March 10, 1953 R. C. SCHLICHTIG 2,630,963

ROTARY ASPIRATOR PUMP

Filed Sept. 27, 1945 2 SHEETS—SHEET 1

Fig. 1

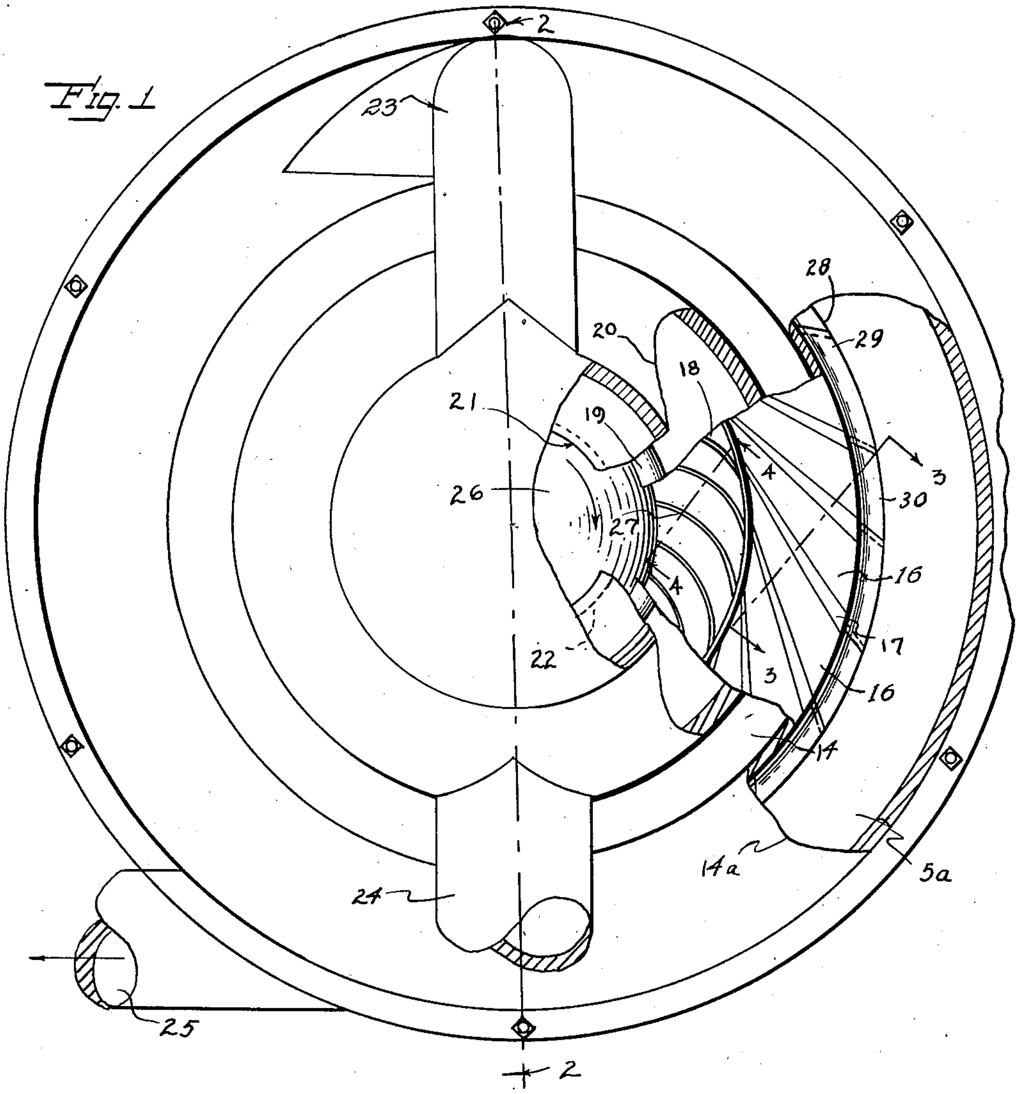
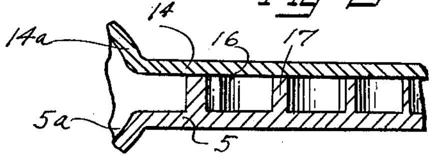


Fig 3



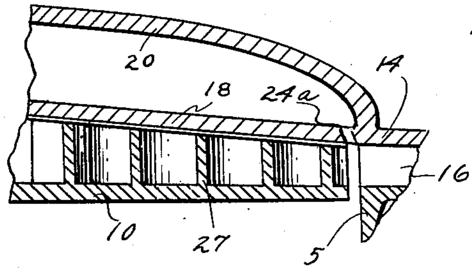


Fig. 4.

