

Sept. 5, 1950

A. E. McMANUS

2,521,592

SLIDING VANE ROTARY PUMP

Filed Dec. 29, 1945

4 Sheets-Sheet 1

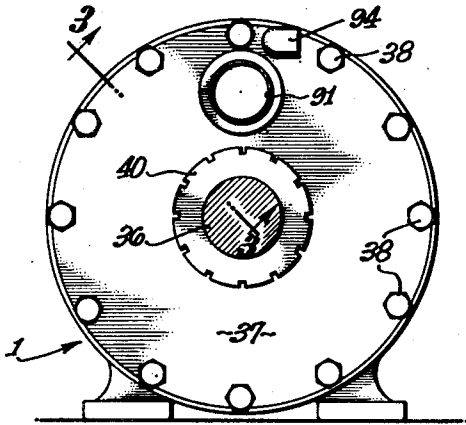


Fig. 2.

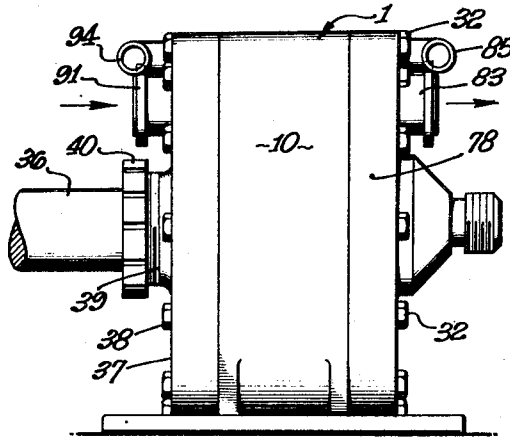


Fig. 1.

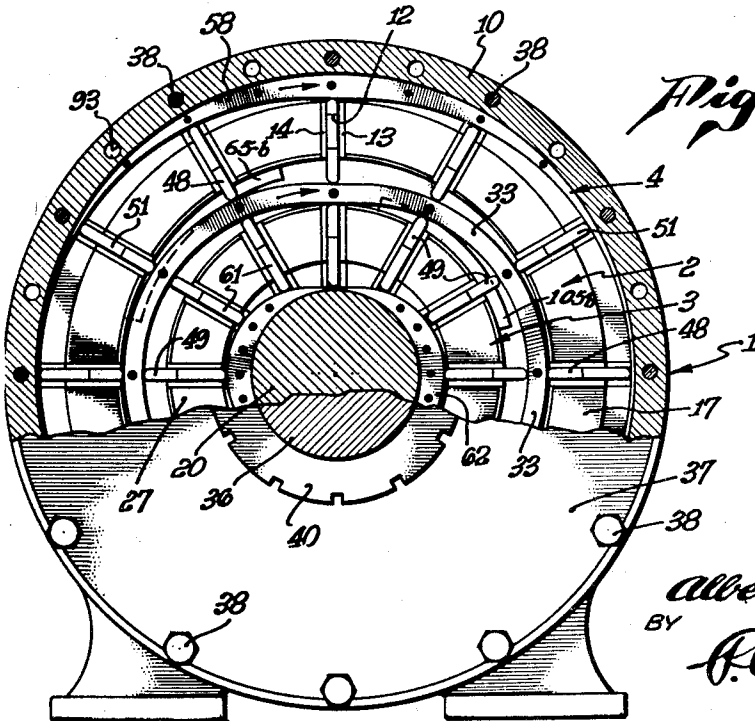


Fig. 5.

INVENTOR
Albert E. McManus
 BY *R. L. Weilein*
 ATTORNEY

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A. E. McMANUS

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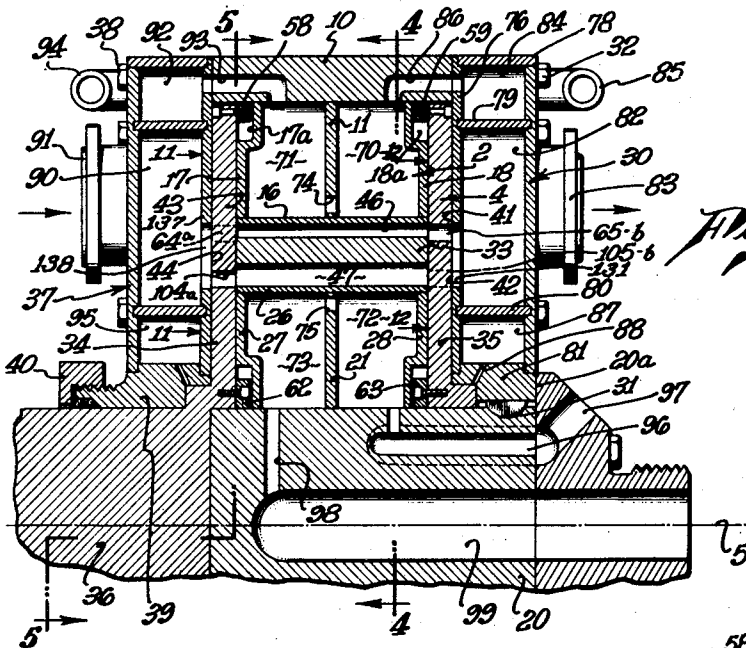


Fig. 3.

