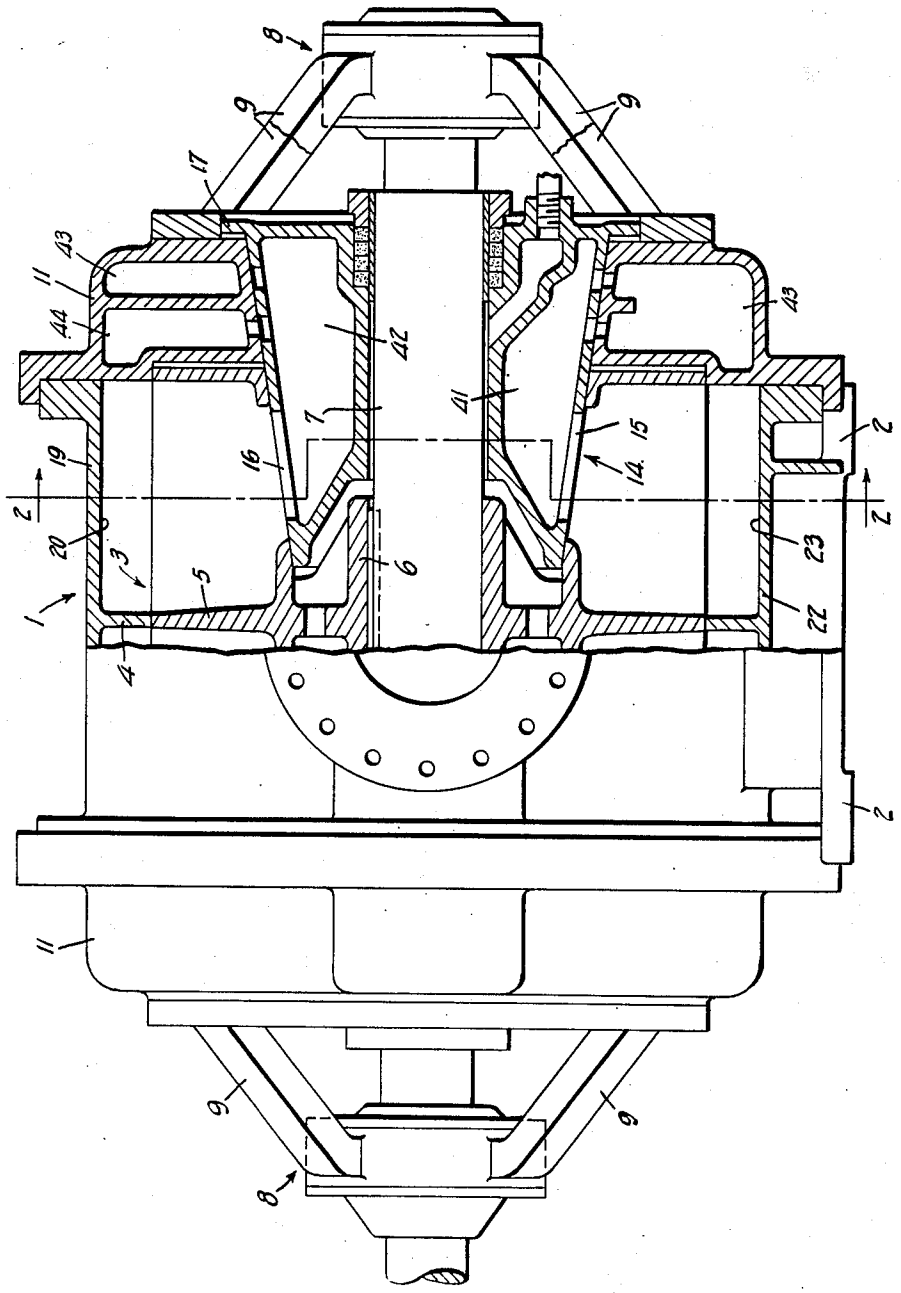
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HYDROTURBINE PUMP

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Fig. 1.




