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Winkelstrater et al.

[11] **3,817,667**

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[54] **ROTARY-PISTON MACHINE**

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[52] **U.S. Cl.** **418/206,** 418/150

[51] **Int. Cl.** **F01c 1/18**

[58] **Field of Search** 418/206, 150

[56] **References Cited**

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[57] **ABSTRACT**

A rotary-piston machine has a housing receiving a pair of geometrically identical impellers each having a pair of identical lobes extending from a hub. Each impeller is symmetrical about a first plane passing through its rotation axis and bisecting its lobes and about a second plane perpendicular to the first plane at the rotation axis. Each lobe is formed with an outwardly circularly convex end surface defining an outer circle and the hub is formed with a pair of outwardly circularly convex lateral surfaces defining an inner circle concentric with the outer circle. Each lobe further has a pair of lateral intermediate surfaces which blend into the lateral surfaces through first transition surfaces and with the end surfaces through second transition surfaces. The intermediate surfaces are straight and parallel to the longitudinal axis of the impeller. The second transition surfaces are circularly arcuate and centered on an intermediate circle equidistant between and concentric with the inner and outer circles.

1 Claim, 9 Drawing Figures

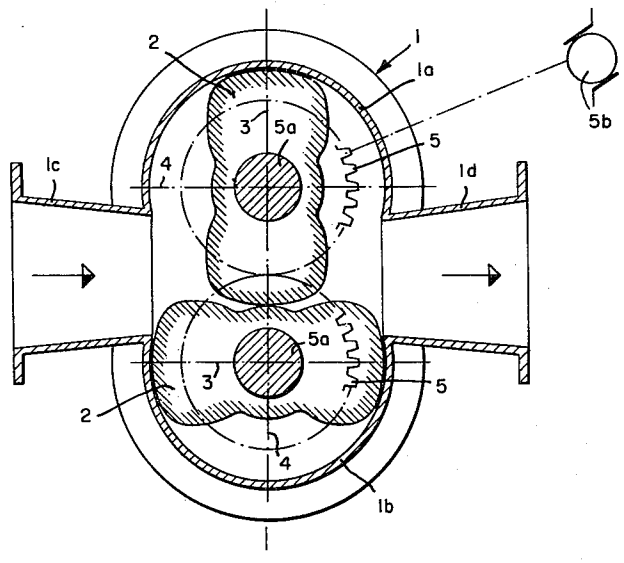
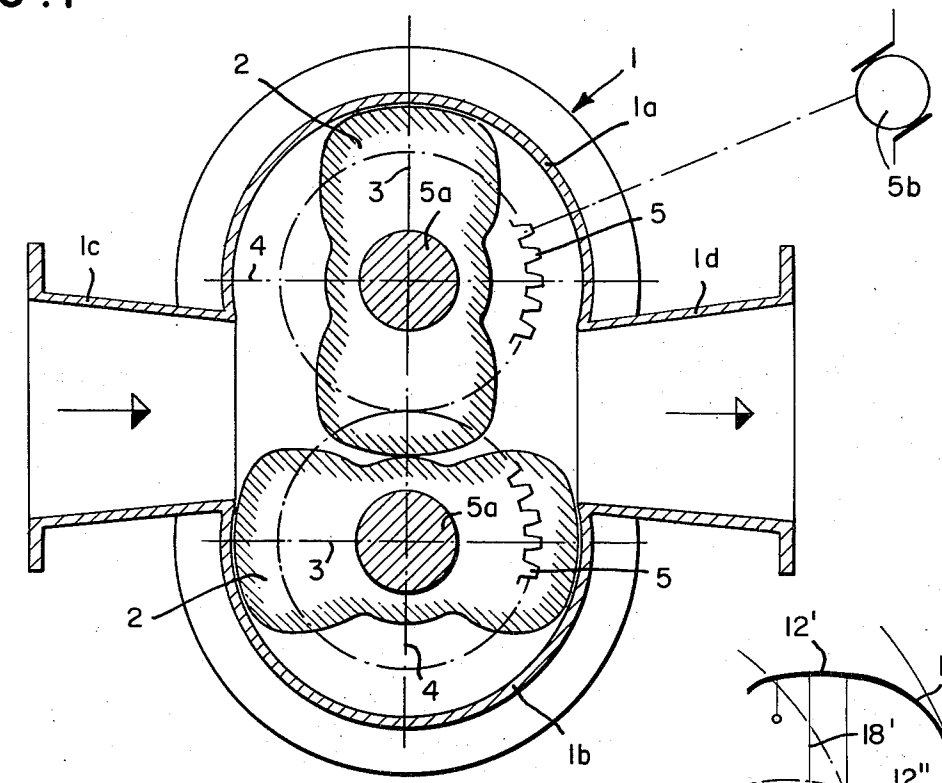


