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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY.DOCKET NO./TITLE	REQUEST ID
15/517,288	04/06/2017	Per E. Fenger	400517-20003	167511

Acknowledgement of Loss of Entitlement to Entity Status Discount

The entity status change request below filed through Private PAIR on 06/06/2022 has been accepted.

CERTIFICATIONS:

Change of Entity Status:

X Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken to be notification of loss of entitlement to small or micro entity status, as applicable.

This portion must be completed by the signatory or signatories making the entity status change in accordance with 37 CFR 1.4(d)(4).

Signature:	/David S. Safran/
Name:	David S. Safran
Registration Number:	27997

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/517,288	08/13/2019	10378518	400517-20003	1448

25570 7590 07/24/2019

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 23 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Per E. Fenger, Terndrup, DENMARK;
LIFTRA IP APS, Aalborg SV, DENMARK;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov

Notice of References Cited	Application/Control No. 15/517,288	Applicant(s)/Patent Under Reexamination FENGER, PER E.	
	Examiner CHWEN-WEI SU	Art Unit 3722	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-1,152,271 A	08-1915	Bisbee, R.A.	A01K89/033	188/186
*	B	US-1,853,255 A	04-1932	BORDEN BRADFORD T	B23B31/101	279/110
*	C	US-3,494,230 A	02-1970	GAST ALBERT K JR	B23B31/16012	279/66
*	D	US-4,623,157 A	11-1986	Rohs; Hans-Gunther	B23B31/102	279/123
*	E	US-4,631,995 A	12-1986	Vroenen; John J.	B23B31/101	82/164
*	F	US-5,015,003 A	05-1991	Ramunas; Valdas S.	B23B31/16275	269/284
*	G	US-2002/0092395 A1	07-2002	EMILIAN, BERNARD	B23B5/163	83/452
*	H	US-2010/0021278 A1	01-2010	STEGEMANN; Klaus	B66C23/06	414/629
*	I	US-2010/0139069 A1	06-2010	Daniels; Jeffrey Michael	F03D1/00	29/402.01
*	J	US-2012/0141292 A1	06-2012	Signore; Jonathan Paul	B66C1/108	416/244R
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N	EP 1101934 A2	05-2001	~~DE~~ EP	WEITKAMP ROLAND DIPL-ING	B66C23/207
	O	EP 1748182 A2	01-2007	~~US~~ EP	CHRISTENSON CRAIG LEONARD	F03D13/10
	P	Change(s) applied				
	Q	to document,				
	R	/A.H./				
	S	6/28/2019				
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

LiftWerx Exhibit 2006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102
Page 3 of 349

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

25570 7590 05/23/2019

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/517,288	04/06/2017	Per E. Fenger	400517-20003	1448

TITLE OF INVENTION: MAIN SHAFT FIXTURE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	08/23/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
SU, CHWEN-WEI	3722	279-110000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 David S. Safran
2 Roberts Mlotkowski Safran Cole & Calderon, P.C.
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: LIFTRA IP APS

(B) RESIDENCE: (CITY and STATE OR COUNTRY): AALBORG, DENMARK

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 50-2478 (400517-20003).

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date June 26, 2019

Typed or printed name David S. Safran Registration No. 27,997

LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102
Page 4 of 349

Electronic Patent Application Fee Transmittal

Application Number:	15517288
Filing Date:	06-Apr-2017
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Filer:	David Scott Safran/Paul Mahan
Attorney Docket Number:	400517-20003

Filed as Small Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	500	500

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**500**

Electronic Acknowledgement Receipt

EFS ID:	36412063
Application Number:	15517288
International Application Number:	
Confirmation Number:	1448
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Customer Number:	25570
Filer:	David Scott Safran/Paul Mahan
Filer Authorized By:	David Scott Safran
Attorney Docket Number:	400517-20003
Receipt Date:	26-JUN-2019
Filing Date:	06-APR-2017
Time Stamp:	09:35:59
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$500
RAM confirmation Number	062619INTEFSW09362400
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Issue_Fee_26Jun2019_AttyDkt_400517_20003.pdf	86687 266e84c1ab4255931e1e44e9918714e4452ceca8	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30254 a4810732b74d3aa07ce2fa6a648dcd8ba5b911f1	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	116941		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

25570 7590 05/23/2019

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102

EXAMINER
SU, CHWEN-WEI

ART UNIT	PAPER NUMBER
3722	

DATE MAILED: 05/23/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/517,288	04/06/2017	Per E. Fenger	400517-20003	1448

TITLE OF INVENTION: MAIN SHAFT FIXTURE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	08/23/2019

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102
Page 9 of 349

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

25570 7590 05/23/2019

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/517,288	04/06/2017	Per E. Fenger	400517-20003	1448

TITLE OF INVENTION: MAIN SHAFT FIXTURE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	08/23/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
SU, CHWEN-WEI	3722	279-110000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102
Page 10 of 349

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/517,288	04/06/2017	Per E. Fenger	400517-20003	1448

25570 7590 05/23/2019

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102

EXAMINER	
SU, CHWEN-WEI	
ART UNIT	**PAPER NUMBER**
3722	

DATE MAILED: 05/23/2019

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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LiftWerx USA, Inc. v. Liftra IP ApS
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Notice of Allowability	Application No. 15/517,288	Applicant(s) Fenger, Per E.	
	Examiner CHWEN-WEI SU	Art Unit 3722	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 04/29/2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 3-4,6-9 and 11-12 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☑ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☑ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: DKPA 2014 00573 .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file areply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☑ Other PTO-2323.

/CHWEN-WEI SU/ Examiner, Art Unit 3722	/ERIC A GATES/ Primary Examiner, Art Unit 3722

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DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Priority

2. Acknowledgment is made of applicant's claim for foreign priority based on an application filed in Denmark on 10/07/2014. It is noted, however, that applicant has not filed a certified copy of the DKPA 2014 00573 application as required by 37 CFR 1.55.

3. It is noted that applicant filed an interim copy of the DKPA 2014 00573 application on 07/09/2018. However, it is not a certified copy.

Allowable Subject Matter

4. Claims 3-4, 6-9, 11-12 are allowed.

5. The following is an examiner's statement of reasons for allowance:

6. The closest prior art of record is Signore et al. in view of Weaver et al. Signore in view of Weaver teaches a main shaft fixture 128 for fixation of a main shaft on a wind turbine as described in the Office Action mailed on 01/31/2019. However, Signore in view of Weaver does not disclose the main shaft fixture "comprising one of a multi-part needle bearing, roller bearing, or ball bearing comprised of a multi-part inner ring fastened to the main shaft, and a cooperating multi-part outer ring comprised of bowed sub-segments corresponding to the number of tap shoes, mounted on the opposing side of the tap shoes facing the inner ring …" as recited in independent claim 9.

7. In addition, Signore in view of Weaver does not teach "a flange element of a rotor lock being fastened at the ends to a first end of two first beam-shaped brackets

extending parallel with each other, and being located on each side of the main shaft, said beam shaped brackets forming part of the main shaft fixture, and where *a second end of the brackets is pivotally mounted with horizontally oriented bolt connections on other brackets that form parts of the main shaft fixture and which are anchored on the bottom frame of the nacelle*." as recited in the independent claim 11.

8. Other prior art or record, alone or in combination, also does not teach every limitation of independent claims 9 and 11.

9. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to CHWEN-WEI SU whose telephone number is (571)272-4998. The examiner can normally be reached on Monday-Friday 9:30 AM-6 PM ET.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sunil K Singh can be reached on 571-272-3460. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/CHWEN-WEI SU/
Examiner, Art Unit 3722

/ERIC A GATES/
Primary Examiner, Art Unit 3722

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/517,288	Fenger, Per E.
	Examiner	**Art Unit**
	CHWEN-WEI SU	3722

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/22/2018	01/25/2019	05/17/2019						
-	1	✓	✓	-						
-	2	✓	-	-						
3	3	✓	✓	=						
4	4	✓	✓	=						
-	5	✓	✓	-						
5	6	✓	✓	=						
6	7	✓	✓	=						
7	8	✓	✓	=						
1	9	✓	=	=						
-	10	✓	✓	-						
2	11	O	=	=						
8	12	O	=	=						
-	13		N	-						

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/517,288	Fenger, Per E.
	Examiner	**Art Unit**
	CHWEN-WEI SU	3722

CPC						
Symbol					**Type**	**Version**
F03D	/	80	/	50	F	2016-05-01
B23B	/	31	/	101	I	2013-01-01
F03D	/	13	/	10	I	2016-05-01
Y10T	/	279	/	1291	A	2015-01-15
Y10T	/	279	/	1986	A	2015-01-15
Y10T	/	279	/	1274	A	2015-01-15
B23B	/	31	/	16	A	2013-01-01
F05B	/	2230	/	60	A	2013-01-01
F05B	/	2260	/	30	A	2013-01-01
F03D	/	80	/	70	A	2016-05-01
Y02P	/	70	/	523	A	2015-11-01
F16C	/	2360	/	31	A	2013-01-01
F05B	/	2230	/	61	A	2013-01-01
F05B	/	2230	/	80	A	2013-01-01
F05B	/	2240	/	60	A	2013-01-01
F16C	/	35	/	062	A	2013-01-01
Y02E	/	10	/	722	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

/CHWEN-WEI SU/ Examiner, Art Unit 3722	17 May 2019	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	8	
/ERIC A GATES/ Primary Examiner, Art Unit 3722	20 May 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/517,288	Fenger, Per E.
	Examiner	**Art Unit**
	CHWEN-WEI SU	3722

INTERNATIONAL CLASSIFICATION					
CLAIMED					
F03D80/50	/	80	/	50	
B23B31/10	/	31	/	10	

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

/CHWEN-WEI SU/ Examiner, Art Unit 3722 (Assistant Examiner)	17 May 2019 (Date)	**Total Claims Allowed:** 8	
/ERIC A GATES/ Primary Examiner, Art Unit 3722 (Primary Examiner)	20 May 2019 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/517,288	Fenger, Per E.
	Examiner	**Art Unit**
	CHWEN-WEI SU	3722

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
-	1	-	10												
-	2	2	11												
3	3	8	12												
4	4	-	13												
-	5														
5	6														
6	7														
7	8														
1	9														

/CHWEN-WEI SU/ Examiner, Art Unit 3722	17 May 2019	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	8	
/ERIC A GATES/ Primary Examiner, Art Unit 3722	20 May 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/517,288	Fenger, Per E.
	Examiner	Art Unit
	CHWEN-WEI SU	3722

CPC - Searched*		
Symbol	Date	Examiner
B23B 31/101, 16, 16287; 2260/008, 0082, 0085; 2215/76; Y10T 279/ 1986, 19, 3462, 1274, 1291, 17752, 17666, Y10S279/903 ;F05B 2230/ 61, 2240/60, 2230/80; F03D 80/50, 13/10.	6/21/2018	CS
Search update	01/25/2019	CS
Search updated	05/17/2019	CS

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Consulted Eric Gates, CPC searches given	6/14/2018	CS
Inventor search	6/21/2018	CS

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
As	searched	05/17/2019	CS

	/CHWEN-WEI SU/ Examiner.Art Unit 3722

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IPR2020-00517

AFCP 2.0 Decision	Application No.	Applicant(s)	
	15/517,288	Fenger, Per E.	
	Examiner	Art Unit	AIA (FITF) Status
	CHWEN-WEI SU	3722	Yes

This is in response to the After Final Consideration Pilot request filed 29 April 2019.

1. **Improper Request** – The AFCP 2.0 request is improper for the following reason(s) and the after final amendment submitted with the request will be treated under pre-pilot procedure.

   ☐ An AFCP 2.0 request form PTO/SB/434 (or equivalent document) was not submitted.

   ☐ A non-broadening amendment to at least one independent claim was not submitted.

   ☐ A proper AFCP 2.0 request was submitted in response to the most recent final rejection.

   ☐ Other: _____

2. **Proper Request**

   A. After final amendment submitted with the request will not be treated under AFCP 2.0.
   The after final amendment cannot be reviewed and a search conducted within the guidelines of the pilot program.

   ☐ The after final amendment will be treated under pre-pilot procedure.

   B. Updated search and/or completed additional consideration.
   The examiner performed an updated search and/or completed additional consideration of the after final amendment within the time authorized for the pilot program. The result(s) of the updated search and/or completed additional consideration are:

   ☑ 1. All of the rejections in the most recent final Office action are overcome and a Notice of Allowance is issued herewith.

   ☐ 2. The after final amendment would not overcome all of the rejections in the most recent final Office action . See attached interview summary for further details.

   ☐ 3. The after final amendment was reviewed, and it raises a new issue(s). See attached interview summary for further details.

   ☐ 4. The after final amendment raises new issues, but would overcome all of the rejections in the most recent final Office action. A decision on determining allowability could not be made within the guidelines of the pilot. See attached interview summary for further details, including any newly discovered prior art.

   ☐ 5. Other: _____

   Examiner Note: Please attach an interview summary when necessary as described above.

Receipt date: 04/29/2019

15/517,288 - GAU: 3722

OK TO ENTER: /C.S./

05/17/2019

Docket No. 400517-20003

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	: **RESPONSE UNDER 37 CFR 1.116**
Per E. Fenger	: **EXPEDITED PROCEDURE**
Application No. 15/517,288	: **EXAMINING GROUP 3722**
Filed: April 6, 2017	: Examiner: Chwen-Wei Su
For: MAIN SHAFT FIXTURE	: Confirmation No. 1448

AMENDMENT AFTER FINAL UNDER PILOT PROGRAM 2.0

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The following is presented in response to the Final Office Action issued January 31, 2019, in connection with the above-captioned patent application.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S109	14008	B23B31/101,16,16287.cpc. or B23B2260/008,0082,0085.cpc. or B23B2215/76.cpc. or Y10T279/1986,19,3462,1274,1291,17752,17666.cpc. or Y10S279/903.cpc. or F05B2230/61.cpc. or F05B2240/60.cpc. or F05B2230/80.cpc. or F03D80/50.cpc. F03F13/10.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2019/05/16 19:58
S110	154	S109 and @pd>="20190125"	US-PGPUB; USPAT; FPRS	OR	ON	2019/05/16 19:59
S111	8	((("Fenger") near3 ("Per") near3 ("E"))).INV.	US-PGPUB; USPAT	OR	ON	2019/05/16 20:00
S112	3	(FENGER-Per-Eske).in.	US-PGPUB; USPAT	OR	ON	2019/05/16 20:02
S113	11	S111 or S112	US-PGPUB; USPAT	OR	ON	2019/05/16 20:02

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S114	1	(Shaft and (fixture or fixation or clamp$3) and (wind and turbine) and mandrel and axis and shoe and (displac$5 or mov$5) and position and (engag$5 or contact$3 or abut$5) and lock$3 and rotor and bearing and ring and ring).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:41
S115	1	(Shaft and (fixture or fixation or clamp$3) and (wind and turbine) and axis and shoe and (displac$5 or mov$5) and position and (engag$5 or contact$3 or abut$5) and lock$3 and rotor and bearing and ring and ring).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:42
S116	1	(Shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and (shoe or plate) and (displac$5 or mov$5) and position and (engag$5 or contact$3 or abut$5) and lock$3 and rotor and bearing and ring and ring).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:44
S117	1	(Shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and (displac$5 or mov$5) and position and (engag$5 or contact$3 or abut$5) and lock$3 and rotor and bearing and ring and ring).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:45
S118	1	(Shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and	US-PGPUB;	OR	ON	2019/05/17 18:46

		(displac$5 or mov$5) and position and (engag$5 or contact$3 or abut$5) and lock$3 and rotor and bearing and (ring or sleeve) and (ring or sleeve)).clm.	USPAT			
S119	1	(Shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and (displac$5 or mov$5) and position and (engag$5 or contact$3 or abut$5) and lock$3 and rotor and (bearing or roller or ball) and (ring or sleeve) and (ring or sleeve)).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:47
S120	9	(Shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and (displac$5 or mov$5) and position and (engag$5 or contact$3 or abut$5) and (bearing or roller or ball) and (ring or sleeve) and (ring or sleeve)).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:48
S121	1	(shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and (displac$5 or mov$5) and position and flange and bolt and (geometry or pattern) and rotor and end and bracket and pivot$4 and mount$3 and horizontal$2).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:56
S122	1	(shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and (displac$5 or mov$5) and position and flange and bolt and (geometry or pattern) and rotor and end and bracket).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:57
S123	1	(shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and (displac$5 or mov$5) and position and flange and rotor and end and bracket).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:57
S124	1	(shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and (displac$5 or mov$5) and position and flange and rotor and bracket).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:58
S125	10	(shaft and (fixture or fixation or clamp$3 or hold$3) and (wind and turbine) and axis and (displac$5 or mov$5) and position and flange and rotor).clm.	US-PGPUB; USPAT	OR	ON	2019/05/17 18:58
S126	16	(Fenger near2 Per).in.	US-PGPUB; USPAT	OR	ON	2019/05/17 19:01

5/ 17/ 2019 7:05:16 PM
C:\ Users\ csu\ Documents\ EAST\ Workspaces\ 15517288.wsp

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/517,288	Filing Date 04/06/2017	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $40 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $210 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	04/29/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 8	Minus	** 20	= 0		x $50 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $230 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/KIMBERLY R WHITE/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: A.NE.AFCP
Document Description: After Final Consideration Pilot Program Request

PTO/SB/434 (05-13)

CERTIFICATION AND REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0

Practitioner Docket No.:	Application No.:	Filing Date:
400517-20003	15/517,288	2017-04-06
First Named Inventor:	**Title:**	
Per E. Fenger	MAIN SHAFT FIXTURE	

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0 (AFCP 2.0) OF THE ACCOMPANYING RESPONSE UNDER 37 CFR 1.116.