INVENTOR.
Harold E. Adams

BY

Mosca, Nolte, Stewart & Berry
ATTORNEYS

Nov. 9, 1954 H. E. ADAMS 2,693,903

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Fig. 3.

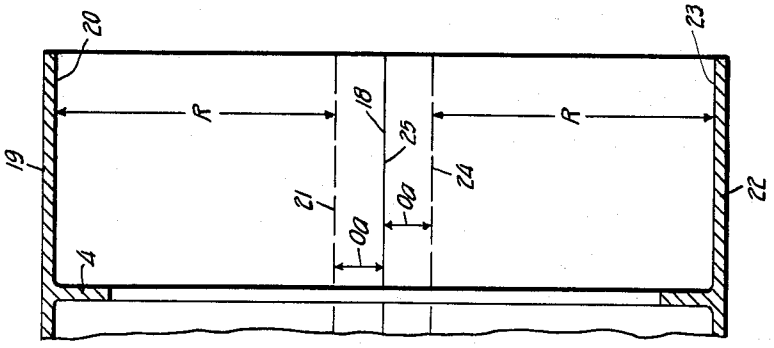
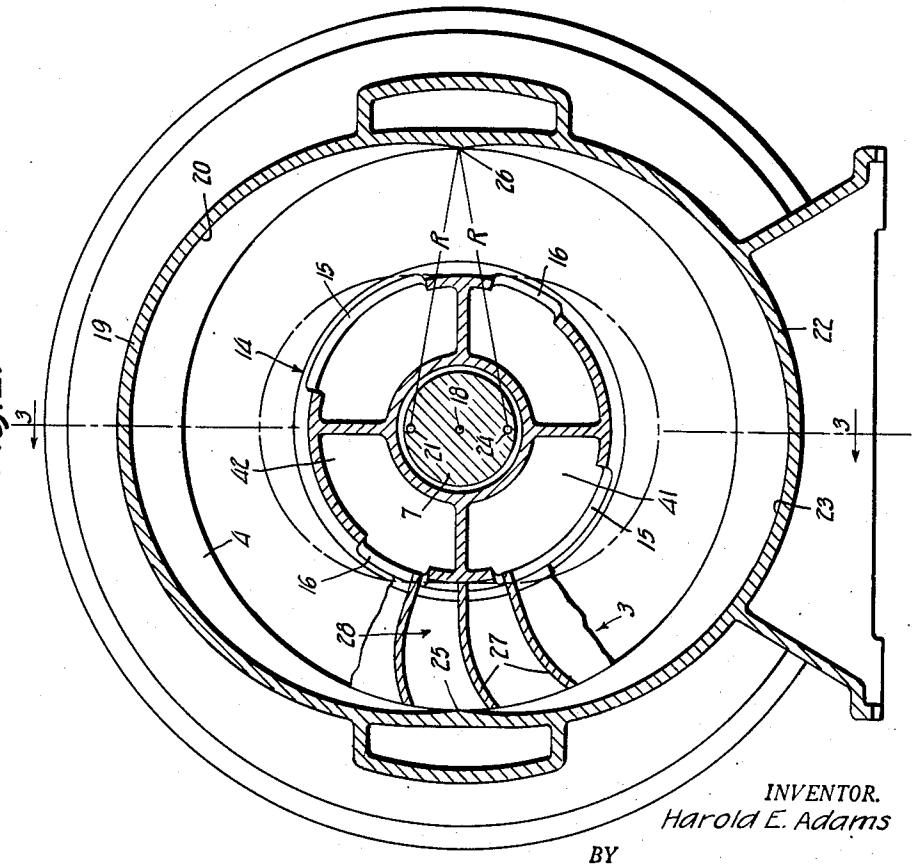



Fig. 2.




