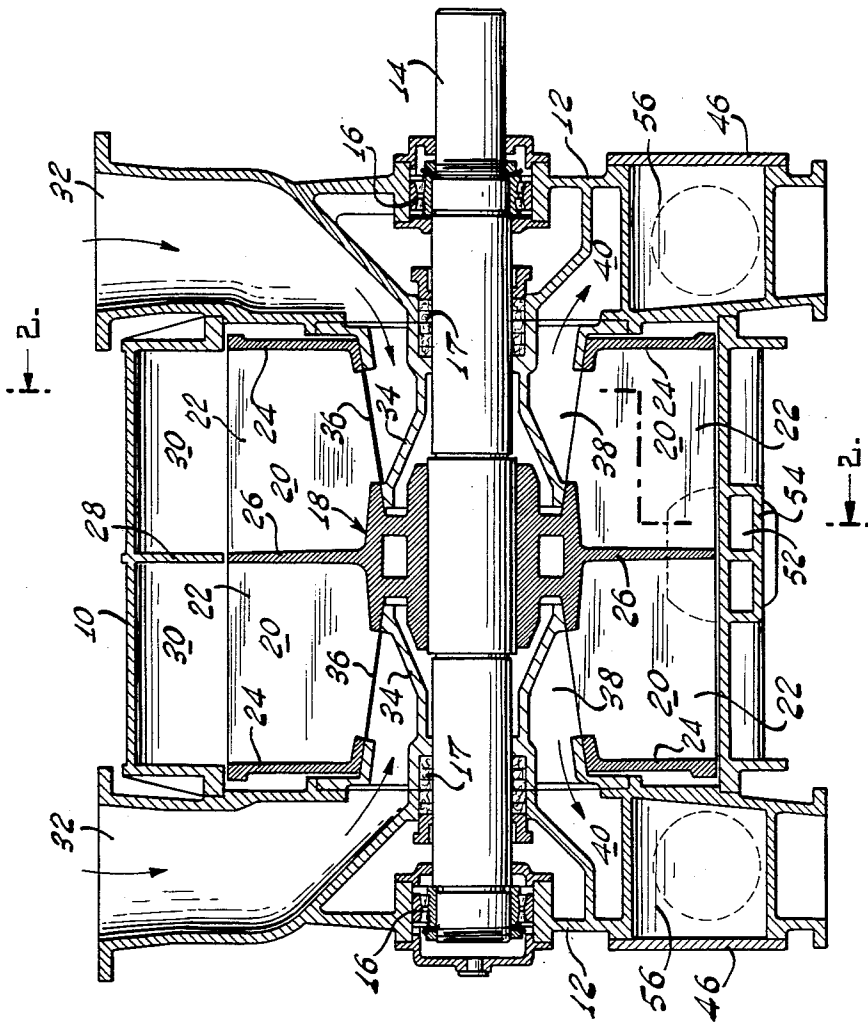


Filed Feb. 20, 1961

PUMPING DEVICE

5 Sheets-Sheet 1



INVENTOR.
IRVING C. JENNINGS
BY
Mises, Woltz, & Woltz
ATTORNEYS

Oct. 27, 1964

I. C. JENNINGS
PUMPING DEVICE

3,154,240

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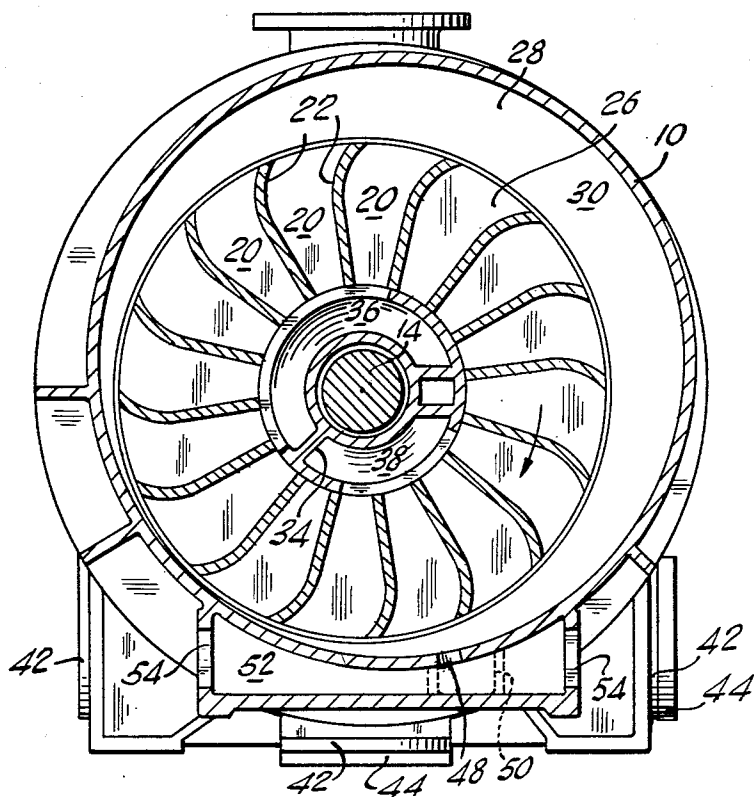


