United States Patent

[11] 3,588,283

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[73] Assignee Nash Engineering Company
Norwalk, Conn.
Continuation of application Ser. No. 730,131, May 17, 1966, now abandoned.

[54] VACUUM PUMP OR COMPRESSOR
8 Claims, 4 Drawing Figs.

[52] U.S. Cl. 417/68
[51] Int. Cl. F04c 19/00
[50] Field of Search 230/79

[56] References Cited
UNITED STATES PATENTS

2,195,174	3/1940	Jennings	230/79
2,230,405	2/1941	Jennings	230/79
2,302,747	11/1942	Dardelet	230/79
3,006,533	10/1961	Adams	417/68
3,217,975	11/1965	Jennings	417/68
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ABSTRACT: The present invention includes a vacuum pump wherein passageways are formed for controlling a predetermined shroud pressure independently of assembly clearances. This invention includes selectively angularly locating passageways between peripheral lobe sweep chambers and rotor end face chambers, and between said rotor end face chambers and a rotor hub. Internal gas and liquid leakage due to pressure differentials in respective positions within the pump assembly is minimized.

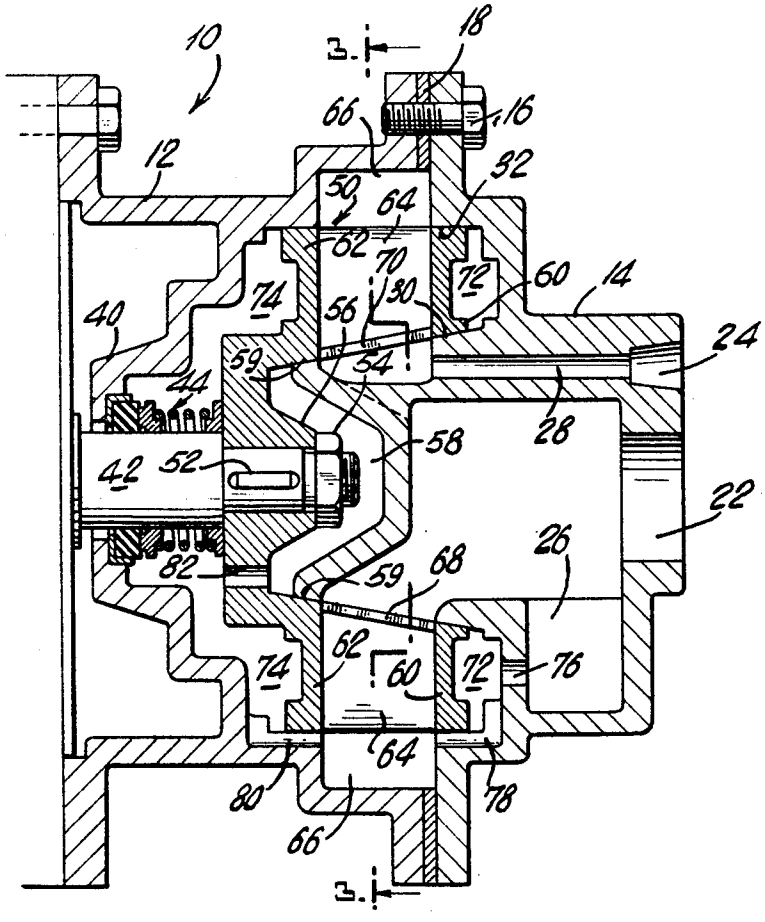


Fig. 1.

