ABSTRACT

A hydraulic pump has a rotary impeller which contains a multiplicity of slots, each in the form of an equilateral triangle with its longitudinal axis each at a certain angle to a radial line thereto from the axis of the impeller shaft. The slots cause the impeller to act as an inclined plane to increase the flow.
FLOW THROUGH IMPELLERS AND FLUID MACHINES EMPLOYING SAME

The present invention relates to fluid (both liquid and gas) impellers and particularly to impellers for hydraulic pumps and motors.

The invention is especially suitable for use in a pump for fluid drives, as in automotive applications wherein the fluid is oil which is pumped at low pressures suitable for driving a prime mover which may be a turbine or an impeller also embodying the invention, the power and/or speed of the drive being controllable at the pump as by changing the speed of rotation of the pump impeller. Other applications for the invention in propellers for boats, sump pumps in internal combustion engines, and in various types of fluid pumps and motors are also available.

Various types of impeller configurations have been employed in hydraulic and other fluid machines. Some use fins or blades while other use augers. Limitations, however, exist upon the amount of flow which can be handled and the pressures which may be achieved by virtue of the shape and size of the impeller. In addition, the control characteristics of the impeller (viz., impeller speed versus flow or pressure obtained) is relatively insensitive to changes in impeller speed, thus requiring additional devices, such as valving, to effectuate such control. Another disadvantage of existing types of impellers is the need for large sizes of impellers to provide large flow capacity; thus, where large quantities of fluid must be moved, huge pumps incorporating such large impellers have been required.

Accordingly, it is an object of the present invention to provide improved fluid impellers.

It is a further object of the present invention to provide improved impellers suitable for use in hydraulic pumps and motors.

It is a still further object of the present invention to provide improved impellers which obtain large fluid flow without requiring large volume or space.

It is a still further object of the present invention to provide an improved impeller which is effectively free from clogging by foreign particles.

It is a still further object of the present invention to provide an improved impeller which can be manufactured without adhering to close dimensional tolerances.

It is a still further object of the present invention to provide an improved impeller which is adaptable to manufacture by various techniques, such as die casting, machining, or sheet metal fabrication.

It is a still further object of the present invention to provide an improved fluid pump.

It is a still further object of the present invention to provide an improved fluid pump wherein flow and/or pressure is readily controlled by varying impeller speed.

Briefly described, an impeller provided in accordance with the invention includes a generally cylindrical body which is mounted on a shaft and is rotatable therewith. The body of the impeller has a plurality of slots. Each slot is an open pressure producer. The slots are desirably triangular in shape, and preferably equilateral sided so that the pressure on the sides of the triangles are in cancelling relationship; thus permitting the walls of the slots to be thin. Each of the slots being spaced from the axis of the shaft and extending longitudinally between the opposite ends of the body. Each of the slots has a longitudinal axis which is canted so that the projection of the axis upon the shaft axis in the direction of fluid flow defines an acute angle. The slots act as inclined planes causing an increase in flow as the cylindrical body rotates. A large number of slots may be disposed in rings, with the triangular cross sections thereof in nested relationship so as to provide a large flow capacity in an extremely small volume. The triangular slots diminish in size in accordance with their radial distance from the axis. The pressure cancellation feature of the slots configuration facilitates thin walls which permit close nesting.

The foregoing and other objects and advantages of the present invention as well as additional features thereof will become more readily apparent from a reading of the following description in connection with the accompanying drawings in which:

FIG. 1 is a perspective view of a fluid machine (a hydraulic pump) embodying the invention;

FIG. 2 is a sectional view of the pump shown in FIG. 1;

FIG. 3 is a perspective view showing a section through the impeller of the pump shown in FIG. 1, the section being taken generally along the line 3-3 in FIG. 2;

FIG. 4 is a front view showing the inlet face of the impeller;

FIG. 5 is a front view showing the outlet face of the impeller; and

FIG. 6 is a schematic view illustrating the dimensional and positional relationships of a typical slot in the impeller with respect to the rotational axis of the impeller.

Referring to FIG. 1 there is shown a housing 10 consisting of a cylindrical section 12 sandwiched between a pair of end plates 14 and 16. An inlet pipe 18 which may be coupled to a hose (not shown) extends from the end plate 14. An outlet pipe 20 which also may be coupled to a hose, extends from the other end plate 16. As shown in FIG. 2, the end plates and the center section are assembled in pressure-tight relationship by bolts 22 which compress O-ring seals 24. A shaft 26 is journaled in the end plates 14 and 16 by bearings 26 and 28. An impeller 30 is rotatably mounted on the shaft as by being welded or keyed thereto. The impeller 30 is a cylindrical body having end faces which are the inlet face 32 and outlet face 34 of the cylindrical body of the impeller. The impeller may be fabricated from sheet metal in sections, such as the section shown in FIG. 3, which sections are assembled together as by soldering or welding.

An inlet chamber 36 is defined between the inlet face 32 and the interior wall of the end plate 14. An outlet chamber 38 is defined between the outlet face 34 and the inner wall of the end plate 16. The pipes 18 and 20 respectively define an inlet port 40 and an outlet port 42 of the pump.

