

March 16, 1954

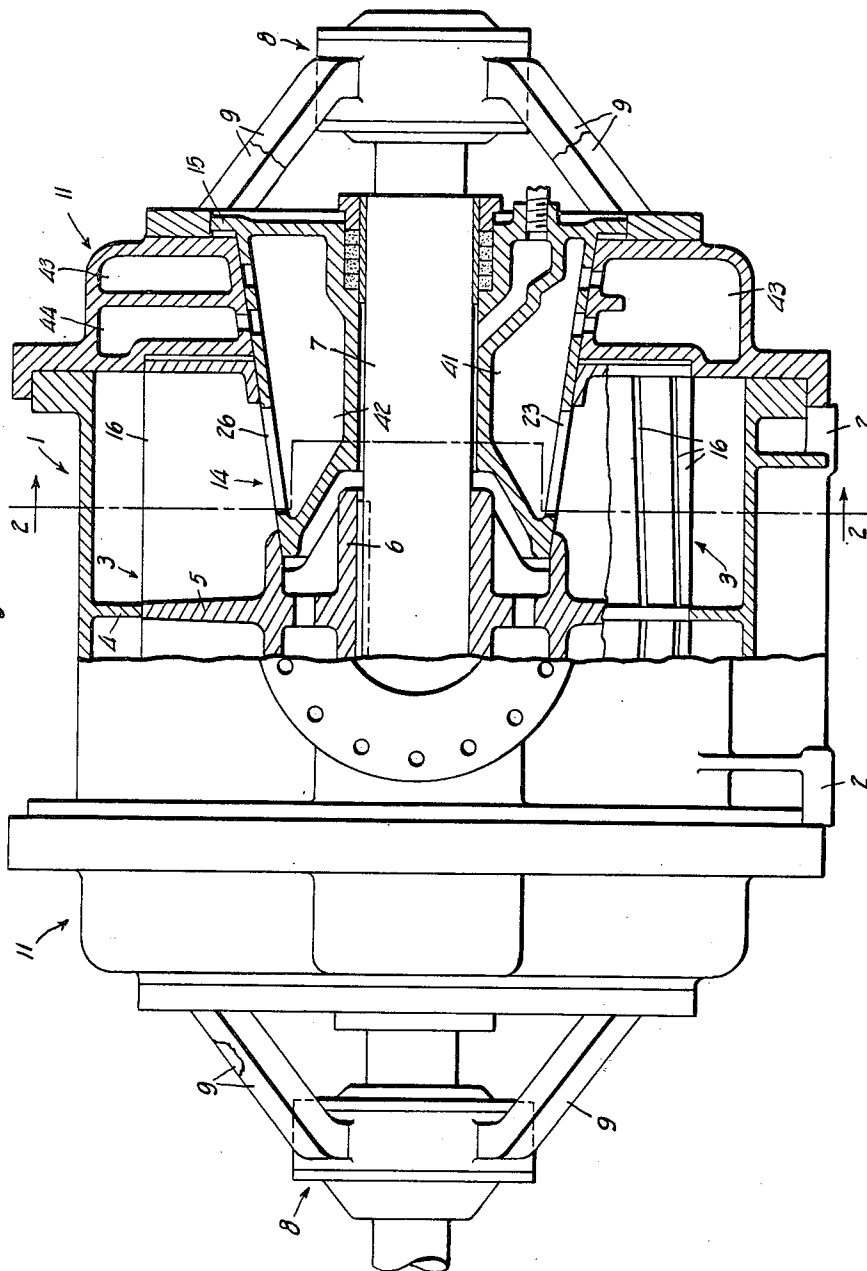
H. E. ADAMS
HYDROTURBINE PUMP

2,672,277

Filed Feb. 15, 1951

6 Sheets-Sheet 1

Fig. 1.



