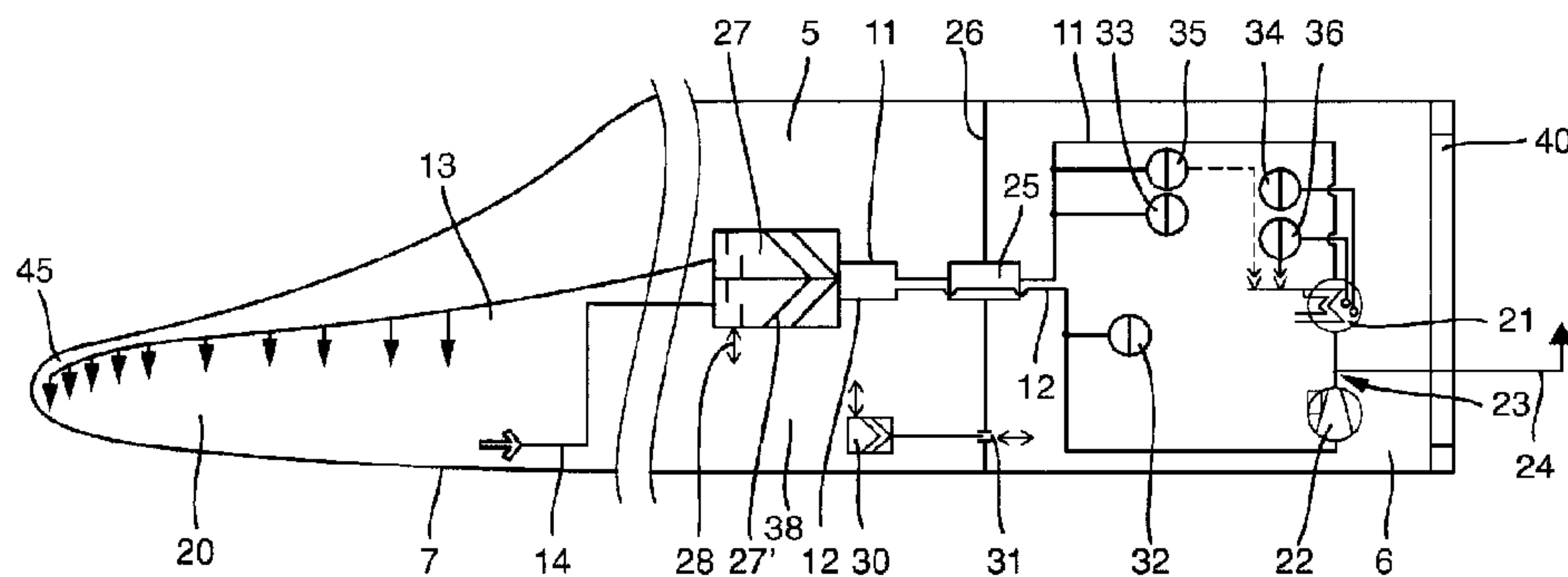




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(54) Titre : DISPOSITIF DE DEGIVRAGE DE PALE DE ROTOR D'UNE EOLIENNE
(54) Title: ROTOR BLADE DE-ICING DEVICE OF A WIND TURBINE



(57) **Abrégé/Abstract:**

The invention relates to a rotor blade de-icing device of a wind turbine (1), wherein the wind turbine (1) has a rotor (10) with at least one rotor blade (5) attached to a hub (4), wherein the rotor blade de-icing device has a heating device (21), a fan (22) and an air-guiding system (9), wherein the air-guiding system (9) has a first duct (11), which conducts a first air stream (13) in the direction of a rotor blade tip (45), and a second duct (12), which conducts a second air stream (14) in the direction of the hub (4).

The rotor blade de-icing device according to the invention is characterized in that the first duct (11) and the second duct (12) are of coaxial form in sections.

Abstract

(in conjunction with figure 3)

5 The invention relates to a rotor blade de-icing device
of a wind turbine (1), wherein the wind turbine (1) has
a rotor (10) with at least one rotor blade (5) attached
to a hub (4), wherein the rotor blade de-icing device
has a heating device (21), a fan (22) and an air-
10 guiding system (9), wherein the air-guiding system (9)
has a first duct (11), which conducts a first air
stream (13) in the direction of a rotor blade tip (45),
and a second duct (12), which conducts a second air
stream (14) in the direction of the hub (4).

15

The rotor blade de-icing device according to the
invention is characterized in that the first duct (11)
and the second duct (12) are of coaxial form in
sections.

5 Rotor blade de-icing device of a wind turbine

Description

10 The invention relates to a rotor blade de-icing device of a wind turbine, and to a corresponding wind turbine.

Rotor blade de-icing devices of wind turbines are basically known. Reference is made for example to the applicant's EP 2 585 713 B1.

15

For rotor blade de-icing, it is basically possible for warm air to be conducted into that region of the rotor blade at which intense ice formation occurs or is to be expected. For this purpose, corresponding heating devices are normally incorporated into a rotor blade. To operate the heating devices, it is necessary for electrical connections for the energy supply and also for closed-loop power control or open-loop control to be incorporated.

25

It is an object of the present invention to provide an improved rotor blade de-icing device which permits reliable and efficient de-icing of rotor blades.

30 Said object is achieved by way of a rotor blade de-icing device of a wind turbine, wherein the wind turbine has a rotor with at least one rotor blade attached to a hub, wherein the rotor blade de-icing device has a heating device, a fan and an air-guiding system, wherein the air-guiding system has a first duct, which conducts a first air stream in the direction of a rotor blade tip, and a second duct, which conducts a second air stream in the direction of

35

the hub, which rotor blade de-icing device is refined in that the first duct and the second duct are of coaxial form in sections.

