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(54) **CENTRIFUGAL PUMP IMPELLER**

(57) This invention relates to equipment designed for pumping fluids and can be used in industry, agriculture and domestically. The technological result achieved by this invention is increasing centrifugal pressure without affecting the efficiency coefficient of the impeller of a centrifugal pump. The essence of this invention consists in the impeller of a rotary pump with the angle between the

line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller in the 40°-90° range, while the shape of the vanes corresponds to second-order surfaces, which permits the vanes to be made inclined towards the impeller rotation direction and stretched towards the eye of the impeller.

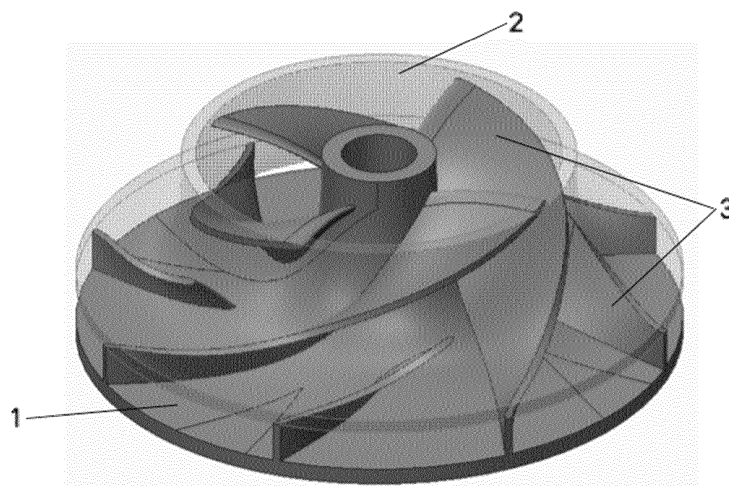


Fig.6

Description

[0001] This invention relates to equipment designed for pumping fluids and can be used in industry, agriculture and in household.

[0002] There is a known centrifugal pump impeller, containing vanes with curvature in one plane [CN2204344, priority date 2.08.1993, publication date 2.08.1995, MPC: FO4D 07/04].

[0003] There exists a centrifugal pump impeller, containing vanes with curvature in one plane [CN205779755, priority date 19.05.2016, publication date 7.12.2016; MPC: FO4D 13/06].

[0004] The centrifugal pump impeller with vanes curving in one plane, with an angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller in the 15°-27° range.

15 - 27 range [CN204152837]; priority date 15.10.2014; publication date 11.02.2015; MPC: FO4D 29/24] was chosen for this invention as its prototype.

[0005] The drawback of the prototype is that fluid moves slowly at the impeller outlet due the small angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller. Increasing that angle would result in hydrodynamic losses and would reduce the efficiency coefficient of the impeller, which impairs service characteristics of the centrifugal pump.

[0006] The technological problem this invention aims to solve, is improving exploitation characteristics of centrifugal pumps.

[0007] The technological result achieved by this invention is a greater centrifugal pressure generated, while the efficiency coefficient of the centrifugal pump impeller is not affected.

[0008] The essence of the invention is as follows.

[0009] Proposed a centrifugal pump impeller, characterized by the angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller being located in the 40°-90° range, while the shape of a vane corresponds to a second-order surfaces, which permits the vanes to be inclined towards the impeller rotation direction and stretched towards the impeller eye.

[0010] The centrifugal pump impeller can be manufactured by either casting or spot welding and can be either flat or concave.

[0011] The impeller includes the main and cover discs and vanes. The impeller has an inlet (eye) in the central part and an outlet on the side (butt) surface. The impeller carries radial working channels between the vanes, running from the eye to the outlet. The vanes are designed to generate a centrifugal force and transform mechanical energy of the impeller to hydrodynamic energy of the fluid. Each vane has a leading and a trailing edge.

[0012] The trailing edges of the vanes cast out the fluid from the radial working channels. The trailing edges are located at the impeller outlet. The angle between the line

tangent to the vane trailing edge and the line tangent to the circumference of the impeller is located in the 40°-90° range, which increases the circumferential component of absolute velocity at the ends of the vanes. Having that angle less than 40° does not increase the centrifugal force, while having that angle above 90° might result in hydraulic resistance becoming too high, thus impairing efficiency and making the impeller wear out faster. To increase the centrifugal force to a maximum, the angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller must be in the 80°-90° range.

