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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:
F03D 3/04	A1	WO 91/04413
		(43) International Publication Date: 4 April 1991 (04.04.91)

(21) International Application Number: PCT/SE89/00503

(22) International Filing Date: 20 September 1989 (20.09.89)

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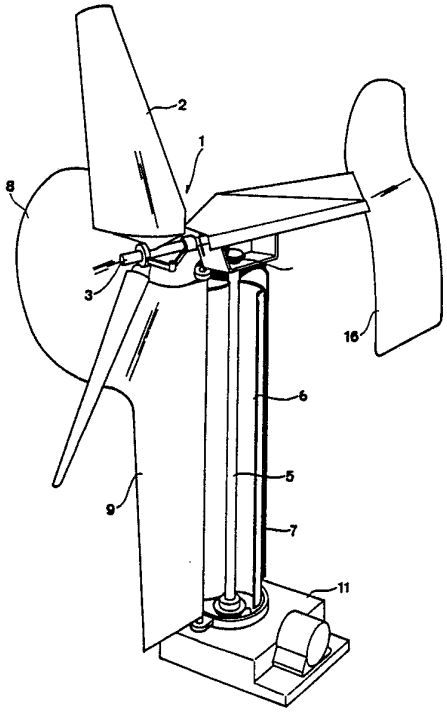
(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent)*, DK, FI, FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), NO, SE (European patent), US.

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: WIND POWER PLANT

(57) Abstract

A wind power plant comprises a blade rotor (1) rotating about a substantially horizontal axis (3) and a generator directly or indirectly driven by the blade rotor, said blade rotor being in a conventional manner intended, in a preferred operating position, to be disposed with its rotation axis (3) directed substantially parallel to the wind direction. In the direction of the rotation axis (3) and in said operating position close behind the propeller blades (2), as viewed in the direction of the wind, at least one screen (8) is so arranged to present surfaces for such a guiding of air streams striking thereupon in the direction of the rotation axis (3) of the blade rotor, that these air streams while co-operating with the propeller blades (2) make a contribution to the power driving the latters and generated as a result of the blade angle thereof.



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Wind power plant

TECHNICAL FIELD OF THE INVENTION AND PRIOR ART

The present invention relates to a wind power plant comprising a blade rotor rotating about a substantially horizontal axis and a generator driven directly or indirectly thereby, said blade rotor being in a conventional manner intended to in a preferred operating position be disposed with its rotation axis directed substantially parallel to the wind direction.

Wind power plants of this type have been developed during the attempts of the passed decades to utilize energy sources being nice to the environment as an alternative to the conventional ones, the utilizing of which interferes more or less in the environment.

Wind power plants of this kind have been installed in all kinds of places where the winds are exceptionally powerful, for instance on the sea coast, on islands and in open places. However, one has always been wrestling with the problem that they deliver an effective output being too low for constituting a satisfying alternative to the conventional energy sources, so far as they are not installed in a very high number, which would on one hand intrude unduly upon the appearance of the

landscape and on the other generate costs being too high and bad economy.

Much energy has been spent on attempts to modify this type of wind power plants, i.e. with a blade rotor with a horizontal rotation axis, so as to make them more efficient. For instance, different appearances of propeller blades and different numbers of propeller blades have been tested, but such modifications have only led to margin effects. The propeller blades can be made larger, but there are also limits therefor.

BRIEF DESCRIPTION OF THE INVENTION

The object of the present invention is to provide a wind power plant of the kind described above, which has a considerably increased generation of power or effective output with respect to wind power plants of this kind already known without making the propeller blades disproportionately big.

This object is obtained according to the invention by the completely new measure within the wind power technique, i.e. by arranging at least one screen in the direction of the rotation axis of the blade rotor and in said operating position close behind the propeller blades, as viewed in the direction of the wind, so that it presents surfaces for such a guiding of air streams striking thereupon in the direction of the rotation axis of the blade rotor, that these air streams while co-operating with the propeller blades make a contribution to the power driving the latter and generated as a result of the blade angle thereof.

Experiments have shown that the arrangement of said screen provided with guiding surfaces in the wind direction behind the propeller blades, has a tremendous influence upon the energy generated by the wind power plant. In these experiments it was possible, from a wind power plant with a screen mounted thereon, to produce as much as 3,5 times the power being produced

with the same wind power plant without the screen. This is obtained thanks to the fact that the invention utilizes the air streams otherwise not influencing the propeller blades and by guiding them towards the rotation axis of the blade rotor also uses these air streams to driving the propeller blades.

Further preferred features and advantages of the invention will appear from the following detailed description of preferred embodiments of the invention as well as the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

With reference to the appended drawings, below follows a specific description of embodiments of the wind power plant according to the invention cited as preferred examples.

