WAY FOR AXIAL FLOW IMPELLER

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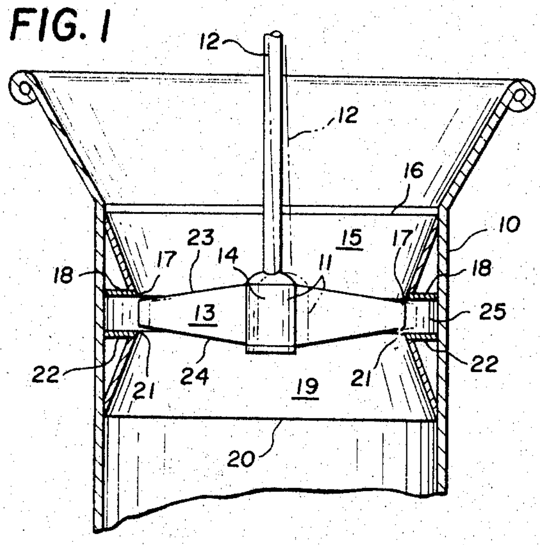
FIG. 1



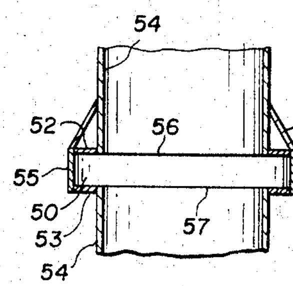


FIG. 3

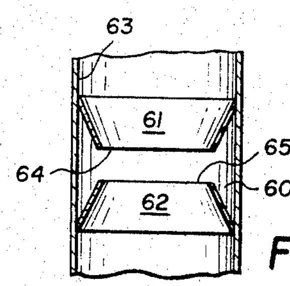
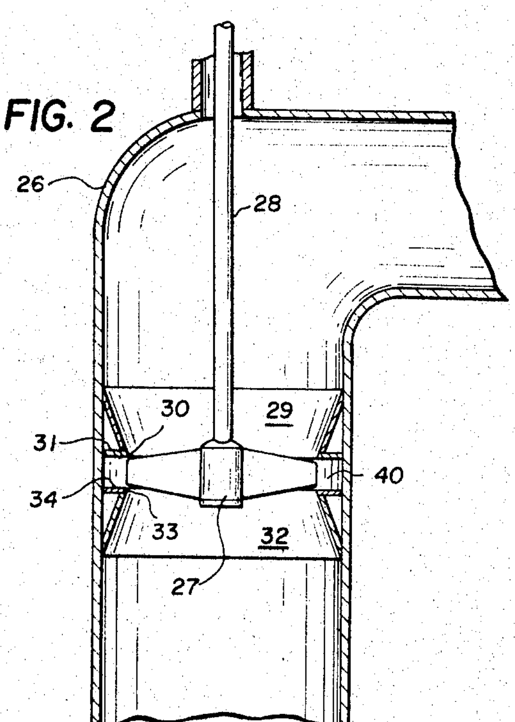


FIG. 4

FIG. 2



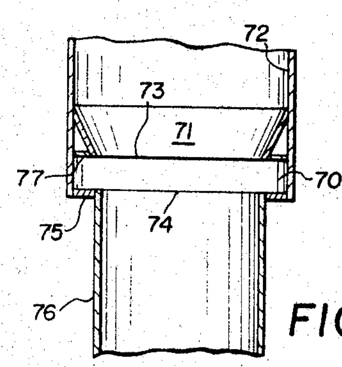


FIG. 5

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WAY FOR AXIAL FLOW IMPELLER

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ABSTRACT OF THE DISCLOSURE

An axial flow impeller is mounted in a housing having an inside diameter substantially larger than the diameter of the impeller, and a way is provided for the impeller by walls extending inward from the housing wall to form edges having approximately the diameter of the impeller and located approximately in the planes of the input and output faces of the impeller at the periphery of the impeller. The edges fôrm two constricted zones of small clearance at the input and output faces of the periphery of the impeller and substantially prevent any back flow of liquid from the output side of the impeller to the input side of the impeller. The space between the edges allows some lateral motion of the impeller so that the housing need not be made to close tolerances, and the impeller can be run without a submerged bearing.

