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(54) Untwisted blade for axial-flow fan

(57) A description is given of untwisted blade (1) for axial-flow fan, equipped, along the trailing edge, with flag (3) sloped to body (2) of blade (1), where said flag (3) is extensional to profile mean line of said body (2) of blade (1) and has a width (5) exceeding that of the flag of known blades.

Said new blade is less noisy and of higher performance than the blades already known.

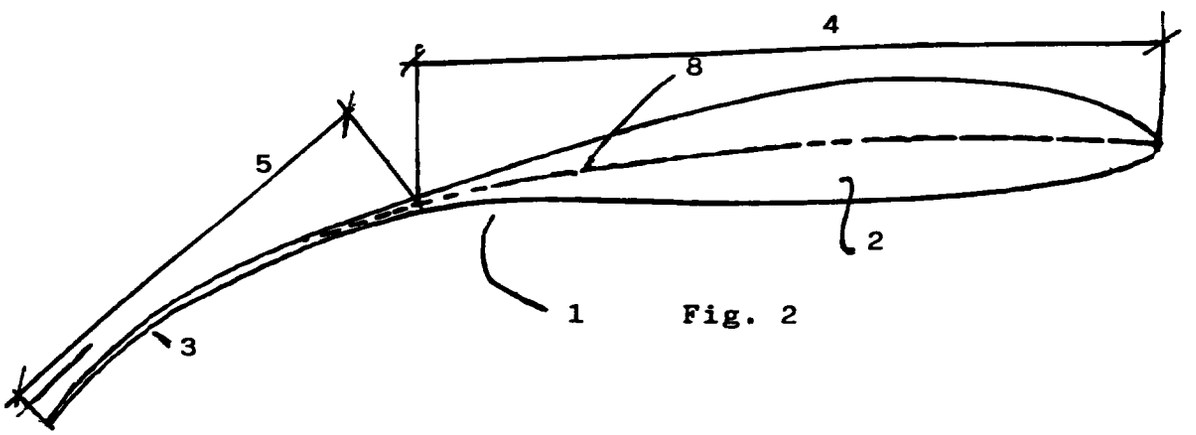

Fig. 2

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Description

Field of the invention

The present invention relates to an untwisted blade for axial-flow fan (equipped, along the trailing edge, with a flag sloped to the blade body) which is less noisy and of higher performance than the blades already known.

Prior art

Untwisted blades for axial-flow fan, equipped, along the trailing edge, with a flag sloped to the blade body, are known to those skilled in the art (e.g. as disclosed in U.S. patent No. 4,618,313 by the Applicant).

Said blades answered the intended purpose and were a commercial success.

Theoretical and experimental studies carried out by the Applicant provided evidence that the fan noise level could be further reduced and, at the same time, the blade performance and axial-flow fan efficiency could be improved by realizing said sloped flag extensional to the mean line of the blade body and by increasing the flag width.

Summary

It is an object of the present invention an untwisted blade for axial-flow fan equipped, along the trailing edge, with a flag sloped to the blade body, where the sloped flag is extensional to the mean line of said blade body.

The sloped flag width is in the range of 35% to 65% of the length of the blade body chord, and preferably of 40% to 50% of said length.

Brief description of the drawings

The present invention will now be described in greater detail, with reference to an exemplary embodiment as illustrated in the drawings, to which the present invention is not intended to be confined. In the drawings,

Fig. 1 is a sectional view of a known blade;
Fig. 2 is a sectional view of a blade according to the invention;
Fig. 3 is a graph illustrating the characteristic curves for a fan equipped with traditional blades and, respectively, with blades according to the invention.

Detailed description

Figure 1 is a sectional view of untwisted blade 1 of the type already known, equipped, along the trailing edge, with flag 3 sloped at a predetermined angle to body 2 of blade 1. At the junction between body 2 and flag 3, blade 1 forms angle (or small-radius junction) at point 6, as clearly shown by the rather sharp direction change of mean line 8 (dashed line in Fig. 1) at said point 6.