The impeller has a plurality of slots 44 which extend longitudinally through the impeller body from the inlet face 32 to the outlet face 34. The slots are arranged in concentric rings. Each slot is a triangle approximately equilateral in cross section, but of progressively smaller altitude in accordance with its radial distance from the axis 46 of the cylindrical impeller body; the axis 46 also being the axis of the shaft 26.
Consider a section of slots as shown in FIG. 3. There are two layers of adjacent slots 48 and 50 which are in nested relationship. This nested relationship provides a large number of slots in a relatively small volume constituted by the body of the impeller, thus affording large flow capacity in a relatively small volume or space. The slots may be constructed out of sheet metal. For example, upper and lower sheets 52 and 54 sandwich a corrugated member 56. The corrugated member and the sheets define a section of nested triangular slots. The nested relationship of the slots defines consecutive sectors (viz., pre-shaped sections which taper inwardly toward the axis 46). The slots may also be formed by machining or milling them out of a solid piece of metal or by casting. It will be appreciated that the thickness of the wall between adjacent triangular slots determines the number of slots which can be accommodated in a given impeller volume.

An important feature of the invention is the orientation of the slots with respect to the rotational axis of the impeller (viz., the axis 46). As shown in FIG. 6, each slot, such as the typical slot 60 has a longitudinal axis 62. The longitudinal axis is disposed so that its projection on the axis 46 forms an acute angle. In the illustrated embodiment of the invention this angle is 45°. Other suitable angles are 15°, 30°, 60° and 75°. It will be noted that this angle is formed between a radial line extending from the axis 46 to the longitudinal axis 62. It will be observed that the 45° angle is formed between the intersection of the longitudinal axis 62 and the plane projected on to the axis 46 in the direction of fluid flow. This orientation of the slots causes the slots to be skewed or canted at different angles with respect to the inlet face 32 and the outlet face 34 as shown in FIGS. 4 and 5. It is also desirable that the slots be canted in a direction toward the axis 46. This provides for a downward orientation of the slots toward the axis 46 in a direction from the inlet face 32 towards the outlet face 34.

As shown in FIG. 6 the slots may be tapered also in the direction of the inlet face 32 towards the outlet face 34. The angle of this taper is preferably 1½° as shown in FIG. 6 and may be provided by having one of the adjacent walls of each slot perpendicular or at angles of 90° to each other, while the other wall is at an angle of 88.5° to its adjacent wall.

In operation the slots in the impeller act as inclined planes forcing large volumes of fluid in the fluid direction from the inlet to outlet faces of the impeller 30. The large number of slots or fluid canals which are provided in the impeller provide a very sensitive impeller speed versus flow control characteristics. Thus, control of flow and pressure is accomplished by varying the speed of rotation of the shaft 26.

It is desirable to adjust the size of the chambers 36 and 38 in accordance with the flow capacity desired. For higher flows and lower pressures the chambers may be larger whereas for higher pressures and lower flows the chambers may be of the smaller volume. Large inlet and outlet ports 40 and 42 may readily be accommodated since flow limitations are reduced by virtue of the design of the impeller 30.

From the foregoing description it will be apparent that there has been provided an improved fluid machine. An embodiment of the machine in the form of a hydraulic pump has been illustrated to explain the invention. Variations and modifications in the herein described pump will undoubtedly suggest themselves to those skilled in the art. For example, each of the sections of slots is canted with respect to the inlet and outlet faces 32 and 34 of the impeller body, inasmuch as these sections are formed from sheet metal. While such canting provides improvements in affording additional cam action at the faces, it may be desirable should casting or other manufacturing processes be used for the end faces to be planar surfaces. Other variations and modifications in the herein described embodiment of the invention will undoubtedly suggest themselves to those skilled in the art. Accordingly, the foregoing description should be taken merely as illustrative and not in any limiting sense.

What is claimed is:

1. A rotary impeller through which fluid flows, which comprises:
   a. a shaft having an axis,
   b. a generally cylindrical body mounted on said shaft and rotatable therewith,
   c. a plurality of triangular slots in said body, each of said slots being spaced from said axis and extending in a substantially straight line between the opposite ends of said body,
   d. each of said slots having a longitudinal axis and each of said slots being disposed with the projection of its longitudinal axis upon said shaft axis in the direction of said fluid flow defining an acute angle.

2. The invention as set forth in claim 1 wherein each of said slots is also disposed with its longitudinal axis canted toward said shaft in the direction of said fluid flow.

3. The invention as set forth in claim 1 wherein each of said slots longitudinal axis intersects a radial line from said shaft axis at said acute angle.

4. The invention as set forth in claim 3 wherein said acute angle is from 15° to 75°.

5. The invention as set forth in claim 4 wherein said slots have at least one wall thereof which tapers inwardly in the direction of said fluid flow.

6. The invention as set forth in claim 5 wherein said shaft is at an angle of about 1.5°.

7. The invention as set forth in claim 1 wherein said triangles are approximately equilateral.

8. The invention as set forth in claim 4 wherein said slots are arranged in a plurality of rings disposed circumferentially around said shaft axis at progressively greater radial distances therefrom, each ring containing a plurality of said slots, said rings of slots in turn occupying sectors of said cylindrical body.

9. The invention as set forth in claim 8 wherein each ring contains a plurality of triangular slots in nested relationship with the slots of the rings adjacent thereto.

10. The invention as set forth in claim 8 wherein the slots in each ring are triangular and have progressively greater altitudes with greater distances from said shaft axis.

11. The invention as set forth in claim 1 including a housing, said impeller being disposed in said housing with said shaft journalled for rotation therein, said housing and the end of said body facing toward said fluid flow and one wall of said housing defining an inlet chamber, and wall of said housing opposite to said one wall and the end of said body facing away from said fluid fluid defining an outlet chamber, and inlet and outlet ports for said fluid respectively communicating with said inlet and outlet chambers.

12. The invention as set forth in claim 11 including means for driving said shaft in a clockwise direction to pump said fluid from said inlet to said outlet ports in said flow direction.