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(54) Title: IMPELLER OF HYDRAULIC MACHINES

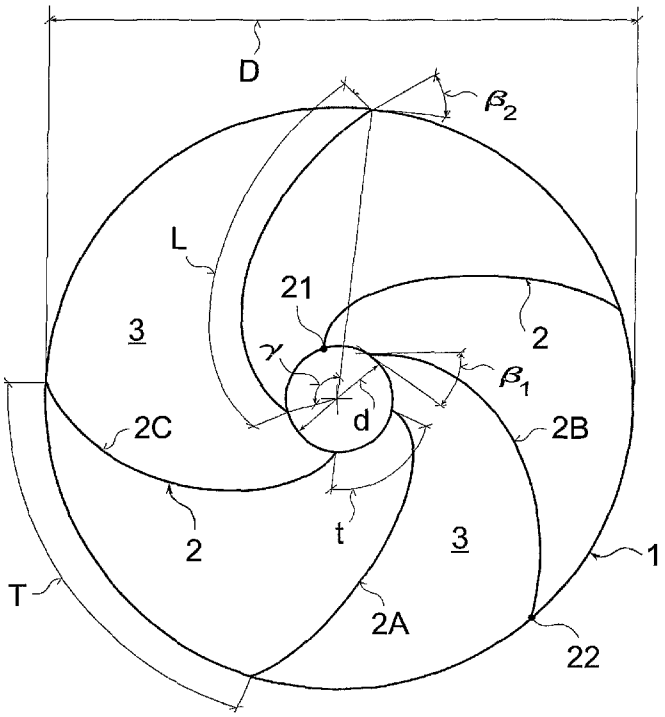

FIG. 1

(57) Abstract: The essence of the invention is an impeller of hydraulic machines created with a supporting disc (1) procured with blades (2) creating through-flow channels (3), wherein the blades (2) are in diameter direction on the supporting disc (1) set irregularly and are created in the way that at least on of the through-flow channels (3) has different shape and different through-flow crosscut whereas the particular blades (2) of an irregular blade cascade are created in the way that their basic parameters an inlet angle (βi), an outlet angle (β2) and a wrapping angle (*y*) are in relation $\beta_{1max} = \beta i \pm 20°$ $\beta_{2max} = \beta 2 \pm 20°$ $Y_{max} = Y \pm 20°$ and the size of inlet spacing (t) on inlet edges (21) and outlet spacing (T) on outlet edges (22) of the blades (2) are in relation $t_{max} = t \pm 20\% t$ $T_{max} = T \pm 20\% T$.

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Impeller of hydraulic machines

Art domain

This invention concerns construction modification of the blades of the impeller of hydraulic machines, for example centrifugal pumps and water turbines.

Present Prior Art

At present the impellers of the hydraulic machines are usually designed with periodical blade cascade, i.e. the blades have the same spacing on inlet and outlet edges, when all the blades have the same shape. A result of this design set is too steep efficiency characteristic η, expressing reliance of water column H on the flow Q of water machine, thus the water machines have optimal efficiency η only at given rotation speed of the impeller, thus for one flow, i.e. one operating point. At lower or higher flow of hydraulic media the value of hydraulic efficiency steeply decreases and furthermore pressure and flow pulsations of the liquid rise significantly and separation of boundary layer of the liquid occurs.

The suppression of pressure and also of flow pulsations of pumped liquid and vibrations of the construction itself both in hydraulic machines and in gas turbines or ventilators is solved in different ways; one of them is irregular set of impellers' blades. Uneven set of the blades of axial machines transferring gaseous media is known for example from the files: US 3,883,264, US 4,253,800, US 4,474,534, US 7,029,227, JP 6248902 or FR 2617914, wherein is altogether solved the problematic of decreasing of the device's vibrations.

Uneven set of stator blade cascade of hydraulic pumping devices is then described for example in the files CN 2440115, GB 2420157 or EP 1956247, which also solve decrease of acoustic pressure transmitted into surrounding. The next known solution is design of the impeller with disposed short blades as it is described for example in the files US 6,508,626 or CZ 17672 U1, when the blades and the short blades are evenly set around periphery of the impeller and the angle of their outlet flow surface is constant on all the periphery.

With regard to nowadays requirements for hydraulic systems dynamic, at present it is not, concerning hydraulic machines, insisted only on their maximal efficiency, but there is an effort to reach wide operating spectrum with high efficiency as well. The aim of submitted solution is to modify the construction of the impeller to flat characteristic Q - H in the widest operating spectrum to be reached, thus at different flows of the hydraulic media through the given system.

The essence of the invention

The mentioned aim is reached with an invention of an impeller of hydraulic machines created with a supporting disc procured with blades which creates through -flow channels, whose essence consists in fact that the blades are in peripheral direction on the supporting disc set irregularly and are created in the way that at least one from the through-flow channels has different shape and/or different through-flow cross-section.