5 By means of the rotor blade de-icing device according to the invention, it is possible for components of the rotor blade de-icing device that were previously assigned to the rotor blade, that is to say which for example moved together with the rotor blade, because
10 the rotor blades are typically rotated relative to the hub with regard to their angle of incidence relative to the wind, to now be assigned to another component of the wind turbine, for example to the rotor blade hub or hub. In this way, it is possible to eliminate the need
15 for electrical contacts to be realized for example by way of sliding contacts, which are highly susceptible to wear.

The heating device preferably serves for heating the
20 first air stream, wherein, in particular, the fan ensures that the first air stream is generated and is conducted through the heating device in order for the first air stream to be heated. The heated air stream then passes in the direction of the rotor blade tip and
25 is conducted to locations of the rotor blade which are to be de-iced. In the process, the air stream cools and passes, as a second air stream, which can be referred to as cooled air stream, back in the direction of the rotor blade root, and back to the fan again in order to
30 be conducted in the circuit again.

During the heating of the first air stream, the latter is heated to a temperature which lies above 0°C. The first air stream is preferably heated to up to 75°C.
35 Depending on ambient conditions, the air cools, as it flows through the rotor blade, to temperatures which lie in the range between 0°C and 50°C.

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The first duct and the second duct preferably form a concentric double pipe in sections. It is furthermore preferable for a part of the rotor blade de-icing device, in particular the fan and/or the heating device, to be connected positionally fixedly to the hub.

A particularly efficient rotor blade de-icing device is provided if a first part of the ducts of coaxial form is formed positionally fixedly with the hub, and a second part of the ducts of coaxial form is formed positionally fixedly with the rotor blade, wherein a rotary leadthrough is provided for connecting the first part and the second part of the ducts of coaxial form, said rotary leadthrough being arranged in particular in a partition of the rotor blade.

In the case of such an embodiment of the rotor blade de-icing device according to the invention, it is possible for the corresponding rotor blade to be de-iced without great loss of heat. The axis of rotation of the rotary leadthrough preferably corresponds to an axis of rotation of the rotor blade. In this case, the axis of rotation passes through the centre of the ducts of coaxial form. A particularly stable connection is made possible in this way.

The first and the second duct are preferably of coaxial form beyond the rotary leadthrough.

The fan preferably has an axis of rotation which is parallel to an axis of rotation of the rotor. If the fan is oriented in this way, it is subject only to low loads, and has a considerably longer service life. In the other case, if the axis of rotation of the fan is not arranged parallel to an axis of rotation of the rotor, the bearings of the fan are subjected to considerable load, leading to increased wear.

It is preferably provided that that part of the rotor blade de-icing device which is connected positionally fixedly to the hub is connected to the hub in vibration-decoupled or vibration-damped fashion. At least some components of that part of the rotor blade de-icing device which are connected positionally fixedly to the hub should be correspondingly vibration-decoupled or vibration-damped. In particular, the fan and/or the heating device are preferably connected to the hub in vibration-decoupled or vibration-damped fashion.

A substantially closed air-guiding system is preferably provided. The air-guiding system ensures that the air situated in the system in the form of the first and the second air stream is conducted in the circuit such that in particular cooled but still slightly heated recirculated air is heated again, whereby less heating power is required. The still slightly heated recirculated air is preferably warmer than the ambient air around the rotor blade.

The air-guiding system has the smallest possible volume in order to also keep the heating power as low as possible. For this purpose, provision is preferably made for those regions of the rotor blade which are at greater risk of icing, and/or which are of increased relevance in terms of aerodynamics with regard to the operation of the installation, to be heated in targeted fashion. These are in particular the nose region or the blade leading edge of the outer half or outer third of the rotor blade toward the rotor blade tip. Furthermore, provision is preferably made for at least the warm-air supply, or a part of the warm-air supply, to be of insulated form.

It is preferable for one or more opening(s), which is or are in particular of predefinable size, to be provided on a pressure side of the fan for the in particular continuous discharge of air out of the rotor
5 blade de-icing device. It is preferable for at least one opening to be provided between the fan and the heating device. The air that is discharged to the surroundings is thus, at most, at a return line temperature.

10 By means of this measure, a part of the air, including any released gas present, air moisture and any dust, is blown out of the rotor blade or out of the circuit. This firstly gives rise to a pressure reduction in the air circuit, and secondly ice is prevented from being
15 able to accumulate within the rotor blade, for example at the rotary leadthrough.

The above measure is preferably enhanced in that, in a suction region of the air-guiding system in a rotor
20 blade interior, there is or are provided one or more opening(s) for the introduction of air from the rotor blade interior into the air-guiding system. Continuous purging of at least parts of the rotor blade interior and/or of the de-icing system is made possible in this
25 way.

It is preferable for one or more opening(s) through which fresh air can be introduced, in particular via the hub, into the rotor blade interior to be provided
30 in a partition of the rotor blade. A corresponding filter is preferably provided in order to filter the fresh air before it is introduced into the rotor blade. Some of the provided openings, or all of the provided openings, may preferably be closable and/or adjustable
35 in terms of their diameter. Through the provision of a further opening in a partition of the rotor blade and the introduction of fresh air, the concentration of gases that are harmful to health in the blade interior

can be continuously reduced. In the context of the invention, fresh air is to be understood to mean air which is introduced, or flows, into the rotor blade from outside the rotor blade, preferably from outside
5 the wind turbine.

The rotor blade de-icing device may also, by way of special arrangements of the openings or sizes of the openings, be operated as a negative-pressure system, or
10 partially as a negative-pressure system, for the purposes of providing targeted pressure open-loop control and air path open-loop control. It is preferable for the openings, or at least the opening on the pressure side of the fan, to be provided as a
15 permanent passive opening by way of a reduced cross section, such that permanent purging of the interior air of the rotor blade or of the rotor blade interior is made possible. A negative-pressure system has the advantage that no heated air escapes at leakage points,
20 such that energy-efficient de-icing is made possible.