This invention relates to a way for an axial flow impeller, and more particularly to a novel and improved configuration of housing walls forming a way for an axial flow impeller.

The objects of the invention include, without limitation:

(a) reducing the cost and manufacturing tolerances of housings, casings, or structures surrounding an axial flow impeller;

(b) combining optimum economy of maunfacture with optimum efficiency of operation of an axial flow impeller; and

(c) eliminating the need for submerged bearings for axial flow impellers.

These and other objects of the invention will be apparent hereinafter from the specification which describes the invention, its use, operation, and prefered embodiments, from the drawings, which constitute a part of the disclosure, and from the subject matter claimed.

Generally, the inventive way for an axial flow impeller is formed in a generally circular-walled housing having an inside diameter substantially larger than the diameter of the impeller in the region of the impeller. Walls inside the housing extend from the input and output sides of the impeller to form a pair of edges having approximately the diameter of the impeller and located respectively near the input and output planes of the impeller at its periphery. The inside housing wall preferably extends smoothly to such edges, and the way is preferably formed to eliminate spaces in which solid materials can collect.

In the drawings:

FIG. 1 is a partially schematic, cross section view of the inventive impeller way formed in a draft tube;

FIG. 2 is a partially schematic, cross section view of the inventive way formed in a casing for an axial flow pump; and

FIGS. 3–5 are partially schematic cross sectional views of alternative way structures according to the invention.

The inventive way as illustrated in FIG. 1 is formed in a draft tube having a generally circular wall **10** for axial flow impeller **11** supported for rotation on shaft **12**. Shaft **12** is powered by any convenient equipment, and impeller **11** can be any of a variety of known, axial flow impellers. As typical of such impellers, impeller **11** has

a plurality of blades **13** extending radially outward from a central hub **14**.

A wall **15** is joined to wall **10** along line **16**, and extends inward to an edge **17**. Annular wall **18** extends from edge **17** to wall **10** and is generally perpendicular thereto. Similarly, below the plan of impeller **11**, annular wall **19** is joined to wall **10** along line **20** and extends inward to an edge **21** from which a wall **22** extends to wall **10** and is approximately perpendicular thereto. The space **25** between walls **18** and **22** and edges **17** and **21** forms a way for impeller **11**.

Annular walls **15** and **19** are oblique to wall **10** and form conical surfaces. Walls **15**, **19**, **18** and **22** are preferably formed of steel and welded to wall **10**. The spaces between wal **10** and walls **15** and **19** are preferably closed off and left empty but also be occupied by a material. Also, instead of separate walls joined to wall **10**, surfaces **15** and **19** can be formed by indentations in wall **10**.

The diameter of edges **17** and **21** are approximately the same as the outside diameter of impeller **11**. At least one of the edges **17** or **21**, and preferably edge **17**, is sufficiently larger in diameter than impeller **11** so that impeller **11** ćan be lowered past edge **17** to its illustrated position axially between edges **17** and **21**. Edges **17** and **21** are also spaced apart axially of impeller **11** a sufficient distance to accommodate relative axial motion of the blade tips and so that the outer ends of the impeller blades **13** can move laterally into way **25** in between edges **17** and **21** a small amount as illustrated by the broken line position of shaft **12** and impeller **11**. Various unavoidable liquid flow conditions create turbulence and other strains producing some wobbling or lateral motion of impeller **1** that is accommodated by way **25**. On the other hand, the axial position of impeller **11** can be set accurately by shims or other adjustments, and normal operating forces cause relatively little change the axial position of impeller **11**. Hence, once impeller **11** is accurately located axially between edges **17** and **21**, it can experience a normal amount of axial and lateral motion in way **25** without contacting any portion of tube **10** or the way walls.

The correct disposition of edges **17** and **21** is related to the planes of the input and output faces of impeller **11** and the perphery of impeller **11**. In such context, the input and output planes of impeller **11** lie respectively in the locus of travel of the injut edge **23** of blades **13** and the output edge **24** of blades **13**. Actually, because of the illustrated taper in impeller blades **13**, such input and output planes are slightly conical rather than truly planar, but for purposes of defining the location of edges **17** and **21**, it is sufficient to refer to the locus of travel of input blade edges **23** as the input face plane of impeller **11** and the locus of travel of output blade edges **24** as the output face plane of impeller **11**. Edges **17** and **21** are then approximately in or axially closely adjacent to the input face plane of impeller **11** and the output face of impeller **11** respectively. Also walls leading to edges **17** and **21** are joined to wall **10** axially above or below the respective lines of intersection with wall **10** of the input and output face planes of impeller **11**. Such lines of intersection are determined by imaginarily extending the input and output face planes of impeller **11** until they intersect wall **10**.