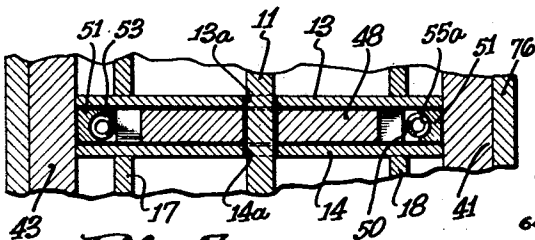


Fig. 7.

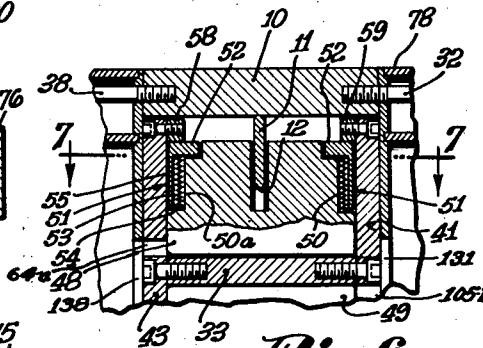


Fig. 6.

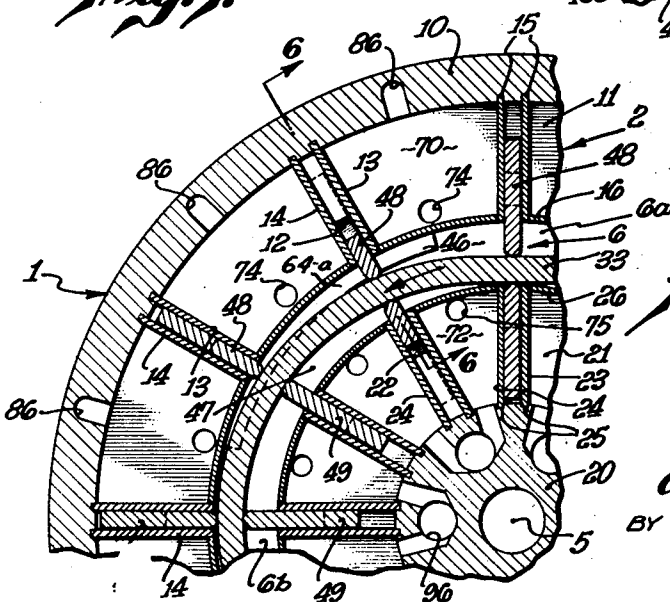


Fig. 4.

INVENTOR
Albert E. McManus
BY *B. W. Weilin*
ATTORNEY

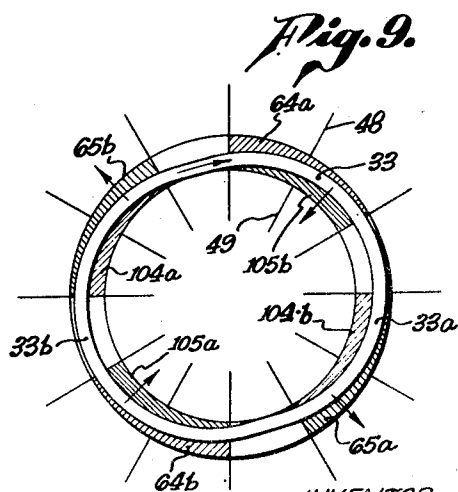
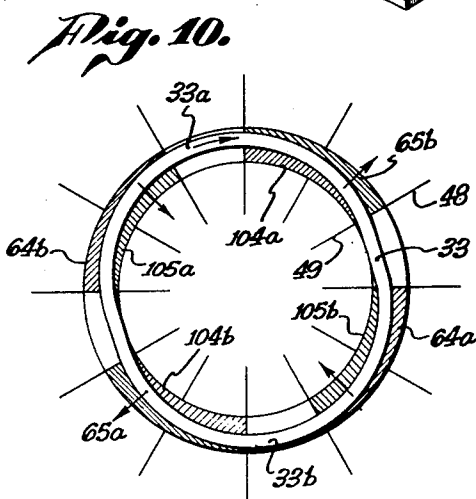
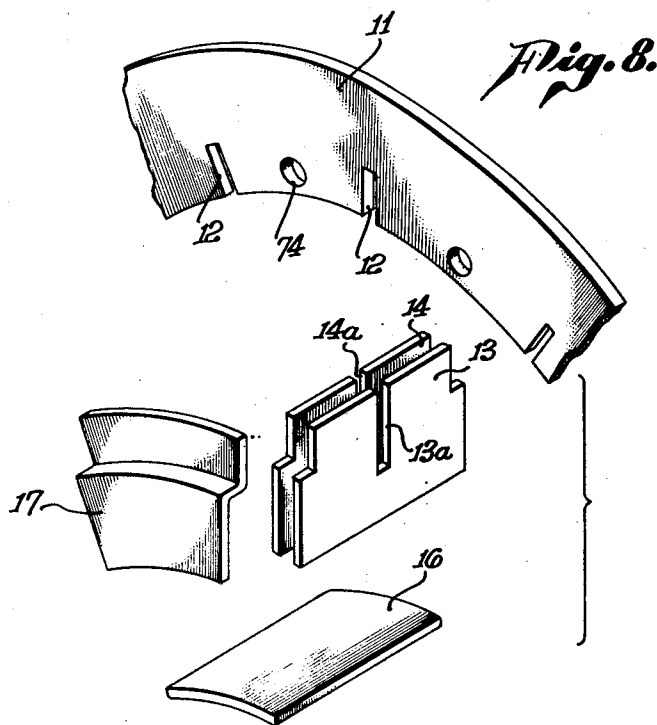
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A. E. McMANUS
SLIDING VANE ROTARY PUMP

