FLUID PUMP

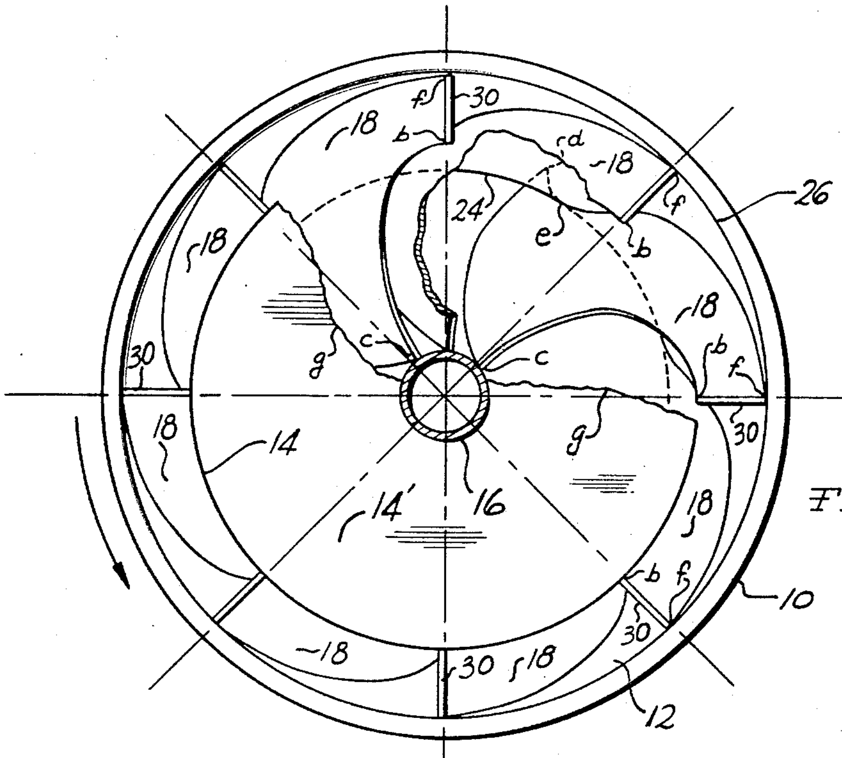

FIG.1

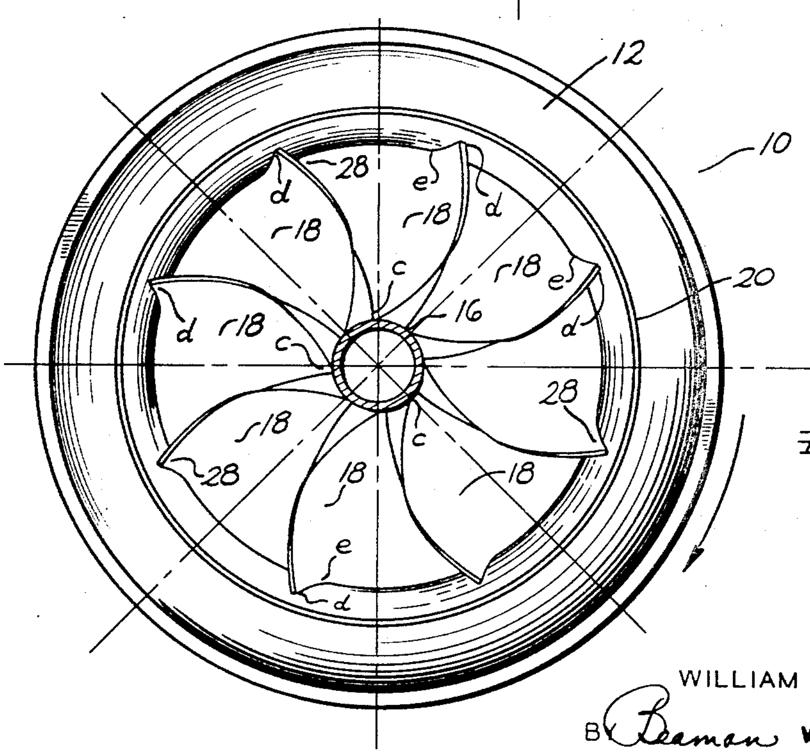

FIG.2

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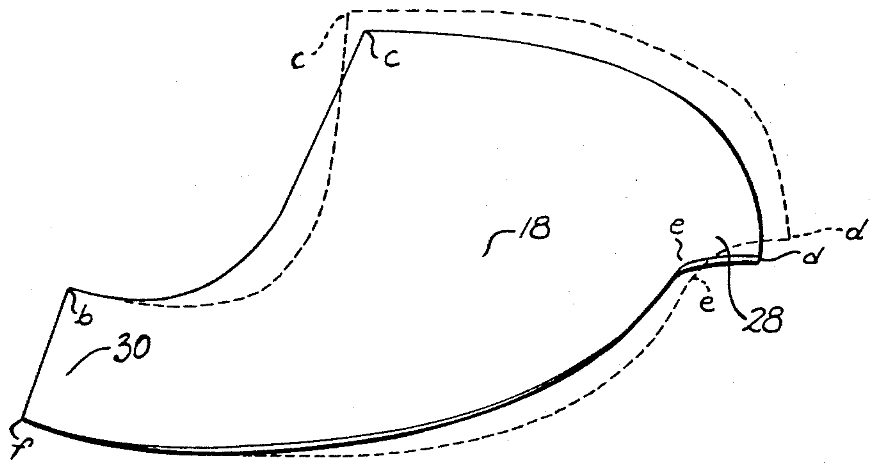

FIG. 4

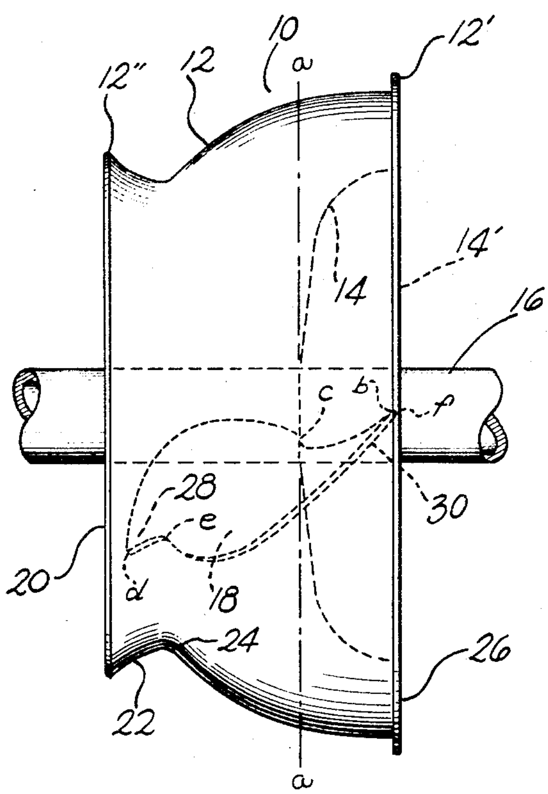

FIG. 3

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1

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FLUID PUMP

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ABSTRACT OF THE DISCLOSURE

The invention relates to a fluid pump having an axial intake and an axial discharge and having a series of continuous vanes which may be of complex surface configuration, the leading end of each vane having an angular portion providing an axial impeller flow zone which merges downstream into a radially expanding, axially extending screw surface defining an axial screw flow zone, terminating in a trailing end having straight, forward or backward (rotationwise) curvature for determining the fluid delivery pattern, there being a centrifugal flow zone imposed upon the screw flow zone. The working surface of each vane is mounted on and has unitary movement with two rotating members mounted for rotation about a common axis, the radially opposed surfaces of the members having sealing relation with the longtudinal edges of each vane.

Background of the invention

Devices for the acceleration of fluids of conventional design, for the most part, fall into two general classes when positive displacement pumps are excluded. One class involves pumps having axial intake and axial discharge and are known as impellers or screws. The other class has axial intake and radial discharge and they are known s centrifugal pumps and blowers. A hybrid design involving these two classes is known as a mixed flow impeller. Blowers in which there is a radial intake as well as a radial discharge are also known.

According to the invention the vanes of my improved fluid pump each represent a continuous working surface of changing configuration which functions first as an impeller having an axial intake, then as an expanding screw having centrifugal characteristics imposed thereon and a generally axial discharge of annular or "doughnut" shape.

Summary of invention

Fluid pumps according to the invention have application to compressible as well as noncompressible fluids.

In its preferred form, the fluid pump of the invention comprises an inner or center dome-like member and an outer conical-like housing having a flared inlet and the housing revolves as a unitary part of the inner dome-like member, said inner member being hereinafter, for convenience of description, referred to as the center dome. Spacing the center dome and the outer housing are a plurality of vanes of complex shape which collectively define, between the inlet and the discharge ends of the fluid pump, an impeller section directly adjacent the flared inlet end of the outer housing and a screw section extending from the impeller section to the discharge end and the screw section providing centrifugal displacement of the fluid being propelled along the axis of rotation between the center dome and the outer housing.