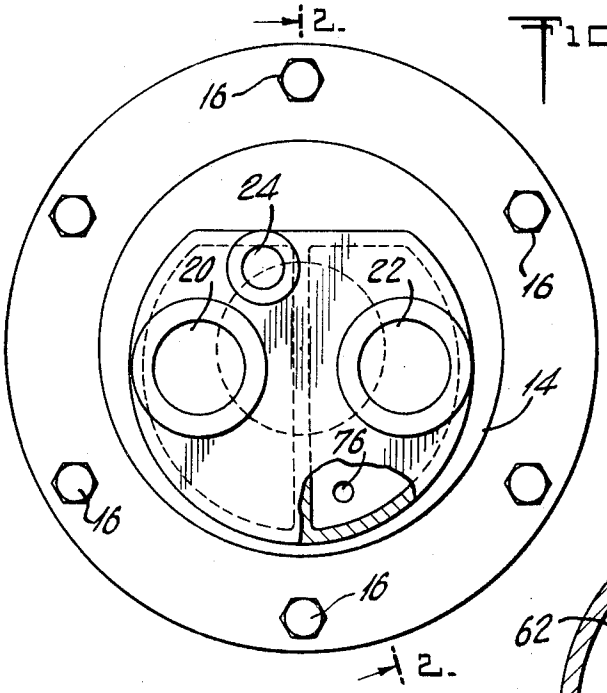
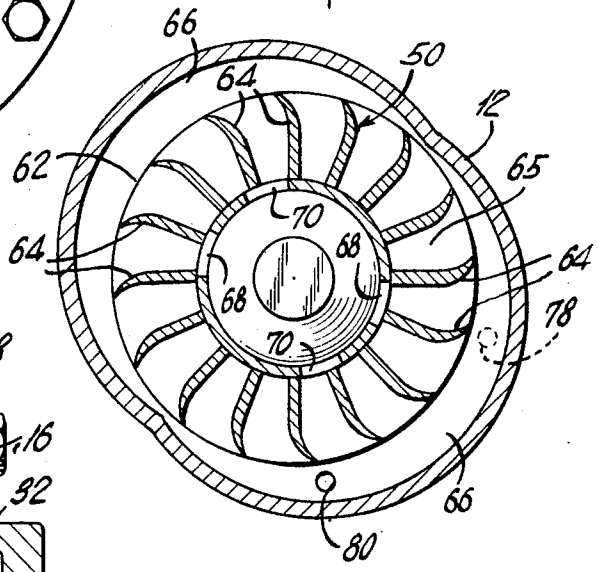


Fig. 3.



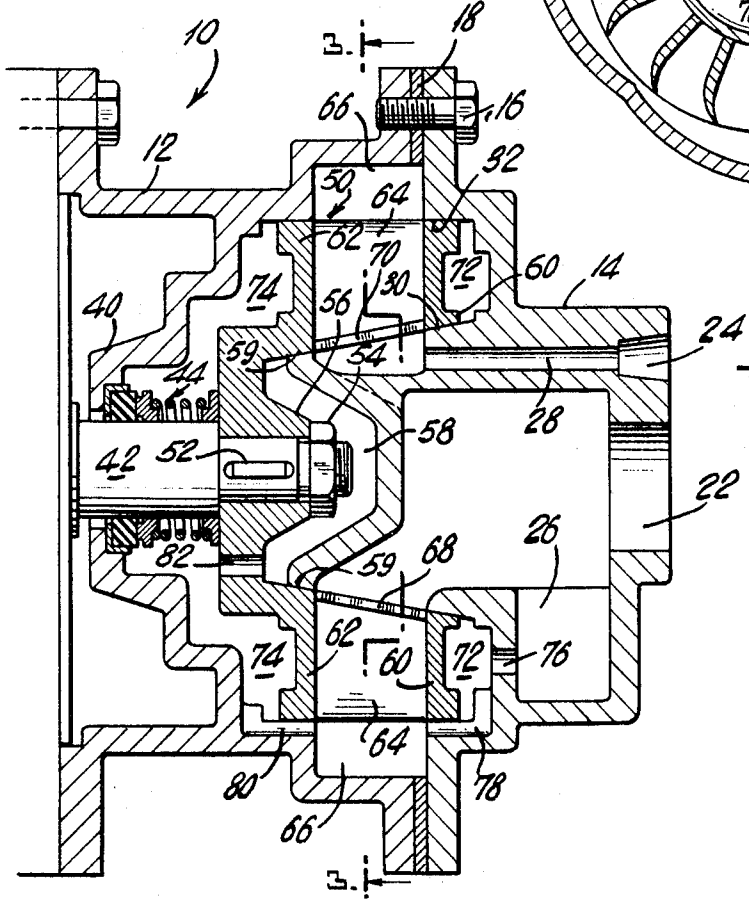


Fig. 2.