FIG. 1



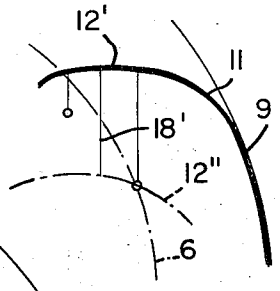


FIG. 2A

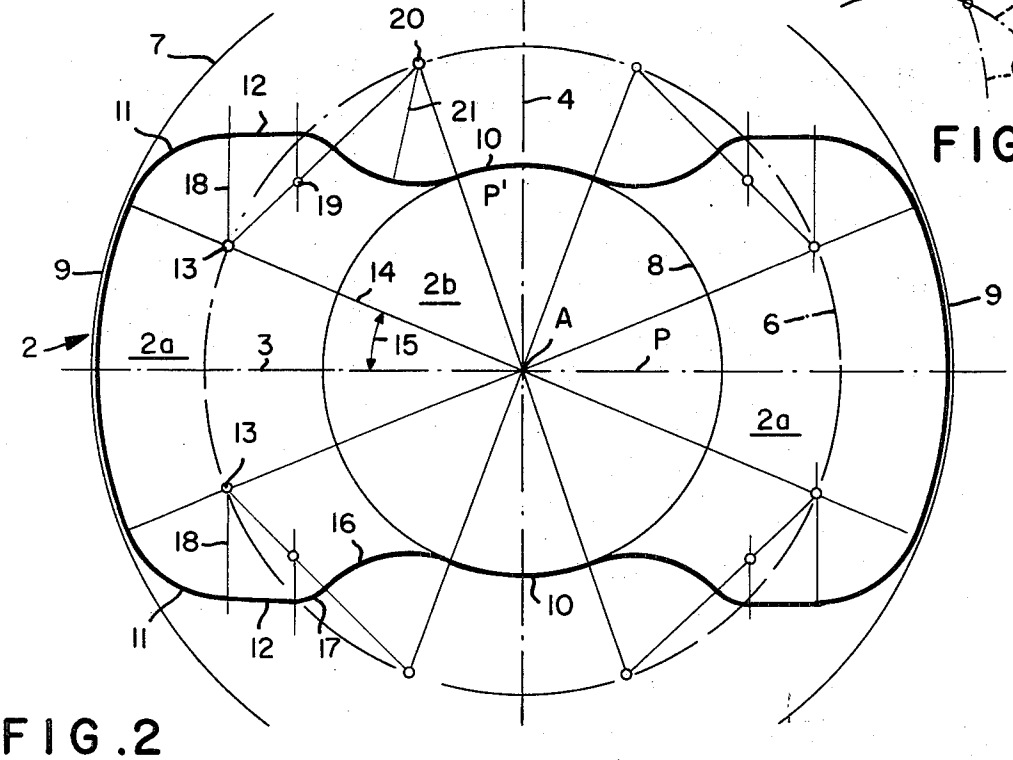


FIG. 2

FIG. 3

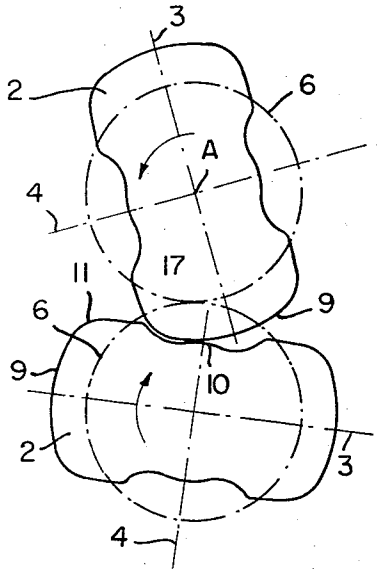


FIG. 4

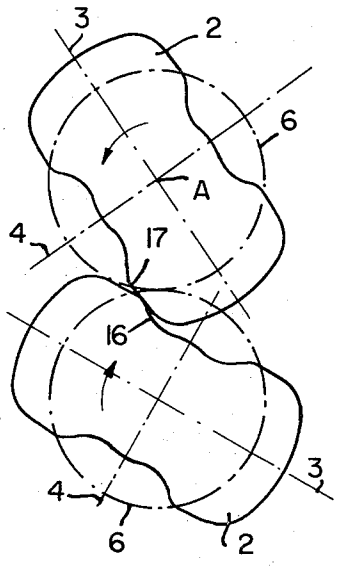
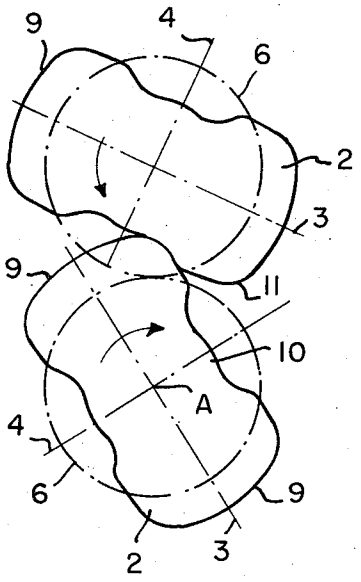


FIG. 5



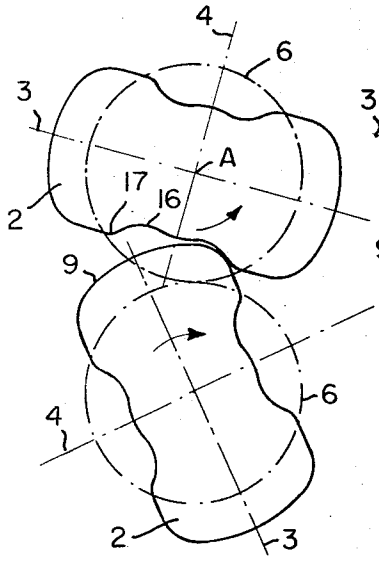


FIG. 6

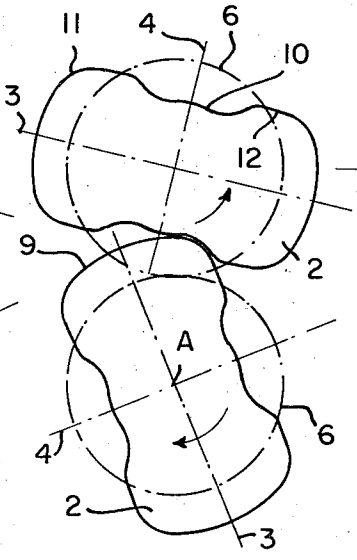


FIG. 7

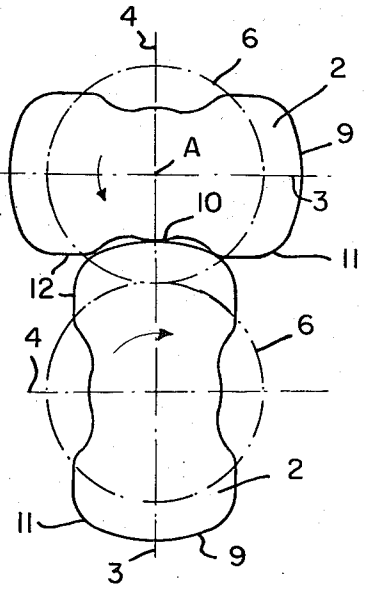


FIG. 8

ROTARY-PISTON MACHINE

FIELD OF THE INVENTION

The present invention relates to a rotary-piston machine. More particularly this invention concerns a rotary pump of the Roots or straight-vane type or a compressor.

BACKGROUND OF THE INVENTION

A rotary pump of the lobar or straight-vane type has a pair of rigid impellers which are rotated in a housing in opposite senses about respective parallel rotation axes. As the impellers turn they form a pocket of fluid which is transferred from one side of the housing to another, from an inlet to an outlet, allowing such a machine to be used either as a vacuum pump or as a compressor, or even conceivably as a prime mover.

