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(54) **CENTRIFUGAL FAN.**

(57) A fan has a spiral-shaped casing in which is mounted the fan impeller consisting of a carrying disk (6) and a cover disk (7) between which are secured blades (8). The entrance angle of each blade (8) increases from the carrying disk (6) towards the cover disk (7). The curved lateral surface (12) of each blade (8) has the form of a linear unrolling surface with their generatrix (16) inclined to the plane perpendicular to the axis of the fan impeller at an angle (α) between 45° and 85°. The projection (17) of at least one of said generatrix on the plane perpendicular to the axis of the fan impeller is a tangent to the section (13) of the curve obtained as a result of intersection of the lateral surface (12) of the blade (8) by said plane.

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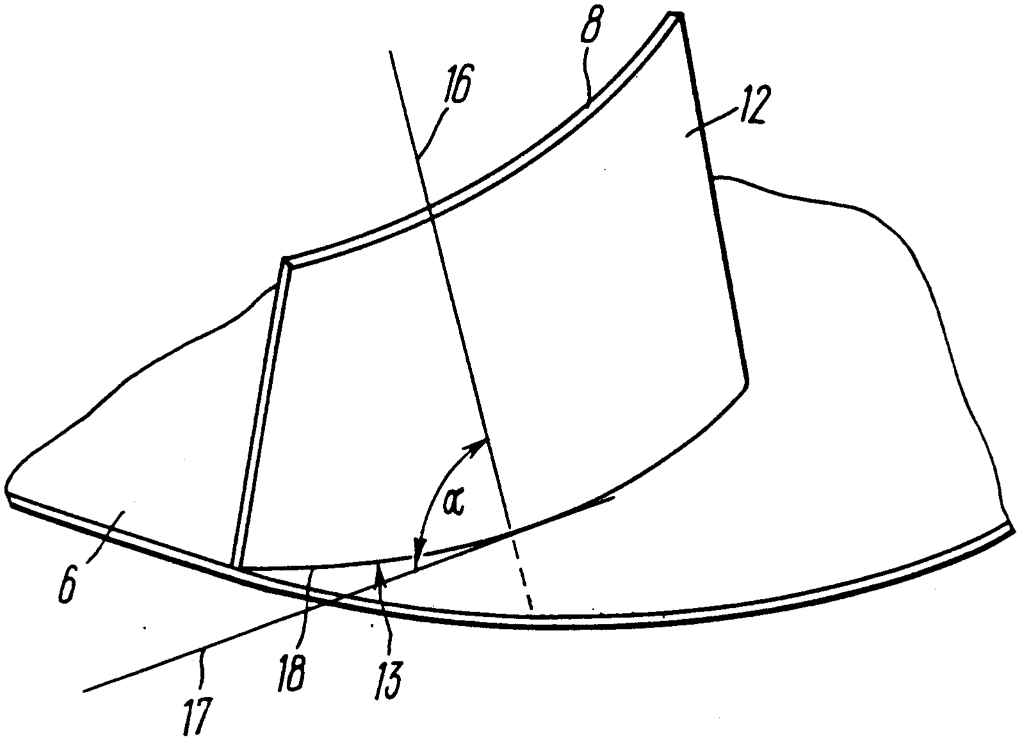


FIG.3

Field of the Invention.

The present invention relates to the field of fan engineering and, more specifically, to the design of a centrifugal fan.

Prior Art.

The present invention will be most useful in the designs of centrifugal fans with medium- and high specific rotational speed used in the ventilation and air-conditioning systems.

The basic requirements for the design of modern fans are high aerodynamic parameters, a wide range of economical operation, technology of manufacturing, strength and reliability of their construction. The term aerodynamic parameters shall be understood as the volumetric flow rate of gas passing through the fan, total pressure provided by the fan and the efficiency of the latter. The notion "wide range of economical operation" shall be understood as the range of its operating modes at a high efficiency.

The tendency towards developing a centrifugal fan that would meet the above requirements has led to evolution of a centrifugal fan (T.S. Solomakhova et al. "Centrifugal fans", 1975, Mashinostroenie Publishing House, Moscow, page 6-7) whose spiral casing accommodates a wheel formed by the carrying and overlying discs with blades therebetween. The side surfaces of each blade have the form of a cylindrical surface with generating lines parallel to the wheel axis. In each of said blades the angle formed by a segment of the curve produced in the section of the blade side surface by a plane perpendicular to the fan wheel axis, and by a circle whose centre lies on the wheel axis and which passes through the point of said segment of the curve nearest to the wheel axis, is constant throughout the width of the fan wheel. This angle will be referred to hereinafter as the "blade entrance angle". Similarly, the angle of these blades formed by the segment of the curve produced in the section of the side surface of each blade by the plane which is perpendicular to the wheel axis and by the circle whose centre lies on the wheel axis and which passes through the point of this segment of the curve farthest from the wheel axis is also constant throughout the width of the fan wheel. This angle will be referred to below as the "blade exit angle".

When the gas flow in the running fan is turned from the axial to the radial direction, there appears nonuniformity of the field of gas flow velocities across the width of the wheel along the entrance edges of blades or, in other words, there develop differencies in the conditions of the gas flow around the blades along the width of the fan wheel. This brings about nonuniform loading of the blades across the width of the fan wheel, develops intensive secondary flows in the channels between blades and the development of separation in the gas flow which ultimately reduces the aerodynamic parameters of the centrifugal fan and narrows the field of its economical operation.

Besides, the practical experience gained in using such type of centrifugal fans has shown that at high peripheral velocities of the fan wheel the blades lose their stability and are deformed which is caused by the effect of strong centrifugal forces and insufficient rigidity of construction. This reduces the strength and reliability of the fan wheel and the centrifugal fan as a whole.