Alternatively, the rotor blade de-icing device may be operated as a positive-pressure system.

25 It is preferable for a first air filter to be provided in the first duct and/or for a second air filter to be provided in the second duct. This prevents dust particles in the interior of the rotor blade, which dust particles were created during the production of
30 the rotor blade or during operation or are possibly still being created, from being deposited on heating elements of the heating device, whereby the risk of fire or explosion upon activation of the heating device is eliminated. The heating device is preferably a
35 heating register.

Furthermore, the respective filters may, in order to permit efficient filtering, be connected in series with

a coarse filter part for coarse parts of high mass and a mechanical capture device for coarse parts and a fine filter for dust particles. Furthermore, a cleaning opening, which is preferably closable, may be provided
5 for efficient cleaning of the filter.

The object is furthermore achieved by means of a rotor blade de-icing device of a wind turbine, wherein the wind turbine has a rotor with at least one rotor blade
10 attached to a hub, wherein the rotor blade de-icing device has a heating device, a fan and an air-guiding system coupling unit, wherein the air-guiding system coupling unit is designed to be connected to an air-guiding system, wherein the air-guiding system has a
15 first duct, which conducts a first air stream in the direction of a rotor blade tip, and a second duct, which conducts a second air stream in the direction of the hub, wherein the first duct and the second duct are or may be of coaxial form in sections. The air-guiding
20 system coupling unit preferably has a rotary leadthrough, in the region of which the first and the second duct are of coaxial form with respect to one another.

25 A wind turbine is preferably equipped with a rotor blade de-icing device as described above.

The invention is furthermore achieved by way of a method for operating a rotor blade de-icing device of a
30 wind turbine, wherein the wind turbine has a rotor with at least one rotor blade attached to a hub, having the steps: heating air by way of a heating device and introducing the heated air by way of a fan into an air-guiding system, which has a first duct, which conducts
35 a first air stream in the direction of a rotor blade tip, and a second duct, which conducts a second air stream in the direction of the hub, wherein the first

duct and the second duct are of coaxial form in sections.

It is preferable for the first air stream to have
5 heated air and/or for the second air stream to have cooled air.

To be able to thaw and shed ice adhering to rotor blades, those surfaces of the rotor blades which are to
10 be de-iced are heated to a temperature higher than 0°C. The heat energy required for this purpose, and the air stream required, are provided by in each case one rotor blade de-icing device, as described above, per rotor blade. Here, a heating device and a fan are provided,
15 preferably in the form of a fan-heater unit, which is arranged within a blade root of the rotor blade and fastened to the rotor hub.

Preferably, the fan-heater unit comprises a fan, a
20 heating device, for example a heating register, and a concentric double pipe in the form of a first and a second duct for the feed and return of the air in the air-guiding system. A counterpart to the concentric double pipe is preferably provided, which counterpart
25 co-rotates with the rotor blade during the pitch adjustment. The counterpart of the rotor blade and the concentric double pipe of the fan-heater unit are preferably connected to one another by way of a rotary leadthrough.

30
By way of an open-loop and closed-loop controller, which is preferably provided externally with respect to the fan-heater unit, the heating device and the fan are actuated and preferably also monitored. The air-guiding
35 system or the ventilation system in each rotor blade is, in terms of basic principle, a closed system, wherein provision may however also be made for small amounts of air to be exchanged or replaced. In this

way, the residual heat in the return line during the rotor blade de-icing process is substantially maintained.

5 The air volume conducted in the circuit in the air-guiding system is preferably 6 m^3 to 20 m^3 . A volume of 8 m^3 to 12 m^3 is particularly preferred. In one exemplary embodiment of the rotor blade de-icing device, between $800 \text{ m}^3/\text{h}$ and $2000 \text{ m}^3/\text{h}$ of air is
10 conveyed in the circuit. It is preferable for approximately $20 \text{ m}^3/\text{h}$ to $100 \text{ m}^3/\text{h}$ of fresh air to be added. However, the invention is not restricted to these ranges. The stated ranges represent preferred embodiments.

15

The ratio of air conveyed in the circuit to freshly added air or fresh air is preferably between 20 and 40, particularly preferably 25 to 30. Fresh air is preferably fed in indirectly, via the air volume of the
20 rotor blade and the supply of the air from the rotor blade into the air conveyed in the circuit, in a region in which the second air stream flows.

Owing to the fixed installation of the heating device and also of the fan or of the fan-heater unit on the
25 hub, the electrical energy supply does not need to be led into the rotating part of the rotor blade, and furthermore, in this way, adequate lightning protection for the electrical energy supply and also for the open-
30 loop control device can be ensured.

By means of the concentric double pipe, which is preferably positioned in the axis of rotation of the rotor blade, the warm feed air is blown via an
35 appropriate counterpart into the duct system or the air-guiding system of the rotor blade, and the cooled return line is led to the suction side of the fan again. By means of this circuit, the heating and fan

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power that is available can be utilized in an efficient manner.

5 The components of the air guide or of the air-guiding system are preferably partially of thermally insulated form. Furthermore, in the air circuit, that is to say in the air-guiding system, there may also be incorporated at least one further component which, for example, mechanically prevents a reversal of the
10 defined air flow. Said component may be a non-return flap or a non-return valve.

The front blade chamber is preferably or alternatively used as a return line in order to simplify the air-
15 guiding system. Material can be saved in this way. Nevertheless, in this case, the air volume that flows through is greater. Nevertheless, the pressure losses in the circuit system or in the air-guiding system are reduced, whereby the volume flow increases and the
20 return line temperature increases, specifically in the case of an unchanged feed line temperature. This can improve the heat transfer conditions.

