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- (54) **Szélturbina-rotorlapát kezeléshez való átmenőnyílásokkal**

Az európai szabadalom ellen, megadásának az Európai Szabadalmi Közlönyben való meghirdetésétől számított kilenc hónapon belül, felszólalást lehet benyújtani az Európai Szabadalmi Hivatalnál. (Európai Szabadalmi Egyezmény 99. cikk(1))

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WIND TURBINE BLADE WITH THROUGH HOLES FOR HANDLING

The present invention relates to a rotor blade for a wind turbine.

5 Rotor blades for wind turbines are generally known. As the wind turbines increase in size and power, the size of the rotor blades and their inherent weight also increase. For assembly of the components, there are therefore required cranes which can transport loads with a relatively high inherent weight at relatively great heights. Accordingly, the required cranes are also larger.

An object of the invention is to simplify the assembly of the rotor blades and to improve the manageability of the rotor blades.

10 The object of the invention is achieved by a rotor blade according to claim 1.

A method for assembling rotor blades on a rotor hub which is connected to a pod of a wind turbine is carried out by means of rotating the rotor hub into a predetermined first position, fitting a rotor blade, rotating the rotor hub using the rotor blade into a predetermined second position, wherein the rotation of the rotor hub is carried out in the direction of the action of gravitational force of the first rotor blade which has already been mounted.

15 Consequently, even when rotor blades are assembled on wind turbines with a relatively large hub height, it is possible to use a crane which is also sufficient to assemble the rotor hub itself or the pod.

In a development of the method, the pod is rotated through 180 degrees before the second rotor blade is fitted. This procedure enables the second rotor blade to be assembled without the crane having to change its location since, as a result of the rotation of the pod, the installation position of the rotor blade is again located at the side of the wind turbine at which the crane is constructed.

In another development of the method, the rotor hub is rotated using the second rotor blade into another predetermined position, the pod is rotated again through 180 degrees and a third rotor blade 23 is fitted.

25 This assembly of the third rotor blade is also possible without changing the location of the crane and, as a result of the omission of the complex change of location of the crane, the rotor blades can be fitted in a time-saving manner.

In order to support the rotation of the hub in a particularly simple and effective manner, the crane can engage on the rotor blade and in particular on a through-hole of the rotor blade and can consequently delay the rotation of the rotor blade in the direction of gravitational force by means of a counter-acting force. As a result, the rotation can be safely controlled and influenced in a simple manner.

In order to improve the manageability of the rotor blade, the rotor blade has through-holes in the rotor blade at a predetermined position. This in particular has the advantage that the handling means which can engage through the rotor blade are more rapid and safer to use than the known handling with belts and lashing ropes.

35 The through-holes extend between the intake side and the pressure side of the rotor blade and thus enable the handling of the rotor blade in a substantially horizontal position, which can be compared with the feathered position. In this instance, the rotor blade has the smallest possible contact surface for the wind and is consequently also naturally subjected to the influence thereof to the smallest possible extent.

40 In a preferred embodiment, the rotor blade has a through-hole which extends substantially perpendicularly to the longitudinal axis of the rotor blade. That rotor blade can thereby be handled in a

substantially horizontal position or in a substantially vertical position in accordance with the orientation of the through-hole in the rotor blade.

In a particularly preferred development of the invention, the rotor blade has at least at one predetermined position of the rotor blade longitudinal axis two intersecting through-holes which extend
5 perpendicularly to the rotor blade longitudinal axis and which enable flexible handling of the rotor blade depending, for example, on local conditions.

Other advantageous embodiments are set out in the dependent claims.

The invention is described in greater detail below with reference to the Figures, in which:

- Figure 1 is a side view of a first embodiment of a rotor blade according to the invention;
- 10 Figure 2 is a side view of a rotor blade which is not part of the invention;
- Figure 3 is a simplified cross-section of a rotor blade portion with a through-hole;
- Figure 4 is a simplified cross-section of a rotor blade portion according to the invention with an alternative embodiment of the through-hole;
- Figure 5 shows the initial situation in the method for assembling the rotor blade;
- 15 Figure 6 shows the first step of the method;
- Figure 7 shows the second step of the method;
- Figure 8 shows the third step of the method;
- Figure 9 shows the fourth step of the method;
- Figure 10 shows the fifth step of the method;
- 20 Figure 11 shows the sixth step of the method;
- Figure 12 shows the seventh step of the method; and
- Figure 13 shows the eighth step of the method.

