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(54) Benævnelse: **KØLEARRANGEMENT TIL EN VINDMØLLE**

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EP-A1- 1 134 410
WO-A1-2012/107049
WO-A2-2009/132671
WO-A2-2010/085960

DESCRIPTION

Description

[0001] The invention relates to a cooling arrangement of a wind turbine.

[0002] Electrical machinery produces heat and often needs a cooling system to remove the heat. The cooling system often comprises a cooling fluid that circulates in ducts or pipes. The cooling system further comprises a cooling arrangement as a heat sink. The cooling arrangement comprises a radiator and a support arrangement. The cooling fluid is then cooled by air flowing though the radiator. The radiator is therefore mounted in a way that the surrounding air can flow through the radiator.

[0003] In the case of e.g. a wind turbine, the cooling system removes the heat from the generator or a bearing. The cooling fluid is cooled in the radiator. The radiator is mounted outside of the nacelle so that the surrounding air can move through the radiator.

[0004] Wind turbines are often installed offshore or close to the cost and are surrounded by salty air. One aim of the installation is to keep salty air out of the nacelle, as salty air will damage the installation in the nacelle. For this the radiator of the cooling system is mounted outside of the nacelle, so no salty air has to be guided through the nacelle.

[0005] To ensure a reliable cooling by the surrounding air moving through the radiator, the radiator is mounted in a way that the surrounding air can easily flow through the radiator. The radiator is mounted mainly in the right angel of the direction of the air flow when the turbine is in operation. The radiator is mounted on top of the nacelle to use the maximum of the air flow and to provide a good access for maintenance.

[0006] WO 2010/085960 A2 discloses a wind turbine comprising a nacelle having a first face with a longitudinal extension in a wind direction and a cooling device extending perpendicular to the top face of the nacelle. Thus, the wind flows towards the cooling device at a perpendicular angle to the longitudinal extension of the cooling area, which results in an optimal cooling.

[0007] For a further example of a cooling device mounted on top of the nacelle, reference is made to WO 2012/107049 A1.

[0008] The same aspects apply for other arrangements where cooling systems are used. A radiator of a cooling system is often installed in a higher area of a building or construction, e.g. on a roof.

[0009] As e.g. wind turbines are often installed offshore they are equipped with a heli-pad, a heli-drop-zone or a heli-hoist platform, as can be seen in EP 1 134 410 A1 and in WO 2009/132671 A2. These platforms are used with a helicopter to land on the platform or to drop or pick up persons or parts by the help of a hoist. It is also possible to use the platform with a crane to hoist or lower gear like technical equipment to the platform by a rope. This is to provide an easy way to deliver or pick up parts or persons, for service or repair reasons.

[0010] The platform is located on top of the nacelle at the rear end of the nacelle. The rear end of the nacelle is the end pointing away from the hub and the rotor, to avoid interference with the rotor.

[0011] A free space of a certain size is needed to deliver or pick up persons or equipment at a platform. Thus accidents and damages are avoided. A barrier is arranged around the platform to avoid that persons or equipment slip from the edge of the platform.

[0012] A hatch is arranged in the nacelle at the front end of the platform, to allow an easy access from the platform into the nacelle and from the nacelle to the platform. The front end of the platform is the end that points towards the hub of the wind turbine.

[0013] This has the disadvantage that the radiator of the cooling system and the platform take up the same area on top of the wind turbine. The radiator is diminishing the space needed for the platform. At the same time the barrier (e.g. a rail) around the platform is diminishing the area of free air to move through the radiator.

[0014] The aim of this invention is to provide a cooling arrangement that provides a reliable cooling and is not limiting the possibilities to use a platform.

[0015] The aim is reached by the features of the independent claim. Preferred embodiments of the invention are described in the dependent claims.

[0016] According to the invention a cooling arrangement of a wind turbine is provided. The wind turbine comprises a nacelle and a cooling device, which is arranged on top of the nacelle. The cooling device is prepared to remove heat of the wind turbine to the ambient air.

[0017] A platform is located on top of the nacelle. It is prepared to be approached by a helicopter. The platform comprises a barrier, which surrounds at least a part of the platform. The barrier comprises at least a part of the cooling device.