The strive for improving the aerodynamic parameters, step up the strength and reliability of the centrifugal fan has resulted in the development of the centrifugal fan (DE, C, 952547) whose spiral casing accommodates a fan wheel formed by the carrying and overlying discs with blades therebetween. Each side surface of the blade is of a curvilinear shape and, being intersected by any plane perpendicular to the wheel axis, forms a segment of a curve which, jointly with the circle whose centre lies on the wheel axis and which passes through the point of this segment of the curve nearest to the wheel axis, forms a blade entrance angle which grows throughout the wheel width in the direction from the carrying disc to the overlying one. In other words, the entrance angle of each blade grows across the width of the fan wheel from the carrying to the overlying disc. This provides for the uniform loading of blades, reduces the intensity of secondary flows in the channels between blades and narrows the zone of separation in the gas flow which improves the aerodynamic characteristics of the centrifugal fan and broadens the range of its economical performance.

However, in order to ensure the growing of the entrance angle of each blade across the wheel width from the carrying disc to the overlying disc, the blade is twisted around its longitudinal axis in the course of manufacture. The practice of using the centrifugal fans with such blades has demonstrated that their performance is particularly efficient when the blade entrance angle at the overlying disc is at least one and a half times larger than the blade entrance angle at the carrying disc. Such twisting of the blade is possible only in case of a large axial extension of the blade at which the relative twisting angle is small. If, however, the axial extension of the blade is small, the relative twisting angle is large. At a large relative twisting angle the material traditionally used for the manufacture of blades fails in the course of manufacture. Therefore, the blades of such centrifugal fans are very long axially. As a result, the diameter of the inlet hole of the fan wheel is large, the radial length of each blade is small and the exit angles of blades bent against rotation of the wheel are small. It is a known fact that at a small radial length and small exit angles of blades the total pressure provided by the centrifugal fan is small.

Besides, twisting of blades causes residual stresses in their material which reduce the strength parameters of blades so that at high peripheral velocities of the fan wheel, characterized by strong centrifugal forces, the blades loss stability and become deformed. This tells adversely on the strength and reliability of the centrifugal fan.

Moreover, twisting of blades complicates their manufacturing technology. It concerns particularly those cases when the blades are made from a sheet material most commonly used in modern fan engineering. Owing to all these factors the centrifugal fans with such blades have not become much popular in fan engineering practice.

Disclosure of the Invention.

The invention is essentially aimed at providing a centrifugal fan, wherein due to configuration of the lateral surface of the blades, there is provided an increase in the full pressure produced by the fan, a better strength of its structure and reliability in operation.

This aim is achieved by providing a centrifugal fan whose spiral casing accommodates a fan wheel comprises of a carrying disc and an overlying disc with blades secured therebetween, at least one curvilinear surface of each blade in the section by a plane perpendicular to the fan wheel axis defines a segment of the curve forming, together with the circle whose centre lies on the fan wheel axis which passes through the point of the segment of the curve, nearest to said centre, a blade entrance angle growing across the width of the fan wheel in the direction from the carrying disc to the overlying disc; said curvilinear side surface of the blade has the shape of a ruled developable surface with the generating lines inclined towards the plane perpendicular to the fan wheel axis at an angle varying from 45°to 85° and the projection of at least one of said generating lines on the plane perpendicular to the fan wheel axis is a tangent to the segment of the curve in said plane.

The requirement for increasing the blade entrance angle across the width of the fan wheel from the carrying disc to the overlying disc in the disclosed fan is ensured by the above-stated shape of the side surface of the blade. And this shape can be manufactured without subjecting the blade material to twisting or any other substantial plastic deformations; it is enough to bend it in order to produce the required shape of the side surface and blade profile. This procedure does not involve residual stresses which limit the axial dimensions of the blade. Consequently, the disclosed centrifugal fan can be made with blades having a variable entrance angle across the width of the fan wheel and having any, even small, axial length. The fans with a small axial length of their blades are characterized by an increased radial length which, all other conditions being equal, brings about an increase in the exit angles of each blade and, accordingly, a higher total pressure provided by the fan.

A smaller axial length of the blades and elimination of considerable residual stresses in the material of the blades improves the strength paramaters of blades and the fan wheel as a whole. This permits either to increase the peripheral velocity of the fan wheel thereby improving the aerodynamic characteristics of the fan, or, by retaining the same peripheral velocity of the fan wheel, to enhance the mechanical strength and reliability of the centrifugal fan.

Besides, as has been stated above, in order to manufacture a blade, it is enough to bend its material to obtain the required profile and shape of its side surface which simplifies its manufacturing technology.

The blades made from sheet materials are used at peripheral velocities of the fan wheel which do not exceed about 70 m/s. At peripheral velocities exceeding 70 m/s the blades are of a profiled shape. This shape makes it possible to design the blades both with one and two side surfaces in the form of a ruled developable surface.

In practice for the fan wheels with a relative width of the blade exit edges not less 0.2 the ruled developable surface should be cylindrical.

In the fan wheels with a relative width at the blade exit edges varying from 0.15 to 0.2 it is practicable that the ruled developable surface should be conical. The conical surface intensifies the changes of the blade entrance angle across the width of the fan wheel in the direction from the carrying disc to the overlying one.

It is no less practicable that the segment of the curve formed when the side surface of the blade is intersected by the plane of the carrying disc should form an arc of the circle wherein the relation of the square of chord length to the difference of squares of the diameters of the circles passing, respectively, through the exit and entrance edges of blades should be within 0.2 to 0.25.

Thus, we receive blade profiles in various blade sections perpendicular to the fan wheel axis which ensure the range of blade entrance and exit angles, which permits achieving high values of efficiency and total pressure of the centrifugal fan.

It is quite reasonable that the segment of a curve which is formed when the side surface of the blade is intersected by the plane of the carrying disc should form on the side of the blade entrance edge an arc of the circle conjugate with the segment of a straight line from the side of the blade exit edge and that the relation of the square of the distance between the ends of said segment of the curve to the difference of squares of the diameters of the circles passing, respectively, through the exit and entrance edges of blades should vary from 0.15 to 0.22.

In the blades of such a profile the blade exit angle is increased and remains constant across the width of the fan wheel which leads ultimately to an increase in the total pressure of the fan. The above-stated relation of the square of the distance between the ends of the above-mentioned segment to the difference of squares of the circle diameters passing through the exit and entrance edges of blades ensures the range of values of the blade entrance and exit angles at which the efficiency and total pressure of the centrifugal fan acquire high values.

