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(54) **Title:** VORTEX IMPELLER WITH RADIALLY SPLIT CONCENTRIC VANES

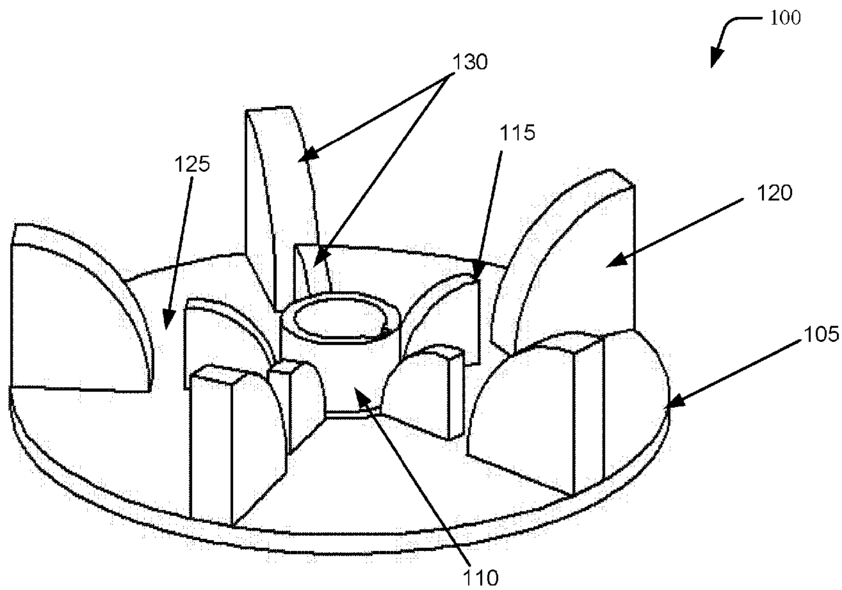

Fig.1

(57) **Abstract:** Vortex impellers (100) with radially split concentric vanes are described. A vortex impeller includes a suction eye (110) at its radial center; a plurality of inlet vanes (115) spaced circumferentially at a periphery of the suction eye (110); and a plurality of outlet vanes (120) spaced circumferentially at a periphery of the impeller (100). An annular passage (125) is defined between the plurality of outlet vanes (120) and the plurality of inlet vanes (115). Each inlet vane extends radially from the periphery of the suction eye (110) and the annular passage (125). Each outlet vane extends radially from the annular passage (125) to the periphery of the impeller (100). Each inlet vane and each outlet vane have a convex face (130) facing the suction eye (110). The outlet vanes (120) and the inlet vanes (115) have different scale sizes.

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VORTEX IMPELLER WITH RADIALLY SPLIT CONCENTRIC VANES

TECHNICAL FIELD

[0001] The present subject matter relates, in general, to impellers, and in particular to vortex generating centrifugal pump impellers.

BACKGROUND

[0002] Centrifugal pumps are mainly used to transfer fluids of various types by the conversion of rotational kinetic energy to hydrodynamic energy of the fluid. The rotational energy typically comes from an engine or electric motor. An impeller is a rotating component of a centrifugal pump that uses the rotational energy from the motor to impart energy to the fluid for its transport. Vortex impeller and Radial flow impeller are two types of impellers that are generally used in centrifugal pumps.

[0003] A vortex impeller creates a vortex of the fluid entering the pump and pumps the fluid out by centrifugal force. The fluids to be transferred may sometimes contain long strings, large diameter solids, sludge waste or a combination of all these. This may lead to blocking or clogging of the pump and may further lead to performance failure of the pumps.

BRIEF DESCRIPTION OF DRAWINGS

[0004] The detailed description is described with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the drawings to reference like features and components.

[0005] Fig. 1 shows an isometric view of a vortex impeller, in accordance with an embodiment of the present subject matter.

[0006] Fig. 2 shows a plan view of the vortex impeller shown in Fig. 1, in accordance with an embodiment of the present subject matter.

[0007] Fig. 3 shows a centrifugal pump having the vortex impeller shown in the Fig.1, in accordance with an embodiment of the present subject matter.

[0008] Fig. 4 shows a side view of a vortex impeller of a centrifugal pump with a casing partially sectioned, in accordance with an embodiment of the present subject matter.

[0009] Fig. 5 shows a graph that illustrates variation of a pump head with respect to flow for a centrifugal pump having a conventional impeller and the vortex impeller, in accordance with an embodiment of the present subject matter.

DETAILED DESCRIPTION

[0010] The present subject matter relates to a vortex generating centrifugal pump impeller. A centrifugal pump having the vortex generating impeller of the present subject matter is capable of pumping fluids that contain solid particles without the pump getting blocked or clogged.

