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(54) **Title**: ROTARY ATOMIZER TURBINE

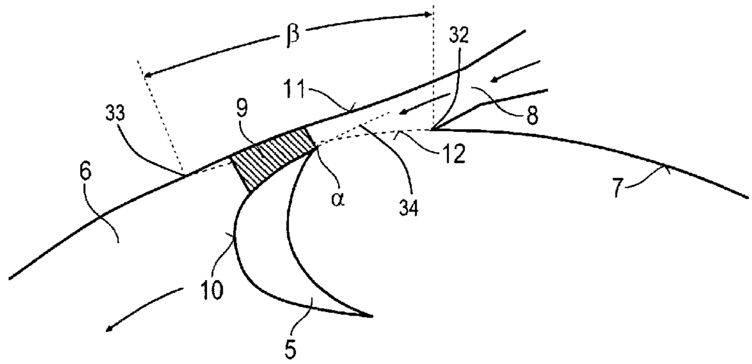

Fig. 4

(57) **Abstract**: A rotary atomizer turbine (1) designed as a radial turbine for driving a spraying body, in particular of a bell plate, in a rotary atomizer, having a turbine wheel (4) with multiple turbine blades (5), a blade duct (6) which contains the turbine blades (5) and is delimited radially at the outside by a duct wall (7), a braking air nozzle (13), a driving air nozzle (8) and an outlet region (9) at the outlet of the driving air nozzle (8), wherein the outlet region (9) is delimited at the outside by the duct wall (7) of the blade duct (6) and at the inside by the turbine blade (5) respectively passing through it. One aspect of the invention provides that the blade duct (6) is delimited radially at the inside opposite the braking air nozzle by a stationary flow barrier which prevents the braking air from exiting the blade duct (6) toward the inside in the radial direction. By contrast, a further aspect of the invention provides that the outlet region (9) of the individual driving air nozzles (8) is a divergent cross-sectional region (9) which widens in the flow direction and rotates with that turbine blade (5) which is passing the driving air nozzle (8).

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DESCRIPTION

ROTARY ATOMIZER TURBINE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of priority from German Patent Application No. 10 2015 000 551.0 (filed January 20, 2015), the contents of which are incorporated herein by reference in its entirety.

BACKGROUND

A rotary atomizer turbine may be designed as a radial turbine for driving a spraying body (for example a bell plate) in a rotary atomizer.

In modern painting installations for the painting of motor vehicle body components, the application of paint is normally performed using rotary atomizers in which a bell plate, as a spraying body, rotates at a high rotational speed of up to 80,000 revolutions per minute.

The bell plate is normally driven by a pneumatically driven turbine, which is normally in the form of a radial turbine, which supplies the driving air for driving the turbine in a plane oriented radially with respect to the axis of rotation of the turbine. A rotary atomizer turbine of said type is known for example from EP 1 384 516 B1 and DE 102 36 017 B3.

Typically, multiple turbine blades are arranged on a rotatable turbine wheel so as to be distributed over the circumference, which turbine blades are subjected to a flow of driving air by driving air nozzles in order to mechanically drive the rotary atomizer turbine.

Furthermore, the known rotary atomizer turbines also permit rapid braking of the rotary atomizer turbine, for example in the event of an interruption in painting operation. For this purpose, the turbine blades are subjected to a flow of braking air counter to the direction of rotation by a separate braking nozzle. However, said known rotary atomizer turbines are not optimal in various respects.

Firstly, the braking performance is not optimal, such that during a braking process, the rotary atomizer turbine comes to a standstill only after a certain run-down time.

Secondly, there is also the aim of increasing the drive power of the rotary atomizer turbine in order that the surface coating performance can be correspondingly increased. Specifically, to increase the surface coating performance, an increased paint flow (amount of paint per unit of time) must be applied, which in turn leads to a greater mechanical load on the rotary atomizer turbine and requires correspondingly increased drive power.

The technological background of the invention also includes DE 102 33 199 A1, DE 10 2010 013 551 A1 and US 2007/0257131 A1. However, these publications do no solve the problem of an unsatisfactory breaking power and drive power.

SUMMARY OF THE DISCLOSURE

The present disclosure is thus based on the object of providing a correspondingly improved rotary atomizer turbine.

Said object is achieved by means of a rotary atomizer turbine according to the present disclosure.

The present disclosure is based on newly obtained findings in the field of fluid dynamics with regard to the disadvantages of the known rotary atomizer turbines as mentioned in the introduction.

Accordingly, the unsatisfactory braking performance in the case of the known rotary atomizer turbines can, in part, be attributed to the fact that the braking air supplied via the braking air nozzle flows partially in a radial direction through the annularly encircling blade arrangement, and then no longer contributes to the braking action. That is to say, a portion of the braking air impinges on the front side of the turbine blades counter to the direction of rotation of the turbine blade, and thus exerts a braking action on the turbine wheel, which is desirable. By contrast, another portion of the braking air flows through the annularly encircling blade arrangement from the outside to the inside, and thus does not contribute to the braking action, or even additionally exerts a driving action on the turbine wheel.

One aspect of the present disclosure therefore makes provision for the braking air to be prevented from being able to flow from the outside to the inside through the annularly encircling blade arrangement. For this purpose, a flow barrier is provided which may be arranged in a stationary position opposite the braking air nozzle, wherein the flow barrier prevents the braking air that emerges from the braking air nozzle from being able to flow from the outside to the inside in the radial direction through the annularly encircling blade arrangement. The flow barrier thus prevents the braking air in the region of the braking air nozzle from emerging again from the blade duct, in which the individual turbine blades run, in the inward direction.

