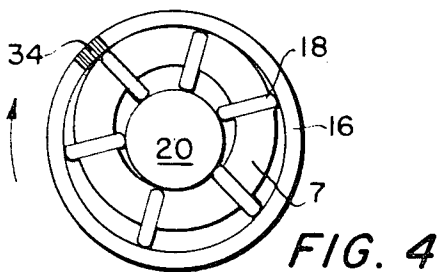


FIG. 4

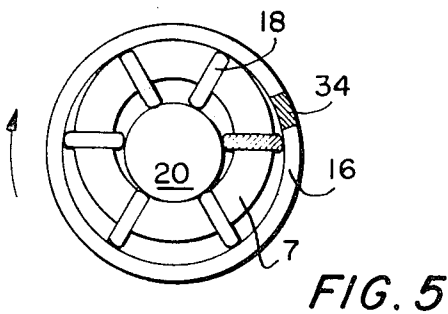


FIG. 5

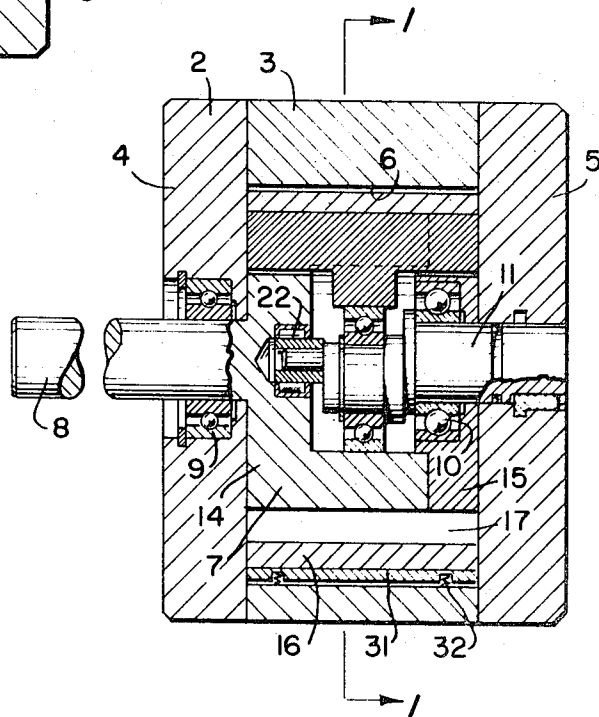


FIG. 2

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1

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SLIDING-VANE ROTARY FLUID DISPLACEMENT MACHINE

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13 Claims

ABSTRACT OF THE DISCLOSURE

A sliding-vane rotary fluid displacement machine which can be utilized as a motor, a pump or a compressor and includes a rotor carrying a plurality of sliding vanes which are positively moved outward by an eccentric as the rotor rotates. The rotor and vanes are surrounded by a cylinder which is supported on the tips of the vanes and rotates with the rotor about the axis of the eccentric.

BACKGROUND OF THE INVENTION

This invention relates to the art of sliding-vane type rotary fluid displacement machines and particularly to vane type gas-operated motors.

Conventional sliding-vane rotary gas motors have the undesirable characteristics of an inability to operate satisfactorily at low speeds, say 100 r.p.m. Generally, this undesirable characteristic is caused by the failure of the vanes to be thrust outward against the motor bore. Many attempts have been made to hold the vanes out at low speeds but generally such attempts have reduced the motor's ability to operate at high speeds and also greatly increased the normal wear of the vanes. In addition, although sliding-vane type motors can operate at relatively high speeds, their maximum speeds are greatly limited by the relatively high friction caused by the rubbing speed of the vane tips on the motor bore.

SUMMARY OF THE INVENTION

The principal object of this invention is to provide a sliding-vane rotary fluid displacement machine which will operate satisfactory at both high and low speeds and will markedly decrease the wear of the vanes as compared to conventional machines of this type.

Other important objects of this invention are: to provide a sliding-vane rotary machine which has its vanes held outward against the surrounding rotor bore at all times; to provide a sliding-vane rotary machine having a cylinder that rotates with the rotor; to provide a sliding-vane rotary machine having a rotary cylinder that is supported on the tips of the rotor vanes; to provide a sliding-vane rotary machine wherein the relative sliding movement or rubbing speed between the vane tips and the rotor bore is less than one tenth the corresponding relative movement in conventional sliding-vane machines; to provide a sliding-vane rotary machine having a much higher terminal speed as compared to conventional machines; and to provide a sliding-vane rotary machine in which metal vanes can be used practically.

The foregoing objects of this invention are generally attained in a machine including a rotor; a cylinder eccentrically surrounding the rotor and forming a fluid displacement space between the cylinder and the rotor, a set of sliding vanes carried by the rotor with their outer ends or tips engaging the interior of the cylinder, and a fixed eccentric holding the vanes outwardly to support the cylinder so that it rotates with the rotor about the eccentric axis of the eccentric. This construction greatly reduces the rubbing speed of the vane tips thus greatly reducing wear of the vanes and allowing the machine

2

to operate at higher speed. The reduction in friction also allows the practical use of vanes made of a variety of materials, such as metal, which are easier to manufacture, more economical, have better frictional properties, have more strength, etc. Finally, when used as a motor, it will operate at very low speeds as well as very high speeds.