It is recommended that in the blades with the profile in the form of art arc of a circle conjugate with a segment of a straight line, the relation of the diameter of the circle passing through the exit edges of the blades to the diameter of the carrying disc should vary from 0.9 to 1.1.

Thus, the blades used in the disclosed fan wheel have, each, a profile with a longer or shorter segment of a straight line. This permits producing a selection of discrete aerodynamic characteristics of the centrifugal fan, thereby broadening the zone of effective operation of the fan, i.e. the zone of high efficiency performance.

Now the invention will be described by way of examples with reference to the accompanying drawings in which:

Fig. 1 is a meridional section of the centrifugal fan according to the invention;

Fig. 2 is a section taken along line II-II in Fig. 1;

Fig. 3 shows a blade installed on the partly-illustrated carrying disc of the fan wheel, isometric view, enlarged;

Fig. 4 is a section taken along line IV-IV in Fig. 1;

Fig. 5 is a section taken along line V-V in Fig. 1;

Fig. 6 is a section taken along line VI-VI in Fig. 1;

Fig. 7 illustrates a blade installed on the partly-shown carrying disc of the fan wheel, another embodiment, isometric view, enlarged;

Fig. 8 is a blade installed on the partly-shown carrying disc of the fan wheel, still another embodiment, isometric view, enlarged;

Fig. 9 is a section taken along line IX-IX in Fig. 1, a further version of the fan wheel blade;

Fig. 10 is a section taken along line X-X in Fig. 1, a still further version of the fan wheel blade.

Given below as an example is a centrifugal fan used, for example, in air conditioning and ventilating systems of industrial or civic buildings. Such a centrifugal fan comprises a spiral casing 1 (Fig. 1) having an inlet pipe 2 and an outlet pipe 3 (Fig. 2). The chamber 4 of the spiral casing 1 houses a fan wheel 5 formed by a carrying disc 6 (Fig. 1) and an overlying disc 7 installed between which over the periphery are blades 8 forming a chamber 9 (Fig. 2) inside the fan wheel 5 and channels between blades 8a. The carrying disc 6 is secured by a hub 10 (Fig. 1) on a drive shaft 11 (not shown in the drawings). The relative width of the fan wheel, i.e. the relation of the width b_2 of the fan wheel 5 at the exit edges of the blades 8 to the diameter D_2 of the circle passing through the exit edges of the blades 8 is equal to 0.25 in this embodiment of the invention.

At least one of the side surfaces 12 (Fig. 3) of each blade 8, and in this embodiment of the invention the blades 8 are made from a sheet material so that both side surfaces 12 of each blade 8 in the section by a plane perpendicular to axis 0_1-0_1 of the fan wheel 5 form a segment 13 (Fig. 4) of the curve which, together with the circle 14 whose centre 0_2 lies on the axis 0_1-0_1 of the fan wheel 5 and which passes through the point 15 of the segment 13 of the curve nearest to said centre 0_2, forms an entrance angle β_1 of the blade 8. The entrance angle β_1 of the blade 8 grows along the width b_1 of the fan wheel 5 in the direction from the carrying disc 6 to the overlying disc 7. In this embodiment of the centrifugal fan the entrance angle β'_1 (Fig. 5) of the blade 8 at the carrying disc 6 amounts approximately to 15° while the entrance angle β_1'' of the blade 8 at the overlying disc 7 is about 21°. The exit angles β_2 (Fig. 4) of the blade 8 are determined in a similar way. The exit angle β_2 of each blade 8 also grows along the width b_2 of the fan wheel 5 in the direction from the carrying disc 6 to the overlying disc 7. In this particular example the blade exit angle β_2' (Fig. 5) at the carrying disc 6 is about 32° while the blade exit angle β_2'' at the overlying disc 7 is about 35°. Each curvilinear side surface 12 (Fig. 3) of the blade 8 is a ruled developable surface, cylindrical in this version of realization. The generating lines 16 of this surface 12 are inclined to the plane perpendicular to the axis 0_1-0_1 of the fan wheel 5 at an angle α varying from 45° to 85°. In this particular realization of the centrifugal fan the angle α is 78° and the plane perpendicular to the axis 0_1-0_1 of the fan wheel 5 is the plane of the carrying disc 6. The projection 17 of at least one of the generating lines 16 (just one in this version) on the plane of the carrying disc 6 is a tangent to the segment 13 of the curve in this plane. The segment 13 of the curve formed by intersection of the side surface 12 of the blade 8 with the plane of the carrying disc 6 is an arc 18 (Fig. 6) of the circle 19. The shape of this arc 18 of the circle 19 in such that the relation of the square of the length l_1 of the chord 20 of said arc 18 to the difference of squares of diameters D_2, D_1 of the circles 21, 22 passing, respectively, through the exit edges 23 and entrance edges 24 of the blades 8 lies within the limits from 0.2 to 0.25; in the given embodiment of the centrifugal fan this relation is 0.21.

Other realization of blades 8 are also possible. In the case, when the fan operating conditions call for the peripheral velocity of the fan wheel 5 higher than 70 m/s, the blades 8 should be of a profiled type. Such a blade 8 is shown in Fig. 7.

If the operating conditions of the centrifugal fan require that the relative width of the fan wheel 5 should be less than 0.2, the aerodynamic parameters of the fan can be raised by using the blades 8 with at least one side surface 12 being conical. In other respects the design of the fan remains the same as that of a fan with cylindrical blades. This version of the blade 8 appears in Fig. 8.

