

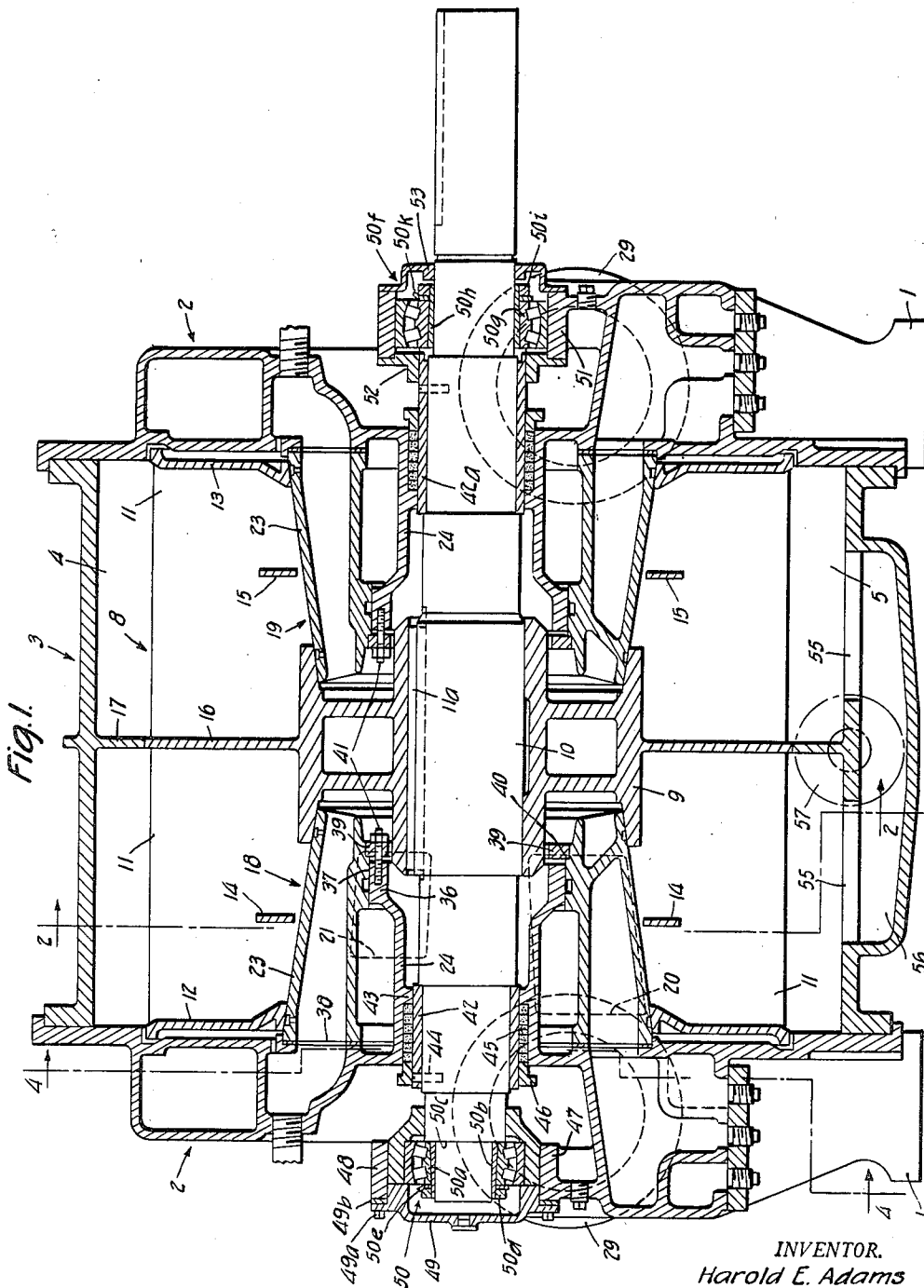
March 16, 1954

H. E. ADAMS
HYDROTURBINE PUMP

2,672,276

Filed Jan. 26, 1951

4 Sheets-Sheet 1



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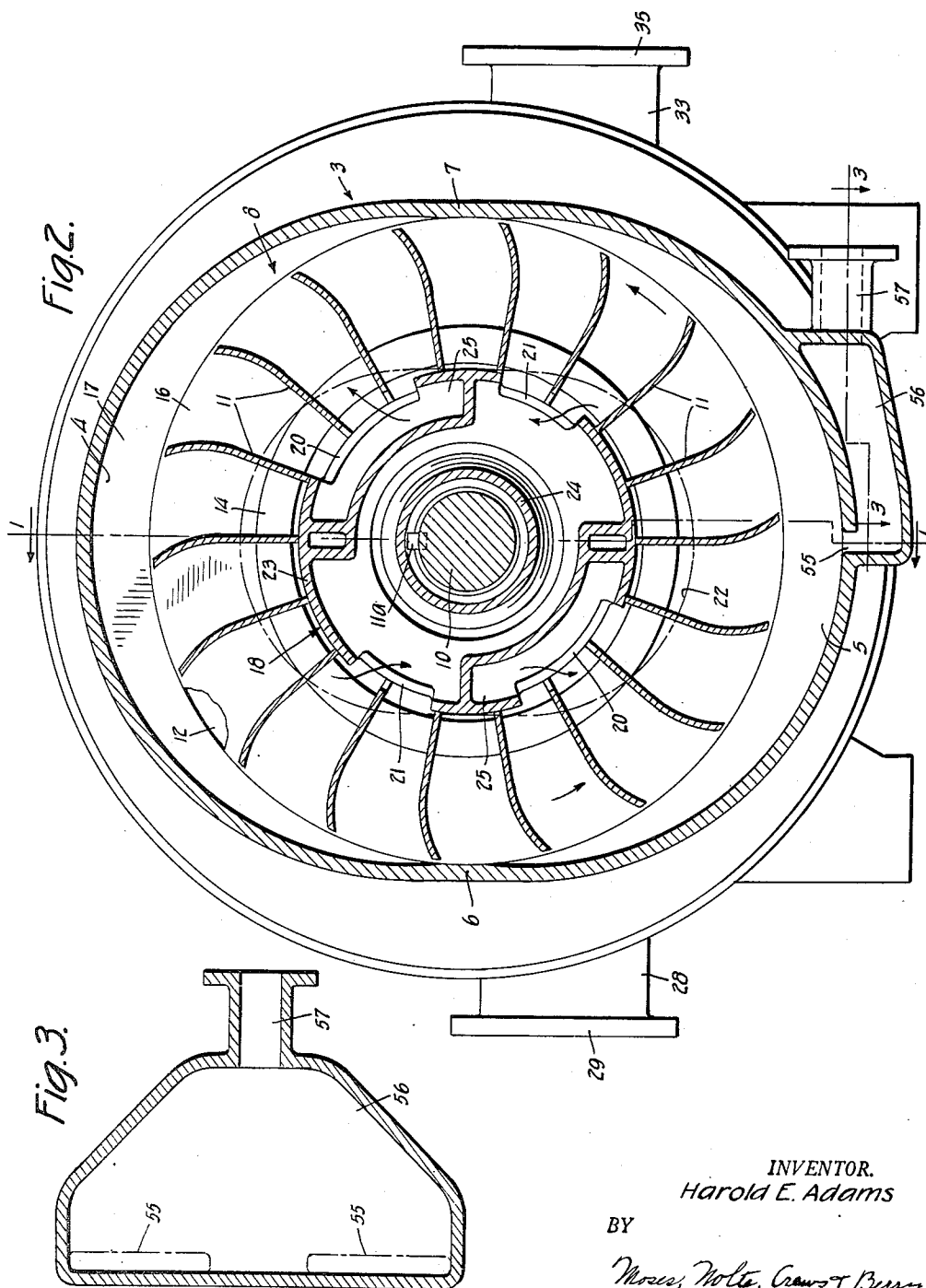