In the drawings:

Fig 1a is a perspective view of a first embodiment of the wind power plant according to the invention,

Fig 1b is a view from above of an embodiment of the invention slightly modified with respect to the embodiment according to Fig 1a,

Figs 2 and 3 are schematical views illustrating a possible embodiment of the screen of the wind power plant according to the invention,

Figs 4 and 5 are schematical views illustrating another possible embodiment of the screen of a wind power plant according to the invention, and

Fig 6 illustrates in a front view a further possible embodiment of the screen of a wind power plant according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

A preferred embodiment of the wind power plant according to the invention is shown in Fig 1a obliquely from the front. The power plant comprises a blade rotor 1 with two propeller blades 2 and a substantially horizontal rotation axle 3 intended to be directed parallelly to the wind direction. The propeller blades 2 are in a conventional manner inclined about radial axes radiating from the rotation axle and have accordingly a so called blade angle. The rotation axle 3 is through a bevelled gear 4 connected to a vertical rotation axle 5, which is arranged to directly or indirectly drive a generator not shown at the lower end thereof. The vertical rotation axle 5 is provided with longitudinal blades 6 and a partial cylinder 7 partially covering the blade wheel thus formed for guiding wind striking upon the blades on one side of the vertical rotation axle 5 and thereby push the latter. Thus, the horizontal blade rotor 1 and the vertical rotor co-operate for generating energy. The wind power plant described so far is already known, for instance by the applicant's own patent 7804020-1.

A screen 8 is arranged behind the propeller blades 2, as seen in the direction of the rotation axle 3. This screen is so designed that air streams striking thereon are diverted inwardly towards the rotation axle 3 and then disappear rearwardly through an opening close to said rotation axle. While moving along the surface of the screen towards the rotation axle 3, these air streams act upon the propeller blades 2 in the rotation direction thereof and accordingly make a contribution to the power driving the latters and generated as a result of the blade angle thereof. The screen 8 is continued downwardly through a portion 9 facilitating appropriate leading of air into and towards the blades 6 of the vertical rotation axle. The screen 8 is through the portion 9 pivotably connected to a body 10 about a vertical axis intersecting the rotational axle 3, on which body also the horizontal and vertical rotors are arranged and which is pivotable with respect to a stand 11 about a vertical axis coinciding with the rotation axle 5.

The reason for the pivotability between the body 10 and the stand 11 as well as possible adjustment of the screen 8 with respect to the body 10 will now be explained more in detail with reference made to Fig 1b, which shows a slightly modified embodiment of the invention from above with respect to the wind power plant shown in Fig 1a. The screen 8 is by a hinge hidden by the rotation axle 3 pivotably arranged with respect to the body 10 about a vertical axis. The screen may thanks to this pivotability be pivoted away backwardly when for instance such powerful winds are prevailing, which otherwise would damage the screen, or when a lower power output by the plant is desired. This adjustment of the screen 8 may be carried out by any kind of a power means influenced by a sensor, but in this embodiment takes place automatically by the wind, which will be understood after reading the description following hereinafter. A first link 13 is pivotably arranged on an attachment 12 on the rear side of the screen. The link 13 is through its opposite end pivotably arranged on a first arm 14 of a double-armed lever, which in its turn is pivotably arranged on a portion 15 of the body 10. The body portion 15 extends rearwardly and a bent plate 16 is pivotably arranged on the rear end thereof about a substantially vertical axis. The definition plate here means something that has a considerable surface and is comparatively thin. However, it does not at all have to be completely flat. The plate 16 has a comparatively important surface for exposition to the wind. A second link 18 is pivotably connected at both ends thereof between the second arm 17 of the double-armed lever and an intermediate portion of the plate 16. Furthermore, a sleeve 19 is displaceably arranged on the rotation axle 3 in the longitudinal direction thereof. Link arms 20 are secured to this sleeve, which arms are transformed into one link arm 21, pivotably arranged on the second arm 17 of the lever. Furthermore, third links 22 are at one end thereof pivotably arranged on the sleeve 19 and on their other end pivotably arranged on an attachment 23 each of each one propeller blade 2.

Since substantially the entire screen 8 is arranged on one and the same side of a vertical plane comprising the rotation axle 3 of the rotor and the plate 16 is arranged on the body on the opposite side of said vertical plane with respect to the screen, the wind striking upon the plate 16 will tend to turn the body 10 with respect to the stand 11 in the direction opposite to the one striven after by the wind striking upon the screen 8, and a position of equilibrium will thus be obtained. The screen 8 an` the plate 16 are so designed that they procure an automatic parallel alignment of the rotational axle of the blade rotor with the wind direction, since the position of equilibrium corresponds thereto. The function of the link system just described is the following. The screen 8 will be pivoted rearwardly upon an increasing wind force. The first link 13 will thereby influence the first arm 14 of the lever to pivot in the clockwise direction, as seen in Fig 1b, and thereby through the second link 18 pivot the plate 16 clockwise. The pivoting clockwise of the second arm 17 simultaneously produces a displacement of the sleeve 19 in the wind direction, through which the third links give rise to an increase of the blade angle of the propeller blades 2 pivotably suspended about radial axes in the rotation axle 3. Accordingly, the propeller blades will automatically be less influenced if the wind force increases, since too strong winds otherwise could damage the propeller blades. It would of course be possible to secure or fix any of the parts in the link system so as to obtain a position of for instance the screen 8 or the propeller blades 2 being independent of the wind force. Furthermore, the modification of the blade angle of the propeller blades 2 could be made independent of the pivoting of the screen 8 and the plate 16.