Besides, when the basic technical requirements for the centrifugal fans are high values of their efficiency and total pressure each of their blades 8 (Fig. 9) should be so constructed that when its side surface 12 is intersected by the plane of the carrying disc 6 this forms a segment 13 of the curve which at the side of the entrance edge 24 of the blade 8 is the arc 25 of the circle 26 conjugate with the segment 27 of the straight line 28 at the side of the exit edge 23 of this blade 8. The shape of this segment 13 of the curve is such that the relation of the square of distance l_2 between its ends to the difference of squares D_2, D_1 of the circles 21, 22 passing, respectively, through the exit edges 23 and entrance edges 24 of the blades 8 lies within the limits from 0.15 to 0.22. In the given embodiment of the centrifugal fan this relation is 0.19. It should be emphasized that this version of the blades 8 is possible both with the cylindrical and conical shapes of the side surface 12.

In order to broaden the range of effective performance of the centrifugal fan, the profile of the blades 8 (Fig. 10) is made in the form of an arc 25 of the circle 26 conjugate with the segment 27 of the straight line 28 in which the relation of the diameter D_2 of the circle 21 passing through the exit edges 23 of the blades 8 to the diameter D_3 of the carrying disc 6 lies within the limits from 0.9 to 1.1. Shown in Fig. 10 is a version of the centrifugal fan wherein said relation is equal to 1.05.

The centrifugal fan functions as follows. As the drive shaft 11 (not shown in the drawings) rotates, its rotation is transmitted via the carrying disc 6 secured on the shaft 11 by means of the hub 10 to the fan wheel 5 installed in the chamber 4 of the spiral casing 1. When the fan wheel 5 rotates along arrow A (Fig. 2), the gas moves in the axial direction shown by arrows B (Fig. 1) through the inlet pipe 2 into the chamber 9 inside the fan wheel 5 where it is acted upon by the vacuum near the entrance edges 24 of the blades 8, changes its direction from axial to radial and moves onto the blades 8 of the fan wheel 5. Turning of the gas flow through 90° causes nonuniformity of its velocities along the entrance edges 24 of the blades 8. This nonuniformity is such that the gas flowing around the blades 8 at the overlying disc 7 has a higher speed than at the carrying disc 6. Owing to an increasing entrance angle β_1 of the blades 8 across the width b_1 of the fan wheel 5 in the direction from the carrying disc 6 to the overlying disc 7 causes by the inclination of the generating lines 16 of the side surface 12 of the blade 8 at an angle α to the plane perpendicular to the axis 0_1-0_1 of the fan wheel 5, the gas flow moves to the blades 8 at an optimum angle of incidence throughout the width b_1 of the fan wheel 5 which reduces pressure losses at the entrance into the fan wheel 5.

As the gas moves further through the channels between blades 8a of the fan wheel 5, it receives energy from the drive successively via the shaft 11, hub 10, carrying disc 6 and blades 8 which builds up a total pressure developed by the fan. This practically eliminates the conditions for the development of separation zones of gas flow in the channels between blades 8a, ensures a uniform load on the blades 8 across the width b_1 of the fan wheel 5 which leads to a minimum intensity of secondary flows at the overlying disc 7. Then the gas flows into the chamber 4 of the spiral casing 1 where part of the dynamic pressure of the gas flow leaving the fan wheel 5 is transformed into static pressure. Then the gas flow leaves the fan through the outlet pipe 3 in the direction shown by arrow C in Fig. 2. The uniform field of velocities at the outlet from the fan wheel 5 reduces the pressure losses in the chamber 4 of the spiral casing 1. All these factors increase the total pressure provided by the fan, and its efficiency.

All the centrifugal fans with blades 8 of the above-described shapes of side surfaces 12 function on the same principle.

Given below is a summary table 1 of fifteen versions of centrifugal fans where:

Z = number of blades 8 of fan wheel 5;

b_2 = width of fan wheel 5 at exit edges 24 of blades 8;

D_1 = diameter of circle 22 passing through entrance edges 24 of blades 8 of fan wheel 5;

D_2 = diameter of circle 21 passing through exit edges 23 of blades 8 of fan wheel 5;

D_3 = diameter of carrying disc 6 of fan wheel 5;

α = inclination angle of generating line 16 of side surface 12 of each blade 8 to the plane perpendicular to axis 0_1-0_1 of fan wheel 5;

β_1' = entrance angle of blade 8 at carrying disc 6 of fan wheel 5;

β_1'' = entrance angle of blade 8 at overlying disc 7 of fan wheel 5;

β_2' = exit angle of blade 8 at carrying disc 6 of fan wheel 5;

β_2'' = exit angle of blade 8 at overlying disc 7 of fan wheel 5;

l_1 = length of chord 20 of arc 18 of circle 19 formed when side surface 12 of blade 8 is intersected by the plane of carrying disc 6;

l_2 = distance between the ends of segment 13 of a curve, formed when the side surface 12 of the blade 8 is intersected by the plane of the carrying disc 6 and forming at the side of the entrance edge 24 of blade 8 an arc 25 of circle 26 conjugated with the segment 27 of a straight line 28 at the side of the exit edge 23 of blade 8;

Q = volumetric gas flow rate of the centrifugal fan;

Pv = total pressure provided by centrifugal fan;

η = efficiency of centrifugal fan.

The speed of the fan wheel is 1450 rpm, diameter D_2 = 0.63 m.

Table 1

Version No.	Shape of blade side surface and profile	Z pc	α deg	β_1' deg	β_1'' deg	β_2' deg	β_2'' deg
1		10	82	13	18	29	31
2	side surface of	10	81	15	20	30	32
3	blade-cylindrical,	12	81	15	20	30	32
4	profile of blade-	12	78	15	21	32	35
5	arc of a circle	12	75	13	20	34	37
6		12	78	15	21	40	40
7	side surface of	13	75	13	20	40	40
8	blade-cylindrical,	12	75	13	20	40	40
9	profile of blade-	12	78	15	21	47	47
10	arc of a circle	12	78	15	21	44	44
11	conjugated with	12	78	15	21	37	37
12	segment of straight line	12	78	15	21	31	31
13	side surface of	12	50	15	31	32	38
14	blade-conical,	12	60	13	25	29	33
15	profile of blade-arc of a circle	10	60	13	25	29	33

Table 1 (continued)