Such positioning of edges **21** provides a close clearance between the upper and lower peripheries of impeller blades **13** and restricts the flow of liquid from the output side of impeller **11** to the input side of impeller **11** so that impeller **11** can function efficiently as an axial flow impeller. The way **25** formed between edges **17** and **21** and walls **18** and **22** tends to hold a swirling ring of liquid and is swept clean by impeller 11. The inventive way 25 eliminates the need for any submerged bearings to hold impeller 11 steady during its rotation. This accomplishes a substantial saving, particularly when the impeller is operating in slurries or corrosive environments. All the problems and expense of construction, accurate location, lubrication, sealing, replacement, and maintenance of such bearings are avoided.

As an example of relative sizes of the inventive impeller way, one successful commercial embodiment of the invention used a way such as illustrated in FIG. 1 in a draft tube having an inside diameter of 106 inches, a diameter for edge 17 of 103 inches, a diameter for edge 21 of 102 inches, an axial spacing between walls 18 and 22 of 10 inches, for receiving an impeller with a 102 inch diameter having blades 13 with an axial width of 9.5 inches at their peripheries. This allowed a diametrical clearance of 1 inch for lowering the impeller into the way, and provided a clearance of about ½ inch between edges 17 and 21 and the upper and lower peripheries of the impeller blades. The resulting way 25 was 3 inches deep to accommodate lateral motion of the impeller.

FIG. 2 shows the inventive way 40 formed in an axial flow pump casing 26 in which impeller 27 is supported for rotation on shaft 28. Way 50 is formed by a conical wall 29 extending inward from casing 26 to form an upper edge 30 connected to the casing wall 26 by a perpendicular, annular wall 31. Similarly, below impeller 27, a conical wall 32 extends inward from casing wall 26 to form an edge 33 joined to casing wall 26 by a perpendicular annular wall 34. Impeller 27 is disposed relative to walls 29 and 32 and edges 30 and 33 in the same manner as described above relative to way 25. Impeller 27 functions as an axial flow pump laterally movable in way 50 as previously described and not requiring a submerged bearing or close manufacturing tolerances.

FIGS. 3–5 show alternative arrangements of walls and housings for impeller ways according to the invention. The way 50 of FIG. 3 is formed of walls 52 and 53 extending radially outward from housing wall 54 and joined together by a wall 55 having a diameter greater than housing wall 54. An axial flow impeller (not shown) having approximately the diameter of wall 54 can be positioned in way 51 so that the outer ends of its blades are closely adjacent edges 56 and 57 formed at the respective junctures of walls 52 and 53 with wall 54. Way 51 then accommodates lateral motion of the impeller and edges 56 and 57 provide the fluid flow restriction as described above. Wall 58 extends from wall 54 to the outer edge of wall 52 to the outer edge of wall 52 to form a sloping surface so that solids or materials in liquids outside wall 54 will not collect on the edge otherwise provided by wall 52.

FIG. 4 shows a way 60 similar to the ways 25 and 50 described above except that perpendicular walls from the housing out to the edges of the way have been omitted. The way 60 is formed by an upper conical wall 61 and a lower conical wall 62 each secured to a housing wall 63 to form edges 64 and 65 that are disposed relative to an impeller in the same way as described above. Since perpendicular walls from edges 64 and 65 to wall 63 have been omitted, way 60 is undercut and extends behind conical walls 61 and 62. Because way 60 is swept clean by a turning impeller, the hollow nature of way 60 does not present a problem in some processes.

The way 70 of FIG. 5 is formed by a conical wall 71 extending inward from upper housing wall 72 to form an edge 73 closely adjacent the upper periphery an impeller (not shown) disposed in way 70. Wall 77 extends from edge 73 to upper housing wall 72. Lower edge 74 is formed by wall 75 extending radially inward from housing wall 72 to lower housing wall 76 which is of smaller diameter than upper housing wall 72. Wall 75 thus forms a step in the housing from the diameter of wall 72 exceeding impeller diameter to the smaller diameter of wall 76 approximating impeller diameter. Edges 73 and 74 are disposed adjacent the periphery of an impeller as described above.

