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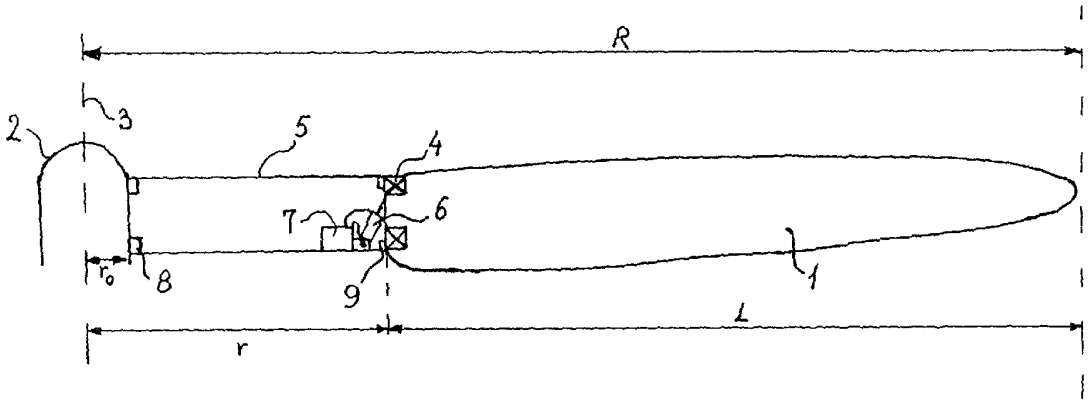
(54) Title: WIND TURBINE ROTOR CONSTRUCTION



(57) Abstract: In a wind turbine rotor construction comprising a number of blades (1) connected to a hub (2) for rotation on a mainly horizontal rotational axis (3), the connection between at least one blade (1) and the hub (2) comprises a hub extension (5) providing an increase r in a radial dimension R of the blade, said radial dimension being defined as the distance R from the rotational axis (3) to the outer end of the blade (1). The hub extension provides an increase in the produced power corresponding to the increased area swept by the blades.

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WIND TURBINE ROTOR CONSTRUCTION

TECHNICAL FIELD

The present invention relates to a wind turbine construction of the kind set forth in the preamble of claim 1.

BACKGROUND ART

In wind turbine rotor constructions of this kind, it is known to provide the wind turbine rotor with a number of blades connected to a hub for rotation on a mainly horizontal rotation axis, and providing a pitch control of the blade by a suitable bearing construction positioned at the connection between the blades and the hub. A wind turbine rotor construction of this kind is known from US-5,660,527.

From WO 01/55590 it is furthermore known to provide a wind turbine rotor construction with two rotors in tandem, in which connection it is indicated to be possible to provide the pitch control for the larger rotor at a distance from the rotation axis corresponding to the diameter of the small rotor, whereby the pitch control mechanism can be dimensioned smaller.

DISCLOSURE OF THE INVENTION

It is the object of the present invention to provide a wind turbine rotor construction of the kind referred to above, with which it is possible to increase the power generation in a simple manner, and this object is achieved with a wind turbine rotor construction of said kind, which according to the present invention also comprises the features set forth in the characterising clause of claim 1. With this arrangement, the power generation is increased corresponding to the increased area swept by the blades and this is achieved without providing any further means for compensating for the possible reduced aerodynamic efficiency, such as e.g. the separate small rotor, considered necessary in accordance with WO 01/55590. Preferred embodiments of

the invention, the advantages of which are revealed in the following detailed description, are the subject of the subordinate and further independent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed part of the present description, the invention will be explained in more detail with reference to the exemplary embodiments of a wind turbine rotor construction according to the invention shown in the drawings, in which

Figure 1 schematically shows a wind turbine rotor construction in accordance with the present invention,

Figure 2 schematically shows the increase in power generation as a function of the radial dimension r of the hub extension, and

Figure 3 is a curve indicating the reduction in torque load on the bearing for the pitch control of the blade as a function of the radial position of said bearing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The wind turbine rotor construction shown in Figure 1 comprises a number of blades 1 (only one shown) connected to a hub 2 for rotation on a mainly horizontal rotation axis 3. A hub extension 5 is provided between the hub 2 and the blade 1, thereby increasing the radial dimension R of the rotor construction and thus the area swept by the blade 1. This will increase the generated power approximately proportional to the increased swept area. A bearing construction 4 is positioned between the blade 1 and the hub 2 in order to be able to control the pitch of the blade 1, said pitch control being used for controlling the turbine load by controlling the power output and the rotational speed of the wind turbine rotor. In the wind turbine rotor construction shown in Figure 1, the position of the bearing 4 is differing from the traditional positioning inside the hub 2, said bearing 4 being positioned at a distance r from the rotational axis 3, and this extra distance is provided by means of a hub extension 5 being fixedly connected to the hub 2 and supporting the bearing construction 4 for mounting the blade 1. The hub extension 5 is an aerodynamically inactive part, i.e. the hub extension 5 does not contribute significantly to the power

generation of the wind turbine rotor, but may be formed in an aerodynamically suitable way in order to reduce the windbreaking function of the hub extension 5.