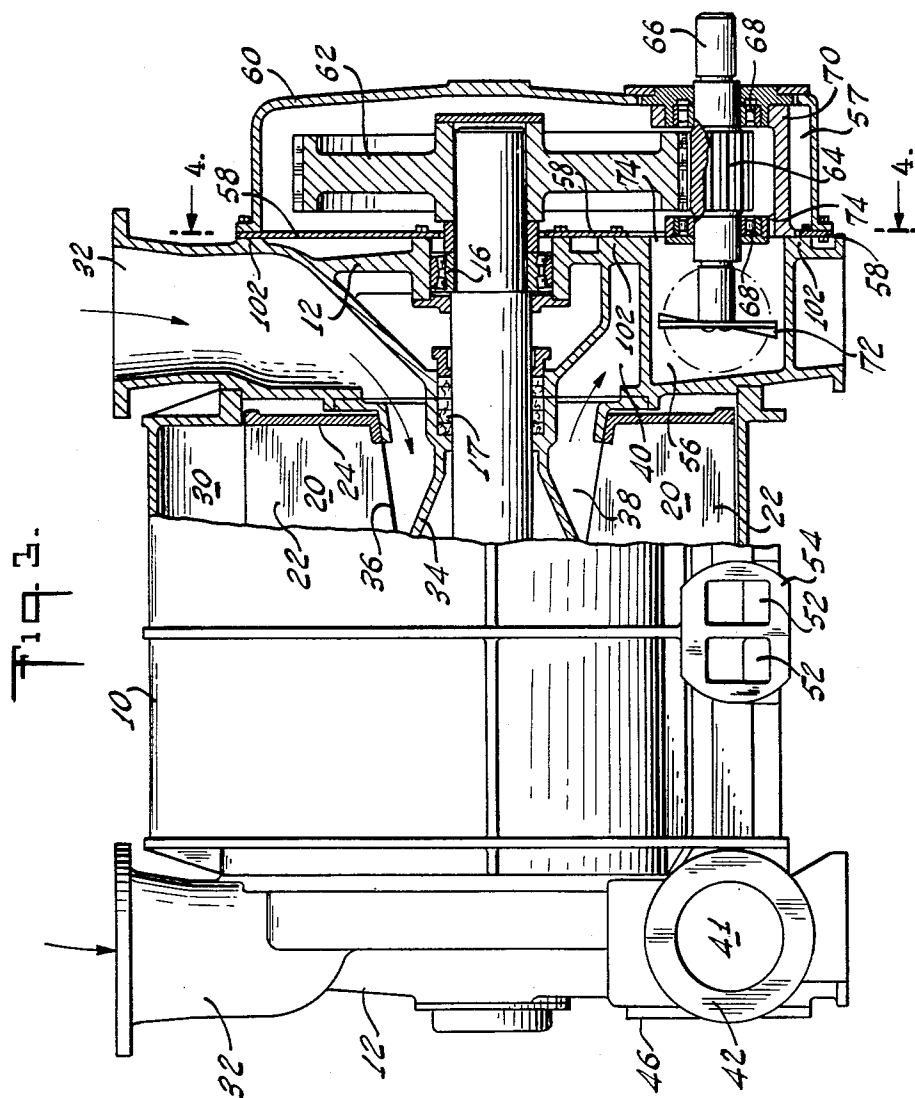
Fig. 2.