The different embodiments of the screen 8 shown in Figs 2-6 all have in common that the screen constitutes a part of or the whole envelope of an imagined cone, the center axis of which coincides substantially with the rotation axle 3 of the blade rotor and is so directed that the tip thereof points in the

wind direction in the preferred operating position, so that the inner surfaces of the envelope will be exposed to wind and divert air streams striking thereon towards the tip of the cone. One or more escape openings for discharging the wind guided towards the rotation axle of the blade rotor are arranged in these screens.

Reference is now made to Figs 2 and 3. The screen 8 shown in this embodimen consists of two parts forming parts of the envelope of one and the same cone, and it appears from Fig 3 that the cone angle is comparatively blunt. The continuous lines in Fig 3 show how the screen 8 is intended to be located in the optimal operating position thereof, i.e. with the longitudinal edge 24 of the propeller blades located closest to the screen extending substantially parallel to the guiding surfaces of the screen, so that it sweeps closely over the screen upon rotation of the rotor. The propeller blades 2 are in this embodiment slightly inclined in the wind direction, so that also their rear longitudinal edges form a generatrix of a cone formed by the rotation of the blades. However, it would also be possible to displace the point of arranging the propeller blades on the rotation axle to the right as seen in Fig 3, so that the longitudinal edges 24 rotate in a vertical plane. The dashed lines in Fig 3 give a hint of how the screen parts 8 are pivotably arranged with respect to the rotation axle 3 of the blade rotor for adjusting the cone angle thereof in accordance with the prevailing wind force and/or the power generation desired, wherein they on very strong wind forces may be pivoted to the position suggested at 32, so that the tip of the cone points in the direction opposite to the previous one, through which air streams passing the propeller blades and striking on the screen are diverted radially outwardly/rearwardly and do not influence the propeller blades 2.

The rear longitudinal edge 24 of the propeller blades is in Fig 2 the rear longitudinal edge as seen in the clockwise direction, so that the propeller blades will rotate in the clockwise

direction. Air streams striking on the screen 8 will be diverted towards the tip of the imagined cone, as indicated by the arrows in Fig 2, so as to, thereafter, disappear rearwardly through the escape openings 25 located between the two screen parts. The longitudinal edge 24 of the propeller blades located closest to the screen makes, as seen in the direction of the rotation axle of the blade rotor, while extending towards the extremety 26 of the respective blade 2 an angle α with an imagined radius extending from the rotation axle 3 towards the extremety and moves closer thereto. The air streams guided towards the tip of the imagined cone will consequently hit the propeller blade in question close to said longitudinal edge 24 and present a force component pushing the propeller blade in the rotation direction. This characteristic as well as the possible creation of a negative pressure between the front edge 27 of the propeller blades and the screen 8 favourably influence the power generation of the wind power plant.

A second possible embodiment of the screen 8 is illustrated in Figs 4 and 5. One part of one of the propeller blades as well as an upper part of the screen in Fig 5 are broken away for the sake of clarity. The screen is also here constituted by several parts forming parts of the envelope of one and the same cone. These parts are constituted by concentric rings 28 with different diameters. Escape openings 25 are arranged between each ring as the outer edge 29 of each ring is slightly displaced, in said preferred operating position towards the wind direction, with respect to the inner edge 30 of the ring arranged immediately outwardly thereof. It would also be possible to produce escape openings by designing the rings 28 so that the outer diameter of each ring is smaller than the inner diameter of the ring arranged immediately outwardly thereof. Thus, air streams striking on a certain ring will be diverted towards the center of the ring and influence the propeller blades 2 until they disappear out through one of the escape openings 5.

A third conceivable embodiment of the screen 8 is shown in Fig 6. This screen 8 has a cone shape corresponding to the screen according to Figs 4 and 5, but the screen in Fig 6 consists of a continuous cone envelope. This screen is by way of bars 31 secured to a bearing in which the rotation axle 3 of the blade rotor rotates. Escape openings are arranged between these bars 31 for discharging the air streams diverted towards the tip of the cone. Thus, the screen 8 is in this embodiment constituted by an truncated cone.

The invention is of course not in any way restricted to the embodiments described above, but many modification possibilities thereof would be apparent to a man skilled in the art without departing from the basic idea of the invention. The different embodiments of the screen are only some examples of conceivable embodiments, and it is either not necessary for the screen to constitute one or more parts of the envelope of an imagined cone, but it is enough that it gives rise to a diverting of the air streams striking thereon in the direction of the rotation axle of the blade rotor. However, the embodiment of the screen as part of the envelope of an imagined cone would probably be the most preferred screen embodiment.