1. The above-identified application is (i) an original utility, plant, or design nonprovisional application filed under 35 U.S.C. 111(a) [a continuing application (*e.g.*, a continuation or divisional application) is filed under 35 U.S.C. 111(a) and is eligible under (i)], or (ii) an international application that has entered the national stage in compliance with 35 U.S.C. 371(c).
2. The above-identified application contains an outstanding final rejection.
3. Submitted herewith is a response under 37 CFR 1.116 to the outstanding final rejection. The response includes an amendment to at least one independent claim, and the amendment does not broaden the scope of the independent claim in any aspect.
4. This certification and request for consideration under AFCP 2.0 is the only AFCP 2.0 certification and request filed in response to the outstanding final rejection.
5. Applicant is willing and available to participate in any interview requested by the examiner concerning the present response.
6. This certification and request is being filed electronically using the Office's electronic filing system (EFS-Web).
7. Any fees that would be necessary consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, extension of time fees, are being concurrently filed herewith. [There is no additional fee required to request consideration under AFCP 2.0.]
8. By filing this certification and request, applicant acknowledges the following:
    - Reissue applications and reexamination proceedings are not eligible to participate in AFCP 2.0.
    - The examiner will verify that the AFCP 2.0 submission is compliant, *i.e.*, that the requirements of the program have been met (see items 1 to 7 above). For compliant submissions:
        - The examiner will review the response under 37 CFR 1.116 to determine if additional search and/or consideration (i) is necessitated by the amendment and (ii) could be completed within the time allotted under AFCP 2.0. If additional search and/or consideration is required but cannot be completed within the allotted time, the examiner will process the submission consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, by mailing an advisory action.
        - If the examiner determines that the amendment does not necessitate additional search and/or consideration, or if the examiner determines that additional search and/or consideration is required and could be completed within the allotted time, then the examiner will consider whether the amendment places the application in condition for allowance (after completing the additional search and/or consideration, if required). If the examiner determines that the amendment does not place the application in condition for allowance, then the examiner will contact the applicant and request an interview.
            - The interview will be conducted by the examiner, and if the examiner does not have negotiation authority, a primary examiner and/or supervisory patent examiner will also participate.
            - If the applicant declines the interview, or if the interview cannot be scheduled within ten (10) calendar days from the date that the examiner first contacts the applicant, then the examiner will proceed consistent with current practice concerning responses after final rejection under 37 CFR 1.116.

Signature	Date
/David S. Safran/	2019-04-29
Name (Print/Typed) David S. Safran	**Practitioner Registration No.** 27997

***Note**: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.*

☑ * Total of 1 forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	35854064
Application Number:	15517288
International Application Number:	
Confirmation Number:	1448
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Customer Number:	25570
Filer:	David Scott Safran/Paul Mahan
Filer Authorized By:	David Scott Safran
Attorney Docket Number:	400517-20003
Receipt Date:	29-APR-2019
Filing Date:	06-APR-2017
Time Stamp:	10:47:25
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	After Final Consideration Program Request	AFCP_Request_29Apr2019_AttyDkt_400517_20003.pdf	226321 cc86e3edbcb365a4e0c0889f583d05fcd4e0779d	no	2

Warnings:

Information:	
Total Files Size (in bytes):	226321

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No. 400517-20003

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	: **RESPONSE UNDER 37 CFR 1.116**
Per E. Fenger	: **EXPEDITED PROCEDURE**
Application No. 15/517,288	: **EXAMINING GROUP 3722**
Filed: April 6, 2017	: Examiner: Chwen-Wei Su
For: MAIN SHAFT FIXTURE	: Confirmation No. 1448

AMENDMENT AFTER FINAL UNDER PILOT PROGRAM 2.0

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The following is presented in response to the Final Office Action issued January 31, 2019, in connection with the above-captioned patent application.

Electronic Acknowledgement Receipt

EFS ID:	35853377
Application Number:	15517288
International Application Number:	
Confirmation Number:	1448
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Customer Number:	25570
Filer:	David Scott Safran/Paul Mahan
Filer Authorized By:	David Scott Safran
Attorney Docket Number:	400517-20003
Receipt Date:	29-APR-2019
Filing Date:	06-APR-2017
Time Stamp:	09:51:50
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Amendment_AF_29Apr2019_AttyDkt_400517_20003.pdf	162335 535a49fb5cf902b0332d417f89b6752d1de19157	yes	5

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	5	5
	Claims	2	4
	Response After Final Action	1	1
Warnings:			
Information:			
	Total Files Size (in bytes):	162335	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

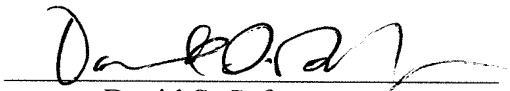
New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

REMARKS

By the above actions, claims 3, 4 & 6 have been amended to depend from allowed claim 11, and claims 1, 2, 5, 10, 13 have been cancelled. Thus, since all of the remaining claims have been either allowed or depend from a claim that has been allowed, this application should now be in condition for allowance. However, in the event that any issues should remain after consideration of this response, then the Examiner is requested to contact the undersigned by telephone for the purpose of resolving any such issue and thereby facilitating prompt approval of this application.

Respectfully submitted,



David S. Safran
Registration No. 27,997

Customer No. 25570

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive, Suite 500
McLean, VA 22102

Direct Telephone: 703-584-3273

DSS:prm

In the Claims:

1. (Cancelled).

2. (Cancelled).

3. (Currently Amended) The main shaft fixture (10) according to claim 11, [[1,]] further comprising mounting facilities (40) for a lightweight crane (12).

4. (Currently Amended) The main shaft fixture (10) according to claim 11, [[1,]] wherein the pressure mandrels (18) are provided with actuators for displacing and retaining the tap shoes (20) in the passive position and the active position, respectively, alternatively in a selectable position between the passive and the active position.

5. (Cancelled).

6. (Currently Amended) The main shaft fixture (10) according to claim 11, [[1,]] wherein slide plates (42, 44) are located between the opposing sides of the surface of the main shaft and tap shoes.

7. (Previously Presented) The main shaft fixture (10) according to claim 6, wherein the slide plates are configured so that the opposing free ends of the tap shoes (20) facing the main shaft (4) are provided with a one of the slide plates (42) which in the active advanced position is engaged with the main shaft (4).

8. (Previously Presented) The main shaft fixture (10) according to claim 6, wherein one of the slide plates is a multi-part slide plate (44) cooperating with the main shaft (4) for mounting on the main shaft (4), where the multi-part slide plate (44) in a mounted position on the main shaft (4) cooperates with the tap shoes (20).

9. (Previously Presented) A main shaft fixture (10) for fixation of a main shaft (4) on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture (10) is divided up into a number of sections for mounting on stable structural parts (2) in a nacelle in a wind turbine, including the bottom frame (2) of the nacelle, wherein the main shaft fixture (10) comprises at least three radially displaceable pressure mandrels (18), substantially symmetrical located around a centre axis (11) of the main shaft, first ends of said pressure mandrels (18) face the main shaft (4) and are furnished with a tap shoe (20), and wherein said pressure mandrels (18) are displaceable between a passive, withdrawn lockable position where the tap shoes (20) are configured to be located at a distance from the surface of the main shaft (4) and an advanced lockable position where the tap shoes (20) are configured to be engaged with the main shaft (4), further comprising a rotor lock (24) for fixation of the rotor (8) of the wind turbine, further comprising one of a multi-part needle bearing, roller bearing, or ball bearing (46) comprised of a multi-part inner ring (48) fastened to the main shaft (4), and a therewith cooperating multi-part outer ring (50) comprised of bowed sub-segments (52) corresponding to the number of tap shoes, mounted on the opposing side of the tap shoes (20) facing the inner ring (48), which in the advanced active position of the pressure mandrels form the outer ring (50) at a distance from the outer periphery of the multi-part inner ring (48), and where a plurality of needle rollers, rollers, or balls (54) are arranged between the inner ring (48) and the outer ring (50), and where means are present for retaining the needles, rollers, or balls (54) in position between the inner ring (48) and outer ring (50).

10. (Cancelled).

11. (Previously Presented) A main shaft fixture (10) for fixation of a main shaft (4) on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture (10) is divided up into a number of sections for mounting on stable structural parts (2) in a nacelle in a wind turbine, including the bottom frame (2) of the nacelle, wherein the main shaft fixture (10) comprises at least three radially displaceable pressure mandrels (18), substantially symmetrical located around a centre axis (11) of the main shaft, first ends of said pressure mandrels (18) face the main shaft (4) and are furnished with a tap shoe (20), and wherein said pressure mandrels (18) are displaceable between a passive, withdrawn lockable

position where the tap shoes (20) are configured to be located at a distance from the surface of the main shaft (4) and an advanced lockable position where the tap shoes (20) are configured to be engaged with the main shaft (4), further comprising a rotor lock (24) for fixation of the rotor (8) of the wind turbine, wherein the rotor lock (24) is comprised of a flange element, with a bolt circle geometry (26) that corresponds to a bolt circle geometry (28) on the rotor, said flange element (24) being fastened at the ends to a first end (21) of two first beam-shaped brackets (22) extending parallel with each other, and being located on each side of the main shaft, said beam shaped brackets (22) forming part of the main shaft fixture, and where a second end (23) of the brackets (22) is pivotally mounted with horizontally oriented bolt connections (30) on other brackets (39) that form parts of the main shaft fixture (10) and which are anchored on the bottom frame (2) of the nacelle.

12. (Previously Presented) The main shaft fixture (10) according to claim 11, wherein at least one actuator (36) is located nearest the rotor lock (24) between the bottom frame (2) of the nacelle and an adjacent side (25) of the first beam-shaped brackets (22) facing the bottom frame (2), and wherein said at least one actuator (36) is displaceable between a first passive outer position and an active outer position by which the flange element (24) is displaced vertically.

13. (Cancelled).

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/517,288	04/06/2017	Per E. Fenger	400517-20003	1448

25570 7590 01/31/2019

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102

EXAMINER	
SU, CHWEN-WEI	

ART UNIT	PAPER NUMBER
3722	

NOTIFICATION DATE	DELIVERY MODE
01/31/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@rmsc2.com
lgallaugher@rmsc2.com
secretaries@rmsc2.com

Office Action Summary	Application No. 15/517,288	Applicant(s) Fenger, Per E.	
	Examiner CHWEN-WEI SU	Art Unit 3722	AIA Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 10/1/2018.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1 and 3-13 is/are pending in the application.

5a) Of the above claim(s) 13 is/are withdrawn from consideration.

6) ☑ Claim(s) 9 and 11-12 is/are allowed.

7) ☑ Claim(s) 1,3-8 and 10 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 10/1/2018 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☑ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Election/Restrictions

Newly submitted claim 13 directed to an invention that lacks unity with the invention originally claimed for the following reasons: Group I (claims 1-12, filed 4/6/2017, drawn to a main shaft fixture) and Group II (new claims 13 filed 10/1/2018, drawn to a self-hoisting crane) lack unity of invention because even though the inventions of these groups require the technical feature of a main shaft fixture, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of Signore et al. (US 2012/0141292) in view of Weaver et al. (EP 1748182). See Office Action mailed 06/29/2018 on the rejection of claim 1.

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, **claim 13 is withdrawn from consideration** as being directed to a nonelected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

Drawings

2. The drawings were received on 10/01/2018. These drawings are acceptable.

Claim Rejections - 35 USC § 103

3. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of

rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

4. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1, 3-4, 6-8, and 10 is/are rejected under 35 U.S.C. 103 as being unpatentable over Signore et al. (US 2012/0141292) in view of Weaver et al. (EP 1748182).

6. Regarding claim 1, Signore discloses a main shaft fixture 128 for fixation of a main shaft 24 on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture is divided up into a number of sections for mounting on stable structural parts in a nacelle in a wind turbine, including the bottom frame 16 of the nacelle, wherein the main shaft fixture comprises at least three torque clamps 244, substantially symmetrical located around a center axis of the main shaft, to facilitate coupling a restraint assembly 136 to the main shaft to limit a movement of the main shaft. (Figs. 1-9, Paragraphs 22, 53-56)

7. Signore does not disclose at least three independently, radial displaceable pressure mandrels, and a tap shoe is provided on a first end of the pressure mandrel. However, Weaver discloses a shaft restraining member 400 attached to a bed plate of a wind turbine. The shaft restraining member includes hydraulic or mechanic operated friction brakes 518. The clamping action of brakes 518 resists torque from rotor shaft

402. The hydraulic or mechanic brake may comprise cylinders supported on brake support flange 519 of the shaft restraining member. (Figs. 4-5, Paragraphs 16-19) Therefore, it would have been obvious to one with ordinary skill in the art before the effective filing date of the claimed invention to modify the torque clamps of Signore to be hydraulic or mechanical operated such that its radial position can be adjusted to fit the main shaft with desired friction. Signore as modified by Weaver teaches that at least three radial displaceable pressure mandrels, first ends of said pressure mandrels face the main shaft and are furnished with a tap shoe (the torque clamps), and wherein said pressure mandrels are displaceable between a passive, withdrawn lockable position where the tap shoes are configured to be located at a distance from the surface of the main shaft and an advanced lockable position where the tap shoes are configured to be engaged with the main shaft. Signore as modified by Weaver teaches that the pressure mandrels are substantially symmetrical located around a center axis of the main shaft.

8. It is noted that Signore discloses each torque clamp 244 is configured to facilitate coupling restraint assembly 136 to drive shaft 24 via a friction fit to facilitate limiting a movement of the drive shaft. Therefore, Signore as modified by Weaver also teaches “enabling the main shaft to be fixed in position by the main shaft fixture while being permitted to rotate.”

9. A claim containing a "recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus” if the prior art apparatus teaches all the structural limitations of the claim. Ex part Masham, 2 USPQ2d 1647 (Bd. Pat. App. & Inter. 1987)

10. Regarding the intended use limitation “The three independently, radially displaceable pressure mandrel is for fixing of cylinder-shaped with different diameters and for the fixing of shafts with conical shapes.”, it is noted that the prior art used in the rejection is capable of being used for this function.

11. Regarding claim 3, Signore as modified discloses the main shaft fixture further comprising mounting facilities for a lightweight crane. Although Signore does not specifically mention mounting facilities for a self-hoisting crane, it is noted that the structure of the main shaft fixture is capable for mounting with a lightweight crane, such as by using a chain or a cable connected between the crane and the main shaft fixture.

12. In addition, a claim containing a "recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus” if the prior art apparatus teaches all the structural limitations of the claim. Ex part Masham, 2 USPQ2d 1647 (Bd. Pat. App. & Inter. 1987)

13. Regarding the intended use limitation “mounting facilities for a lightweight crane”, it is noted that the prior art used in the rejection is capable of being used for this function.

14. Regarding claim 4, Signore as modified by Weaver teaches the pressure mandrels are provided with actuators (hydraulic or mechanical operated) for displacing and retaining the tap shoes in the passive position and the active position, respectively, alternatively in a selectable position between the passive and the active position.

15. Regarding claim 6, Weaver teaches slide plates 520 (the surface are Teflon-covered) are located between the opposing sides of the surface of the main shaft and tap shoes (the inner end the brake) (Fig. 5, Paragraph 18). Therefore, it would have

been obvious to one with ordinary skill in the art before the effective filing date of the claimed invention to modify the tap shoes 244 of Signore to have a Teflon plate as taught by Weaver to allow rotation of the main shaft above a predetermined torque.

16. Regarding claim 7, as set forth in claim 6 above, the slide plates 520 are configured so that the opposing free ends of the tap shoes facing the main shaft are provided with a one of the slide plate 520 (Teflon) which in the active advanced position is engaged with the main shaft.

17. Regarding claim 8, one of the slide plate 520 is a multi-part slide plate cooperating with the main shaft for mounting on the main shaft, where the multi-part slide plate in a mounted (clamped or engaged) position on the main shaft cooperates with the tap shoes.

18. Regarding claim 10, the main shaft fixture further comprising a rotor lock 134 for fixation of the rotor of the wind turbine. (Figs. 5-8, Paragraphs 22 and 54)

19. Claim 5 is/are rejected under 35 U.S.C. 103 as being unpatentable over Signore et al. in view of Weaver et al., and further in view of Borden (US 1,853,255).

20. Regarding claim 5, Signore as modified does not disclose "the pressure mandrels are comprised of threaded bolts having opposing free ends that face the main shaft and are furnished with tap shoes, and wherein said threaded bolts cooperate with threaded holes in respective sections of the fixture." However, Borden discloses a work holder comprising three mandrels 5, 6, 7 for clamping a work piece. The mandrel is threaded at an inner end 5a which passes through a corresponding threaded hole in the body 1 of the work holder. (Figs. 1-3, p. 1 lines 32 - 59) Therefore, it would have been

obvious to one with ordinary skill in the art before the effective filing date of the claimed invention to modify the mechanical operated pressure mandrel of Signore as modified to be threaded bolts for adjusting the clamping force or size depending on the diameter of the main shaft with low cost and ease.

Allowable Subject Matter

21. Claims 9, 11-12 are allowed.

Response to Arguments

22. Applicant's arguments filed 10/1/2018 have been fully considered but they are not persuasive. Applicant first argues that

23. **A**: "*Signore does not disclose radially displaceable pressure mandrels, as Signore is not concerned with adaptability to a number of various diameter or conical main shafts. As such, Signore would not provide a reason for one of ordinary skill to use at least 3 independently displaceable pressure mandrels*." While Signore does not disclose radially displaceable pressure mandrel, Weaver teaches this feature.

24. **B**: *"If Signore were to be viewed in combination with Weaver, the person of ordinary skill in the art would use the only two shaft restricting devices*." Signore teaches four torque clamps 244 as seen in Fig. 7. While the embodiment of Weaver shows 2 friction brakes 518, one with ordinary skill in the art would have modified all four torque clamps of Signore to be radially displaceable, not only two.

25. **C**: "*Teflon lining is not appropriate with the current claim to teach … each the tap shoes that are configured to be engaged with the main shaft in a manner enabling the main shaft to be fixed in position by the main shaft fixture while being permitted to rotate."* First, Teflon lining is not used for teaching the limited rotating of the main shaft

as applicant argues above. Instead, as described in the current Office Action, Signore discloses each torque clamp 244 is configured to facilitate coupling restraint assembly 136 to drive shaft 24 via a *friction fit* to facilitate *limiting a movement* of the drive shaft. Therefore, Signore as modified by Weaver also teaches "enabling the main shaft to be fixed in position by the main shaft fixture while being permitted to rotate." Second, the Teflon-covered surface 520 is considered to be a slide plate. It can be seen clearly from Fig. 5 of Weaver that the Teflon-covered surface 520 including a separate layer fixed to the brake 518. This layer-like Teflon-covered surface is interpreted as a slide plate.