INVENTOR
IRVING C. JENNINGS
BY *Moses, Walte, & Walte*
ATTORNEYS

Filed Feb. 20, 1961

PUMPING DEVICE

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INVENTOR:
IRVING C. JENNINGS
BY
Moses, Nolt, & Nolt
ATTORNEYS

Oct. 27, 1964

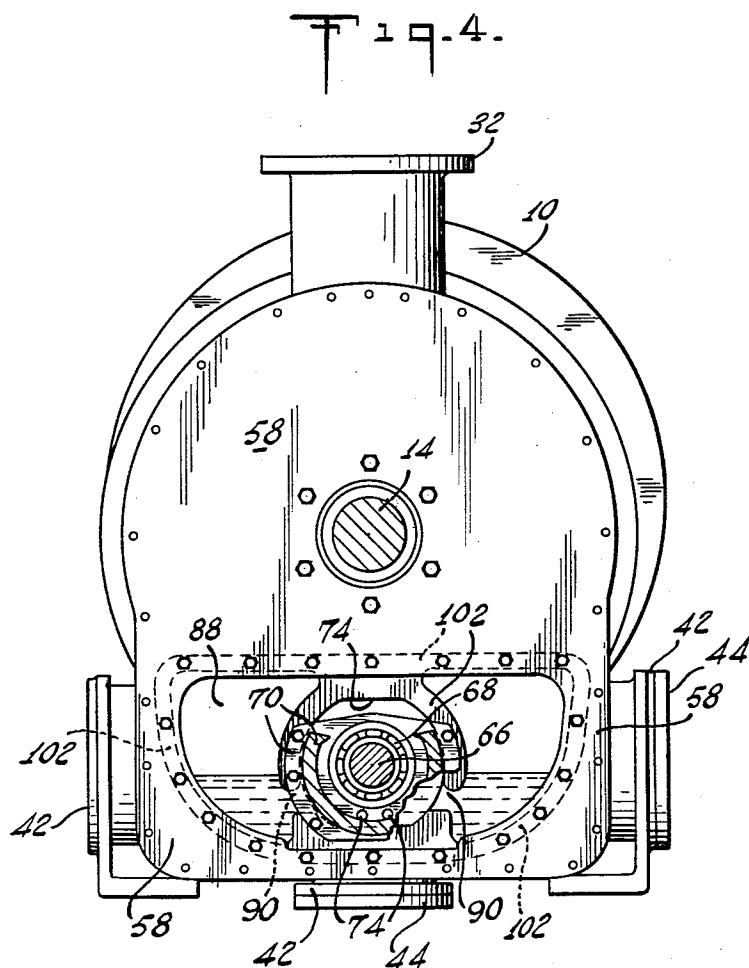
I. C. JENNINGS

3,154,240

PUMPING DEVICE

Filed Feb. 20, 1961

5 Sheets-Sheet 4



INVENTOR
IRVING C. JENNINGS

BY
Moses, Nette, & Nette
ATTORNEYS

Oct. 27, 1964

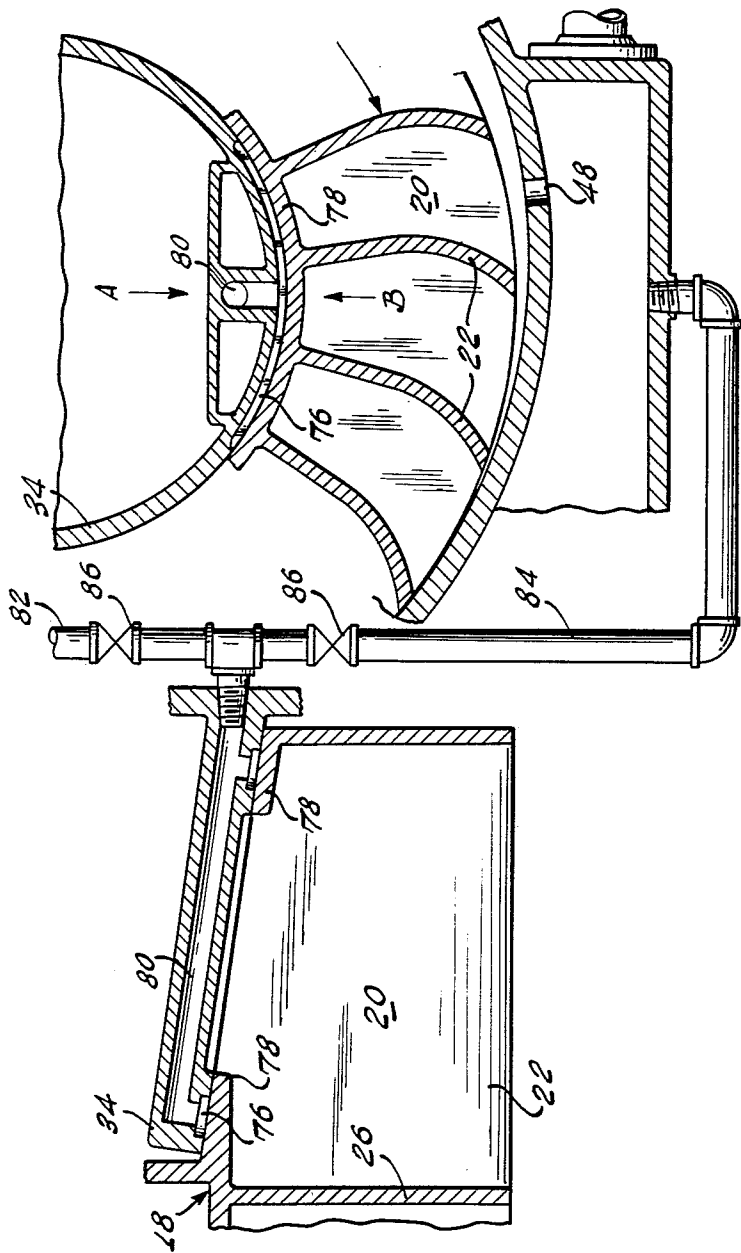
I. C. JENNINGS
PUMPING DEVICE

3,154,240

Filed Feb. 20, 1961

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Fig. 5.



INVENTOR.
IRVING C. JENNINGS
BY
Moses, Maltz, & Maltz
ATTORNEYS

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3,154,240

PUMPING DEVICE

Irving C. Jennings, % Nash Engineering Co.,
South Norwalk, Conn.Filed Feb. 20, 1961, Ser. No. 90,287
10 Claims. (Cl. 230—79)

This invention relates to liquid ring pumps in general and in particular to improvements in the construction of single lobe liquid ring pumps.

In pumps of this type, water or other liquid is revolved in a circular path within a casing by a rotor containing a plurality of blades which form displacement chambers. The liquid, following the casing due to centrifugal force, alternately recedes from and is forced back into the displacement chambers within the rotor. Stationary inlet and outlet ports cooperate with the rotor displacement chambers to permit the air or gas to be drawn into and discharged from the chambers after compression. This type of pump is well known in the art and is fully described by way of example in applicant's prior Patent No. 1,797,980, dated March 24, 1931 and in Patent No. 1,718,294 dated June 25, 1929.

Pumps of this type have preferably been designed with an elliptical or double lobe casing. The advantage of this type design was always believed to reside in the fact that a greater volumetric capacity could be obtained from a given structure at a given speed by having the pumping action take place twice in one revolution, with the added benefit that the radial pressure against the rotor was balanced because the compression cycles take place simultaneously on opposite sides of the rotor.