[0018] Thus the cooling device is a part of the barrier. Thus no separate barrier and separate cooling device is needed while extra material is avoided. Thus the weight, the costs and working time to prepare and install the separate barrier and the separate cooling device are saved.

[0019] Preferably the cooling device comprises a radiator segment and a support structure to

support the radiator segment. Thus the radiator is mounted via a support structure to the nacelle or to the barrier. Thus the radiator can be exchanged easily in case of a fault.

[0020] Preferably at least a part of the radiator of the wind turbine is an integral part of the barrier.

[0021] Preferably an internal cooling system of the wind turbine is connected with the cooling device or radiator. Thus at least two coupled cooling circuits are used to remove heat out of the nacelle or wind turbine. Each cooling circuit might use a specific cooling fluid like water, oil and/or air. Thus there is no need to use salty air from the outside of the nacelle for internal cooling purposes.

[0022] Preferably the barrier is arranged at three sides of the platform. A remaining fourth side is left free to provide access from a hatch to the platform.

[0023] Preferably the radiator is arranged at the rear part of the platform as barrier. Thus the wind, which moves along the nacelle to cool the radiator when the turbine is in operation, moves easily along the platform and reaches the cooling device. Thus the surface of the cooling device is arranged frontal to the direction of the ambient air when the wind turbine is in operation.

[0024] Preferably the radiator is arranged at the front part of the platform as barrier. Thus the wind can easily flow through the rotor and directly to the cooling device when the turbine is in operation. Thus the wind is not blocked before it reaches the radiator.

[0025] Preferably the support structure comprises a triangular shaped side support, which is prepared to absorb the wind load of the ambient air passing through the radiator. Thus forces, being generated by the wind load, are transferred from the radiator over the support structure to the nacelle of the wind turbine. In addition the use of material and the weight is optimized.

[0026] Preferably the cooling device is arranged with a certain spacing to the nacelle. Thus air is allowed to move between the cooling device and the nacelle. Thus low turbulence airflow is provided. The airflow of the ambient air around the radiator is optimized and a congestion of the airflow is avoided.

[0027] According to the invention, the cooling device is partially arranged in a groove of the nacelle to achieve a predefined distance between the level of the platform and the top edge of the cooling device. Thus a limitation of the maximum height of the barrier in respect to the platform is observed. In addition a large radiator area can be provided while mandatory constructional dimensions are kept.

[0028] According to the invention, the platform is elevated in respect to the cooling device to achieve a predefined distance between the level of the platform and the top edge of the cooling device. Thus a limitation of the maximum height of the barrier in respect to the platform

is observed. In addition a large radiator area can be provided while mandatory constructional dimensions are kept.

[0029] Preferably the barrier comprises a metal grid. Thus the air of a hovering helicopter can move through the barrier. Thus congestion of the air is prevented. Thus complex turbulent airflow and ground effects are prevented for the helicopter.

[0030] Preferably the metal grid comprises openings of a certain size, which prevents that a grounding hook or a grounding conductor of a helicopter, which is hovering over the platform, is entangled or gets entangled. Thus the hook gets not entangled and moves freely. Dangerous situations for the helicopter are avoided.

[0031] Preferably a floor of the platform comprises a hole to drain water. Thus the danger of slipping of persons or equipment on the wet surface is minimized.

[0032] Preferably a grid is prepared as floor of the platform. Thus friction of equipment and shoes of persons is higher then on a plane metal surface. Thus sliding and slipping of equipment and persons is minimized.

[0033] The invention is shown in more detail by help of figures.

[0034] The figures show preferred configurations and do not limit the scope of the invention.

FIG 1
shows a nacelle of a wind turbine according to the invention,
FIG 2
shows a wind turbine according to the invention,
FIG 3
shows a platform according to the invention in a first view,
FIG 4
shows the platform of FIG 3 in a second view,
FIG 5
shows another embodiment of the solution invented,
FIG 6
shows a detail of the solution invented.

[0035] FIG 1 shows a nacelle 2 of a wind turbine according to the invention. The nacelle 2 comprises a platform 3 that is surrounded by a barrier 4. The rear end of the platform is the part pointing away from the hub 5.

[0036] A cooling device 6 is provided on to of the nacelle 2. This cooling device 6 is an integral part of the rear part of the barrier 4. The barrier 4 surrounds the platform 3 at three sides. At the right and left side the barrier comprises a metal grid 7, so that the air flow of a hovering

helicopter can move through the barrier 4.