As an alternative to conventional rotor blade
25 materials, or in addition to these, it is possible, in the zones in which de-icing is to be performed, to use a material which exhibits greater thermal conductivity than the conventional rotor blade material, such as for example glass fibre-reinforced plastic, in order to
30 increase the heat transfer to the blade leading edge. For this purpose, use may be made, for example, of a graphite-containing fibrous material or carbon fibre. As an alternative or additionally the fibre-reinforced plastic can be enhanced with respect to the
35 conductability of temperature by addition of soot or carbon black or by ceramic filler material into the polymer matrix. The last example has the advantage that

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the material of the blade remains electrically non-conducting.

It is preferable for at least the fan and/or the heating device to be fastened to the hub in vibration-decoupled or vibration-damped fashion. In this way, vibrations and deformations of the hub are not transmitted, or are transmitted only to an insignificant extent, to at least the fan and/or the heating device, and vibrations of the fan are preferably not transmitted to the hub. In this way, the service life of the components of the rotor blade de-icing device, and also of further components of the wind turbine, is increased. Elastomer buffers are preferably used for the vibration decoupling.

Preferably or alternatively, a single heating device and a single fan are used for de-icing all of the rotor blades of a wind turbine. In this way, components and space are saved.

Alternatively, it is possible for multiple heating devices and multiple fans to be provided, which are arranged at different sides of the hub, for the purposes of safeguarding against failure.

Preferably or alternatively, the air-guiding systems of the rotor blades are connected hydraulically in series in order that all of the rotor blades can be de-iced by way of a single fan and a single heating device. To provide a hydraulic series connection of the air-guiding systems of the rotor blades for utilization of one fan and one heating device for de-icing purposes, it may be provided that a second duct of a first rotor blade de-icing device, which is assigned to a first rotor blade, is connected to the first duct of a second rotor blade, wherein then, furthermore, the second duct of the second rotor blade is connected to the first

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duct of a third rotor blade, and the second duct of the
third rotor blade is connected to the first duct of the
first rotor blade. In this way, in the case of a rotor
with three rotor blades, all of the rotor blades are
5 correspondingly de-iced.

Provision may furthermore be made for the cooled air
from the second air stream to be caused to flow, for
pre-warming purposes, into the first duct in a further
10 rotor blade, and for the method according to the
invention for operating a rotor blade de-icing device
to subsequently be performed in the first duct of the
further rotor blade. This air stream guidance may also
be performed in permutating fashion. Provision may also
15 be made for the cooled air from the second air stream
to be caused to flow, for follow-up heating purposes,
into the first duct of a rotor blade that has already
previously been heated.

20 Further features of the invention will become clear
from the description of embodiments according to the
invention together with the claims and the appended
drawings. Embodiments according to the invention may
satisfy individual features or a combination of
25 multiple features. The preferred embodiments above
and/or below may be advantageously combined with the
above-discussed solutions according to the invention.

The invention will be described below, without
30 restriction of the general concept of the invention, on
the basis of exemplary embodiments and with reference
to the drawings, wherein, with regard to all details of
the invention that are not discussed in any more detail
in the text, reference is made explicitly to the
35 drawings, in which:

figure 1 shows a schematic view of a wind turbine,

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figure 2 is a schematic illustration of a rotor blade
on a hub,

5 figure 3 is a schematic illustration of the rotor
blade de-icing device according to the
invention,

10 figure 4 is a schematic illustration of a part of the
rotor blade de-icing device according to the
invention in a three-dimensional
illustration,

15 figure 5 is a schematic illustration of a part of the
rotor blade de-icing device according to the
invention in a schematically indicated part
of a rotor blade.

20 In the drawings, identical or similar elements and/or
parts are in each case denoted by the same reference
designations, such that a repeated explanation will be
omitted in each case.

25 Figure 1 schematically shows a wind turbine 1. The wind
turbine 1 comprises a tower 2 on which there is
provided a nacelle 3. Three rotor blades 5 are arranged
on a hub 4. The wind turbine is of horizontal-axis
type. The horizontal axis simultaneously also
30 constitutes the axis of rotation of the rotor 10,
formed from the hub 4 and the rotor blades 5, of the
wind turbine 1. In figure 1, the axis of rotation
points substantially perpendicularly out of the plane
of the drawing.

35 Each rotor blade 5 extends from a rotor blade root 6,
which is arranged on the hub 4, to a rotor blade tip
45.

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In the case of wind turbines 1 installed in cold regions with an atmosphere that gives rise to icing, accumulations of ice commonly occur on the rotor blade, specifically with such intensity that the performance of the installation is considerably reduced, which in the extreme case can lead to the shut-down of the installation. To ensure the operation of the wind turbine, provision is made for the rotor blades 5 to be de-iced by way of corresponding measures.

10

For this purpose, a rotor blade de-icing device of a wind turbine 1 is proposed, which rotor blade de-icing device, as schematically indicated in figure 2, conducts air substantially in a circuit in an air-guiding system 9, which air is heated in the vicinity of the hub 4 or in the vicinity of or in the rotor blade root 6 and is conducted to the rotor blade tip 45 in a first duct 11. In the tip region of the rotor blade 5, the warm air passes into a second duct 12 which is arranged in the vicinity of the blade leading edge 7. The first duct 11 is arranged further toward the trailing edge 8 of the rotor blade 5.

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20

To conduct the heat energy to the locations at which the icing is most likely or most intense, the first duct 11 is equipped with insulation 16 so as to conduct the warm-air stream 13 in the direction of the rotor blade tip 45 with the least possible heat losses. In the region of the rotor blade tip 45, the warm-air stream 13 is, preferably by way of transverse flows 15, conducted in the direction of the rotor blade leading edge 7, around the blade leading edge, which exhibits the greatest icing tendency, specifically in particular that part of the rotor blade leading edge which is arranged toward the rotor blade tip 45. In this way, ice is correspondingly thawed and can fall off. The somewhat cooled air is conveyed, as a cooled air stream 14, back to the heater (not illustrated in figure 2).