However, pumps with an eccentric casing or single lobe have certain potential advantages over the double lobe type, particularly at high rates of compression. In single lobe pumps, because a single compression cycle takes place only once per revolution, there is more time for the water to enter and leave the displacement chambers and because the water has a smoother passage around the casing (which may be cylindrical), the pump may be run at a considerably higher r.p.m. In fact, one such example of a single lobe pump according to applicant's construction has a capacity of 6,000 cubic feet per minute which is at least 50% more capacity than the same size pump in the previous double lobe construction, and is capable of producing a much higher vacuum equivalent in performance to two stage pumps in the prior art.

Up to the present time, it has not been thought practical to introduce stationary central port members extending axially into the rotor in single lobe pumps for the reason that the unbalanced side thrust against the rotor dictated a wide clearance between the port member and the rotor due to the deflection of the shaft. Large operating clearances between these ports produce a corresponding loss of efficiency. However, a feature of applicant's present invention is the reduction of unbalanced forces upon the rotor and its shaft so that the port to rotor clearances may be made small. The force balancing techniques of the invention thereby allow the construction of a practical and highly efficient single lobe pump design. Single lobe pumps are advantageous because the central port member may be made in a much smaller diameter than in the prior art double lobe pump due to the fact that only one set of inlet and outlet passages are required therein instead of the usual four passageways of a double lobe pump. This economy of space in a single lobe central port member makes possible the construction of a rotor containing deeper displacement chambers with consequent greater capacity. In actual practice, the average diameter of the port member can be made smaller than one-half the

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diameter of the rotor, while still providing ample area for the inlet and outlet passages therein.