The flow barrier may for example be a simple annularly encircling plate which is arranged at the inside on the blade duct, opposite the braking air nozzle.

The flow barrier is preferably stationary, that is to say the flow barrier does not rotate together with the turbine wheel.

It may for example be provided that the flow barrier in the region of the braking air nozzle extends in the circumferential direction over an angle of 5°-90°, specifically, for example, an angle of 30°-40° (and more specifically, for example, approximately 33°).

In this context, it must be mentioned that the turbine wheel may be open in a radial direction over a part of its circumference, such that the driving air from the driving air nozzles can flow in the radial direction from the outside to the inside through the annularly encircling blade arrangement in the open part of the turbine wheel, as is also the case in the conventional rotary atomizer types described in the introduction. It is therefore expedient for the flow barrier to extend in the circumferential direction only over the region of the braking air nozzle, in order that the flow barrier impedes the driving air to the least possible extent.

The open form of the turbine wheel mentioned above may for example be realized by virtue of the turbine wheel having a disc, from one side of which the turbine blades project in an axial direction into the blade duct. It is thus possible for the driving air to flow from the outside to the inside through the annularly encircling blade arrangement of the turbine blades.

It is however alternatively also possible for the turbine wheel to have two parallel rotating discs, axially between which the individual turbine blades are arranged. The turbine wheel can thus also be closed on both sides.

Furthermore, the present disclosure is based on findings in the field of fluid dynamics that the unsatisfactory drive power of the known rotary atomizer turbines arises, in part, from the fact that a convergent-divergent flow duct is formed downstream of each of the individual driving air nozzles at the outlet of the driving air nozzles, giving rise to an intense, high-loss compression shock owing to the fact that the flow passes into the subsonic state there. Said convergent-divergent flow duct is typically formed at the outside by the duct wall of the blade duct and at the inside by the encircling front side of the respective turbine blade. Owing to the intense curvature of typical individual turbine blades, the driving air flow thus passes initially through a convergent region, in which the flow cross section between the arched front side of the turbine blade and the duct wall of the blade duct narrows. The driving air flow then subsequently passes through a divergent region in which the flow cross section between the intensely arched front side of the respective turbine blade and the duct inner wall widens. A convergent-divergent flow profile of said type corresponding to a de Laval nozzle is however undesirable owing to the abovementioned disruptive compression shocks.

The present disclosure therefore provides that an outlet region of the individual driving air nozzles between the duct wall of the blade duct and the respective turbine blade runs in an exclusively divergent manner, such that the cross-sectional region widens in the flow direction and rotates with that turbine blade which is presently passing the outlet region of the driving air nozzles. This aspect of the invention thus targetedly prevents a convergent-divergent flow duct from forming in a supersonic flow at the outlet of the individual driving air nozzles downstream of the respective driving air nozzle. In the case of the rotary atomizer turbine according to the present disclosure, therefore, it is thus advantageously the case that no convergent cross-sectional region is provided downstream of the driving air nozzle.

The divergent cross-sectional area preferably forms an output-side part of a Laval nozzle, which rotates with the turbine wheel. The upstream portion of the Laval nozzle is then preferably formed by the driving air nozzle which then narrows in the direction of flow (converges). The Laval nozzle then consists of a revolving nozzle part (i.e. the divergent cross-sectional area) and a stationary nozzle part (i.e. the driving air nozzle).

In the divergent cross-sectional area, the flow be accelerated and the pulse is increased again, whereas - as in the prior art shown in Figure 6 - (i.e. narrowing in the flow direction) a convergent cross-sectional area would produce a disturbing shock wave.

The Laval nozzle generates in this case preferably a supersonic flow, at least in the downstream, divergent nozzle portion, but optionally also in the upstream convergent nozzle portion. This is a fundamental difference to a subsonic flow, such as in a diffuser, as in US 2007/0257131 A1. According to the invention, a super-sonic flow preferably enters the divergent cross-sectional area where the flow velocity is further increased.

This is achieved by means of a suitable curvature of the individual turbine blades and by means of a corresponding design of the blade duct in the outlet region of the individual driving air nozzles.

In an exemplary embodiment of the present disclosure, the divergent cross-sectional region of the outlet region of the individual driving air nozzles widens in the flow direction with an angle of at least 2°, 4°, or even at least 6°.

The divergent cross-sectional region may extend in the circumferential direction over an angle of more than 5°, 10°, 15°, 20°, or even 30°.

It has already been mentioned above that the exclusively divergent cross-sectional region may be realized, *inter alia*, by means of a suitable design of the duct wall of the blade duct. In the exemplary embodiment of the present disclosure, the duct wall of the blade duct therefore has, in the outlet region of the driving air nozzle, an outwardly arched recess for forming the divergent cross section. The expression "arched recess" is in this case to be understood in relation to an ideal circular circumference of the duct wall, wherein the arched recess deviates outwardly from the ideal circular circumference of the duct wall in order to form the divergent cross section.

In the exemplary embodiment, said arched recess in the duct wall of the blade duct is concave and extends in the circumferential direction over an angle of 10°-90°, for example, an angle of 40°-50°. It is important here that the arched recess, on the one hand, and the arched front side of the individual turbine blades, on the other hand, together form a divergent cross section which rotates with the rotation of the turbine wheel.