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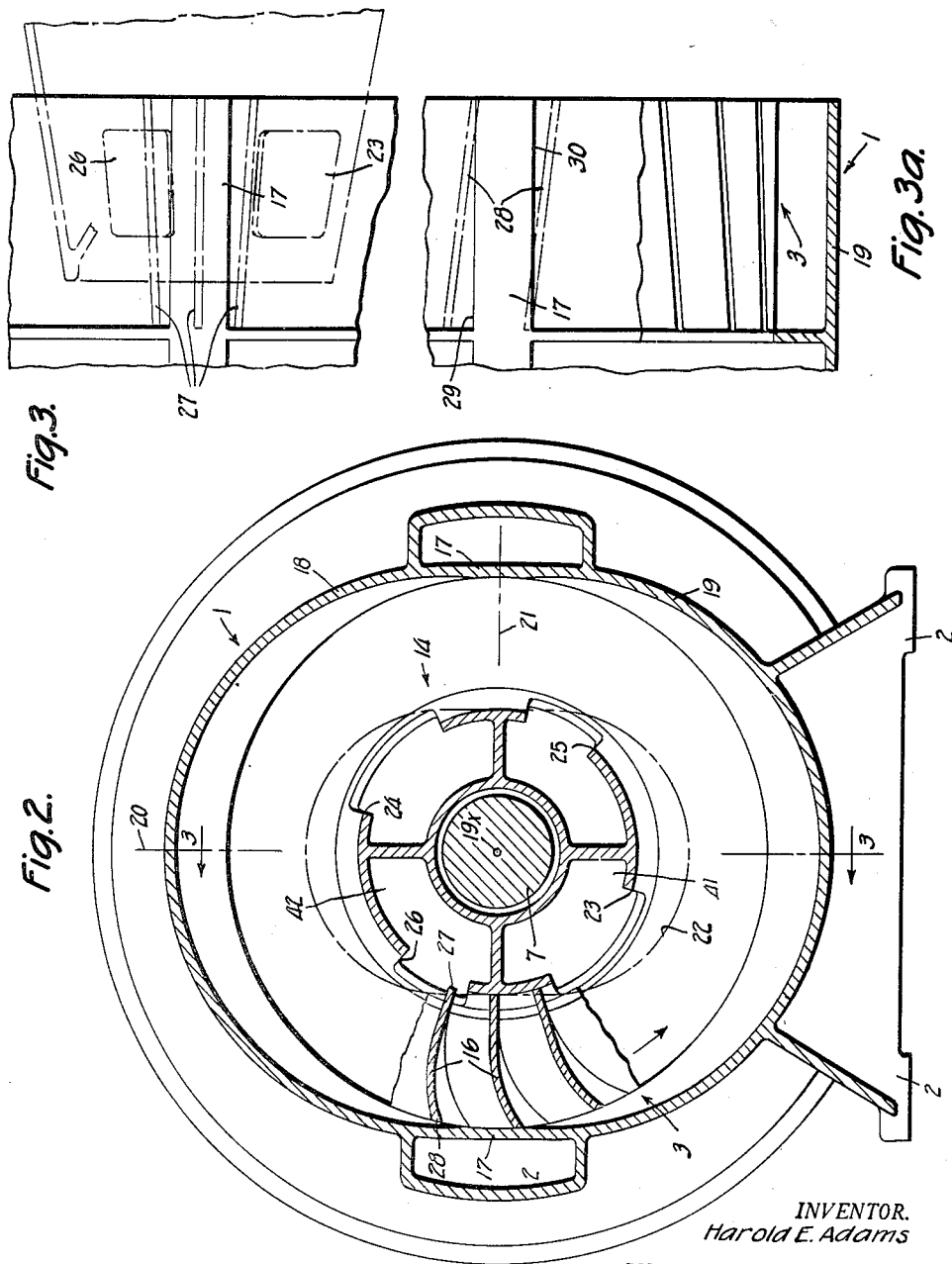
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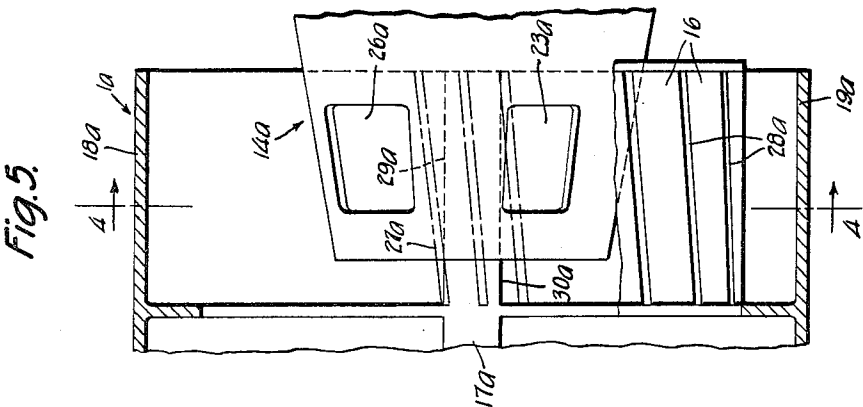
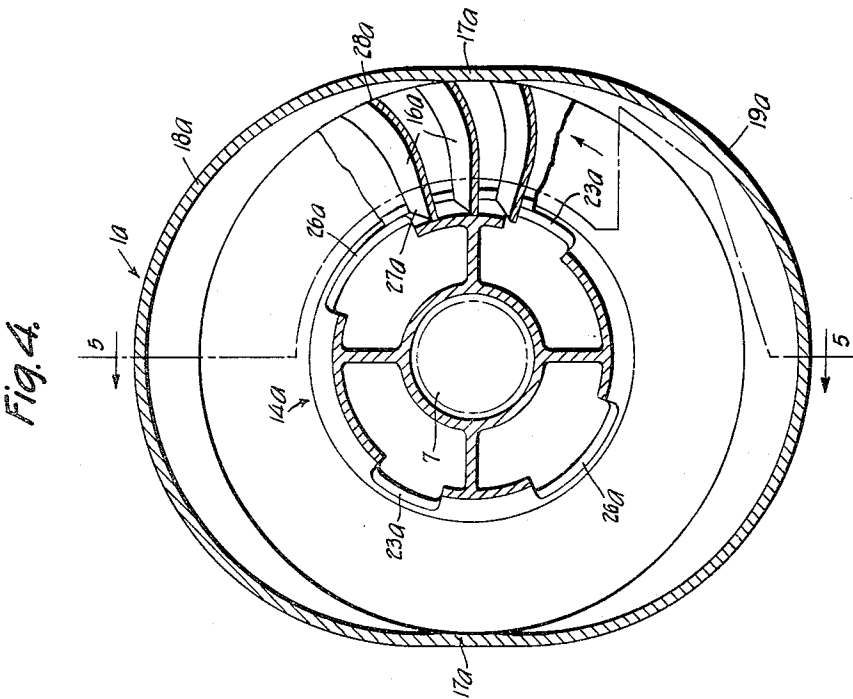
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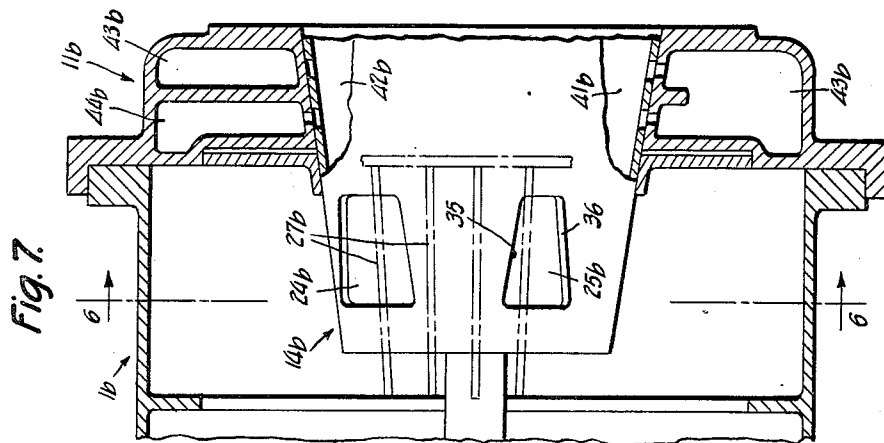
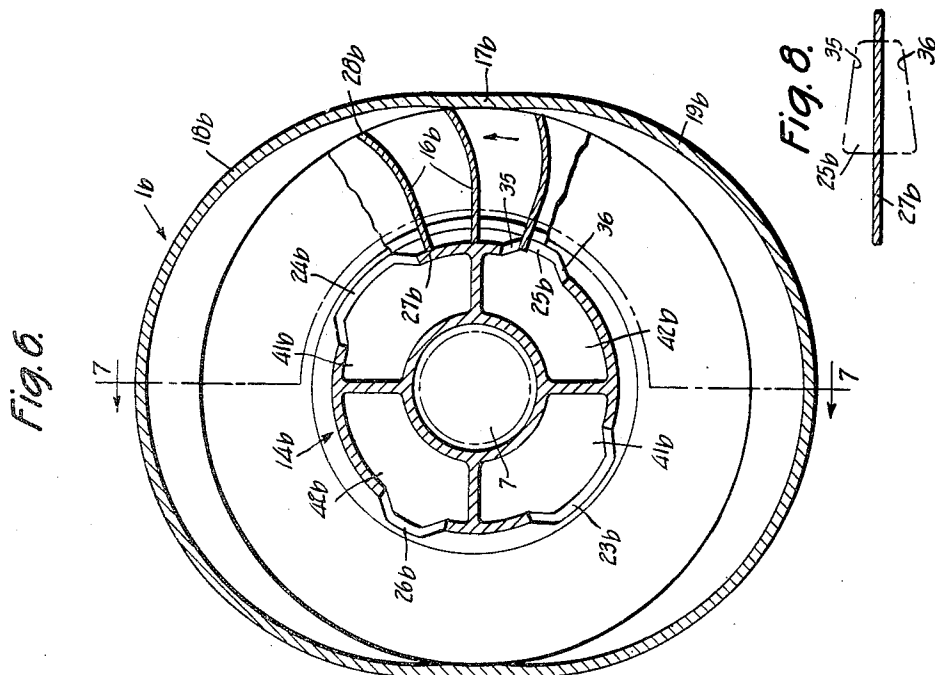
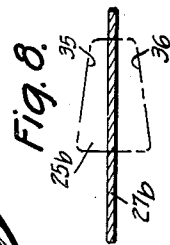
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Fig. 10.