At the inlet section of the fluid pump, according to the invention, the outer housing is preferably flared when air or other readily compressible fluid is being handled. In this area, the leading end of the vanes are of air scoop cross section and the flared inlet construction provides a restricted throat portion which provides precompression of the inlet fluid stream. Such a construction has been found, in practice, to reduce noise by equalizing pressures at the leading ends of the vanes as well as producing additional reactive axial thrust and greater fluid flow. Within the air scoop section of the pump the vanes are preferably bent in the direction of rotation so as to reduce the shock angle of initial acceleration of static and low velocity conditions.

2

More specifically, the fluid pump of the present invent comprises an outer conical-like housing with an inner dome-like member carrying the hub and shaft mount, the housing and member being spaced and supported from each other by vanes of complex shape to provide three major states of acceleration of the material being handled by the fluid pump, namely, an impeller stage, a centrifugal stage, and a screw stage, the centrifugal stage being superimposed upon the screw stage.

The blades of the fluid pump are preferably continuously attached along their longitudinal edges to the inner and outer surfaces of the outer and inner housing and member to avoid leakage between the vanes and the structure embracing their longitudinal edges which define the shape of the fluid stream flowing between the inlet and discharge ends of the fluid pump concentric with the axis of rotation.

A plurality of circumferentially positioned vanes of the fluid pump preferably each having a continuous working surfaces which embraces the three distinct integrated propelling stages of the pump. The initial air scoop stage of each vane is so shaped as to cut or slice into the particular fluid being handled to force the same into the expanding screw which embraces the compound capability of centrifugal force plus the screw action. Thus, the entrained fluid material is smoothly projected toward the annular or "doughnut" shaped rotating discharge opening of the fluid pump. In practice, to assure both maximum efficiency and capacity for handling the compressible fluids, it has been found that the area of the substantially round intake of the fluid pump should be in the order of 1.5 times the area of the annular or "doughnut" shaped discharge. This ratio also applies in the handling of noncompressible fluids for free discharge such as water aeration in sanitary lagoon operations where a large centrifugally coned water pattern is desired. This acceleration ratio leverage is considered a major factor in obtaining the smooth uniform transfer of energy from the propelling surfaces of the vanes of the fluid pump to the material being handled and, in practice, results in an operating efficiency in the order of 90% over a relatively wide range of discharge pressures. In the handling of liquids and slurries against substantial head pressures, the comparative areas of the inlet and discharge ends of the fluid pump should be substantially 1 to 1 for good efficiency.

By imparting a forward curvature to the trailing ends of the vanes, an increase in rotative movement of the annular discharge or "doughnut" flow results and produces increased jet action which may be advantageously employed in VTOL and air cushion vehicle performance requirements.

A straight trailing edge on the vanes provides maximum volumetric capacity with median rotative movement of the discharge flow, while a backward curvature produces minimum rotative movement of the discharge flow with minimum sound level.

Between each pair of adjacent vanes, a twisted passage is defined, which at the intake end is elongated radially in cross section and at the discharge end is elongated circumferentially in cross section. The cross-sectional area of this passage is less at the discharge end than at the intake end with a substantial reduction taking place at the throat of the flare at the intake end of the fluid pump. The amount of twist of the passage between adjacent vanes will correspond in general to the pitch of the screw section.

Fluid pumps designed according to the invention may be conveniently installed in straight lengths of duct work, a common labyrinth seal being used between the duct work and opposite ends of the outer housing.

Detailed description

In the illustrated form of the invention,

FIG. 1 is an end view of a fluid accelerator or pump taken from the discharge end,

FIG. 2 is a view similar to FIG. 1 taken from the intake end of the pump,

FIG. 3 is a side elevational view of the pump shown in FIGS. 1 and 2, with a single vane shown in dotted outline, and

FIG. 4 is a perspective view of one of the vanes removed from the assembly.

Referring to the drawings, the fluid pump **10**, in its preferred form, comprises a conical-like member **12** and a dome-like member **14** carried on a shaft **16** in any suitable manner and adapted to rotate therewith as a unit. The shaft **16** may be the extension of the driven shaft on an electric motor or any other form of prime mover. The member **12** constitutes a rotating shroud and it is preferably supported from the member **14** by a plurality of vanes **18** attached along their longitudinal edges to the interior surface of the member **12** and the exterior surface of the member **14**.

At the intake end **20** of the member **12** the peripheral edge portion is flared at **22** to provide a slightly restricted throat at **24**. From the throat **24** to the discharge end **26** the member **12** is generally conical. The member **14** is substantially disposed within the member **12** and is carried in any suitable manner on the shaft **16** with the radially opposed interior and exterior surfaces of the members **12** and **14** defining an annular or "doughnut" discharge. Depending upon the material to be handled by the fluid pump, the cross-sectional area of the collective passages between the ends **20** and **26** may remain substantially constant or diminish.