It has already been briefly mentioned above that the individual turbine blades are each curved in a radial direction, such that the outer end of the turbine blades is directed counter to the direction of rotation of the turbine wheel. The individual turbine blades may then, in each case with their front side at the outer end of the turbine blades, enclose a particular angle with the outer circular circumference of the blade duct, wherein said angle may be at least 2°, 5°, or even at least 10°.

The turbine according to the invention is preferably adapted to be driven by pressurized air with an air pressure of 6 bar which is the standard air pressure in painting installations. It should be noted that the improved efficiency of the atomizer according to the invention allows more operations (i.e. different values of rotary speed, paint flow rate, etc.) with the standard air pressure of 6 bar without the need for an increased air pressure. However, the turbine can alternatively be adapted to be driven by pressurized air with an air pressure of 8 bar.

In any case, the invention allows a higher driving power compared with conventional atomizer turbines. This in turn allows higher flow rates of the paint. For example, the rotary speed of the atomizer can be higher than 10,000 rpm, 20,000 rpm, 50,000 rpm or even higher than 60,000 rpm. Further, the flow rate of the paint applied by the atomizer can be higher than 200 ml/min., 300 ml/min., 400 ml/min., 500 ml/min. or even higher than 600 ml/min..

It must also be mentioned that the present disclosure does not only include the above-described rotary atomizer turbine according to the present disclosure as an individual component. Rather, the present disclosure also includes a complete rotary atomizer with a rotary atomizer turbine of said type.

DRAWINGS

Other advantageous refinements of the present disclosure are explained in more detail below together with the description of the exemplary embodiments of the present disclosure on the basis of the figures, in which:

Figure 1 shows a side view of a rotary atomizer turbine,

Figure 2 shows an exploded side view of the rotary atomizer turbine from Figure 1,

Figures 3A-3F are schematic illustrations of the divergent cross-sectional region at the outlet of the driving air nozzles for different, successive angular positions of the turbine wheel,

Figure 4 is a detail illustration of the divergent cross-sectional region,

Figure 5 shows a cross-sectional view illustrating a flow barrier opposite the braking air nozzle,

Figure 6 is a schematic illustration of the disruptive convergent-divergent cross-sectional region in the case of the prior art.

DETAILED DESCRIPTION

Referring to Figures 1-2, a rotary atomizer turbine 1 for driving a bell plate according to the present disclosure is shown, which rotary atomizer turbine 1 may be screwed onto a bell plate shaft 2, wherein the bell plate shaft 2 rotates about an axis of rotation 3 during operation.

The bell plate shaft 2 bears a turbine wheel 4, i.e., the turbine wheel 4 is mounted to the bell plate shaft 2. Numerous turbine blades 5 are attached to the turbine wheel 4 so as to be distributed over the circumference and project axially from the turbine wheel 4, e.g., the turbine blades 5 are formed on a side of the turbine wheel 4. The turbine wheel 4 presents a circular disk 17 extending to a peripheral rim. The turbine blades 5 extend radially relative to the axis 3 and are spaced annularly about the circular disk 17. The individual turbine blades 5 project in this case into a blade duct 6 (shown in Figures 3A-5), which is delimited radially at the outside by an annularly encircling duct wall 7.

The housing 16 of the rotational atomizer turbine 1 has several housing parts, as shown in Figures 1 and 2. The rotary atomizer turbine 1 includes a first end component 25, a nozzle ring 26, a distance ring 27 and a second end component 28. The first and second end components 25, 28, the nozzle ring 26 and the distance ring 27 are axially and radially coupled to one another, e.g., with fastening pins 30, about the bell plate shaft 2 to for a housing assembly for the rotary atomizer turbine 1, such that the bell plate shaft 2 may rotate about the axis 3 when encased in the housing (Figure 1). The nozzle ring 26 surrounds the turbine wheel 4, as shown in Figure 5, so that the interior of the nozzle ring 26 forms a cylindrical turbine chamber 25, in which the turbine wheel 4 is rotated.

Multiple driving air nozzles 8 issue into the blade duct 6 from the outside, as can be seen from Figures 3A-3F and 4. The air nozzles 8 are defined in the nozzle ring 26. It should be understood that the nozzle ring 26 may define any suitable number of air nozzles 8. The individual driving air nozzles 8 each discharge a driving air flow substantially tangentially, in the direction of the arrow shown in Figures 3A-5, into the blade duct 6 in order to rotate the turbine wheel 4. In this case, at the outlet region of the driving air nozzles 8, the driving air flows initially through a divergent cross-sectional region 9.

The divergent cross-sectional region 9 is formed at the inside by an arched front side 10 of the turbine blade 5 that is presently passing through and at the outside by an arched recess 11 in the duct wall 7. The divergent cross-sectional region 9 thus rotates in the direction of rotation with that turbine blade 5 which is respectively presently passing the outlet region of the respective driving air nozzle 8.

By contrast to the known rotary atomizers described in the introduction, however, no convergent-divergent cross-sectional region similar to a de Laval nozzle is formed at the outlet of the individual driving air nozzles 8, because this would lead to high-loss compression shocks. The absence of such a disruptive convergent-divergent cross-sectional region thus advantageously leads to an increase in drive power of the rotary atomizer turbine 1 according to the present disclosure.

Referring again to FIG. 2, of the pair of pins 30 may extend through openings defined in the first and second end components 25, 28, the nozzle ring 26 and the distance ring 27 to lock these parts together in assembled mode and prevent side movement of the first and second end components 25, 28, the nozzle ring 26 and the distance ring 27 relative to one another.