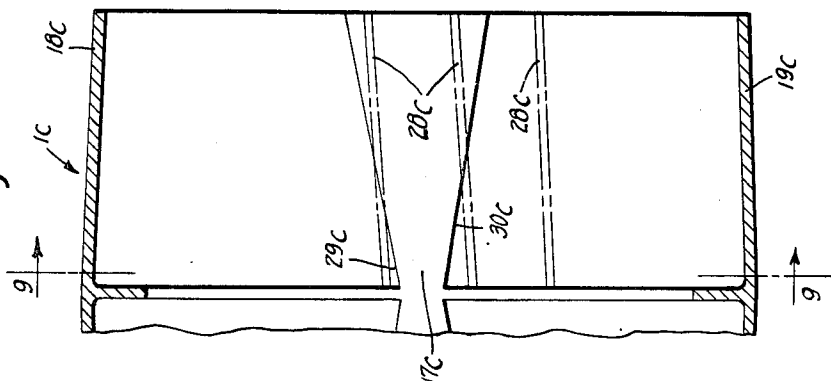
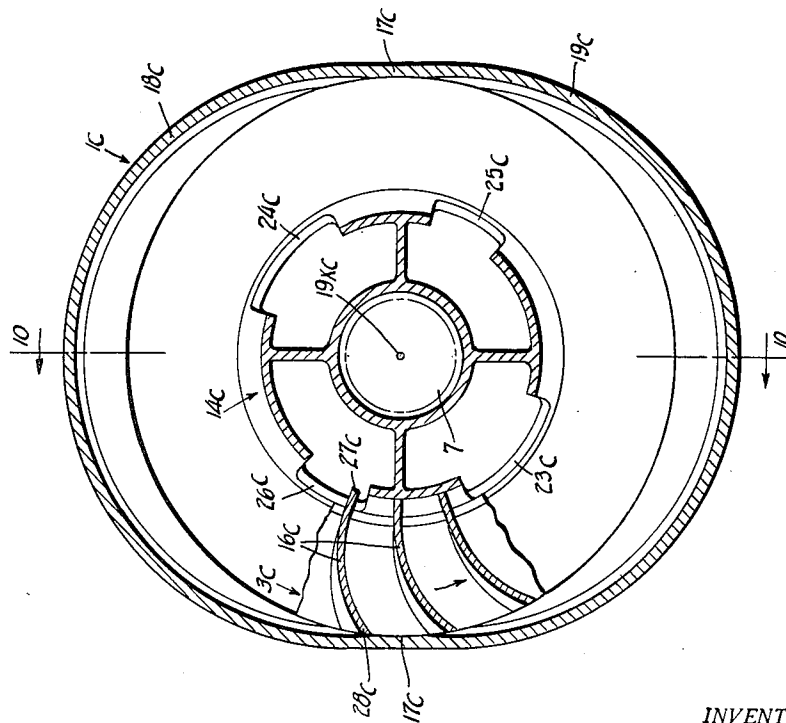