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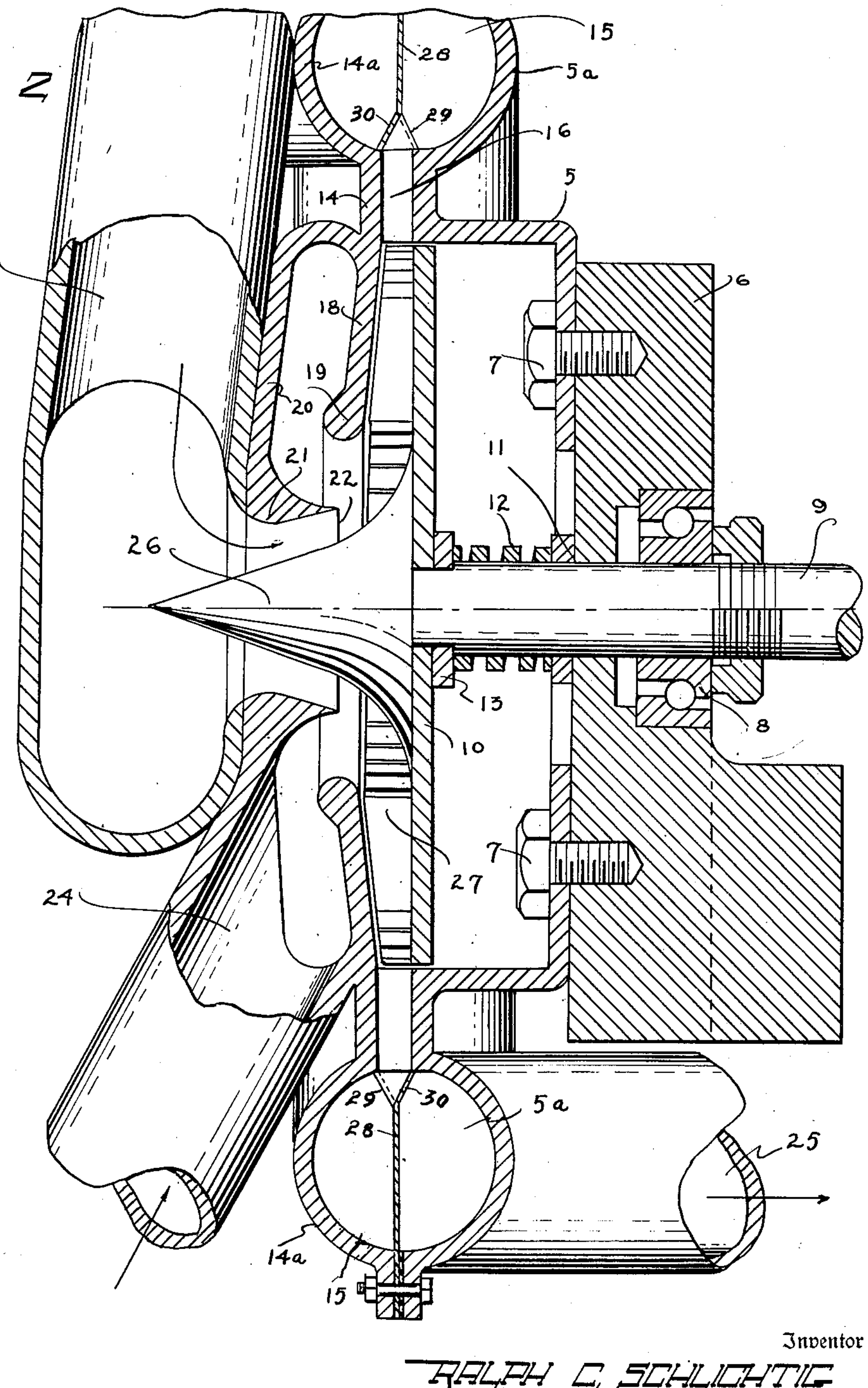
Fig. 2