The annular intermediate chamber 12 is covered by the distance ring 27, to cover the opening in the mounted state.

The fixed nozzle itself is a Laval nozzle. This is characterized by a convergent channel which accelerates the flow to sonic speed up to the narrowest cross section. From the narrowest cross-section, the channel is divergent, whereby an acceleration to supersonic speed is carried out. The divergent channel between the housing and the blade is a supersonic nozzle when the flow enters at supersonic speed. This divergent channel between the housing and the rotating blade can also be viewed as an extension of the Laval nozzle.

Downstream of the individual driving air nozzles 8, the arched recess 11 extends in the circumferential direction in each case over an angle β in the range of 15°-30°. Specifically, as shown in Figure 4, the driving air nozzles 8 include an edge 32 and an end 33 spaced along the circumference of the duct wall 7, i.e., along an arc of the duct wall 7. The path of the circumference of the duct wall 7 across the air nozzle 8 from the edge 32 to the end 33, i.e., an ideal circumference of the duct wall 7, is identified with reference numeral 12 in Figure 4. The angle β extends along the path 12 from the edge 32 to the end 33. The angle β shown in Figure 4 is shown for example, and it should be appreciated that the angle β may be between 15°-30°, as set forth above.

With continued reference to Figure 4, the front side 10 of the individual turbine blades 5 encloses in each case, at its outer, free end 33, an angle α = 15°-30° with the path 12 of the circumference of the duct wall 7. Specifically, the tangent 34 of the front side 10 of the turbine blade 5 at the free end 33 is shown in Figure 4. The angle α is defined between the tangent 34 of the front side 10 and the path 12 of the circumference of the duct wall 7, as shown in Figure 4.

Referring to Figure 5, a braking air nozzle 13 opens out into the blade duct 6 in order to subject the turbine blades 5 to a flow of working air, wherein the braking air flow is directed counter to the direction of rotation of the turbine wheel 4.

In this case, at the inner side of the blade duct 6, there is situated a flow barrier 14 which prevents the braking air from the braking air nozzle 13 from simply flowing in a radial direction through the annularly encircling blade arrangement and then emerging from the blade duct 6 again at the inside. Referring in particular Figure 2, the flow barrier 14 is fixed to the distance ring 27, and extends axially toward the turbine wheel 4. When assembled, as shown, e.g., in Figure 1, the flow barrier 14 is radially inward of the turbine blades 5 and the blade duct 6. In this way, the braking air that emerges from the braking air nozzle 13 is retained within the blade duct 6 and thus contributes in a significantly more efficient manner to the braking of the turbine wheel 4.

The flow barrier 14 may extend in the circumferential direction over an angle of 20°-40°, wherein, in one example, an angle of 33° is preferred.

Finally, Figure 6 shows, for comparison, the outlet region of the driving air nozzle 8 in the case of a conventional rotary atomizer turbine. It can be seen from the drawing that, upstream of the divergent cross-sectional region 9, there is initially a convergent cross-sectional region 15. The convergent cross-sectional region 15 thus forms, together with the subsequent divergent cross-sectional region 9, a nozzle similar to a de Laval nozzle, which leads to undesired compression shocks, whereby the drive power of the rotary atomizer turbine is reduced.

It should be understood that the present disclosure is not restricted to the exemplary description herein. Rather, numerous variants and modifications are possible according to the principles of the present disclosure.

List of reference numerals:

1 Rotary atomizer turbine
2 Bell plate shaft
3 Axis of rotation of the bell plate shaft
4 Turbine wheel
5 Turbine blades
6 Blade duct
7 Duct wall of the blade duct
8 Driving air nozzles
9 Divergent cross-sectional region
10 Front side of the turbine blades
11 Arched recess in the duct wall
12 Ideal circular circumference without the arched recess
13 Braking air nozzle
14 Flow barrier
15 Convergent cross-sectional region
16 Housing
17 Circular disc
25 First end component
26 Nozzle ring
27 Distance ring
28 Second end component
32 Edge
33 End
34 Tangent

* * * * *

CLAIMS

1. Rotary atomizer turbine (1) designed as a radial turbine for driving a spraying body, in particular of a bell plate, in a rotary atomizer, having

a) a turbine wheel (4) which has multiple turbine blades (5) distributed over the circumference and which, during operation, rotates in a particular direction of rotation about an axis of rotation (3),

b) a blade duct (6) which is of encircling annular form coaxially with respect to the axis of rotation (3), contains the turbine blades (5) and is delimited radially at the outside by a duct wall (7),

c) at least one braking air nozzle (13) which opens out into the blade duct (6) from radially outside, in order to subject the turbine blades (5) to a flow of braking air counter to the direction of rotation for the purpose of braking the turbine wheel (4),

d) at least one driving air nozzle (8) which opens out into the blade duct (6) from radially outside, in order to subject the turbine blades (5) to a flow of driving air in the direction of rotation for the purpose of driving the turbine wheel (4), and

e) an outlet region (9) at the outlet of the driving air nozzle (8), wherein the outlet region (9) is delimited at the outside by the duct wall (7) of the blade duct (6) and at the inside by the turbine blade (5) respectively passing through it,

characterized

f) in that the blade duct (6) is delimited radially at the inside opposite the braking air nozzle (13) by a stationary flow barrier (14) which prevents the braking air from exiting the blade duct (6) toward the inside in the radial direction, and/or

g) in that the outlet region (9) of the individual driving air nozzles (8) is a divergent cross-sectional region (9) which widens in the flow direction and rotates with that turbine blade (5) which is passing the driving air nozzle (8).