[0037] FIG 2 shows a wind turbine 1 according to the invention. The wind turbine 1 is equipped with a platform 3 on top of the nacelle 2. The platform 3 is surrounded by a barrier 4.

[0038] The platform 3 can be approached by a helicopter. The platform 3 can be prepared to land on it with the helicopter. Or it is prepared to be used as a heli-drop zone or a heli-hoist platform to deliver or pick up equipment and personal to and from the platform.

[0039] A cooling device 6 is provided at the rear end farthest away from the hub 5 of the wind turbine 1. This cooling device 6 is integrated in the barrier 4 and forming a part of the barrier 4.

[0040] FIG 3 shows a platform 3 according to the invention in a first view. The nacelle 2 is equipped with a platform 3. Around the platform 3 is a barrier 4.

[0041] At the rear part of the barrier 4 a cooling device 6 is arranged as a part of the barrier 4. The cooling device 6 comprises a radiator 8 and a support structure 9. The radiator 8 can be constructed of several radiator elements.

[0042] The barrier 4 comprises metal grids 7. The metal grids 7 allow air to flow and thus avoids a congestion of air e.g. from a helicopter hovering above the platform 3.

[0043] The barrier 4 is surrounding the platform 3 at three sides. The side in the direction of the hub, the front side, is just equipped with a railing. Thus personal and equipment can easily reach the platform 3 through the hatch 10.

[0044] The cooling device 6 is equipped with a triangular shaped side support 9. This side support 9 is taking in the wind load of the ambient air moving through the radiator 8 and is leading the forces into the nacelle 2.

[0045] FIG 4 shows the platform of FIG 3 in a second view. A Cooling device 6 is arranged on top of a nacelle 2 of a wind turbine. The cooling device 6 comprises a support structure 9 and a radiator 8. The cooling device 6 is a part of the barrier 4 that surrounds the platform 3.

[0046] The barrier 4 surrounds the platform 3 at three sides. Thus the wind, that cools the radiator when the turbine is in operation, can blow through the rotor along the nacelle 2 over the platform 3 and through the radiator 6 without being disturbed by a barrier in front on the platform 3.

[0047] Also personal can easily reach the platform 3 through the hatch 10 and handle equipment in and out of the nacelle 2. At the side of the hatch 10 the platform 3 is equipped with a railing. On top of this railing additional equipment is installed.

[0048] The barrier 4 comprises a metal grid 7 that allows the air to flow through it. Thus the

congestion of the air is minimized and complex turbulent air flow and ground effects are prevented for the helicopter hovering above the platform 3.

[0049] The metal grid has openings that are small enough so that the grounding hook or the grounding conductor of the helicopter cannot get entangled in the grid.

[0050] FIG 5 shows another embodiment of the solution invented. On top of the nacelle 2 of a wind turbine 1 a platform 3 is installed to be used with a helicopter. The platform is surrounded by a barrier 4. At the front end of the platform, at the end that is pointing towards the hub 5, the barrier 4 is connected to a cooling device 6. Thus the cooling device 6 is a part of the barrier 4 at the front end of the platform. The cooling device is equipped with a triangular shaped support structure 9.

[0051] In this embodiment the cooling device 6 is mounted in the front end of the platform 3. When the wind turbine 1 is in operation, the wind can easily flow through the rotor and along the nacelle 2 to the cooling device 6 that comprises the radiator 8. The radiator 8 is arranged mainly fontal to the wind. So the wind provides an optimized cooling effect.

[0052] FIG 6 shows a detail of the solution invented. The figure shows a radiator 8 of the cooling device in a side view. Between the radiator 8 and the nacelle 2 is a certain spacing that leads to an air gap 12. This air gap allows the air flow 13 to flow between the radiator 8 and the nacelle 2. Thus the air flow 13 is not blocked in front of the radiator 8. Thus a congestion of air is prevented and the cooling effect is optimized.

[0053] The radiator 8 is arranged in a certain level on top of the nacelle 2. In this case the platform 3 is arranged in a higher level on the nacelle 2. The platform 2 is elevated in respect to the cooling device 6. Thus the distance between the upper end of the cooling device 6 and the level of the platform floor can be arranged to have a predetermined maximum distance. Thus requirements regarding the height of the barrier 4 surrounding the platform 3 can be met.

REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO2010085960A2 **[0006]**
- WO2012107049A1 **[0007]**
- EP1134410A1 **[0009]**
- WO2009132671A2 **[0009]**

PATENTKRAV

1. Kølearrangement til en vindmølle (1),

- med en nacelle (2) af vindmøllen (1),

- med en køleindretning (6), der er anbragt oven på nacellen (2), og som er indrettet til at fjerne varme fra vindmøllen (1) til omgivelsesluften,

- med en platform (3), der er lokaliseret oven på nacellen (2), og som er indrettet til, at en helikopter lander derpå,

- hvor platformen (3) omfatter en barriere (4), der omgiver mindst en del af platformen (3),

- hvor barrieren (4) omfatter mindst en del af køleindretningen (6), **kendetegnet ved, at**:

- køleindretningen (6) delvist er anbragt i en rille i nacellen (2) til opnåelse af en foruddefineret afstand mellem platformens (3) niveau og køleindretningens (6) overkant, eller

- platformen (3) er forhøjet i forhold til køleindretningen (6) til opnåelse af en foruddefineret afstand mellem platformens (3) niveau og køleindretningens (6) overkant.

2. Kølearrangement ifølge krav 1, hvor køleindretningen (6) omfatter et køler (8)-segment og en understøtningsstruktur (9) til understøtning af køler (8)-segmentet.

3. Kølearrangement ifølge krav 1, hvor mindst en del af vindmøllens (1) køler (8) er en integreret del af barrieren (4).

4. Kølearrangement ifølge krav 2 eller krav 3, hvor et internt kølesystem til vindmøllen (1) er forbundet med køleindretningen (6) eller køleren (8).

5. Kølearrangement ifølge et af de foregående krav, hvor barrieren (4) er anbragt på tre sider af platformen (3).

6. Kølearrangement ifølge et af de foregående krav, hvor køleren (8) er anbragt på den bageste del af platformen (3) som barriere (4).

7. Kølearrangement ifølge et af de foregående krav, hvor køleren (8) er anbragt på den forreste del af platformen (3) som barriere (4).

8. Kølearrangement ifølge et af de foregående krav, hvor understøtningsstrukturen (9) omfatter en trekantsformet sideunderstøtning, der er indrettet til at absorbere vindlasten fra den omgivelsesluft, der passerer gennem køleren (8).

9. Kølearrangement ifølge et af de foregående krav, hvor køleindretningen (6) er anbragt med en vis afstand til nacellen (2), således at luft tillades at bevæge sig mellem køleindretningen (6) og nacellen (2).

10. Kølearrangement ifølge et af de foregående krav, hvor barrieren (4) omfatter et metalgitter (7).

11. Kølearrangement ifølge krav 10, hvor metalgitteret (7) omfatter åbninger med en vis størrelse, hvilket forhindrer, at en jordforbindelseskrog eller en jordforbindelsesleder fra en helikopter, der svæver over platformen (3), er eller bliver fanget.

12. Kølearrangement ifølge et af de foregående krav, hvor et gulv på platformen (3) omfatter et hul til afdræning af vand.