A further feature of applicant's construction is the provision of identical head members upon opposite ends of the pump casing to provide manufacturing economy. The head members are of unique construction and incorporate multiple outlet discharge apertures to provide connection flexibility. Also included is a recessed portion therein which provides an oil reservoir in contact with the cool discharge passageways in the head to enhance the cooling of the lubricant employed when the pump is gear driven.

Yet another feature of the invention is the positioning of the lobe around the rotor in such a way that the weight of the rotor tends to balance the side pressure against the stationary port member.

Another feature of applicant's single lobe pump construction is the provision of an arcuate groove upon the outer periphery of the central port member which when supplied with fluid under pressure, exerts a compression counterbalancing force upon adjacent flange portions of the rotor.

The novel features which are believed to be characteristic of the invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a vertical cross section of one form of the invention;

FIG. 2 is a cross sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a view partially in cross section of another form of the invention employing a gear drive;

FIG. 4 is an end view partially in section taken along lines 4—4 of FIG. 3; and

FIG. 5 is a fragmentary schematic view, partially in section, showing a method of compensating for unbalanced forces upon the rotor.

Referring to the drawings in particular, a single lobe pump according to the invention includes a cylindrical or other shaped single lobed casing member 10 having a pair of identical casing enclosing heads 12 secured at either end. A main drive shaft 14 rotationally mounted in a pair of bearings 16 supports a rotor 18 which is suitably keyed to the shaft. A pair of liquid sealing packing and gland assemblies 17 are fitted into the heads 12 and the ports 34 to prevent liquid seepage about the rotating shaft. The rotor 18 is of the duplex variety containing a plurality of radially extending pumping chambers 20 defined therein by blades 22, side shrouds 24 and a central partition wall 26, which is in line with a corresponding partition wall 28 in the casing 10 to form adjacent crescent shaped lobed pumping chambers 30. Disposed at each end of the pump are a pair of inlet passages 32 formed in the head member 12 which direct inlet air or gas to right and left hand port members 34. The port members include inlet passages 36 in communication with the pumping chambers 20 within the rotor and discharge passages 38 also in communication therewith. The discharge passageways 38 communicate with a header chamber 40 formed in each head 12 to provide access to several alternate discharge port flanges 42 located on the lower sides and bottom of the head. As shown in FIGS. 1 and 4, suitable cover plates 44 are attached to the bottom and right hand flanges 42 to direct all of the pump discharge from header 40 through passageway 41 (FIGS. 3 and 4) to the left hand flange port 42. However, it should be appreciated that the location of the cover plates 44 may be altered to provide any desired discharge direction.

Formed in the end surface of each head 12 is a recess

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chamber 56 which may be covered by a plate 46 (FIG. 1). The recess chamber 56 does not communicate with the interior pump passageways but its function will be explained hereafter in relation to the gear drive embodiment of FIG. 3.

Horizontally disposed in an axial direction along the bottom portion of the casing 10, are two unloader passageways 50 in communication through apertures 48 with the interior respectively of each crescent shaped pumping chamber of the casing 10. Intersecting the passageways 50 and extending transversely across the bottom of the casing, are joining passageways 52 terminating in exit ports 54 on each side of the pump. These passageways function to provide an unloading or drain connection to the pump by virtue of valves and piping not shown connected to the flange portion 54 so that the passageways 50, 52 may be opened to atmosphere whenever it is desired to unload the pump or completely drain the fluid therefrom. However, it should be appreciated that during normal operation the chamber 52 and ports 54 are sealed by means not shown to provide proper pumping operation.

In operation, this form of the invention performs as a liquid ring vacuum pump wherein the receding of liquid within chambers 20 in the area of the intake port 36 creates a suction in passageway 32, and when forced back toward the center of the rotor produces compression through port 38.

Referring to FIG. 2, the lobe 30 is located in such a position that the maximum unbalanced thrust, due to compression, is up from the bottom of the pump in direct opposition to the weight of the rotor, which in the case of a large pump, may be several thousand pounds. This compressive thrust tending to deflect the pump shaft 14 in an upward direction is thereby opposed by the weight of the rotor and effectively canceled. The reduced bending moment on the shaft 14 allows much closer operating tolerances between the rotor surfaces and the port members to yield higher pumping efficiency.