26. **D**. "*Borden workholder will not enable a workpiece held by it so as be able to rotate while being held in place as disclosed and now claimed by the present applicant. Thus, Borden cannot suggest mandrels provided with tap shoes to enable a shaft held be the mandrels to rotate while being held in place*." While Burdon teaches a workholder clamping a tubular workpiece by three threaded set screws as applicant argues, one will not completely tighten the workpiece (the main shaft) held there without rotation at all when combined with Signore and Weaver. This is because Signore as modified already teaches this feature: permitting limited rotation of the main shaft while holding it. Therefore, it would have been obvious to one with ordinary skill in the art to modify the mechanical operated pressure mandrel of Signore as modified to be threaded bolts for adjusting the clamping force depending on the desired friction for holding the main shaft but still permitting limited rotation.

27. Finally, new claim 19 is withdrawn for consideration as stated in the Election/Restriction Section above.

Conclusion

28. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

29. Any inquiry concerning this communication or earlier communications from the examiner should be directed to CHWEN-WEI SU whose telephone number is (571)272-4998. The examiner can normally be reached on Monday-Friday 9:30 AM-6 PM ET.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sunil K Singh can be reached on 571-272-3460. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/CHWEN-WEI SU/
Examiner, Art Unit 3722

/ERIC A GATES/
Primary Examiner, Art Unit 3722

Notice of References Cited	Application/Control No. 15/517,288	Applicant(s)/Patent Under Reexamination Fenger, Per E.	
	Examiner CHWEN-WEI SU	Art Unit 3722	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20120217089-A1	08-2012	Fenger; Per E	F03D80/50	182/2.1
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102
Page 49 of 349

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/517,288	Fenger, Per E.
	Examiner	Art Unit
	CHWEN-WEI SU	3722

CPC - Searched*		
Symbol	Date	Examiner
B23B 31/101, 16; 2260/008, 0082, 0085, 16287; 2215/76; Y10T 279/ 1986, 19, 3462, 1274, 1291, 17752, 17666, Y10S279/903 ;F05B 2230/ 61, 2240/60, 2230/80; F03D 80/50, 13/10.	6/21/2018	CS
Search update	01/25/2019	CS

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Consulted Eric Gates, CPC searches given	6/14/2018	CS
Inventor search	6/21/2018	CS

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

	/CHWEN-WEI SU/ Examiner.Art Unit 3722

LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2020-00125

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/517,288	Fenger, Per E.
	Examiner	**Art Unit**
	CHWEN-WEI SU	3722

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/22/2018	01/25/2019							
	1	✓	✓							
	2	✓	-							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
	8	✓	✓							
	9	✓	=							
	10	✓	✓							
	11	O	=							
	12	O	=							
	13		N							

LiftWerx Ex. 1005
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102
Page 51 of 349

Bibliographic Data

Application No: 15/517,288

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /CHWEN-WEI SU/ Examiner's Signature [ ] Initials

Title: MAIN SHAFT FIXTURE

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
04/06/2017	279	3722	400517-20003
RULE			

APPLICANTS

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INVENTORS

Per E. Fenger Terndrup, DENMARK

CONTINUING DATA

This application is a 371 of PCT/DK2015/000040 10/06/2015

FOREIGN APPLICATIONS

DENMARK PA 2014 00573 10/07/2014

DENMARK PA 2015 00527 09/04/2015

IF REQUIRED, FOREIGN LICENSE GRANTED**

07/14/2017

**** SMALL ENTITY ****

STATE OR COUNTRY

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7918 Jones Branch Drive
Suite 500
McLean, VA 22102
UNITED STATES

FILING FEE RECEIVED

$740

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S96	3	"15517288"	US-PGPUB; USPAT; FPRS; JPO	OR	ON	2019/01/23 17:59
S97	1	"15517288" and (con$4 near5 shaft)	US-PGPUB; USPAT; FPRS; JPO	OR	ON	2019/01/23 19:17
S98	1	"15517288" and (con$4)	US-PGPUB; USPAT; FPRS; JPO	OR	ON	2019/01/23 19:18
S99	1	"15517288" and winch	US-PGPUB; USPAT; FPRS; JPO	OR	ON	2019/01/23 20:26
S100	6	(US-20120141292-$ or US-20100275442-$).did. or (US-1853255-$).did. or (EP-1748182-$).did.	US-PGPUB; USPAT; FPRS	OR	ON	2019/01/23 20:30
S101	1	S100 and winch	US-PGPUB; USPAT; FPRS; JPO	OR	ON	2019/01/23 20:30
S103	13335	B23B31/101,16.cpc. or B23B2260/008,0082,0085,16287.cpc. or B23B2215/76.cpc. or Y10T279/1986,19,3462,1274,1291,17752,17666.cpc. or Y10S279/903.cpc. or F05B2230/61.cpc. or F05B2240/60.cpc. or F05B2230/80.cpc. or F03D80/50.cpc. F03F13/10.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2019/01/23 20:37
S104	377	S103 and @pd>="20180621"	US-PGPUB; USPAT; FPRS	OR	ON	2019/01/23 20:37
S105	8	((("Fenger") near3 ("Per") near3 ("E"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2019/01/23 22:05
S106	6	(US-20100275442-$ or US-20120141292-$).did. or (US-1853255-$).did. or (EP-1748182-$).did.	US-PGPUB; USPAT; FPRS	OR	ON	2019/01/23 22:09
S107	2	S106 and crane	US-	OR	ON	2019/01/23

			PGPUB; USPAT; FPRS; JPO			22:09

EAST Search History (Interference)

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1/ 25/ 2019 3:09:33 PM
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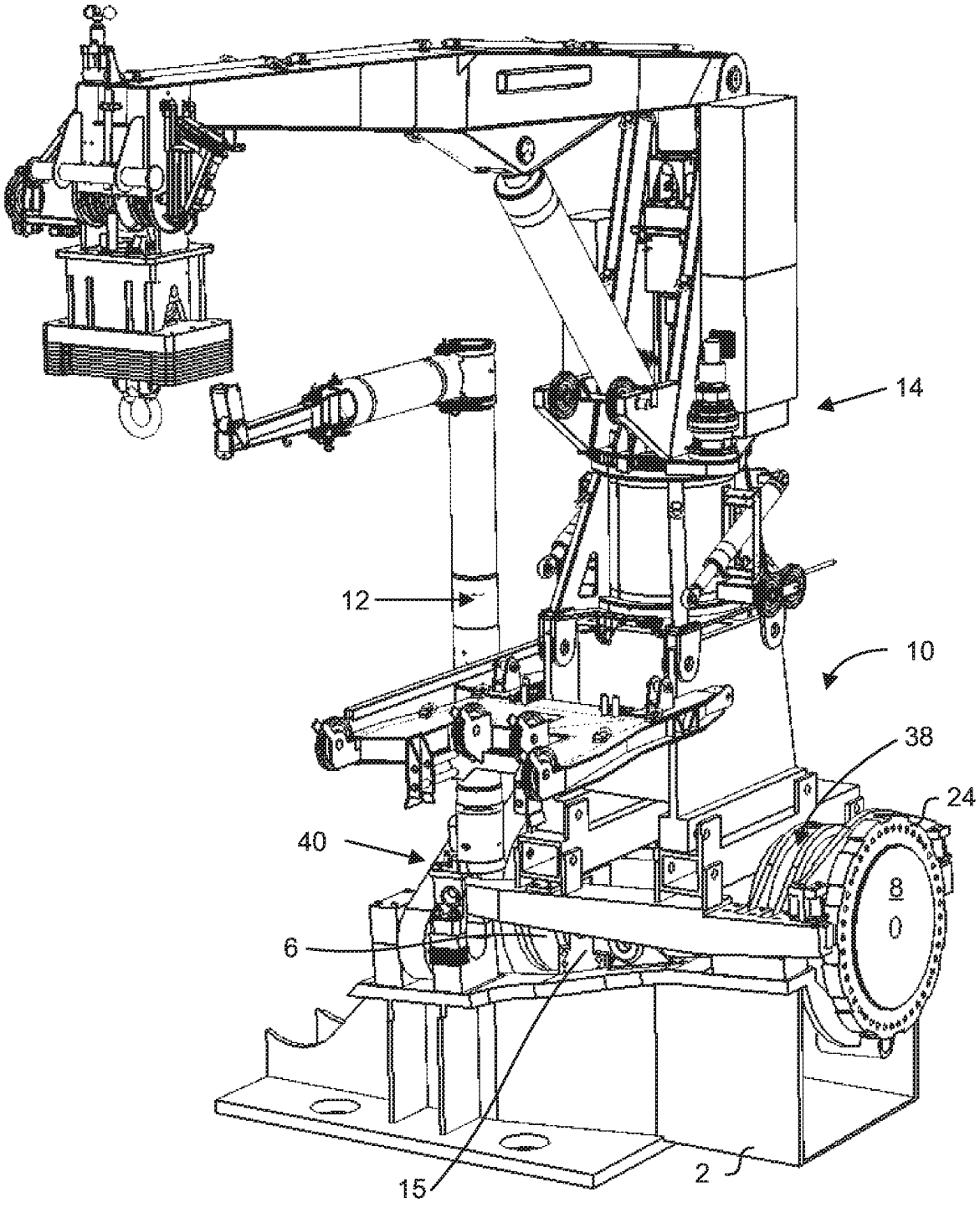


