

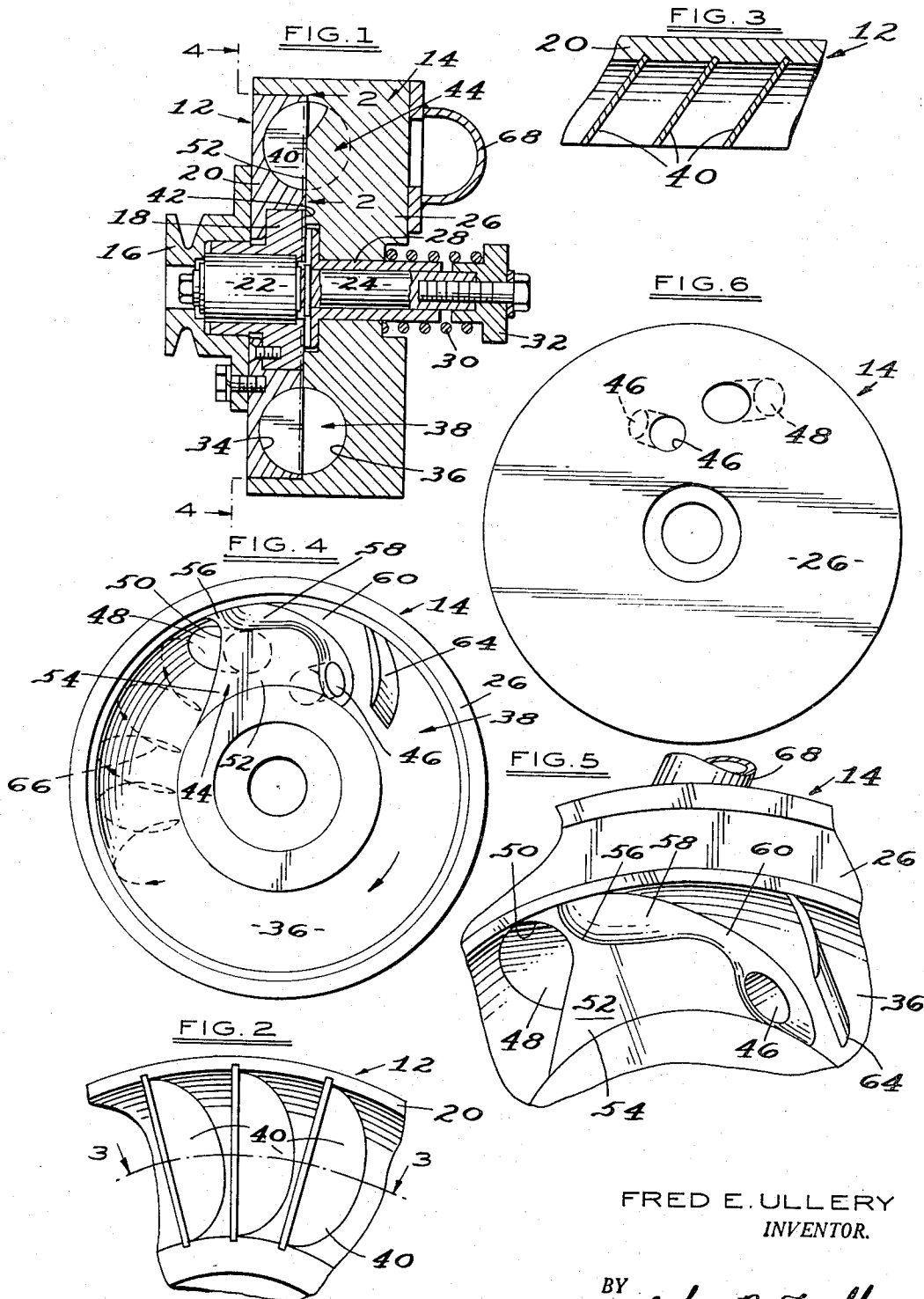
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CENTRIFUGAL FLUID PUMP