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4 Sheets-Sheet 2



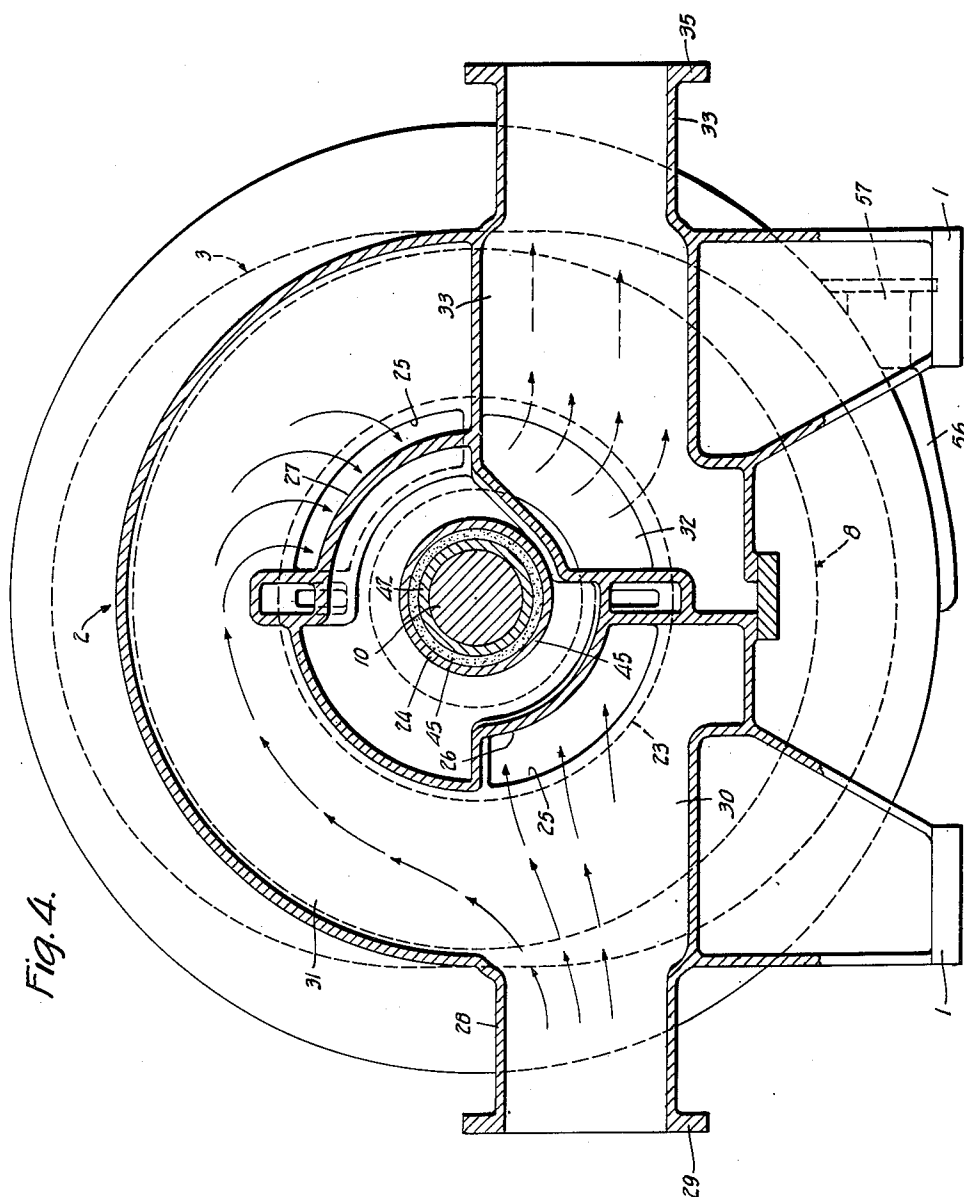
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4 Sheets-Sheet 3