13. Kølearrangement ifølge et af de foregående krav, hvor et gitter er indrettet som gulv til platformen (3).

DRAWINGS

Drawing

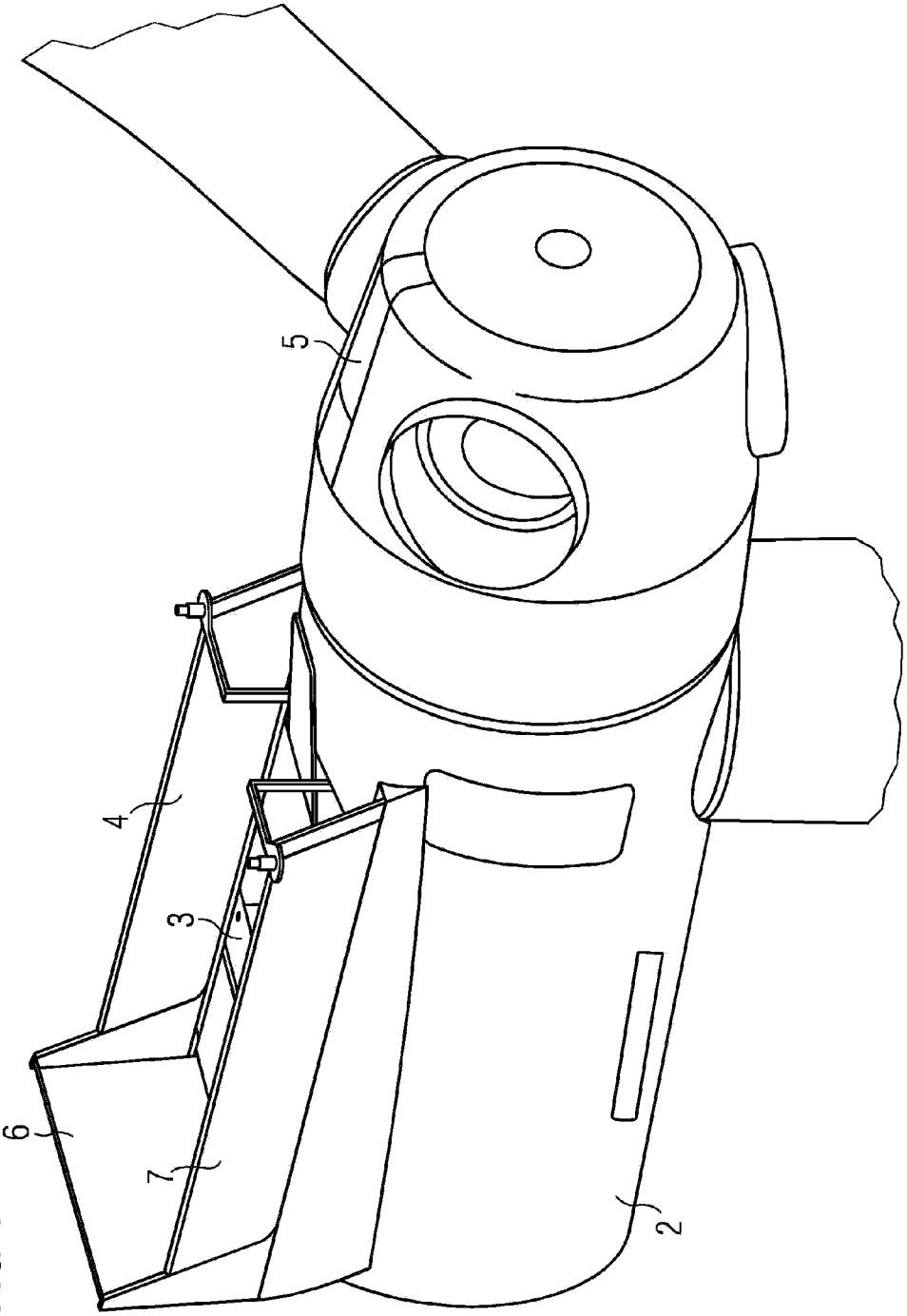
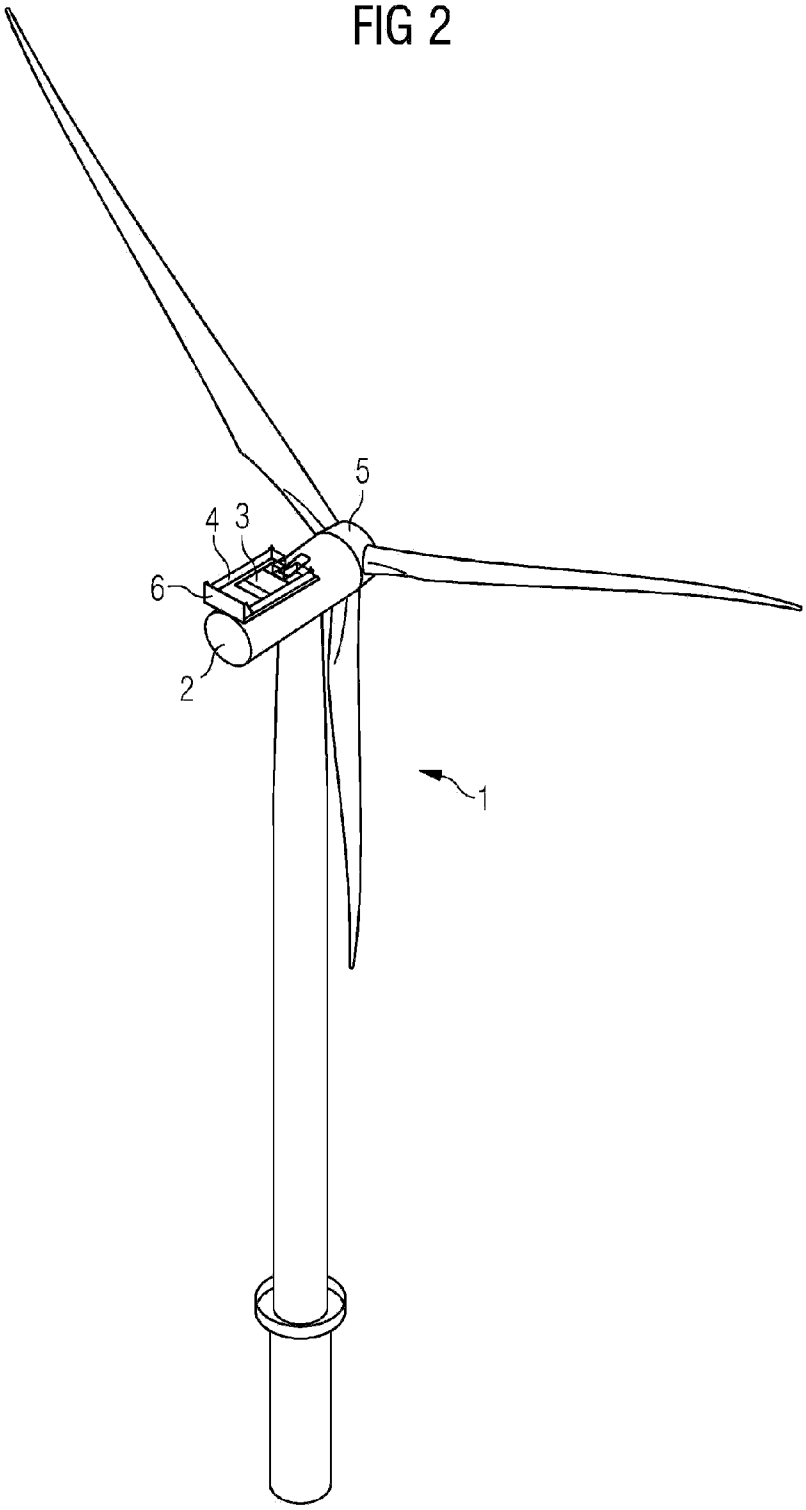