Fig. 9.



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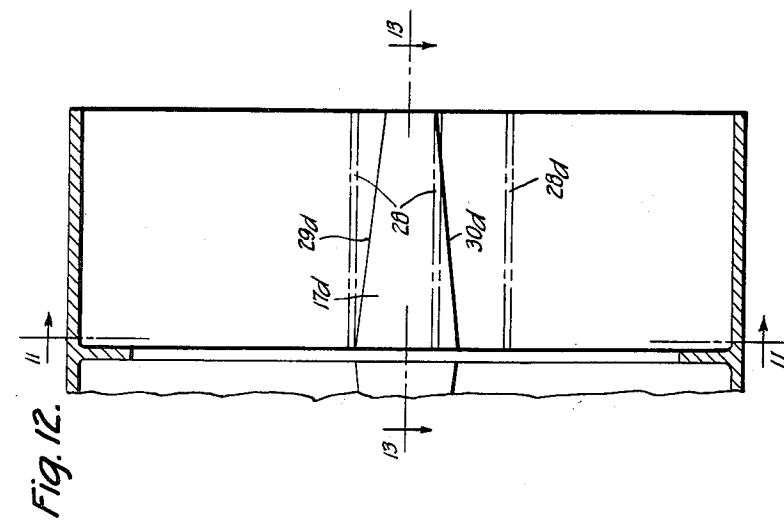
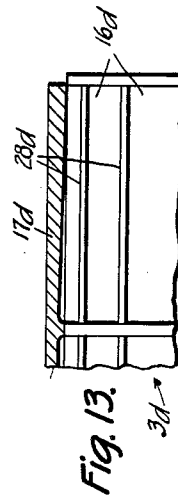
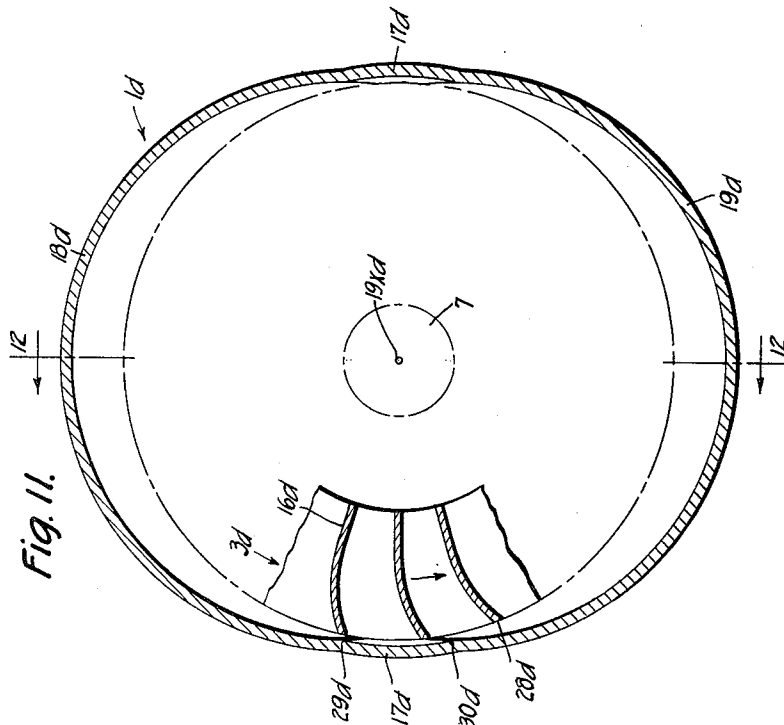
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HYDROTURBINE PUMP

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6 Sheets-Sheet 6



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2,672,277

HYDROTURBINE PUMP

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Application February 15, 1951, Serial No. 211,167

14 Claims. (Cl. 230—79)

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This invention relates to gas pumps of the hydroturbine type. In a pump of this type, a rotating ring of liquid, operated within an eccentric casing, is made to serve as the displacement medium. The well known Nash type compressor or vacuum pump is a good illustration of the type of structure to which the invention is applicable.