FIG. 1

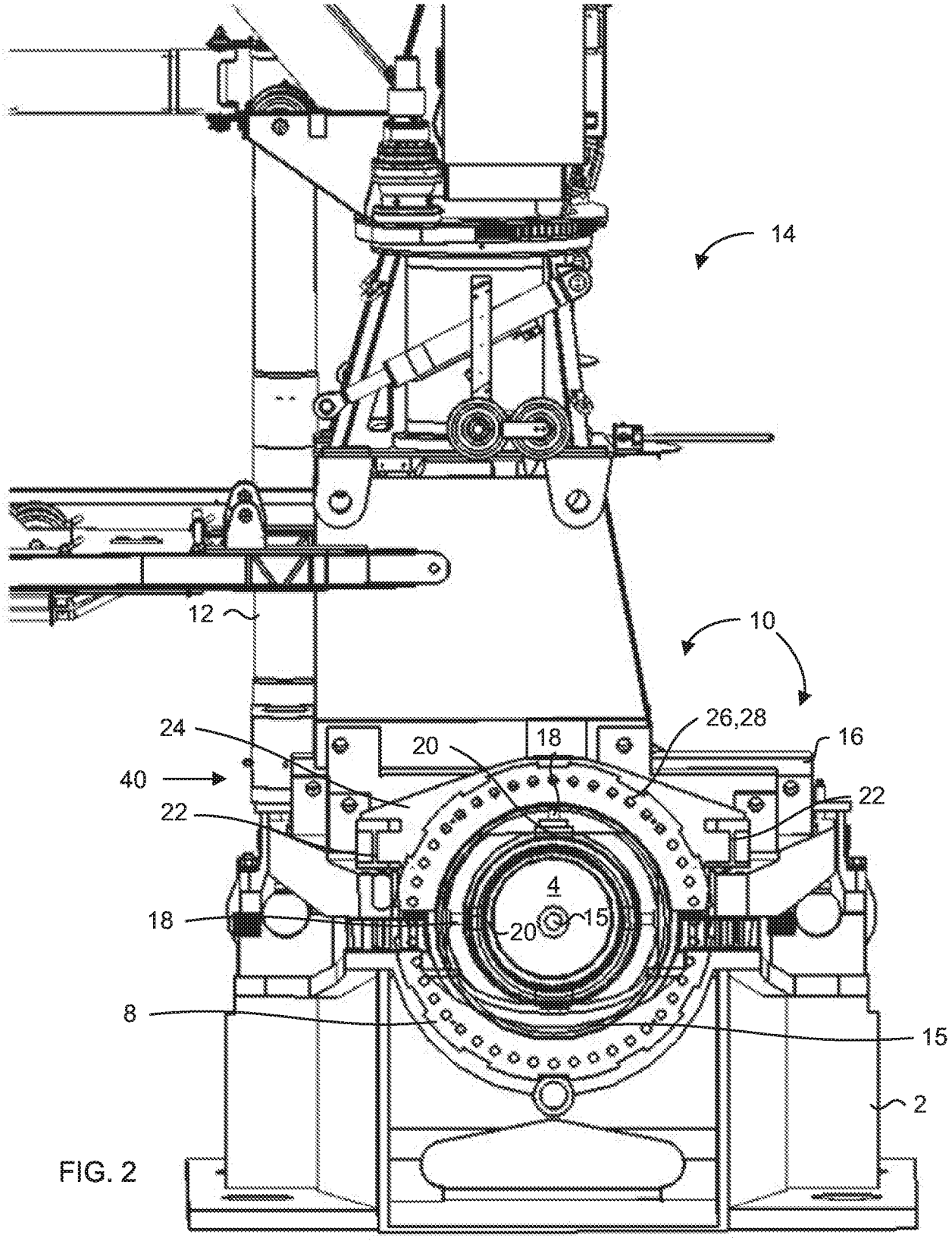


FIG. 2

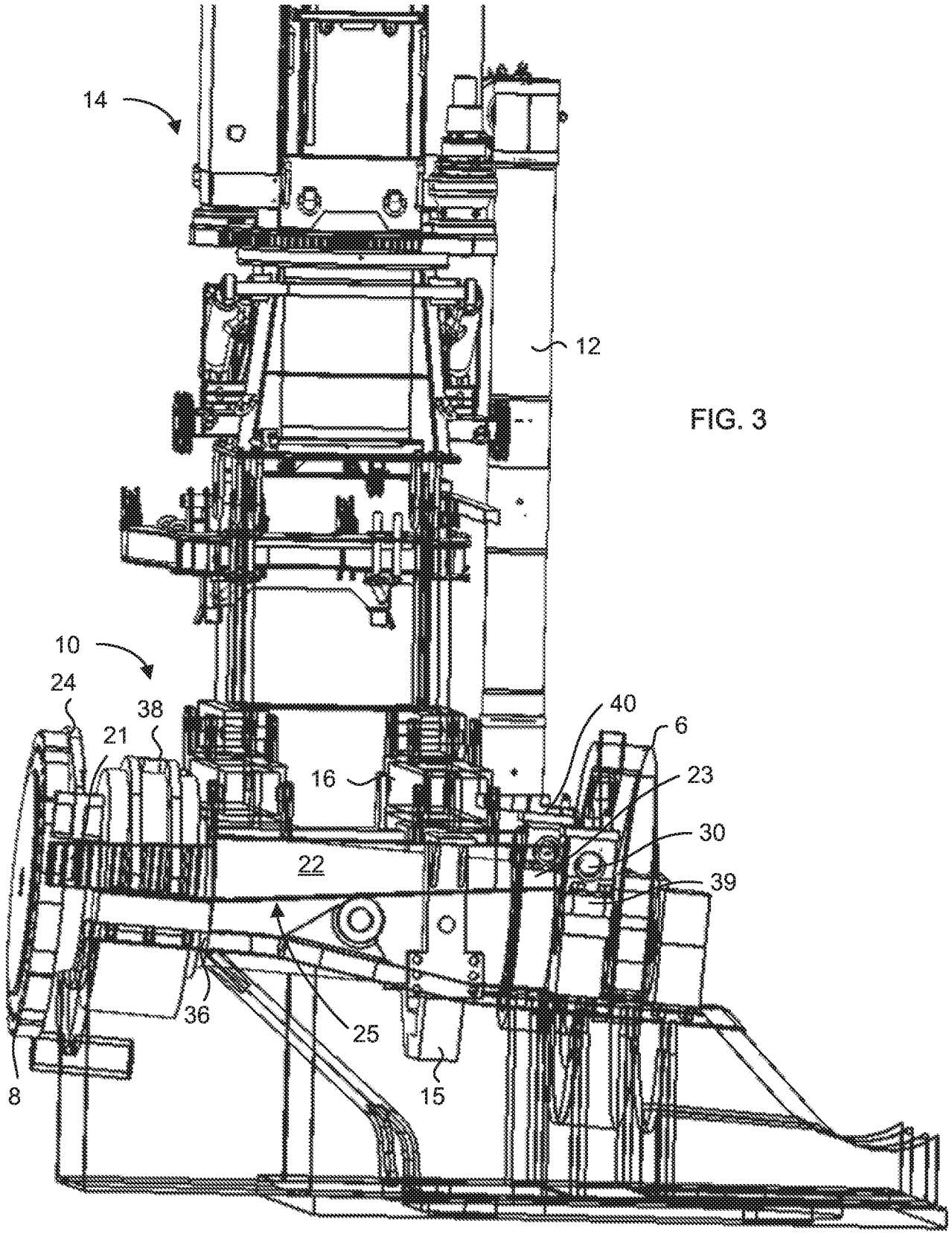


FIG. 3

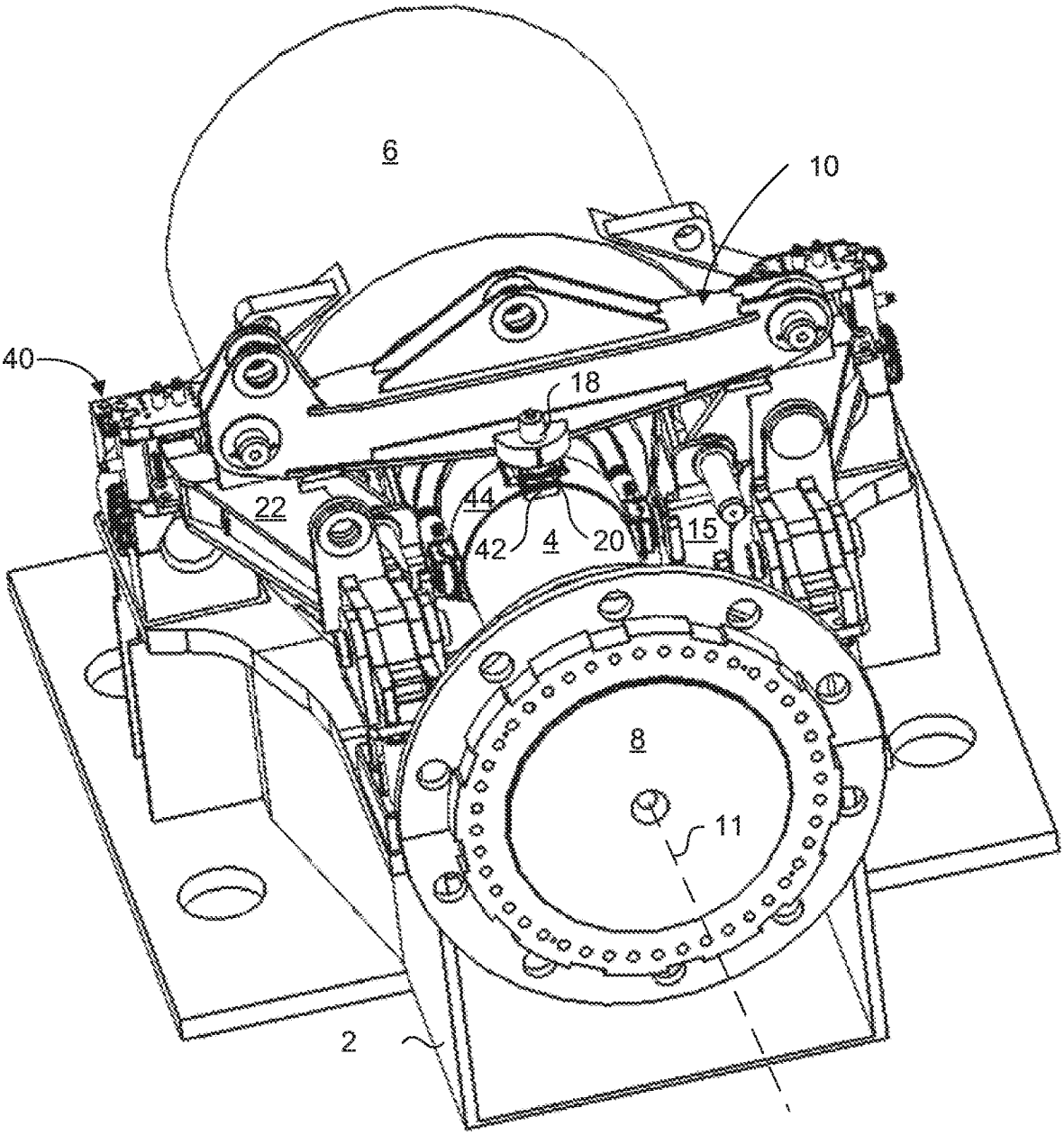


FIG. 4

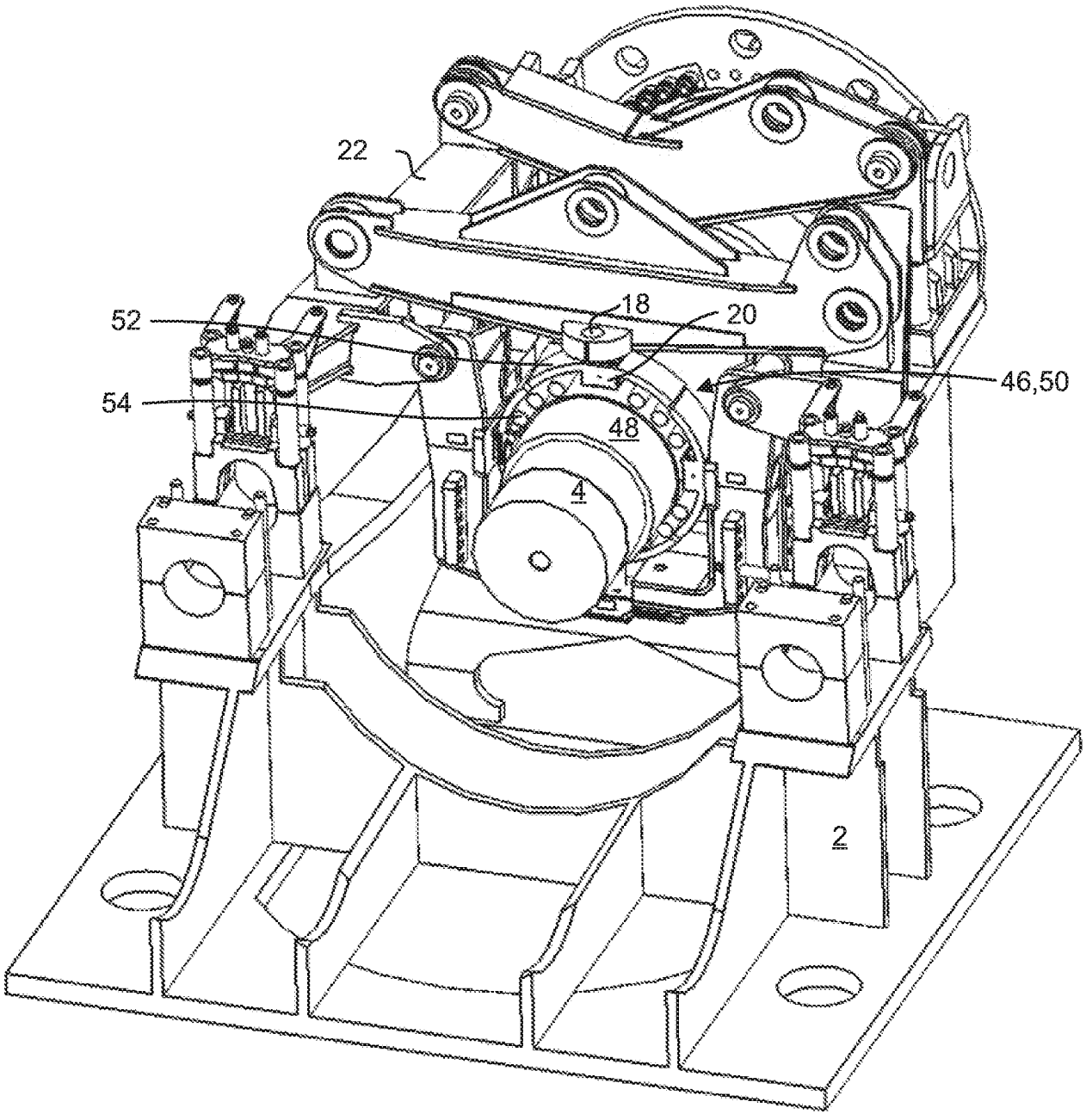


FIG. 5

Electronic Acknowledgement Receipt

EFS ID:	33880688
Application Number:	15517288
International Application Number:	
Confirmation Number:	1448
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Customer Number:	25570
Filer:	David Scott Safran/Paul Mahan
Filer Authorized By:	David Scott Safran
Attorney Docket Number:	400517-20003
Receipt Date:	01-OCT-2018
Filing Date:	06-APR-2017
Time Stamp:	14:52:11
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Drawings-only black and white line drawings	Updated_Replacement_Dwgs_400517_2003.pdf	725023 1d0d43710323461e3d0cc490c276ba646902d7b3	no	5

Warnings:

Information:	
Total Files Size (in bytes):	725023

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No. 400517-20003

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	: Confirmation No. 1448
Per E. Fenger	: Group Art Unit: 3722
Application No. 15/517,288	: Examiner: Chwen-Wei Su
Filed: April 6, 2017	:
For: MAIN SHAFT FIXTURE	:

AMENDMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The following is presented in response to the Office Action issued June 29, 2018, in connection with the above captioned patent application.

In the Specification:

Please amend paragraphs [0016] to [0018] as follows:

[0016] With the intent of being able to permit rotation of the main shaft during performance of servicing of a relevant wind turbine and in order to protect the main shaft and the main shaft fixture, [[a]] slide plates ~~lining~~ may exist between the opposing sides of the main shaft's surface and the tap shoes.

[0017] This enables the main shaft to be fixed in its position by the main shaft fixture, but with the main shaft being permitted to rotate without it being damaged due to the presence of the slide plates ~~lining~~.

[0018] In a first embodiment of the slide plates, ~~lining,~~ this could comprise the free ends of tap shoes facing against the main shaft being furnished with slide plates, which in the active extended position are engaged with the main shaft.

Please amend paragraph [0043] as follows:

[0043] As shown in Fig. 4, a slideway ~~lining~~ 42, 44 is located between the opposing sides of the tap shoes 20 facing the surface of the main shaft 4.

Please amend paragraph [0047] as follows:

[0047] The presence of the slide plates ~~lining~~ 42, 44, alternatively the multi-part needle bearing, roller bearing, ball bearing 46, involves the main shaft 4 being permitted to rotate simultaneously with it being fixed in its position during servicing of the wind turbine, which can serve a purpose namely for larger wind turbines.

In the Claims:

1. (Currently Amended) A main shaft fixture (10) for fixation of a main shaft (4) on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture (10) is divided up into a number of sections for mounting on stable structural parts (2) in a nacelle in a wind turbine, including the bottom frame (2) of the nacelle, wherein the main shaft fixture (10) comprises at least three ~~radial~~ independently, radially displaceable pressure mandrels (18) for fixing of cylinder-shaped shafts with different diameters and for the fixing of shafts with conical shapes, the pressure mandrels being substantially symmetrical located around a centre axis (11) of the main shaft, first ends of said pressure mandrels (18) face the main shaft (4) and are furnished with a tap shoe (20), and wherein said pressure mandrels (18) are displaceable between a passive, withdrawn lockable position where the tap shoes (20) are configured to be located at a distance from the surface of the main shaft (4) and an advanced lockable position where the tap shoes (20) are configured to be engaged with the main shaft (4) in a manner enabling the main shaft to be fixed in position by the main shaft fixture while being permitted to rotate.

2. (Cancelled).

3. (Previously Presented) The main shaft fixture (10) according to claim 1, further comprising mounting facilities (40) for a lightweight crane (12).

4. (Previously Presented) The main shaft fixture (10) according to claim 1, wherein the pressure mandrels (18) are provided with actuators for displacing and retaining the tap shoes (20) in the passive position and the active position, respectively, alternatively in a selectable position between the passive and the active position.

5. (Previously Presented) The main shaft fixture (10) according to claim 1, wherein the pressure mandrels (18) are comprised of threaded bolts having opposing free ends that face the main

shaft and are furnished with tap shoes (20), and wherein said threaded bolts cooperate with threaded holes in respective sections of the fixture (10).

6. (Currently Amended) The main shaft fixture (10) according to claim 1, wherein ~~a slideway lining~~ slide plates (42, 44) [[is]] are located between the opposing sides of the surface of the main shaft and tap shoes.

7. (Currently Amended) The main shaft fixture (10) according to claim 6, wherein the ~~slideway lining is~~ slide plates are configured so that the opposing free ends of the tap shoes (20) facing the main shaft (4) are provided with a one of the slide ~~plate~~ plates (42) which in the active advanced position is engaged with the main shaft (4).

8. (Currently Amended) The main shaft fixture (10) according to claim 6, ~~further comprising~~ wherein one of the slide plates is a multi-part slide plate (44) cooperating with the main shaft (4) for mounting on the main shaft (4), where the multi-part slide plate (44) in a mounted position on the main shaft (4) cooperates with the tap shoes (20).

9. (Currently Amended) A main shaft fixture (10) for fixation of a main shaft (4) on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture (10) is divided up into a number of sections for mounting on stable structural parts (2) in a nacelle in a wind turbine, including the bottom frame (2) of the nacelle, wherein the main shaft fixture (10) comprises at least three radially displaceable pressure mandrels (18), substantially symmetrical located around a centre axis (11) of the main shaft, first ends of said pressure mandrels (18) face the main shaft (4) and are furnished with a tap shoe (20), and wherein said pressure mandrels (18) are displaceable between a passive, withdrawn lockable position where the tap shoes (20) are configured to be located at a distance from the surface of the main shaft (4) and an advanced lockable position where the tap shoes (20) are configured to be engaged with the main shaft (4), further comprising a rotor lock (24) for fixation of the rotor (8) of the wind turbine, ~~The main shaft fixture (10) according to claim 1,~~ further comprising one of a multi-part needle bearing, roller bearing, or ball bearing (46) comprised of

a multi-part inner ring (48) fastened to the main shaft (4), and a therewith cooperating multi-part outer ring (50) comprised of bowed sub-segments (52) corresponding to the number of tap shoes, mounted on the opposing side of the tap shoes (20) facing the inner ring (48), which in the advanced active position of the pressure mandrels form the outer ring (50) at a distance from the outer periphery of the multi-part inner ring (48), and where a plurality of needle rollers, rollers, or balls (54) are arranged between the inner ring (48) and the outer ring (50), and where means are present for retaining the needles, rollers, or balls (54) in position between the inner ring (48) and outer ring (50).

10. (Previously Presented) The main shaft fixture (10) according to claim 1, further comprising a rotor lock (24) for fixation of the rotor (8) of the wind turbine.

11. (Currently Amended) ~~The main shaft fixture (10) according to claim 10,~~ A main shaft fixture (10) for fixation of a main shaft (4) on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture (10) is divided up into a number of sections for mounting on stable structural parts (2) in a nacelle in a wind turbine, including the bottom frame (2) of the nacelle, wherein the main shaft fixture (10) comprises at least three radially displaceable pressure mandrels (18), substantially symmetrical located around a centre axis (11) of the main shaft, first ends of said pressure mandrels (18) face the main shaft (4) and are furnished with a tap shoe (20), and wherein said pressure mandrels (18) are displaceable between a passive, withdrawn lockable position where the tap shoes (20) are configured to be located at a distance from the surface of the main shaft (4) and an advanced lockable position where the tap shoes (20) are configured to be engaged with the main shaft (4), further comprising a rotor lock (24) for fixation of the rotor (8) of the wind turbine, wherein the rotor lock (24) is comprised of a flange element, with a bolt circle geometry (26) that corresponds to a bolt circle geometry (28) on the rotor, said flange element (24) being fastened at the ends to a first end (21) of two first beam-shaped brackets (22) extending parallel with each other, and being located on each side of the main shaft, said beam shaped brackets (22) forming part of the main shaft fixture, and where a second end (23) of the brackets (22) is pivotally mounted with horizontally oriented bolt connections (30) on other brackets (39) that

form parts of the main shaft fixture (10) and which are anchored on the bottom frame (2) of the nacelle.

12. (Previously Presented) The main shaft fixture (10) according to claim 11, wherein at least one actuator (36) is located nearest the rotor lock (24) between the bottom frame (2) of the nacelle and an adjacent side (25) of the first beam-shaped brackets (22) facing the bottom frame (2), and wherein said at least one actuator (36) is displaceable between a first passive outer position and an active outer position by which the flange element (24) is displaced vertically.

13. (New) A self-hoisting crane comprising:

mounting facilities for mounting to a lightweight crane,

a winch located on a ground surface near a foot of the wind turbine, and

a main shaft fixture for fixation of a main shaft on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, the fixture being divided up into a number of sections for mounting on stable structural parts in a wind turbine nacelle including a bottom frame of the nacelle, wherein the main shaft fixture comprises at least three independently, radially displaceable pressure mandrels for fixing of cylinder-shaped shafts with different diameters and for the fixing of shafts with conical shapes, the pressure mandrels being substantially symmetrical located around a center axis, first ends of said pressure mandrels, in use, facing the main shaft and being furnished with a tap shoe, wherein said pressure mandrels are displaceable between a passive, withdrawn lockable position where the tap shoes are configured to be located at a distance from the surface of the main shaft and an advanced lockable position where the tap shoes are configured to be engaged with the main shaft, in use, said tap shoes enabling the main shaft to be fixed in position by the main shaft fixture while being permitted to rotate.

REMARKS

By the above actions, claims 1, 6-9, & 11 have been amended, and claim 2 cancelled and replaced by new independent claim 13. Enclosed are Replacement Sheets with corrected Figs. 1-5 presented to address the objection to the drawings raised by the Examiner. In view of these actions and the following remarks, reconsideration of this application is requested.

First, the Examiner's indications of allowable subject matter are appreciated and based thereon, claims 9 & 11 have been placed in allowable independent form with the area of indefiniteness in claim 9 being corrected consistent with the manner in which the indefinite language was construed by the Examiner. Thus, withdrawal of the rejection of claim 9 under § 112, second paragraph and formal allowance of claims 1 and 3-13 is requested.

Claims 1-4, 6-8 and 10 have been rejected under 35 USC § 103 as being unpatentable over the Signore et al. published application 2012/0141292 (Signore) when viewed in combination with the Weaver et al. European reference EP 1748182 (Weaver), while claim 5 has been rejected when the Signore and Weaver combination is viewed in further combination with the Borden patent 1,853,255. At least to the extent that these rejections might apply to the claims as now presented, they are inappropriate for the following reasons.

Signore does not disclose radially displaceable pressure mandrels, as Signore is not concerned with adaptability to a number of various diameter or conical main shafts. As such, Signore would not provide a reason for one of ordinary skill to use at least 3 independently displaceable pressure mandrels. If Signore were to be viewed in combination with Weaver, the person of ordinary skill in the art would use the only two shaft restricting devices.

The Examiner claims that the torque clamps of Signore should be modified with a Teflon lining. This is probably due to the incorrect use of the word "lining" instead of "plates", that has been corrected in the specification and claims. Thus, the Signore teaching of a Teflon lining is clearly not appropriate with respect to the current claims since no combination of these references would teach the tap shoes that are configured to be engaged with the main shaft in a manner enabling the main shaft to be fixed in position by the main shaft fixture while being permitted to rotate.

As for Borden, this reference discloses a workholder in which a tubular workpiece is clamped by three threaded set screws. The Borden workholder will not enable a workpiece held

by it so as be able to rotate while being held in place as disclosed and now claimed by the present applicant. Thus, Borden cannot suggest mandrels provided with tap shoes to enable a shaft held be the mandrels to rotate while being held in place.

For all of these reasons, the outstanding rejections under § 103 should be withdrawn and such action is hereby requested.

Therefore, in the absence of new and more relevant prior art being discovered, this application should now be in condition for allowance and action to that effect is requested. However, while it is believed that this application should now be in condition for allowance, in the event that any issues should remain, or any new issues arise, after consideration of this response which could be addressed through discussions with the undersigned, then the Examiner is requested to contact the undersigned by telephone for the purpose of resolving any such issue and thereby facilitating prompt approval of this application.