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CENTRIFUGAL FLUID PUMP

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ABSTRACT OF THE DISCLOSURE

A centrifugal pump has a toroidal shaped cavity that is split in two along a plane normal to the axis of rotation. One-half of the torus contains a bladed rotor, the other half being bladeless, but containing a block seal or abutment with a fluid inlet and outlet to the torus chamber located on opposite sides of the abutment. The abutment in general is wider circumferentially than the space between two adjacent rotor blades, to seal and trap fluid in the space as the blades pass over the abutment. However, a portion of the outer part of the abutment is cut away and angled towards the inlet to direct a portion of the trapped fluid toward the inlet in a manner to impart energy to it.

This invention relates in general to a fluid pump, and more particularly to one of the centrifugal type.

The prior known centrifugal pumps of the type in mind generally contain a toroidal-shaped cavity that is split in two along a plane normal to the axis of rotation. One-half of the torus contains blades and is rotatable, the other half being bladeless and held stationary. The stationary or stator half usually has a single fluid inlet and outlet located on opposite sides of a block seal or fluid abutment. The block seal normally is of a circumferential width slightly greater than the distance between rotor blades and has a radial surface that sealingly cooperates with the peripheral edges of the blades. This prevents the fluid contained in the stator half of the torus from flowing between the outlet and inlet when the blades pass over the abutment.

When the rotor portion is driven, fluid is drawn through the inlet into the rotor blade cavities, and, by centrifugal force, is thrown outwardly in the general direction of movement of the blades into the stator torus cavity. Due to the shape of the stator torus wall, the fluid is redirected back into the rotor blade cavities where additional energy is imparted to it. The repetition of this cycle several times per revolution establishes a helical spiral motion to the fluid during its circumferential progression around the torus. The fluid is then expelled out through the outlet.

In general, most of the prior art constructions of this type have several disadvantages. One is that the outlet generally is so disposed adjacent the block seal that the direction of motion of the discharging fluid changes abruptly. This decreases the fluid energy, increases the pressure, and in effect causes the fluid to pile up at the outlet, thus reducing the output of the pump.

Another equally, if not more important, disadvantage is the large clearance volume or size of the cavities between rotor blades in which considerable fluid energy is trapped or retained and carried over to the low pressure inlet side of the pump as the blades pass over the abutment seal surface.

Since the operational performance of a pump of this type fundamentally is dependent upon the fluid movement having a whirl component that is induced and maintained by the rotor blades, a further disadvantage of the prior art devices is the general lack of suitable means

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to effectively start the whirl of the fluid in the vicinity of the inlet.

The invention eliminates the above disadvantages by providing a centrifugal pump construction in which; the fluid outlet port is so located and disposed near the outer periphery of the stator shell that the fluid is discharged substantially without a change in the direction of movement of the fluid; the fluid abutment or block seal is formed to direct the fluid to the outlet port near the outer periphery of the fluid path; the abutment is constructed to recirculate a portion of the normally trapped rotor blade cavity fluid toward the inlet side of the pump to aid the inducement of a whirl motion to the incoming fluid; and, a whirl inducing blade is provided adjacent the pump inlet so that fluid will enter the rotor blade cavities in an efficient manner.

One of the principal objects of the invention, therefore, is to improve the performance effectiveness of a centrifugal pump of the general type described.

A further object of the invention is to provide a centrifugal pump with a fluid outlet cooperatively located with respect to the fluid abutment and so disposed as to effect an efficient discharge of the fluid with a minimum change in direction of motion of the fluid being discharged.

A further object of the invention is to provide a centrifugal pump with a fluid abutment or block seal constructed to provide a fluid passage progressively increasing in cross-sectional area towards the fluid inlet whereby fluid normally trapped in the cavity between rotor blades as they pass over the block seal will be recirculated to the pump inlet and induce a whirl component to the entering fluid.