2,521,592

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INVENTOR
Albert E. McManus
BY *R. W. Weir*
ATTORNEY

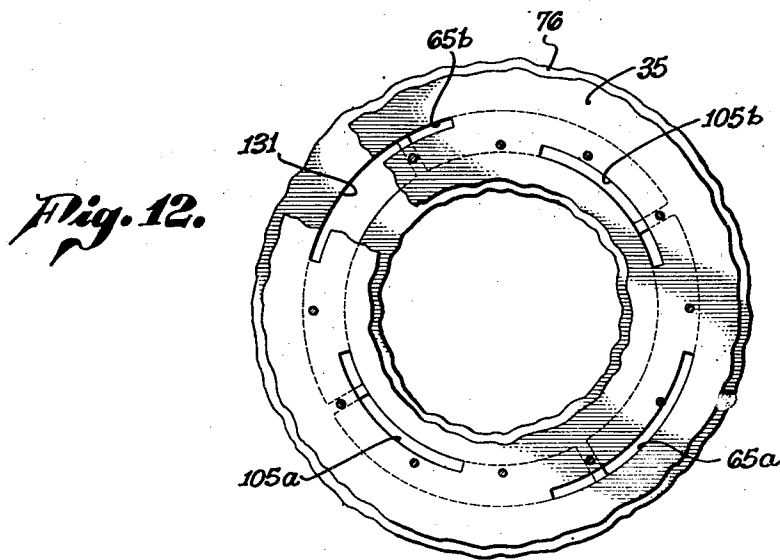
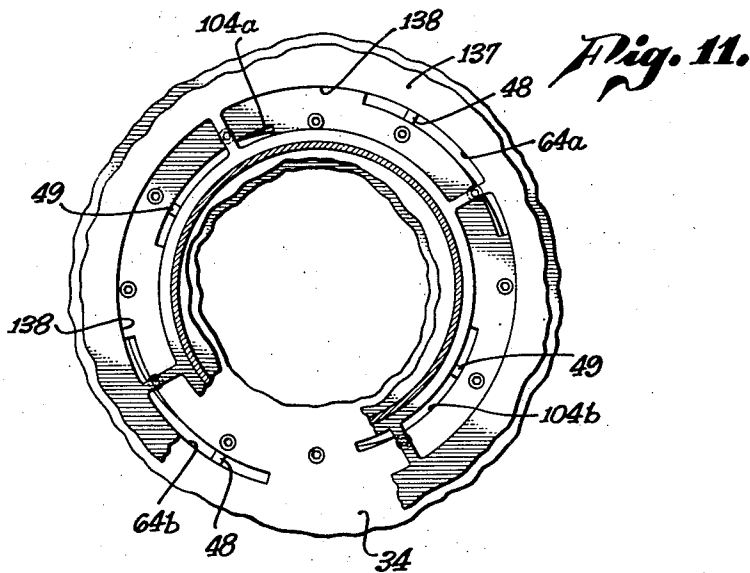
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A. E. McMANUS
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INVENTOR.
Albert E. McManus
BY
Paul A. Weilsin
ATTORNEY

UNITED STATES PATENT OFFICE

2,521,592

SLIDING VANE ROTARY PUMP

Albert E. McManus, Los Angeles, Calif.

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13 Claims. (Cl. 103—123)

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This invention relates to a vane type pump.