Fig. 1 also shows chord 4 of body 2 and width 7 of flag 3; only in some cases width 7 of flag 3 exceeds 30% of the length of chord 4 of body 2 of blade 1.

Figure 2 is a sectional view of untwisted blade 1 according to the invention, equipped, along the trailing edge, with flag 3 sloped at a predetermined angle to body 2 of blade 1, said angle being usually equal to the inclination angle of flag 3 of the traditional blade (Fig. 1).

Flag 3 is extensional to the mean line of body 2 without forming angles or small-radius junctions, as shown by the curve of mean line 8 (dashed line in Fig. 2) that, at the junction between body 2 and flag 3, gradually curves without any sharp direction change.

Fig. 2 also shows chord 4 of body 2 and width 5 of flag 3; width 5 of flag 3 is in the range of 35% to 65% of the length of chord 4 of body 2 of blade 1 and, preferably, of 40% to 50% of the length of said chord 4.

The advantages provided by a flag 3 extensional to the mean line of body 2 of blade 1 and by increasing width 5 of flag 3 without changing the dimensions of body 2 of blade 1, were checked experimentally.

Measurements of static pressure Ps (a significant parameter for estimating blade performance), of sound pressure level SPL (correlated with noise) and of power input (correlated with fan efficiency) gave the results reported hereinafter.

In particular, the reduced noise and the higher efficiency of the fan may essentially be attributed to the flag 3 extensional to the mean line of body 2 of blade 1, while the improvement in blade performance may also be attributed to the larger width 5 of flag 3.

Furthermore, the performance of the blades according to the invention being higher, fans consisting of a lower number of blades may often meet the clients' specific requirements and obviously be economically advantageous.

Static pressure Ps

The test was conducted using a four-blade fan rotating at 600 r.p.m. in a 2 m dia. wind tunnel. The value of the static pressure Ps (measured in kg/m^2) was determined as a function of capacity Po (measured in m^3/h x 1000).

The results are plotted in Fig. 3: curve 9 was obtained with a fan equipped with traditional blades and curve 10 with a fan equipped with the blades of the invention.

The cross-hatched area represents the performance improvement achieved with the claimed blades.

The test was repeated using fans with different numbers of blades and blades of different diameters. The results obtained are analogous to those illustrated in Fig. 3.

Sound pressure level SPL

The test was conducted using a five-blade fan rotating at 960 r.p.m. in a 1.25 m dia. wind tunnel. The sound

pressure level SPL was measured in dB(A) with a phonometer the microphone of which is placed in a fixed position, 2 m from the rotating member centre.

For both types of blades (traditional, respectively according to the invention) the test was repeated with different pitch settings (incidence angles of the blades), resetting the fan at an as nearly identical working condition as possible, defined by the total pressure Pt (measured in kg/m^2) and dynamic pressure Pd (measured in kg/m^2).

Table 1 shows the sound pressure levels (SPL) (of a fan with traditional blades, respectively with the blades of the invention) for four different pitch settings and, for each pitch setting, for three different working conditions.

As may be noticed, the blades according to the invention allow a reduction in the sound pressure level by approx. 2 dB(A).

Said test was repeated using fans with different numbers of blades and blades of different diameters. The results obtained are analogous to those illustrated in Table 1.

TABLE 1

Fan with traditional flag			Fan with new flag		
Pt	Pd	SPL	Pt	Pd	SPL
13.8	11.7	89.2	14.0	71.6	87.2
21.6	9.4	91.0	21.4	9.5	89.1
31.7	6.8	96.2	32.0	6.6	93.5
21.4	18.0	87.0	21.7	18.0	85.5
29.8	15.4	87.0	30.0	15.5	84.9
40.7	10.5	93.0	41.0	11.0	82.0
30.7	26.4	86.0	31.0	26.3	84.0
46.0	18.7	88.5	47.0	18.7	86.0
55.0	11.4	92.4	54.2	12.8	90.0
41.0	35.0	85.8	42.2	35.2	85.0
66.0	20.0	88.0	66.4	19.5	85.5
72.0	12.0	91.0	73.0	12.1	89.5

Power input

Power input was measured (in ampere) on a four-blade fan rotating at 600 r.p.m. in a 2 m dia. wind tunnel. For both types of blades (traditional, respectively according to the invention) the test was repeated with different pitch settings, resetting the fan at an as nearly identical working condition as possible, defined by the total pressure Pt (measured in kg/m^2) and dynamic pressure Pd (measured in kg/m^2).