2. Rotary atomizer turbine (1) according to Claim 1, **characterized in that** the flow barrier (14) in the region of the braking air nozzle (13) extends in the circumferential angle over an angle of greater than 5°, 10°, 20° or 30° and/or less than 90°, 70°, 50° or 40°.

3. Rotary atomizer turbine (1) according to one of the preceding claims, **characterized in that** the turbine wheel (4) is open in a radial direction at least over a part of its circumference, such that the driving air can flow in the radial direction from the outside to the inside through the turbine blades (5) in the open part of the turbine wheel (4).

4. Rotary atomizer turbine (1) according to one of the preceding claims, **characterized in that** the outlet region of the individual driving air nozzles (8) in each case does not have, upstream of the divergent cross-sectional region (9), a convergent cross-sectional region (15) which narrows in the flow direction and which rotates with that turbine blade which is presently passing the driving air nozzle (8).

5. Rotary atomizer turbine (1) according to one of the preceding claims, **characterized in that** the divergent cross-sectional region (9) of the outlet region of the driving air nozzle (8) widens in the flow direction with an angle of at

least 2°, 4° or 6°.

6. Rotary atomizer turbine (1) according to one of the preceding claims, **characterized**

a) in that the duct wall (7) of the blade duct (6) has, in the outlet region of the driving air nozzle (8), an outwardly arched recess (11) for forming the divergent cross section (9), and/or

b) in that the arched recess (11) is of concave form, and/or

c) in that the arched recess (11) in the duct wall (7) of the blade duct (6) extends in the circumferential direction over an angle (β) of at least 10°, 20°, 30° or 40° and at most 90°, 70°, 60° or 50°.

7. Rotary atomizer turbine (1) according to one of the preceding claims, **characterized in that** the individual turbine blades (5) are each curved in a radial direction such that the outer end of the turbine blade (5) is directed counter to the direction of rotation of the turbine wheel (4).

8. Rotary atomizer turbine (1) according to Claim 7, **characterized in that** the individual turbine blades (5), in each case by way of their front side (10) at the outer end of the turbine blade (5), enclose a particular angle (α) of at least 2°, 5° or 10° with the outer circular circumference of the blade duct (6).

9. Rotary atomizer turbine (1) according to one of the preceding claims, **characterized**

a) in that the driving air nozzle (8) is a de Laval nozzle, and/or

b) in that the turbine wheel (4) has a disk, from one side of which the turbine blades (5) project in an axial direction into the blade duct (6), and/or