Version No.	$\frac{b_2}{D_2}$	$\frac{l_1^2}{D_2^2-D_1^2}$	$\frac{l_2^2}{D_2^2-D_1^2}$	$\frac{D_2}{D_3}$	Q	Pv	η
	-	-	-	-	m^3/s	Pa	%
1	0.25	0.250	-	1.0	2.89	1015	84
2	0.25	0.226	-	1.0	2.95	1043	84
3	0.25	0.226	-	1.0	3.06	1084	85
4	0.25	0.210	-	1.0	3.28	1119	85
5	0.25	0.206	-	1.0	3.13	1089	84
6	0.25	-	0.190	1.0	3.28	1200	86
7	0.25	-	0.200	1.0	3.15	1210	83
8	0.25	-	0.200	1.0	3.11	1200	84
9	0.25	-	0.204	1.1	3.27	1744	83
10	0.25	-	0.200	1.05	3.28	1483	84
11	0.25	-	0.180	0.95	2.81	1105	85
12	0.25	-	0.170	0.9	2.61	839	82
13	0.16	0.210	-	1.0	2.53	1120	83
14	0.15	0.250	-	1.0	2.14	1030	84
15	0.15	0.250	-	1.0	2.03	1005	83

Industrial Applicability.

The present invention can most advantageously be used in centrifugal medium and high-speed fans employed in ventilation and air conditioning systems.

Claims

1. A centrifugal fan whose spiral casing (1) houses a wheel (5) formed by a carrying and an overlying discs (6,7) between which blades (8) are secured, at least one of the lateral surfaces (12) of each of which is curved and defines a portion (13) of a curve in the section formed by a plane perpendicular to the axis (0_1-0_1) of the fan wheel (5), said portion (13) forming an entrance angle (β_1) of the blade (8) with a circumference (14) whose centre (0_2) lies on the axis (0_1-0_1) of the wheel (5) and which passes through a point (15) of the portion (13) of the curve closest to said centre (0_2), said entrance angle (β_1) of the blade (8) increasing across the width (b_1) of the wheel (5) in the direction from the carrying disc (6), to the overlying disc (7), **characterized** in that the lateral surface (12) of the blade (8) is substantially a linear developable surface having generating lines (16) inclined to the plane perpendicular to the axis (0_1-0_1) of the wheel (5) at an angle (α) lying within the limits from 45° to 85°, and the projection (17) of at least one of said generating lines (16) on the plane perpendicular to the axis (0_1-0_1) of the fan wheel (5) is a tangent to the portion (13) of the curve in this plane.

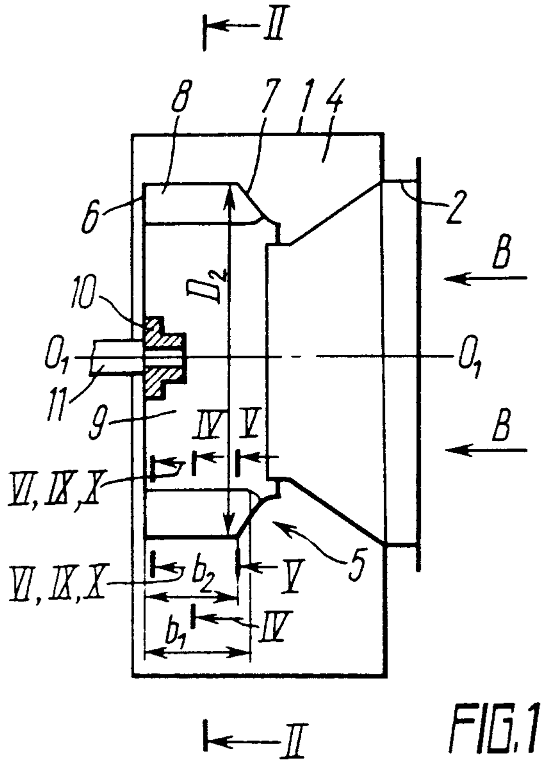
2. A centrifugal fan as claimed in Claim 1, **characterized** in that the linear developable surface is a cylindrical surface.

3. A centrifugal fan as claimed in Claim 1, **characterized** in that the linear developable surface is substantially a conic surface.

4. A centrifugal fan as claimed in Claim 1, **characterized** in that the portion (13) of the curve formed at the intersection of the lateral surface (12) of the blade (8) by the plane of the carrying disc (6) is substantially an arc (18) of a circle (19), whose ration of the square of the length (l_1) of a chord (20) to the difference of squares of diameters (D_2, D_1) of circles (21, 22) passing respectively through the forward and entry tips (23, 24) of the blade (8) is within the range of from 0.2 to 0.25.

5. A centrifugal fan as claimed in Claim 1, **characterized** in that the portion (13) of the curve, formed at the intersection of the lateral surface (12) of the blade (8) by the plane of the carrying disc (6) is substantially an arc (25) of a circle (26) on the side of the entry tip (24), said arc being conjugated with a portion (27) of a straight line (28) on the side of the forward tip (23) of the blade (8), and the ratio of the square of the distance (l_2) between ends (29) of said portion (13) of the curve to the difference of squares of the diameters (D_2, D_1) of the circles (21, 22) passing respectively through the forward and entry tips (23,24) of the blades (8) is within the range of from 0.15 to 0.22.