It is an object of this invention to provide a pump of this type capable of operating at high speed and of handling large amounts of fluid, which is of light weight and which may be fabricated in an inexpensive manner.

It is another object of this invention to provide a vane type pump of a balanced design, so that no radial load is imposed on the rotating parts by the pressure of the fluid handled.

It is another object of this invention to provide a vane type pump capable of operation in either direction.

It is another object of this invention to provide such a pump wherein there is no centrifugal force acting on the vanes.

It is another object of this invention to provide such a pump in which the force acting to urge the vanes to sealing relation is substantially constant for all positions of the vanes and independent of the speed of the pump.

It is still another object of this invention to provide a vane type pump which is adapted without alteration to handle liquid or gases.

It is still another object of this invention to provide a vane type pump in which there is no knock caused by fluid locked in the pump.

It is still another object of this invention to provide a vane type pump in which pulsations in the output are substantially reduced.

It is still another object of this invention to provide such a pump having large chambers for cooling fluid.

It is still another object of this invention to provide such a pump adapted to have the major parts formed by assembling and joining suitable stampings of sheet stock, or of sheet stock and tubing.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of one embodiment of the invention. For this purpose there is shown a form in the drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

In the drawings:

Figure 1 is a side elevation of a pump incorporating the features of the invention;

Figure 2 is an end elevation, as seen from the left in Figure 1;

Figure 3 is a fragmentary section on an en-

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larged scale, taken as indicated by line 3—3 of Figure 2;

Figure 4 is a fragmentary cross section, taken as indicated by line 4—4 of Figure 3;

5 Figure 5 is a cross section partly in elevation, taken as indicated by line 5—5 of Figure 3, on a reduced scale;

Figure 6 is a fragmentary cross section taken as indicated by line 6—6 of Figure 4;

10 Figure 7 is a fragmentary cross section on an enlarged scale, taken as indicated by line 7—7 on Figure 6;

Figure 8 is a pictorial view illustrating the manner of fabricating one of the pump stators;

15 Figures 9 and 10 are diagrams, useful in explaining the operation of the pump; and,

Figures 11 and 12 are cross sections taken substantially as indicated by the correspondingly numbered lines on Figure 3, and partly broken away to show the structure.

20 The pump is of that type wherein a pair of relatively rotatable members provide opposed eccentric surfaces, the distance between which at a given point varies in accordance with the rotation of the members, one of said members carrying one or more vanes radially movable to contact the surface of the other member and divide the space between the surfaces into pockets. Appropriate inlet and outlet ports are provided 30 for the space. Thus, as the capacity of a pocket increases as the surfaces separate due to rotation of the member, fluid enters through the inlet. As the capacity of the pocket decreases due to the surfaces approaching each other, fluid 35 is discharged through the outlet.

In the present instance, one of the members provides a pair of cylindrical surfaces forming an annular space. The other member of ring like form is disposed in this space, the opposite sides 40 of the ring providing surfaces which are eccentric with respect to the cylindrical surfaces. The member providing the cylindrical surfaces is provided with a plurality of vanes adapted to contact respectively the opposite surfaces of the ring-like member. Thus, a plurality of pockets 45 are provided on opposite sides thereof, which vary in capacity in response to relative rotation between the members, as above pointed out.

Referring to the drawings, the pump comprises 50 a casing 1 providing a pair of stators 2 and 3, and enclosing and rotatably supporting the rotor 4. The casing 1 comprises an external cylindrical member 10 to which is secured intermediate the ends thereof a central ring 11 (see Figures 3, 4 and 8) provided with angularly spaced 55 radial slots 12 extending from the inner periph-

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ery. Transversely extending radial pairs of spaced plates 13 and 14 are secured to the ring 11 respectively on opposite sides of each slot 12. Each plate 13 and 14 has a slot 13-a, 14a into which the ring 11 fits, the plates 13, 14 extending beyond the outer periphery of ring 11 where they are accommodated in grooves 15 in the outer member 10 (see Figure 4). Cylindrical segments 16 are fitted between the projecting inner ends of adjacent pairs of plates 13 and 14 at the inner periphery of the ring 11. Circular segments 17 are positioned between the outer ends of adjacent pairs of plates 13 and 14, and between the member 10 and segments 16, cooperating to form an outer ring spaced axially from the central ring 11. Segments 18 similarly form a ring on the opposite side of the ring 11. The assembly just described is secured together in a fluid tight manner by any suitable means, for example as by oven brazing, forming the outer stator 2. As clearly shown in the drawings, all of the pieces 11, 13, 14, 16 and 17 are adapted to be formed of plate material, as by a stamping operation.