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35

On the path to there, the second duct 12 is equipped with insulation 17 in order that the residual heat in the cooled air stream is not lost at locations where it does not need to be released.

5

Figure 3 schematically shows a rotor blade de-icing device according to the invention of a wind turbine 1. The rotor blade 5 is attached to the hub 4, which is merely indicated. Also connected positionally fixedly
10 to the hub is a heating device 21, which may be in the form of a heating register, and the fan 22.

By means of the heating device 21 and the fan 22, warm air is conducted through the first duct 11, via the
15 rotary leadthrough 25, in the direction of the rotor blade tip 45. The warm air is conducted onward, having been filtered by way of a filter 27, in the direction of the rotor blade tip 45. A corresponding warm-air stream 13 is schematically indicated here. The arrows
20 are intended to illustrate the warm-air streams which are conducted into a blade heating chamber 20 which is arranged at the rotor blade nose in the region of the rotor blade tip 45.

25 Cooled air 14 or a cooled air stream 14 passes back via an air filter 27' and the second duct 12 in the direction of the fan 22 via the rotary leadthrough 25.

For corresponding open-loop or closed-loop control of
30 the amounts of air and/or the amount of heat, multiple temperature sensors are provided. For example, the temperature sensor 32, which measures the temperature of the returned air, and the temperature sensors 33 and 34. The temperature sensor 34 measures the heating
35 device temperature or the heating register temperature, and the temperature sensor 33 measures the feed line temperature. The measurement values of the sensors 32, 33 and 34 are provided to an open-loop control unit 44

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(not illustrated) (see figure 5) for the open-loop and/or closed-loop control of the heating device 21 and the fan 22.

5 As a safety measure, there is also provided a temperature sensor 35 which, for example in the presence of an excessively high feed line temperature, can directly shut off the heating device 21. Correspondingly, the heating device can also be shut
10 off by way of the temperature sensor 36, by means of which the heating device temperature is measured.

Furthermore, on the pressure side of the fan 22, there is provided a small opening 23 via which a small volume
15 flow of the air that is conducted in the circuit can be discharged via a purging air line 24. Furthermore, an opening 28 may be provided on the suction side of the air-guiding system 9 or at the inlet side of the filter 27' in order to draw off air from the rotor blade
20 interior and thus permit a removal of gases from the rotor blade interior.

The system may for example be operated with a negative pressure overall.

25 Furthermore, in the partition 26 in which the rotary leadthrough 25 is arranged, there may be provided an opening 31 via which fresh air, which passes into the rotor blade interior for example via the hub 40, passes, having been filtered by way of a filter 30,
30 into the rotor blade interior to the left of the partition 26 in figure 3. Permanent purging is ensured in this way.

35 Figure 4 shows a part of the rotor blade de-icing device according to the invention in a schematic three-dimensional illustration. Said figure illustrates, specifically, a fan-heater unit. The fan 22 is driven

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by way of a correspondingly illustrated motor and conveys air from the second duct 12 to the heating device 21 in the first duct 11. The first duct 11 is the inner duct of the coaxial ducts at the rotary leadthrough 25. The second duct 12 is the outer duct at the rotary leadthrough 25. It is also shown in figure 4 that the fan-heating device unit is held by way of a bracket 37. The bracket 37 is fastened to a hub (not illustrated), and thus the fan 22 and the heating device 21 are realized positionally fixedly with the hub.

Furthermore, corresponding temperature sensors 32, 33, 34, 35 and 36 are indicated. The function of said temperature sensors has already been discussed with regard to figure 3.

Figure 5 schematically shows the fan-heater unit 41 in a schematic illustration in an indicated rotor blade 5. The fan-heater unit 41 is fastened to the hub 4. Also schematically illustrated, in a cut-away view and by way of dash-dotted lines, is a part of a rotor blade 5 comprising an outer shell and two webs 39. Furthermore, the rotor blade interior 38 is illustrated. The rotary leadthrough 25 is incorporated in the partition 26.

Also illustrated is an open-loop control device 44 for the open-loop control of the components of the rotor blade de-icing device according to the invention. The open-loop control device 44 may also serve for the open-loop and/or closed-loop control of the rotor blade de-icing devices of further rotor blades.

Finally, the connection of the rotor blade 5 to the hub 4 is illustrated. A rotor bearing 42 is shown, wherein it is possible, by way of the positioning drive 43, for the rotor blade 5 to be adjusted in terms of its angle of incidence relative to the wind, specifically about

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an axis of rotation 46. Since the fan-heater unit 41 and thus the fan 22 and the heating device 21 are connected positionally fixedly to the hub 4, and at the same time a pitch adjustment of the rotor blade 5 is possible, a rotary leadthrough 25 is provided in the region of the partition 26, because the fan-heater unit 41 remains positionally fixed with the hub, whereas the rotor blade 5 with the partition 26, and the further lines and possible filters which are arranged in the rotor blade 5 and which lead to the rotor blade tip, co-rotate with the rotor blade 5.

All of the stated features, even the features that emerge only from the drawings and also individual features that are disclosed in combination with other features, are regarded as being essential to the invention individually and in combination. Embodiments according to the invention may be satisfied by individual features or a combination of multiple features. In the context of the invention, features referred to using "in particular" or "preferably" are to be understood as optional features.