The curve shown in Figure 2 indicates the increase in power production as a function of the radial dimension r of the hub extension for a construction in which the radial dimension L of the blade is kept constant and the hub extension is varied. The curve is calculated for a radial dimension L of the blade 1 equal to 45 metres.

The curve shown in Figure 3 indicates how the torque load on the bearing construction 4 is reduced, when the radial distance r is increased from being equal to the radius r_o of the hub 2, and shows that a reduction of approximately 50% can be achieved with a radius r equal to approximately 15 metres for the construction for which these calculations have been made in this graphical illustration, namely a rotor radius R equal to 45 metres.

As can be seen from the above curve in Figure 2, it is possible to increase the produced energy and maintain full control of the pitch of the wind turbine rotor construction, allowing traditional pitch control. The construction in accordance with Figure 1 comprises a pitch mechanism 6, 7 in the form of a hydraulic piston 6 driven by a hydraulic drive unit 7 mounted in the hub extension 5. As an alternative, the pitch control can be performed by means of other types of mechanical drive means, such as electrical drive, pneumatic drive, etc.

From the curve shown in Figure 3, it can be seen that the torque load on the bearing 4 for the pitch control mechanism of the blade is reduced in accordance with the radial position r of the bearing 4. Correspondingly, the pitch control mechanism 6, 7 can be reduced in size due to the reduced torque.

In the construction shown in Figure 1, the hub extension 5 is provided as a separate unit connected to the hub 2 by means of suitable connecting means 8 and connected to the blade 1 and the corresponding pitch bearing 4 by means of suitable connecting means 9. The hub extension 5 shown in Figure 1 contains the necessary pitch mechanism 6, 7 for controlling the pitch of the blade 1.

The blade 1 for connecting to the hub extension 5 is preferably dimensioned in its aerodynamic profile in accordance with the increased radial position of the blade 1. The provision of the hub extension 5 and the blade 1 as separate elements makes the transport of these separate elements from the production site to the erection site easier due to the relative smaller dimensions r, L compared to the total dimension R of the rotor blade with similar radial dimension. Furthermore, the adapted aerodynamic profile of the blade 1 is slimmer than would be the case if the blade 1 extended all the way in direction of the hub 2.

In a simplified version, it would be possible to provide an existing wind turbine with a hub extension 5 without changing the profile of the blade 1 and thus increase the possible power generation of the wind turbine correspondingly. However, the adaptation of the profile of the blade 1 will provide a further increase in the generated power. Furthermore, it may be necessary to reduce the rotational speed of the wind turbine rotor in order to keep the speed of the tip of the blade 1 below certain limits dictated by among other things the noise generation from the wind turbine.

Above, the invention has been described in connection with preferred embodiments thereof and numerous variations can be envisaged within the scope of the following claims.

WIND TURBINE ROTOR CONSTRUCTION

CLAIMS

1. Wind turbine rotor construction comprising a number of blades (1) connected to a hub (2) for rotation on a mainly horizontal rotational axis (3), c h a r a c t e r i s e d by the connection between at least one blade (1) and the hub (2) comprising a hub extension (5) providing an increase r in a radial dimension R of the blade, said radial dimension being defined as the distance R from the rotational axis (3) to the outer end of the blade (1).

2. Wind turbine rotor construction in accordance with claim 1, c h a r a c t e r i z e d by said increase r amounting to at least 15% of the total radial dimension R.

3. Wind turbine rotor construction in accordance with claim 1 or 2, c h a r a c t e r i s e d by the aerodynamic profile of the blade (1) being dimensioned in accordance with the increased radial position of the blade (1).

4. Wind turbine rotor construction in accordance with any of the preceding claims, c h a r a c t e r i s e d by the connection between each blade (1) and the hub (2) comprising a hub extension (5).

5. Wind turbine rotor construction in accordance with any of the preceding claims c h a r a c t e r i s e d by the connection between the hub (2) and the blade (1) comprising a pitch bearing (4) allowing pitch control of the blade (1).