The inner stator 3 is built up from plate materials in a similar way on a central stub shaft or tubular member 20 (see Figures 3 and 4). Thus, there is a central ring 21 having slots 22 extending radially from the outer periphery, with transverse radial pairs of plates 23 and 24 secured therein, the inner ends of plates 23 and 24 being accommodated in grooves 25 in the member 20. Cylindrical segments 26 are provided on the outer periphery of the ring 21 between adjacent pairs of transverse plates 23 and 24, and circular segments 27 are provided between segments 26 and member 20, and between the outer ends of said pairs of plates. The segments 27 cooperate in a manner similar to segments 17, and form a ring on one side of the central ring 21, segments 28 forming a ring on the opposite side. The assembly is secured together in a fluid tight manner as before, for example by a brazing process.

The outer and inner stators 2 and 3 are secured in assembled relation by means of a manifold structure 30 (Figure 3), which is secured against a shoulder 20-a on the central member 20, and is restrained from rotating thereon as by a key 31. The outer member 10 carrying the stator 2 is secured to the manifold 30 by a number of bolts 32.

When assembled, the cylindrical segmental plates 16 and 26 provide surfaces curved about the axis of rotation 5 of the rotor structure 4, to provide a space 6 in which a ring like portion 33 of the rotor 4 revolves. Furthermore, the exterior surfaces of the plates or outer rings formed respectively by the segments 17 and 27, and by the segments 18 and 28 are aligned.

The rotor 4 comprises a pair of spaced circular plates 34 and 35 between which the ring like portion 33 extends. Plate 35 is rotatably mounted on the central member 20 near its outer end, plate 34 being rotatably supported on the inner end of the member 20 and secured to a driving shaft 36 by which the rotor 4 may be driven.

A manifold structure 37, similar to the manifold 30, is secured on the opposite end of the member 10 as by bolts 38 and provides a bearing 39 for the shaft 36. A suitable packing means 40 prevents leakage along the shaft. The member 10 has a greater axial length than the stators 2 and 3. The arrangement is such that when assembled these stators provide a space 41 between the face 42 of manifold 30 and the face of

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plates 18 and 28 for accommodating the rotor plate 35 and a similar space 43 between the face 44 of manifold 37 and the face of plates 17 and 27 for accommodating the rotor plate 34.

The ring like portion 33 of the rotor 4 extends between the plates 34 and 35 through the space 6 defined between the stators dividing the space into outer and inner fluid spaces 6-a and 6-b. As clearly shown in Figures 4 and 5, the ring like portion 33 is non-circular with respect to its axis of rotation 5, thus, when the rotor revolves the opposite surfaces of the ring move toward and away from the stator surfaces defining the space 6.

To cause such movement to create a pumping action, the spaces 6-a and 6-b are each divided into a plurality of pockets 46 and 47, by vanes or blades 48 and 49 slidably accommodated in the spaces between the transverse plates 13-14, and 23-24, and urged to seal respectively against the opposite surfaces of the ring 33. Spring means are provided for resiliently urging the vanes 48 and 49 to sealing relation, and means are provided for maintaining the springs under substantially constant tension.

Thus, referring to Figures 6 and 7, each outer corner of the vanes 48 are recessed at 50 to accommodate a shoe 51 having a head 52 for confining a compression spring 53 against a shoulder 54 on the vane. As shown in Figure 7, the leg 55 of the shoe has a recess 55-a for confining the spring 53 in one plane, the spring being confined in a plane at right angles thereto between the inside of the leg 55 and the face 50-a of the recess 50.

To appropriately tension the springs 53, cams 58 and 59 are provided on the rotor plates 34 and 35 respectively for engaging the shoes 51. These cams 58 and 59, as clearly indicated in Figure 5, have configurations similar to the outer surface of ring portion 33. Thus, as this surface moves away from the stator 2, at any given point, the vanes 48 adjacent thereto are caused to move toward the surface by the cams 58 and 59; when the surface moves away from the stator, the cams 58 and 59 allow the vanes to move outwardly. It will be understood that the parts are so proportioned that shoes 51 act on the vanes 48 only through the springs 53, the cams 58 and 59 serving to maintain the force exerted by these springs substantially constant for all positions of the vanes. Circular recesses 17-a and 18-a are provided about the stator 2 for accommodating cams 58 and 59.

The vanes 49 of the inner stator 3 are similarly arranged to be urged resiliently against the inner surface of ring portion 33, being provided with shoes 61 for this purpose, engaging cams 62 and 63, which have the same configuration as the inner surface of the ring portion 33.