25

List of reference designations

	1	Wind turbine
	2	Tower
5	3	Nacelle
	4	Hub
	5	Rotor blade
	6	Rotor blade root
	7	Blade leading edge
10	8	Blade trailing edge
	9	Air-guiding system
	10	Rotor
	11	First duct
	12	Second duct
15	13	First air stream
	14	Second air stream
	15	Transverse flow
	16	Insulation
	17	Insulation
20	20	Blade heating chamber
	21	Heating device
	22	Fan
	23	Opening, pressure side
	24	Purging air line
25	25	Rotary leadthrough
	26	Partition
	27, 27'	Filter
	28	Opening, suction side
	30	Filter
30	31	Opening, blade partition
	32	Temperature sensor
	33	Temperature sensor
	34	Temperature sensor
	35	Temperature sensor with hardware deactivation
35	36	Temperature sensor with hardware deactivation
	37	Bracket
	38	Rotor blade interior
	39	Web

	40	Hub connection
	41	Fan-heater unit
	42	Rotor bearing
	43	Positioning drive
5	44	Open-loop control device
	45	Rotor blade tip
	46	Axis of rotation

Patent Claims

1. Rotor blade de-icing device of a wind turbine (1),
wherein the wind turbine (1) has a rotor (10) with
5 at least one rotor blade (5) attached to a hub (4),
wherein the rotor blade de-icing device has a
heating device (21), a fan (22) and an air-guiding
system (9), wherein the air-guiding system (9) has
10 a first duct (11), which conducts a first air stream
(13) in the direction of a rotor blade tip (45), and
a second duct (12), which conducts a second air
stream (14) in the direction of the hub (4),
characterized in that the first duct (11) and the
second duct (12) are of coaxial form in sections.
15
2. Rotor blade de-icing device according to Claim 1,
characterized in that a part of the rotor blade de-
icing device is connected positionally fixedly to
the hub (4).
20
3. Rotor blade de-icing device according to Claim 2,
wherein the part of the rotor blade de-icing device
includes the fan (22) and/or the heating device
(21).
25
4. Rotor blade de-icing device according to any one of
claims 1 to 3, characterized in that a first part
of the ducts (11, 12) of coaxial form is formed
positionally fixedly with the hub (4), and a second
30 part of the ducts (11, 12) of coaxial form is formed
positionally fixedly with the at least one rotor
blade (5), wherein a rotary leadthrough (25) is
provided for connecting the first part and the
second part of the ducts (11, 12) of coaxial form.
35

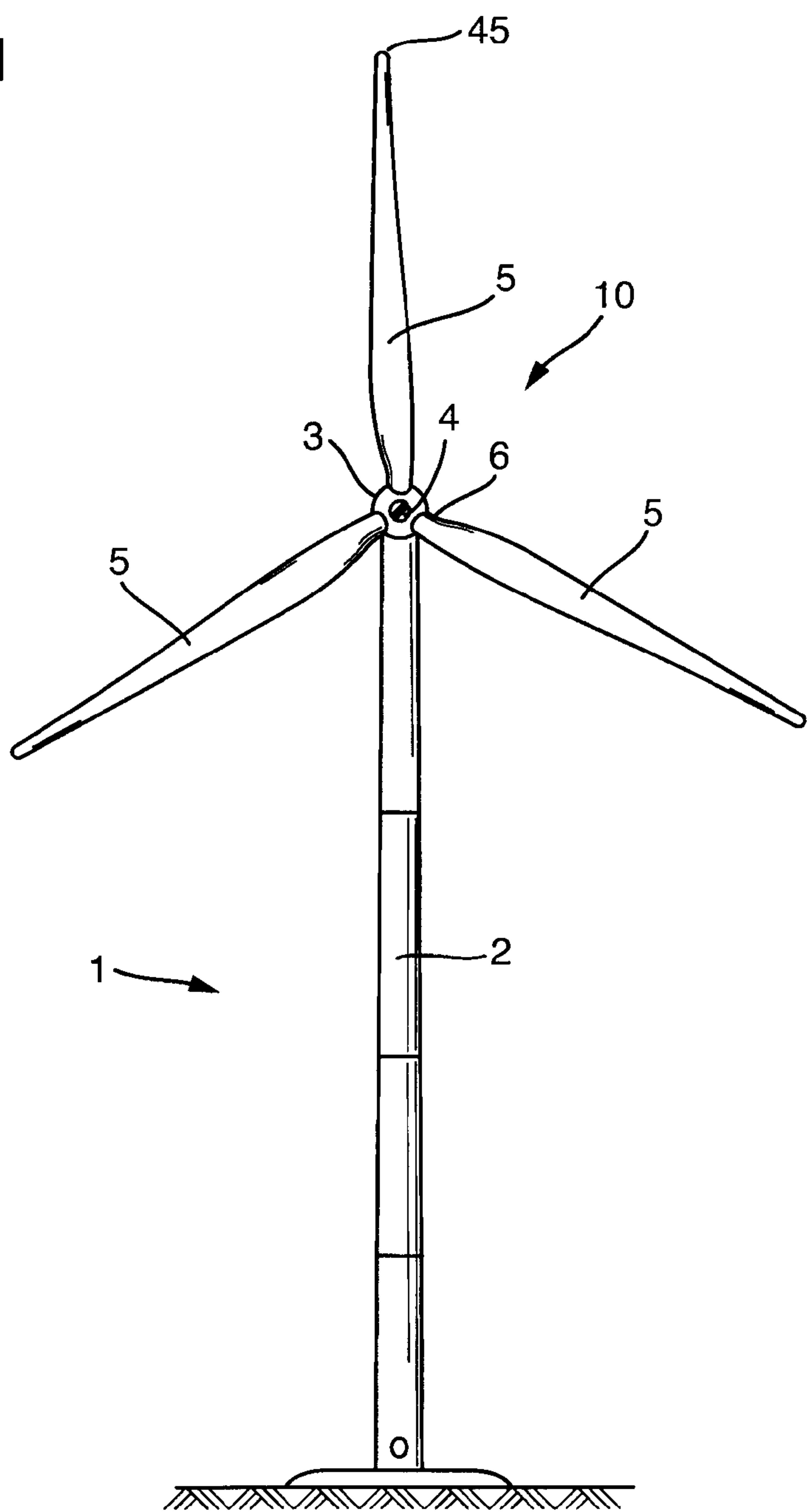
5. Rotor blade de-icing device according to Claim 4, characterized in that the axis of rotation (46) of the rotary leadthrough (25) corresponds to an axis of rotation (46) of the at least one rotor blade (5).
5
6. Rotor blade de-icing device according to any one of Claims 1 to 5, characterized in that the fan (22) has an axis of rotation which is parallel to an axis of rotation of the rotor (10).
10
7. Rotor blade de-icing device according to any one of Claims 2 to 6, characterized in that that part of the rotor blade de-icing device which is connected positionally fixedly to the hub (4) is connected to the hub (4) in vibration-decoupled or vibration-damped fashion.
15
8. Rotor blade de-icing device according to any one of Claims 1 to 7, characterized in that a substantially closed air-guiding system (9) is provided.
20
9. Rotor blade de-icing device according to any one of Claims 1 to 7, characterized in that one or more opening(s) (23) is or are provided on a pressure side of the fan (22).
25
10. Rotor blade de-icing device according to Claim 9, wherein each of the one or more openings has a predefineable size.
30
11. Rotor blade de-icing device according to Claim 9 or 10, wherein the one or more openings are provided for continuously discharging air out of the rotor blade de-icing device.
35

