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(11) **EP 1 193 369 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
03.04.2002 Bulletin 2002/14

(51) Int Cl.7: **F01D 1/02, F01D 9/02,
F04D 5/00, F04D 23/00**

(21) Application number: **00919186.7**

(86) International application number:
PCT/RU00/00132

(22) Date of filing: **14.04.2000**

(87) International publication number:
WO 00/70189 (23.11.2000 Gazette 2000/47)

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

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(30) Priority: **12.05.1999 RU 99109484**
02.09.1999 RU 99119419

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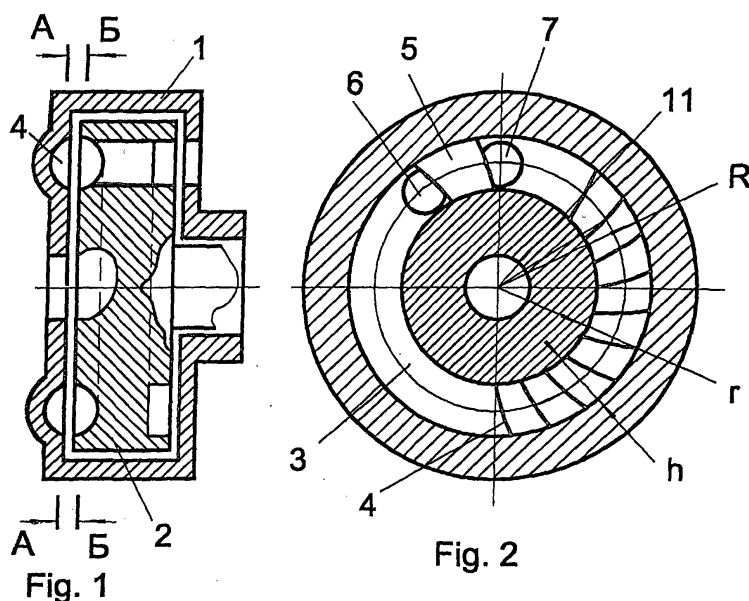
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(54) **ROTARY EDDY MACHINE**

(57) The rotary-vortex machine contains stator (1) and rotor (2). The rotor and stator form between them torus-type working cavity (3), which has blades (4) and separator (5) connected accordingly to the stator and rotor. The working cavity is connected to channel (6) to supply the working medium, arranged in the rotor, and to channel (7) for removal of the working medium. A sec-

tion width of the working cavity is equal to a difference of the maximum and minimum radii of the working cavity determined accordingly as a distance from the axis to the most remote point of the working cavity and distance from the axis to the nearest point. A ratio of the maximum radius of the working cavity (R) to its section width (h) is no less than 4.5 and no more than 9.5.



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Description

Field of Engineering

[0001] The present invention relates to the engineering industry field and can be used in pumps, compressors and engines.

Prior Engineering Level

[0002] A rotary-vortex machine is known, containing a stator and rotor having a working torus-type cavity between them, comprising blades and a separator connected respectively to the stator and rotor and the working cavity is connected to a channel to supply the working medium arranged in the rotor and a channel for removal of the working medium. Its section width is equal to a difference of maximum and minimum radii of the working cavity, determined accordingly as a distance from the axis to the most remote point of the working cavity and a distance from the axis to the nearest point (See published Application No. W098/46886, cl. F01D 9/02, F04D 5/00, 1998).

[0003] A shortcoming of the indicated machine is a low efficiency caused by considerable volumetric and hydraulic losses caused by leaks from the working cavity through slit clearances between the rotor and stator, transfer of the working medium from the section with high pressure to the section with low pressure through the working cavity, low intensity of vortex formation at the inlet of the working medium to the working cavity and hydraulic losses of the vortex flow in the working cavity.

Invention Object

[0004] The object of the present invention is to provide means for increasing the machine efficiency at the expense of reduction of total volumetric and hydraulic losses by optimization of the ratio of the maximum radius to a width of the working cavity section effecting the values of leaks from the working cavity through slit clearances between the rotor and stator, transfer of the working medium from the section with high pressure to the section with low pressure through the working cavity, intensity of vortex formation at the inlet to the working cavity and hydraulic losses of the vortex flow in the working cavity.

[0005] The assigned objective is accomplished by the fact that in the rotor-vortex machine containing the rotor and stator having a torus-type working cavity between them, containing blades and separator, connected accordingly with the stator and rotor and the working cavity is connected to a channel to supply the working medium, arranged in the rotor and channel for removal of the working medium and its section width is equal to a difference of the maximum and minimum radii of the working cavity, determined accordingly as a distance from the axis to the most remote point of the working cavity

and a distance from the axis to the nearest point, in compliance with the invention a ratio of the minimum radius of the working cavity with its section width is no less than 4.5 and no more than 9.5.