[0013] The shape of the vanes is represented by second-order surfaces, which means that any section of a vane along any plane has a curvature, which makes it possible to have the vanes inclined towards the rotation direction of the impeller as well as their maximum stretching towards the eye of the impeller. The second-order surface can be profiled by calculating triangles of velocity for a large number of sections, taking into account the chosen angles between the lines tangent to the trailing and leading edges of the vanes on the one hand and the lines tangent to the circumferences of the impeller on the other hand.

[0014] In addition, to reduce hydrodynamic resistance and increase the efficiency coefficient of the impeller, the leading edge of a vane can be placed as close to the eye of the impeller as possible, while the angle between the line tangent to the leading edge of a vane and the line tangent to the circumference of the impeller can be chosen in the 10-25° range.

[0015] To achieve a greatest possible reduction of hydrodynamic resistance and increase the centrifugal force without affecting efficiency of the impeller, the angle between the line tangent to the leading edge of a vane and the line tangent to the circumference of the impeller can be chosen in the 12°-15° range, while the angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller can be chosen in the 80°-90° range.

[0016] In addition, to increase the centrifugal force as well as stiffness and strength and to improve anti-cavitation characteristics of the impeller, the latter may contain one or more rows of auxiliary vanes, which can be of the same shape as the main vanes. The trailing edges of the auxiliary vanes in relation to the trailing edges of the main vanes can be placed at the same distance from the rotation axis of the impeller. The length of the auxiliary vanes of the first row can measure 40-60% of the length of the main vanes, while the auxiliary vanes of the consecutive rows can measure 40-60% of the length of the vanes of the preceding rows, which ensures their lowest hydrodynamic resistance to the flow of fluid. The angle between the line tangent to the trailing edge of an auxiliary vane and the line tangent to the circumference of the impeller can be chosen in the 40°-90° range, which also drives up the centrifugal force. Also, the use of auxiliary vanes improves the weight and size characteristics of

the impeller because the number and thickness of main vanes can be reduced. It also affords having impellers manufactured out of polymer materials.

[0017] This invention possesses the previously unknown in set of essential technological characteristics, characterised by the following:

- the angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller is in the 40° to 90° range, which increases the circumferential component of absolute velocity at the impeller outlet and increases the dynamic component of the centrifugal force generated by the impeller.
- the vanes are shaped as second order surfaces, which permits having the vanes inclined towards the impeller rotation direction and stretched towards the eye of the impeller, which means that the leading edges of the vanes can be placed as close to the eye of the impeller as possible, and this reduces hydrodynamic resistance and improves cavitation resistance of the impeller.

[0018] Thus, the set of new features of this invention increases the dynamic component of the centrifugal force, reduces hydrodynamic resistance and improves cavitation resistance of the impeller, thus achieving the desired technological goals: increasing the centrifugal force without affecting the efficiency coefficient of the impeller and improving service characteristics of centrifugal pumps. The new important characteristics of this invention suggest that it meets the "novelty" and "level of invention" criteria of patentability.

[0019] This model can be manufactured from available materials, using commonly used methods, which means that this invention meets the "industrial applicability" criterion of patentability.

[0020] The invention is illustrated with the following drawings.

Fig. 1. An outline drawing (plan view) of the impeller of a centrifugal pump; indicated are the angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller and the angle between the line tangent to the leading edge of a vane to the line tangent to the circumference of the impeller.

Fig. 2. The centrifugal pump impeller, view from the left, a longitudinal section.

Fig. 3. The centrifugal pump impeller, plan view, a cross section.

Fig. 4. The centrifugal pump impeller with auxiliary vanes as seen from the left, a longitudinal section.

Fig. 5. The centrifugal pump impeller with auxiliary vanes, a plan view, a cross section.

Fig. 6. The centrifugal pump impeller with auxiliary vanes, a three-dimensional model, an axonometric view.

Fig. 7. The centrifugal pump impeller with auxiliary vanes, a three-dimensional model, view from the left.

Fig. 8. A vane of the centrifugal pump impeller, shaped as a second-order curve; a general view.

[0021] The centrifugal pump contains an impeller with an eye and an outlet, which includes the main disk 1, the cover disk 2 and the vanes 3 shaped as a second-order curve, which makes it possible to have the vanes inclined towards the impeller rotation direction and their stretching towards the impeller eye. The β_1 angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller is 90° , while the β_2 angle between the line tangent to the leading edge of the vane and the line tangent to the circumference of the impeller is 12° .