The plan view in Figure 1 is a simplified illustration of the rotor blade 21. This rotor blade 21 has in its longitudinal direction between the rotor blade root 25 and the rotor blade tip 26 two through-holes 30, 32. The
25 through-hole 32 is formed in the region of the rotor blade tip 26, whilst the through-hole 30 is located in the region close to the rotor blade root. In this instance, these positions are fixed in such a manner that safe handling of the rotor blade during its assembly on a rotor hub of a wind turbine is ensured. The fixing of the position for the holes 30, 32 is carried out taking into account a connection of the rotor blade 21 to the carrying structure.

Figure 2 shows a rotor blade 21 which is not part of the invention and which has only one through-hole
30. This individual through-hole 30 is advantageously arranged at the centre of gravity of the rotor blade so that the rotor blade can also be handled safely with a handling means. In this instance, a connection to the carrying structure is also naturally taken into account.

Other embodiments with more than two through-holes are also possible.

Figures 3 and 4 show by way of example alternative embodiments of the through-holes.

35 Figure 3 shows a cylindrical through-hole 30, 32 which can be closed by means of suitable covers.

Figure 4 shows a through-hole 30, 32 which is also cylindrical in a central portion, but wherein the end portions of the through-hole 30, 32 adjacent to the surfaces of the rotor blade 21 expand. This expansion enables improved fitting of covers, which close the through-hole 30, 32 in order, on the one hand, to prevent the
introduction of dirt and moisture and, on the other hand, to prevent an influence of the flow on the rotor blade
40 by the hole by the covers being inserted into the surface in a flush manner. In this instance, in order to secure

such a cover (not illustrated), different possibilities which are known per se may be considered, such as, for example, an undercut, thread, etcetera.

Figure 5 shows the starting situation of the method for fitting rotor blades to the rotor hub of a wind turbine. In this instance, rotor blades with through-holes, as illustrated in Figures 1 and 2, are preferably used. In this Figure and the following Figures 5-13, the components which are required for explanation are illustrated in a highly simplified manner. In this instance, the reference numeral 10 refers to the tower of a wind turbine, 12 indicates the orientation of the pod, 14 represents the rotor circle, 16, 17 and 18 indicate the orientation of the rotor blade connections and 21, 22 and 23 refer to rotor blades which have been fitted.

In order to assemble the rotor blades on the rotor hub of the pod of a wind turbine, handling means are secured in the through-holes 30, 32 in order to be able to move the rotor blades safely upwards towards the rotor hub using the handling means and a crane. Since the through-holes extend between the intake and the pressure side of the rotor blade, the rotor blades can be safely handled in a horizontal position. The provision of the above-described through-holes in the rotor blades considerably simplifies the method described below for assembling these rotor blades.

In Figure 5, the rotor circle 14 is located in the viewing direction behind the tower 10 of the wind turbine and the rotor blade connections 16, 17, 18 are located in the 12 o'clock, 4 o'clock and 8 o'clock positions.

In the first method step, the rotor hub is now moved into a predetermined position. This is illustrated in Figure 6. The significant aspect in this instance is that the rotor blade connection 17 is now in the 9 o'clock position. Accordingly, the rotor blade connection 16 is now in the 1 o'clock position and the rotor blade connection 18 is in the 5 o'clock position.

As a result of the orientation of the rotor blade connection 17 achieved in this manner, it is possible to fit a rotor blade 21 in a horizontal orientation to this rotor blade connection. To this end, the rotor hub is secured in the desired position. This securing is assumed for the remaining description and is no longer explicitly mentioned.

The situation after the assembly of the first rotor blade 21 is shown in Figure 7. In this instance, the rotor blade 21 is in the 9 o'clock position, whilst the rotor blade connections 16 and 18 are in the 1 o'clock and 5 o'clock positions.

The next method step is illustrated in Figure 8. In this instance, the rotor blade 21 is lowered into the 7 o'clock position. This lowering action can be carried out by means of the action of gravitational force. At the same time, the crane (not illustrated) which has raised the rotor blade 21 into the assembly position can counteract the rotation and thus cause a controlled rotation.