INVENTOR.
Harold E. Adams

BY
Moses, Nolte, Crews & Berry
ATTORNEYS

United States Patent Office

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# HYDROTURBINE PUMP

Harold E. Adams, Norwalk, Conn., assignor to Nash Engineering Company, South Norwalk, Conn., a corporation of Connecticut

Application February 15, 1951, Serial No. 211,168

1 Claim. (Cl. 230—79)

This invention relates to hydroturbine gas pumps as exemplified by the well known Nash type vacuum pump or compressor. In a pump of this kind a ring of liquid is made to serve as the pumping medium. The liquid ring is driven by the blades of a rotor, which rotor turns in an eccentric pumping chamber. The blades divide the rotor into buckets or compartments which are open at their inner and outer ends. The outer chamber wall is formed with alternate lobes and lands.

The lands have inner cylindrical surfaces which are coaxial with the rotor and which conform closely to the cylindrical path of the outer rotor blade edges. The lobes vary in depth circumferentially of the chamber, increasing from a first land through a suction sweep and then diminishing toward a second land through a discharge sweep. As a bucket travels from a land through the suction sweep the liquid is progressively forced out of the bucket centrifugally into the lobe, causing gas to be drawn into the inner end of the bucket through an intake port formed in the inner chamber wall, and as the bucket travels through a discharge sweep toward a land, the liquid is forced back into the bucket causing the gas in the bucket to be compressed and discharged through an outlet port formed in the inner chamber wall.

The land occurs between the discharge sweep of one lobe and the suction sweep of the next. Its purpose has been to separate these two sweeps, to prevent by-passing of the liquid from the discharge sweep to the suction sweep. Because of this, the land has usually been made equal in angular extent to the distance between two adjacent rotor blades, so that one lobe would always be sealed off from the other by at least one blade. If a twenty blade rotor were used, this meant an arc of fifteen degrees to eighteen degrees for each land, depending upon the blade thickness.

The other reason for this dwell has been to prevent possible re-expansion of air from the open outlet port through forcing of the liquid out of the bucket prematurely, or the loss of liquid to the inlet sweep from the outlet sweep. The presence of these lands in the case of the conventional two lobe compressor or vacuum pump has meant that no useful work was being done during a total of thirty degrees to thirty-six degrees in each revolution. This has involved a loss of eight to ten percent of the available working space in the body.

Consideration of the various factors involved in the operation of these pumps has led me to believe that the lands are a detriment, rather than a benefit. I have accordingly constructed and tested pumps of no-land construction, and have found them to be decidedly superior to prior conventional pumps in which lands are present.

It is accordingly a primary object of the present invention to increase the work of compression which can be performed by a given size hydroturbine pump rotor by eliminating the lands which have been conventionally provided between the lobes, thereby enabling a higher vacuum to be obtained in a vacuum pump, a higher pressure to be obtained in a compressor, and a greater capacity of gas to be handled over a given compression range.

It is a further object of the invention to take advantage in a no-land hydroturbine pump of the extended suction and compression periods made available by the elimination of the lands, by increasing the angular extent of the intake and discharge ports.

Other objects and advantages will hereinafter appear.

In the drawing forming part of this specification:



Figure 1 is a fragmentary view partly in side elevation and partly in section showing a novel pump which embodies the invention;

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

Figure 3 is a fragmentary sectional view of the pump casing or body taken upon the section line 3—3 of Figure 2, looking in the direction of the arrows.

In the illustrative pump, the body or casing **1**, supported by feet **2**, forms the outer boundary for two working chambers in which the rotor **3** runs. The body **1** is formed with an inwardly extending flange **4** which meets and cooperates with a partition **5** that forms part of the rotor **3**. This divides the working space into two distinct pumping chambers which are duplicates of one another.

The rotor **3** has its hub **6** keyed to a drive shaft **7**. The shaft **7** is mounted in bearings **8** which are carried by brackets **9**. The brackets **9** are secured by screws (not shown) to respective heads **11**, and the heads in turn are secured upon the body **1** by bolts and nuts, (not shown).