Respectfully submitted,

/David S. Safran/

_____

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Electronic Patent Application Fee Transmittal

Application Number:	15517288
Filing Date:	06-Apr-2017
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Filer:	David Scott Safran/Paul Mahan
Attorney Docket Number:	400517-20003

Filed as Small Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
INDEPENDENT CLAIMS IN EXCESS OF 3	2614	1	230	230
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**230**

Electronic Acknowledgement Receipt

EFS ID:	33880414
Application Number:	15517288
International Application Number:	
Confirmation Number:	1448
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Customer Number:	25570
Filer:	David Scott Safran/Paul Mahan
Filer Authorized By:	David Scott Safran
Attorney Docket Number:	400517-20003
Receipt Date:	01-OCT-2018
Filing Date:	06-APR-2017
Time Stamp:	14:42:48
Application Type:	U.S. National Stage under 35 USC 371

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Payment Type	CARD
Payment was successfully received in RAM	$230
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Deposit Account	502478
Authorized User	Paul Mahan

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.492 (National application filing, search, and examination fees)

37 CFR 1.492(a) (Basic national fee only)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Amendment_400517_20003.pdf	49973 220a4d7103c6bb2f2c80332c4528aa66a9a41cc6	yes	8

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Specification	2	2
Claims	3	6
Applicant Arguments/Remarks Made in an Amendment	7	8

Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30435 f4590b018d94e193342cd8a8e173cfa73a95651a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	80408		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No. 400517-20003

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE PATENT APPLICATION OF	:	Confirmation No. 1448
Per E. Fenger	:	Group Art Unit 3722
Application No. 15/517,288	:	Examiner Chwen-Wei Su
Filed: April 6, 2017	:	
For: MAIN SHAFT FIXTURE	:	

SUBMISSION OF INTERIM COPY OF PRIORITY DOCUMENT UNDER 37 CFR 1.55(i)

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The U.S. National Phase was entered on April 6, 2017 for the above-identified application and the USPTO only obtained one of the two priority documents for the above-identified application. The Office obtained DK PA 2015 00527 filed 4 September 2015 but did not obtain DK PA 2014 00573 filed 7 October 2014. Applicant files herewith a copy of DK PA 2014 00573 filed 7 October 2014 obtained at the WIPO website. Therefore, Applicants are submitting the accompanying document as an Interim Copy as provided for under 37 CFR 1.55(i) in support of their priority claim. It is requested that the Office obtain the copy from WIPO for this application as soon as possible.

Respectfully submitted,

By: _____
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July 9, 2018

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DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

International application number:		**PCT/DK2015/000040**
International filing date:		**06 October 2015 (06.10.2015)**
Document type:		**Certified copy of priority document**
Document details:	Country/Office:	**DK**
	Number:	**PA 2014 00573**
	Filing date:	**07 October 2014 (07.10.2014)**
Date of receipt at the International Bureau:		**12 October 2015 (12.10.2015)**

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-*bis*)

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CERTIFICATE OF AVAILABILITY OF A CERTIFIED PATENT DOCUMENT IN A DIGITAL LIBRARY

The International Bureau certifies that a copy of the patent application indicated below has been available to the WIPO Digital Access Service since the date of availability indicated, and that the patent application has been available to the indicated Office(s) as of the date specified following the relevant Office code:

Document details: Country/Office: DK
Filing date: 07 Oct 2014 (07.10.2014)
Application number: PA 2014 00573

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Date of issue of this certificate: 17 Oct 2015 (17.10.2015)

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Kingdom of Denmark

Patent application No.:	PA 2014 00573
Date of filing:	7 October 2014
Applicant: (Name and address)	LIFTRA IP ApS Karlskogavej 12 DK-9200 Aalborg SV Denmark

Title: Hovedaksel-fikstur til vindmøller

IPC: (I): F 03 D 1/00 (2006.01), F 03 D 11/04 (2006.01)

This is to certify that the attached documents are exact copies of the above mentioned patent application as originally filed.

12 October 2015

Danish Patent and Trademark Office
Ministry of Economic and Business Affairs

General Director Jesper Kongstad

J Kongstad

Den foreliggende opfindelse angår et hovedaksel-fikstur til vindmøller til fiksering af hovedakslen på en vindmølle ved gennemførelse af montage- og reparationsarbejder på tunge dele af vindmøllen arrangeret i nacellen på vindmøller, hvilket fikstur opdelt i et antal sektioner for montering på stabile konstruktionsdele, der forefindes i en vindmølles nacelle, herunder nacellens bundramme.

Ved gennemførelse af montage og reparationsarbejder i nacellen på vindmøller, er der ofte behov for at foretage fiksering af vindmøllens hovedaksel, f.eks. ved skift og servicering af vindmølles gearkasse, generator, eller ved udskiftning af dennes hovedlejer, eller andre tunge konstruktionsdele der forefindes i nacellen på en vindmølle. Nævnte komponenter der er indbyrdes forbundne og forankrede til nacellens bundramme, er i samlet tilstand stabile, men når der skal foretages en adskillelse ved reparation og servicering af møllen, opstår der statisk ustabilitet og ubalance, der kan medføre at møllens konstruktionsdele beskadiges, derfor er der et behov for at fiksere vindmøllens hovedaksel.

Hidtil har det været nødvendigt at standse møllen, dvs. bremse denne af og fiksere rotoren med en rotorlås, og derefter montere et egentligt fikstur til fastholdelse af hovedakslen, hvorefter servicering af komponenterne i vindmøllens nacelle kan finde sted. Imidlertid er det uhensigtsmæssigt at skulle indstille driften af vindmøllen imens montage af hovedaksel-fiksturet finder sted, idet stilstand af vindmøllen i den tid der medgår til montage af fiksturet, medfører et ikke ubetydeligt driftstab i form af manglende produceret energi (strøm). Yderligere er de kendte hovedaksel-fiksturer relativt ufleksible i forhold til akselgeometri, hvilket betyder at der i praksis skal konstrueres og oplagres tilnærmelsesvis lige så mange forskellige fiksturer, som der forekommer forskellige akselgeometrier, hvilket er uhensigtsmæssigt. Desuden er anvendelse af selvophejsende kraner, hvis spil er placeret på jordoverfladen nær møllens tårn under udbredelse, idet anvendelsen heraf rummer store besparelser i omkostningsniveauet til servicering af vindmøller, idet anvendelse af store mobilkraner til håndtering af ovennævnte store og tunge komponenter, overflødiggøres. Dette medfører imidlertid behov for faciliteter til forankring af den selvophejsende kran med det jordbaserede spil i nacellen. Yderligere fordrer det selvophejsende spil dog tilstedeværelse af en letvægtskran, til

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ophejsning af kastetblokke m.m. der skal forankres på/i nacellen eller på vindmøllens vinger, hvilket stiller krav om faciliteter for montage af letvægtskranen.

Det er således opfindelsens formål at angive et hovedaksel-fikstur, der tilgodeser en mere universel anvendelse i forhold til akselgeometri, der endvidere ikke fordrer standsning og fiksering af vindmøllens hovedaksel.

Det er endvidere opfindelsens formål at angive et hovedaksel-fikstur der yderligere frembyder faciliteter for montage af en selvophejsende kran, med et jordbaseret spil.

Det er ved opfindelsen indset, at dette er muligt ved et hovedaksefikstur af den indledningsvist angivne art, som er kendetegnet ved, at hovedaksel-fiksturet omfatter i det mindste tre, fortrinsvist fire, i hovedsagen, omkring hovedakslens centerakse symmetrisk placerede, radialt forskydelige trykdorne, hvis imod hovedakslen vendende ender er forsynede med tryksko, og hvilke trykdorne er forskydelige imellem en passiv, tilbagetrukket position hvor trykskoene er lokaliseret i afstand fra aksel overfladen, og en aktiv fremskudt låsbar position hvor trykskoene er i anlæg med hovedakslen.

Herved opnås en betragtelig fleksibilitet med hensyn til hovedaksel-fiksturets anvendelse til fiksering af hovedaksler med forskellig geometri på vindmøller, idet alene graden af forskydeligheden af trykdornene og størrelsen af hovedaksel-fiksturet er begrænsende for anvendeligheden heraf. Hovedaksel-fiksturet er således både anvendeligt til fiksering af cylinderformede aksler med forskellige diametre, og til fiksering af aksler med konisk facon. Hovedaksel-fiksturet ifølge opfindelsen er flerdelt, og kan monteres på faste konstruktionsdele, fortrinsvist nacellens bundramme, mens vindmøllens rotor er i drift.

I den hensigt at kunne anvende et selvophejsende kran, med et jordbaseret spil sammen med hovedaksel-fiksturet ifølge opfindelsen, kan at dette omfatte monteringsfaciliteter for en selvophesjsende kran, hvis spil er placeret på jordoverfladen nær vindmøllens fod.

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Herved opnås den fordel, at etablering af faciliteter til fiksering af vindmøllens hovedaksel, samt etablering af monteringsfaciliteter for den selvophejsende kran med et jordbaseret spil, finder sted samtidigt, hvilket sparer arbejdsgange, og plads, hvilket er af stor vigtighed, idet pladsforholdene i nacellen i en vindmølle oftest er sparsomme, og yderligere, at såvel hovedaksel-fiksturet som monteringsfaciliteterne for en selvophejsende kran i nacellen, normalt benytter de samme faste konstruktionsdele i nacellen til forankring.

I den hensigt at sikre en let og hurtig etablering af den selvophejsende kran, hvilket fordrer ophejsning af kastetblokke med wirer hidrørende fra det jordbaserede spil med en letvægtskran, der monteres på stabile konstruktionsdele i nacellen, kan hovedaksel-fiksturet omfatte monteringsfaciliteter for en letvægtskran.

I den hensigt at sikre en hurtig fiksering af hovedakslen med hovedaksel-fiksturet ifølge opfindelsen, kan trykdornene være forsynede med aktuatorer for forskydning og fastholdelse af trykskoene i henholdsvis den passive position og den aktive position, alternativt en valgfri position imellem den passive og den aktive position. Herved opnås en tidsbesparelse ved forskydning af trykskoene imellem den passive position og den aktive position, trykket an imod hovedakslens overflade.

I en mere enkel udførelsesform af hovedaksel-fiksturet, ifølge opfindelsen, kan trykdornene udgøres af gevindskårne bolte hvis imod hovedakslen vendende frie ender er forsynede med trykskо, hvilke gevindskårne bolte samvirker med gevindskårne huller i relevante sektioner af fiksturet. Herved kan trykdornene med trykskoene ved manuel drejning af de gevindskårne bolte forskydes imellem den passive position og den aktive position.

I den hensigt at kunne fiksere rotoren på vindmøllen efter denne er bremset op, kan hovedaksel-fiksturet, ifølge opfindelsen omfatte en rotorlås, for fiksering af vindmøllens rotor.

I en foretrukket udførelsesform af rotorlåsen udgøres denne af en flange, hvis boltcirkel geometri modsvarer en boltcirkel geometri på rotoren, hvilken flange

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i enderne er fastgjort til den første ende af to parallelt med hovedakslen og på hver side af denne forløbende, første bjælkeformede konsoller tilhørende hovedaksel fiksturet, hvilke konsollers anden ende er drejeligt lejrede med horisontalt orienterede boltforbindelser, på andre konsoller tilhørende hovedaksel-fiksturet, der er forankrede til nacellens bundramme.

I den hensigt at kunne foretage udskiftning af akslens hovedleje, uden at være nødsaget til at afmontere hovedakslen, kan hovedaksel-fiksturet yderligere omfatte i det mindste en anden aktuator, imellem nacellens bundramme og den imod denne tilvendende side af de første bjælkeformede konsoller og nærmest rotorlåsen, hvilken anden aktuator er forskydelig imellem en første passiv yderposition og en aktiv yderposition hvorved flangeelementet forskydes vertikalt.

Herved opnås det, at hovedakslen kan hæves fra sit leje hængende i rotorlåsen, således at akslens hovedleje kan udskiftes eller serviceres uden at akslen skal fjernes fra nacellen.

Opfindelsen forklares nærmere i det følgende med henvisning til tegningen, hvor;

fig. 1 er et perspektivbillede af dele af en vindmølles nacelle, udvisende nacellens bundramme, vindmøllens hovedaksel, samt et hovedaksel-fikstur ifølge opfindelsen, med en letvægtskran og en selvophejsende kran monteret,

fig. 2 er et mere detaljeret perspektivbillede fra en anden vinkel af det i fig. 1 viste, hvor hovedakslen er gjort transparent, udvisende trykdorne med tryksko, tilhørende hovedaksel-fiksturet ifølge opfindelsen, og

fig. 3 er et mere detaljeret perspektivbillede fra en anden vinkel af det i fig. 1 viste, hvor hovedakslen er gjort transparent, udvisende aktuatorerne for hævning af hovedakslen.

I fig. 1 ses en bundramme 2 i en nacelle (ikke vist) på en vindmølle (ikke vist), hvor vindmøllens hovedaksel 4, med gearkasse 6 og rotoren 8 er vist, og hvor hovedaksel-fiksturet 10 ifølge opfindelsen er vist i monteret tilstand, bærende henholdsvis en letvægtskran 12 og en selvophejsende kran 14, med et jordbaseret spil (ikke vist). Bundrammen 2 er af hensyn til overskueligheden gjort transparent.

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Hovedaksel-fiksturet 10 er i den viste udførelsesform forankret på bundrammen 2 nær gearkassen 6 og nær rotoren 8, og omfatter en flerdelt ramme 14, der sammen med en derpå fastspændt tværdrager 16, omslutter et stykke af hovedakslen 4 imellem rotoren 8 og gearkassen 6. Den flerdelte ramme 14 er forankret på bundrammen 2.

I fig. 2 ses det i fig. 1 viste, men som ende-billede, set fra rotorsiden af akslen 4, og hvor rotoren 8 af hensyn til overskueligheden er gjort transparent. Som det fremgår af fig. 2 omfatter den flerdelte ramme 14 og tværdrageren 16 i alt 4 omkring hovedakslen 2 symmetrisk placerede trykdorne 18, med tryksko 20, der er bragt i anlæg med hovedakslen 4, for fastholdelse af denne.

Trykdornene 18, kan udgøres af hydraulisk drevne stempler hvis frie ender omfatter trykskoene 20.

Som det fremgår af fig. 3, omfatter hovedaksel-fiksturet 10, to parallelt forløbende første dragere 22 på hver side af hovedakslen 4, i hvis første ender, nærmest rotoren 8, er fastgjort rotorlås i form af et flangeelement 24, hvis hulcirkel 26 geometri er ligedannet med hulcirkel 28 geometrien på rotoren 8 over en del af rotorens periferi. Ved låsning af rotoren 8 bringes hullerne 7 i rotoren 8 og hullerne 9 i flangeelementet 24 til overlapning, hvorefter der indføres bolte gennem hullerne, der tilspændes med møtrikker, hvorefter rotoren 8 er fastholdt/låst af flangeelementet 24.

Den anden ende af de parallelt forløbende første dragere 22 er nærmest gearkassen 6 drejeligt forankret på horisontalt orienterede lejebolte 30, på en konsol 32, der er fastgjort til bundrammen 2. De parallelt forløbende første dragere 22 er indbyrdes forbundne med andre tværdragere 34, på hvilke ses konsolfaciliteter 23 for en selv ophejsende kran 14 med et jordbaseret spil (ikke vist).

Som det fremgår af fig. 3 og fig. 1, findes der imellem bundrammen 2 og de paralleltforløbende første dragere 22 en aktuator 36. Aktivering af aktuatoren 36 vil medføre en ændring af afstanden imellem bundrammen 2 og de første dragere 22, i hvilket flangeelementet 24 er ophængt, hvilket vil medføre at flangeelementet 24 og rotoren 8, og dermed hovedakslen 4 hæves, hvilket vil medføre, at det bliver muligt at udskifte hovedakslens leje 38, uden at være nødsaget til at hejse hoved-

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akslen 4 ned på jorden, hvilket er meget besparende, såfremt hovedaksellejet 38 skal repareres eller udskiftes.

I fig. 1 ses endvidere hvorledes hovedaksel-fiksturet 10 omfatter monteringsfaciliteter 40 for letvægtskranen 12.

Opfinderen har erkendt, at hovedaksel-fiksturet 10 kan antage andre udformninger en den foran beskrevne og i figuren viste, men det ændrer ikke på det opfinderiske aspekt der består i at angive et hovedaksel-fikstur 10 af den angivne art, der omfatter justerbare trykdorne 18 med tryksko 20, der medfører at fiksturet 10 bliver anvendeligt uanset geometrien af hovedakslen 4 på en vindmølle, og således, at dette kan monteres uden at fiksere rotoren 8, og yderligere at kombinere hovedaksel-fiksturet med faciliteter (40) montering af henholdsvis en letvægtskran 12, og en selvophejsende kran 14, med et jordbaseret spil, samt en rotorlås 24 og sluttelig at indrette hovedaksel-fiksturet 10 med aktuatorer 36, således at hovedakslen 4 og hovedaksellejet 38 kan hæves tilstrækkeligt fra dettes leje i nacellen til, at lejet kan serviceres eller udskiftes.

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KRAV

1. Hovedaksel-fikstur (10) til fiksering af hovedakslen (4) på en vindmølle ved gennemførelse af montage- og reparationsarbejder på tunge dele af vindmøllen arrangeret i nacellen på vindmøller, hvilket fikstur (10) opdelt i et antal sektioner for montering på stabile konstruktionsdele (2), der forefindes i en vindmølles nacelle, herunder nacellens bundramme (2), k e n d e t e g n e t v e d , at hovedaksel-fiksturet (10) omfatter i det mindste tre, fortrinsvist fire, i hovedsagen, omkring hovedakslens centerakse (11) symmetrisk placerede, radialt forskydelige trykdorne (18), hvis imod hovedakslen (4) vendende ender er forsynede med tryksko (20), og hvilke trykdorne (18) er forskydelige imellem en passiv, tilbagetrukket position hvor trykskoene (20) er lokaliseret i afstand fra hovedakslen (4) overfladen, og en aktiv fremskudt låsbar position hvor trykskoene (20) er i anlæg med hovedakslen (4).

2. Hovedaksel-fikstur (10), ifølge krav 1, k e n d e t e g n e t v e d , at dette omfatter monteringsfaciliteter for en selvophejsende kran (14), hvis spil er placeret på jordoverfladen nær vindmøllens fod.

3. Hovedaksel-fikstur (10), ifølge krav 1 eller 2, k e n d e t e g n e t v e d , at dette omfatter monteringsfaciliteter (40) for en letvægtskran (12).

4. Hovedaksel-fikstur (10), ifølge et hvilket som helst af kravene 1-3, k e n d e t e g n e t v e d , at trykdornene (18) er forsynede med aktuatorer til forskydning og fastholdelse af trykskoene (20) i henholdsvis den passive position og den aktive position, alternativt en valgfri position imellem den passive og den aktive position.

5. Hovedaksel-fikstur (10), ifølge et hvilket som helst af kravene 1-3, k e n d e t e g n e t v e d , at trykdornene (18) udgøres af gevindskårne bolte hvis imod hovedakslen vendende frie ender er forsynede med tryksko (20), hvilke gevindskårne bolte samvirker med gevindskårne huller i relevante sektioner af fiksturet (10).