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Patented Mar. 10, 1953 2,630,963

UNITED STATES PATENT OFFICE

2,630,963

ROTARY ASPIRATOR PUMP

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Application September 27, 1945, Serial No. 618,885

4 Claims. (Cl. 230—45)

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My invention is in the nature of a rotary aspirator pump. The principal object of my invention is to provide a pump of this character which is capable of developing much greater pressure than the theoretical pressure of a centrifugal pump of like diameter and speed of rotation, and which is also capable of operating in reverse as a fluid turbine of high efficiency.

A device embodying my invention may be utilized for many purposes. For example one objective application is to accomplish approximate adiabatic compression of the gaseous working medium of a heat transfer mechanism. In reverse it may be utilized to effect approximate adiabatic expansion of the gaseous medium of a heat transfer mechanism. It is also useful in the compression of air or fuel mixtures to supercharge internal combustion engines, in transforming energy of fluids under pressure into mechanical energy, compressing air or vapors for use in various low pressure mechanisms and such other fields as the removal of vapor from one vessel to another in distillation processes.

My invention is embodied in an aspirator construction wherein an aspirator throat leading from a low pressure chamber or area to be evacuated has an injector duct leading centrally into the throat and providing therewith a restricted cross section where fluid of relatively high velocity from the injector picks up fluid in the throat. The fluid flow is directed against a torodial conoid forming the central portion of a rotor so as to change the direction of the fluid from axially of the rotor to radially of the rotor. The rotor is provided with blades that take the fluid from the central portion initially in substantially a radial direction and then curve in the direction of rotation of the rotor to the periphery of the rotor so as to effect a restriction of the cross section of the fluid passages at the periphery and to utilize the centrifugal force of the fluid outwardly against the advancing blades to increase the velocity of the fluid in the direction of rotation of the rotor. The construction is also such as to effect constriction of depth of the passages between blades as these passages approach the periphery of the rotor. Thus the pressure energy of the fluid in the rotor is further converted into velocity energy by reason of the constriction of the passages. The velocity of the fluid is therefore at its maximum at the periphery of the rotor. This also is the point of lowest pressure in the system. The discharge from the rotor is in a direction nearly tangential to the rotor into outwardly expanding passages for converting the

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velocity energy of the fluid into pressure energy in a toroidal chamber around the outer ends of the passages.

The novel features of my invention are set forth with particularity in the appended claims. This invention itself, however, both as to its embodiment in a practical device and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings in which:

Figure 1 is a face view of an aspirator pump constructed in accordance with the invention, certain parts being broken away to illustrate the interior construction;

Figure 2 is a sectional view taken on the line 2—2 of Figure 1;

Figure 3 is a fragmentary sectional view taken on the line 3—3 of Figure 1; and

Figure 4 is a fragmentary sectional view taken on the line 4—4 of Figure 1, but showing a modification of fluid feed to the rotor.

Referring now to the drawings, the pump comprises a back casing section 5 which may be mounted upon a support 6 by screw-bolts 7. The support 6 mounts a bearing 8 for a rotor shaft 9. A rotor 10 is carried by the shaft which extends through a seal plate 11 which is backed up by a spring 12 that in turn bears against a washer 13 that is mounted on the shaft 9 against the rotor 10. The housing of the rotor is completed by a front casing section 14 which is bolted to the section 5 at the periphery. A suitable gasket is used to seal the two casing sections together.

The two casing sections 5 and 14 have outer semicircular portions 5*a* and 14*a* which form a toroidal chamber 15 at the periphery of the casing. Inside this chamber there is an annular restricted passage 16 that extends in to the periphery of the rotor. This passage is sometimes referred to hereinafter as the "diffuser" chamber of the pump. The section 5 has ribs 17 thereon which are tapered in thickness and which are approximately tangential to the rotor periphery on the rotor facing surface thereof. The section 14 rests on the ribs 17.