Table 2 shows the power input values for four different pitch settings and, for each pitch setting, for three different working conditions.

As shown in said table, under all working conditions, the blades according to the invention allow a reduction in the power required by the fan.

TABLE 2

Fan with traditional flag			Fan with new flag		
Pt	Pd	A	Pt	Pd	A
9.0	7.5	21.5	3.0	1.7	21.5
16.4	5.2	23.0	16.5	5.5	22.5
23.0	2.7	23.5	13.0	2.9	23.2
14.2	12.4	30.5	14.5	12.5	30.0
19.5	9.6	32.5	19.1	9.5	32.3
28.5	5.4	33.5	29.0	5.0	33.1
19.6	17.0	48.0	19.9	17.0	48.0
28.0	11.0	48.5	27.8	11.5	48.0
31.0	9.0	48.0	31.0	9.8	47.8
23.0	19.8	65.0	22.5	20.0	64.6
28.0	15.5	65.0	28.2	15.5	64.0
35.0	9.2	61.0	36.0	9.5	62.0

All modifications of and improvements in untwisted blade for axial-flow fan as suggested by experience and by the natural evolution of the technique may be effected by those skilled in the art without departing from the scope of the invention.

Claims

1. Untwisted blade for axial-flow fan, equipped, along the trailing edge, with a flag sloped to the body of said blade, characterized in that said sloped flag (3) is extensional to the mean line (18) of body (2) of said blade (1).

2. The blade according to claim 1, characterized in that width (5) of said sloped flag (3) is in the range from 35% to 65% of the length of chord (4) of said body (2) of said blade (1).

3. The blade according to claim 2, characterized in that width (5) of said sloped flag (3) is in the range from 40% to 50% of the length of chord (4) of said body (2) of said blade (1).