As the rotor 4 rotates, the pockets 46 and 47 increase and decrease in volume cyclically. Thus, by providing an inlet to the pockets when their volume is increasing and an outlet when their volume is decreasing, a pumping action may be provided. For this purpose the rotor plate 34 is provided with a pair of oppositely disposed arcuate ports 64-a and 64-b of limited angular extent, the rotor plate 35 being provided with a similar pair of ports 65-a and 65-b, disposed at 90° with respect to ports 64-a and 64-b (see Figures 9, 10, 11 and 12). The ports 64-a and 64-b serve as inlet ports, the ports 65-a and 65-b serving as outlet ports, being caused to communicate with the appropriate pockets 46

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in the outer space 6—a by the valving action of the vanes 48, as the ports are swept past the vanes 48 by the rotation of the rotor 4. Similarly, inlet ports 104—a and 104—b are provided in plate 34, and outlet ports 105—a and 105—b are provided in plate 35, for the pockets 47 in the inner space 6—b, being controlled by the blades 49. The manifold structure 37 forms the intake manifold, for which purpose the inner plate 137 thereof, which contacts plate 34, is provided with an annular opening 138 overlying the inlet ports 64—a, 64—b, 104—a and 104—b. The structure 30 then forms the outlet manifold, the plate 76 thereof which contacts the plate 35 having an annular opening 131 overlying the outlet ports 104—a, 104—b, 105—a and 105—b.

To provide a mechanically balanced rotor as well as to improve the pumping action, the rotor 4 is made symmetrical about the axis 5. Thus, as shown in Figures 4, 5, 9 and 10, the ring-like portion 33 is made of oval form to provide a pair of diametrically opposite lobes 33—a and 33—b. In this way, diametrically opposite pockets 47 within the ring portion 33 are under identical pressure conditions. Similarly diametrically opposite pockets 46 without the ring portion 33 are also under identical pressure conditions. Thus the fluid pressure on the rotor is always balanced, and the capacity of the pump is increased. Further, since the outer pockets 47 are at right angles with the inner pockets 46 under corresponding pressure conditions, the output is more nearly constant.

The operation of the pump is best explained in connection with the diagrams, Figures 9 and 10, wherein the vanes 48 and 49 are indicated by single lines and for clarity both the inlet and outlet ports are shown although actually only one or the other set of ports would be visible, the inlet ports being indicated by cross hatching inclined toward the right, the outlet ports being indicated by cross hatching inclined toward the left. Referring to Figure 9, with the rotor ring 33 rotating clockwise, the outer surface of the ring in the upper right hand and the lower left hand quadrants of the figure, will be moving inwardly, causing pockets 46 in those quadrants to increase in volume, and liquid to be drawn into them through the intakes 64—a and 64—b. In the other two quadrants, the outer surface of the rotor ring 33 will be moving outwardly forcing fluid from the pockets 46 in these quadrants through the outlet ports 65—a and 65—b.

Movement of the rotor 4 will cause the ports 64—a and 64—b, and 65—a and 65—b to sweep past the vanes 48, so that those pockets formerly connected with the inlet ports will be connected to the outlet ports and vice versa. Thus, after 90° rotation of the rotor 4 conditions will be as shown in Figure 10. Therein, the size of the pockets in the upper right hand and the lower left hand quadrants is decreasing and fluid is being discharged therefrom through the ports 65—b and 65—a which are now positioned to communicate with them. Similarly, fluid is now being drawn into the pockets in the other quadrants since the ring surface therein is moving inwardly, ports 64—a and 64—b now being in the appropriate positions.

The operations of fluid intake and discharge by the pockets within the rotor ring 33 through ports 104—a and 104—b and 105—a, 105—b respectively, are exactly the same as just described but differ therefrom by a 90° movement of the

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rotor 4, in the example shown embodying a two lobed ring, it being readily apparent that the points of closest approach of the inner surface to its stator are spaced 90° from the points of the closest approach of the outer surface to its stator.

The chambers 70, 71 and 72, 73, Figures 3 and 4 which are formed in the stator members 2 and 3 as an incident to their method of fabrication, are well adapted for the circulation of a coolant fluid should such be desirable. For this purpose, each pair of chambers 70 and 71 is placed in communication by suitable apertures 74 through the center ring 11. Similarly, each pair of chambers 72 and 73 communicates through aperture 75 in ring 21.

The manifold structure 30 is built up of a pair of circular plates 76 and 77 secured in spaced relation by a plurality of concentric rings 78, 79 and 80, and a base member 81. The rings 79 and 80 provide a space 82 in the manifold for receiving the discharge from ports 65—a and 65—b, and 105—a and 105—b and leading it to a common outlet 83. The rings 78 and 79 form a chamber 84 for leading coolant from an inlet 85 to a plurality of ports 86 in the member 10, each of which communicates with a pocket 70. The ring 80 and the base 81 form a chamber 87 which may be used for lubricant, the lubricant being fed through suitable ducts, one of which is shown at 88, to the relatively rotating surfaces. The chamber 87 may be supplied with lubricant by suitable means (not shown).