More specifically, the invention relates to improvements in pump structures of the kind disclosed in Adams Patents #1,847,548 and #1,847,586 of March 1, 1932, and #2,195,375 of March 26, 1940, wherein a rotor of uniform external diameter operates within an eccentric casing and cooperates with tapered conical port members which extend centrally into the rotor from opposite ends thereof.

In the usual pump of this kind, the body is constructed to provide lobes and lands in alternation, divided by boundary edges which extend parallel to one another and to the axis of the rotor. The cone ports are formed with lateral boundary edges which are disposed in axial planes. The rotor blades are also disposed in axial planes. Neither the inner edges nor the outer edges of the rotor blades have any circumferential component. As the rotor turns the inner rotor blade edges are caused one after another to cross the lateral boundary edges of the ports, and the outer rotor blade edges are caused one after another to cross the lobe edges successively.

Since the lobe edges and the outer rotor blade edges both extend axially, each outer blade edge crosses each lobe edge throughout its entire length at a single instant. Since each such crossing marks either the end of a compression period or the beginning of a suction period and, therefore, a change of operating conditions, the abrupt crossing is objectionable. It causes shock, strain, vibration, noise and cavitation. Each lateral boundary edge of each cone port is crossed by each inner blade edge with similar abruptness and with similar though somewhat less objectionable effects.

It is a primary object of this invention to provide a hydroturbine pump structure in which abrupt changes of operating conditions of the kinds referred to above are avoided. It is equally within the scope of the invention to improve the coaction of the outer blade edges with the body or the coaction of the inner blade edges with the cone, or both.

To this end it is a feature that a relative skewing is provided between the lobe boundary edges and the outer rotor blade edges and/or between the port lateral boundary edges and the inner

rotor blade edges, so that the relatively skewed edges will be caused to cross one another progressively. In this way the change of operating conditions caused by the crossing of relatively skewed edges is caused to occur gradually, being extended in each instance through several degrees of rotation. This may be accomplished in various ways.

The relative skewing of the outer blade edges and the lobe boundary edges may be brought about by maintaining the usual axial disposition of the lobe edges while skewing the outer blade edges, or by maintaining the usual axial disposition of the outer blade edges while skewing the lobe edges. As a further alternative, both the lobe edges and the outer blade edges may be skewed away from the usual axial disposition. Any arrangement which causes the lobe edges and the outer blade edges to be disposed in attitudes causing them to cross one another obliquely and, therefore, progressively is within the scope of the invention.

The relative skewing of the inner blade edges and the port boundary edges may be brought about by maintaining the axial disposition of the port boundary edges while skewing the inner blade edges, or by maintaining the conventional axial disposition of the inner blade edges while skewing the port boundary edges. Here again, the inner blade edges and the port boundary edges may both be skewed away from the usual axial disposition. Any arrangement which causes the port edges and the inner blade edges to be disposed in attitudes causing them to cross one another obliquely and, therefore, progressively, is within the scope of the invention.

The skewing of an edge as referred to herein is intended to mean a turning of the edge away from the true axial disposition so that it has both axial and circumferential components. A relative skewing of edges is intended to mean that the edges are disposed to intersect obliquely whether or not one of them is axially disposed.

A skewing of the port boundary edges can be brought about simply by forming the ports with their lateral boundary edges disposed in arbitrarily selected directions which include both axial and circumferential components. A simultaneous skewing of the inner and outer edges of the rotor blades may be brought about by disposing the flat blades in non-axial planes so that the inner and outer edges both have circumferential as well as axial components. A skewing of the outer blade edge only may be brought about by disposing the inner blade edge axially and

making the blade of twisted form so that the outer edge will extend in the desired direction.

The lobes may be caused to have skewed edges by varying the radius and/or offset of the lobe bores, or by varying slightly the radius of the land bore while forming the lobe bores of uniform radius and offset in accordance with usual practice.

It may be here remarked that the usual practice is to form a cylindrical land bore which is to be coaxial with the rotor and then to form eccentric cylindrical lobe bores whose axes extend parallel to the axis of the land bore and are equally offset from it.

In my copending application Serial No. 211,166 for Hydroturbine Pump, filed concurrently herewith, disclosure is made of several forms of body construction for varying the lobe depth in order to secure matched displacement of the lobe and rotor lengthwise of the pumping chamber, all of which have the incidental effect of producing skewed lobe boundary edges. Structures falling within the principle of the disclosure of said application are claimed therein, but the principle of providing relative skewing between rotor blade edges and edges which they cross is broadly claimed herein. The disclosure of Serial No. 211,166, in its entirety, is made a part of the present specification by reference.

Other objects and advantages will hereinafter appear.