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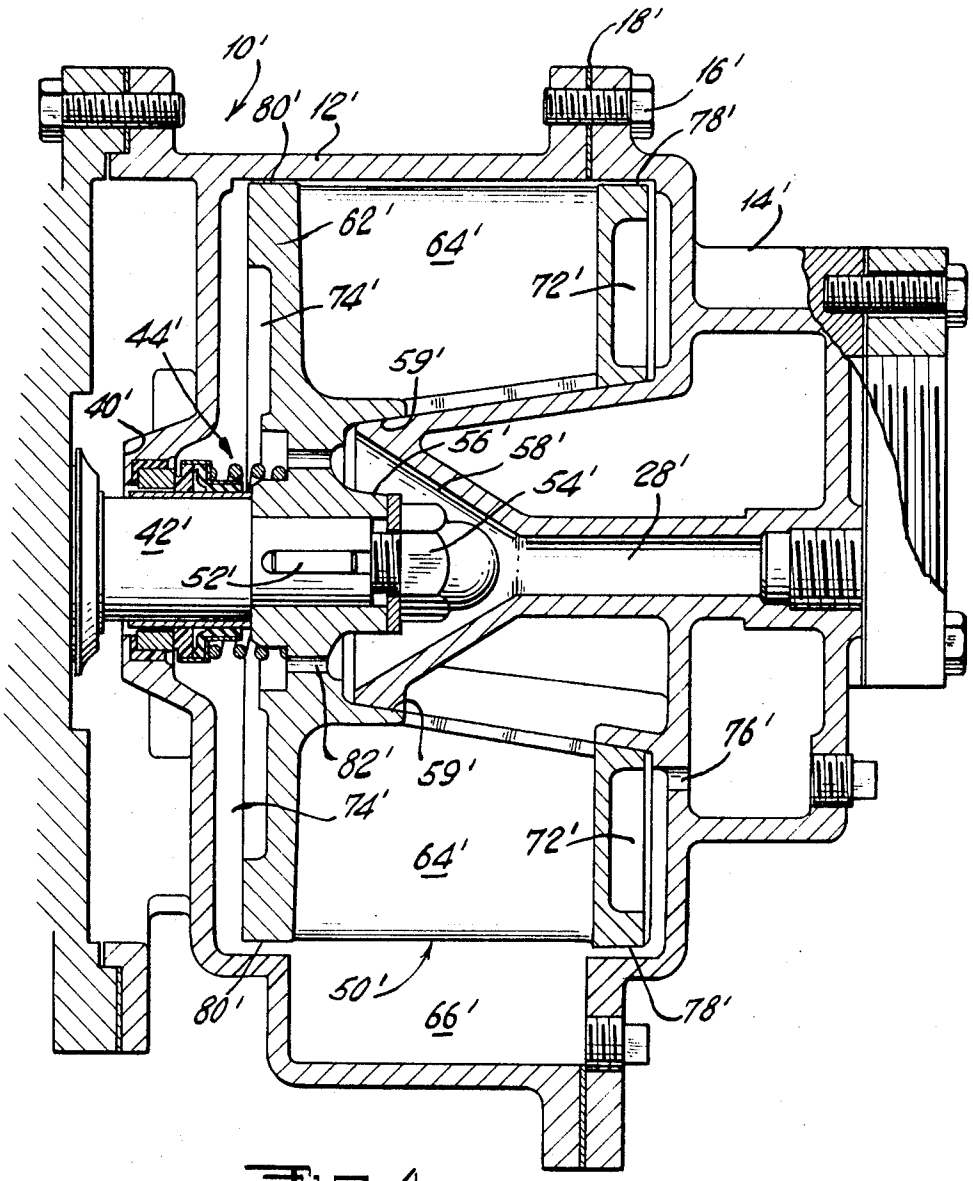


Fig. 4.

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VACUUM PUMP OR COMPRESSOR

This application is a continuation of application 730,131, filed May 17, 1968, now abandoned.

This invention relates generally to pumps, compressors or the like and more specifically to improved internal fluid connection means for sealant liquid recirculation.

The structure to be described hereinafter relates generally to the type of pump described in U.S. Pat. No. 2,195,174, which issued on Mar. 26, 1940 to I. C. Jennings, as well as U.S. Pat. No. 2,195,375, which issued on Mar. 26, 1940 to H. E. Adams. The construction and operation of these pumps are known in the art and will not here be described again in detail. Several structural differences exist in the present invention which provide improved operating characteristics. For example, known pumps use lobe liquid pressure to seal sealing surfaces with liquid at a greater pressure than discharge pressure. The present invention does not specifically rely upon the pressure in the sealing chambers being greater than the discharge pressure for internal sealing purposes.

It is an object of the present invention to provide a liquid ring pump or compressor in which a specific pressure is exacted from the liquid ring.

Another object of the present invention is to provide a pump or compressor in which internal leakage of gas is minimized and virtually controlled.

Yet another object of the present invention is to provide a pump or compressor in which control water or liquid may be added or relieved in predetermined amounts.