The manifold structure 37 is quite similar, being arranged to provide a chamber 90 for distributing fluid from an inlet 91 to the inlet ports 64—a and 64—b, and 104—a and 104—b, a coolant chamber 92 into which the ports 93 from the chambers 71 open and having an outlet 94, and a lubricant chamber 95. The central member 20 is provided with a plurality of ports 96 leading from a common inlet 97 to chambers 72, and a common outlet 99 into which ports 98 from spaces 73 open, for coolant flow.

I claim:

1. In a vane pump: a pair of relatively rotatable members having opposed surfaces curved about the axis of rotation and providing a fluid space between the members, a plurality of vanes carried by one of said members for movement in a generally radial direction with respect to said axis to cause their edges to seal against the surface of the other member, whereby said space is divided into a plurality of fluid tight pockets, means providing a cam face, consistently curved with respect to the surface of said other member about said axis and spaced radially from said surface of the other member, said cam face engaging said vanes opposite said sealing edges to maintain said vanes in sealing relation with said surface, said means extending across the ends of said space and sealing against said vanes, and having openings controlled by said vanes in accordance with the relative rotation between said members, to form inlet and outlet ports for said pockets.

2. In a vane pump: a pair of relatively rotatable members having opposed surfaces curved about the axis of rotation and providing a fluid space between the members, a plurality of vanes carried by one of said members for movement in a generally radial direction with respect to said axis to cause their edges to seal against the surface of the other member, whereby said space is divided into a plurality of fluid tight pockets,

means providing a cam face, consistently curved with respect to the surface of said other member about said axis and spaced radially from said surface of the other member, means interposed between said cam face and said vanes resiliently urging said sealing edges toward said surface, and means adapted to form inlet and outlet ports for said pockets, said last mentioned means extending across the ends of said space and sealing against said vanes, and having openings controlled by said vanes in accordance with the relative rotation between said members.

3. In a vane pump: a pair of relatively rotatable members having opposed surfaces curved about the axis of rotation and providing fluid space between the members, a plurality of vanes carried by one of said members for movement in a generally radial direction with respect to said axis to seal against the surface of the other member and divide said space into a plurality of fluid tight pockets, spring means urging said vanes against said surface of the other member, means maintaining the force exerted by said springs substantially constant, comprising a cam having a configuration substantially identical with said surface, and means providing inlet and outlet ports for said pockets, said last mentioned means extending across the ends of said space and sealing against said vanes, and having openings controlled by said vanes in accordance with the relative rotation between said members.

4. In a vane pump: a pair of relatively rotatable members, one of said members having a pair of radially spaced surfaces curved about the axis of rotation provided a space extending about said axis, the other of said members having a ring-like portion accommodated in said space, the opposite surfaces thereof being correspondingly curved and so curved as to cooperate respectively with said first mentioned surfaces to provide a pair of fluid spaces on opposite sides of said ring-like portion, radially movable vanes carried by said one member for engaging the opposite surfaces of said ring like portion and dividing each space into a plurality of fluid tight pockets, the size of which varies in response to relative rotation between the members; means adapted to form inlet and outlet ports for said pockets respectively in accordance with increase and decrease of size thereof; cam means spaced radially inwardly and outwardly of the surfaces of said ring-like portion, and of a configuration corresponding respectively to said surfaces; and means whereby said cam means maintains the vanes in sealing relation with their respective surfaces.

5. In a vane pump: a pair of relatively rotatable members, said members having opposed surfaces curved about the axis of rotation and providing a fluid space between the members, the curvature of one surface differing from that of the other surface, a plurality of radially extending vanes sealing between said surfaces, whereby said fluid space is divided into a plurality of fluid tight pockets which vary in size in accordance with the relative rotation of the members, means forming inlet and outlet ports for said pockets, and means forming chambers for coolant fluid extending about said axis inwardly and outwardly of said space.

6. In a vane pump: a pair of relatively rotatable members, said members having opposed surfaces curved about the axis of rotation and providing a fluid space between the members, the curvature of one surface differing from that of

the other surface, a plurality of radially extending vanes sealing between said surfaces, whereby said fluid space is divided into a plurality of fluid tight pockets which vary in size in accordance with the relative rotation of the members, a pair of plates closing respectively the opposite ends of said space, ports in said plates forming respectively inlets and outlets for said pockets and controlled by said vanes in response to relative movement between the members, means forming a manifold for connecting the ports of each plate, and means forming chambers for coolant fluid extending about said axis inwardly and outwardly of said space.

7. A built up pump element for a vane pump, comprising a center ring, an outer ring spaced axially on each side thereof, cylindrical members connecting respectively the inner and outer peripheries of said rings, angularly spaced pairs of parallel plates extending between said outer rings and between said members, one of said members being grooved to accommodate the ends of said plates, the other member as well as said outer rings having through openings for accommodating the plates as a pair, said center ring having slots extending from that periphery opposite the grooved member part way to the other periphery for accommodating said plates as a pair, said rings, said plates and said members being joined in a fluid tight manner.