In the drawing forming part of this specification

Figure 1 is a view in side elevation, partly broken away, of a two-chamber hydroturbine pump embodying the present invention;

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 fragmentary sectional view taken upon the line 3—3 of Figure 2 looking in the direction of the arrows;

Figure 3a is a fragmentary view generally similar to Figure 3, but with parts broken away to reveal underlying structure;

Figure 4 is a transverse, vertical sectional view through a second form of pump embodying the invention, the section being taken upon the line 4—4 of Figure 5 looking in the direction of the arrows;

Figure 5 is a fragmentary sectional view, partly broken away, the section being taken upon the line 5—5 of Figure 4 looking in the direction of the arrows;

Figure 6 is a transverse, vertical sectional view showing a third form of pump embodying the invention, the section being taken upon the line 6—6 of Figure 7 looking in the direction of the arrows;

Figure 7 is a fragmentary sectional view taken upon the line 7—7 of Figure 6 looking in the direction of the arrows;

Figure 8 is a detail sectional view showing the inner portion of one of the rotor blades half way across one of the cone ports;

Figure 9 is a transverse, vertical sectional view showing a fourth form of pump embodying the invention, the section being taken upon the line 9—9 of Figure 10 looking in the direction of the arrows;

Figure 10 is a fragmentary sectional view taken upon the line 10—10 of Figure 9 looking in the direction of the arrows;

Figure 11 is a vertical transverse sectional view of a fifth form of pump embodying features of

the invention, the section being taken upon the line 11—11 of Figure 12 looking in the direction of the arrows;

Figure 12 is a fragmentary sectional view taken upon the line 12—12 of Figure 11 looking in the direction of the arrows; and

Figure 13 is a fragmentary sectional view taken upon the line 13—13 of Figure 12 looking in the direction of the arrows.

In the illustrative pump of Figures 1 to 3a, 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 partition flange 4 which meets and cooperates with a partition 5 that forms part of the rotor 3.

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 by bolts and nuts (not shown).

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

The rotor 3 comprises blades 16 whose outer edges at every point travel in a common cylindrical path. The body of casing 1 is of eccentric construction. It is made to comprise narrow lands 17 having inner surfaces which are cylindrical and which barely clear the outer edges of the rotor blades. The body is also made to include upper and lower lobes 18 and 19 whose inner surfaces are also cylindrical but whose axes extend parallel to the rotor axis 19x, being offset equally and oppositely from the rotor axis. A liquid ring is driven around by the rotor within the casing, the liquid in each bucket formed between successive blades being forced outward by centrifugal force as it approaches the major axial plane 20 of the chamber and being forced inward by the contracting lobe as it approaches the minor axial plane 21 of the chamber. The inner boundary of the ring is indicated at 22. As the liquid moves outward it draws gas into the chamber through inlet ports 23 and 24 and as it is returned inward it compresses the gas and forces it out through exhaust ports 25 and 26. The pumping cycle is performed twice for each revolution of a bucket.

As shown in Figures 2 and 3a the lateral boundary edges of the inlet and outlet ports lie in axial planes while the edges which divide the lobes 18 and 19 from the lands 17 also lie in axial planes. The inner edges 27 of the rotor blades 16 extend in axial planes and therefore each inner blade edge crosses each lateral port edge instantaneously.

In the usual construction of the prior art the outer blade edges are also disposed in axial planes and cross the lobe edges simultaneously. In the present construction, however, the blades 16 have a twisted form so that their outer edges 28 are caused to be skewed. The outer edges instead of lying in axial planes have circumferential, as well as axial components. As one of these edges

Each lobe has a cylindrical bore whose axis extends parallel to the rotor axis 19zd. The lands 17d are, however, bored on a slight taper so that their inner surfaces are slightly conical in form. This is done for the purpose of causing the boundary edges 29d and 30d to be skewed so that the axially disposed outer edges 28d of the rotor blades 16d will cross the edges 29d and 30d progressively. The forming of the land bore as a conical bore causes the land surfaces to be spaced slightly from the cylindrical path of the rotor blades, but the clearance is so slight that no substantial loss of efficiency results.

While some of the illustrative forms disclosed herein take into account the desirability only of causing the outer rotor blade edges to cross casing edges progressively and others take into account only the desirability of causing the inner rotor blade edges to cross port edges progressively, it is to be understood that structures combining these features are to be regarded equally as within the scope of the invention.

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 hydroturbine pump comprising, in combination, a rotor having blades formed with inner and outer edges, means forming a chamber in which the rotor turns comprising an outer wall forming member having successive segments of different contours which are divided from one another by common boundary edges which edges are successively crossed by the outer edges of the blades, and an inner wall forming member provided with inlet and outlet ports in alternation, which ports have boundary edges successively crossed by the inner edges of the blades, a portion at least of said boundary edges and the blade edges which cross them being relatively skewed in order to cause such blade edges to cross the relatively skewed boundary edges progressively.

2. A hydroturbine pump comprising, in combination, a rotor having blades formed with inner and outer edges, means forming a chamber in which the rotor turns comprising an outer wall forming member formed with lands and lobes in alternation which meet along boundary edges successively crossed by the outer edges of the blades, and an inner wall forming member provided with inlet and outlet ports in alternation, which ports have boundary edges successively crossed by the inner edges of the blades, a portion at least of said boundary edges and the blade edges which cross them being relatively skewed, in order to cause such blade edges to cross the relatively skewed boundary edges progressively.

3. In a hydroturbine pump, in combination, a rotor having blades formed with inner and outer edges, and means forming a chamber in which the rotor turns, comprising an outer wall formed with lands and lobes in alternation which meet along boundary edges successively crossed by the outer edges of the blades, a portion at least of said boundary edges being skewed relative to the blade edges which cross them in order to cause such blade edges to cross progressively the relatively skewed boundary edges.