BRIEF DESCRIPTION OF DRAWINGS

The invention is described in connection with the accompanying drawing wherein:

FIG. 1 is a cross-section of a sliding-vane rotary motor taken on line 1—1 of FIG. 2 and illustrating applicant's invention;

FIG. 2 is an axial section taken on line 2—2 of FIG. 1;

FIGS. 3 to 5 are schematic views showing sequential relative positions of the rotor and cylinder in the motor; and

FIG. 6 is a schematic sectional view of a vane illustrating its correspondence to a portion of a cylinder.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The air motor 1 shown in the drawing includes a casing 2 composed of a body 3 and a pair of end plates 4 and 5. The end plates 4 and 5 are attached to the casing body 3 by several longitudinal bolts (not shown) passing through each of the casing parts.

The casing body 3 includes a cylindrical bore 6 extending between the end plates 4 and 5 and having the several moving components of the motor 1. A cylindrical rotor 7 is mounted eccentrically in the bore 6. One end of the rotor 7 includes a driving shaft 8 extending through the end wall 4 and rotatably mounted in a bearing 9. The other end of the rotor 7 is rotatably mounted on a bearing 10 supported on a fixed spindle 11 attached in the end wall 5. The rotor 7 is made in two parts 14 and 15 to aid in assembly of the motor. The rotor part 14 is cup-shaped and is integral with the drive shaft 8. The rotor part 15 is an end cap which closes the open end of the rotor part 14.

The rotor 7 is surrounded by a hollow cylinder 16 which fits in the casing bore 6 with a substantial amount of clearance therebetween. Both the rotor 7 and the cylinder 16 are sealingly engaged by the end walls 4 and 5 of the casing to substantially prevent leakage while allowing these elements to rotate freely with small friction losses. The cylinder 16 is eccentrically spaced from the rotor 7 to form a crescent shaped fluid displacement space 17 between the rotor 7 and the cylinder 16.

The rotor 7 carries a plurality of radially extending sliding vanes 18 spaced around its periphery and having their tips or outer edges engaging the interior of the cylinder 16. The inner edges of the vanes 18 ride on a bearing 19 rotating on a fixed eccentric 20 which is adjusted to cause the cylinder 16 to rotate in the casing bore 6 and about the axis of the eccentric 20. The eccentric 20 is supported on the inboard end of the spindle 11. In essence, the cylinder 16 is carried on the outer tips of the sliding vanes 18 and the vanes 18 are carried on the eccentric 20, as a result, causing the cylinder to rotate around the axis of the eccentric.

The inner end of the eccentric 20 and spindle 11 is further supported in a bearing 22 mounted in the rotor part 14, thus providing the spindle with support at both ends and contributing additional support to the rotor 7.

Fluid is fed into and exhausted from the crescent-shaped fluid displacement space 17 through ports located in the end wall 5 of the casing 2. The casing body 3 includes an inlet 23 and an outlet 24. The inlet 23 extends along an inlet passage 25 formed as a groove in the bore 6 to an inlet port 27, which is also formed as an

arcuate groove formed in the inside face of the end wall 5. The outlet 25 also is connected by an outlet passage 28 to an exhaust port 29 formed in the face of the end wall 5.

The compressed air or other fluid is fed through the inlet port 27 into the fluid displacement space 17, expands and drives the vanes 18, rotor 7 and cylinder 16 in a clockwise direction, as shown in FIGS. 1 and 3 to 5. When the motor rotates sufficiently, the compressed fluid is exhausted through the exhaust port 29 and out of the outlet 25. It is believed that the general principles of the operation of a sliding-vane rotary motor is well known to those skilled in the art and that the foregoing is sufficient to understand the rotation of the motor 1.

In order to prevent leakage between the inlet and exhaust ports 27 and 29, a plurality of seals 31 are placed between the bore 6 and the exterior of the cylinder 16. Each seal 31 is located in a longitudinal groove in the wall of the bore 6 and extends the length of the cylinder 16. Light springs 32 are positioned behind each seal 31 near its ends to urge it inwardly against the cylinder 16. The placement of the seal 31 can be adjusted to substantially balance the pressures acting on the exterior and interior of the cylinder 16 so that the eccentric bearing 19 does not carry a large unbalanced load. In other words, the seal 31 are located so that the cylinder 16 substantially floats in the bore 6.