It can further be seen in this Figure that the rotor blade connection 18 is now in the 3 o'clock position and the rotor blade connection 16 is located in the 11 o'clock position.

Figure 9 illustrates that, with the position of the rotor hub remaining unchanged, the pod has been rotated through 180 degrees so that the rotor circle 14 is located in the viewing direction in front of the tower 10. As a result of this rotation of the pod, the rotor blade 21 is now in the 5 o'clock position, the rotor blade connection 16 is in the 1 o'clock position and the rotor blade connection 18 is in the 9 o'clock position. Consequently, another rotor blade which has been raised in a horizontal position by the crane can be fitted to this rotor blade connection 18 without the crane having to change its location.

The situation which then occurs is illustrated in Figure 10. In this instance, the rotor blade connection 16 is still in the 1 o'clock position, the first rotor blade 21 is in the 5 o'clock position, whilst the second rotor blade 22 is now illustrated in the 9 o'clock position.

In order to prepare for assembling the third rotor blade, as illustrated in Figure 11, the rotor blade 21 is then pivoted using the crane from the 5 o'clock position into the 7 o'clock position. The second rotor blade 22 thereby reaches the 11 o'clock position and the rotor blade connection 16 reaches the 3 o'clock position. Subsequently, the pod is again rotated through 180 degrees.

The result of this rotation is illustrated in Figure 12. When viewed from the direction of the viewer, this rotor circle 14 is now behind the tower 10 again. With the position of the rotor hub remaining unchanged, the first rotor blade 21 is thereby in the 5 o'clock position, the second rotor blade 22 is in the 1 o'clock position and the rotor blade connection 16 is located in the 9 o'clock position. Consequently, it is again possible to fit a third rotor blade to this rotor blade connection 16 without changing the location of the crane. This is shown in Figure 13. The first rotor blade 21 is located in the 5 o'clock position, the second rotor blade 22 is in the 1 o'clock position and the third rotor blade 23 is in the 9 o'clock position. Consequently, the method is complete and all three rotor blades have been fitted to the wind turbine.

SZÉLTURBINA-ROTORLAPÁT KEZELÉSHEZ VALÓ ÁTMENŐNYILÁSOKKAL

Szabadalmi igénypontok

1. Toronnyal (10) és gondolával (12) rendelkező szélturbina szélturbina-rotorlapátja, melynek van első átmenőnyílása (32) kezelésszék fogadására a rotorlapátcsúc (26) tartományában, és második átmenőnyílása (30) kezelésszék fogadására a rotorlapát-tő-közeli tartományban, ahol az első és a második átmenőnyílás a rotorlapát (21, 22, 23) szívóoldala és nyomóoldala között helyezkedik el.
2. Az 1. igénypont szerinti rotorlapát, ahol az első és a második átmenőnyílások (30, 32) helye összeköttetésben van a rotorlapát (21) tehérviselő szerkezetével.
3. Az 1-2. igénypontok bármelyike szerinti rotorlapát, melynek az átmenőnyílások (30, 32) zárásához oldható lefedőeszköze is van.
4. Az 1-3. igénypontok bármelyike szerinti rotorlapát, ahol a rotorlapát a gondola (12) rotoragyára erősítésre alkalmasan van kiképezve.