The screen embodiments according to Figs 2-6 are badly suited to a wind power plant according to Figs 1a, 1b, i.e. where an automatic adjustment only controlled by the wind of the rotation axle of the blade rotor in the wind direction has to take place. Rather would an adjustment with respect to the wind direction through an appropriate power means be suitable in these screen embodiments.

It would also be possible to arrange appropriate power means for adjusting the cone angle of the screens illustrated in Figs 2-5.

Claims

1. A wind power plant comprising a blade rotor (1) rotating about a substantially horizontal axis (3), said blade rotor being in a conventional manner intended to in a preferred operating position be disposed with its rotation axis (3) directed substantially parallel to the wind direction, c h a r a c t e r i z e d in that in the direction of the rotation axis (3) of the blade rotor and in said operating position, close behind the propeller blades (2), as viewed in the direction of the wind, at least one screen (8) is so arranged that it presents surfaces for such a guiding of air streams striking thereupon in the direction of the rotation axis (3) of the blade rotor, that these air streams while co-operating with the propeller blades (2) make a contribution to the power driving the latters and generated as as result of the blade angle thereof.

2. Wind power plant according to claim 1, c h a r a c t e - r i z e d in that the screen (8) constitutes a part of or the entire envelope of an imagined cone, the center axis of which coincides substantially with the rotation axis (3) of the blade rotor and is so directed that its tip in said operating position points in the wind direction, so that the internal surfaces of said envelope will be exposed to the wind and divert air streams striking thereupon towards the tip of the cone, and that the screen (8) is provided with one or more escape openings (25) for discharging the wind guided towards the rotation axis (3) of the blade rotor.

3. Wind power plant according to claim 2, c h a r a c t e - r i z e d in that the propeller blades (2) are inclined with respect to the vertical plane, so that the longitudinal edge (24) located closest to the screen extends substantially parallelly to the guiding surfaces of the screen and is arranged to sweep closely over the screen (8) on rotation of the rotor.

4. Wind power plant according to claims 2 or 3, c h a r a c - t e r i z e d in that the longitudinal edge (24) of the propeller blades located closest to the screen (8), as viewed in the direction of the rotation axis (3) of the blade rotor, makes, while extending towards the extremity (29) of the respective blade (2), an angle (α) with an imagined radius extending from the rotation axis (3) towards the extremity (29) and gets closer to this, so that radially guided air streams, as viewed in said direction, will strike upon the respective propeller blade (2) close to said longitudinal edge (24) and present a power component pushing the propeller blade in the direction of rotation.

5. Wind power plant according to any of the claims 2-4, c h a r a c t e r i z e d in that the screen (8) is pivotably arranged with respect to the rotation axis (3) of the blade rotor for adjustment of the cone angle thereof, and that means are arranged to pivot the screen (8) and adjust the cone angle in accordance with the wind force prevailing and/or the power generation desired and on a wind force lying above a threshold value pivot the screen so that the cone is turned inside out and its tip points in the opposite direction as before, through which air streams passing the propeller blades (2) and striking the screen (8) are diverted radially outwardly-backwardly and do not effect the propeller blades (2).

6. Wind power plant according to any of the claims 2-4, c h a r a c t e r i z e d in that the screen (8) is constituted by an all around continuous cone envelope having one or more escape openings (25) arranged around the rotation axis (3) of the blade rotor at the tip of the cone.

7. Wind power plant according to any of the claims 2-5, c h a r a c t e r i z e d in that the screen (8) is made of several parts forming parts of the envelope of one and the same cone, and that these parts are spaced by through-cuts (25) extending from the base of the cone to the tip thereof.

8. Wind power plant according to any of the claims 2-5, c h a r a c t e r i z e d in that the screen (8) is made of several parts forming parts of the envelope of one and the same cone, that these parts consist of concentric rings (28) with different diameters, and that escape openings (25) are arranged between each ring, either by the fact that the outer diameter of each ring is smaller than the inner diameter of the one arranged immediately externally thereof, or by the fact that in said preferred operating position the outer border of each ring (28) is slightly displaced in the direction of the wind with respect to the inner border (30) of the ring (28) disposed immediately externally thereof.

9. Wind power plant according to claim 5, c h a r a c t e - r i z e d in that a transmission is arranged between the screen (8) and the propeller blades (2) to, on pivoting of the screen for changing the cone angle thereof, influence the propeller blades (2) to pivot, so that their blade angle is changed, and that the transmission is arranged to assure the greater blade angle of the propeller blades (2) the more the screen (8) is pivoted backwardly.