[0011] A conventional vortex impeller comprises a circular base plate with an impeller eye at its centre. An outer circumference of the base plate defines an impeller periphery. The conventional vortex impeller further includes a plurality of vanes. Each vane extends from the impeller eye in the radial direction, towards the impeller periphery. The impeller is a rotating component and assembled in a stationary pump casing. When fluid enters the impeller through a suction inlet of the pump casing, the fluid becomes trapped between the impeller vanes and the pump casing, and the velocity of the flow increases as the fluid moves from the impeller eye toward the periphery of the impeller, and the fluid is then discharged through an outlet of the pump. However, when the fluid contains solid particles, the centrifugal pumps using the conventional vortex impellers may be blocked or clogged by the solid particles or deposits in the fluid. This leads to performance failure of the pumps. In particular, axial and radial thrust of the pumps may be increased and it may result in reducing performance and efficiency of the centrifugal pumps.

[0012] The present subject matter provides an improved vortex impeller with radially split concentric vanes. The vortex impeller of the present subject matter comprises a circular base plate having a suction eye or an impeller eye at its radial center. The vortex impeller comprises a plurality of inlet vanes spaced circumferentially at a periphery of the suction eye, and a plurality of outlet vanes spaced circumferentially at a periphery of the impeller. Further, an annular passage is defined between the plurality of outlet vanes and the plurality of inlet vanes. Each inlet vane extends radially between the periphery of the suction eye to the annular passage, and each outlet vane extends radially between the annular passage to the periphery of the impeller. Each inlet vane and each outlet vane has a convex face facing the suction eye. Further, the outlet vanes and the inlet vanes have different scale sizes. The design of the inlet vanes and the outlet vanes facilitates in creating a vortex to move the solid particles in the fluid towards an outlet of the pump while the impeller is being rotated. Further, the vortex impeller of the present subject matter facilitates in reducing the axial and radial thrust of the pump, thereby the performance of the pump is enhanced.

[0013] Fig.1 shows an isometric view of the vortex impeller in accordance with an embodiment of the present subject matter. The vortex impeller 100 of the present subject matter comprises a circular base plate 105 having a suction eye or an impeller eye 110 at its radial center. The vortex impeller 100 comprises a plurality of inlet vanes 115 spaced circumferentially at a periphery of the suction eye 110, and a plurality of outlet vanes 120 spaced circumferentially at a periphery of the impeller 100. In an example, the number of inlet vanes 115 and the outlet vanes 120 are five. However, it is understood by a person skilled in the art that the number of inlet and outlet vanes can be of any number depending on the requirements. Further, an annular passage 125 is defined between the plurality of outlet vanes 120 and the plurality of inlet vanes 115. Each inlet vane 115 extends radially between the periphery of the suction eye 110 to the annular passage 125, and each outlet vane 120 extends radially between the annular passage 125 to the periphery of the impeller 100. Further each inlet vane 115 and each outlet vane 120 has a convex face 130 facing the suction eye 110. Further, the outlet vanes 120 and the inlet vanes 115 have different scale sizes. In an aspect, a size of the outlet vanes 120 is greater than a size of the inlet vanes 115. In an aspect, the inlet vanes 115 and the outlet vanes 120 are elliptical segment shaped vanes having the convex face 130 facing the suction eye 110. Further, the vortex impeller 100 includes a back-shroud plate (not shown in Figures) having a balancing hole.

[0014] In one example, each inlet vane 115 has a vertical side surface extending perpendicularly from the plane of the circular base plate 105 and a base surface extending along the surface of the circular base plate 105. A first end of the vertical side surface coincides with a first end of the base surface forming an L-shape. The convex face 130 of the inlet vane extends from a second end of the vertical side surface to a second end of the base surface, i.e., between the free-ends of the L-shape. Further, as mentioned above, the convex face 130 faces the suction eye 110. Thus, as will be understood, the second end or free-end of the base surface is closer to the suction eye 110 than the first end of the base surface from which the vertical surface extends. For example, the first ends of the base surfaces of the inlet vanes 115 are provided along an inner perimeter of the annular passage 125 and the second ends of the base surfaces of the inlet vanes 115 are provided along the periphery of the suction eye 110.

[0015] Similar to the inlet vanes 115, each outlet vane 120 has a vertical side surface and a base surface forming an L-shape and the convex face 130 extends between the free-ends of the L-shape. Also, similar to the inlet vanes 115, the second end or free-end of the base surface of each of the outlet vanes 120 is closer to the suction eye 110 than the first end of the base surface from which its vertical surface extends. For example, the first ends of the base surfaces of the outlet vanes 120 are provided along the periphery of the circular base plate 105 and the second ends of the base surfaces of the outlet vanes 120 are provided along an outer perimeter of the annular passage 125.