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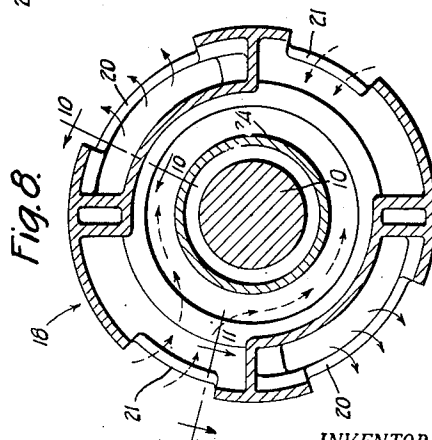
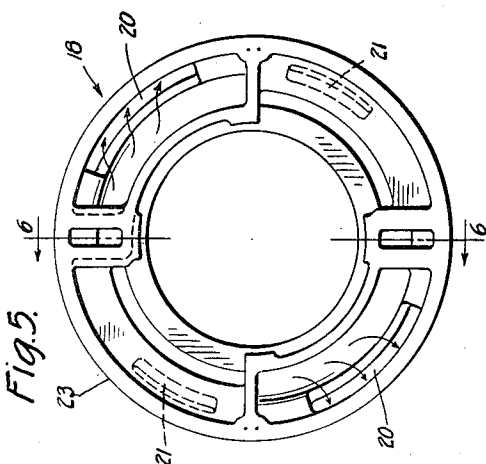
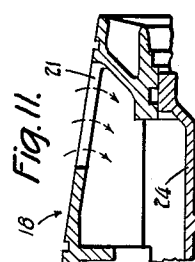
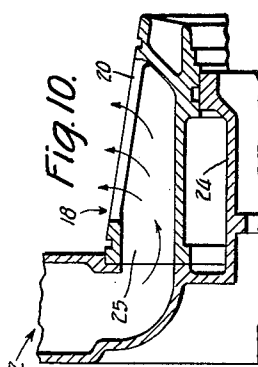
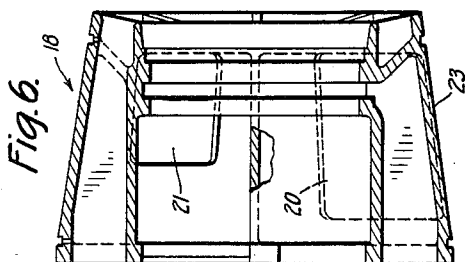
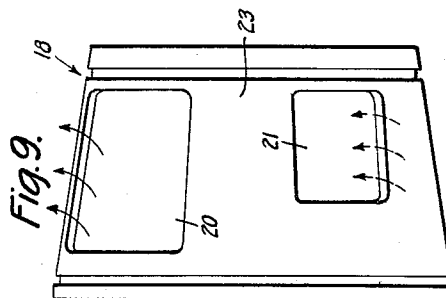
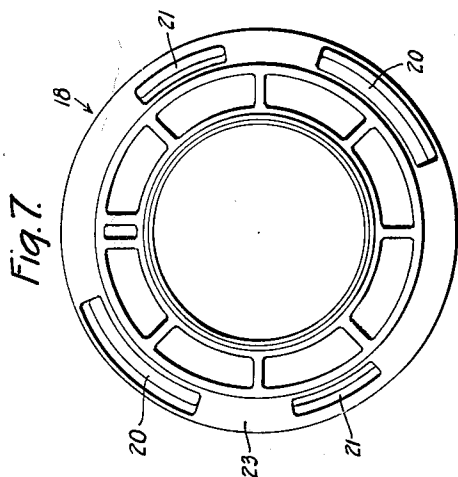
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4 Sheets-Sheet 4



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2,672,276

HYDROTURBINE PUMP

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Application January 26, 1951, Serial No. 207,918

15 Claims. (Cl. 230—79)

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This invention relates to pumps of the hydro-turbine or liquid ring type as exemplified by the well-known Nash pump. The invention is in the nature of an improvement upon the pump disclosed in Letters Patent of the United States No. 1,847,586, granted to me on March 1, 1932.

In prior pumps of the kind referred to a pair of pumping chambers is provided within a lobed body. A vaned rotor, mounted upon a drive shaft, runs in the chambers, the rotor including a central partition which meets a partition flange of the body to form the dividing wall between the chambers. The inner boundaries of the respective chambers are formed by ported cones having passageways through which gas is conducted to and from the pumping chambers. The end boundaries of the respective chambers are formed by heads in which intake and discharge passages are provided for communicating respectively with the intake and discharge passages of the cones.