8. A built-up pump element for a vane pump, comprising a center ring having angularly spaced radial slots extending from one periphery of said ring for accommodating the vanes, pairs of transverse, spaced radial plates on opposite sides respectively of said slots for guiding the vanes, and extending beyond each periphery of the ring, a cylindrical member extending entirely about one periphery of the ring having an axial length exceeding that of said plates and being slotted to receive the plates, cylindrical segments extending between adjacent pairs of plates along the other periphery of the ring, and circular segments also extending between adjacent pairs of plates as well as between the corresponding cylindrical segment and said member, said member, said plates and said segments being joined in a fluid tight manner.

9. In a vane pump: a stationary member having a pair of opposed curved surfaces providing a fluid space; a rotatable member, comprising a ring-like element having inner and outer surfaces differently curved than the respective surfaces of the stationary member and dividing said space into fluid chambers; a plurality of angularly spaced radially directed vanes carried by said stationary member for movement to engage respectively the surfaces of said rotatable member, said vanes sealing between said members to form fluid tight pockets varying in volume in accordance with the rotation of said rotatable member; said rotatable member including end elements secured to the opposite ends of said ring-like element for rotation therewith to seal said spaces and having angularly spaced ports cooperating with said vanes to form inlets for said pockets when increasing in size as well as angularly spaced ports cooperating with said vanes to form outlets for said pockets when decreasing in size; and means carried by said end elements maintaining said vanes in contact with the surfaces of the ring-like element.

10. In a vane pump: a stationary member, comprising a pair of spaced curved cylindrical

elements cooperating to provide a fluid space, and inner and outer members joined in radially spaced relation to said elements providing spaces extending about said fluid space; a rotatable member having a ring-like element in said fluid space differently curved than said elements and dividing said fluid space into fluid chambers; means forming a plurality of angularly spaced radially directed guides extending respectively between the inner cylindrical element and the inner member, and between the outer cylindrical element and the outer member and dividing said spaces into segments; a radial wall dividing each segment into a pair of coolant chambers; and permitting limited communication therebetween; vanes slidably accommodated in said guides for sealing respectively against the surfaces of said ring-like element, dividing the fluid space into a plurality of fluid tight pockets varying in size in accordance with the rotation of the rotatable member; means forming inlet and outlet ports for said pockets; and means forming a fluid passage connecting corresponding coolant chambers of each pair.

11. In a vane pump: a stationary member, comprising a pair of spaced curved cylindrical elements cooperating to provide a fluid space, and inner and outer members joined in radially spaced relation to said elements providing spaces extending about said fluid space; a rotatable member having a ring-like element in said fluid space differently curved than said elements and dividing said fluid space into fluid chambers; means forming a plurality of angularly spaced radially directed guides extending respectively between the inner cylindrical element and the inner member, and between the outer cylindrical element and the outer member and dividing said spaces into segments; a radial wall dividing each segment into a pair of coolant chambers; and permitting limited communication therebetween; vanes slidably accommodated in said guides for sealing respectively against the surfaces of said ring-like element, dividing the fluid space into a plurality of fluid tight pockets varying in size in accordance with the rotation of the rotatable member; said rotatable member including end elements secured to the opposite ends of said ring-like element for rotation therewith to seal said spaces, and having angularly spaced ports, the ports in one end element cooperating with said vanes to form inlets for said pockets when increasing in size, the ports in the other end element cooperating with said vanes to form outlets for said pockets when decreasing in size; means forming manifolds con-

necting respectively the ports in each end element, said manifolds also providing respectively fluid passages for connecting corresponding coolant chambers of each of said pairs.

12. In a vane pump: a stationary member having a pair of coaxial opposed spaced cylindrical surfaces; a rotatable member comprising a ring-like element accommodated in the space between said surfaces and having a plurality of oppositely directed lobes dividing said space into a plurality of substantially equal fluid chambers on opposite sides of the element; a plurality of angularly spaced radially directed vanes sealing respectively between said element and said surfaces to divide said chambers into a plurality of fluid tight pockets, said pockets varying in volume in accordance with the rotation of the rotatable member; and means carried by said element and having openings for cooperating with said vanes to form inlet ports for these pockets increasing volume and to form outlet ports for those pockets decreasing in volume, the oppositely directed lobes causing corresponding pressure conditions in pockets disposed at right angles and on opposite sides of said element, whereby a more nearly constant out-put is provided.

13. In a vane pump: a stationary member having a pair of opposed, spaced curved surfaces providing a fluid space; a rotatable member comprising a ring-like element dividing said space into fluid chambers and having inner and outer surfaces differently curved than the surfaces of the stationary member, and a plurality of angularly spaced radially movable blades mounted by said stationary member, respectively sealing against the opposite surfaces of said element.

ALBERT E. McMANUS.

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