Referring to FIG. 3, wherein like numerals indicate like elements in FIG. 1, a cover plate 58 is attached to a raised boss 102 on the end surface of the head 12 to provide a mounting surface for a gear chamber cover 60. Within the drive gear chamber 57 formed thereby is a gear 62 suitably keyed to the end of shaft 14 in driving engagement with a pinion gear 64 and a pinion shaft 66 mounted in bearings 68, 68 and supported by a bracket 70 to the end surface of the head 12. This specific arrangement of pinion gear mounting directly upon the surface of the pump head is described more fully in applicant's recently issued Patent 2,974,538, dated March 14, 1961. In the arrangement of FIG. 3, the pinion shaft 66 is provided with a portion extending to the left into the recess chamber 56 which has been uncovered by the removal of plate 46, shown in FIG. 1. The chamber 56 acts as an oil reservoir for the lubricant within the gear case, which lubricant is cooled by the contacting relation of the walls of the chamber 56 with the adjacent pump discharge passages 40, 41 which are continually conveying relatively cool seal liquid therethrough. The cooling of the lubricant within the recess 56 is further enhanced by the provision of a propeller or agitator blade 72 affixed to the end of the pinion shaft 66 which creates a continual flow of lubricant within the chamber past the cool walls. Oil cooled within the chamber 56 may readily circulate to the gear chamber 57 through the multiple passageways 74 about and through the bracket 70.

Referring to FIG. 4, additional oil cooling area is provided by surfaces 88 of generally triangular shape which are defined in the head 12 on either side of the recess chamber 56 by portions of the raised boss 102. Relieved portions 90 are formed in the portion of the boss 102 about the opening of the recess chamber 56 to further enhance oil circulation between the chambers. The cover

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plate 58 contains an enlarged oval aperture 100 to provide direct contact of the oil in chamber 57 with the surfaces 88.

Referring to FIG. 5, yet another feature which may be embodied into applicant's novel single lobe pump is disclosed wherein an arcuate groove 76 is recessed into a peripheral portion of the port member 34 adjacent the sealing flange portions 78 of the rotor. A connecting passageway 80 communicates with the arcuate groove 76 and further connects through shut-off valves 86 to alternate pressure supply pipes 82, 84 which may be connected respectively to either an independent source of outside pressure or to the unloading passageway 52 below the casing of the pump. The liquid in chamber 52 communicates with the seal liquid within the casing through the unloading port 48 and it may readily be appreciated that during operation of the pump this liquid is under considerable pressure due to centrifugal force and the conduit 84 will transmit this pressure back to the inside of the pump via the passageway 80 and arcuate grooves 76 to effectively provide a downward force in the direction of the arrow A to effectively cancel the upward compressive force in the direction of the arrow B.

While a specific embodiment of the invention have been shown and described in detail to illustrate the application of the invention principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

I claim:

1. A single lobe liquid ring pump comprising a stationary hollow casing member having at least one cylindrical inside portion, means for mounting said casing member so that the central axis of said inside portion is substantially horizontal, a shaft extending into said casing member, a rotor having means defining a plurality of radially extending displacement chambers mounted upon said shaft for rotation therewith with the outer periphery of said displacement chambers in non-contacting eccentric clearance relationship with said casing member cylindrical inside portion, central port means axially aligned with said shaft and extending axially within said rotor and having inlet and discharge portions in communication with said rotor displacement chambers, said port means having a mean outside diameter less than one-half the diameter of said rotor, head means having inlet and discharge passageways in communication with said port means inlet and discharge portions, and bearing members rotationally supporting the axis of said shaft and rotor below the central axis of said casing member inside portion and horizontally offset from said central axis in the direction of rotation of said rotor so that the dynamic forces acting upon said shaft and rotor are oriented upwardly in a direction substantially opposite to gravity to thereby permit closer operating clearance dimensions between the central port means and the inner ends of the means defining the radially extending displacement chambers of said rotor.

2. A single lobe liquid ring pump according to claim 1 including, partition means within said rotor to divide said displacement chambers into substantially equal volume adjacent pumping portions.

3. A single lobe liquid ring pump according to claim 2 including a gear upon an end portion of said shaft, a pinion gear pivotally mounted upon a portion of said head means in mesh with said gear, cover means cooperating with said head means enclosing said gear and pinion gear to form a lubricant chamber thereabout, whereby the lubricant in said chamber is in continual contact with the relatively cool discharge passageways within said head means.