It is characteristic of these hydroturbine pumps that a liquid ring is driven in each chamber by the rotor and serves as the pumping medium. The body is provided with a pair of diametrically opposed lobes and with intervening lands between the lobes. The liquid is caused to recede from and return toward the center of rotation alternately, first to draw gas in through an intake port and then to force it out through a discharge port, there being an intake port and a discharge port provided in the cone for each lobe of the associated working chamber.

As heretofore constructed each head has been made to include a cross-over passage for placing a common inlet in communication with separate intake passages of the associated cone, and with a further cross-over passage for placing a common outlet in communication with separate discharge passages of an associated cone. This has made the heads of considerable thickness so that they have necessarily occupied a substantial amount of space lengthwise of the shaft. Each cone has been made to extend through the associated head and has been attached to the outer face of the head through a cone flange.

The cone has been made adjustable axially with the head in prior pumps by providing more or less shim thickness between the head and the body. This has enabled a fine clearance between the cone and the associated rotor to be obtained. It has, however, been an awkward adjustment to make. It has been made clumsy by the large diameter shims. Because of the large shim diameter, moreover, the shims were available only in paper and the required thickness had to be built up from numerous layers.

It is a feature of the present invention that the tapered portion of the cone is made merely to meet the associated head and not to pass through it. The cone and head can, therefore, be axially adjusted relative to one another without affecting clearances. With this arrangement it becomes possible to adjust the cone relative to the rotor and relative to the head by providing relatively small diameter shims between the cone and head. The smaller diameter shim may be of one-piece construction, being cut from stock of whatever thickness is required, this stock being in metal, synthetic materials, or paper, as desired.

The cone has been caused to occupy substantially all of the space between the head and the shaft, making the shaft inaccessible for bearing support within the confines of the head. Brackets have been attached to the heads for supporting shaft bearings well out from the heads. This has necessitated the leaving of a wide span between bearings which has tended to permit deflection of the shaft and has interfered with the securing of the desired fine clearance between the rotor and the cones. It has also contributed importantly to the weight of the pump.

The multiplicity of parts, particularly the provision of separate head, cone and bearing bracket members, has made difficult the securing of the desired concentricity and fine working tolerances of parts, because of the accumulation of tolerances between mating parts.

Although two working chambers have been provided, the inlet and outlet passages have been carried through passageways in the heads to common inlet and discharge flange connections located upon the body, so that the entire pump has been capable of application only to a single service.

The present invention includes among its objects the effecting of improvements with reference to each of the points of disadvantage noted above.

It is a feature of the invention that each cone is made to include separate inner and outer parts, the outer part being a wear part which is formed complementary to the rotor and which is longitudinally adjustable relative to the head to secure the desired rotor clearance. The division of the cone into inner and outer parts obviates the need for adjusting the head relative to the body from time to time. The required adjustment of the cone is greatly simplified. A greater range of adjustment is made available because a greater shim thickness can be tolerated between the cone and the head than between the head and the body. The division of the cone also

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simplifies the casting of the cone by reducing the number of blind cores that have to be set.

It is a further feature that the cone, itself, is made to include a cross-over connection between the outlet ports, thus obviating the necessity for providing an outlet cross-over in the head. This enables the head to be reduced in thickness, simplified in construction and so modified in shape that the shaft may be made accessible for bearing support within the bounds of the head itself.

It is a further feature that the inner cone portion and the bearing bracket are made integral with the head. The unitary construction automatically secures concentricity of these parts and avoids cumulative tolerance errors.

It is still another feature of the invention that the head, cone and bracket construction is so contrived as to bring the bearings within the bounds of the head itself, thus greatly reducing the bearing span of the shaft for a pump of given capacity and, as a consequence, bringing about a pronounced and very important reduction of weight.

It is also a feature that separate inlet and discharge connections are provided for the respective heads so that the two working chambers can be devoted to distinct services, this feature being a very desirable one in some installations.

In accordance with a further feature, the pump is arranged for automatically unloading a considerable portion of the ring liquid upon stopping. This is effected by placing the discharge flange below the center line of the unit, so that upon stopping most of the water ring is caused automatically to drain through the discharge connection and to a lower drain connection. This automatic drainage feature greatly facilitates the starting of the pump, making it feasible to employ synchronous motors having limited starting torque characteristics.

Although the invention is illustrated as applied to a two-chamber pump, it will be evident that some of the features may be utilized to advantage in a pump having only one working chamber.

Other objects and advantages will hereinafter appear.

In the drawing forming part of this specification:

Figure 1 is a longitudinal, vertical, sectional view through an illustrative pump which embodies features of the invention, the section being taken upon the line 1—1 of Figure 2 looking in the direction of the arrows;

Figure 2 is a transverse vertical sectional view taken upon the line 2—2 of Figure 1, looking in the direction of the arrows;

Figure 3 is a horizontal sectional view taken upon the line 3—3 of Figure 2, looking in the direction of the arrows;

Figure 4 is a transverse vertical sectional view taken upon the line 4—4 of Figure 1, looking in the direction of the arrows;

Figure 5 is an end view of the left hand cone of Figure 1, as viewed from the left;

Figure 6 is a vertical sectional view taken upon the line 6—6 of Figure 5, looking in the direction of the arrows;

Figure 7 is an end view of the cone of Figures 5 and 6 as viewed from the right;

Figure 8 is a sectional view through the left hand cone taken upon the line 2—2 of Figure 1, looking in the direction of the arrows;

Figure 9 is an external view in side elevation of the cone illustrated in Figures 5 to 8;

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Figure 10 is a fragmentary sectional view taken upon the line 10—10 of Figure 8, looking in the direction of the arrows; and

Figure 11 is a fragmentary sectional view taken upon the line 11—11 of Figure 8, looking in the direction of the arrows.