4. In a hydroturbine pump, in combination, a rotor having a defined axis of rotation and having blades formed with inner and outer edges, means forming a chamber in which the rotor turns, comprising outer walls formed with lands

and lobes in alternation which meet along boundary edges successively crossed by the outer edges of the blades, the outer blade edges having both axial and circumferential components such that the outer blade edges will extend obliquely to the boundary edges which separate the lands from the lobes as they cross such edges.

5. In a hydroturbine pump, in combination, a rotor having a defined axis of rotation and having blades formed with inner and outer edges, means forming a chamber in which the rotor turns, comprising outer walls formed with lands and lobes in alternation which meet along parallel axially extending boundary edges successively crossed by the outer edges of the blades, the outer blade edges having both axial and circumferential components which cause such outer edges to cross progressively the boundary edges which separate the lands from the lobes.

6. In a hydroturbine pump, in combination, a rotor having a defined axis of rotation and having blades formed with inner and outer edges and means forming a chamber in which the rotor turns, comprising an outer wall formed with lands and lobes in alternation which meet along parallel, axially extending boundary edges successively crossed by the outer edges of the blades, the blades being twisted and disposed to cause their inner edges to extend axially of the rotor but their outer edges to have both axial and circumferential components so that the outer blade edges will be caused to cross progressively the boundary edges which separate the lands from the lobes.

7. In a hydroturbine pump, in combination, a rotor having blades formed with inner and outer edges, and means forming a chamber in which the rotor turns, comprising an inner wall formed with inlet and outlet ports in alternation, which ports have boundary edges successively crossed by the inner edges of the blades, a portion at least of said boundary edges being skewed relative to the blade edges which cross them in order to cause such blade edges to cross progressively the relatively skewed boundary edges.

8. In a hydroturbine pump, in combination, a rotor having a defined axis of rotation and having blades formed with inner and outer edges, means forming a chamber in which the rotor turns, comprising an inner wall provided with inlet and outlet ports in alternation, said ports having boundary edges located in axially extending planes, which edges are successively crossed by the inner edges of the blades, the blades being so constructed and arranged that their inner edges have both axial and circumferential components, which cause the inner blade edges to cross the boundary edges of the ports progressively.

9. In a hydroturbine pump, in combination, a rotor having a defined axis of rotation and having blades formed with inner and outer edges, the outer edges at least having both circumferential and axial components, means forming a chamber in which the rotor turns, comprising a body forming an outer chamber boundary and formed to provide lobes and lands in alternation with the land edges disposed in such attitudes that they must be crossed obliquely by the outer blade edges.

10. In a hydroturbine pump, in combination, a rotor having a defined axis of rotation and having blades formed with inner and outer edges, means forming a chamber in which the rotor turns, comprising an inner wall forming an inner chamber

28 crosses a lobe edge it extends obliquely to it. One end of the blade therefore crosses the lobe edge first and the crossing continues progressively to the opposite end of the blade. In this way, the change of condition brought about when a blade edges crosses a lobe edge is caused to occur gradually and not abruptly as heretofore. As has been pointed out, this relieves the pump of shock, strain and vibration by spreading out the change of condition over several degrees or rotation. The novel construction also results in a reduction of noise and cavitation.

In Figures 3 and 3a the boundary edges between the lands and lobes are illustrated at 29 and 30. The inclination or skewing of the outer blade edges 28 is directly illustrative in full line in Figure 3a and is illustrated in broken lines for the blades at the far side of the rotor in the same figure. In Figure 3 the axial disposition of the inner edges of the rotor blades as illustrated in broken lines, as well as the axial disposition of the lateral boundary edges of the cone ports 23, 26.

In the form of the invention illustrated in Figures 4 and 5 provision is made both to cause a gradual or progressive crossing of the lobe edges by the outer edges of the rotor blades and to cause a gradual or progressive crossing of the lateral boundary edges of the cone ports by the inner edges of the rotor blades.

The construction is generally like that of Figures 1 to 3a and accordingly corresponding reference characters have been applied to corresponding parts with the subscript "a" added in each instance. The casing 1a and the cone 14a are of the same construction as before, while the parts not illustrated are identical with the showing of Figure 1. The rotor blades 16a are not twisted, however, but are skewed in their entirety so that both the inner edges 27a and the outer edges 28a have circumferential, as well as axial components. As a result of this arrangement, the outer blade edges 28a are caused to cross the lobe and land edges 29a and 30a progressively as in the construction of Figures 1 to 3a. The skewing of the inner rotor blade edges 27a, however, causes the inner blade edges to cross the lateral boundary edges of the cone ports progressively so that the change of conditions produced by these crossings will be caused to occur gradually and not abruptly as before.

In Figure 5, the lobe and land edges 29a and 30a are illustrated, and the skewed outer edges 28a of the rotor blades are shown in full line. The cone ports 23a and 26a are shown with lateral boundary edges disposed in axial planes, and the skewed inner edges 27a of the rotor blades 16a are shown in broken lines. One of these blades is illustrated as intersecting a lateral boundary edge of the port 23a.