4. A single lobe liquid ring pump according to claim 3 wherein said head means includes a recessed chamber in communication with and forming a part of said lubricant chamber to provide an enlarged heat transfer surface between the lubricant and the head means.

5. A single lobe liquid ring pump comprising a sta-

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tionary non-rotatable cylindrical casing, a rotor having a plurality of vanes forming a plurality of annularly arranged open ended displacement chambers, said rotor being eccentrically mounted for rotation within said casing and cooperative therewith to circulate a ring of seal liquid in direct contact with the interior of said casing, and a stationary frusto-conical central port member extending into said rotor along the axis of rotation thereof, said port member including inlet and outlet passage means and having a mean outside diameter substantially less than one half the diameter of said rotor, and wherein the diameter of said cylindrical casing and the eccentric displacement of the axis of the rotor relative to the axis of the casing is sufficient to produce a lobe depth adequate to utilize the increased depth of the rotor displacement chambers resulting from the small mean outside diameter of said port member, whereby the volumetric capacity of the pump is at least 50% greater than a double lobe liquid ring pump having similar interior casing dimensions.

6. A single lobe liquid ring pump according to claim 1 wherein said rotor includes axially extending flange portions adjacent said port means, and wherein said port means includes downwardly facing arcuate sector groove means extending through a limited circumferential arc of said port means adjacent said flange portions in a downwardly facing peripheral area of said port means so that liquid under pressure within said groove means will produce a force in the direction of gravity on said rotor to supplement the weight of the rotor in counter-balancing the dynamic bending forces upon said shaft due to operation of said pump.

7. A single lobe liquid ring pump comprising a stationary non-rotatable cylindrical casing, a rotor having a plurality of vanes eccentrically mounted for rotation within said casing and cooperative therewith to circulate a ring of seal liquid in direct contact with the interior of said casing, and a stationary frusto-conical central port member extending into said rotor along the axis of rotation thereof, said port member including inlet and outlet passage means and having a mean outside diameter substantially less than one half the diameter of said rotor whereby the volumetric capacity of the pump is at least 50% greater than a double lobe liquid ring pump having similar interior casing dimensions.

8. A single lobe liquid ring pump according to claim 7 wherein the cylindrical casing is arranged to be mounted with its central axis extending horizontally and wherein the axis of rotation of the rotor is located within the lower quadrant of the cylindrical casing on the rotor upstroke side of a vertical plane passing through the central axis of said cylindrical casing.

9. The method of balancing the unbalanced dynamic forces acting upon the rotor of a single lobe liquid ring pump having a horizontally mounted non-rotatable cylindrical casing member, an annular rotor having a plurality of radially extending displacement chambers mounted on

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a shaft extending through said casing member, and a stationary central port member in axial alignment with said shaft and extending axially inward into the rotor to provide passageways in communication with the interior of said rotor displacement chambers, comprising, the step of positioning the shaft mounting the rotor below the central axis of the casing member and horizontally offset therefrom in the direction of rotation of said rotor whereby the unbalanced forces of compression acting upon said rotor and shaft will act in a direction substantially opposite to gravity to decrease the bending forces thereon to permit an inward radial deepening of the rotor displacement chambers and a corresponding decrease in the diameter of the central port member to substantially less than one-half the diameter of said rotor without having to unduly enlarge the operating clearances between the central port member and the rotor whereby the volumetric capacity of the pump is at least 50% greater than a double lobe liquid ring pump construction having a casing member of similar outside physical dimensions.

10. The method of balancing the unbalanced dynamic forces acting upon the rotor of a single lobe liquid ring pump having a horizontally mounted non-rotatable cylindrical casing member, an annular rotor having a plurality of radially extending displacement chambers mounted on a shaft extending through said casing member, and a stationary central port member in axial alignment with said shaft and extending axially inward into the rotor to provide passageways in communication with the interior of said rotor displacement chambers, comprising, the steps of ascertaining the direction in which the unbalanced dynamic forces upon the rotor due to pump operation act and positioning the shaft mounting the rotor eccentrically in relation to the casing member below the central axis of the casing member and horizontally offset therefrom in the direction of rotation of said rotor whereby the unbalanced dynamic forces upon said rotor and shaft will act in an upward direction substantially opposite to gravity to decrease the bending forces thereon.

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