The illustrative pump is supported in its entirety from feet 1 which are desirably made integral with heads 2. Between the heads there is supported a body 3 having upper and lower lobes 4 and 5 and intervening lands 6 and 7. A rotor 8 runs in the body. The rotor comprises a hub portion 9 which is secured upon a drive shaft 10 by means of a key 11a. The rotor 8 also includes a series of equally spaced identical blades or vanes 11, which are connected to one another through end shrouds 12 and 13, connecting webs 14 and 15, and a central partition 16. The partition 16 meets an inwardly extending partition flange 17 of the body 3 and cooperates with it to divide the working space into right hand and left hand pumping chambers. The inner boundary of the rotor is double conical in form, being adapted to maintain fine clearances with ported cones 18 and 19. Each cone includes two diametrically opposed inlet ports 20 and two diametrically opposed outlet ports 21. During operation, a liquid ring which acts as the pumping medium is maintained in each pumping chamber, the inner boundaries of one of the rings being indicated by the broken line 22 of Figure 2. Broadly the operation of the illustrative pump is the same as that of prior pumps of the Nash type. As the rotor travels counter-clockwise (as viewed in Figure 2) it drives the water with it, developing in the water ring centrifugal force which carries the water outward away from center of rotation as far as the inner body wall will permit. As the water crosses the inlet port 20 it is moving away from the center and sucks gas in through the port into one after another of the buckets formed between successive rotor blades 11. After the water crosses the major axis of the body, this being the vertical axis as illustrated, it begins to compress the gas and then forces the gas out through the discharge port 21.

In accordance with the present invention each of the cones 18 and 19 comprises an outer wear portion 23 in which the ports 20 and 21 are formed and an inner complementary portion 24 which is integral with the associated head 2. Right and left hand halves of the pump are of like construction, employing parts which are either of identical or of mirror image construction except for minor differences having to do with the shaft seats and bearings. The description of the left hand end which follows may therefore be assumed to apply to the right hand end except where the contrary is indicated.

The cone member 23 is formed to include separate intake passages 25 (Figure 4) which communicate respectively with diametrically opposed intake passages 26 and 27 of the head 2. An intake conduit 28, forming a unitary part of the head, is provided with a flange 29 for connection to a source of gas supply. The conduit 28 communicates through branch passages 30 and 31 formed in the head with the respective passages 26 and 27, the inlet cross-over being provided in the head as shown.

The outlet ports 21 of the cone 18 communicate directly with one another across the central region of the cone (Figure 2). They discharge through a common outlet passage 32 (Figure 4) to a single outlet passage 33 of the head, the dis-

charge cross-over being provided in the cone and not in the head, as heretofore.

The passage 33 leads directly away from the lower side of the cone, so that upon stopping of the pump a substantial portion of the liquid ring is drained away into the passage 33. This greatly reduces the starting load upon the rotor, making it practical to drive the pump by means of a synchronous motor having low torque starting characteristics. Most of the water which runs out into the passage 33 escapes through the discharge conduit (not shown). The passage 33 is provided with a flange 35 to which a discharge conduit may be connected.

Attention is particularly called to the fact that each side of the pump has its own separate intake and discharge flanges 29 and 35 so that the two sides of the pump can be connected either to a common source of supply or to separate sources of supply and to a common discharge conduit or to separate discharge conduits, if desired. This is an important and advantageous feature of the invention because there are occasions when it is highly desirable to use the two sides of the pump for separate services. One such instance occurs in paper making machinery where the illustrative pump may be utilized to apply different degrees of suction to different services, say a 20" vacuum to the suction couch roll and an 18" vacuum to the suction press roll.

The end face at the large end of the cone member 18 is made plane to bear against a plane seat provided in the head. The inner cone member 24, which forms an integral part of the head, extends within the cone member 18 and is formed at its inner extremity with an outwardly displaced cylindrical portion 36 which accurately fits an inner cylindrical surface 37 of the cone member 18. Shims 38 are interposed between the seat formed in the head 2 and the left hand end of the cone member 18. A ring 39 bears against a rightwardly facing shoulder 40 of the cone member 23, being drawn against the shoulder by bolts 41 which are threaded into the portion 36 of the cone member 24.

The making of the cone member 18 as a separate member has many advantages. The desired clearance between the cone and the rotor is obtained by longitudinal adjustment of the cone relative to the head 2. Heretofore the entire cone has been made unitary but not integral with the head, so that it could only be adjusted by adjusting the head relative to the body. This has involved adjustment of the shim thickness between the head and the body. Such adjustment is awkward and cumbersome because of the large diameter of the shims. No very great range of adjustment could be provided, moreover, because a large shim thickness cannot be tolerated between the head and body where the centrifugal force of the water is applied with maximum effect.

The use of multiple paper shims or gaskets under the heads sometimes caused faulty alignment of the head due to uneven take-up on the resilient gaskets by the head bolts. This in turn cocked the cone in reference to the rotor, thus upsetting the cone clearance. It also upset the bearing alignment and adjustment.