Still another object of the present invention is to provide a pump or compressor in which the specific pressure obtained from the liquid ring is a function of rotational speeds, pressure differentials, lobe pressure and the angle at which internal passageways are disposed, the latter angle being predetermined.

A still further object of the present invention is to provide a pump or compressor in which axial thrust of the rotor is minimized through pressure balance accomplished independently of pump clearances.

Another object of this invention is to provide a pump or compressor in which preselected internal liquid passageways permit flow of liquid from the liquid ring to preselected points within the device, thereby increasing performance characteristics.

These and other objects, features and advantages of the present invention will become obvious from the following description of specific embodiments of the invention, taken in conjunction with the accompanying drawings which from an integral part hereof, and in which:

FIG. 1 is an end elevational view, partly in section illustrating one embodiment of the present invention;

FIG. 2 is a longitudinal sectional view taken along the line 2–2 of FIG. 1;

FIG. 3 is a transverse sectional view taken along the line 3–3 of FIG. 2 illustrating the rotor and displacement chambers of the resent invention; and

FIG. 4 is a sectional fragmentary elevational view of yet another embodiment of the present invention.

In contrast to prior art attempts to solve problems inherent in known pumps and compressors, the present invention contemplates and specifically provides for the selective positioning by angular and peripheral location of connection passageways between the lobe sweep chambers and the end face chambers, such that a given and preselected specific pressure will be obtained from the liquid ring. Substantially air-free liquid in these chambers is inherent with the device of the present invention. The passageways of the present invention are sized such that liquid pressure in the sealing chambers is essentially independent of clearances resulting from manufacturing and assembly tolerances and wear, particularly at the diameters of the rotor.

Referring now in more detail to the drawings, pump **10** includes a main housing **12** and an end housing **14** secured to one another by means of fastening means, such as bolts **16**. Spacer means **18** are provided as an optional feature of the present invention between the confronting flanges of housing sections **12** and **14** in order to accurately establish the precise width of the pump lobes. The use of the spacers or shims assures that maximum capacity of the pump is achieved with the power available. Design economies are realized because an individual set of component elements may be utilized while permitting the lobe width to be varied by the selection of the proper spacers.

Housing section **14** is provided with an inlet port **20**, a discharge port **22**, and a sealant inlet port **24**. Discharge port **22** communicates directly with an internal discharge chamber **26** and the sealant inlet port communicates directly with the rotor chambers or lobes **66** by means of a passageway **28**. Housing section **14** is further provided with a tapered hub **30** as well as an internal shoulder **32**. Housing section **12** includes a hub portion **40** rotatably supporting drive shaft **42** and conventional sealing means **44** are disposed about the shaft **42** intermediate hub **40** and the left-hand end face of rotor assembly **50** (FIG. 2). Key means **52** and nut **54** threadedly secured to the drive shaft are utilized to secure the rotor assembly **50** to the shaft **42**. It should be noted that instead of nut **54**, a cap screw or any other suitable fastening means may be utilized.

The rotor assembly **50** is provided with a hub **56** that is disposed within and spaced from a portion of hub **30** of housing **14** to define chamber **58**. The rotor is also provide with end faces **60** and **62**. The outside and inside diameters of which are in sliding relationship with housing hub **30** and internal shoulder **32** respectively. As may be seen in FIG. 3, the rotor includes a plurality of radially extending angularly spaced blades **64** which, in combination with a portion of housing section **12**, define buckets **65** and lobes **66**. Inlet port **70** and outlet port **68** are also provided. It is also seen in FIG. **2** that end wall **60** is spaced from housing section **14** to define a first chamber **72** and end wall **62** is spaced from housing section **12** to define second chamber **74**. Chambers **72** and **74** are annular, thereby providing means for smoothly and evenly distributing fluid entering therein through passageways.

Passageway **76** communicates directly between discharge chamber **26** and chamber **72**. Passageway **68** communicates with chamber **72** and lobe **66**. Fluid is able to flow from lobe **66** into passageway **78** and vice versa as determined by operating conditions, thereafter into a portion of chamber **72** adjacent the openings of passageway **78** into chamber **72** and thence around the annular space defined by chamber **72**.