[0006] In addition, it is expedient that an angle of setting the blades is within the limits from 0° to 26° and every blade has a front edge faced to the rotor with a direction angle within the limits from 20° to 70° . A sum of setting angles of blades and direction of the front edge should be no less than 22° and no more than 94° .

[0007] This will provide the increase of efficiency of the machine at the expense of reduction of hydraulic losses of the vortex flow of the working medium in the working cavity and reduction of transfer of the working medium from the section of the working cavity with high pressure through a clearance between the blades and separator and through the working cavity in arrangement of values of the front edge direction angle and blade setting angle simultaneously close to their boundary values.

Brief Description of Drawings Figures

[0008] Fig. 1 presents a meridian section of the rotor-vortex machine with blades arranged in one plane.

[0009] Fig. 2 presents the lateral section of the machine presented in Fig. 1 in plane A-A.

[0010] Fig. 3 presents a section of the machine presented in Fig. 1 in plane B-B (enlarged).

[0011] Fig. 4 presents a meridian section of an alternative embodiment of a rotor-vortex machine with front edges of blades arranged on the cylinder surface.

[0012] Fig. 5 presents a lateral section of the machine presented in Fig. 4 in plane B-B.

[0013] Fig. 6 presents a section of the machine presented in Fig. 5, with cylinder plane $\Gamma-\Gamma$ (enlarged).

[0014] Fig. 7 presents a lateral section of a blade presented in Figs 3 and 6, plane E-E passing through the center of its front edge, perpendicular to its meridian plane and chord connecting the ends of the front edge.

Preferred Embodiment of Invention

[0015] The rotary-vortex machine consists of stator 1 and rotor 2 having torus-type working cavity 3 between them. Contours of the working cavity (in the plane perpendicular to the machine axis) and contour of the working cavity section (in the meridian plane passing through the longitudinal axis of the machine plane) can be made round or with insignificant deviations from the round form (oval). The working cavity incorporates blades 4 and separator 5 connected accordingly to stator 1 and rotor 2.

[0016] The working cavity has connection to channel 6 to supply the working medium, arranged in the rotor, and to channel 7 for removal of the working medium.

[0017] Maximum radius (R) of the working cavity is equal to a distance from the machine axis to the most

remote point of the working cavity; minimum radius (r) is equal to a distance from the machine axis to the nearest point of the working cavity; width (h) of the working cavity is equal to difference ($R-r$) of the maximum and minimum radii.

[0018] Ratio (R/h) of the maximum radius of the working cavity to its section width is no less than 4.5 and no more than 9.5 ($9.5 \geq R/h \geq 4.5$).

[0019] Every blade 4 (See Figs 6 and 7) has front edge 8 faced to rotor 2 and arranged on crossing of surface 9 of blade 4 and median secant of surface 10 of blade 4. Median secant surface 10 of blade 4 is a surface dividing in two parts a distance between the concave and convex sections of the blade surfaces counted over the normal to these surfaces. Median secant 10 of blade 4 can be arranged as a geometric place of centers of spheres arranged between the indicated parts of the blade surface. Angle α of the blade front edge direction, i. e. angle between meridian plane 11 passing through center 12 of front edge 8 and tangent line 13 to middle line 14 of the lateral section of blade 4 in the crossing point of middle line 14 with front edge 8 (in center 12) is no less than 20° and no more than 70° . Middle line of the lateral section is the line of crossing the median secant surface 10 of blade 4 and plane passing through center 12, perpendicular to meridian plane 11 and chord 15 connecting the opposite ends of front edge 8. Angle β of setting the blades, i. e. angle between chord 15 and meridian plane 11, passing through center 12 of front edge 8 is no less than 0° and no more than 26° . A sum of angles α and β should be no less than 22° and no more than 94° ($22^\circ < \alpha + \beta < 94^\circ$).

[0020] In operation of the rotor-vortex machine in the engine mode the working medium flow is fed through channel 6 to working cavity 3, where under the effect of torus-type sections of the surface of the stator and rotor and blades acquires a vortex form, excluding a potentiality of its free flow over the working surface to channel 7. As a result separator 5 is under effect of the working medium pressure differential and rotor 2, to which the separator is connected, performs revolving motion, which is applied to the machine shaft.