[0022] The invention operates as follows.

[0023] The centrifugal pump is immersed in a fluid, and its impeller starts to rotate. The fluid is sucked through the eye of the impeller and, skirting the leading edges of the vanes 3, placed at the β_2 angle at a minimum hydrodynamic resistance, moves along the second-order curves of the vanes 3, interacts with the trailing edges of the vanes 3, placed at the β_1 angle, and- acquiring a maximum absolute velocity- leaves the impeller. This achieves the desired technological result: increasing the centrifugal force without impairing the efficiency coefficient of the impeller and improving exploitation characteristics of the centrifugal pump.

Claims

1. The impeller of a centrifugal pump, **characterised by** the angle between the line tangent to the trailing edge of the vanes and the line tangent to the circumference of the impeller being in the 40° - 90° range, while the shape of the vanes corresponds to second order-surfaces, which enables the vanes to inclined towards the impeller rotation direction and stretched towards the eye of the impeller.
2. The impeller of a rotary pump as in claim 1, **characterised by** the angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller being in the 80° - 90° range.
3. The impeller of a rotary pump as in claim 1, **characterised by** the angle between the tangent to the lead-

ing edge of a vane and the line tangent to the circumference of the impeller being within the 10°-25° range.

4. The impeller of a rotary pump as in claim 3, **characterised by** the angle between the line tangent to the leading edge of a vane and the line tangent to the circumference of the impeller being within the 12°-15° range and the angle between the line tangent to the trailing edge of a vane and the line tangent to the circumference of the impeller being within the 80°-90° range. 5
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5. The impeller of a rotary pump as in claim 1, **characterised by** containing a row of auxiliary vanes. 15
6. The impeller of a rotary pump as in claim 5, **characterised by** the length of the auxiliary vanes being 40-60% of the length of the main vanes. 20
7. The impeller of a rotary pump as in claim 5, **characterised by** the angle between the line tangent to the outlet end of the auxiliary vanes and the line tangent to the circumference of the impeller being in the 40°-90° range. 25
8. The impeller of a rotary pump as in claim 5, **characterised by** containing an additional row of auxiliary vanes. 30
9. The impeller of a rotary pump as in claim 8, **characterised by** the length of the additional auxiliary vanes being 40-60% of the length of auxiliary vanes. 35

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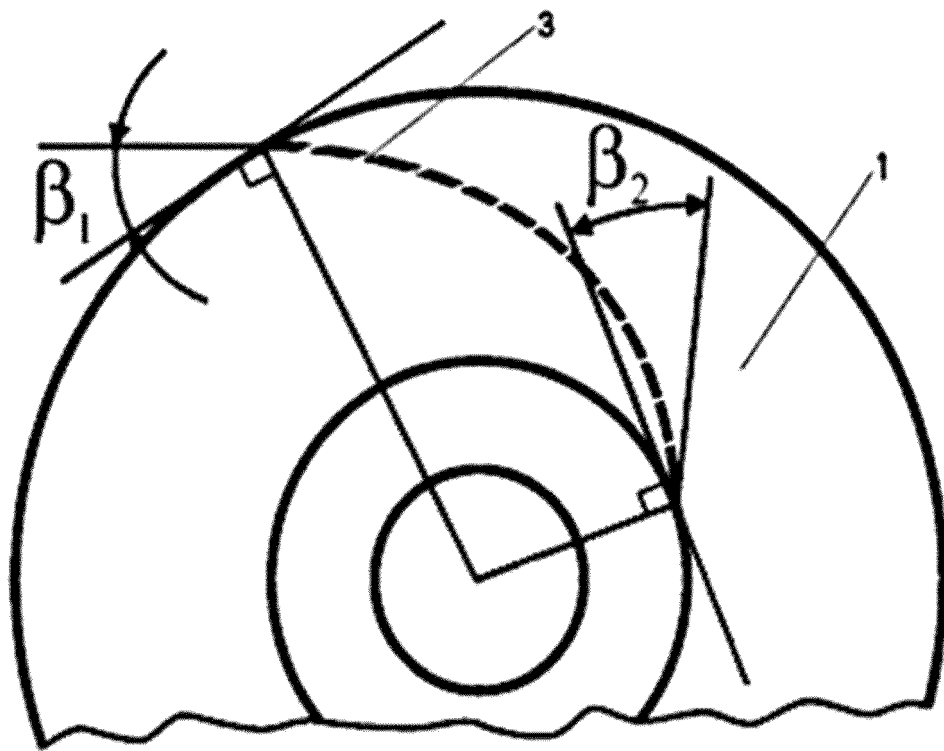