6. Wind turbine rotor construction in accordance with claim 5, c h a r a c t e r i s e d by the pitch bearing (4) being positioned at the outer end of the hub extension (5).

7. Wind turbine rotor construction in accordance with claim 5 or 6, c h a r a c t e r i s e d by the pitch control mechanism (6, 7) being positioned at the pitch bearing (4).

8. Wind turbine rotor construction in accordance with any of the claims 5-7, characterised by the pitch control mechanism comprising a hydraulic piston (6) for controlling the pitch of the blade (1).

9. Wind turbine rotor construction in accordance with claim 8, characterised by the hydraulic station (7) for supplying hydraulic fluid under pressure to the hydraulic piston (6) being positioned close to the pitch control mechanism (6).

10. Wind turbine rotor construction in accordance with any of the claims 5-7, characterized by the pitch control mechanism comprising an electrical drive mechanism.

11. Blade construction for use in connection with a wind turbine rotor construction with a hub extension (5), characterised by the blade (1) having an aerodynamic profile dimensioned in accordance with the increased radial position of the blade (1).

12. Hub extension (5) for a wind turbine rotor construction, characterised by comprising means (8) for connecting to the hub (2) and means (9) for connecting to the blade (1), the connection to the blade (1) comprising a bearing (4) for allowing pitch control of the blade (1).

13. Hub extension (5) in accordance with claim 12, characterised by the pitch control mechanism (6, 7) being positioned close to the bearing (4).

14. Hub extension (5) in accordance with claim 12 or 13, characterised by the pitch control mechanism (6, 7) being provided in the form of a hydraulic or electric drive (6, 7).

15. Method of increasing the power generated by a wind turbine rotor construction, characterised by comprising the steps of increasing the area swept by the blades (1) by inserting a hub extension (5) between the hub (2) and the blade (1).

16. Method in accordance with claim 15, c h a r a c t e r i s e d by further comprising the step of adapting the profile of the blade (1) to the increased radial position thereof.

17. Method in accordance with any of the claims 15 or 16, c h a r a c t e r i s e d by further comprising the step of reducing the rotational speed of the wind turbine rotor in accordance with the increased radial dimension of the rotor construction.

18. Method in accordance with claim 17, c h a r a c t e r i s e d by further comprising the step of adapting the profile of the blade (1) to the reduced rotational speed of the wind turbine rotor construction.