The new construction minimizes uneven pressure on the shims, which in this case may be metal, and it prevents cocking of the cones out of alignment, also it has no effect whatsoever on the bearing alignment and adjustment.

In the present construction, moreover, a con-

siderable shim thickness can be tolerated between the cone member 18 and the opposed head seat. The adjustment can be effected more conveniently and expeditiously than with the prior construction, due in no small measure to the smaller diameter of the shim and to the fact that a one-piece shim of selected thickness may be utilized.

A further advantage realized from the provision of the separate cone part 18 is that this relatively minor part is subjected to nearly all the wear and can be discarded and replaced at relatively small expense when it is unfit for further use.

Still another advantage which results from the provision of the separate cone part 18 is that the part 18 can be adjusted rotatively with reference to the part 24 to change the angular positions of the intake and outlet ports 20 and 21 relative to the lobes. It is sometimes desirable to adjust these ports to abnormal positions where special compression ratios are required.

The fact that the outlet cross-over is provided within the cone itself and therefore within the longitudinal bounds of the body is taken advantage of to make the shaft 10 accessible within the heads so that the shaft bearings can be brought much closer together than formerly, and can be located directly over the supporting feet 1 (Figure 1).

The shaft 10 carries sleeves 42 upon which an internal flange 43 of the cone member 24 bears. The sleeve is fixed to the shaft by a screw 44. Packing rings 45 are clamped between the flange 43 and a gland 46. The packing is provided within the cone member 24 and largely within the longitudinal bounds of the body. The passages of the head 2 are so contrived that a clear space is left around the shaft 10 within the head. A bearing bracket 47 integral with the head constitutes a bearing support. The bearing brackets 47 and 51 are carried directly over the feet 1 by which the structure is supported. This provides improved balance and reduces vibration. The bearings at opposite ends of the pumps are not duplicates. At the end remote from the drive motor a bearing housing comprises a cup-like cartridge member 48 and a cap 49, the latter having a flange secured by screws 49a to the bracket 47. The bearing 50 itself is of the conventional tapered sleeve.

The inner race 50a is secured in fixed axial position relative to the shaft, being mounted upon a tapered adapter sleeve 50b and urged against a shaft shoulder 50c by a nut 50d threaded on the sleeve 50b. A lock washer 50e is interposed between the nut 50d and the inner race 50a. The outer race is clamped between the cap 49 and the cartridge 48, being secured against axial movement by the securement of the cap 49 to the bracket 47.

The cap 49 is separated from the bracket 47 by shims 49b. The rotor 8 may be adjusted to center it between the cones 18 and 19 by adjusting the shaft 10, itself, axially. Provision for adjusting the shaft 10, the bearing 50 and the cartridge 48 as a unit is made by removing the cap 49 and changing the thickness of the shims 49b between the cap and the bracket 47.

At the driven end of the shaft 10 a bearing 50f, similar to the bearing 50 is mounted directly within a bracket 51 and between enclosing rings or discs 52 and 53 which are secured to the bracket. The bearing 50f is free to move axially within the bracket 51, and relative to the discs

52 and 53. The inner race 50g is mounted upon a tapered adapter sleeve 50h which is clamped to the shaft by a nut 50i and a lock washer 50k. By backing off the nut, the sleeve 50h can be caused to relax its grip on the shaft to permit disassembly. Normally the bearing 50f is fixed relative to the shaft and rotor and is free to shift with them when the shim thickness at 49b is adjusted.

The fact that the cones, heads and brackets have been modified so as to enable the bearings to be brought much closer together than heretofore is considered a feature of very great importance. The new pump having a basic capacity of 5,200 cubic feet per minute weighs approximately 18,880 pounds, as compared to the older design with a lower capacity of 4,600 cubic feet per minute but a higher weight of 22,060 pounds. On a weight per cubic foot of air delivered basis, the new pump is 3.5 pounds compared to 4.45 pounds for the old pump. This is greater than a twenty percent improvement on the basis of net capacity.

That the larger capacity pump should weigh less per cubic foot of air delivered is quite remarkable in view of the normal trend. All sizes of Nash pumps operate at the same peripheral speed for a given pressure range. The capacity of each varies therefore approximately as to the square of the rotor diameter, but the physical volume of each pump of similar proportions varies as the cube of the diameter. The weight of the pump does not go up, however, in proportion to the cube of the diameter, because the larger pumps can use proportionately smaller sections. The trend toward increased weight per cubic feet of air delivered is indicated in the following table, in which pumps 1, 2, 3 and 4 are of the prior design and pump No. 5 is of the new design embodying the present invention.

Pump No.	Rotor Dia., Inches	R. P. M. at 40-42 Ft./Sec.	C. F. M. 20" Vac.	Shipping Weight Less Sole Plate	Pounds Weight/cubic Foot Air Delivered
1-----	27.4	350	1,325	4,492	3.38
2-----	33.490	286	1,975	7,646	3.88
3-----	41	234	3,200	13,578	4.25
4-----	51.19	187	4,600	22,060	4.45
5-----	53	181	5,200	18,880	3.5

The making of the head integral with the cone part 24 and the bearing bracket 47 simplifies the pump construction and reduces the variation in clearances in the pump caused by accumulation of machine tolerances of mating parts. One of the important relationships which must be maintained in pumps of this nature is the clearance between the internal cone diameter of the rotor 8 and the outside cone diameter of the cone 19. The concentric relationship and clearance between these parts depends upon the accuracy of the machining and the number of parts to be fitted together. There is, of course, a necessary tolerance on these machining dimensions between each two fitting parts. The overall clearance between the cone and the rotor can not be any closer than the accumulation of the machining tolerances of the various mating parts. In the case of the old design, the following machining tolerances had to be taken into consideration in maintaining the concentric relationship between the rotor and its cone.