FIG 1

FIG 2



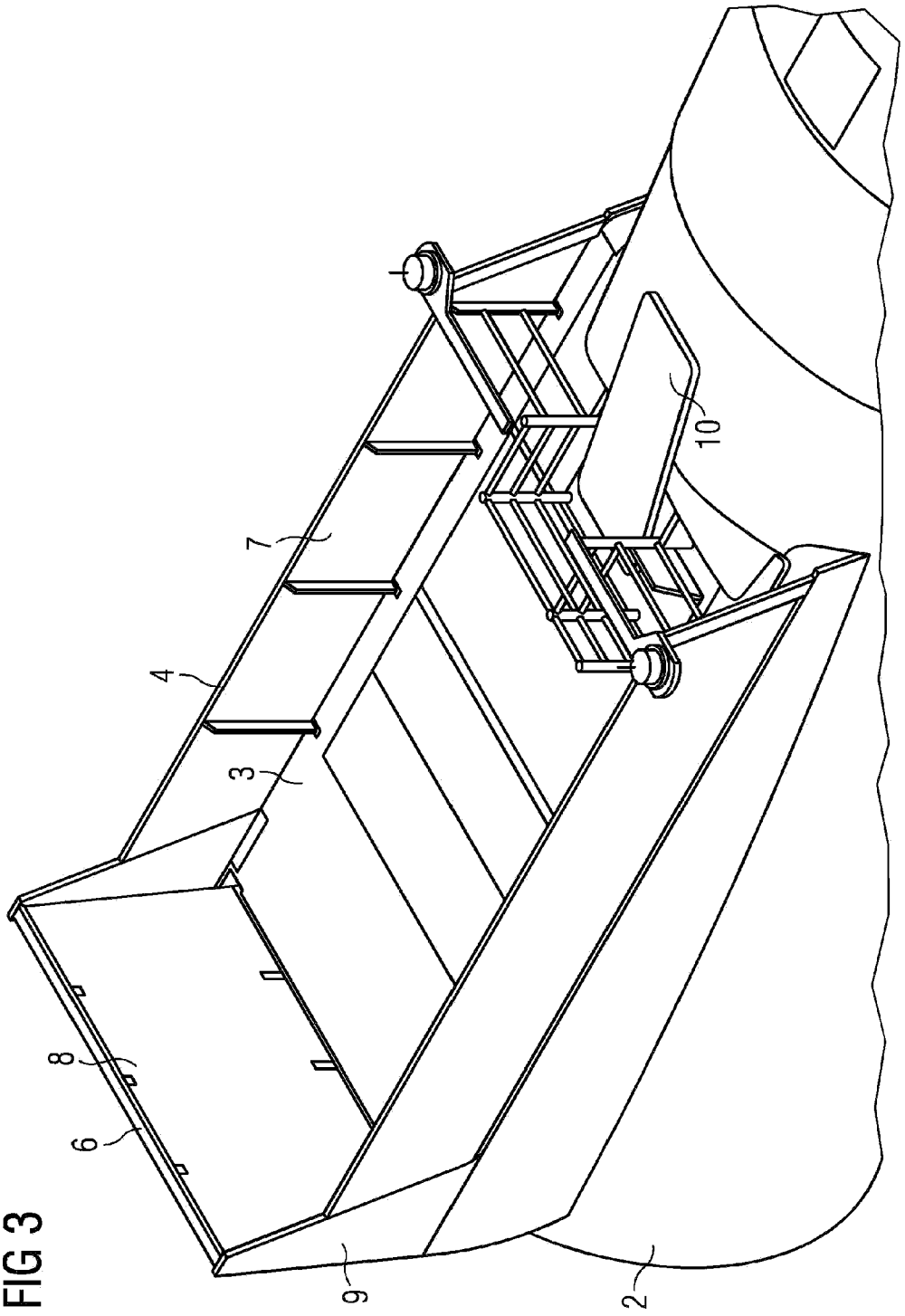


FIG 3

FIG 4