Thus, the annular passage 125 is formed between the second ends of the base surfaces of the outlet vanes 120 and the first ends of the base surfaces of the inlet vanes 115.

[0016] In one example, the inlet vanes 115 may have the same structure but may be scaled down in size as compared to the outlet vanes 120. Thus, the height of the vertical side surface of the outlet vane 120 is greater than the height of the vertical side surface of the inlet vane 115. Similarly, the length of the base surface of the outlet vane 120 is greater than the length of the base surface of the inlet vane 115. In one example, the ratio of the height of the vertical side surface to the length of the base surface may remain the same for the outlet vanes 120 and inlet vanes 115.

[0017] In an embodiment, the inlet vanes 115 and the outlet vanes 120 are parallel to one another, as shown in the Fig.1. In another embodiment, the inlet vanes 115 and the outlet vanes 120 are at an angle to each other. Further, as shown in the Fig.1, the inlet vanes 115 and the outlet vanes 120 are positioned in a concentric manner.

[0018] Fig.2 shows a plan view of the vortex impeller 100 shown in Fig.1, in accordance with an embodiment of the present subject matter. As can be clearly seen from Fig.2, the annular passage 125 is defined between the inlet vanes 115 and the outlet vanes 120.

[0019] Fig.3 shows a centrifugal pump having the vortex impeller shown in the Fig.1, in accordance with an embodiment of the present subject matter. The centrifugal pump 300 comprises a vortex impeller 100, which is to be rotated by a motor (not shown in Fig.3). The pump 300 comprises a stationary volute casing 305 having a suction inlet 310 and an outlet 315. In an embodiment, the vortex impeller 100 is assembled inside the stationary volute casing 305 in such a way that a center of the vortex impeller 100 is at a distance from a center of the stationary volute casing 305.

[0020] Fig.4 shows a side view of a vortex impeller 100 of a centrifugal pump 300 with a casing partially sectioned, in accordance with an embodiment of the present subject matter. The dotted line 405 represents the central line of the stationary volute casing while the dotted line 410 represents the central line of the vortex impeller 100. As can be seen, the central lines 405 and 410 are not aligned but spaced apart. This also helps in reducing blockage and improving flow of the fluid with entrained solid matter.

[0021] In operation, when the vortex impeller 100 is rotated by a motor, a suction pressure is created and the fluid with solid particles enters the suction inlet of the pump. The fluid passes towards the impeller eye 110 from the suction inlet 310. The vortex impeller 100 which is positioned at a distance from a center of volute casing creates a vortex of fluid flow. In particular, the inlet vanes 115 and the outlet vanes 120 that are radially split, creates the vortex of the fluid flow and impart energy to the incoming flow and increase velocity in the radial direction. The inlet vanes 115, which are smaller vanes, induces the flow from the suction inlet 310, and the outlet vanes 120 turns the fluid flow into radial direction. The fluid between the inlet vanes 115 and the outlet vanes 120 of the impeller 100 generates the vortex and moves with vanes at a constant velocity. In an embodiment, the vortex impeller 100 creates the fluid flow in the form of a helical shaped flow. In another embodiment, the vortex impeller 100 creates the fluid flow in the form of a spiral shaped flow. The vortex of the fluid flow imparts energy to the incoming flow and increases velocity in radial direction.

[0022] The vortex of the fluid flow moves the solid particles in radial direction towards the outlet 315 of the pump 300 for discharging the solid particles. The pressure drop is created around the vortex of the fluid flow to propel the solid particles in radial direction. The minimum pressure of the vortex is at the center of the impeller 100 and increases radially towards the periphery of the impeller 100.

[0023] Further, in an embodiment, the vortex fluid flow generated by the vortex impeller 100 is substantially improved by incorporating the convex shape on the impeller vanes. The convex shape of the impeller reduces the tip loss to improve the vortex fluid pressure. As mentioned previously, the minimum pressure of the vortex is at the center of the impeller 100 and increases radially towards the periphery of the impeller 100.

[0024] The annular passage 125 between the inlet vanes 115 and the outlet vanes 120 reduces the blockage and aids in inducing the vortex further.

[0025] Further, with the present design of the vortex impeller 100, axial thrust and radial thrust of the pump 300 is reduced, thereby enhancing the performance of the pumps 300 having the vortex impeller 100 of the present subject matter.

[0026] In an embodiment, the balancing hole on a back-shroud plate (not shown in Figures) of the vortex impeller 100 further aids in reducing the axial and radial thrust of the pumps, thereby further enhancing the efficiency of the pumps.