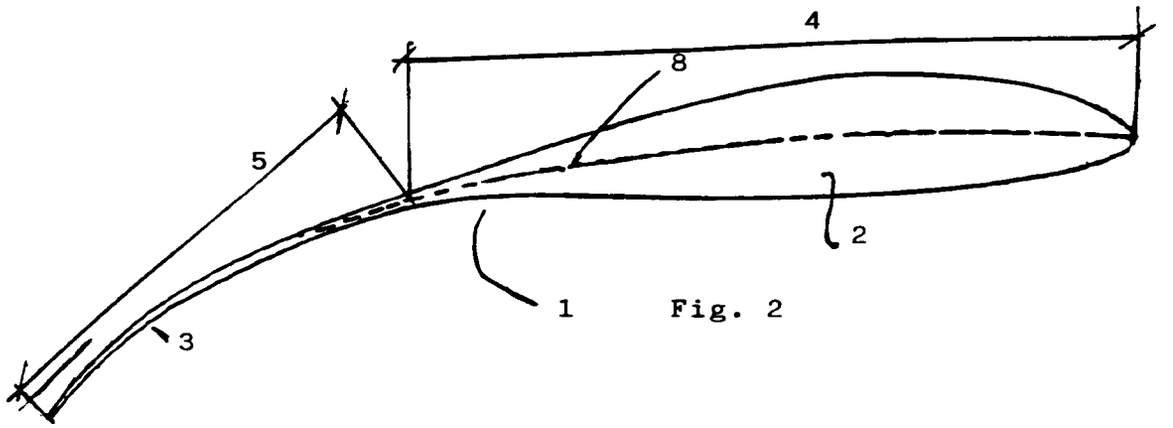

Fig. 2

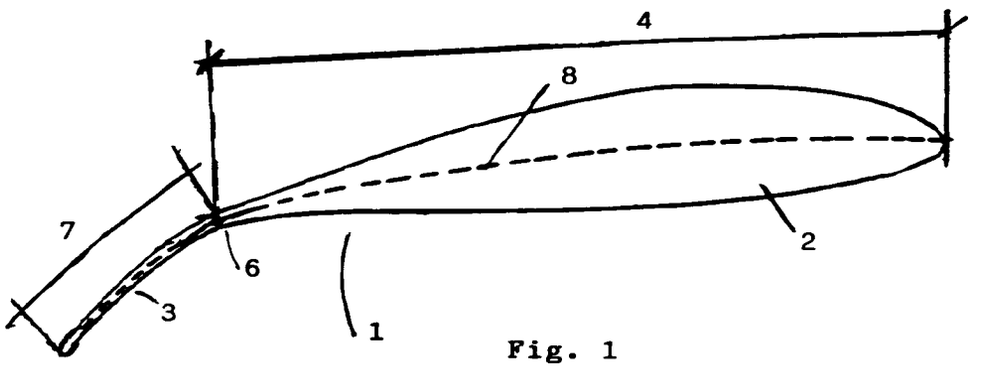

Fig. 1

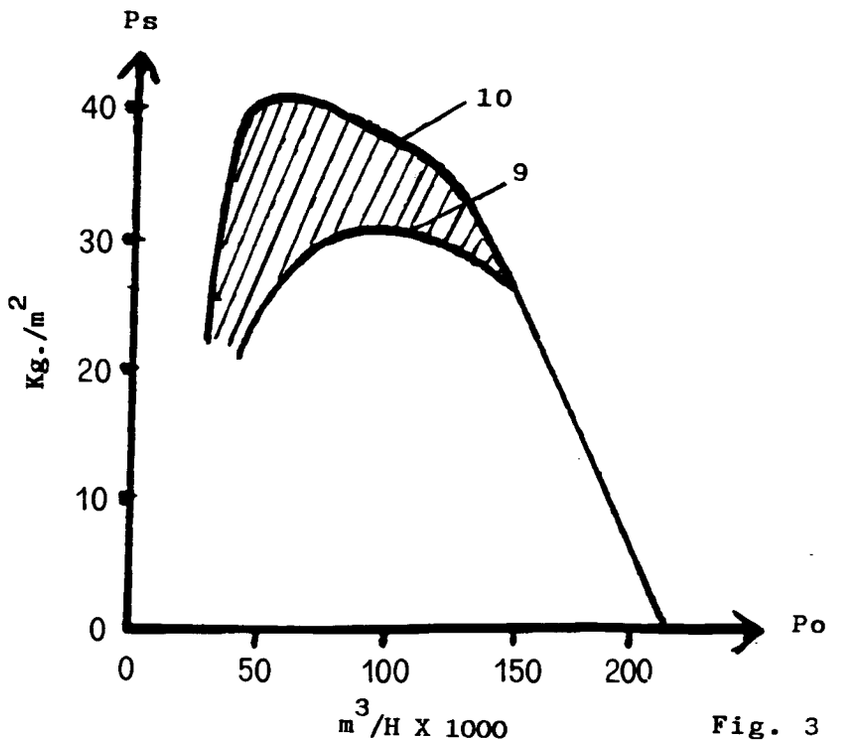

Fig. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 10 8151

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	FR-A-1 205 472 (VARTIAINEN) * the whole document *	1	F04D29/38
X	US-A-4 892 460 (VOLK) * the whole document *	1	
A	US-A-3 825 369 (ALBERTZART) * the whole document *	1-3	
A	DE-A-21 12 261 (BATTELLE-INSTITUT) * the whole document *	1-3	
A	GB-A-909 544 (TWIST)		
A	WO-A-92 01865 (HOWDEN WIND TURBINES)		
A,D	US-A-4 618 313 (MOSIEWICZ)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F04D F03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 October 1995	Teerling, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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