The next essence of the invention is that particular blades of uneven blade cascade are created in the way that for their basic parameters inlet angle (β_i), outlet angle (β_2) and wrapping angle (/) are in relation

$$\beta_{imax} = \beta_i \pm 20°$$

$$\beta_{2max} = \beta_2 \pm 20°$$

$$/_{max} = \gamma \pm 20°.$$

Furthermore the essence of the invention is that for the size of inlet pitch (t) on inlet edges and outlet pitch (T) on outlet edges of the blades are in relation

$$t_{max} = t \pm 20\%t$$

$$T_{max} = T \pm 20\%T.$$

Finally the essence of the invention is that the inlet edge of at least one blade is placed on another diameter than inlet diameter (d) of the impeller and that the outlet edge of at least one blade is placed on another diameter than outlet diameter (D) of the impeller.

The new impeller design is characterized by its unlike size of the through-flow channels between individual blades, where each through-flow channel has other operation optimum, thus its shape is calculated and tuned on different parameters. By this modification was significantly decreased machine sensitivity to flow change and was widened its operating spectrum in the way that it has flat characteristic at conservation of relatively high efficiency.

Description of the figures on enclosed drawings

A particular example of the invention design is schematically illustrated on enclosed drawings, where

fig.1 illustrates five blades impeller crosscut in ground plan view and

fig.2 illustrates a crosscut of six blades impeller alternative design in ground plan view

Examples of the invention design

An impeller of hydraulic machines is created with a supporting disc 1, on its upper surface are set blades 2 creating through-flow channels 3. Particular blades 2 are corresponding with required parameters for the machine operating and are set on the supporting disc 1 irregularly and create so called irregular cascade. The blades 2 are constructed individually and on the supporting disc 1 and are set in a way that either each flow-through channel 3 or some of flow-through channels 3 have different shape thus are tuned for other optimal parameters. The shape of the flow-through channels 3 is dependent on a blade angle J3, which is possible to change along he the whole length L of the blade 2 from an inlet angle β_i on an inlet edge 21_of the blades 2 to an outlet angle β_2 on an outlet edge 22 of the blades 2, which results in the change of a wrapping angle y. between the inlet edge 21 and the outlet edge 22 of the blade 2. A different shape of the flow-through channels 3 is also possible to reach with the change of an inlet pitch t between the inlet edges 21 of the blades 2 and the outlet spacing T between the outlet edges 22 of the blades 2. The basic criteria for the construction of the irregular cascade of the blades 2 are maximal values of their basic parameters

, which compare to even set of the blade grating, are in relations:

$\beta_{imax} = \beta_i \pm 20°$

$\beta_{2max} = \beta_2 \pm 20°$

$Y_{max} = Y \pm 20°$

$t_{max} = t \pm 20\% \ t$

$T_{max} = T \pm 20\% \ T$

The impeller on the enclosed **fig.** 1 is an example of five blades irregular cascade, where couple of the blades 2A and 2B set by turns are of the same shape and the fifth blade 2C is different in construction, concretely is significantly shorter and creates the flow-through channels 3 with far bigger outlet pitch T.

Described solution is not the only possible solution of the blades 2 irregular cascade of the impeller, but generally the blades 2 can be constructed and set on the supporting disc 1 in the way that their inlet edges 21 do not lay at all the blades 2 on one inlet diameter d at homothetic points of the impeller and eventually their outlet edges 22 do not lay at all the blades 2 on same diameter D of the impeller at homothetic points. Likewise the number of the blades 2 of the impeller can be different and varies in the range from 3 to 18. An example of six blades impeller is then illustrated in the fig. 2.

Above mentioned solution concerns both impeller with supporting or covering disc with applications in water turbines and in classic pumps but also turbines and pumps only with supporting disc and also of special centrifugal pumps for example with shortened or other way adjusted disc.

Industrial use

The impeller with irregular cascade of the blades according to the invention is possible to use for hydraulic centrifugal pumps and water turbines.

PATENT CLAIMS

1. An impeller of hydraulic machines created with a supporting disc (1) procured with blades (2) creating through-flow channels (3), **wherein** the blades (2) are in diameter direction on the supporting disc (1) set irregularly and are created in the way that at least on of the through-flow channels (3) has different shape and different through-flow crosscut.