[0027] In one example, the diameter of the vortex impeller 100 of the present subject matter is less than the diameter of the conventional vortex impeller for providing similar head. For example, the diameter of the old impeller is about 308mm, and the diameter of the vortex impeller 100 of the present subject matter is about 288mm. Thus, with the reduced diameter of the vortex impeller, the vortex impeller occupies less space and therefore the centrifugal pump with the impeller is not bulky like conventional centrifugal pumps.

[0028] Fig.5 shows a graph that illustrates variation of a pump head with respect to flow for a centrifugal pump having a conventional impeller and the vortex impeller, in accordance with an embodiment of the present subject matter. The graph 505 represents the variation of a pump head with respect to flow for a centrifugal pump 300 having a conventional impeller, and the graph 510 represents the variation of a pump head with respect to flow for the centrifugal pump 300 having the vortex impeller 100 of the present subject matter. As can be seen from the graphs 505 and 510, the variation of the pump head is increased for different fluid flows for the vortex impeller 100 of the present subject matter compared to the conventional impeller.

[0029] Although embodiments for the vortex impeller have been described in language specific to structural features, it is to be understood that the present subject matter is not necessarily limited to the specific features described. Rather, the specific features are disclosed as example embodiments.

I/We claim:

1. A vortex impeller (100) comprising:

   a suction eye (110) at its radial center;

   a plurality of inlet vanes (115) spaced circumferentially at a periphery of the suction eye;

   a plurality of outlet vanes (120) spaced circumferentially at a periphery of the impeller; and

   an annular passage (125) defined between the plurality of outlet vanes (120) and the plurality of inlet vanes (115), wherein each inlet vane extends radially between the periphery of the suction eye (110) to the annular passage (125) and each outlet vane extends radially between the annular passage (125) to the periphery of the impeller, and each inlet vane and each outlet vane has a convex face (130) facing the suction eye, and wherein the outlet vanes (120) and the inlet vanes (115) have different scale sizes.

2. The vortex impeller (100) as claimed in claim 1, wherein the inlet vanes (115) and the outlet vanes (120) are parallel to one another.

3. The vortex impeller (100) as claimed in claim 1, wherein the inlet vanes (115) and the outlet vanes (120) are at an angle to each other.

4. The vortex impeller (100) as claimed in claim 1, wherein the inlet vanes (115) and outlet vanes (120) are positioned in a concentric manner.

5. The vortex impeller (100) as claimed in claim 1, wherein a size of the outlet vanes (120) is greater than a size of the inlet vanes (115).

6. The vortex impeller (100) as claimed in claim 1, wherein the inlet vanes (115) and the outlet vanes (120) are elliptical segment shaped vanes having the convex face (130) facing the suction eye (110).

7. The vortex impeller (100) as claimed in claim 1, wherein the vortex impeller (100) includes a back-shroud plate having a balancing hole.

8. A centrifugal pump (300) comprising:

a rotating vortex impeller (100) having:

a suction eye (110) at its radial center;

a plurality of inlet vanes (115) spaced circumferentially at a periphery of the suction eye;

a plurality of outlet vanes (120) spaced circumferentially at a periphery of the impeller; and

an annular passage (125) defined between the plurality of outlet vanes (120) and the plurality of inlet vanes (115), wherein each inlet vane extends between the periphery of the suction eye (110) to the annular passage (125) and each outlet vane extends between the annular passage (125) to the periphery of the impeller (100), and each inlet vane and each outlet vane has a convex face (130) facing the suction eye (110), and wherein the outlet vanes (120) and the inlet vanes (115) have different scale sizes; and

a stationary volute casing (305), wherein the vortex impeller (100) is assembled inside the stationary volute casing (305) and a center of the vortex impeller (405) is at a distance from a center of the stationary volute casing (410).