The vanes **18** are shown as eight in number and are disposed 45° apart about the longitudinal axis of the shaft **16**. Between the intake end **20** and the discharge end **26** the intermediate portion of the vanes have the surface thereof substantially defined by radial lines normal to the longitudinal axis of the shaft **16**. Between the ends **20** and **26** the pitch of the main body portion of the vanes **18** with respect to the longitudinal axis of the shaft **16** can be in the order of 15° to 45°, depending upon the material to be handled by the fluid pump and the peripheral speed of the outer housing. The leading and trailing ends **28** and **30** of each vane **18** are preferably of a different configuration than the portion between the ends, as will be more fully described.

It will be appreciated that the width of each vane **18** between its terminal ends will be of varying shape and dimension in order to bridge the complex space between the members **12** and **14** between the ends **20** and **26**. In the area where the inner dome-like member **14** is not radially disposed from the outer housing member **12**, the inner longitudinal edges of the vanes **18** are preferably substantially contiguous with the other surface of the shaft **16**.

The cross-sectional area of the intake end **20** of the fluid pump substantially equals that of a circle having a diameter equal to that of the end **20** less the area of the shaft **16**. At the throat **24** this intake area will be slightly less. Downstream but directly adjacent the throat **24** the area of the intake passage will increase. However, the cross-sectional area downstream between the members **12** and **14** will start to reduce the radial plane *a* and continue to be reduced to the discharge **26** with an accompanying acceleration of the fluid being forced along the passages between the vanes of the fluid pump.

In FIG. 4 is shown one of the vanes **18** of the eight of the illustrated embodiment. Prior to being formed, the flat blank of sheet material from which the vane **18** is fabricated is shown in dotted outline. The full line showing is the vane **18** in perspective after forming.

In the assembly of FIGS. 1–3, each vane **18** is attached along the edge portion *b–c* to the exterior surface of the dome-like member **14**. Edge portion *c–d* is unsupported and disposed in opposed relation to the shaft **16**. Edge portion *d–e* is attached to the interior of the housing **12** between the throat **24** and intake **20**. Edge portion *e–f* is attached to the interior of the housing **12** between the throat **24** and the discharge **26**.

To provide support for the fluid pump **10** on the shaft **16**, the member **14** is shown with a radial flange **14'**. In FIG. 1 the member **14** and flange **14'** is shown broken away along the line *g* to fully expose one of the vanes **18** except for the edge *d–e* back of the flare **22** and the slight overlap of the *f–d* edge by the adjacent vane **18**. It will be noted that the lead or pitch of the exposed vane along *c–b* is approximately 45°. The screw portion of the vane **18** is generally defined by the edge portions *b–c* and *e–f*. Edge portions *c–d* and *d–e* generally define the scoop portion of the impeller section at the intake end **20** and define the area which may be slightly angularly disposed to the screw section. The area of each vane directly adjacent the edge portion *f–b* of the trailing end **30** may be of a form interrupting that of the screw surface, or it may be a true continuation thereof depending upon the desired shape of the fluid stream leaving the discharge end **26**.

It will be noted from FIG. 2 that the passage between adjacent vanes **18** at the intake end of the fluid pump **10** is of elongated cross-sectional form in a radial direction and that each such passage is disposed between the shaft **16** and the throat **24**. However, such passages are twisted along their downstream course and at the discharge end **24** take the cross-sectional shape shown in FIG. 1, namely, that of narrow circumferential slots of reduced area disposed between the exterior surface of the member **14** and the interior surface of the member **12** and the edge portions *f–b* of adjacent vanes **18**.

To accommodate suitable labyrinth seals, the housing **12** is shown with radially projecting flanges **12'** and **12''**.

It will be appreciated that the fluid being pumped is always being acted upon by the same side of each vane **18** as it is propelled through the impeller screw and centrifugal sections of the pump.

Having thus described my invention, what I claim to be new is:

1. A fluid impeller of the mix flow type comprising a rotating housing means, said housing means including an outer member having an upstream portion converging in a downstream direction to a minimum cross section and a downstream portion increasing in cross section to a maximum cross section, said housing means including an inner generally conical member of increasing cross section in a downstream direction, said inner member having an upstream end axially spaced downstream of said minimum cross section of said outer member and radially inwardly thereof, vanes extending between said inner and outer members, said vanes having free upstream leading inner edges depending from the outer member and starting approximately on the plane of minimum cross section of said outer member and terminating at said inner member, each of said vanes having upstream axial pumping portions curved in the direction of rotation of the impeller and extending from said outer member to said inner member, and a downstream centrifugal rearwardly curved portion, the curvature of the vanes being such whereby the fluid being impeller by said vanes is impelled solely by leading surfaces of said impeller vanes to be discharged axially from said housing and vanes.

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