Fig 1

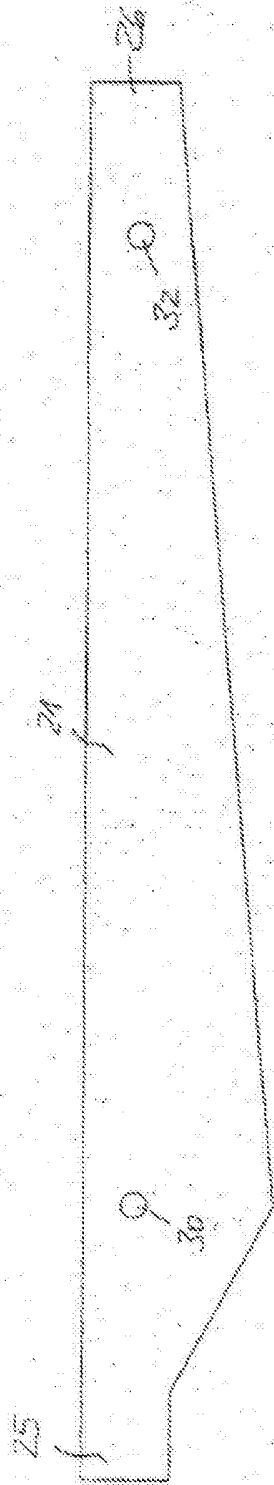


Fig 2



Fig. 3

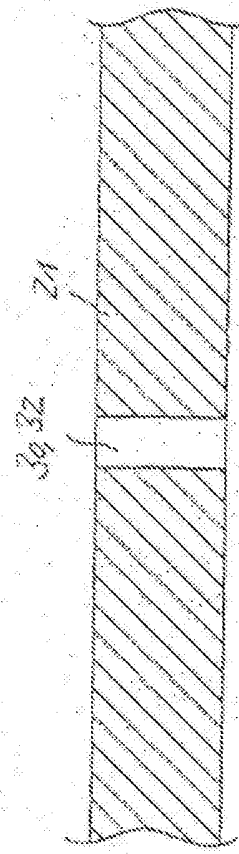
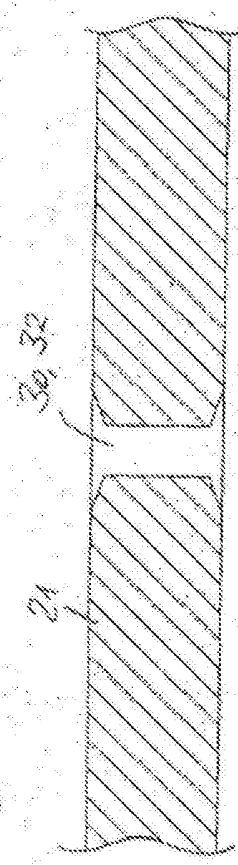