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6. Hovedaksel-fikstur (10), ifølge et hvilket som helst af kravene 1-5, k e n d e t e g n e t v e d , at dette omfatter en rotorlås (24), for fiksering af vindmøllens rotor (8).

7. Hovedaksel-fikstur (10), ifølge et hvilket som helst af kravene 1-6, k e n d e t e g n e t v e d , at rotorlåsen (24) udgøres af et flangeelement, hvis boltcirkel geometri (26) modsvarer en boltcirkel geometri (28) på rotoren, hvilket flangeelement (24) i enderne er fastgjort til den første ende (21) af to parallelt med hovedaksien og på hver side af denne forløbende, første bjælkeformede konsoller (22) tilhørende hovedaksel fiksturet, hvilke konsollers (22) anden ende (23) er drejeligt lejrede med horisontalt orienterede boltforbindelser (30), på andre konsoller (39) tilhørende hovedaksel-fiksturet (10), der er forankrede på nacellens bundramme (2).

8. Hovedaksel-fikstur (10), ifølge krav 7, k e n d e t e g n e t v e d , at der imellem nacellens bundramme (2) og den imod denne tilvendende side (25) af de første bjælkeformede konsoller (22) og nærmest rotorlåsen (24), findes i det mindste en aktuator (36), hvilken aktuator (36) er forskydelig imellem en første passiv yderposition og en aktiv yderposition hvor flangeelementet (24) forskydes vertikalt.

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Sammendrag

Der angives et hovedaksel-fikstur (10) til fiksering af hovedakslen (4) på en vindmølle ved gennemførelse af montage- og reparationsarbejder på tunge dele af vindmøllen arrangeret i nacellen på vindmøller, hvilket fikstur (10) opdelt i et antal sektioner for montering på stabile konstruktionsdele (2), der forefindes i en vindmølles nacelle, herunder nacellens bundramme (2).

Hovedaksel-fiksturet (10) omfatter justerbare trykdorne (18) med tryksko (20), der medfører at fiksturet 10 bliver anvendeligt uanset geometrien af hovedakslen (4) på en vindmølle, og således, at dette kan monteres uden at fiksere rotoren (8). Hovedaksel-fiksturet (10) omfatter tillige faciliteter (40) montering af henholdsvis en letvægtskran (12), og en selvophejsende kran (14) med et jordbaseret spil, samt en rotorlås (24), der i kombination med til hovedaksel-fiksturet (10) hørende aktuatorer (38) imellem hovedaksel-fiksturet (10) og bundrammen (2), medfører, at det er muligt at forskyde hovedakslen (4) og hovedakselleiet (38) vertikalt fra dettes leje i nacellen til, at lejet kan serviceres eller udskiftes.

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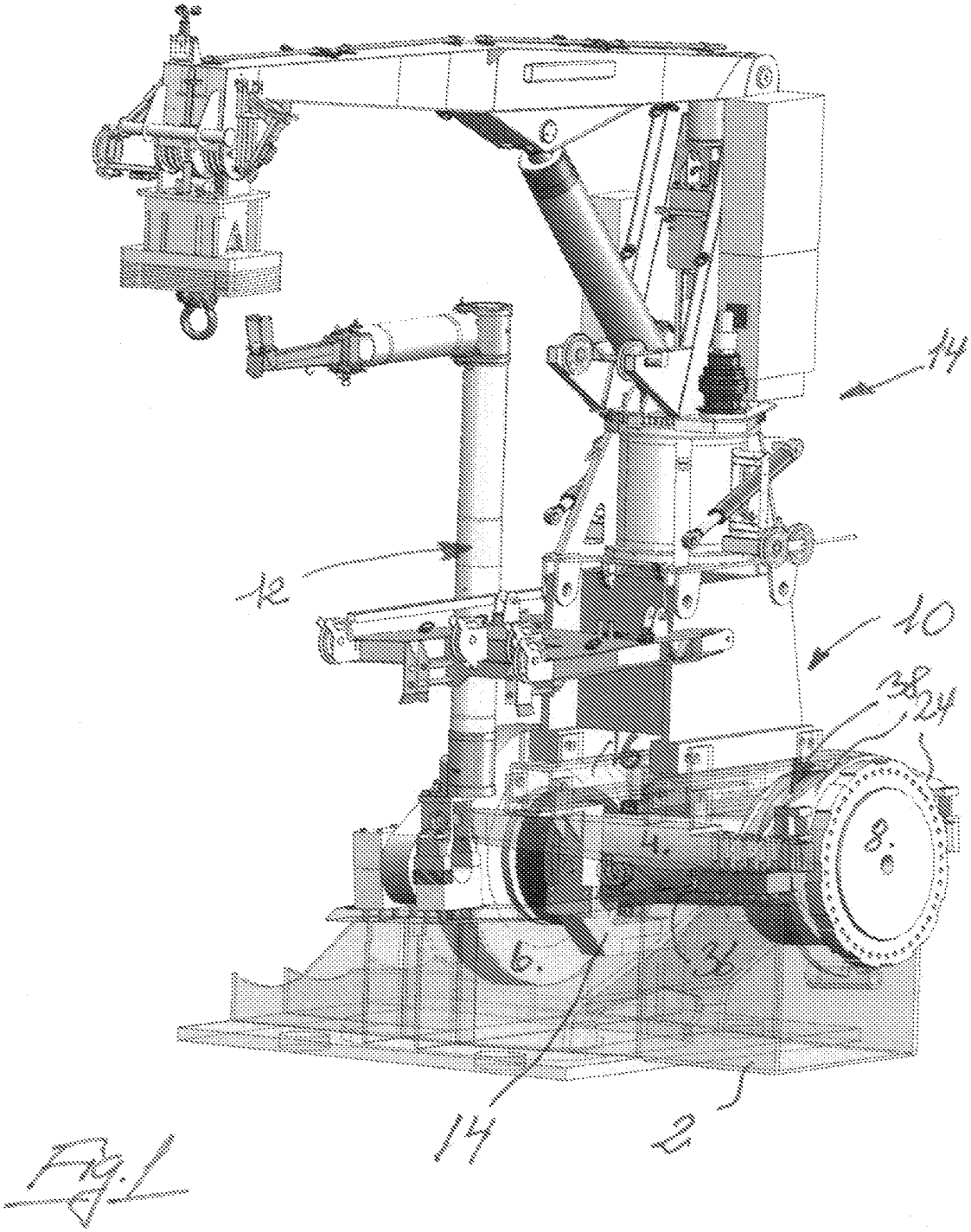


Fig. 1

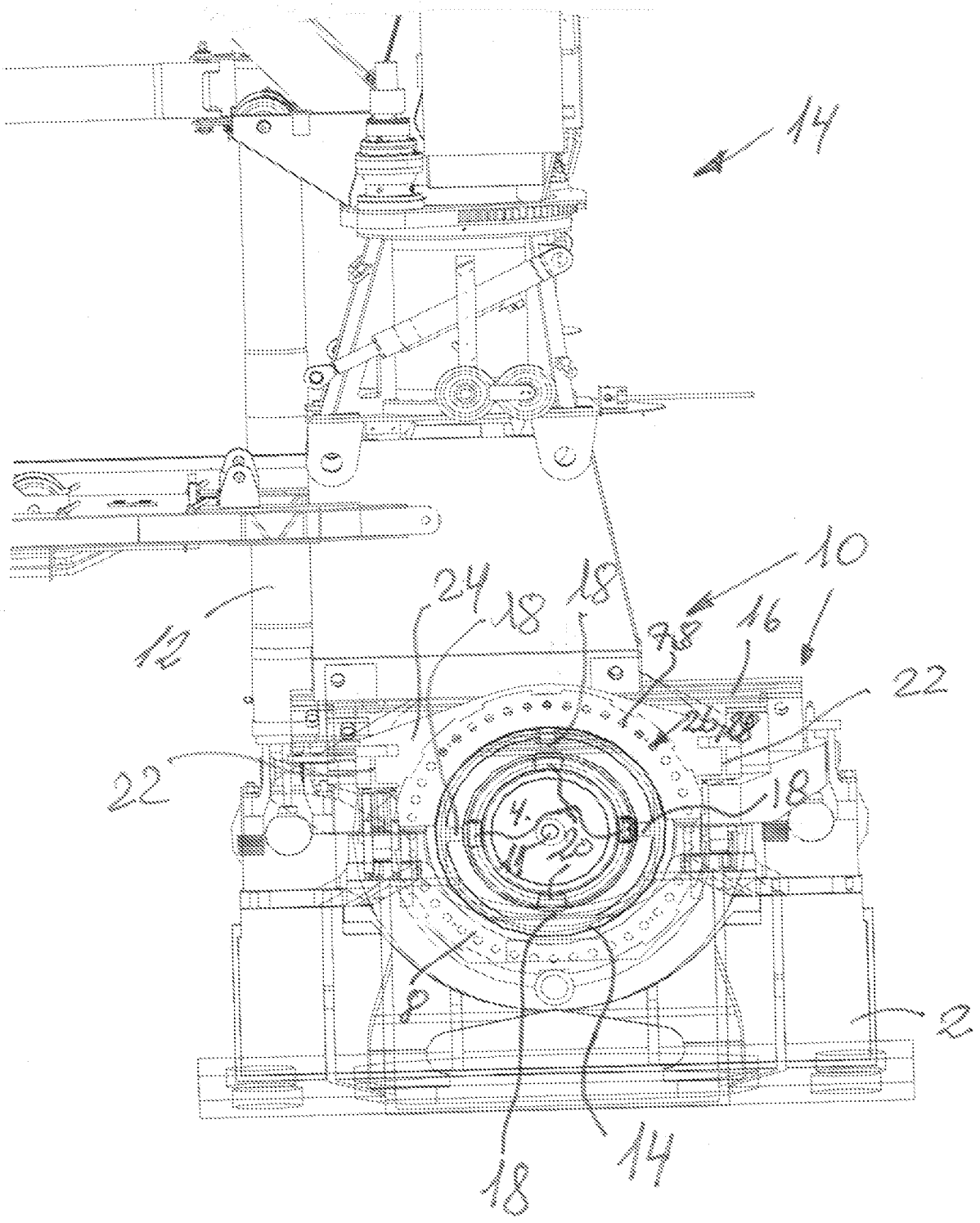


Fig. 2

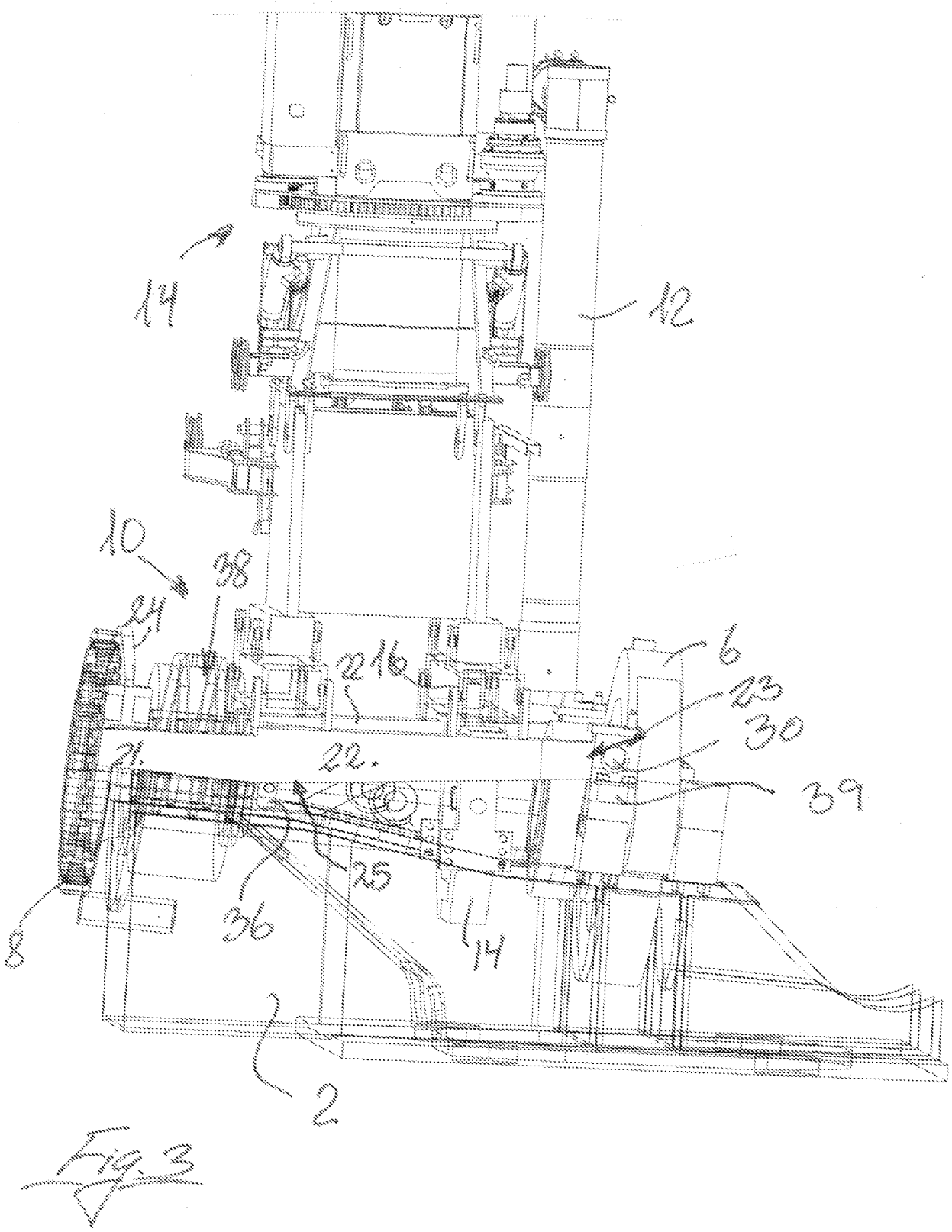


Fig. 3

Electronic Acknowledgement Receipt

EFS ID:	33120493
Application Number:	15517288
International Application Number:	
Confirmation Number:	1448
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Customer Number:	25570
Filer:	David Scott Safran/Kathleen McManus
Filer Authorized By:	David Scott Safran
Attorney Docket Number:	400517-20003
Receipt Date:	09-JUL-2018
Filing Date:	06-APR-2017
Time Stamp:	14:10:28
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Interim Copy of the Foreign Priority Document	SubmissionofInterimCopy_07_09_2018_400517_20003.pdf	37006 74e9de1598233977cee280db882ecd53808424a5	no	1

Warnings:

Information:					
2	Interim Copy of the Foreign Priority Document	PDOC_135.pdf	1114283 b7517fdda620423944fdbb38757638765a7767f3	no	15
Warnings:					
Information:					
		Total Files Size (in bytes):	1151289		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/517,288	04/06/2017	Per E. Fenger	400517-20003	1448

25570 7590 06/29/2018

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102

EXAMINER
SU, CHWEN-WEI

ART UNIT	PAPER NUMBER
3722	

NOTIFICATION DATE	DELIVERY MODE
06/29/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

lgallaugher@rmsc2.com
docketing@rmsc2.com
secretaries@rmsc2.com

Office Action Summary	Application No. 15/517,288	Applicant(s) FENGER, PER E.	
	Examiner CHWEN-WEI SU	Art Unit 3722	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04/06/2017*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-12* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-10* is/are rejected.

8)☒ Claim(s) *11 and 12* is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *04/06/2017* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☒ Some** c)☐ None of the:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

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The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

DETAILED ACTION

Priority

Acknowledgment is made of applicant's claim for foreign priority based on an application filed in Denmark on 10/07/2014. It is noted, however, that applicant has not filed a certified copy of the PA 2014 00573 application as required by 37 CFR 1.55.

Drawings

New corrected drawings in compliance with 37 CFR 1.121(d) are required in this application because the line resolution of the drawing is not fine enough to clearly see the features of the instant invention. In addition, the numerals in the drawing are handwritten which makes the drawing appear to be informal. Applicant is advised to employ the services of a competent patent draftsperson outside the Office, as the U.S. Patent and Trademark Office no longer prepares new drawings. The corrected drawings are required in reply to the Office action to avoid abandonment of the application. The requirement for corrected drawings will not be held in abeyance.

Claim Interpretation

The following is a quotation of 35 U.S.C. 112(f):

> (f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

The following is a quotation of pre-AIA 35 U.S.C. 112, sixth paragraph:

> An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

Use of the word “means” (or “step for”) in a claim with functional language creates a rebuttable presumption that the claim element is to be treated in accordance with 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph). The presumption that 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph) is invoked is rebutted when the function is recited with sufficient structure, material, or acts within the claim itself to entirely perform the recited function.

Absence of the word “means” (or “step for”) in a claim creates a rebuttable presumption that the claim element **is not** to be treated in accordance with 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph). The presumption that 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph) is not invoked is rebutted when the claim element recites function but fails to recite sufficiently definite structure, material or acts to perform that function.

Claim elements in this application that use the word “means” (or “step for”) are presumed to invoke 35 U.S.C. 112(f) except as otherwise indicated in an Office action. Similarly, claim elements that do not use the word “means” (or “step for”) are presumed not to invoke 35 U.S.C. 112(f) except as otherwise indicated in an Office action.

Claim Rejections - 35 USC § 112

1. The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claim 9 is rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

3. Claim 9 recites “The main shaft fixture (10) according to claim 1, further comprising a multi-part needle bearing, roller bearing, ball bearing (46) comprised of ..” (lines 1-3). It is unclear if the limitation includes all of a needle bearing, roller bearing, *and* ball bearing, or just one of the three types of bearings. For the purpose of examination, examiner has interpreted it means "a multi-part needle bearing, roller bearing, *or* ball bearing comprised of …”.

Claim Rejections - 35 USC § 103

4. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

5. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the

> claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1-4, 6-8, and 10 is/are rejected under 35 U.S.C. 103 as being unpatentable over Signore et al. (US 2012/0141292) in view of Weaver et al. (EP 1748182).