The conical or oblique surfaces 15, 19, 29, 32, 61, 62, and 71, described above relative to the inventive impeller ways are preferred for smooth axial flow of fluid to and from impellers. Obstructions, or projecting surfaces inside the housings for axial flow impellers are to be avoided because they restrict liquid flow. However, curved or other surfaces that do not restrict fluid flow can extend to the edges of the impeller ways according to the invention.

The inventive ways can be formed in a wide variety of generally known housings or casings, and different combinations of edges and walls for the inventive ways can be formed in such housings and casings. Also, different construction materials and methods can be used in the inventive impeller ways.

Other features, advantages, and other specific embodiments of this invention will be apparent to those exercising ordinary skill in the pertinent art after considering the foregoing disclosure. In this regard, while specific preferred embodiments have been described in detail, such disclosure is intended as illustrative, rather than limiting, and other embodiments, variations, and modifications can be effected within the spirit and scope of the invention as disclosed and claimed. Furthermore, the following claimed subject matter is intended to cover fully all the aspects of the disclosed invention that are unobvious over prior art, including all equivalent embodiments.

I claim:

1. A way for a liquid axial flow impeller said way comprising:

(a) a generally circular-walled housing forming a passage way for said liquid;

(b) means outside said housing for rotatably supporting said impeller axially within said housing in said liquid;

(c) said housing in the region of said impeller having an inside diameter substantially larger than the diameter of said impeller;

(d) a first annular wall joined to said housing wall on the input side of the line of intersection with said housing wall of the plane of the input face of said impeller;

(e) said first annular wall extending inward to an edge having a diameter approximately equal to the diameter of said impeller and located in the region of the input side of said plane of the input face of said impeller at the periphery of said impeller;

(f) a second annular wall joined to said housing wall on the output side of the line of intersection with said housing wall of the plane of the output face of said impeller;

(g) said second annular wall extending inward to an edge having a diameter approximately equal to the diameter of said impeller and located in the region of the output side of said plane of said output face of said impeller at the periphery of said impeller;

(h) said first wall edge and said second wall edge being spaced apart axially a distance greater than the axial dimension of the periphery of the impeller;

(i) the diameter of at least one of said wall edges being slightly larger than the diameter of said impeller;

(j) said first and second annular walls each being continuous around the inside of said housing to contain a substantial volume of said liquid in a region extending radially around said impeller for a substantial distance radially beyond the periphery of said impeller between said first and second annular walls and said housing; and

(k) said impeller being supported for substantial motion off the axis of said housing between said first and second annular walls in response to turbulence in said liquid.

2. The way of claim 1 wherein said first annular wall forms a conical surface oblique to said housing wall.

3. The way of claim 2 wherein said second annular wall forms a conical surface oblique to said housing wall.

4. The way of claim 3 including a pair of annular walls each generally perpendicular to said housing wall, and each extending respectively between said first and second annular walls and said housing wall.

5. The way of claim 4 wherein said housing comprises a draft tube, and said impeller is supported on a vertical shaft for rotation inside said draft tube.

6. The way of claim 4 wherein said housing comprises an axial flow pump casing, and said impeller is supported on a vertical shaft for rotation inside said pump casing.

7. The way of claim 2 including an annular wall generally perpendicular to said housing wall and extending between said first annular wall and said housing wall.

8. The way of claim 1 wherein one of said annular walls is approximately perpendicular to said housing wall.

9. The way of claim 8 wherein said housing wall extends smoothly to said edge of said second annular wall from axially beyond said impeller.

10. The way of claim 8 wherein each of said annular walls is approximately perpendicular to said housing wall.

11. The way of claim 10 including surfaces extending smoothly to each of said edges of said first and second annular walls respectively from the input and output sides of said housing.

12. The way of claim 1 wherein said housing comprises a draft tube, and said impeller is supported on a vertical shaft for rotation inside said draft tube.

13. The way of claim 1 wherein said housing comprises an axial flow pump casing.

14. The way of claim 13 wherein said impeller is supported on a vertical shaft for rotation inside said pump casing.

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