Fig. 4



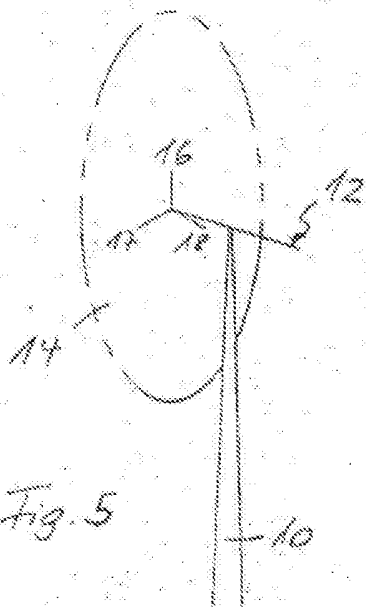


Fig. 5

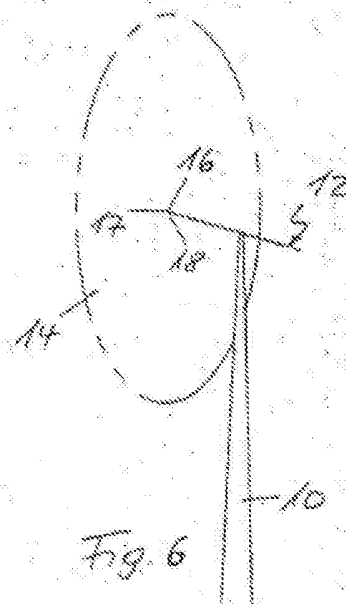


Fig. 6

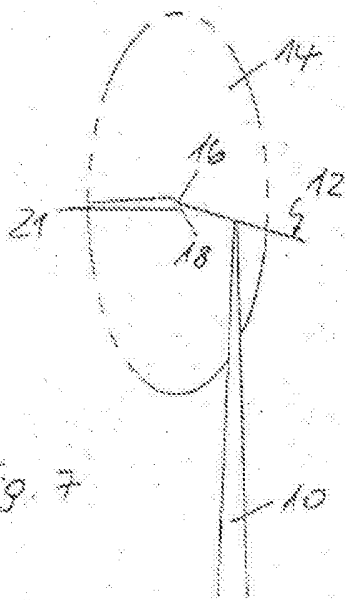


Fig. 7

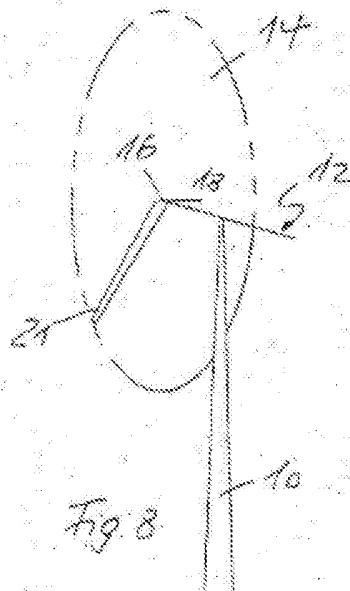


Fig. 8

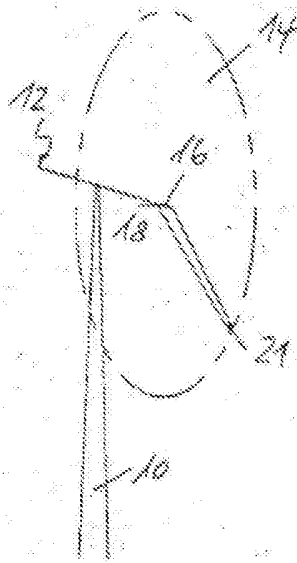


Fig. 9

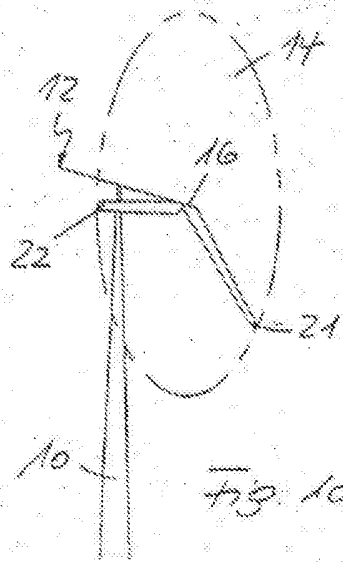


Fig. 10

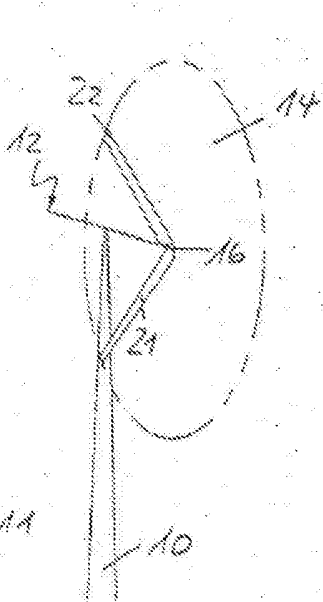


Fig. 11

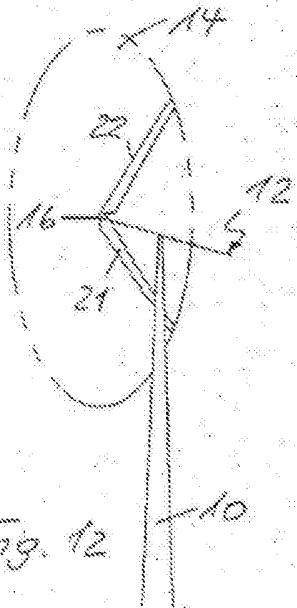


Fig. 12

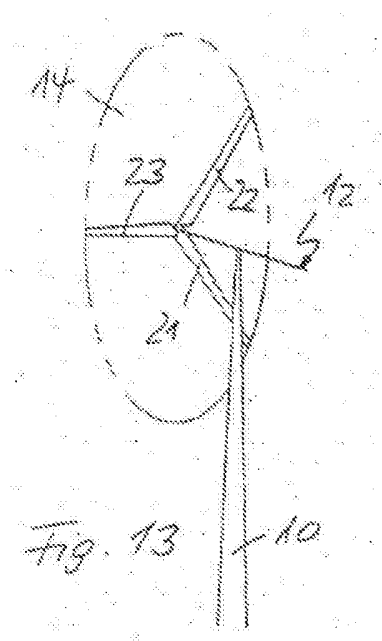


Fig. 13