The concentric and axial relationship between the rotor cone taper bore and the shaft bore; the relationship between the shaft rotor journal

and the bearing journal; the fit between the ball bearing and the bracket recess; the concentric relationship within the bracket itself of the bearing recess bore and the rabbet bore engaging the cone part; the fit between the rabbet and the bracket and the corresponding flange of the cone itself; the concentric relationship between the cone flange outside diameter and the taper of the cone port extension. In addition, the fit between the cone and the head, the fit of the head rabbet to the outside body flange and the concentric relationship between these rabbet fits and the internal bore of the head all had an influence.

In the old design the amount of clearance between the cone and the rotor was adjusted by the longitudinal positioning of the heads with respect to the body by means of a series of gaskets between the body and the head flange.

In the case of the new design the number of fits is materially reduced. In this design moreover the inner portion of the cone, the head and the bracket are all one piece and may be machined at one time. This not only reduces the number of fits and concentric relationships existing in the present construction but, by being in one piece and machined in one setting, the concentric relationship between these parts is automatically assured and maintained. In addition to these advantages, a reduction in machining costs is realized because of the reduction in the number of parts and the reduction in the number of setups for machining.

The lower lobes of the pumping chambers are connected with one another through ports 55 and a conduit 55. This kind of connection between the chambers of a duplex pump is old in the art as a means of providing a common unloader through a common outlet 57.

In the present instance the connection may also serve as a common unloader, but it has a new use in combination with the provision of separate inlets and outlets for the two halves of the pump. In prior pumps the function of the unloader is to dump excess water, or all of the water seal out of the pump whenever this is desirable; for example, to reduce the power requirement when starting the pump, or for bleeding off excess liquid. When the two halves of the pump are operating in different services to produce different degrees of vacuum, it is not essential that the two pumping chambers be interconnected in the manner illustrated but the operation is improved by such connection.

The connection between the two sides of the pump serves as an equalizing passage for the division of the water ring seal to the best advantage when one-half of the pump is operating at a different vacuum from the other half, with both halves discharging to a final common pressure, such as atmospheric pressure. The interconnection provides an automatic compensation device to distribute the liquid in the liquid ring to the best advantage between the two halves.

It is a characteristic of the liquid ring vacuum pump that it requires more make up liquid when operating over large compression ratios than it does when operating over small compression ratios. This liquid preferably is supplied to the inlet, or at any point ahead of the compression stroke on the liquid ring. An increased quantity of sealing liquid is desirable to make up for increased slippage losses when operating at higher compression ratios and also to supply additional weight of liquid to perform the greater work required at the higher compression ratio.

It will be noted that when half the pump is operating at, say, twenty inch vacuum to atmospheric pressure, the average absolute pressure in its individual liquid ring is lower than the average absolute pressure in the liquid ring of the companion side when operating at a lower vacuum, say eighteen inches. As a result of this, there is a transfer of liquid from the low vacuum side to the high vacuum side caused by this difference in the absolute pressures. This automatically supplies additional sealing liquid to the side doing the greater amount of work without detracting objectionably from the lower vacuum side. The interconnection between the lobes can be furnished as a separate compensating device or it may be combined with the unloading function which has been referred to.

There are various sealing features incorporated in the illustrative pump, but since they form no part of the present invention they have not been described.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. A gas pump of the liquid ring type comprising in combination, a lobed body, a rotor operative therein, the body and rotor including partition members for dividing the working space into two pumping chambers, separate ported cone members defining the inner boundaries of the respective pumping chambers and constructed and arranged to transmit gas to and from the respective chambers, and heads closing the outer ends of the respective chambers and having passages therein constructed and arranged to transmit gas to and from the respective cones, each head being provided with its own separate inlet and outlet so that the two chambers can be applied to separate pumping services if desired.

2. A structure as set forth in claim 1 in which the body includes a conduit through which the outer extremities of the chambers are placed in communication with one another to permit a balancing transfer of liquid from the ring in one chamber to the ring in the other.

3. A hydroturbine gas pump having a pumping chamber comprising, in combination, a lobed body defining the outer boundary of the chamber, a rotor operative therein, a ported cone defining the inner boundary of the chamber and a head closing an end of the chamber and having passages therein constructed and arranged to transmit gas to and from the cone, said head including an outlet port disposed below the level of the cone and in direct communication therewith.

4. In a hydroturbine gas pump, in combination, a lobed body, a ported cone and a head jointly bounding a working chamber, and a rotor operable in the chamber, the ported cone being divided into an inner part and an outer wear part adjacent the rotor and complementary to the inner part, the outer part being longitudinally adjustable relative to the inner part.

5. In a hydroturbine gas pump, in combination, a lobed body, a ported cone and a head jointly bounding a working chamber, and a rotor operable in the chamber, the ported cone being divided into an inner part and an outer wear part adjacent the rotor and complementary to the inner part, the outer part being longitudi-

nally and rotatively adjustable relative to the inner part.