The section 14 has an inwardly extending rotor cover portion 18 that terminates in a rounded inner lip 19. Over the portion 18 the section 14 is formed with a wall 20 that extends to a restricted injection nozzle 21, the inner edge 22 of which extends into the space within the lip 19. A pressure fluid manifold 23 leads from the toroidal chamber 15 inwardly to the nozzle 21.

A low pressure inlet 24 is provided to the space around the nozzle 21. A high pressure fluid connection to the chamber 15 is provided at 25. The chamber 15 has a partition 28 arranged with offset portions 29 and 30 directing fluid from the diffuser passages 16 to either the conduit 23 or the conduit 25.

In Figure 4 of the drawings, the low pressure inlet is provided by several openings 24a that enter the rotor chamber just outwardly of the rotor periphery. This space is the space of lowest pressure in the system due to the high velocity discharge of fluid across it from the constricted passages between the rotor blades.

The rotor 10 has a center 26 that extends out through the injection nozzle 21. The outer portion of the member 26 is a true cone but the inner portion is of toroidal shape. The rotor also has blades 27 extending outwardly from the base of the center 26. These blades as shown are highest at their inner ends and cover 18 is shaped to fit closely over them. The blades at their inner ends extend in substantially a radial direction with respect to the rotor axis. Toward their outer ends the blades curve forwardly in the direction of rotation of the rotor to approach alignment at their outer ends, with the ribs 17. As shown in the drawings each rotor blade at its outer ends has its inner surface directed forwardly and outwardly at an angle of about sixty degrees to a radial line from the center of the rotor through the outer end of the blade. The blades of the rotor must not be pitched so steeply forward that the fluid moved radially outward by centrifugal force would be deflected inwardly again by the blades. Such a condition would decrease the velocity of the fluid toward the diffuser, and, defeat the purposes of the present invention. The blades 27 cause an outward flow of fluid through the spaces between the diffuser blades 17 without the help of high pressure at the inlet 23. This curvature and the reduction in blade depth greatly reduces the cross section of fluid passage at the periphery of the rotor. It is evident from an inspection of Figure 1 that as the blades approach the outer periphery of the rotor they are curved more nearly to the curvature of the rotor periphery. The distance directly across the space between adjacent blades from one blade to the other thus decreases when they approach the rotor periphery. Each blade 27 is somewhat thickened toward its outer end which further reduces the cross section of the space between the blades.

The operation in principle is as follows: Let P_1 be the pressure energy of a given volume (say 1 cc.) of fluid in the pressure manifold 23 and Pc be the added pressure energy that is impressed on the fluid by centrifugal force due to rotation of the rotor and the blades 27; with d as the density of the fluid and Vc as the velocity of travel at the circumference of the rotor. The pressure energy P_1+Pc is converted into kinetic energy of velocity as the stream of fluid is forced through the narrow aspirator channels between the blades 27.

The relative velocity of the fluid stream at the periphery of the rotor with respect to the rotor velocity is given by the formula $V=\sqrt{2(P_1+Pc)/d}$ where the pressure energy is substantially all converted to kinetic energy of velocity. Since the velocity of the rotor 10 at the periphery is Vc the total fluid velocity V is $Vc+\sqrt{2(P_1+Pc)/d}$. As the energy is proportional to the square of the total velocity and since this energy is converted (except for friction losses) into pressure by the diverging ribs 17 in the diffuser 16 this pressure P_2 will equal $\frac{1}{2}dV^2$ or

$$P_1+Pc+\tfrac{1}{2}dVc^2+Vc\sqrt{2d(P_1+Pc)}.$$

As P_1+Pc would be the pressure at the diffuser 16 if only centrifugal force (such as is found in the regular centrifugal pump) were called into play it is apparent that the pressure developed in this pump is much greater than in a plain centrifugal pump of like size and speed. In practice I have developed a pressure more than five times that of a centrifugal pump of the same size and speed. The necessary energy to obtain this high pressure is supplied to the shaft 9 by a sufficiently powerful motor. I find also that the pump has a large volume capacity. Furthermore due to the high velocity imparted to the fluid in the rotor 10 I get a very low intake pressure in the intake manifold 24. Thus the big pressure difference is between 24 and 16.