Passageway **80** connects lobe **66** with annular chamber **74**. In this way, fluid flows from lobe **66** through passageway **80** into chamber **74** and thence to the area adjacent the spring associated with sealing means **44** where pressure is greater than atmospheric pressure or as suits axial thrust balance as determined as best for the particular application. Thus, a positive pressure is in effect which maintains proper lubrication of the mechanical seal or stuffing box of the pump. Fluid may also flow from chamber **74** through passageway **80** back to lobe **66**. Thus seal **44** is subjected to liquid flow through chamber **74**. Further, rotor hub **56** is provided with aperture **82** which provides direct communication between chamber **74** and chamber **58**. Liquid flows from chamber **58** through the interface **59** and thereafter into lobe **66**, thereby preventing the passage of gas through interface **59**. This novel sealing feature cannot be found in the prior art, per se.

By carefully selecting the angular and peripheral location of passageways **78** and **80** between lobe sweeps **66** and the rotor face chambers **72** and **74**, a specific pressure in the chambers is determined independent of pump clearances. The pressure in the rotor face chambers is also determined independent of pump clearances by connecting the small end of rotor hub **56** with rotor face chambers **72** and **74** by means of apertures **82**. Passageways **78**, **80** and **82** insure the establishment of air-free liquid in chambers **72**, **74** and **58** at a pressure that is best for minimum internal liquid leakage between discharge and inlet sections of the pump. By sealing with liquid at the best pressure, there is minimum internal air leakage, that is recircula-

tion with loss of capacity and power, at the rotor inside diameter particularly at front face chamber 72 and chamber 58.

Minimum axial thrust is provided by balancing the pressure at all end faces by direct pressurization independent of pump clearances. To achieve this, the pressure in chambers 72, 74 and 58 is made substantially equal. Again, the location of passageways 78 and 80 are preselected to provide a predetermined specific pressure.

Maximum high pressure ratio capacity is achieved by providing gas-free sealant flow from chamber 26 through passageway 76. Chamber 26 and passageway 76 are located behind the rotational discharge of air and liquid from discharge passageway 22. Thus there is a minimum of liquid submergence of passageway 76. In FIG. 3 it is seen that the land centerline is oriented at 1:30 o'clock with the discharge passageway being approximately at 3 o'clock. This leaves the internal liquid collection chamber 26 in the leeward position with respect to violent air-water discharge flow from the discharge port as it flows toward the discharge pipe.

Maximum shaft seal life is assured by providing air-free liquid in chambers 72 and 74 and by continually cooling and flushing the shaft seal with liquid flowing through passageway 80 into chamber 74 and through passageway 82 to chamber 58 across interface 59 to blades 64 of the rotor.

When the present invention is applied to large pressure ratio vacuum pumps and compressors, maximum capacity at high pressure ratio is achieved by providing the required additional recirculation of liquid from the pump discharge through passageway 76 and into chamber 72. The selected location of connections 78 and 80 can be varied to determine at what pressure the recirculation is to begin. On a tight ported high pressure ratio vacuum pump or compressor, minimum power and maximum capacity at low pressure ratio with standard sealant rate is provided by a pressure in chamber 72 that varies with the pressure ratio to vent excess sealant liquid to discharge 22 through passage 76. It is within the scope of the present invention to locate connection means 78 and 80 with respect to lobe sweep chambers 66 such that the pressure in chamber 72 will exceed discharge pressure at low pressure ratio and be less than discharge pressure at high pressure ratio. In addition, a check valve may be installed to limit the flow to one desired direction.

It should be noted that the present construction has the desirable result of controlling the recirculation of the water quantity through passage 76 by maintaining the pressure differential independent of pump clearances. Thus, the pressure in chamber 72 is established by the lobe pressure and is independent of leakage clearance variations. Accordingly, the pressure differential across passage 76 remains essentially consistent and also the flow rate remains consistent. In prior art constructions heretofore, the pressure variations in chamber 72, because of variations in clearance, acted so as to increase the sealant rate to chamber 72 at a time when the pump was less capable of handling it and vice versa. The present construction, therefore, improves internal liquid sealing and reduces internal gas leakage and excessive sealant circulation. The results in improved performance of the pump, repeatability and stability even with unusual variations in internal clearances resulting from both machining and assembly tolerances.