10. Rotary atomizer having a rotary atomizer turbine (1) according to one of the preceding claims.

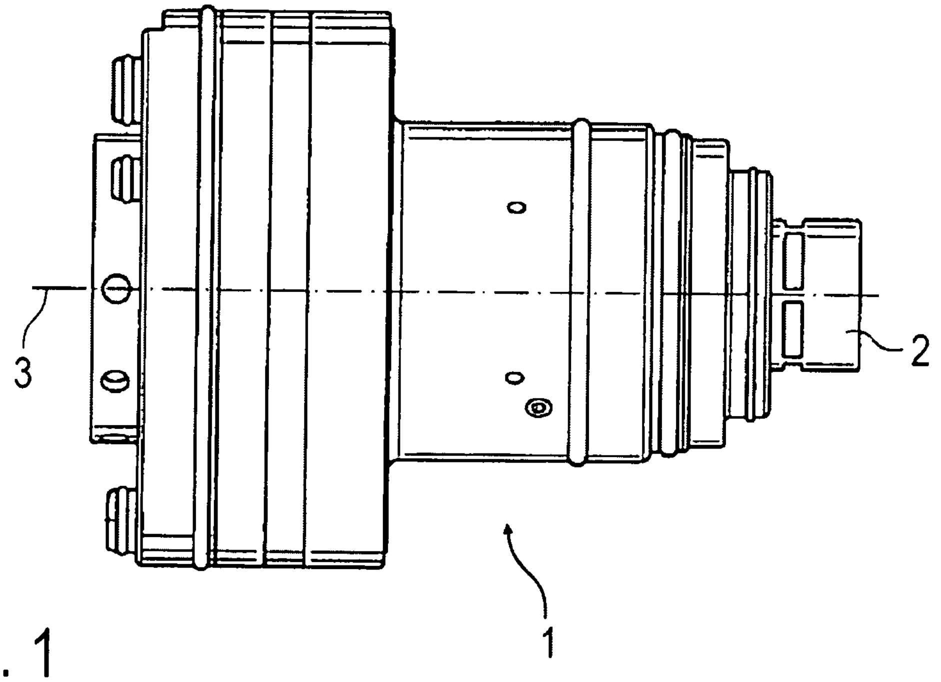

Fig. 1

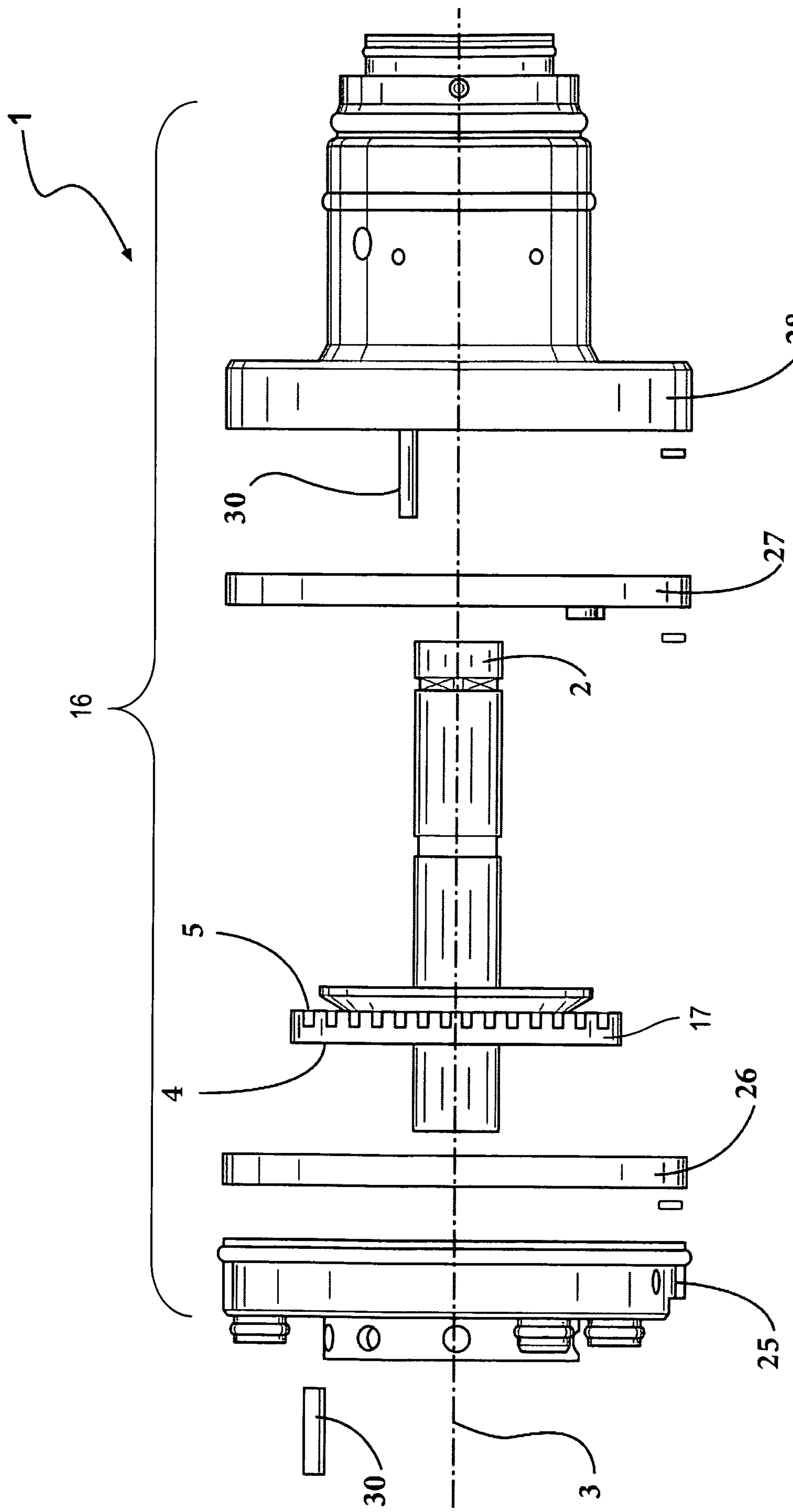

FIG. 2

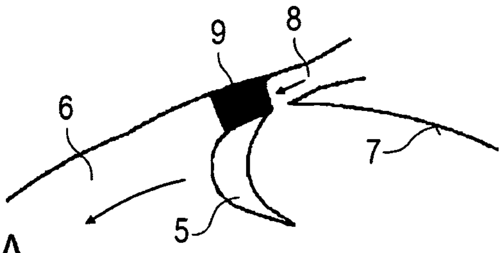

Fig. 3A

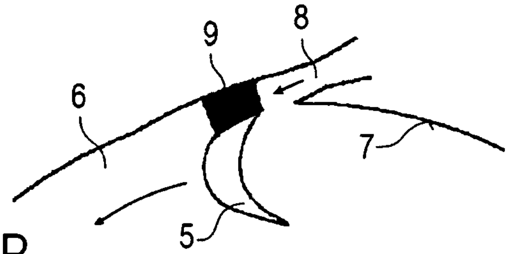

Fig. 3B

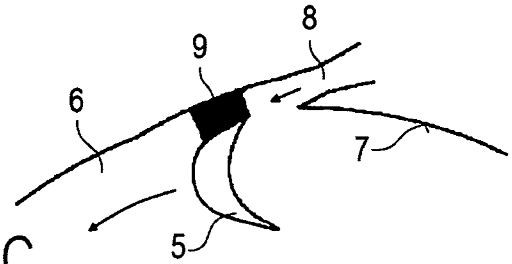

Fig. 3C

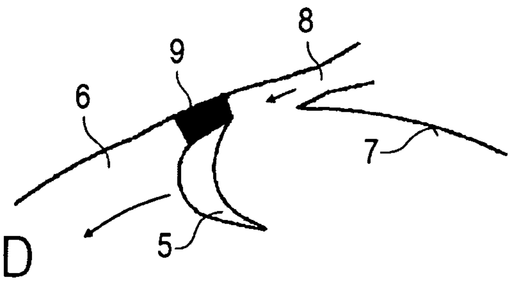

Fig. 3D

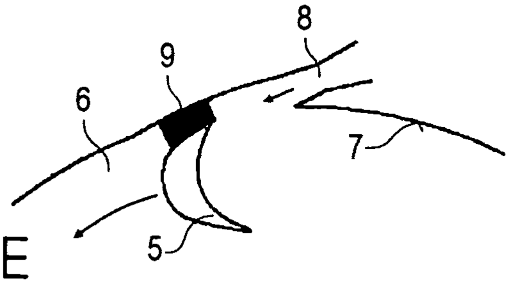

Fig. 3E

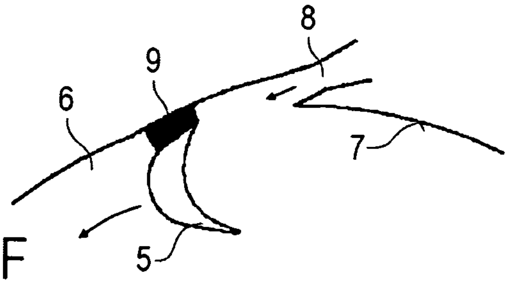

Fig. 3F

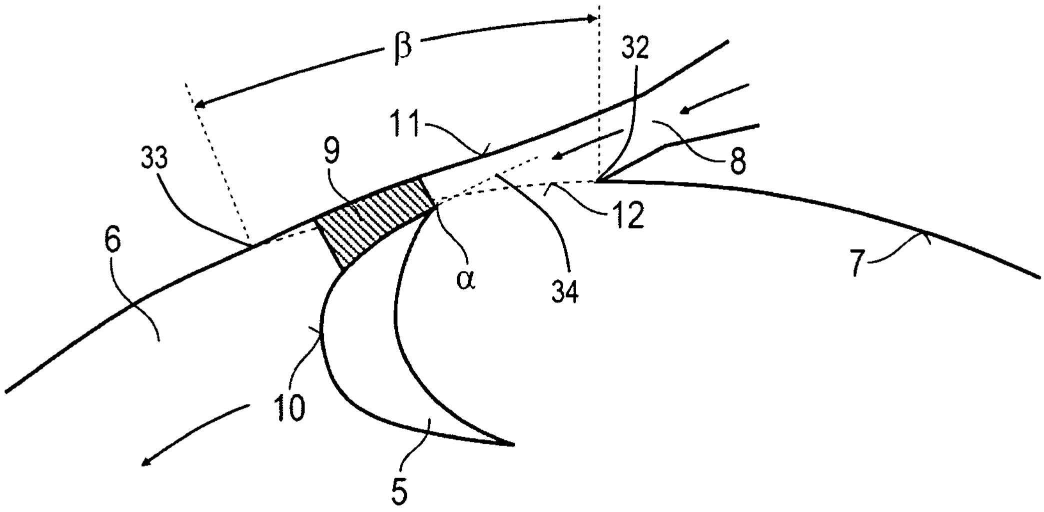

Fig. 4

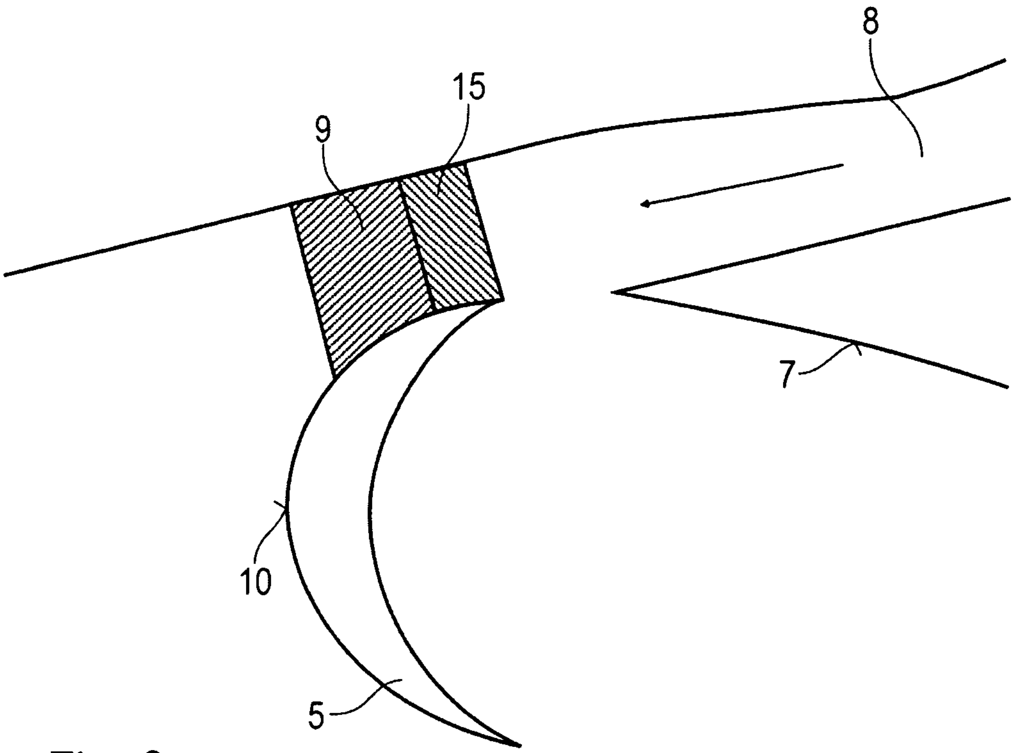

Fig. 6
Prior Art

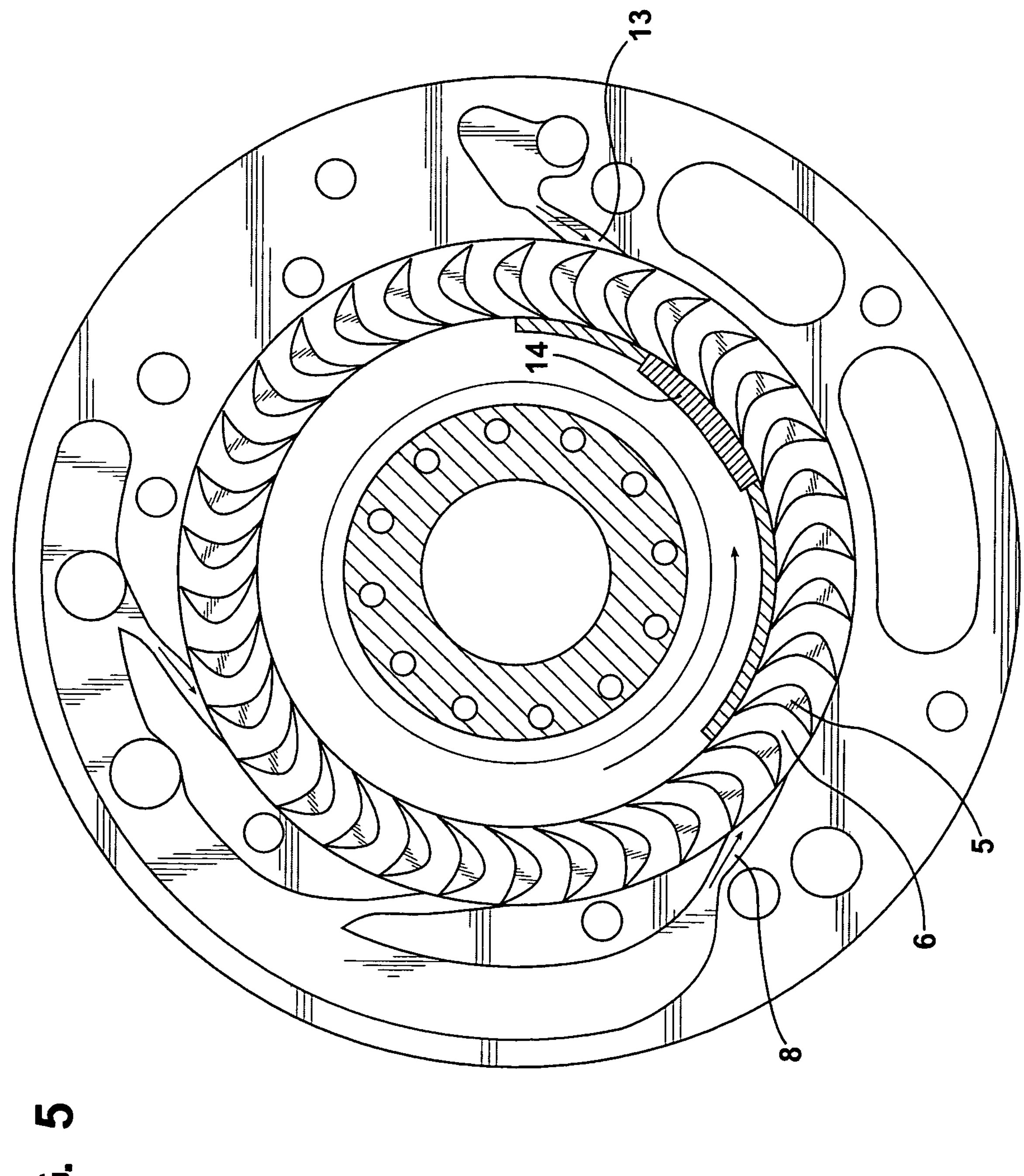

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/000101

A. CLASSIFICATION OF SUBJECT MATTER
INV. B05B3/10 B05B5/04