The form of the invention illustrated in Figures 6 to 8 is again generally like that of Figures 1 to 3a. Corresponding reference characters have been applied to corresponding parts with the subscript "b" added in each instance. The casing 1b is the same as casing 1 of Figures 1 to 3a but the rotor blades 16b are of conventional construction. The inner edges 27b lie in axial planes while the outer edges 28b also lie in axial planes. As here shown, no provision is made for causing the outer blade edges to cross the lobe and land edges progressively but provision is made for causing the inner blade edges 27b to cross the lateral edges of the ports 23b, 24b, 25b and 26b progressively. For this purpose, the

lateral boundary edges of the ports are skewed. The arrangement is best illustrated in Figure 8 in which the edges 35 and 36 of the port 25b are shown as skewed equally but oppositely. The inner edge 27b of one of the blades is shown as extending axially midway between the port boundary edges 35 and 36. It is evident of course that the inner blade edge 27b will cross each of these edges progressively. In Figure 7, several of the inner edges 27b are shown in dot and dash lines in association with the ports 25b and 24b.

The form of pump illustrated in Figures 9 and 10 is also generally similar to the pump of Figures 1 and 3a and accordingly corresponding reference characters have been applied to corresponding parts with the subscript "c" added in each instance. The ported cone 14c is the same as the cone 14 and the rotor 3c is the same as the rotor 3. The rotor 3c comprises twisted blades 16c having inner edges 27c which are disposed in radial planes and skewed outer edges 28c.

The pump of Figures 9 and 10 includes a casing 1c having tapered lands 17c. The pump casing is desirably in all respects like the pump casing illustrated in Figures 15 and 16 of my copending application Serial No. 211,166. The land bore is a cylindrical bore whose axis coincides with the rotor axis 19xc. The bores of the lobes 18c and 19c are conical in form, the bore axes extending parallel to the axis 19xc but being equally and oppositely offset from the axis 19xc. The bore radius for each lobe increases progressively from the chamber end in which the cone 14c is largest to the chamber end in which the cone is smallest. The primary purpose in constructing a lobe in the manner described is to provide matched displacement of the lobe and rotor, and thereby to avoid the setting up of a cross-current within the chamber, as pointed out in Serial No. 211,166. The formation of the casing 1c in the manner described causes the boundary edges 29c and 30c which divide the lands from the lobes to be skewed, however, as illustrated in Figure 10. The fact that these edges are skewed would of itself cause the outer rotor edges to cross the edges 29c and 30c progressively, even if the outer rotor edges were disposed in axial planes according to the conventional arrangement.

The pump of Figures 9 and 10, however, illustrates a further point. It will be observed that the edges 29c and 30c of Figures 9 and 10 are equally and oppositely skewed. If, therefore, the outer edges 28c of the rotor blades 16c were disposed in axial planes, each of the edges 29c and 30c would be crossed in equal time intervals by an axially disposed blade edge. By skewing the outer blade edges to increase the angle at which they intersect the edge 30c and to diminish the angle at which they intersect the edge 29c, the crossing periods are rendered unequal. While each of the edges 29c and 30c is crossed progressively by a blade, the crossing of the edge 30c to initiate an intake period is made relatively protracted while the crossing of an edge 29c to terminate a discharge period is made relatively brief. This is a desirable condition.

The pump illustrated in Figures 11 to 13 is also generally similar to that of Figures 1 to 3a and accordingly corresponding reference characters have been applied to corresponding parts with the subscript "d" added in each instance. The rotor 3d is of conventional construction, and the ported cone (not shown) is also of conventional construction.

The casing 1d comprises lobes 18d and 19d.

boundary provided with inlet and outlet ports in alternation, said ports having boundary edges located in axially extending planes, which edges are successively crossed by the inner edges of the blades, and an outer wall formed to define alternate lobes and lands divided by straight axially extending edges, the blades being so constructed and arranged that both their inner and outer edges have circumferential as well as axial components, the inner edges being disposed to cross the port edges progressively and the outer edges being disposed to cross the land edges progressively.

11. In a hydroturbine pump in combination, a rotor having a defined axis of rotation and having blades formed with inner and outer edges, the outer edges at least having both circumferential and axial components, the pump including means forming a chamber in which the rotor turns, said chamber forming means comprising a body forming an outer chamber boundary and formed to provide lobes and lands in alternation with the land edges each disposed to have both axial and circumferential components but to be crossed obliquely by the outer blade edges.

12. In a hydroturbine pump, in combination, a rotor having a defined axis of rotation and having blades formed with axially extending outer and inner edges, means forming a chamber in which the rotor turns, comprising an outer wall formed with lands and lobes in alternation which meet along boundary edges successively crossed by the outer edges of the blades, and an inner wall provided with inlet and outlet ports in alternation, which ports have boundary edges

successively crossed by the inner edges of the blades, a portion at least of said boundary edges being skewed relative to the blades so that they will be crossed progressively by the associated blade edges.

13. In a hydroturbine pump, in combination, a rotor having blades formed with inner and outer edges, and means forming a chamber in which the rotor turns, said chamber having an outer wall formed with lands and lobes in alternation which meet along boundary edges that are skewed relative to the outer edges of the blades so that they will be crossed progressively by the outer blade edges.

14. In a hydroturbine pump, in combination, a rotor having a defined axis of rotation and having blades formed with inner and outer edges, and means forming a chamber in which the rotor turns, said chamber forming means having lobes of uniform radius and whose surfaces are separated by conical surfaces coaxial with the rotor, and whose boundary edges have circumferential as well as axial components, there being a relative skewing between the outer rotor blade edges and said boundary edges so that the rotor blade edges are caused to cross the boundary edges progressively.

HAROLD E. ADAMS.

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