A still further object of the invention is to provide a centrifugal pump of the type described above in which the abutment passage consists of a curved ramp surface connected to the fluid inlet.

Another object of the invention is to provide a whirl inducing blade adjacent the fluid inlet so that the incoming fluid will enter the rotor blade cavities in a favorable direction.

It is also an object of the invention to provide a centrifugal pump of the type described in which the fluid inlet is formed as a part of the block seal or fluid abutment, and is alternately located in the radial face sealing surface for low volume and high velocity pump operation, or is obliquely disposed through the ramp for higher volume operation.

Other objects, features and advantages of the invention will become apparent upon reference to the succeeding, detailed description thereof, and to the drawings illustrating the preferred embodiments thereof; wherein,

FIGURE 1 is a cross-sectional view of a centrifugal pump embodying the invention;

FIGURE 2 is an enlarged cross-sectional view taken on a plane indicated by and viewed in the direction of the arrows 2-2 of FIGURE 1;

FIGURE 3 is a reduced cross-sectional view taken on a plane indicated by and viewed in the direction of the arrows 3-3 of FIGURE 2;

FIGURE 4 is a cross-sectional view taken on a plane indicated by and viewed in the direction of the arrows 4-4 of FIGURE 1;

FIGURE 5 is an enlarged view of a detail of FIGURE 4; and,

FIGURE 6 is rear-elevational view of FIGURE 1 viewed from right to left.

FIGURE 1, which is essentially to scale, shows a centrifugal-type pump consisting essentially of annular rotatable and stationary members 12 and 14 that are nested in a fluid sealing manner. Rotor member 12 is made up of

three portions that are bolted or otherwise secured together: a driving pulley 16, a flanged hub or sleeve 18, and a radially extending torus shell member 20. Sleeve 18 is journaled on the enlarged end 22 of a shaft 24 that extends axially to the right for support of the stator shell 26. The stator shell is essentially a thick plate or disc, and is axially slidably mounted on a sleeve 28. The sleeve is slidable axially on shaft 24, and non-rotatably pinned to it, as shown. Stator 14 is biased toward rotor 12 by a spring 30 that abuts the stator hub at one end, as shown, and is seated at its opposite end against the flange of a retainer 32. The retainer is axially adjustably secured to shaft 24.

The construction described permits axial movement of stator shell 26 relative to rotor shell 20 when the internal pressure of the pump exceeds a predetermined level, to prevent a pressure buildup beyond a useable level, and thereby prevent further increase in the engine horsepower loss.

The rotor and stator shells 20 and 26 are formed respectively with semi-toroidal-shaped cavities 34 and 36. The cavities face each other and are substantially contiguous so as to form a toroidal chamber 38 for the circumferential flow of a fluid such as air through it. As best seen in FIGURES 1, 2 and 3, rotor cavity 34 has a number of circumferentially spaced blades 40 that extend in the general direction of rotation of the rotor and are of an axial width to extend to the inner radial face 42 of rotor disc 20.

Stator cavity 36, on the other hand, is void of blades. As best seen in FIGURE 4, the stator cavity is provided in general with a single fluid abutment or block seal 44 that circumferentially separates a fluid inlet port 46 from a fluid outlet port 48.

The fluid inlet is obliquely positioned through the abutment 44, for a purpose to be described. The fluid outlet 48 is obliquely disposed near the outer periphery of the fluid path so that it is substantially in line with the direction of flow at this point. This provides a minimum change in the direction of movement of the fluid as it is discharged, and, therefore, retains most of the fluid energy developed. The axial face 50 of the abutment 44 at this point is suitably curved to direct the fluid into the discharge port.

The block seal 44 is secured to the stator in any suitable manner. The seal is of an axial thickness to fill up the stator cavity 36 at this point, and has an inner radial or face surface 52 in sealing relationship to the tips of rotor blades 40.