10. Wind power plant according to claim 8 or 9, c h a r a c - t e r i z e d in that the blade rotor (1) and the screen (8) are arranged on a body (10) being pivotable with respect to the fixed stand (11) around a vertical axis preferably intersecting the rotation axis of the blade rotor, that substantially the entire screen (8) is arranged on one and the same side of a vertical plane, comprising the rotation axis (3) of the blade rotor, that a plate (16) is arranged on the body (10) on the opposite side of said vertical plane with respect to the screen (8), so that wind striking on the plate tends to turn the body (10) with respect to the stand (11) in the direction opposite to the direction in which the wind striking onto the screen (8) is aiming at and accordingly a position of equilibrium is obtained, that the screen (8) and the plate (16) are arranged to procure an automatic parallel alignment of the rotation

axis (3) of the blade rotor to the direction of the wind by the fact that the equilibrium position corresponds thereto, that the screen (8) and the plate (16) are pivotably arranged about substantially vertical axes, and that a transmission is arranged between the screen (8) and the plate (16) to transmit the pivoting motion of the screen to the plate, so that the latter is pivoted to expose a larger surface to the wind when the screen is pivoted to expose a larger surface to the wind so as to maintain the position of equilibrium with the rotation axis (3) of the blade rotor in alignment with the direction of the wind.