6. A centrifugal fan as claimed in Claim 5, **characterized** in that the ratio of the diameter (D_2) of the circle (24) passing through the forward tips (23) of the blades (8) to the diameter (D_3) of the carrying disc (6) is within the range of from 0.9 to 1.1.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8
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1
4
6
2
B
10
D2
O1
O1
11
9
IV
V
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b2
V
5
b1
IV
II

FIG.1

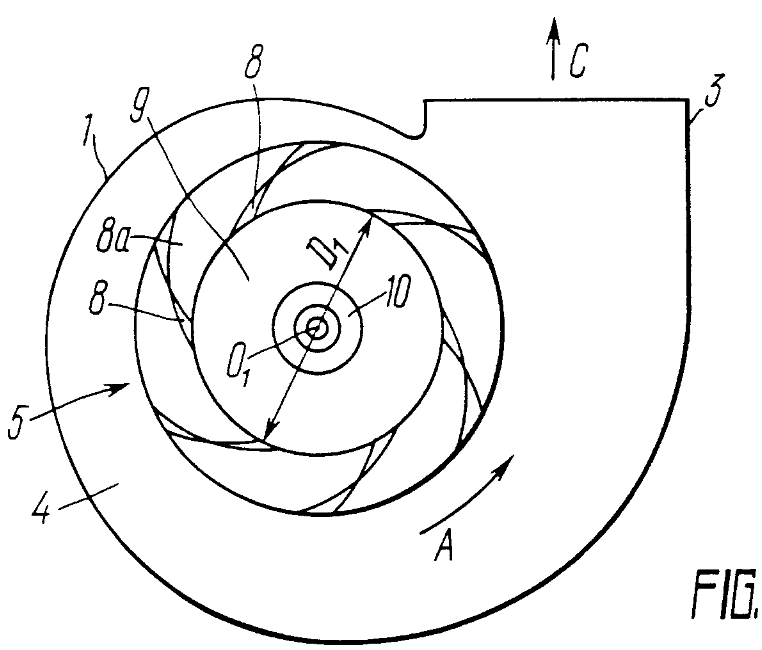
C
8
3
9
1
8a
D1
8
10
O1
5
4
A

FIG.2

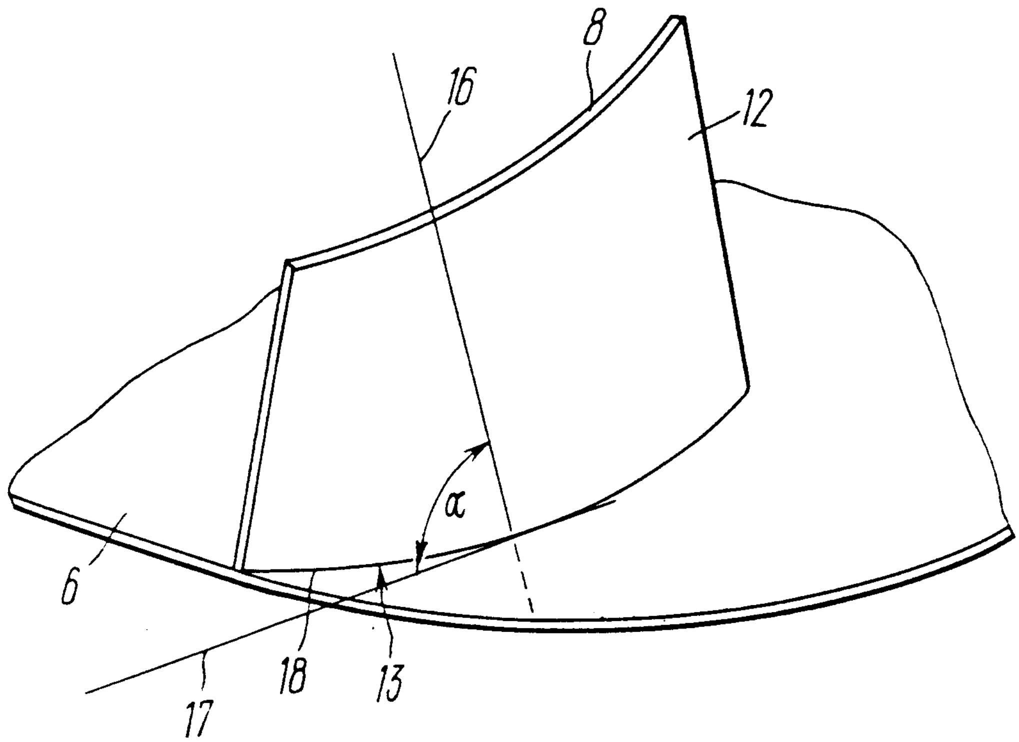

FIG.3

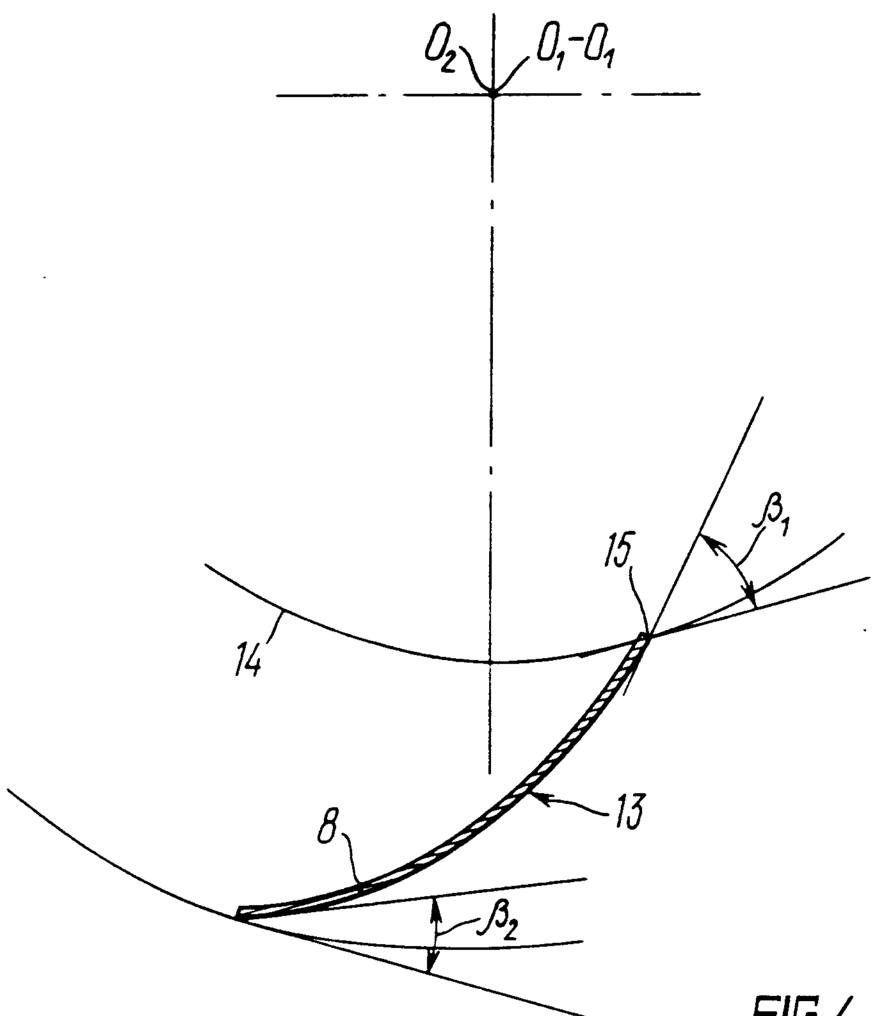

FIG.4