Ported cones **14** form the inner boundaries of the respective pumping chambers, being formed with inlet and discharge ports **15** and **16**, through which gas is admitted to the pumping chambers and expelled therefrom. The cones **14** extend through the heads **11** and are formed with flanges **17** through which they are attached by means of screws (not shown) to the respective heads **11**. The cones **14** are provided with inlet and discharge passages **41** and **42** which communicate with the corresponding passages **43** and **44** of the heads **11**.

In the usual casing there is a first or cylindrical land bore concentric with the rotor axis **18** and two cylindrical lobe bores having axes parallel to the axis **18** but equally and oppositely offset from it. Such a construction is shown in Figure 3 of Patent No. 1,718,294. In the patent the width of such land is shown as considerably greater than the width of a rotor bucket.

In the present construction, however, as seen in Figure 2, the land bore is omitted altogether. The upper lobe **19** has an inner cylindrical surface **20** whose axis **21** is uniformly offset from the axis **18** by an amount designated "O*a*" on the drawing. The surface **20** has a uniform radius "R" as indicated on the drawing.

The lower lobe **22** has a cylindrical inner surface **23** whose axis **24** is offset from the axis **18** by the amount O*a*. The surface **23** has the same radius R as the surface **20** of the upper lobe **19**. The surfaces **20** and **23** intersect in straight lines **25**, **26** which are parallel to one another and to the axis **18**. These lines barely clear the outer edges of the rotor blades **27**.

Referring to the bucket **28** which is shown in Figure 2 as in the act of crossing the edge **25**, it will be observed that the outward movement of the liquid has already begun notwithstanding the fact that the bucket is still in communication with the discharge port **16**. While this appears to permit a premature reexpansion of the gas remaining in the inner end of the bucket toward the conclusion of the compression or discharge sweep, the actual loss of compression and operating efficiency from this cause is extremely small if, in fact, there is any loss at all.

In the operation of a pump there is a tendency to lose liquid through the outlet port toward the conclusion of each discharge period, and make-up liquid is constantly supplied to the pump chamber. The loss of liquid begins as the bucket traverses the discharge sweep and normally continues as the bucket traverses the land. The result is that in the conventional pump the liquid falls considerably short of filling the inner end of the bucket at the end where the cone diameter is least, and hence considerably short of expelling all the gas from the bucket because of the deficiency of liquid available for effecting such expulsion. This limits the compression ratio. If, however, the tendency to force liquid toward the center is reversed late in the discharge sweep but early enough to avoid some of the spilling out of the liquid, a greater average amount of liquid will be retained in the bucket and the compression ratio will suffer no substantial impairment because of such reversal.

The advantage of eliminating the lands arises from the fact that these pumps are preeminently velocity type, kinetic energy machines. Kinetic energy is built up in the water ring by centrifugal force acting during the suction sweep of the lobe, and this built up kinetic energy is redirected by the lobe on the discharge sweep back into a rotor bucket to compress and discharge the air which was trapped in the bucket on the suction sweep.

By the time the compressed air has been discharged, practically all the excess kinetic energy of the liquid ring has been used up and it is important that the rebuilding of the energy start immediately. This reverse direction of the liquid can start immediately without danger of prematurely losing seal from one lobe to the other. This is true because most of the built up kinetic energy has been spent, and also because the natural inertia of the liquid mass precludes overall instantaneous bypassing of the already rapidly revolving mass.

Both the inlet and outlet ports **15** and **16** can be advantageously extended within the new working limits made available by the extension of the working space. As shown, the suction sweep of one lobe may be separated from the discharge port of the preceding lobe by a space less than the angular extent of a rotor bucket. Similarly, the discharge sweep of one lobe may be separated from the inlet port of the following lobe by a space less than the angular extent of a rotor bucket.

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 claim.

I claim:

A hydroturbine pump comprising a rotor having blades which divide it into buckets or compartments, means forming a chamber in which the rotor runs comprising an inner boundary member having inlet and discharge ports arranged in alternation and an outer casing, said casing being formed to define lobes of varied depth which terminate in proximity to the path of the rotor periphery, said pump being characterized by the fact that the lobes have inner eccentric cylindrical surfaces which meet one another along common boundary lines.

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