12. Rotor blade de-icing device according to any one of Claims 9 to 11, characterized in that, in a suction region of the air-guiding system (9), in a rotor blade interior (38), there is or are provided one or more opening(s) (28) for the purposes of introducing air into the air-guiding system (9) from the rotor blade interior (38).
13. Rotor blade de-icing device according to Claim 12, characterized in that, in a partition (26) of the at least one rotor blade (5), there is or are provided a further opening (31) or multiple further openings (31) through which fresh air can be introduced into the rotor blade interior (38).
14. Rotor blade de-icing device according to any one of Claims 1 to 13, characterized in that a first air filter (27) is provided in the first duct (11) and/or a second air filter (27') is provided in the second duct (12).
15. Wind turbine (1) having a rotor blade de-icing device according to any one of Claims 1 to 14.
16. Method for operating a rotor blade de-icing device of a wind turbine (1), wherein the wind turbine (1) has a rotor (10) with at least one rotor blade (5) attached to a hub (4), having the steps:
heating air by way of a heating device;
introducing the heated air by way of a fan into an air-guiding system (9); wherein the air-guiding system (9) has a first duct (11) and a second duct (12), wherein the first duct (11) and the second duct (12) are of coaxial form in sections;
conducting a first air stream (13) in the direction of a rotor blade tip (45) by way of the first duct (11), and conducting a second air stream (14) in the

direction of the hub (4) in sections coaxially to the first air stream (13) by way of the second duct (12).

- 5 17. Method according to Claim 16, characterized in that the first air stream (13) has heated air and/or the second air stream (14) has cooled air.