ADD.

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)
B05B F03B F01D

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)

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 Y	EP 2 505 778 A1 (NSK LTD [JP]) 3 October 2012 (2012-10-03) paragraph [0041] - paragraph [0054]; figures 1,2	1,5,7,10 1
Y	JP 2013 245607 A (NSK LTD) 9 December 2013 (2013-12-09) abstract; figures	1
Y	JP 2006 300024 A (NTN TOYO BEARING CO LTD) 2 November 2006 (2006-11-02) abstract; figures	1
	-/--	

[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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Date of the actual completion of the international search	Date of mailing of the international search report
17 March 2016	29/03/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Innecken, Axel

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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	DOTY F D ET AL: "HIGH-EFFICIENCY MICROTURBINE TECHNOLOGY", AEROSPACE POWER SYSTEMS. BOSTON, AUG. 4 - 9, 1991; [PROCEEDINGS OF THE INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE], NEW YORK, IEEE, US, vol. 2, 4 August 1991 (1991-08-04), pages 436-442, XP000280527, ISBN: 978-0-89448-163-5 figures 2,3 -----	1
A	FR 2 238 382 A5 (RHONE POULENC TEXTILE [FR]) 14 February 1975 (1975-02-14) page 3, line 17 - page 5, line 14; figures -----	1
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/000101

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			US	3926535	A	16-12-1975
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