7. Regarding claim 1, Signore discloses a main shaft fixture 128 for fixation of a main shaft 24 on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture is divided up into a number of sections for mounting on stable structural parts in a nacelle in a wind turbine, including the bottom frame 16 of the nacelle, wherein the main shaft fixture comprises at least three torque clamps 244, substantially symmetrical located around a center axis of the main shaft, to facilitate coupling a restraint assembly 136 to the main shaft to limit a movement of the main shaft. (Figs. 1-9, Paragraphs 22, 53-56)

8. Signore does not disclose at least three radial displaceable pressure mandrels, and a tap shoe is provided on a first end of the pressure mandrel. However, Weaver discloses a shaft restraining member 400 attached to a bed plate of a wind turbine. The shaft restraining member includes hydraulic or mechanic operated friction brakes 518. The clamping action of brakes 518 resists torque from rotor shaft 402. The hydraulic or mechanic brake may comprise cylinders supported on brake support flange 519 of the shaft restraining member. (Figs. 4-5, Paragraphs 16-19) Therefore, it would have been obvious to one with ordinary skill in the art before the effective filing date of the claimed invention to modify the torque clamps of Signore to be hydraulic or mechanical operated

such that its radial position can be adjusted to fit the main shaft with desired friction. Signore as modified by Weaver teaches that at least radial displaceable pressure mandrels, first ends of said pressure mandrels the main shaft and are furnished with a tap shoe (the torque clamps), and wherein said pressure mandrels a displaceable between a passive, withdrawn lockable position where the tap shoes are configured to be located at a distance from the surface of the main shaft and an advanced lockable position where the tap shoes are configured to be engaged with the main shaft.

9. Regarding claim 2, Signore as modified discloses the main shaft fixture further comprising mounting facilities for a self-hoisting crane having winch located on a ground surface near a foot of the wind turbine. Although Signore does not specifically mention mounting facilities for a self-hoisting crane, it is noted that the structure of the main shaft fixture is capable for mounting with a self-hoisting crane, such as by using a chain or a cable connected between the crane and the main shaft fixture.

10. In addition, a claim containing a "recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus" if the prior art apparatus teaches all the structural limitations of the claim. Ex part Masham, 2 USPQ2d 1647 (Bd. Pat. App. & Inter. 1987)

11. Regarding the intended use limitation "mounting facilities for a self-hoisting crane", it is noted that the prior art used in the rejection is capable of being used for this function.

12. Regarding claim 3, for the same reasons as set forth in claim 2 above, Signore as modified also teaches the main shaft fixture further comprising mounting facilities for a lightweight crane.

13. Regarding claim 4, Signore as modified by Weaver teaches the pressure mandrels are provided with actuators (hydraulic or mechanical operated) for displacing and retaining the tap shoes in the passive position and the active position, respectively, alternatively in a selectable position between the passive and the active position.

14. Regarding claim 6, Weaver teaches a slideway lining 520 (Teflon) is located between the opposing sides of the surface of the main shaft and tap shoes (the inner end the brake) (Fig. 5, Paragraph 18). Therefore, it would have been obvious to one with ordinary skill in the art before the effective filing date of the claimed invention to modify the tap shoes 244 of Signore to have a Teflon lining as taught by Weaver to allow rotation of the main shaft above a predetermined torque.

15. Regarding claim 7, as set forth in claim 6 above, the slideway lining 520 is configured so that the opposing free ends of the tap shoes facing the main shaft are provided with a slide plate 520 (Teflon) which in the active advanced position is engaged with the main shaft.

16. Regarding claim 8, the slideway linings 520 are a multi-part slide plate cooperating with the main shaft for mounting on the main shaft, where the multi-part slide plate in a mounted (clamped or engaged) position on the main shaft cooperates with the tap shoes.

17. Regarding claim 10, the main shaft fixture further comprising a rotor lock 134 for fixation of the rotor of the wind turbine. (Figs. 5-8, Paragraphs 22 and 54)

18. Claim 5 is/are rejected under 35 U.S.C. 103 as being unpatentable over Signore in view of Weaver, and further in view of Borden (US 1,853,255).

19. Regarding claim 5, Signore as modified does not disclose " the pressure mandrels are comprised of threaded bolts having opposing free ends that face the main shaft and are furnished with tap shoes, and wherein said threaded bolts cooperate with threaded holes in respective sections of the fixture." However, Borden discloses a work holder comprising three mandrels 5, 6, 7 for clamping a work piece. The mandrel is threaded at an inner end 5a which passes through a corresponding threaded hole in the body 1 of the work holder. (Figs. 1-3, p. 1 lines 32 - 59) Therefore, it would have been obvious to one with ordinary skill in the art before the effective filing date of the claimed invention to modify the mechanical operated pressure mandrel of Signore as modified to be threaded bolts for adjusting the clamping force or size depending on the diameter of the main shaft with low cost and ease.

Allowable Subject Matter

20. Claim 9 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), 2nd paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

21. Claims 11 and 12 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

22. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to CHWEN-WEI SU whose telephone number is (571)272-4998. The examiner can normally be reached on 9:00 AM - 6:00 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, SUNIL K. SINGH can be reached on (571)272-3460. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/CHWEN-WEI SU/
Examiner, Art Unit 3722

/ERIC A. GATES/
Primary Examiner, Art Unit 3722

Notice of References Cited	Application/Control No. 15/517,288	Applicant(s)/Patent Under Reexamination FENGER, PER E.	
	Examiner CHWEN-WEI SU	Art Unit 3722	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-1,152,271 A	08-1915	Bisbee, R.A.	A01K89/033	188/186
*	B	US-1,853,255 A	04-1932	BORDEN BRADFORD T	B23B31/101	279/110
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*	G	US-2002/0092395 A1	07-2002	EMILIAN, BERNARD	B23B5/163	83/452
*	H	US-2010/0021278 A1	01-2010	STEGEMANN; Klaus	B66C23/06	414/629
*	I	US-2010/0139069 A1	06-2010	Daniels; Jeffrey Michael	F03D1/00	29/402.01
*	J	US-2012/0141292 A1	06-2012	Signore; Jonathan Paul	B66C1/108	416/244R
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N	EP 1101934 A2	05-2001	DE	WEITKAMP ROLAND DIPL-ING	B66C23/207
	O	EP 1748182 A2	01-2007	US	CHRISTENSON CRAIG LEONARD	F03D13/10
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(54) Windkraftanlage mit bewegbarem Bordkran

(57) Die Windkraftanlage (10) ist mit einem Turm (14) und einem an dem Turm (14) um eine Vertikalachse (20) drehbaren Maschinengehäuse (18) zur Aufnahme zumindest einer Welle (28) mit einem Wellenlager (27), eines Getriebes (32) und eines Generators (36), untereinander mechanisch verbunden sind, versehen, wobei das Maschinengehäuse (18) einen radial vom Turm (14) abstehenden Gehäuseteil (24) aufweist. Ferner weist die Windkraftanlage (10) einen Rotor (29) mit einer mit der Welle (28) verbundenen Nabe (30) und mit mindestens einem von dieser abstehenden Rotorblatt (31) und einen im Maschinengehäuse (18) angeordneten Bordkran (52) mit einem Gestell (53) und einem Lastaufnahmeorgan (62) auf, wobei das Gestell (53) des Bordkrans (52) zum Anhängen sowohl des Generators (36) als auch des Getriebes (32) an dem Lastaufnahmeorgan (62) an dem Maschinengehäuse (18) bewegbar geführt ist, in der Bodenwand (48) des radial vom Turm (14) abstehenden Maschinengehäuseteils (24) eine Öffnung (50) ausgebildet ist, und die Öffnung (50) in der Bodenwand (48) derart bemessen ist, dass durch sie hindurch mittels des Bordkrans (52) sowohl der Generator (36) als auch das Getriebe (32) hindurch bewegbar ist.

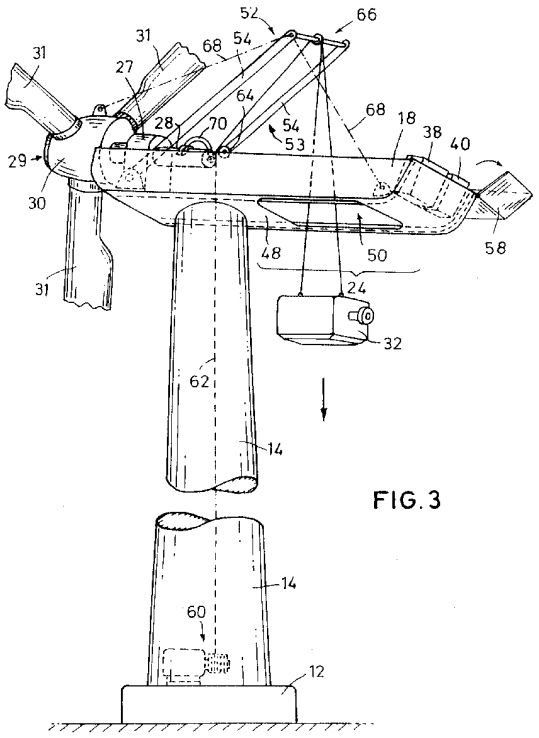


FIG. 3

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Beschreibung

[0001] Die Erfindung betrifft eine Windkraftanlage sowie ein Verfahren zum Austausch der Hauptkomponenten des Maschinengehäuses einer Windkraftanlage mittels bordeigenen Mitteln.

[0002] Für die Montage einer Windkraftanlage sind entweder sehr große Krane erforderlich, um das Maschinengehäuse (auch Gondel genannt) als Ganzes zu heben (Gewichte bis zu 100 t bei heutigen Gondeln), oder die Hauptkomponenten des Maschinengehäuses werden einzeln auf den Turm gehoben. Bei den Hauptkomponenten handelt es sich in erster Linie um den Rotor, bestehend aus Rotornabe mit mindestens einem Rotorblatt, die Hauptwelle mit Wellenlagerung, den Generator und das zwischen Welle und Generator geschaltete Getriebe. Diese Hauptkomponenten bilden den Triebstrang der Windkraftanlage. Wie bei der Montage, so ist auch beim Austausch einer dieser Hauptkomponenten sowie für die Montage und den Austausch des Rotors ein Kran erforderlich.

[0003] Dieses Problem verschärft sich in dem Augenblick, in dem das Gewicht der Gondel an die Grenzen der Krankapazität kommt bzw. diese überschreitet oder Windkraftanlagen in weniger stark industrialisierten Ländern, in denen beispielsweise mobile Krane nicht so ohne weiteres zur Verfügung stehen, betrieben werden. Hier bietet es sich an, die Windkraftanlage mit einem bordeigenen Kransystem zu versehen, wie es in der AT-PS 401674 beschrieben ist. Dabei ist jedoch zu beachten, dass diese Bordkransysteme für die derzeit weit verbreiteten WKA-Konzepte ungeeignet sind oder sehr stabil und damit schwergewichtig ausgebildet sein müssen, um die einzelnen Komponenten bei aus dem Gehäuse auskragendem Kran ablassen und anheben zu können.

[0004] In DE 196 47 515 A1 und DE 197 41 988 A1 werden Verfahren zum Aufbau einer Windkraftanlage beschrieben, bei denen zum Aufbau des Turms durch Aufeinandersetzen einzelner Turmsegmente ein längs dieser hochfahrbarer Kran verwendet wird, der schließlich auch das Maschinengehäuse und dessen Hauptkomponenten zur Turmspitze befördert. Aus DE 28 23 525 A1 ist schließlich bekannt, das Maschinengehäuse mittels Seile, die ausgehend von einer am Boden des Turms angeordneten Winde über Umlenkrollen am oberen Ende des Turms zurück nach unten geführt sind, anzuheben.

[0005] Es ist bereits auf der Fachmesse "Substain '99 - The World Sustainable Energy Fair" (25. bis 27. Mai 1999) von der Anmelderin Windenergie erstmals der Öffentlichkeit ein Konzept vorgestellt worden, bei dem der Generator mittels eines bordeigenen Kransystems durch eine Öffnung in der Bodenwand des Maschinengehäuses aus diesem heraus abgelassen bzw. in dieses hineinbefördert wird. Bei diesem Konzept besteht allerdings noch das Problem, dass im Falle eines Getriebeschadens das Getriebe weiterhin mittels eines externen Krans nach oben aus dem Maschinengehäuses herausgehoben bzw. von oben in das Maschinengehäuse hinein abgesenkt werden muss.

[0006] Der Erfindung liegt die Aufgabe zugrunde, eine Windkraftanlage zu schaffen, die unter Beibehaltung eines bewährten Maschinenkonzeptes derart konstruiert ist, dass die einzelnen Bordkomponenten des Maschinengehäuses auf einfachere Weise mittels eins bordeigenen Kransystems getauscht bzw. montiert werden können.

[0007] Zur Lösung dieser Aufgabe wird mit der Erfindung eine Windkraftanlage nach Anspruch 1 vorgeschlagen.

[0008] Wie bei einer Windkraftanlage üblich, befinden sich in bzw. an einem auf einem Turm angeordneten Maschinengehäuse eine Welle mit mindestens einem Wellenlager, ein Getriebe, ein Generator und ein Rotor. Diese Komponenten (nachfolgend auch als Hauptkomponenten bezeichnet) bilden den Triebstrang der Windkraftanlage und sind entlang einer Achse des Maschinengehäuses nebeneinanderliegend und untereinander mechanisch verbunden angeordnet. Während die Welle aus der einen Seite des Maschinengehäuses herausragt, befindet sich das Getriebe innerhalb des Maschinengehäuses im wesentlichen in Verlängerung des Turms, während der Generator in einem radial vom Turm abstehenden Teil des Maschinengehäuses untergebracht ist. An der Welle ist der Rotor mit einer Nabe befestigt, von der mindestens ein Rotorblatt radial absteht. Unterhalb des Generators befindet sich in der Bodenwand des Maschinengehäuses eine Öffnung. Ferner befindet sich in dem Maschinengehäuse der erfindungsgemäßen Windkraftanlage ein Bordkransystem, das insbesondere als schwenkbares und/oder verfahrbares Portalkransystem ausgebildet ist.

[0009] Erfindungsgemäß ist die Öffnung in der Bodenwand des Maschinengehäuses derart bemessen, dass man durch diese Öffnung sowohl den Generator als auch bei nicht vorhandenem Generator, also bei noch nicht montiertem oder bereits demontiertem oder von der Öffnung weggeschobenem Generator, das Getriebe hindurchtransportieren kann. Zu diesem Zweck lässt sich der Bordkran derart manövrieren, dass sich gegebenenfalls nach dem Ablassen oder Verschieben des Generators das Getriebe innerhalb des Gehäuses bis über die Bodenwandöffnung bewegen und alsdann durch die Bodenwandöffnung ablassen lässt. Der umgekehrte Vorgang findet dann beim Einbau des Getriebes statt.

[0010] Mit der Erfindung wird also vorgeschlagen, die Öffnung in der Bodenwand des Maschinengehäuses für das Getriebe bzw. nicht nur für die Montage, den Einbau und den Ausbau des Generators, sondern auch für das Getriebe zu nutzen.

[0011] Um das Volumen des Maschinengehäuses trotz Unterbringung eines bordeigenen Kransystems relativ klein zu halten, ist gemäß einer vorteilhaften Weiterbildung der Erfindung vorgesehen, in der Oberseite

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des Maschinengehäuses eine Öffnung vorzusehen, die mit einer oder mehreren Klappen verschlossen und geöffnet werden kann. Noch vorteilhafter ist es, wenn mittels entsprechender Klappen- bzw. Deckelkonstruktionen sich die gesamte obere Maschinengehäusehälfte aufklappen lässt. Der Bordkran kann dann aus einer Parkposition, in der er abgeklappt oder auf andere Weise eine nur geringe Bauhöhe aufweist, in eine Arbeitsposition aufgerichtet werden, in der er oben aus dem Maschinengehäuse durch die Öffnung herausragt. Ein seitliches Herauskragen des Bordkrans zur Seite und/oder nach hinten aus dem Maschinengehäuse ist jedoch nach der Erfindung nicht vorgesehen, da der Generator und das Getriebe über die Bodenwandöffnung aus dem Maschinengehäuse abgelassen bzw. bis in dieses angehoben werden.

[0012] Das Maschinengehäuse der erfindungsgemäßen Windkraftanlage ist ferner mit einer vorzugsweise neben dem Generator angeordneten Kranluke versehen, durch das hindurch das Gestell des Krans oder zumindest das Seil bis außerhalb des Maschinengehäuses bewegbar ist. Hierdurch lassen sich sämtliche Nebenaggregate des Maschinengehäuses, wie beispielsweise Kühler, Ölpumpen, Azimutantriebe usw., nach unten ablassen bzw. nach oben anheben. Um zu vermeiden, dass Komponenten beim Ablassen durch Windturbulenzen an den Turm schlagen, werden diese Komponenten zweckmäßigerweise durch geeignete Vorrichtungen, wie beispielsweise ein gespanntes Stahlseil oder eine außen an der Turmwand montierte Führungsschiene geführt.

[0013] Der Antrieb des Zugorgans, bei dem es sich insbesondere um ein Seil handelt, kann in dem Maschinengehäuse untergebracht sein. Um hierfür im Maschinengehäuse jedoch keinen Platz zur Verfügung stellen zu müssen, ist es zweckmäßig, eine Seilwinde oder dergleichen Lastzugorganantrieb am Fundament bzw. am unteren Ende des Turms anzuordnen, um dann das Seil durch den Turm bzw. außen am Turm vorbei bis oben in das Maschinengehäuse zu führen. Die Winde wird dann für die Dauer der Montagetätigkeit montiert (Kostenersparnis).

[0014] Durch den über die gesamte Länge des Gehäuses (betrachtet in axialer Richtung des Triebstrangs) bewegbaren Bordkran der erfindungsgemäßen Windkraftanlage ist es darüber hinaus möglich, mit diesem Bordkran auch die Welle und das Hauptwellenlager abzulassen bzw. in das Maschinengehäuse zu heben. Beides kann sowohl über die Bodenwandöffnung als auch über die Vorderseite des Maschinengehäuses (dort, wo der Rotor angeordnet ist) erfolgen. Der zuletzt genannte Fall macht es erforderlich, dass der Bordkran derart verfahrbar bzw. verschwenkbar ist, dass er über die Vorderseite des Gehäuses auskragt. Dies hat darüber hinaus den Vorteil, dass der Bordkran nun auch für die Montage und den Austausch des Rotors verwendet werden kann. Die Montage des Rotors kann nämlich nun so erfolgen, dass zunächst die Nabe angehoben und an der Welle befestigt wird, um danach das mindestens eine Rotorblatt oder sämtliche Rotorblätter einzeln anzuheben und an der Nabe zu befestigen. Die gleichen Verfahrensschritte erfolgen in umgekehrter Reihenfolge bei der Abnahme des Rotors. Sofern kein Rotor an der Welle angebracht ist, lässt sich diese bei über die Vorderseite auskragbarem Kransystem ggf. nach vorheriger Entfernung des Hauptlagers oder mit diesem zusammen ablassen und anheben.