Fig. 1



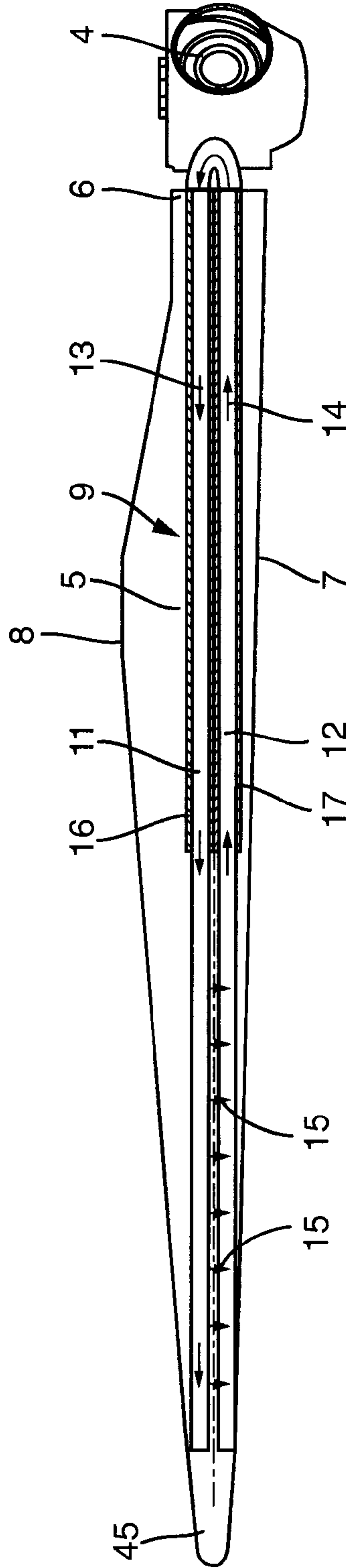


Fig. 2

Fig. 3

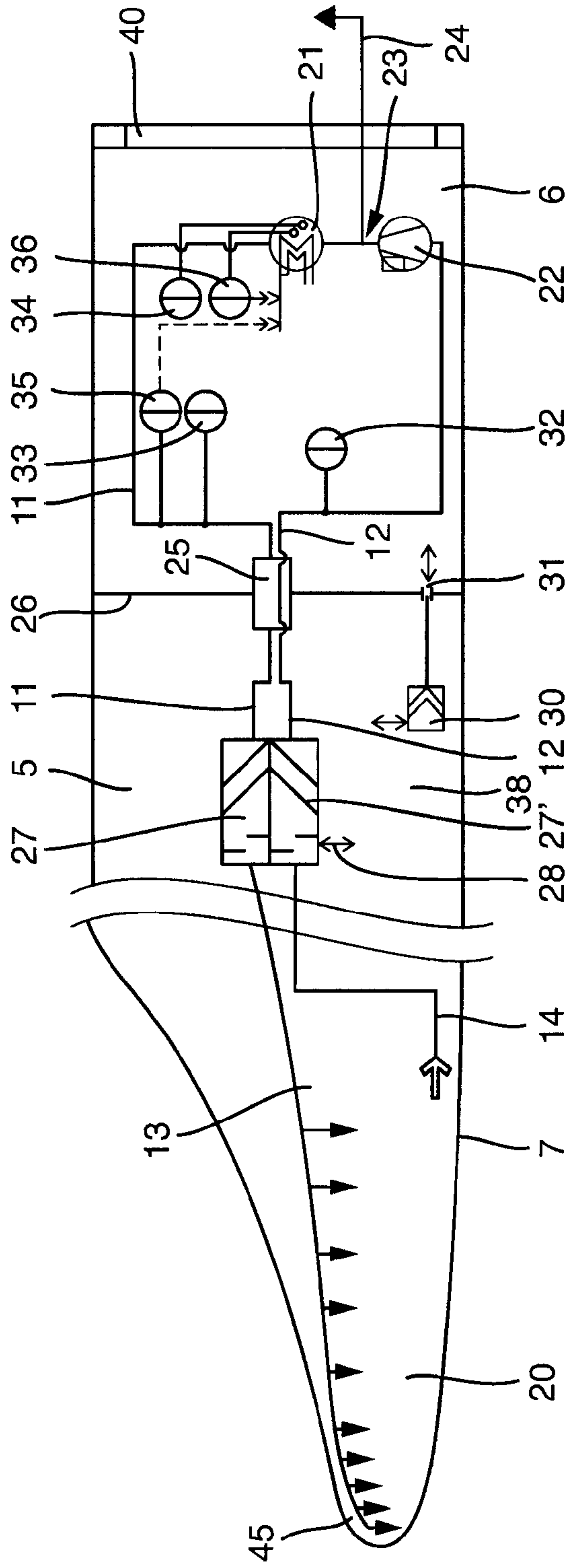


Fig. 4

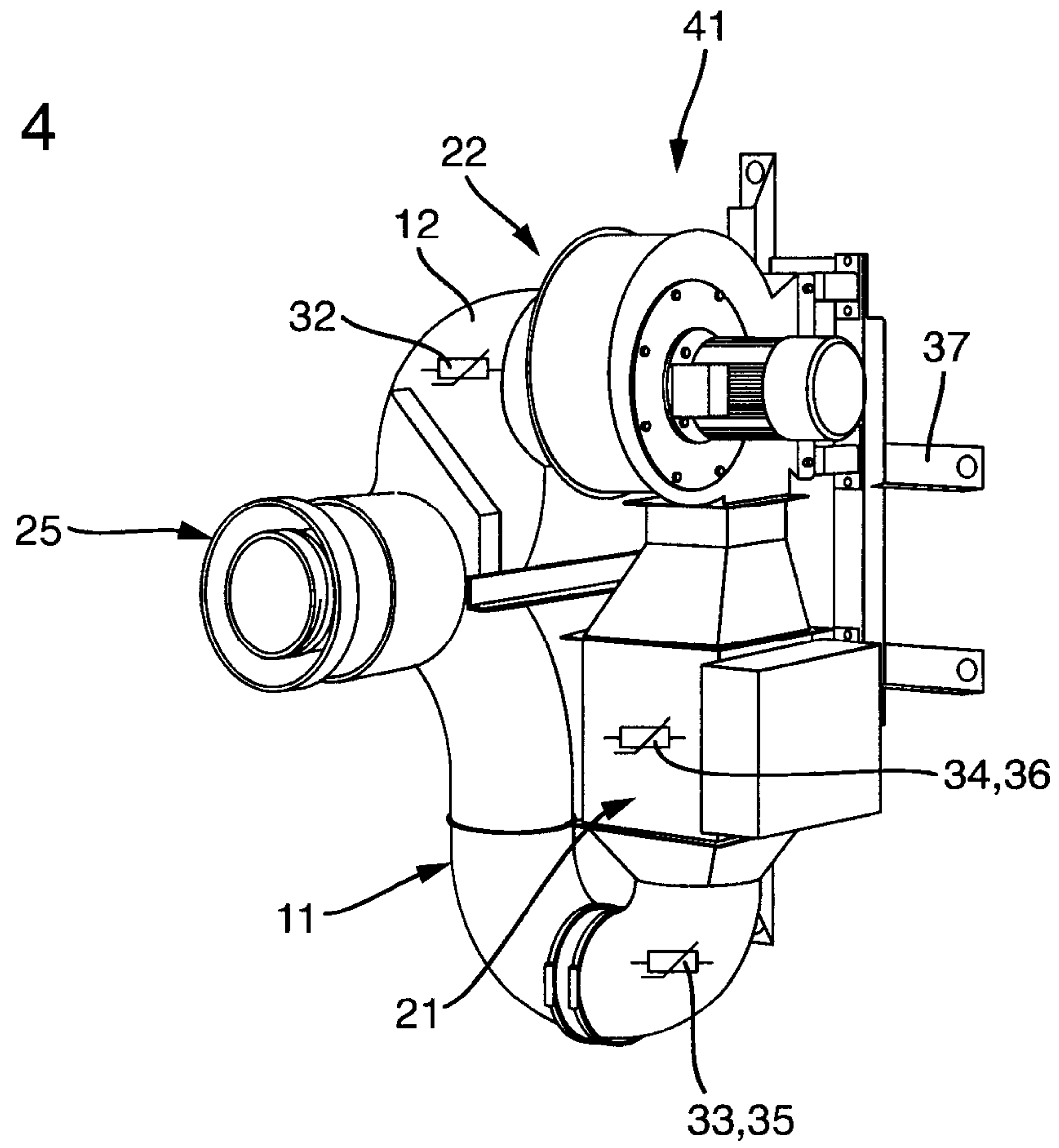


Fig. 5