FIG. 4 illustrates, in another embodiment of the present invention, a circular lobe rotating device such as a pump or compressor. The structure in FIG. 4 discloses a vacuum pump similar to the double lobe pump of FIG. 2 but wherein the liquid seal enters the center of the housing section 14' through the passageway 22' against the pressure prevalent in chamber 58' rather than through passageway 28 and inlet port 70 as shown in FIG. 2. Features of the invention shown in FIG. 4 have been assigned reference numerals with prime suffixes such that the basic numeral will correspond, by function and purpose, to the elements of the invention shown in FIG. 2 and heretofore described. The circular lobe embodiment differs structurally, however it is within the scope of the present invention to provide liquid sealant properties as described in a circular lobe pump or compressor. Thus, liquid passes from lobe 66' through passageway 80' into chamber 74' and thence to the area surrounding seal means 44' encircling shaft 42'. Thereafter fluid flows through passageway 82' into the area designated 58' such that liquid flow through interface 59' and thence back to lobe 66' may occur, thereby preventing gas from flowing past interface 59' as a result of pressure differentials. Similarly, liquid flows from liquid ring 66' through passageway 78' into chamber 72' and thence through passageway 76', in the case of pressure differentials favoring flow in that direction. However these passageways are of equal importance to the construction of FIG. 2 or the construction of FIG. 4.

While certain novel features of my invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the form and details of the device illustrated and in its operation can be made by those skilled in the art without departing from the spirit of the invention.

I claim:

1. A liquid ring pump comprising a housing, centrally recessed rotor means including a plurality of displacement chambers, a drive shaft for rotating said recessed rotor means within said housing, said recessed rotor means and said housing having a plurality of contiguous surfaces, a stationary member nested within the recess of said recessed rotor means and including inlet and outlet passage means for admitting and withdrawing fluid from said displacement chambers, said stationary member and said rotor means having a plurality of contiguous surfaces, said housing, rotor means and stationary member establishing therebetween at least one compartment including at least a single lobe, reservoir means communicating with said outlet passage means for collecting liquid discharged from said displacement chambers substantially at the discharge pressure of said pump, sealing liquid chamber means communicating with at least one of said contiguous surfaces, first conduit means for connecting said sealing liquid chamber means to said lobe, second conduit means for continuously connecting said sealing liquid chamber means to said reservoir means whereby until said discharge pressure increases and becomes equal to the lobe pressure at said first conduit means a portion of the fluid supplied to said sealing chamber means through said first conduit means will be discharged therefrom through said second conduit means and the remaining portion which increases as the discharge pressure increases will be directed to said contiguous surfaces.

2. The liquid ring pump according to claim 1, wherein said first conduit means communicates with said lobe at a point such that at high pressure ratio operation said discharge pressure exceeds said lobe pressure at said first conduit.

3. A liquid ring pump according to claim 2, wherein said conduit means connecting said sealing chamber means to said lobe further comprises check valve means for preventing the flow of sealing liquid from said sealing chamber means to said lobe through said conduit means.

4. The liquid ring pump according to claim 1, wherein said pump comprises a single compartment having two lobes.

5. The liquid ring pump according to claim 1 wherein said reservoir means is located within said housing and is situated in a leeward position with respect to the fluid being discharged through said outlet passage means, whereby substantially gas-free liquid at discharge pressure, will collect in said reservoir means.

6. The liquid ring pump according to claim 1, wherein said rotor means comprises a pair of shrouds, one of said shrouds being positioned at the discharge end of said pump, said sealing liquid chamber means being situated between said one shroud and said housing.

7. The liquid ring pump according to claim 1, wherein said first and second conduit means are so dimensioned that the flow area thereof is sufficient to make the pressure in said sealing chamber substantially independent of the clearances between said sealing surfaces.

8. A liquid ring pump comprising a housing, centrally recessed rotor means including a plurality of displacement chambers, a drive shaft for rotating said recessed rotor means within said housing, said recessed rotor means and said housing having a plurality of contiguous surfaces, a stationary member nested within the recess of said recessed rotor means and including inlet and outlet passage means for admitting and withdrawing fluid from said displacement chambers, said stationary member and said rotor means having a plurality of contiguous surfaces, said housing, rotor means and stationary member establishing therebetween at least one compartment including at least a single lobe, reservoir means located within said housing communicating with said outlet passage means and situated in a leeward position with respect to the fluid being discharged through said outlet passage means for collecting liquid discharged from said displacement chambers substantially at the discharge pressure of said pump, sealing liquid chamber means communicating with at least one of said contiguous surfaces, conduit means for connecting said sealing liquid chamber means to said reservoir means whereby fluid will be supplied to said sealing chamber means through said conduit means and will be directed to said contiguous surfaces.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,588,283 Dated June 28, 1971

Inventor(s) James B. Fitch

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE HEADNOTE:

Column 1, line 9, change "730,131, May 17, 1966, now abandoned." to --730,131, May 17, 1968, now abandoned.--

Signed and sealed this 30th day of May 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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