In the prior art centrifugal pump constructions, as stated previously, the abutment or block seal is generally solid or continuous throughout its width and length, and is of a circumferential width wherein even the narrowest portion is slightly wider than the distance between rotor blades. Thus, in the prior art constructions, considerable velocity energy is lost by the trapping of a large volume of fluid in the cavity between the rotor blades as it passes over the abutment seal surface. This invention makes use of a portion of this velocity energy to induce a whirl component to the incoming fluid, thereby increasing the efficiency of the pump.

More specifically, the radially inner portion 54 of abutment seal surface 52 is circumferentially wider than the distance rotor blades, and is considerably wider than the radially outer portion 56, as seen in FIGURE 5. The narrow outer portion is formed by providing an arcuately curved groove that defines an arcuate ramp or inclined surface 58. The ramp together with the surrounding parts of the abutment and stator cavity forms a passage 60 that gradually increases in cross-sectional area towards the inlet side of the pump. This permits a portion of the discharge air that is normally trapped in the cavity between rotor blades 40 to pass over the narrow ridge portion 56 of the block seal and down the ramp 58 to be recirculated

back to the inlet 46. The ramp curvature is such as to induce a whirl component to the fluid flowing down the ramp and to the fluid admitted through the inlet 46. The incoming fluid, therefore, now enters the cavity between rotor blades 40 on the low pressure side of the pump in a more efficient manner and in a favorable direction so that a greater output can be obtained.

The obliquely disposed inlet port 46 further aids in the development of a whirl component to the incoming air by directing the incoming fluid in a path substantially parallel to the direction of flow of the fluid down the ramp passage. This is an advantageous location for the inlet to provide high volume, low pressure pump operation.

Alternatively, if low volume, high pressure operation is desired, the inlet could be located in the face of the abutment or block seal surface 52. In this latter location, the outer portion of the fluid normally trapped between the rotor blade cavities would flow down the ramp passage 60, with any loss in the volume of fluid in the rotor blade cavity being made up from the inlet in the face of the block seal. The two volumes of air then combine at the inlet side of the block seal, the ramp passage air inducing a whirl component to the incoming air.

To further aid in inducing a whirl component to the incoming air, a whirl inducing blade member 64 is fixed to the stator shell 26 and positioned slightly downstream of the fluid inlet 46. It is appropriately curved in cross-sectional shape to provide the desired amount of whirl to afford the most efficient entry into the rotor blade cavities. While it is described as being fixed, it will be clear that it could be pivotally mounted and adjusted by any suitable means, automatic or manual, without departing from the scope of the invention.

In operation, rotation of rotor 12 by any suitable means, such as, for example, a fan belt driven by the crankshaft of an internal combustion engine (not shown), initially induces a flow of incoming fluid through, say, the obliquely disposed inlet 46 to fill up the cavities between rotor blades 40. Because of the rotation and direction of inclination of the rotor blades, the air is thrown forwardly and outwardly by centrifugal force from the roots to the tips of the blades and into the stator cavity. The dish-like cross-sectional shape of the stator wall then guides the fluid back into the rotor blade cavities where it has additional energy imparted to it.

The repeated forward ejection and return of the fluid establishes a helical spiral path to the fluid during its circumferential progression around the toroidal cavity. The fluid velocity thus progressively increases, and as it approaches the outlet port 48, the fluid is flowing in a helical spiral path, as indicated by arrows 66 in FIGURE 4. Since outlet port 48 is obliquely positioned so as to be substantially aligned with the fluid entering it, there is a minimum of change to the direction of motion of the fluid as it passes through the port, and, therefore, substantially little loss in velocity energy. The curvature of the face 50 of the abutment at this point aids in directing the fluid into the outlet. The discharging fluid will then enter an outlet manifold 68 and be diffused whereby the velocity energy is converted to pressure.