2. The impeller according to the claim 1, **wherein** the particular blades (2) of an irregular blade cascade are created in the way that their basic parameters an inlet angle (βi), an outlet angle (β_2) and a wrapping angle *(y)* are in relation

$$\beta_{imax} = \beta i \pm 20°$$

$$\beta_{2max} = \beta_2 \pm 20°$$

$$Y_{max} = Y \pm 20°.$$

3. The impeller according to the claim 1 or 2, **wherein** the size of inlet pitch (t) on inlet edges (21) and outlet spacing (T) on outlet edges (22) of the blades (2) are in relation

$$t_{max} = t \pm 20\%t$$

$$T_{max} = T \pm 20\%T.$$

4. The impeller according to some of the claims 1 to 3, **wherein** the inlet edge (21) of at least one blade (2) lays on another than an inlet diameter (d) of the impeller.

5. The impeller according to some of the claims 1 to 4, **wherein** the outlet edge (22) of at least one blade (2) lays on another than an outlet diameter (D) of the impeller.

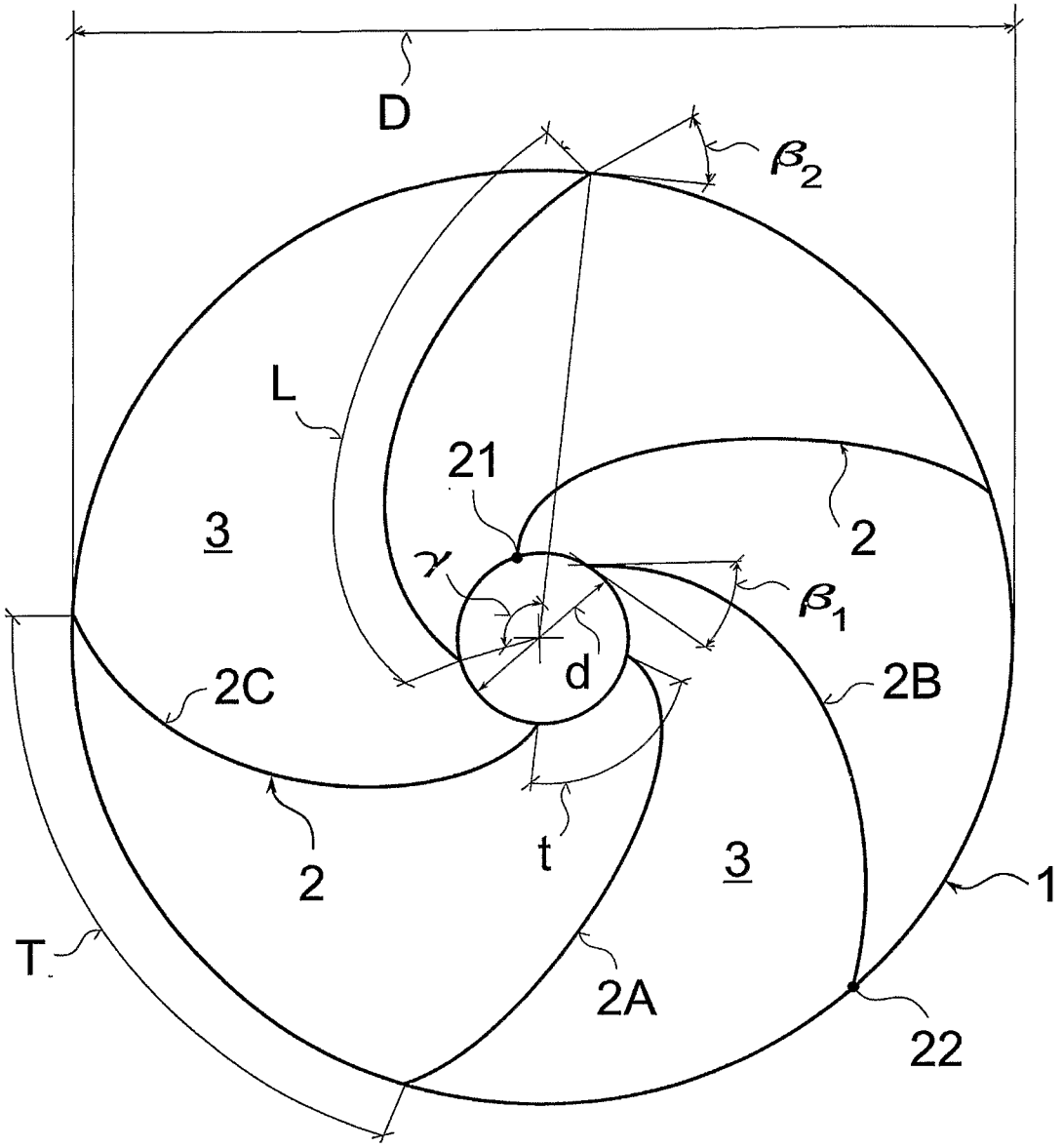

FIG. 1

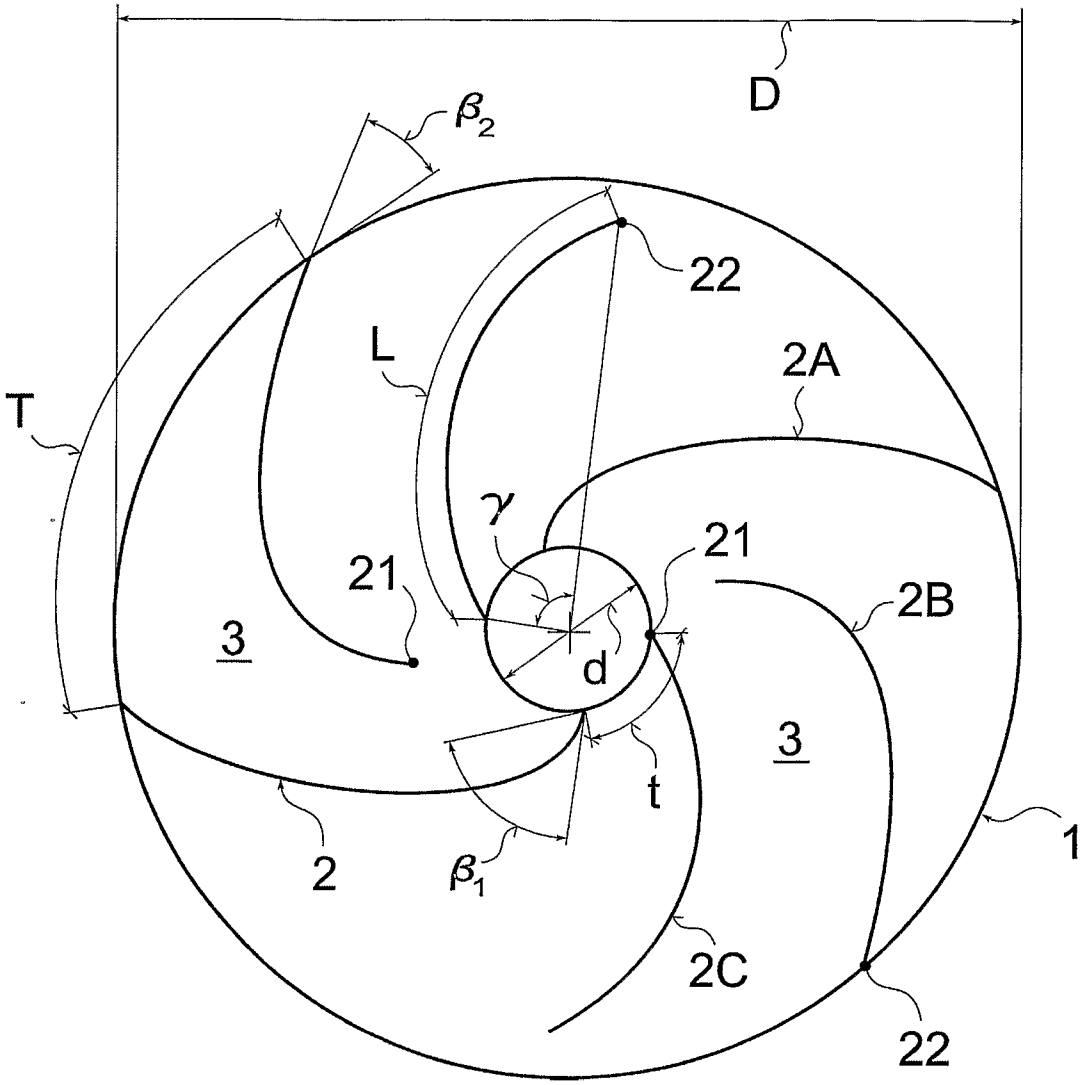

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. F04D29/22 F04D29/24 F04D29/66

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 practical, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X	DE 44 18 662 Al (GRUNDFOS AS [DK]) 30 November 1995 (1995-11-30) the whole document claims 1-4; figures 1-4	1-5
X	US 912 362 A (CAPELL G.M.) 16 February 1909 (1909-02-16) the whole document figures 1,3	1-5
X	US 2004/202539 Al (BLANK ANDREAS CDE] ET AL) 14 October 2004 (2004-10-14) the whole document figure 1	1-5

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[X] Further documents are listed in the continuation of Box C

[X] 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

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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
8 March 2010	16/03/2010

Name and mailing address of the ISA/	Authorized officer
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International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
A	EP 1 249 615 A2 (BOSCH GMBH ROBERT [DE]) 16 October 2002 (2002-10-16) the whole document claims 1,6; figure 3 -----	1-5
A	EP 0 676 546 Al (CARRIER CORP [US]) 11 October 1995 (1995-10-11) figure 4 -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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