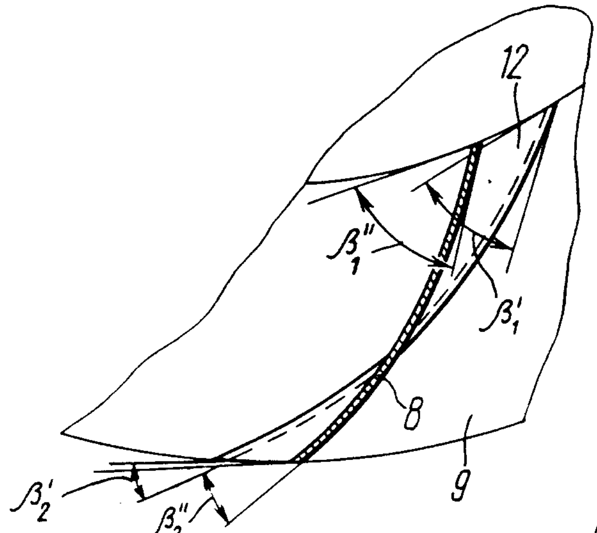

FIG.5

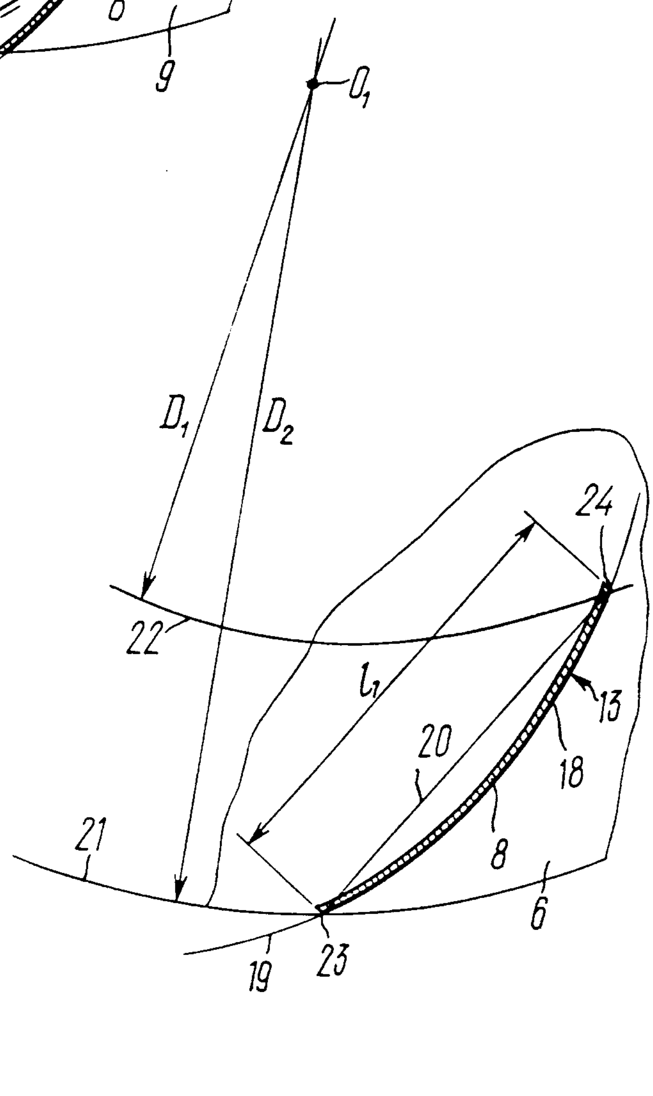

FIG.6

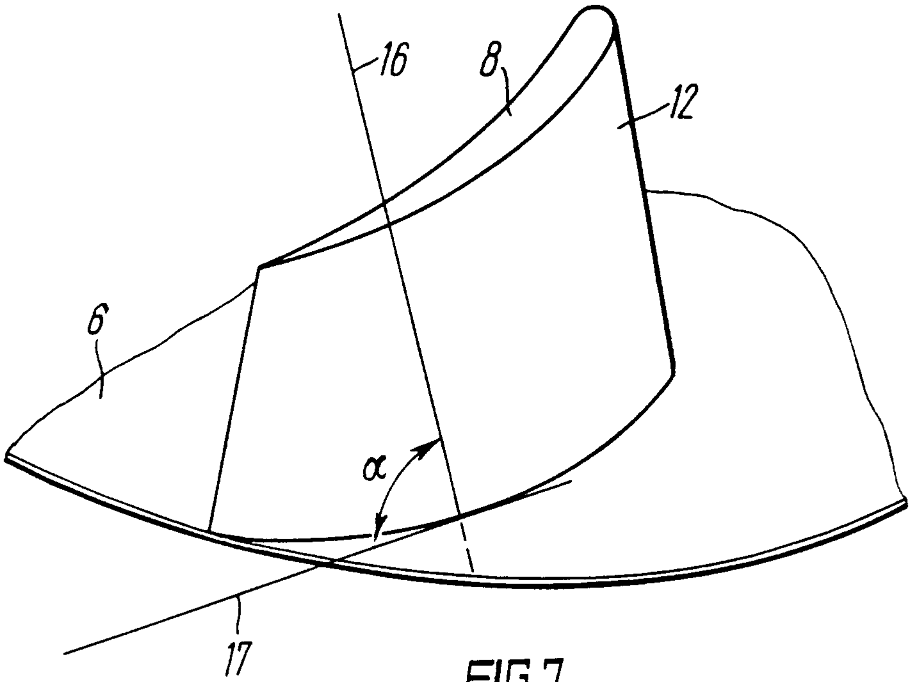

FIG.7

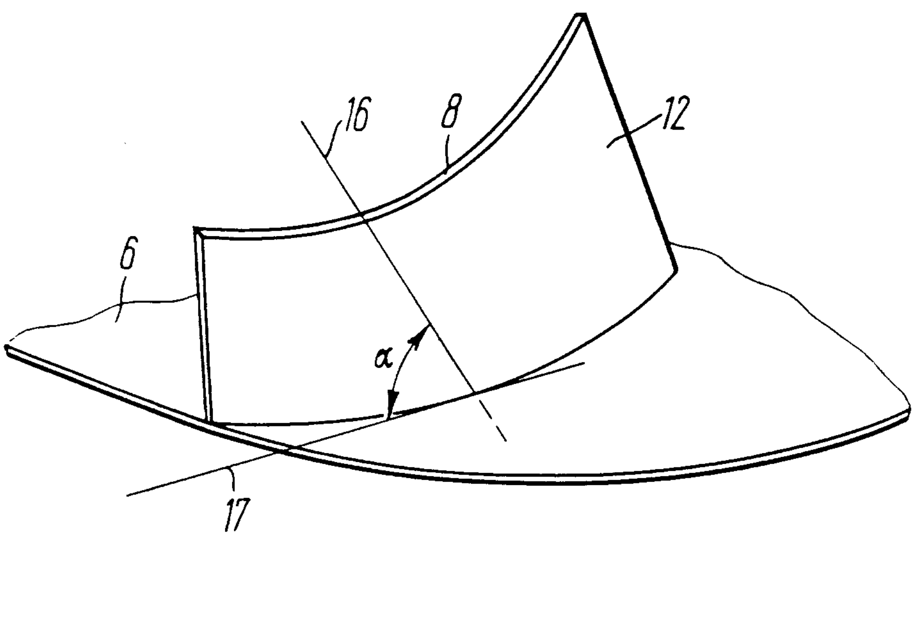

FIG.8

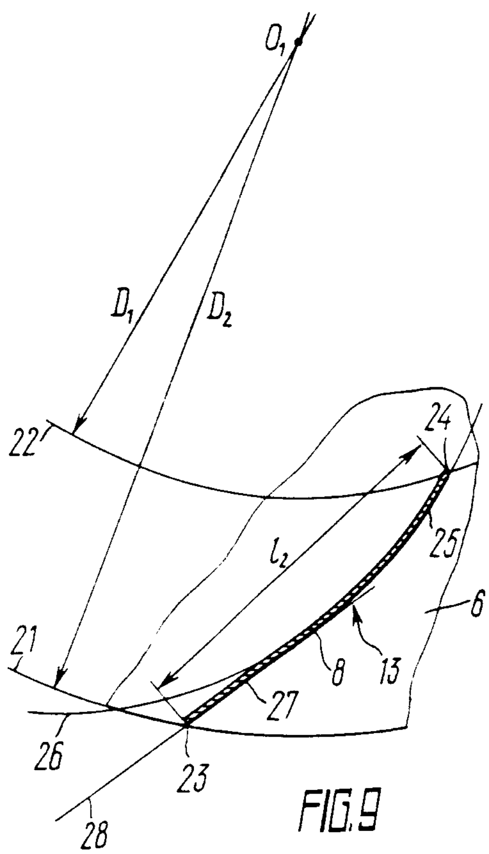
O1
D1
D2
22
24
l2
25
6
21
8
13
27
26
23
28

FIG.9

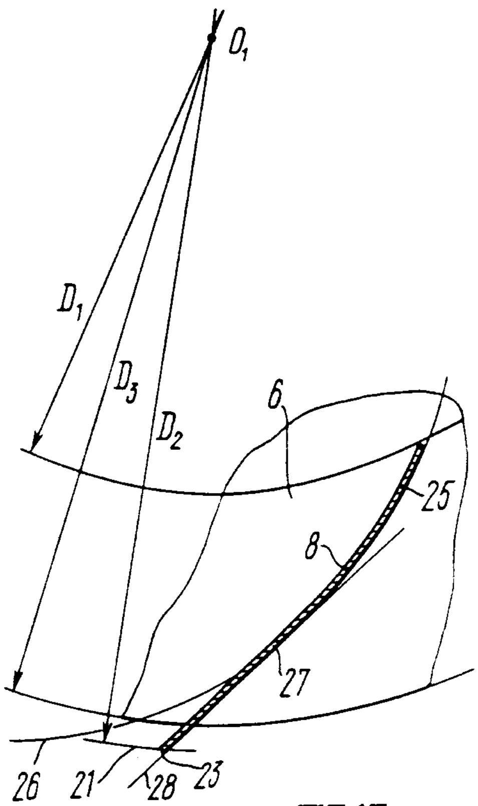
O1
D1
D3
D2
6
25
8
27
26
21
28
23

FIG.10

INTERNATIONAL SEARCH REPORT

International Application No PCT/SU 90/00147

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.^{5} F 04 D 17/08, 29/30

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
Int. Cl.^{5}	F 04 D 17/08, 29/28, 29/30

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	SU, A1, 1337555 (Leningradsky politekhnichesky institut im. M.I. Kalinina), 15 September 1987 (15.09.87), the claims	1-6
A	Tsentrobezhnye ventilyatory pod red. T.S. Solomakhovoi, 1975, "Mashinostroenie" (Moscow), pages 7-9, fig. 4-6	1-6
A	DE, C, 952547 (BRUNO ECK, KOLN-KLETTENBERG) 15 November 1956 (15.11.56) (cited in the description)	1-6

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"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

"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

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
18 March 1991 (18.03.91)	11 April 1991 (11.04.91)
International Searching Authority	**Signature of Authorized Officer**
ISA/SU	