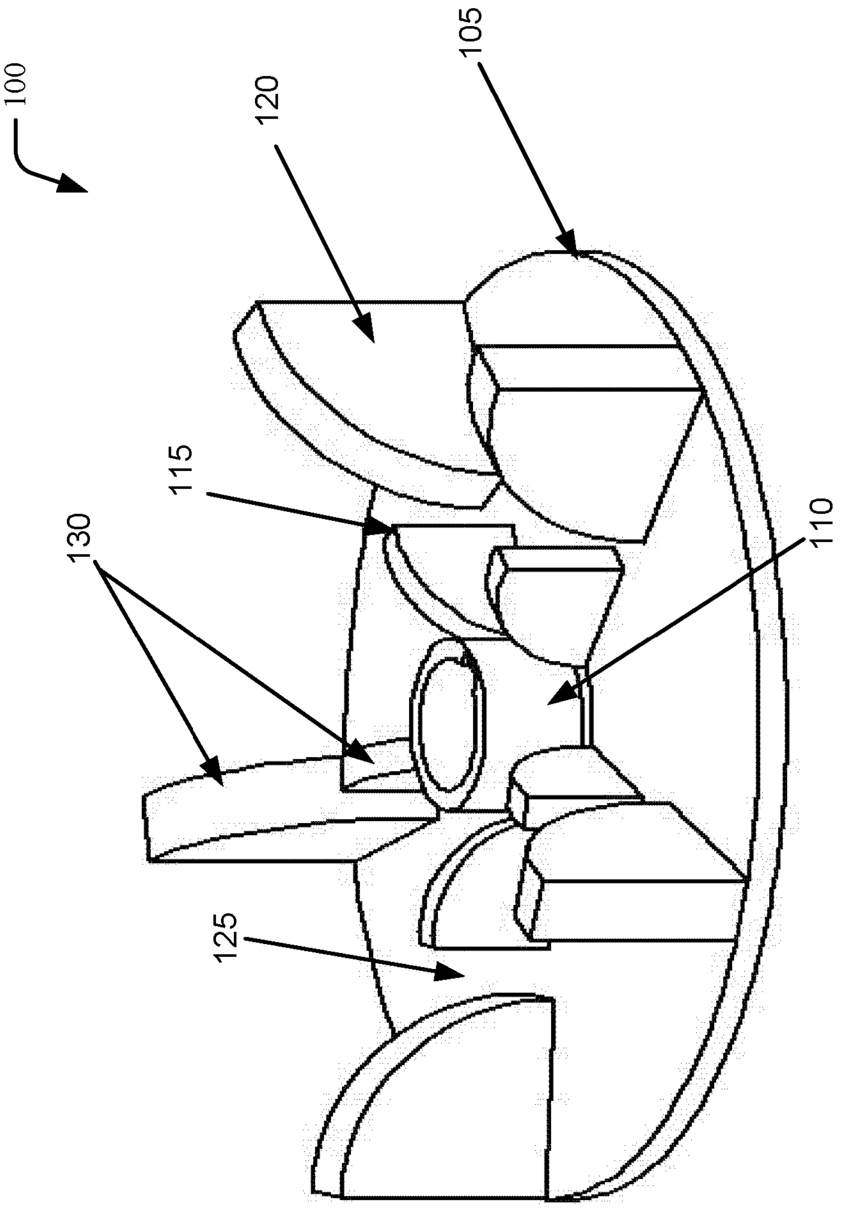

Fig.1

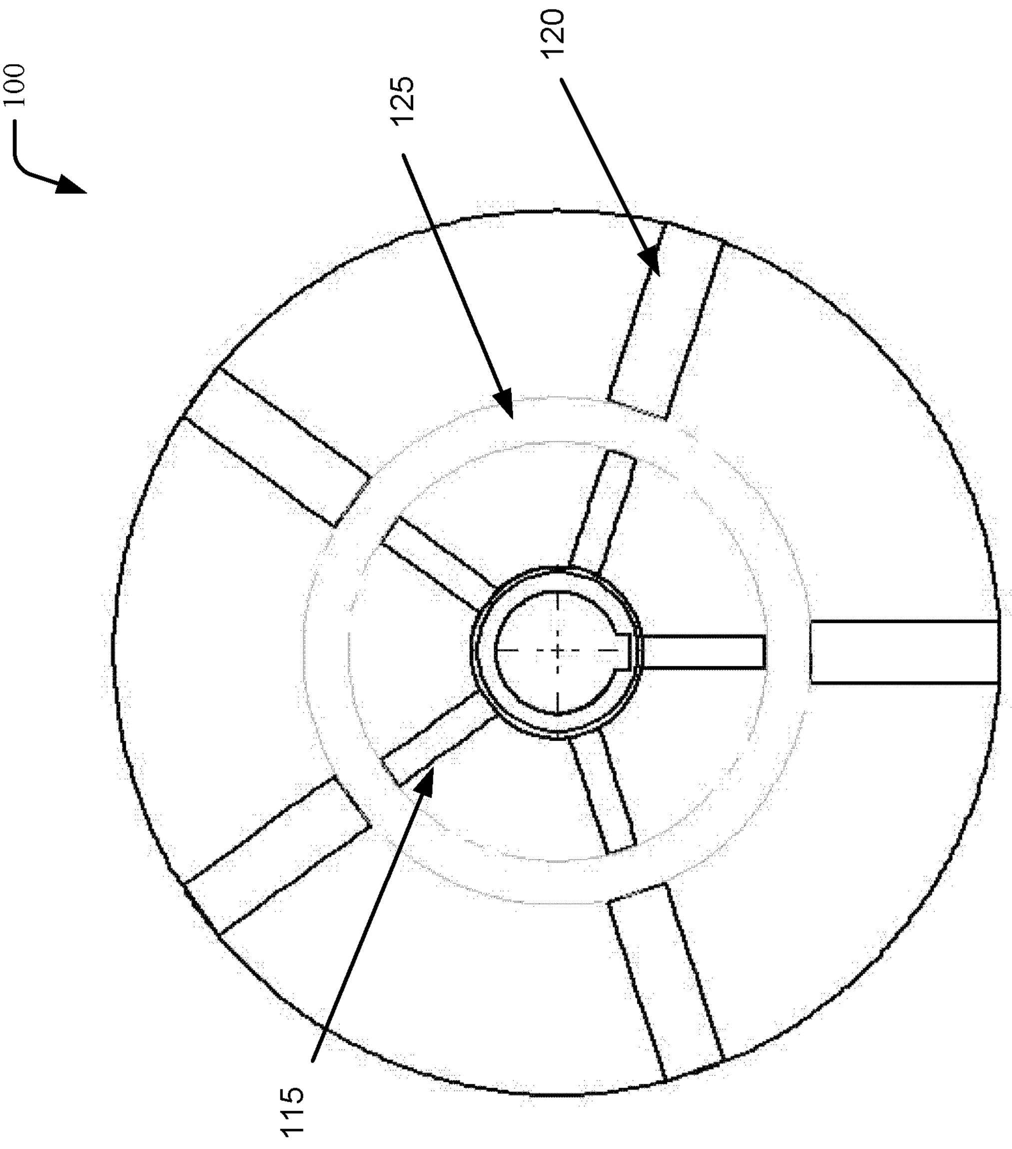

Fig.2

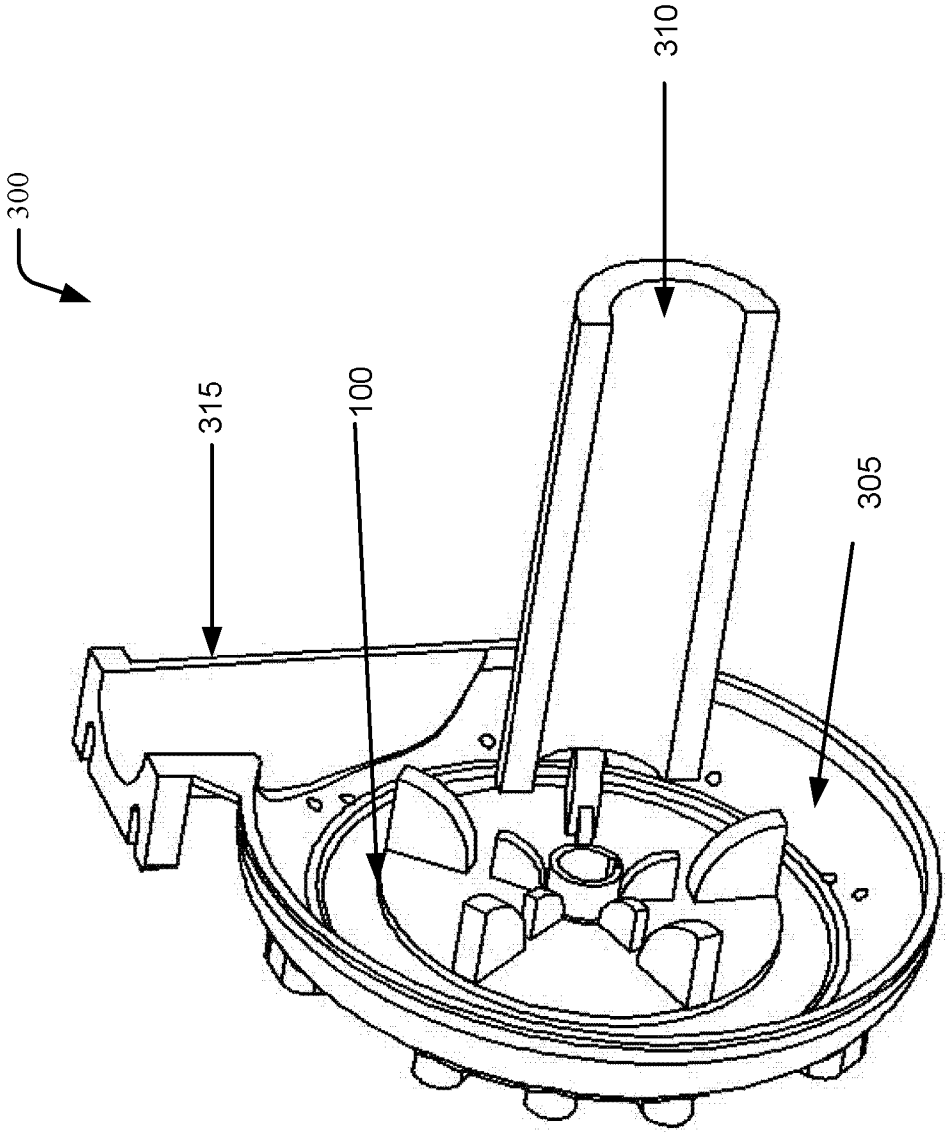

Fig.3

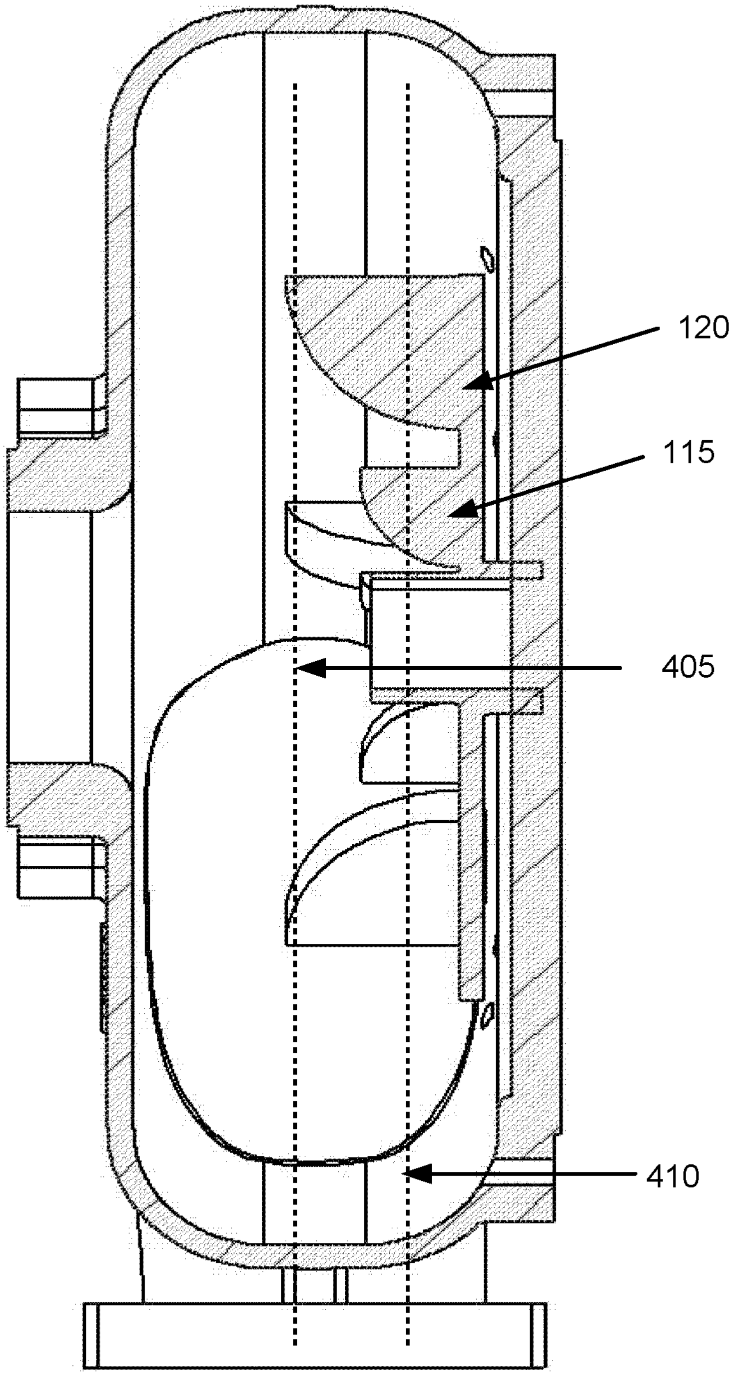

Fig.4

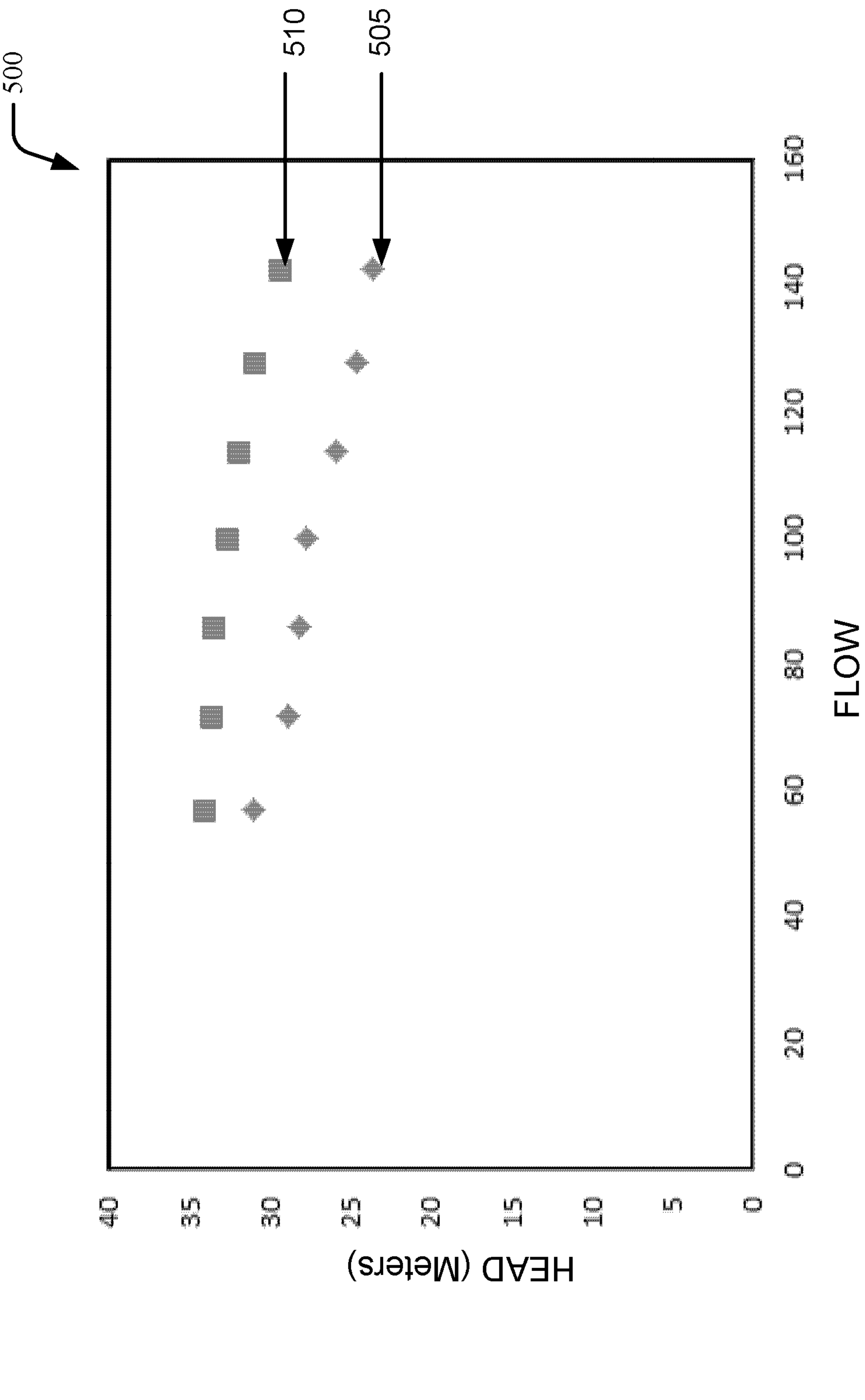
500
510
505
0
20
40
60
80
100
120
140
160
FLOW
40
35
30
25
20
15
10
5
0
HEAD (Meters)

Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2019/050089

A. CLASSIFICATION OF SUBJECT MATTER
F04D29/24 Version=2019.01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

TotalPatent One, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US6676366 B2 (BAKER HUGHES INCORPORATED) 13 January 2004 (13.01.2004) Column 3; line 57 - Column 4; line 52, Figure 3	1-8
A	GB1277416 A (MAKEARN HOLDINGS LTD) 14 June 1972 (14.06.1972) Page 2; line 24-92, Figure 2	1-8

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01-05-2019	01-05-2019

Name and mailing address of the ISA/	Authorized officer
Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Seetha Raman A Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2019/050089

Citation	Pub.Date	Family	Pub.Date
US 6676366 B2	13-01-2004	AU 2003225653 A1	22-09-2003
		CA 2477293 A1	18-09-2003
		RU 2004129596 A	10-09-2005
		WO 03076811 A1	18-09-2003
GB 1277416 A	14-06-1972	AT 308549 B	10-07-1973
		BE 734809 A	01-12-1969
		CH 530560 A	15-11-1972
		DE 1930481 A1	02-01-1970
		FR 2011959 A1	13-03-1970
		NL 6909433 A	23-12-1969