As the rotor 7 and its vanes 18 rotate, the tips of the vanes 18 support the cylinder 16 and carry it with the rotor 7 so that the cylinder 16 rotates at about the same speed as the rotor. The exact relationship between the speeds of the rotor 7 and cylinder 16 will vary due to the motor speed, the friction between the vane tips 18 and the cylinder 16, and the unbalanced load on the cylinder. Generally, it has been found that the cylinder 16 and rotor 7 will rotate at equal r.p.m. at low motor speeds and that the cylinder 16 will rotate at slightly less r.p.m. than the rotor 7 at high speeds. However, the foregoing does not always hold true. The relative speed between the cylinder 16 and rotor 7 is a function of the frictional forces acting on these two elements, generally the rubbing friction of the vanes on the cylinder 16, and these frictional forces vary under different conditions. At times, the cylinder 16 rotates slightly faster than the rotor 7 at high motor speeds.

FIGS. 3 to 5 illustrate three sequential positions of the rotor 7, vanes 18 and cylinder 16 when the cylinder 16 is traveling at a slightly slower speed than the rotor 7. A spot 34 is placed on the cylinder 16 in each of these views to illustrate the relative positions of the cylinder 16 as the motor parts rotate.

I have found that this motor will rotate at very low speeds, say 100 r.p.m., and also rotate at about twice the maximum speeds of a conventional sliding-vane motor having similar dimensions. In addition, the rubbing tip speeds of the vanes 18 on the cylinder 16 is reduced about 95 percent of that in a conventional motor, which will provide much longer wear life of the vanes and will enable the use of other materials, such as metal, which are not practical in conventional sliding-vane motors.

In order for the vanes 18 to support the cylinder 16 firmly, without wobbling of the cylinder, each vane 18 comprises a diametrical portion of an imaginary cylindrical roller. This construction of the vane 18 is shown in FIG. 6. The roller 36 is shown in dotted lines while the vane 18 is shown in solid lines. The axes of the roller 36 and the vane 18 are the same and the edge 37 of the vane 18 are portions of the circumference of the roller 36. By having cylindrical edges 37, the vanes 18 can move slightly out of a diametrical relationship with the cylinder 16 as they must do as the rotor 7 rotates, without allowing the cylinder 16 to wobble.

Although the described embodiment is referred to as a motor, it could be a compressor simply by driving the

drives shaft 8. The concepts set forth could also be used in making a pump.

I claim:

1. A sliding-vane rotary fluid displacement machine comprising:

a casing;

a rotor mounted in said casing to rotate about a given axis and carrying at least three vanes slidably projecting from its circumference at angularly spaced locations about said axis;

a cylinder freely mounted in said casing surrounding said rotor and having an axis eccentric to said rotor axis to provide a fluid displacement space between said rotor and the interior of said cylinder; and

means positively holding said vanes outward against the interior of said cylinder and simultaneously supporting and forcing said cylinder to rotate about said eccentric axis while said rotor rotates about its axis.

2. The machine of claim 1 wherein: said vanes have arcuate edges engaging said cylinder and said means.

3. The machine of claim 2 wherein: each of said vanes has a cross-section which corresponds to a portion of a cylindrical cross-section.

4. The machine of claim 1 wherein:

said casing includes a pair of end walls engaging the ends of said rotor and cylinder and sealing said fluid displacement space; and

at least one of said end walls contains a fluid port for introducing fluid into said fluid displacement space.

5. The machine of claim 4 wherein: at least one of said end walls contains a fluid port for exhausting fluid pressure from said fluid displacement space.

6. The machine of claim 5 wherein: said casing includes sealing means engaging the outer periphery of said cylinder to separate said fluid ports.

7. The machine of claim 1 wherein: said means is a fixed eccentric engaging the inner edges of said vanes.

8. The machine of claim 7 wherein: said eccentric includes a bearing rotating around an eccentric core and engaging the inner edges of said vanes.

9. The machine of claim 7 wherein:

said rotor includes a rotatable shaft projecting from one end of said casing and is rotatively supported on a fixed spindle mounted at the other end of said casing; and

said eccentric is supported on said fixed spindle.

10. The machine of claim 7 wherein: said rotor is rotatably supported on said fixed spindle at two separate points located on the opposite sides of said fixed eccentric.

11. A rotary fluid displacement machine comprising:

a rotor;

a cylinder eccentrically surrounding the rotor, mounted free to rotate with said rotor and forming a fluid displacement space between said cylinder and rotor;

a pair of opposite end plates closing the ends of said displacement space and sealingly engaging the ends of said cylinder and rotor;

a set of vanes slidably carried by said rotor and having their outer ends extending outwardly from the circumference of said rotor and engaging the interior of said cylinder; and

a fixed eccentric cam holding the vanes outwardly to support said cylinder so that it rotates with said rotor about an axis eccentric to the rotor axis.

12. The machine of claim 11 wherein: said eccentric includes a bearing surface engaging said vanes to reduce wear.

13. A rotary fluid displacement machine comprising:

a rotor;

a casing having a bore eccentrically surrounding the rotor;

a pair of opposite end plates closing the ends of said bore and sealingly engaging the ends of said rotor;

5

a set of vanes slidably carried by said rotor and having their outer ends engaging the interior of said bore; and
a fixed eccentric cam holding the vanes outward against said bore to cause the outer tips of said vanes to continuously engage said bore during the rotation of said rotor.

6

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