[0021] In operation of the machine in the mode of a pump or compressor with rotation of rotor 2 the working medium under effect of separator 5, blades 4 and torus-type sections of the surface of the stator and rotor acquires the vortex form motion. Such a motion of the working medium guards against its free flowing over the working cavity in the direction of rotation of the rotor from channel 6 to channel 7. As a result the vortex-form flow of the working medium is fed by the separator to channel 7, and through channel 6 a new quantity of the working medium is sucked in the working cavity.

[0022] Change of a ratio (R/h) of the maximum radius of the working cavity of the machine to its section width, for example to the side of increase, is connected with increase of the maximum radius of the working cavity (under condition of remaining the consumption charac-

teristic of the machine) and results from one side in the increase of leaks from the working cavity through slit clearances between the rotor and stator, at the expense of increase of the area of the passage section of the slit clearance between the rotor and stator, and from the other side - in reduction of leaks of the working medium from the section with high pressure to the section with low pressure over the working cavity at the expense of increase of the working cavity length. In addition increase of R results in the increase of the centrifugal acceleration applied to the working medium by the rotor and thus in more intensive vortex formation at the inlet of the working medium to the working cavity, which finally results in reduction of the working medium transfer over the working cavity. Experimental data showed that accomplishment of $9.5 \geq R/h \geq 4.5$ is optimal with regard to the ratio of indicated characteristics, as well as optimal with regard to hydraulic losses of the vortex flow at the expense of friction of the working medium against the blades, rotor and stator.

Claims

1. A rotary-vortex machine, containing a stator and rotor having a working torus-type cavity, comprising blades and a separator connected respectively to the stator and rotor and the working cavity is connected to a channel to supply the working medium arranged in the rotor and a channel for removal of the working medium. Its section width is equal to a difference of maximum and minimum radii of the working cavity, determined accordingly as a distance from the axis to the most remote point of the working cavity and a distance from the axis to the nearest point, is **characterized by** the fact that a ratio of the maximum radius of the working cavity to its section width is no less than 4.5 and no more than 9.5.
2. The rotor-vortex machine in compliance with P. 1 is **characterized by** the fact that an angle of setting the blades is within the limits from 0° to 26° and every blade has a front edge faced to the rotor with a direction angle within the limits from 20° to 70° . A sum of setting angles of blades and direction of the front edge should be no less than 22° and no more than 94° .