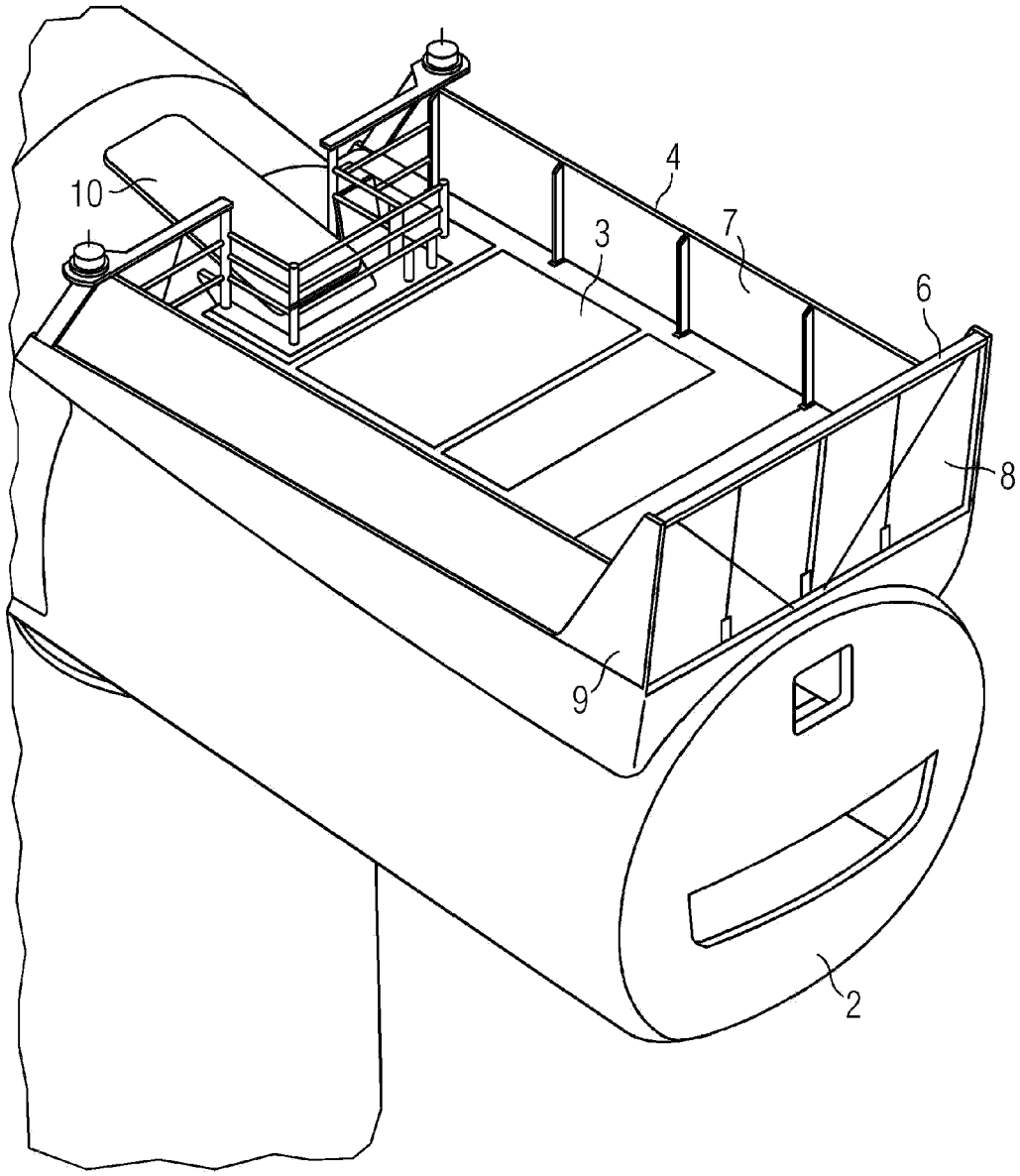


FIG 5

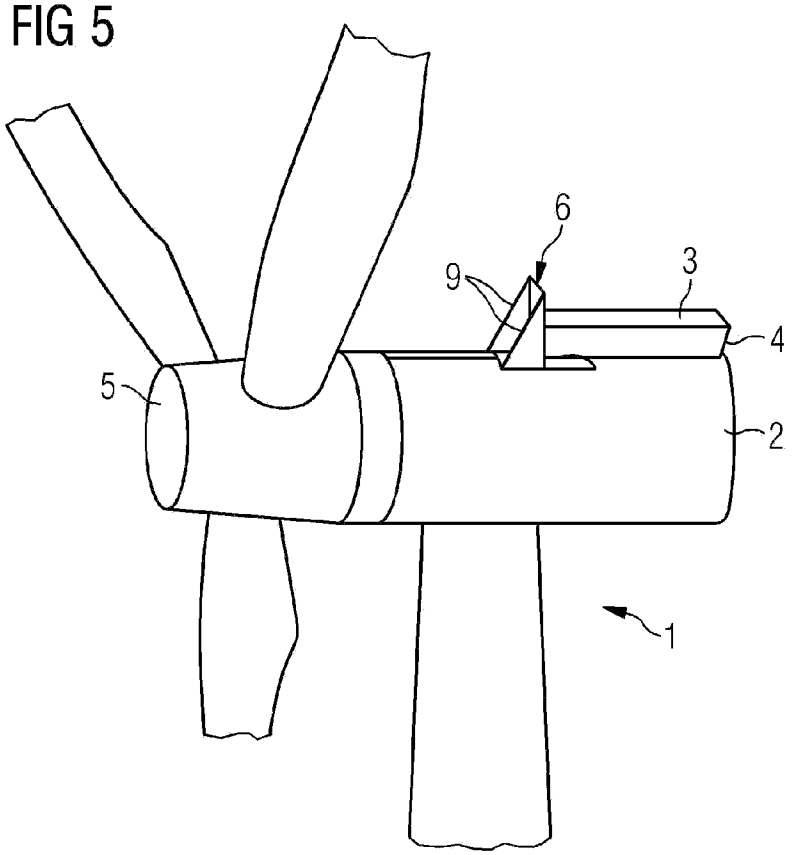


FIG 6