The impellers are usually symmetrical about two mutually perpendicular planes passing through their respective rotation axis, one of the planes bisecting the two lobes which extend from a central hub. On rotation the end of one impeller passes over the side of the other, while the opposite end sweeps the inside of the housing, and then vice versa so that leakage is possible as the result of the play between the impellers as they rotate and between these impellers and the housing.

The usual shape of such impellers is determined with respect to the desired use. When high efficiency with a minimum of backflow is required the ends of the lobes are made relatively broad to provide the greatest possible sealing surface against the interior of the housing. Such a construction, however, means that the ends of the lobes will strike the opposite hubs on rotation thereby making a good deal of noise, and creating a good deal of wear. When only line contact, although actually the impellers sweep the housing with a minute clearance, is used the coaction with the hubs is smoother, but a good deal of leakage is inevitable.

OBJECTS OF THE INVENTION

It is therefore an object of the invention to provide an improved rotary-piston machine.

Another object is the provision of such a machine wherein back leakage is reduced to a minimum while the machine is operable at a high rate of speed.

Yet another object is to provide an improved impeller for such a rotary-piston machine.

SUMMARY OF THE INVENTION

These objects are attained according to the present invention by a rotary-piston machine of the above-described general type whose impellers each have circularly arcuate end surfaces defining an outer or crown circle, borrowing terminology from the gear art. The hub is also formed with two circularly arcuate lateral surfaces which lie to either side of the first plane of symmetry of the impeller which bisects the lobes, these lateral surfaces defining an inner or root circle. Each lobe is further formed with a pair of intermediate surfaces that can be parallel to the first plane of symmetry. Each intermediate surface blends into the neighboring end surface through an outwardly circularly convex (constant radius of curvature) transition region having a center of curvature lying near or on an intermediate circle concentric with the inner and outer circles and equispaced radially therebetween. In the other direction each transition surface blends into the neighboring lateral surface through two transition surfaces, one outwardly convex and the other inwardly convex, this latter surface having the same radius of curvature as the transition surface to the other side of the respective intermediate surface, with its center of curvature also lying on the intermediate circle.

In such an arrangement the two impellers form extremely tight seals with each other and with the walls of their housing. At the same time the compressor or vacuum pump so constituted functions virtually noiselessly and has a long service life.

According to other features of the present invention the end surfaces subtend arcs of 45° and the transition surfaces bordering on these end surfaces each have their center of curvature on a diameter drawn through the respective rotation axis and forming an angle of 22.5° with the first (longitudinal) plane of symmetry. This diameter also marks the end of the end surface.

Such impellers are easily produced through the use of a milling machine and a pattern. The shape is not unduly complicated so that conventional machining tools may be used to cut them.

DESCRIPTION OF THE DRAWING

The above and other objects, features, and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. **1** is a sectional view of the machine according to the present invention;

FIG. **2** is a view of an impeller according to this invention;

FIG. **2A** is a view of a detail of an alternative embodiment of the present invention, and

FIGS. **3–8** show the machine rotors of the fluid machine in successive positions.

SPECIFIC DESCRIPTION

The machine according to the present invention can be used as a compressor or vacuum pump. It comprises a housing **1** having a pair of lobes **1***a* and **1***b* each receiving an impeller **2.** The housing further has an inlet **1***c* and an outlet **1***d.* Each impeller is mounted on a shaft **5***a* connected outside the housing **1** to a gear **5** which meshes with an identical gear **5** of the other impeller. A motor **5***b* serves to counterrotate the two impellers **2.** Fluid is drawn in the inlet **1***c* and expelled from the outlet **1d.**

As seen in FIG. **2** each impeller has a pair of lobes **2***a* and a hub **2***b*, giving it a generally dumb-bell or peanut shape. The particular shape of the impeller **2** is best described with reference to three terms borrowed from the spur-gear vocabulary: inner root or dedenum circle **8,** outer crown or addendum circle **7,** and intermediate or pitch circle **6.** All of these circles **6–8** are concentric on the rotation axis A of the impeller **2,** and the pitch circles of the impellers **2** osculates. The impellers **2** are elongated transverse to their rotation axis and each has a longitudinal axis **3** passing through the axis A, and a transverse axis **4** orthogonal to the axis **3** and also passing through the axis A. These axes **3** and **4** form with the axis A respective mutually perpendicular symmetry planes P and P′ for the impeller **2.**

FIG. **2A** also shows how an arcuate surface **12′** can replace the straight section **12,** in which case an imaginary arc **12″** parallel to the arc **12′** is spaced from it

by a radial distance 18' equal to the radial distance 18.