Fig.1

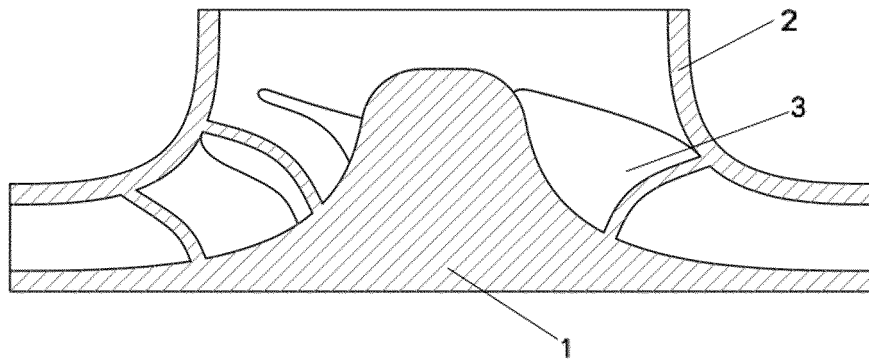


Fig.2

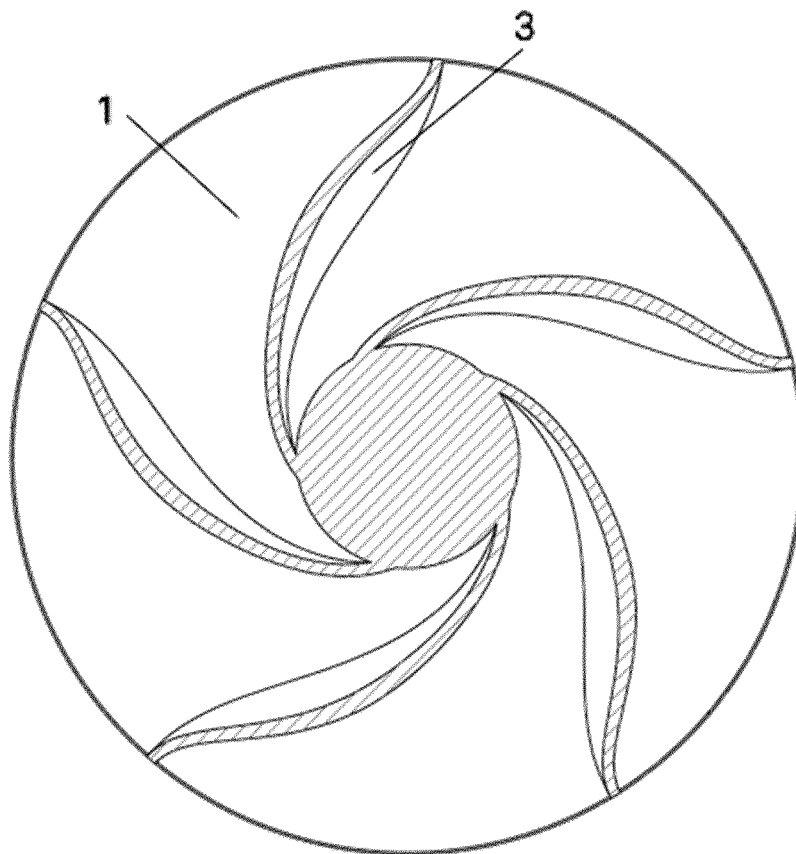


Fig.3

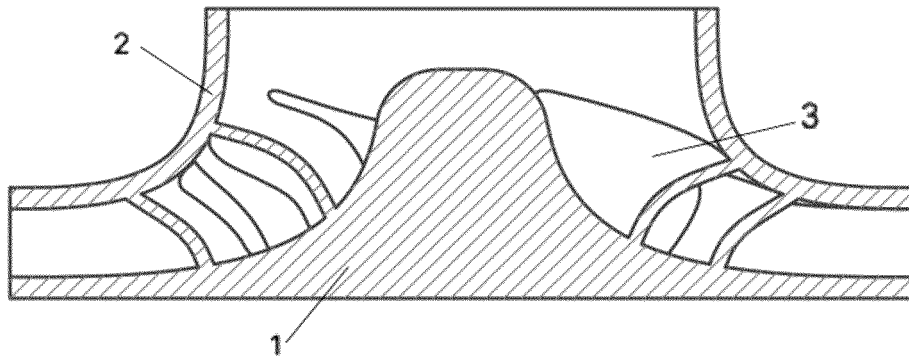


Fig.4

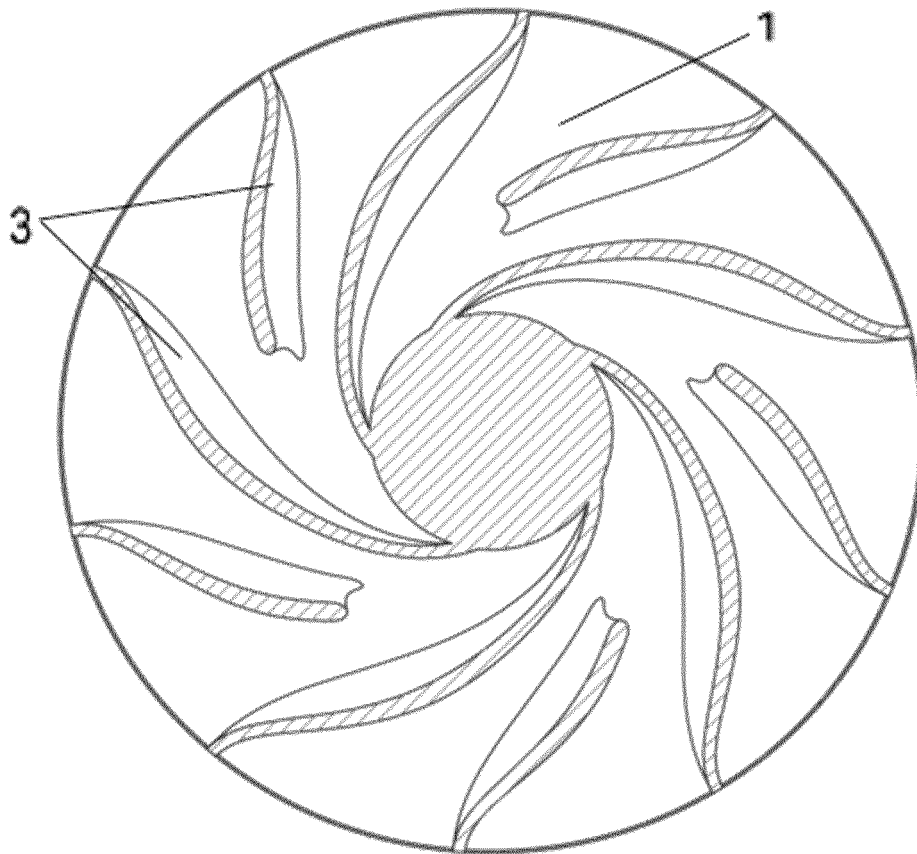


Fig.5

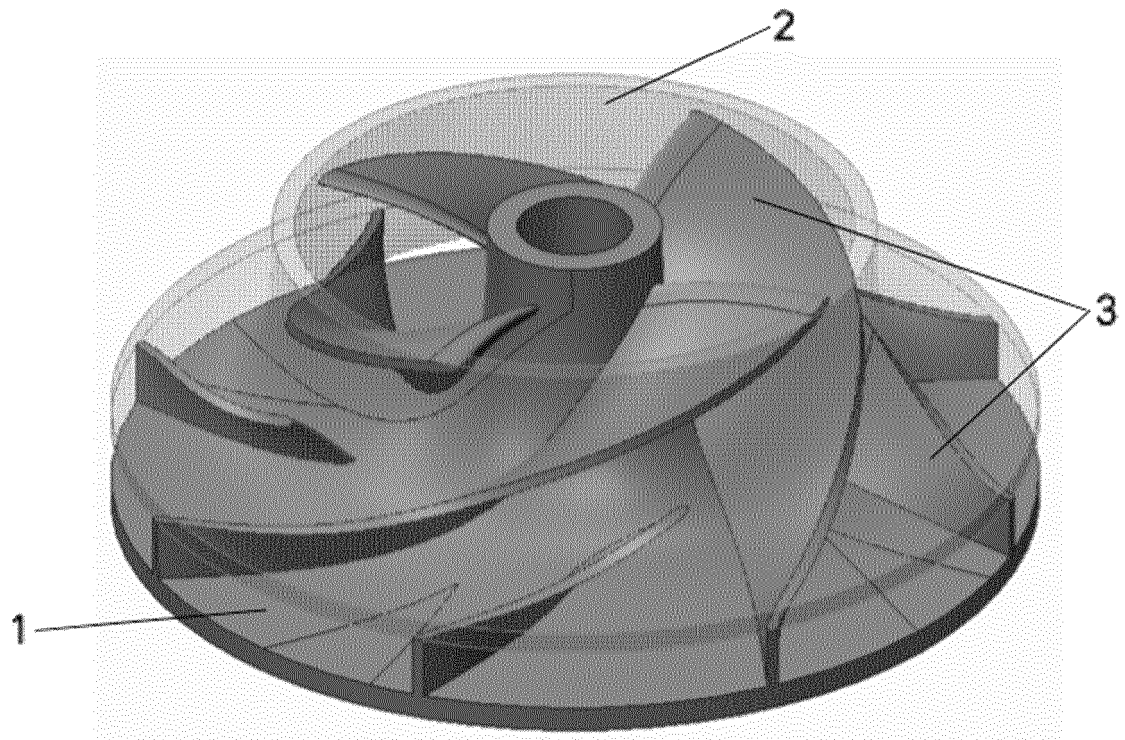


Fig.6

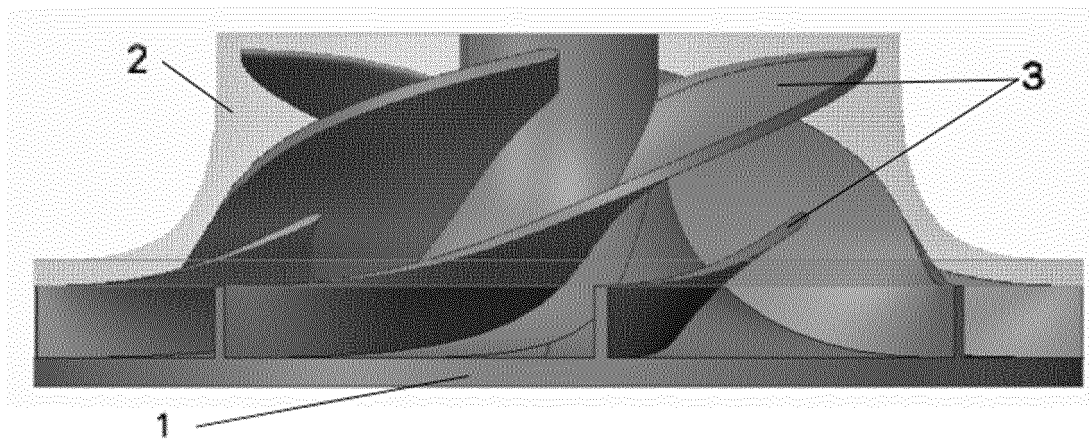


Fig.7



Fig.8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2018/050046

5	A. CLASSIFICATION OF SUBJECT MATTER F04D 29/24 (2006.01)	
	According to International Patent Classification (IPC) or to both national classification and IPC	
	B. FIELDS SEARCHED	
10	Minimum documentation searched (classification system followed by classification symbols) F04D 29/00, 29/18- 29/30	
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched	
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE	
	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
20	Category*	Citation of document, with indication, where appropriate, of the relevant passages
		Relevant to claim No.
25	X Y	CN 204152837 U (HUANG XIAODONG) 11.02.2015, the abstract, fig.2
		1-7 8-9
	Y	CS 234599 B1 (VYKOPAL JAN et al.) 01.01.1987, the abstract, fig.2
		8-9
	A	RU 2126102 C1 (KOZLOV ANATOLY IVANOVICH et al.) 10.02.1999
30		1-9
	A	WO 1999/36701 A1 (EBARA CORPORATION) 22.07.1999
		1-9
35		
40	☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.	
45	* 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 "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "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	
50	Date of the actual completion of the international search 22 August 2018 (22.08.2018)	Date of mailing of the international search report 23 August 2018 (23.08.2018)
	Name and mailing address of the ISA/ RU	Authorized officer
55	Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 2204344 [0002]
- CN 205779755 [0003]
- CN 204152837 [0004]