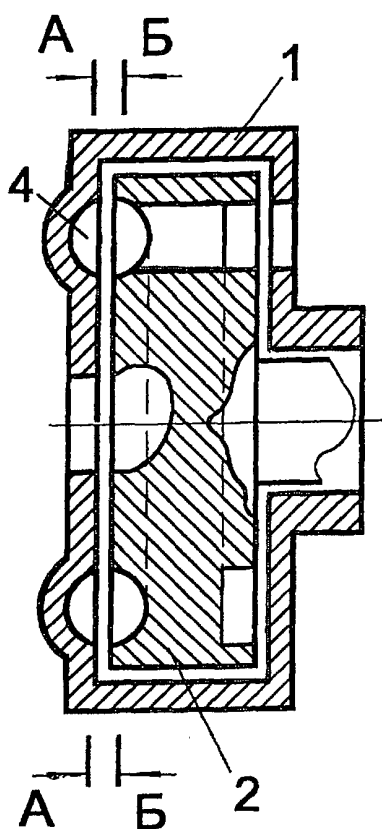


Fig. 1

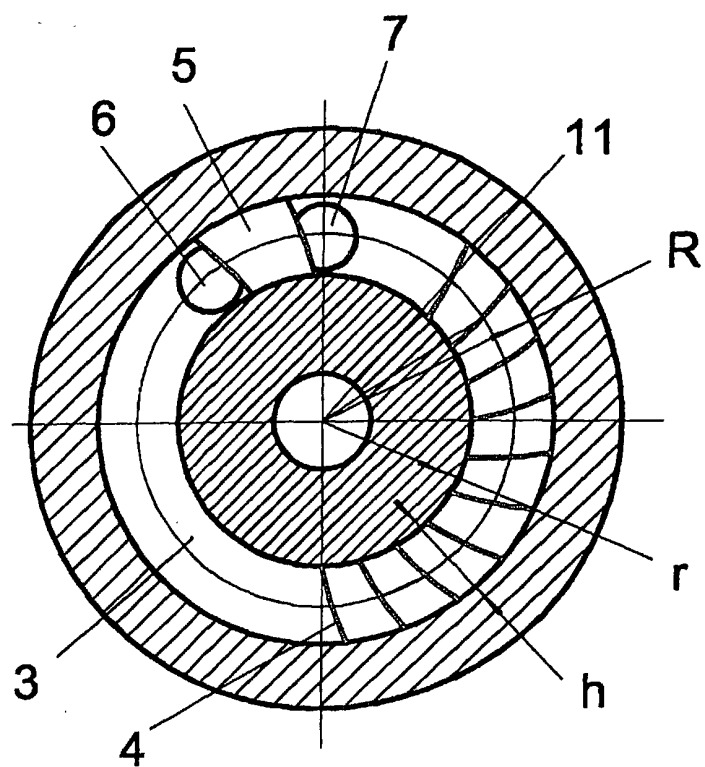


Fig. 2

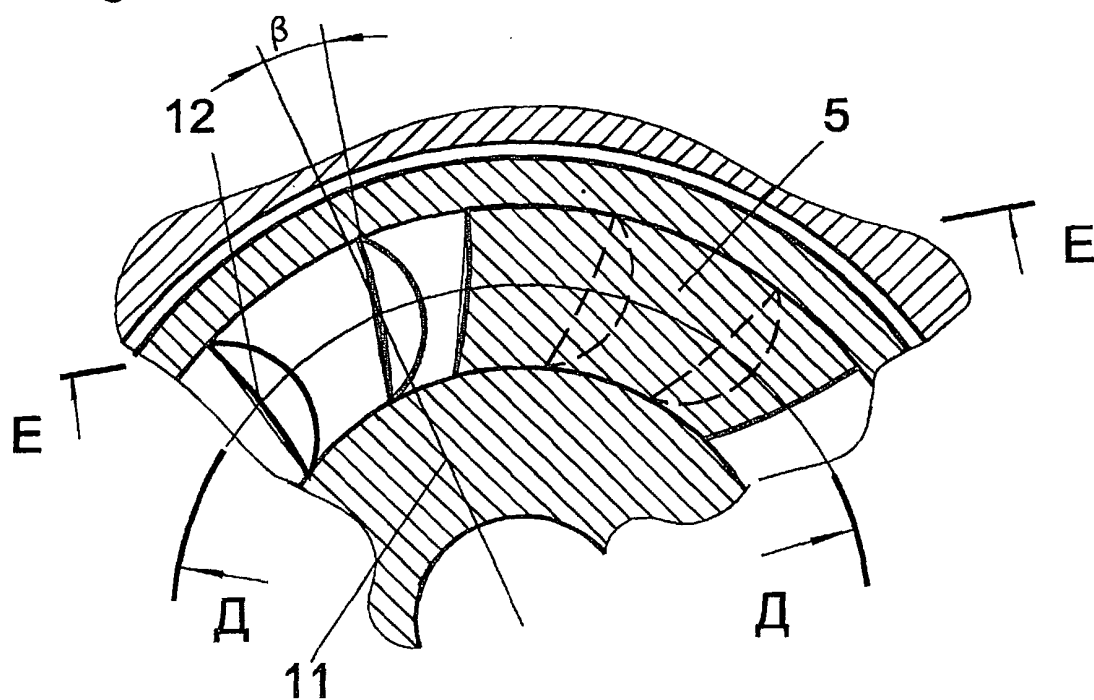
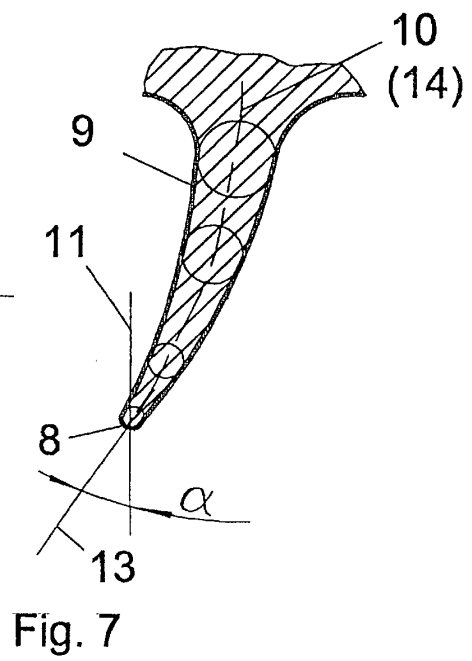
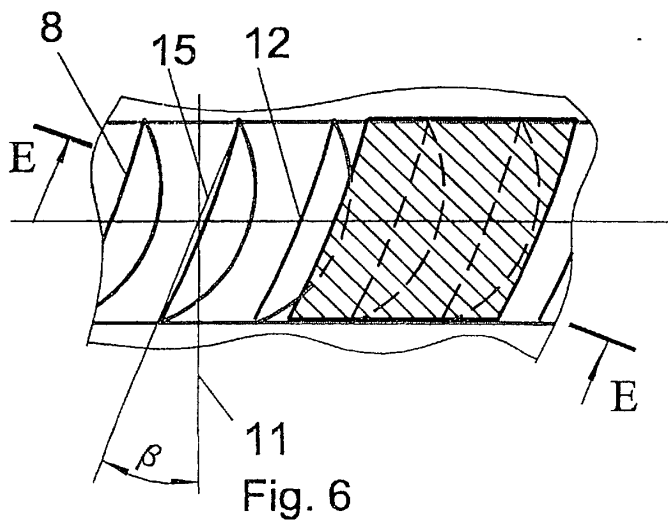
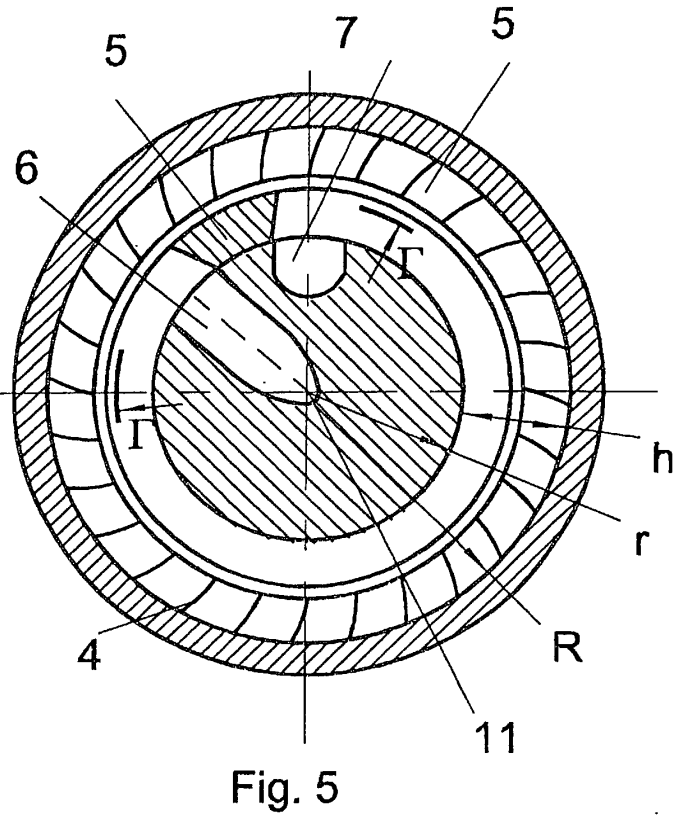
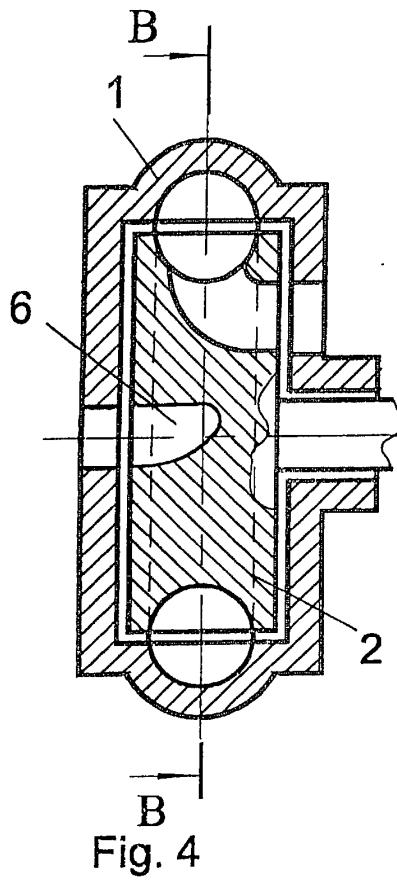


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/RU00/00132

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 F01D 1/02, 9/02, F04D 5/00, 23/00 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) IPC 7 F01D 1/00, 1/02, 9/00, 9/02, F04D 5/00, 23/00, 29/40-29/44 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)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 2121608 C1 (ANOKHIN VLADIMIR DMITRIEVICH et al) 10 November 1998 (10.11.98)	1-2
A	SU 1697596 A3 (V.D. ANOKHIN et al) 07 December 1991 (07.12.91)	1-2
A	US 4932833 A (WEBASTO AG FAHRZEUGTECHNIK) 12 June 1990 (12.06.90)	1-2
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 10 July 2000 (10.07.2000)		Date of mailing of the international search report 13 July 2000 (13.07.2000)
Name and mailing address of the ISA/ RU		Authorized officer
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Form PCT/ISA/210 (second sheet) (July 1992)