The very ends of each lobe 2*a* are circular arc segments 9 lying on the crown circle 7 and subtending an arc 45° wide, this arc being bisected by the plane P to form an angle 15 of 22.5° between the axis 3 and the two lines 14 drawn to the axis A and marking the ends of the arcuate end 9. Thereafter the end 9 goes over into two circularly arcuate corners 11 subtending arcs of 77.5° about a center 13 lying at the intersection of the respective line 14 and the pitch circle 6. Thus a line 18 drawn from the center 3 out at a right angle to the axis 3, and therefore parallel to the axis 4, defines the arc 11 with the end of line 13 on each side of end 9. Continuing on in toward the hub 2*b* the edge configuration becomes that of two arcs 17 and 16 that join a circularly arcuate region 10 that lies on the root circle 8. The arcuate section 17 has a center of curvature 19 and the section 16 a center 20 which all lie on a straight line extending through the point 13. In addition the point 20 lies outside the impeller 20 on the circle 6 and the point 19 lies inside the impeller. The radius 21 of curvature of the arcuate region 16 is identical to the radium of curvature 18 of the region 11, which distance is equal to the radial spacing from circle 6 to each of circles 7 and 8.

The particular shape of each impeller 2 described above allows the two to operate with a minimum of noise or leakage. FIGS. 3–8 describe their operation.

As soon as the position shown in FIG. 1 is left, as shown in FIG. 3, the corner 11 fits snugly into the arcuate region 16, these two arcuate regions being of identical arc length. Thereafter, as shown in FIG. 4 the surface 12 of one impeller rolls over the surface 17 of the other impeller, and then vice versa until the two surfaces 17 and 12 come into momentary contact, as shown in FIG. 5. Thereafter the region 11 fits into the arc 16 (FIG. 6) the end 9 begins to osculatingly glide across the section 10 (FIG. 7) and finally the two assume mutually orthogonal positions (FIG. 8) whence all of the above positions are repeated around the next quarter-region of each impeller.

We claim:

1. In a rotary-piston machine having a housing receiving a pair of geometrically similar impellers rotatable in opposite senses about respective parallel rotation axes, each impeller being formed with a hub and a pair of diametrically opposite lobes extending from said hub, each impeller having a first axial plane of symmetry bisecting said lobes and a second axial plane of symmetry perpendicular to said first plane, the improvement wherein:

each lobe has a circular-arc segment end surface of constant radius of curvature defining an outer circle centered on the respective impeller rotation axis;

said hub has a pair of circular-arc-segment lateral surfaces of constant radius of curvature on opposite sides of said first plane and defining an inner circle concentric with and lying within said outer circle;

each lobe has a pair of mutually parallel rectilinear intermediate surfaces lying on opposite sides of said first plane between said inner and outer circles and parallel to said first axial plane of symmetry bisecting said lobes;

each lobe has a pair of first transition surfaces on opposite sides of said first plane and each lying between a respective intermediate surface and a respective lateral surface; and

each lobe has a pair of outwardly circularly convex second transition surfaces of constant radius of curvature on opposite sides of said first plane and each lying between a respective intermediate surface and a respective end surface and each centered substantially on an intermediate circle concentric with and lying between said inner and outer circles, the intermediate circle of each impeller osculating the intermediate circle of the other impeller, each of said second transition surfaces having a center of curvature lying on said intermediate circle, each of said end surfaces subtending a circular arc of substantially 45°, each of said first transition surfaces being formed of a pair of neighboring curved surfaces, one of each pair of curved surfaces being inwardly convex and adjoining a respective lateral surface, and the other of each pair of curved surfaces being outwardly convex and adjoining the respective intermediate surface, said one of each pair of curved surfaces having a radius of curvature similar to that of each second transition surface, and a center of curvature lying on said intermediate surface, the center of curvature of each of said second transition surfaces lying at the intersection of said intermediate circle and an imaginary diameter from the respective rotation axis forming an angle of substantially 22.5° with said first plane, said intermediate circle being equispaced radially between said inner and outer circles.

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