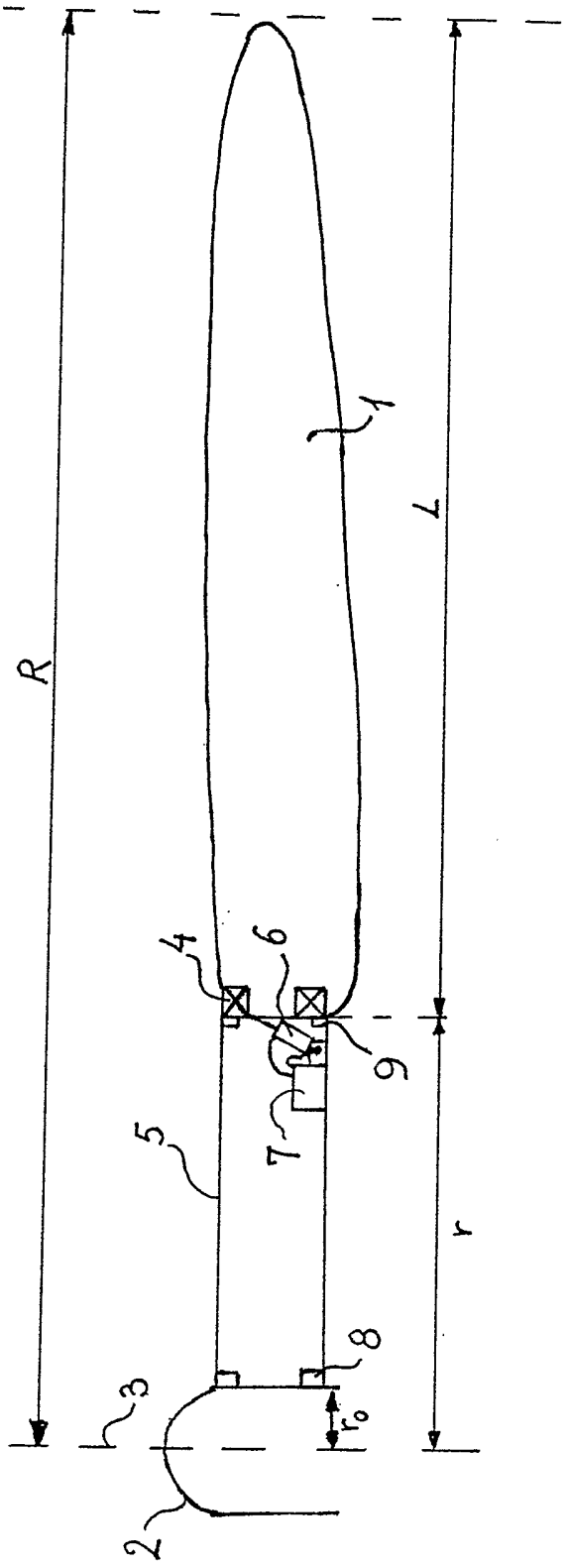

Fig. 1.