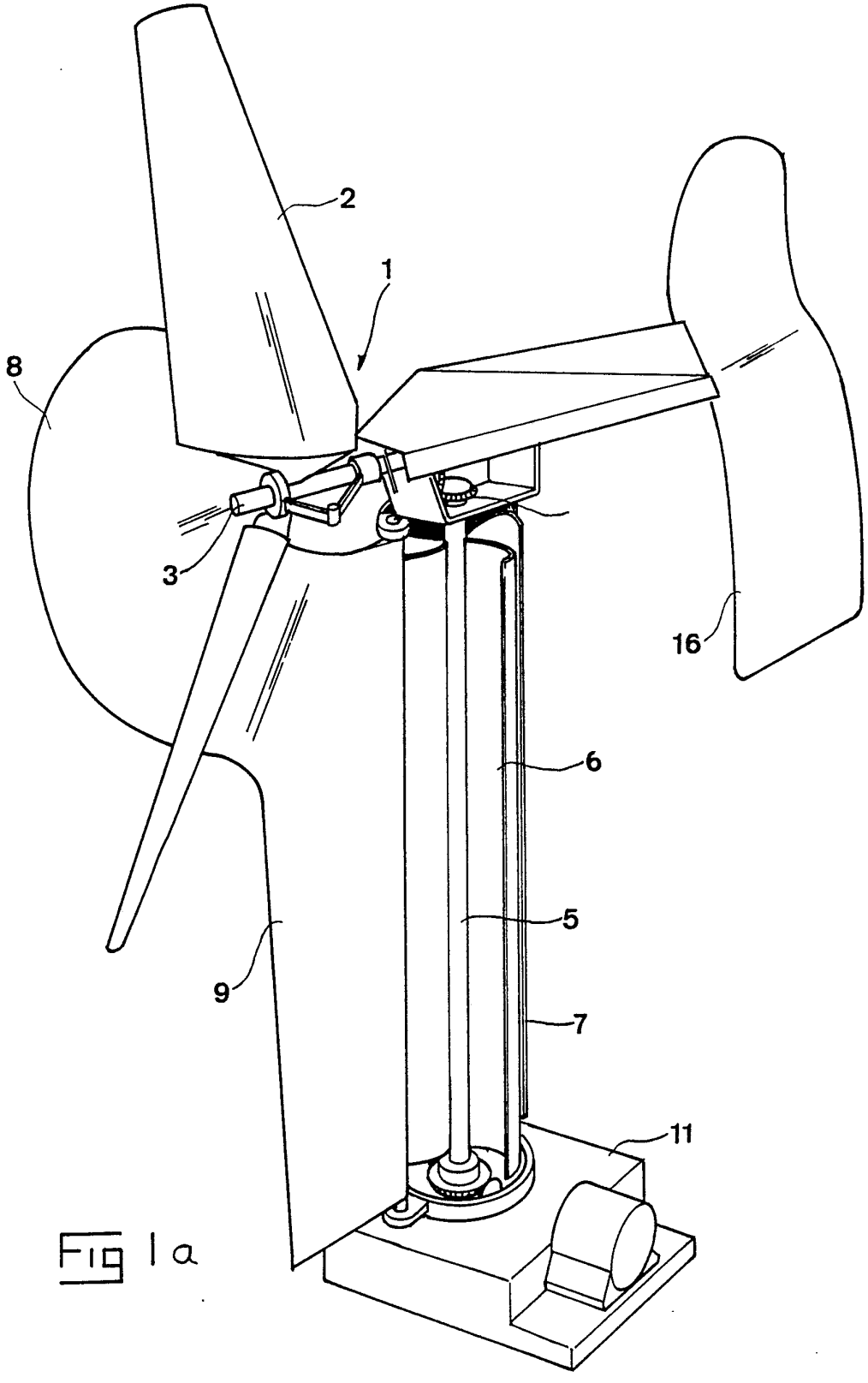

Fig 1a

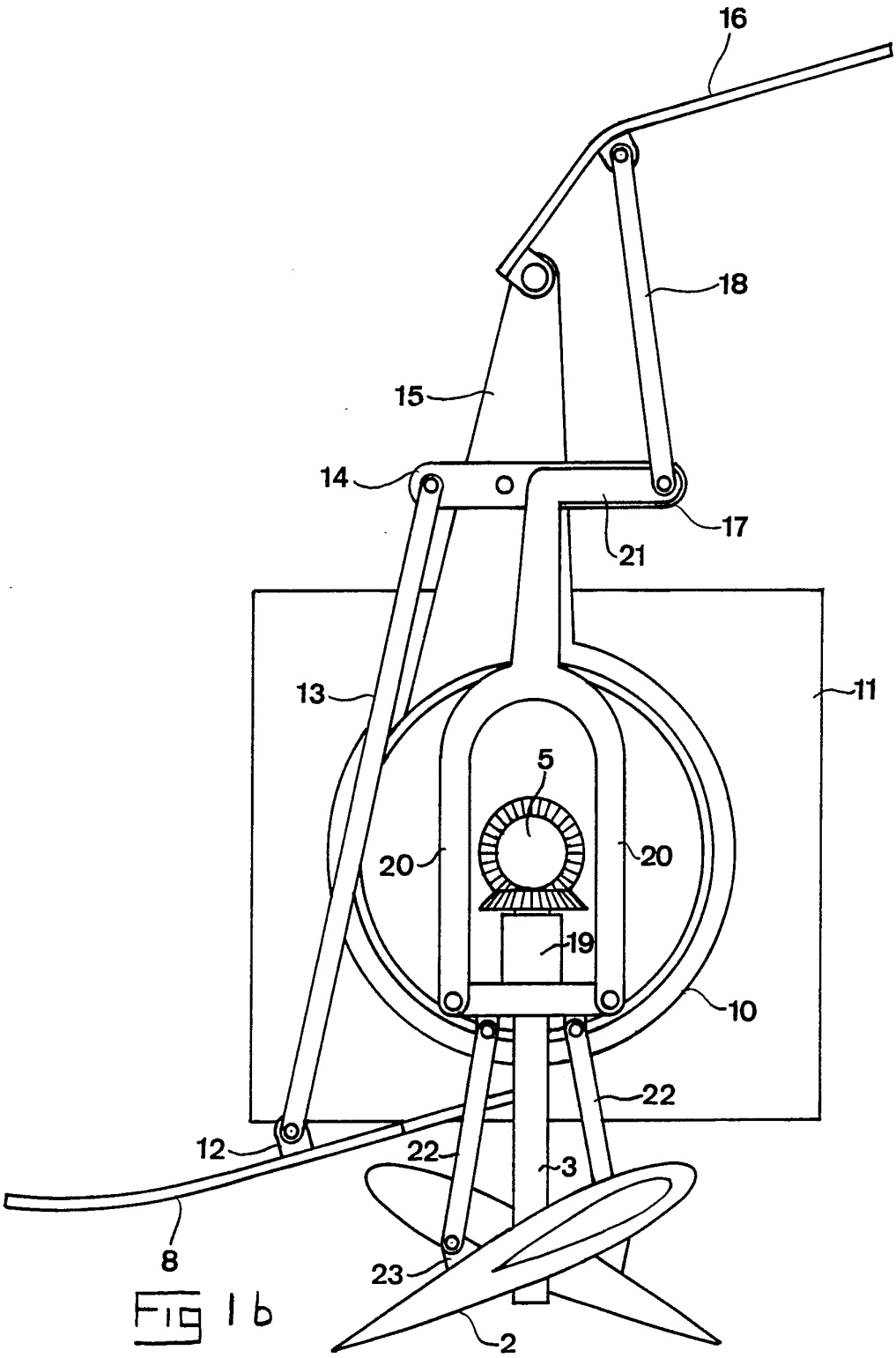

Fig 1b

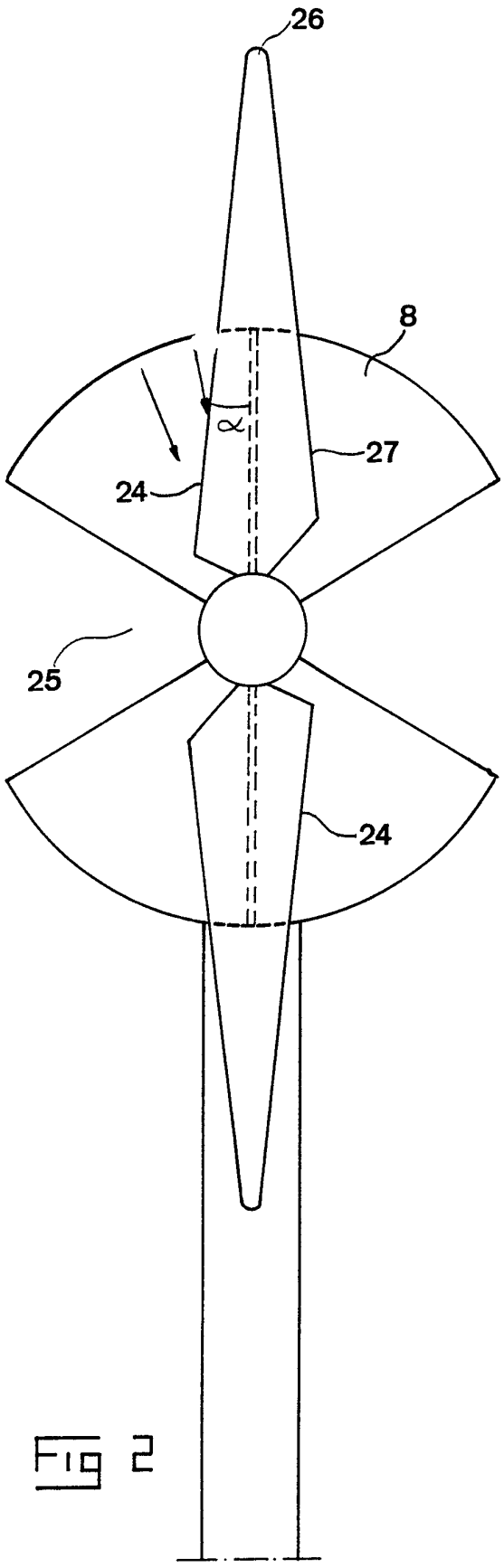

Fig 2

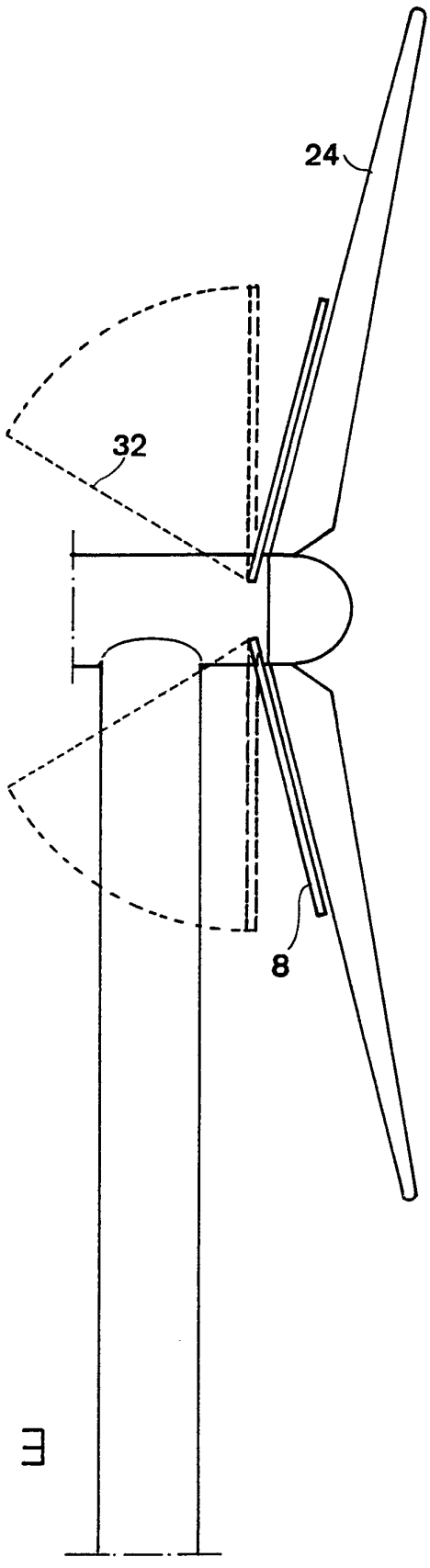

Fig 3

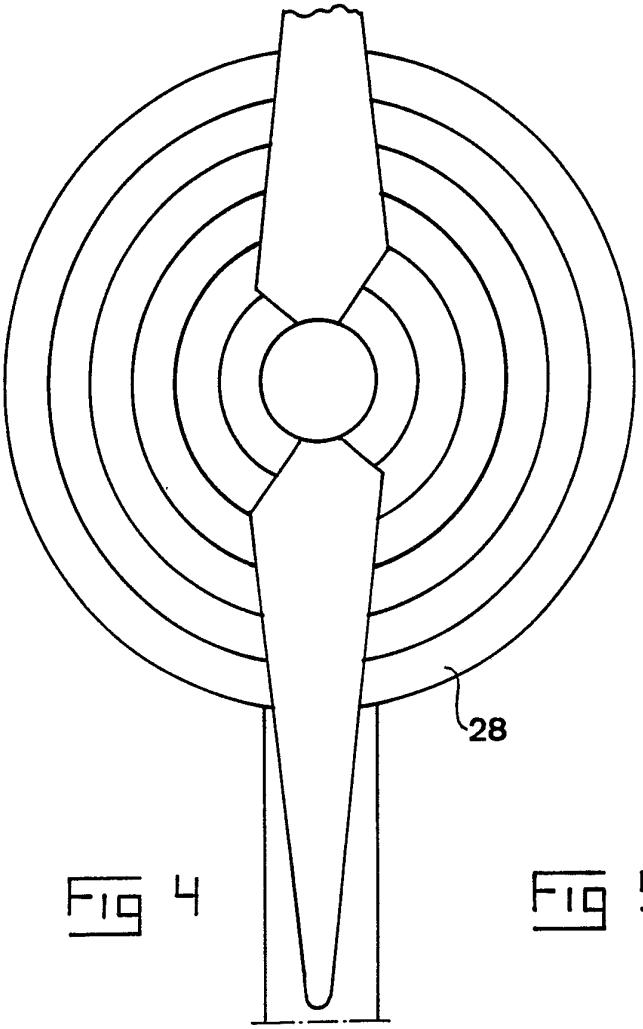

Fig 4

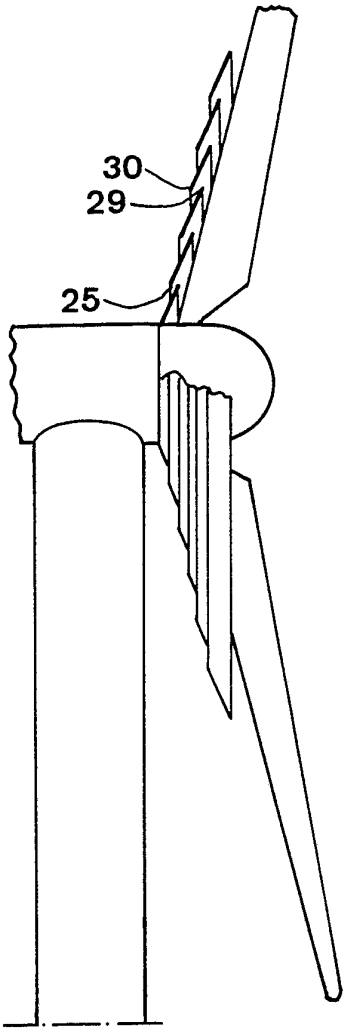

Fig 5

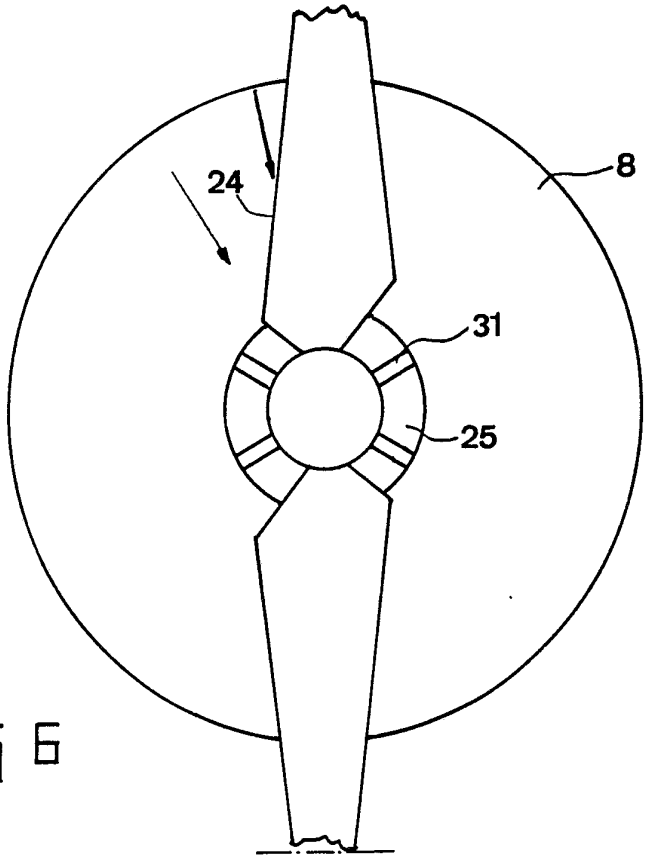

Fig 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 89/00503

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

IPC5: F 03 D 3/04

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	F 03 D

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

SE,DK,FI,NO classes as above

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]
Y	SE, B, 422612 (A B I HOLMGREN) 15 March 1982, see figures 1,2 --	1
A	DE, C, 804090 (PAUL DÜMMEL) 16 April 1951, see figures 1-3 --	
A	DE, C, 686574 (HERMANN HONNEF) 12 January 1940, see figures 1-2 --	
Y	Patent Abstracts of Japan, Vol 7, No 71, M202, abstract of JP 57-212380, publ 1982-12-27 (KATSUO HASHIMOTO) --	1

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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
3rd May 1990	1990 -05- 04
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Krister Bengtsson

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 89/00503

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 90-03-30
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
SE-B- 422612	82-03-15	SE-A- 7804020	79-10-12
DE-C- 804090	51-04-16	NONE	
DE-C- 686574	40-01-12	NONE	