At this point, the rotor blades begin to pass over the radial seal surface 52 of the block seal or abutment 44. The radially outer portion of the discharge air that is normally trapped in the cavities between rotor blades now passes over the narrow abutment ridge 56 and immediately is forced into the diverging passage 60. The arcuate walls of the passage then guide the fluid in a direction past the obliquely disposed inlet 46 to provide a whirl component to the entering air. This whirl component is additionally fortified by the flow of the air past the whirl blade 64. As a result, the velocity energy of the fluid passing down the ramp is imparted to the incoming air and in a direction substantially tangent to

the ultimate helical spiral path that is established as it travels around the torus from inlet 46 to outlet 48.

It will be clear that suitable shut-off or fluid-blocking means, automatically or manually operated, can be provided to alternately change the outlet from the obliquely inclined port 46 to the flush port 62 in the face seal surface 52, without departing from the scope of the invention.

It will also be clear that while the obliquely disposed outlet and inlet ports are shown as being substantially elliptical in cross section, that other suitable shapes could be provided without departing from the scope of the invention.

From the foregoing, therefore, it will be seen that the invention provides a centrifugal pump having a number of features that provide better operating efficiency for a pump of this type; namely, a fluid outlet port that is obliquely disposed so as to be substantially in line with the direction of motion of the discharging fluid to thereby reduce losses through the port; a block seal or abutment that has a curvature to aid the discharge of fluid through the outlet port; a block seal that is recessed to provide a ramp surface of an area progressively increasing towards the fluid inlet to utilize some of the fluid energy normally trapped in the cavity between rotor blades to induce a whirl component to the incoming fluid; alternate positions for the fluid inlet port for varying the pump operation desired; and, finally the use of a whirl inducing blade to aid in the inducement of a whirl component to the incoming fluid.

While the invention has been described preferably for use as an air pump, it will be clear that it would be suitable to pump liquids and other media as well.

While the invention has been described and shown in its preferred embodiment, it will be clear to those skilled in the arts to which the invention pertains that many changes and modifications may be made thereto without departing from the scope of the invention.

I claim:

1. A fluid pump of the centrifugal type comprising axially aligned annular stationary and rotatable members in substantially contiguous relationship each having a semitoroidal-shaped fluid cavity defined therein, said cavities facing each other to together define a toroidal-shaped cavity for the flow of fluid therearound, said rotatable member cavity having circumferentially space blades mounted therein and extending across the axial width thereof, said stationary member having a fluid inlet and an outlet circumferentially separated by a fluid flow abut-

ment blocking communication in the normal flow direction between said inlet and outlet through said stationary member cavity, said abutment having a radial seal surface in fluid sealing relationship with said rotor blades, the radially inner circumferential portion of said abutment surface being longer than the circumferential space between a pair of rotor blades to trap fluid in said space as said pair of blades rotates past said surface, the radially outer portion of said abutment surface being circumferentially shorter than said inner portion and the spaces between pairs of blades whereby a portion of the fluid trapped in each of said rotor blade spaces as it passes said abutment is forced towards said inlet prior to the communication of all of the space with said inlet.

2. A fluid pump as in claim 1, wherein said shorter outer abutment portion defines a ramp inclined downwardly towards said inlet from said surface to provide a passage that progressively increases in cross-sectional area towards said inlet.

3. A fluid pump as in claim 2, including a fluid whirl inducing guide blade positioned adjacent the path of flow of fluid through said passage.

4. A fluid pump as in claim 1, wherein said shorter outer abutment portion defines an area between said outer abutment portion and said inlet that increases in cross-sectional area towards said inlet.

5. A fluid pump as in claim 1, wherein said shorter outer abutment portion defines a fluid guide passage with a cross-sectional area increasing in the direction of said inlet.

6. A fluid pump as in claim 5, wherein said passage has a curvature inducing a whirl motion to fluid entering said stationary member cavity through said inlet.

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