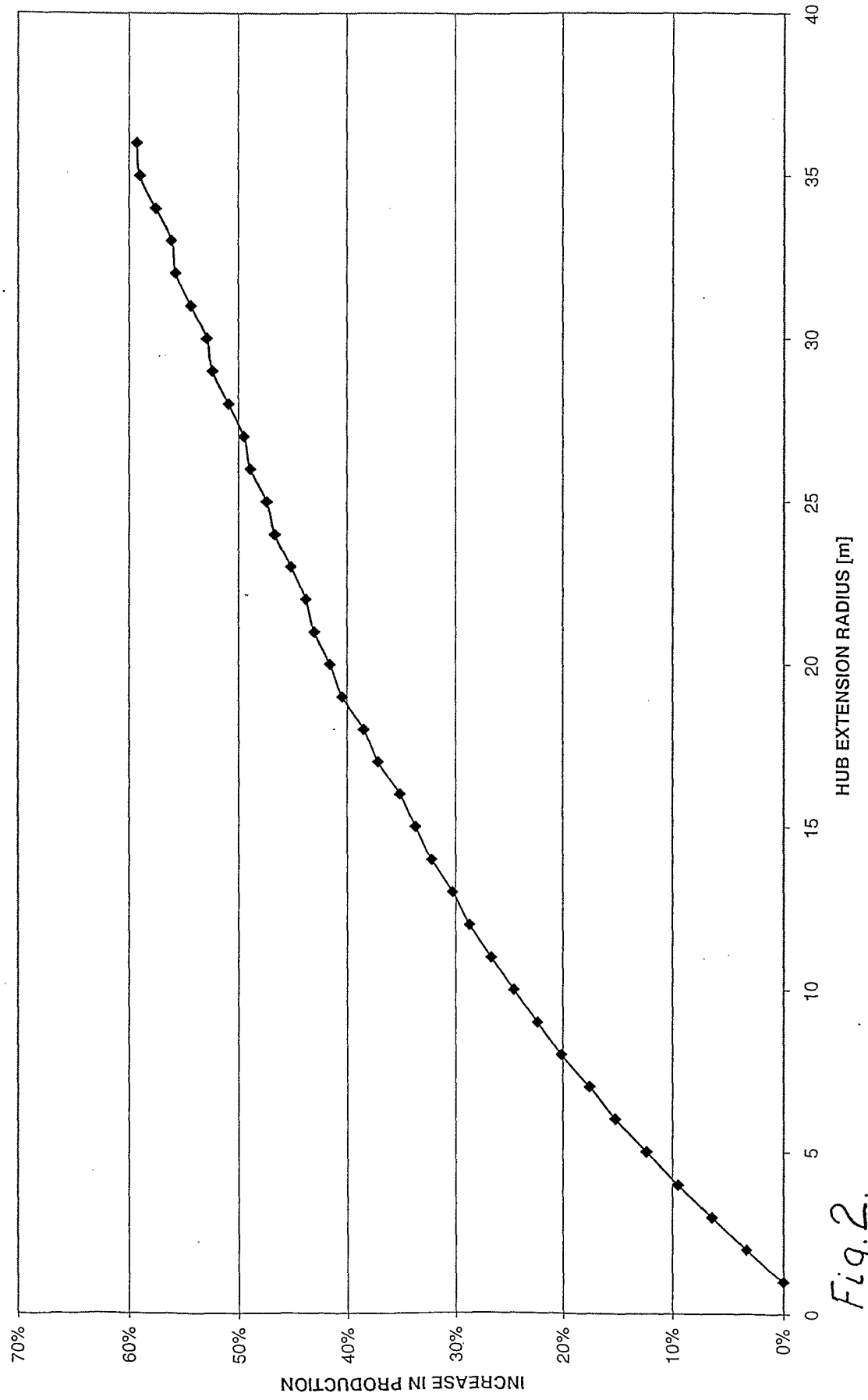
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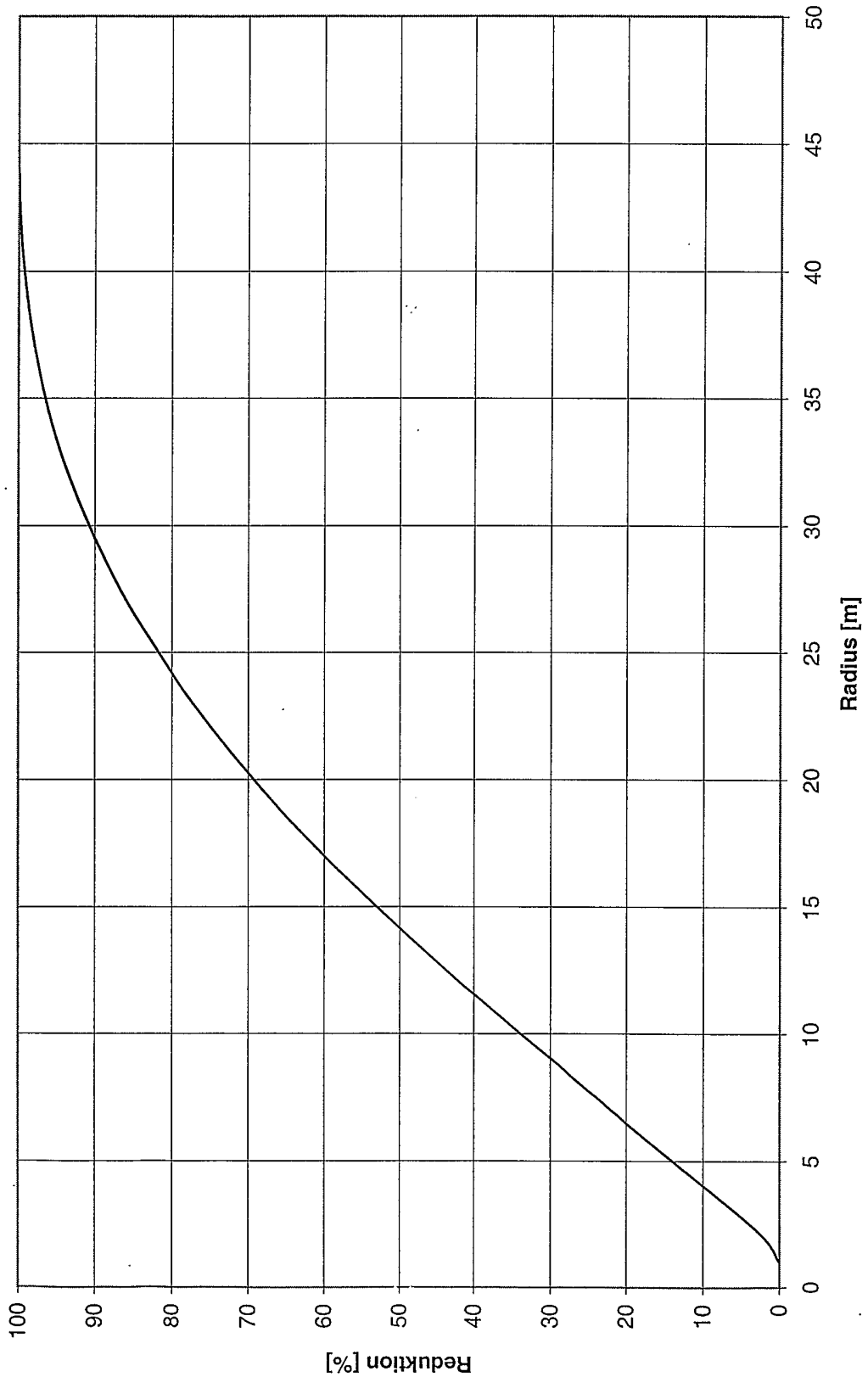
Fig. 2.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30
35
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45
50

Fig. 3.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F03D1/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	DE 29 13 407 A (GOSLICH HANS DIETRICH) 16 October 1980 (1980-10-16) fig. 2 and adherent text	1-4,11, 15-18
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
7 January 2003	23. 01. 2003

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INTERNATIONAL SEARCH REPORT

PCT/DK 02/00327

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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