6. In a hydroturbine gas pump, in combination, a lobed body, a ported cone and a head jointly bounding a working chamber, and a rotor operable in the chamber, the ported cone being divided into an inner part integral with the head and an outer wear part adjacent the rotor and complementary to the inner part, the outer part being longitudinally and rotatively adjustable relative to the inner part.

7. In a hydroturbine gas pump, in combination, a lobed body, a ported cone and a head jointly bounding a working chamber, and a rotor operable in the chamber, a rotor shaft, the ported cone being divided into an outer wear part adjacent the rotor and an inner complementary part integral with the head and relative to which the outer part is longitudinally and rotatively adjustable, and a bracket integral with the head for supporting the rotor shaft.

8. In a hydroturbine gas pump, in combination, a lobed body, a head, and a ported cone defining boundaries of a working chamber, a rotor operable in the chamber, the cone having diametrically opposite chamber inlet ports through its periphery with separate inlet passages leading thereto diametrically opposite outlet ports and a common outlet passage, the outlet ports directly communicating with one another and with the common outlet passage, and the head having divided inlet passages leading to the respective inlet passages of the cone and a single outlet passage leading from the single outlet passage of the cone.

9. In a hydroturbine gas pump, in combination, a lobed body, a head, and a ported cone defining boundaries of a working chamber, a rotor operable in the chamber and having an end disposed adjacent an end of the head, a shaft for driving the rotor, the cone being divided into an outer wear portion adjacent the rotor and an inner portion complementary thereto, the inner portion being integral with the head and constituting an inward extension thereof, a seal between the head and shaft disposed along said inward extension of the head and largely within the longitudinal bounds of the rotor, and a bearing bracket carried by the head within the longitudinal bounds of the head.

10. In a duplex hydroturbine gas pump, in combination, a lobed body, a rotor operative therein, a shaft upon which the rotor is mounted, the body and rotor including complementary partition members for dividing the working space into two distinct pumping chambers, separate ported cone members defining inner boundaries for the chambers, and separate head members having ends which define end boundaries for the outer ends of the chambers and which lie adjacent to opposite ends of the rotor, each cone being divided into an outer wear portion and an inner portion complementary thereto, the inner portion being integral with the associated head and constituting an inward extension thereof, seals between the shaft and the respective heads disposed along such inward extensions of the heads and largely within the longitudinal bounds of the rotor, and bearing brackets for the shaft carried by the respective heads within the longitudinal bounds thereof.

11. In a hydroturbine gas pump having a working chamber, in combination, a rotor and a rotor shaft, a lobed body forming an outer boundary of the working chamber, a ported cone defining

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an inner boundary of the working chamber within the body, a head defining an end boundary of said chamber and having inlet and outlet passages formed in it which lead to and from the ported cone, and a bearing bracket for the rotor shaft, the cone having a separate outer wear part and an inner part complementary thereto, the bracket and the inner cone port having circular portions and the head having the bracket and said inner cone part formed integral with it to eliminate tolerances and to assure the concentricity of the circular portions of these parts.

12. In a hydroturbine gas pump having a working chamber, in combination, a rotor and a rotor shaft, a lobed body forming an outer boundary of the working chamber, a ported cone defining an inner boundary of the working chamber within the body, a head defining an end boundary of said chamber and having inlet and outlet passages formed in it which lead to and from the cone, the ported cone comprising a separate outer wear portion engageable with the rotor and an inner portion integral with the head and constituting an inward extension of the head, said wear portion being longitudinally slidable relative to the head, the head being formed with an annular seat toward which the wear portion of the cone is thrust, and clamping means carried by the inner cone portion for urging the wear portion toward said seat, the construction and arrangement of the head and the cone portions together with said clamping means being such that the wear portion of the cone may be clamped firmly to the head in different positions of longitudinal adjustment by the interposition of shims of different selected thicknesses between the wear portion and said seat.

13. In a hydroturbine gas pump having a working chamber, in combination, a lobed body partly bounding the working chamber, a head, and a cone, a rotor operable in said chamber, a shaft upon which the rotor is mounted, a bearing bracket for the shaft, the cone being divided into distinct inner and outer portions which jointly define passageways leading to and from the chamber, the outer cone portion being axially adjustable relative to the head, and the head

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having integral with it the inner cone portion and a bearing bracket for the shaft.

14. In a hydroturbine gas pump having a working chamber, in combination, a lobed body partly bounding the working chamber, a head, and a cone, a rotor operable in said chamber, a shaft upon which the rotor is mounted, a bearing bracket for the shaft, and supporting feet for the head in transverse alignment with the bearing bracket, the cone being divided into inner and outer portions which jointly define passageways leading to and from the chamber, the outer cone portion being axially adjustable relative to the head, and the head having integral with it the inner cone portion, the bearing bracket for the shaft, and the supporting feet in transverse alignment with the bearing bracket.

15. In a hydroturbine gas pump, in combination, a lobed body, a head, a ported cone defining the boundary of a working chamber, a rotor operable in the chamber, the cone having a diametrically opposed pair of chamber inlet ports and a diametrically opposed pair of chamber outlet ports, and the head and cone jointly providing an inlet system including a common inlet and passages leading from said common inlet to said inlet ports and an outlet system including a common outlet and passages leading from said outlet ports to said common outlet, one of said systems including a single passage in the head and branch passages in the cone which are joined in the cone to connect one pair of ports with the single passage in the head, and the other of said systems including branch passages which are joined in the head and which are connected through separate cone passages with the respective ports of the other pair.

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