In operating the device as a turbine, flow takes place in the reverse order and the extreme high pressure in 16 drives the rotor 10 to deliver power to the shaft 9. The spent fluid discharge may be through both the manifold 24 and the nozzle 22, but of course the conduit 23 is not connected to the chamber 15.

The center 26 of the rotor is adapted to serve two purposes. The outer or tip portion is a true cone and serves as a means of forming the restriction at the nozzle 21 of the aspirator. The inner toroidal conoid surface changes the direction of the fluid from predominantly axial with respect to the rotor to a radial direction on the rotor. The radial position of the aspirator inlet nozzle 21 with respect to the rotor is not critical. In other words, the cone center 26 may be larger or smaller and the injector nozzle 21 may be a narrower slot on a larger circle or may be much smaller in diameter and be less restricted by the cone center.

Having thus described my invention, I claim:

1. An aspirator pump comprising a rotor having tapered blades extending outwardly and curving forwardly in the direction of rotation, the blades approaching each other and decreasing in width toward the rotor periphery to provide fluid passages which are constricted toward the outer edge of the rotor, and which extend forwardly in the direction of rotation of the rotor from their inner ends to their outer ends, an enclosing housing having a diffuser chamber projecting outwardly from the outer edge of the rotor, said housing also having concentric fluid inlets to the rotor, and means to conduct part of the fluid from said diffuser to the inner of said inlets, said means comprising a toroidal chamber about the diffuser, a return conduit having its inlet end connected to the toroidal chamber and having its outlet end directed toward the rotor on the axis of the rotor and an injector nozzle on said conduit forming the inner inlet.

2. An aspirator pump comprising a rotor having tapered blades extending outwardly and curving forwardly in the direction of rotation, the blades approaching each other and decreasing in width toward the rotor periphery to provide fluid passages which are constricted toward the outer edge of the rotor, and which extend forwardly in the direction of rotation of the rotor from their inner ends to their outer ends, an enclosing housing having a diffuser chamber projecting outwardly from the outer edge of the rotor, said housing also having concentric fluid inlets to the

rotor, and means to conduct part of the fluid from said diffuser to the inner of said inlets, said means comprising a toroidal chamber about the diffuser, a return conduit having its inlet end connected to the toroidal chamber and having its outlet end directed toward the rotor on the axis of the rotor and an injector nozzle on said conduit forming the inner inlet, and means to separate the rest of the fluid discharged from the diffuser from the part returned to the inner inlet, comprising an annular radial partition in said toroidal chamber.

3. An aspirator pump comprising a rotor having curved fluid passages extending in a radial direction on the rotor and inclined forwardly in the direction of rotation of the rotor, the maximum forward inclination being at the rotor periphery and being insufficient to overcome the outward flow of the fluid in said passages due to centrifugal force, said passages being gradually restricted in cross sectional area from their inner ends to their outer ends, an enclosing housing having a diffusing chamber at the periphery of the rotor into which said passages discharge, said housing having concentric annular high pressure and low pressure inlets opening to the rotor, and the rotor center having a pointed tip projecting into the high pressure inlet and curving outwardly at its base toward the inner ends of said passages.

4. An aspirator pump comprising a rotor having a raised center curving outwardly toward its base and having blades on the base extending outwardly from said center and, the inner ends of said blades being directed substantially radially to the rotor and the blades curving forwardly in the direction of rotation of the rotor to the periphery thereof, the blades being decreased in height and their adjacent faces being brought closer together toward the outer ends thereof to provide passages between the blades that de-

crease in cross section from the inner ends to the outer ends of said blades, an enclosing housing having diffuser channels leading outwardly and forwardly from the periphery of said rotor, which channels increase in cross section as they recede from the rotor, said housing having concentric fluid inlets opening to the center of said rotor, partition means in said housing at the outer ends of said diffuser channels separating the outlet ends of part of said diffuser channels from the outlet ends of the other diffuser channels and a conduit leading from one side of said partition means to the inner inlet.

RALPH C. SCHLICHTIG.

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