[0015] Weiterhin ist es zweckmäßig, den Kran bei montiertem Rotor zum Anheben bzw. Ablassen der Einbauten der Nabe (beispielsweise Rotorblattverstell-system) einzusetzen.

[0016] Nachfolgend wird anhand der Zeichnung ein Ausführungsbeispiel der Erfindung näher erläutert. Anhand der einzelnen Fign. 1 bis 6 werden dabei schematisch der Aufbau des Maschinengehäuses und die einzelnen Verfahrensschritte für den Austausch der Hauptkomponenten des Maschinengehäuses und des Rotors dargestellt. Dabei ist zu beachten, dass die einzelnen Verfahrensschritte in umgekehrter Reihenfolge bei der Montage und beim Einbau der Hauptkomponenten bzw. des Rotors ablaufen. Die Fign. 7 bis 9 zeigen weitere Alternativen von Windkraftanlagenkonstruktionen und der Montage sowie Demontage des Rotors.

[0017] In Fig. 1 ist der prinzipielle Aufbau einer Windkraftanlage 10 gemäß einem bevorzugten Ausführungsbeispiel schematisch dargestellt. Auf einem Fundament 12 befindet sich der Turm 14, an dessen oberem Ende ein Maschinengehäuse 18 um eine vertikale Drehachse 20 drehbar gelagert ist. Das Maschinengehäuse 18 weist eine quer zur Vertikalachse 20 gerichtete Längserstreckung 22 auf und steht mit seinem Gehäuseteil 24 radial vom Turm 14 ab. An dem vorderen Ende 26 des Maschinengehäuses 18 befindet sich in diesem das Hauptlager 27 für die Welle 28, an der der Rotor 29 befestigt ist. Der Rotor 29 weist eine Nabe 30 mit im Regelfall ein, zwei oder drei Rotorblättern 31 auf. Die Welle 28 ist mechanisch mit einem Getriebe 32 verbunden, das über eine schnelllaufende Welle 34 mit einem Generator 36 verbunden ist. Optional befinden sich in dem Maschinengehäuse 18 ein Transformator 38 sowie diverse Schaltschränke 40.

[0018] Der Generator 36 steht auf Füßen 42, unter denen zwei quer zur Längserstreckung 22 verlaufende Quertraversen 44 angeordnet sind. Die Quertraversen 44 sind von unten an zwei in Längserstreckung 22 verlaufenden und voneinander beabstandeten Längsträgern 46 des Maschinengehäuses 18 befestigt. Unterhalb der Quertraversen 44 und der Längsträger 46 befindet sich in der Bodenwand 48 des Maschinengehäuses 18 eine Bodenöffnung 50, die derart bemessen ist, dass der Generator 36 sich durch diese Öffnung hindurch in das Maschinengehäuse 18 hinein- bzw. aus dem Maschinengehäuse 18 herausbewegen lässt.

[0019] Alternativ zur Lagerung des Generators auf Querträgern kann dieser auch direkt an dem Getriebe 32 angeflanscht sein.

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[0020] Die Beförderung des Generators 36 aus dem Maschinengehäuse 18 heraus bzw. in dieses hinein erfolgt mittels eines bordeigenen als Schwenkportalkran ausgebildeten Krans 52, der ein Gestell 53 mit zwei schwenkbaren Kranarmen 54 aufweist. In Fig. 1 ist der Bordkran 52 in seiner Parkposition dargestellt, in der er vollständig in dem Maschinengehäuse 18 untergebracht ist. Bei 56 sind in Fig. 1 Scharnierachsen für zwei Deckelklappen 58 des Maschinengehäuses dargestellt, die symmetrisch zur Längserstreckung 22 angeordnet sind. Durch Aufklappen dieser Deckelklappen 58 ist das Maschinengehäuse 18 nach oben hin geöffnet, so dass nun der Schwenkportalkran 52 aufgerichtet werden kann (s. Fig. 2). Unten am Fundament 12 des Turms 14 lässt sich eine Seilwinde 60 montieren, von der ein Seil 62 im Turm oder außen am Turm 14 vorbei bis in das Maschinengehäuse 18 und von dort über eine Umlenkrolle 64 bis zum oberen Ende 66 der Kranarme 54 verläuft. Zum Ablassen des Generators 36 wird der Schwenkportalkran 52 derart verschwenkt, dass die oberen Enden 66 seiner Arme 54 oberhalb des Generators 36 angeordnet sind. Nun kann der Generator 36 durch die Bodenöffnung 50 hindurch abgelassen bzw. angehoben werden.

[0021] Die Montage bzw. der Austausch des Getriebes 32 kann dann erfolgen, wenn sich der Generator 36 noch nicht im Maschinengehäuse 18 befindet oder wenn er zur Seite oder nach hinten von der Bodenöffnung 50 in eine Zwischenposition wegbewegt ist oder sich in seiner Betriebsposition außerhalb der Bodenöffnung befindet. Die Öffnung 50 in der Bodenwand 48 ist nämlich derart bemessen, dass das Getriebe 32, das im Regelfall größere Dimensionen quer zur Längserstrekkung 22 des Gehäuses aufweist, ebenfalls durch diese Öffnung 50 hindurch transportiert werden kann. Der Transport des Getriebes 32 innerhalb des Maschinengehäuses 18 erfolgt dabei durch entsprechende Verschwenkung der Kranarme 54. Je nach Ausführung der Lagerung der Welle 28 (nämlich unter Einschluss des Getriebes als zweiter Lagerpunkt - sogenannte Dreipunktlagerung) kann es erforderlich sein, die Welle mittels einer Wellenniederhaltevorrichtung 70 zu fixieren, bevor das Getriebe 32 demontiert werden kann.

[0022] In den Fign. 2 und 3 sind Verzurrungen 68, z. B. handelsübliche Schwerlast-Kettenzüge, dargestellt, mit denen der Schwenkportalkran 52 einerseits am Maschinengehäuse 18 und andererseits an der Nabe 30 des Rotors 29 arretierbar ist. Der Schwenkportalkran 52 kann anstelle dieser Verzurrungen bzw. zusätzlich zu diesen Verzurrungen über Hydraulikstempel-/Zylinder-Einheiten verfügen, mit denen sich die Kranarme 54 verschwenken lassen.

[0023] Durch Verschwenken der Kranarme 54 in Richtung des vorderen Endes 26 des Gehäuses 18, bis die Enden 66 der Kranarme 54 über den Rotor 29 vorstehen, lässt sich der Schwenkportalkran 52 auch zur Montage sowie Demontage des Rotors 29 einsetzen. In der Darstellung gemäß Fig. 4 wird zunächst jedes einzelne Rotorblatt 31 abgenommen, wobei man jeweils dasjenige Rotorblatt 31 montiert bzw. demontiert, das vertikal nach unten weisend an der Nabe 30 angebracht ist bzw. anzubringen ist. Nachdem auf diese Weise sämtliche Rotorblätter 31 abgenommen sind, lässt sich die Nabe 30 ablassen (s. Fig. 5). Nachdem dies erfolgt ist, kann nun das Hauptwellenlager 27 ggf. mit der Hauptwelle 28 mittels des Schwenkportalkrans 52 abgelassen werden. Damit wird also die letzte Hauptkomponente des Maschinengehäuses 18 ebenfalls mit Hilfe des Schwenkportalkrans 52 abgelassen bzw. angehoben.

[0024] Bei der erfindungsgemäßen Windkraftanlage 10 lassen sich also sämtliche in der Höhe befindlichen Komponenten durch bordeigene Mittel montieren bzw. demontieren. Dies stellt einen ganz entscheidenden Vorteil dar, wenn man die Windkraftanlage an Standorten aufbauen will, an denen externe Krane nicht so ohne weiteres verfügbar sind. Hier sei auch das Anwendungsgebiet der Offshore-Anlagen genannt, bei denen bisher mit Schiffskranen gearbeitet wird, die Bewegungen des Schiffsrumpfs ausgleichen müssen, um die Hauptkomponenten montieren bzw. demontieren zu können.

[0025] In Fig. 7 ist schematisch eine alternative Konstruktion einer Windkraftanlage 10' mit Zweiblattrotor gezeigt. Soweit die in Fig. 7 gezeigten Teile der Windkraftanlage 10' denjenigen der Windkraftanlage 10 der Fign. 1 bis 6 gleichen bzw. funktionsmäßig entsprechen, sind sie mit den gleichen Bezugszeichen versehen.

[0026] In Fig. 7 ist der Aufbau des Maschinengehäuses 18 so gewählt, dass die Bodenöffnung 50 entweder gar nicht oder lediglich teilweise von dem Generator 36 in dessen Betriebsposition überdeckt ist. Im erstgenannten Fall kann der Generator 36 in seiner Betriebsposition außerhalb der Bodenöffnung 50 verbleiben, wenn das Getriebe 32 ausgetauscht werden muss. Im zweitgenannten Fall ist es erforderlich, den Generator 36 aus seiner Betriebsposition, in der er teilweise die Bodenöffnung 50 überdeckt, in eine Zwischenposition innerhalb des Maschinengehäuses 18 zu verschieben, so dass dann die Bodenöffnung 50 freigelegt ist, um das Getriebe 32 auszutauschen.

[0027] Fig. 7 zeigt ein Maschinengehäuse 18 mit einem als Portalkran 52' ausgeführtem Kransystem, das eine auf dem Gestell 53 verfahrbare Laufkatze 55 aufweist. Um bei einem derartigen Portalkransystem auch noch vor dem Rotor 29 arbeiten zu können, weist das Gestell 53 zwei Schwenkarme 54 auf, die an dem Gestell 53 schwenkbar gelagert sind. Alternativ können die schwenkbaren Arme 54 auch als aus dem Gestell 53 teleskopierbare Schienen ausgebildet sein, auf denen dann die Laufkatze 55 bis über und vor dem Rotor 29 verfahrbar ist.

[0028] Je nach Gewicht und Größe des Rotors 29 lässt sich dieser entweder als Einheit in einer Horizontalstellung (s. Fig. 8) oder in Einzelteilen in einer Vertikalstellung (s. Fig. 9) montieren bzw. demontieren. Im

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letztgenannten Fall ist es erforderlich, dass der Portalkran 52' an seinem bis über und vor dem Rotor 29 verschwenkbaren vorderen Ende "gegabelt" ist, so dass die beiden Schwenkarme 54 beidseitig des hochstehenden Rotorblatts 31 angeordnet sind.

Patentansprüche

1. Windkraftanlage mit

   - einem Turm (14),
   - einem an dem Turm (14) um eine Vertikalachse (20) drehbaren Maschinengehäuse (18) zur Aufnahme zumindest einer Welle (28) mit mindestens einem Wellenlager (27), eines Getriebes (32) und eines Generators (36), die untereinander mechanisch verbunden sind, wobei das Maschinengehäuse (18) einen radial vom Turm (14) abstehenden Gehäuseteil (24) aufweist,
   - einem Rotor (29) mit einer mit der Welle (28) verbundenen Nabe (30) und mit mindestens einem von dieser abstehenden Rotorblatt (31), und
   - einem im Maschinengehäuse (18) angeordneten Bordkran (52,52') mit einem Gestell (53) und einem Lastaufnahmeorgan (62), wobei

     - das Gestell (53) des Bordkrans (52,52') zum Anhängen sowohl des Generators (36) als auch des Getriebes (32) an dem Lastaufnahmeorgan (62) an dem Maschinengehäuse (18) bewegbar geführt ist,
     - in der Bodenwand (48) des radial vom Turm (14) abstehenden Maschinengehäuseteils (24) eine Öffnung (50) ausgebildet ist, und
     - die Öffnung (50) in der Bodenwand (48) derart bemessen ist, dass durch sie hindurch mittels des Bordkrans (52,52') sowohl der Generator (36) als auch das Getriebe (32) hindurch bewegbar ist.

2. Windkraftanlage nach Anspruch 1, dadurch gekennzeichnet, dass der obere Teil des Maschinengehäuses (18) zumindest bereichsweise abnehmbar und/oder auf- bzw. abklappbar ist.

3. Windkraftanlage nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass das Gestell (53) des Bordkrans (52,52') derart bewegbar in dem Maschinengehäuse (18) angeordnet ist, dass an das Lastaufnahmeorgan (62) sowohl das mindestens eine Wellenlager (27) als auch die Welle (28) anhängbar und bewegbar ist.

4. Windkraftanlage nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass das Gestell (53) des Bordkrans (52,52') derart bewegbar in dem Maschinengehäuse (18) angeordnet ist, dass an das Lastaufnahmeorgan (62) sowohl ein Rotorblatt (31) als auch die Nabe (30) - mit oder ohne dem mindestens eine Rotorblatt (31) - anhängbar ist.

5. Windkraftanlage nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, dass der Bordkran (52,52') als Schwenkportalkran mit verschwenkbaren Armen (54) und/oder als verfahrbarer Portalkran ausgebildet ist.

6. Windkraftanlage nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, dass zum Anheben und Absenken des Lastaufnahmeorgans (62) eine Winde (60) vorgesehen ist, die am Fuß des Turms (14) anbringbar ist, und dass sich das Lastaufnahmeorgan (62) von der Winde (60) aus in oder an dem Turm (14) bis in das Maschinengehäuse (18) hinein erstreckt.

7. Verfahren zum Ausbau des Getriebes einer Windkraftanlage, die in einem an einem Turm drehbar angebrachten Maschinengehäuse untergebracht sind, wobei das Maschinengehäuse eine außerhalb des Turms (14) angeordnete Bodenöffnung (50) aufweist, über der sich innerhalb des Maschinengehäuses (18) gegebenenfalls der Generator (36) zumindest teilweise befindet, wobei bei dem Verfahren

   - mittels eines in dem Maschinengehäuse (18) untergebrachten verfahr- und/oder verschwenkbaren Bordkrans (52,52') zunächst der Generator (36) demontiert oder entweder durch die Bodenöffnung (50) des Maschinengehäuses (18) abgelassen oder innerhalb des Maschinengehäuses (18) von der Bodenöffnung (50) wegbewegt wird,
   - anschließend mittels des Bordkrans (52,52') das Getriebe (32) innerhalb des Maschinengehäuses (18) bis über die Bodenöffnung (50) bewegt wird und
   - danach durch die Bodenöffnung (50) das Getriebe (32) mittels des Bordkrans (52,52') abgelassen wird
     oder
   - mittels des Bordkrans (52,52') das Getriebe (32) direkt über die Bodenöffnung (50) des Maschinengehäuses (18) bewegt und durch die Bodenöffnung (50) abgelassen wird.

8. Verfahren zum Einbau des Getriebes einer Windkraftanlage, die in einem an einem Turm drehbar angebrachten Maschinengehäuse untergebracht sind, wobei das Maschinengehäuse eine außerhalb des Turms (14) angeordnete Bodenöffnung (50)

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aufweist, über der sich innerhalb des Maschinengehäuses (18) gegebenenfalls der Generator (36) zumindest teilweise befindet, wobei bei dem Verfahren

- mittels eines in dem Maschinengehäuse (18) untergebrachten verfahr- und/oder verschwenkbaren Bordkrans (52,52') zunächst das Getriebe (32) durch die Bodenöffnung (50) des Maschinengehäuses (18) in dieses gehoben wird,
    - danach mittels des Bordkrans (52,52') das Getriebe (32) innerhalb des Maschinengehäuses (18) bis zu seiner Einbaustelle von der Bodenöffnung (50) wegbewegt wird und
    - anschließend mittels des Bordkrans (52,52') der Generator (36) entweder durch die Bodenöffnung (50) hindurch in das Maschinengehäuse (18) gehoben wird oder innerhalb des Maschinengehäuses in seine Betriebsposition verschoben wird,
    oder
- mittels des Bordkrans (52,52') das Getriebe (32) bei in seiner Betriebsposition befindlichen Generator (36) durch die Bodenöffnung (50) hindurch in das Maschinengehäuse (18) gehoben wird.

9. Verfahren zum Ausbau des Hauptlagers einer Welle einer Windkraftanlage, die in einem an einem Turm drehbar angebrachten Maschinengehäuse (18) untergebracht ist, wobei an der Welle ein Rotor mit einer Nabe und mit mindestens einem von dieser abstehenden Rotorblatt angebracht ist, wobei bei dem Verfahren

- mittels eines in dem Maschinengehäuse (18) untergebrachten verfahr- und/oder verschwenkbaren Bordkrans (52,52') zunächst der Rotor (29) abgelassen wird und
- danach mittels des Bordkrans (52,52') das mindestens eine Lager (27) der Welle (28) zusammen mit der Welle (28) oder das mindestens eine Lager (27) und die Welle (28) getrennt nacheinander abgelassen werden.

10. Verfahren nach Anspruch 9, dadurch gekennzeichnet, dass zum Ablassen des Rotors (29) mittels des Bordkrans (52,52') zunächst das mindestens eine Rotorblatt (31) oder die einzelnen Rotorblätter (31) abgelassen wird bzw. werden und anschließend mittels des Bordkrans (52.52') die Nabe (30) abgelassen wird.

11. Verfahren zum Anbau des Rotors einer Windkraftanlage an einer an einem Lager (27) gelagerten Welle (28), die beide in einem an einem Turm drehbar angeordneten Maschinengehäuse untergebracht sind, wobei bei dem Verfahren

- mittels eines in dem Maschinengehäuse (18) untergebrachten verfahr- und/oder verschwenkbaren Bordkrans (52,52') zunächst das Lager (27) oder die Welle (28) oder beide gemeinsam in das Maschinengehäuse (18) gehoben werden und
- danach mittels des Bordkrans (52,52') der Rotor (29) angehoben wird.

12. Verfahren nach Anspruch 11, dadurch gekennzeichnet, dass zum Anheben des eine Nabe (30) und mindestens ein Rotorblatt (31) aufweisenden Rotors (29) mittels des Bordkrans (52,52') zunächst die Nabe (30) angehoben und an der Welle (28) befestigt wird und anschließend mittels des Bordkrans (52,52') das mindestens eine Rotorblatt (31) oder die Rotorblätter (31) einzeln angehoben und an der Nabe (30) befestigt wird bzw. werden.

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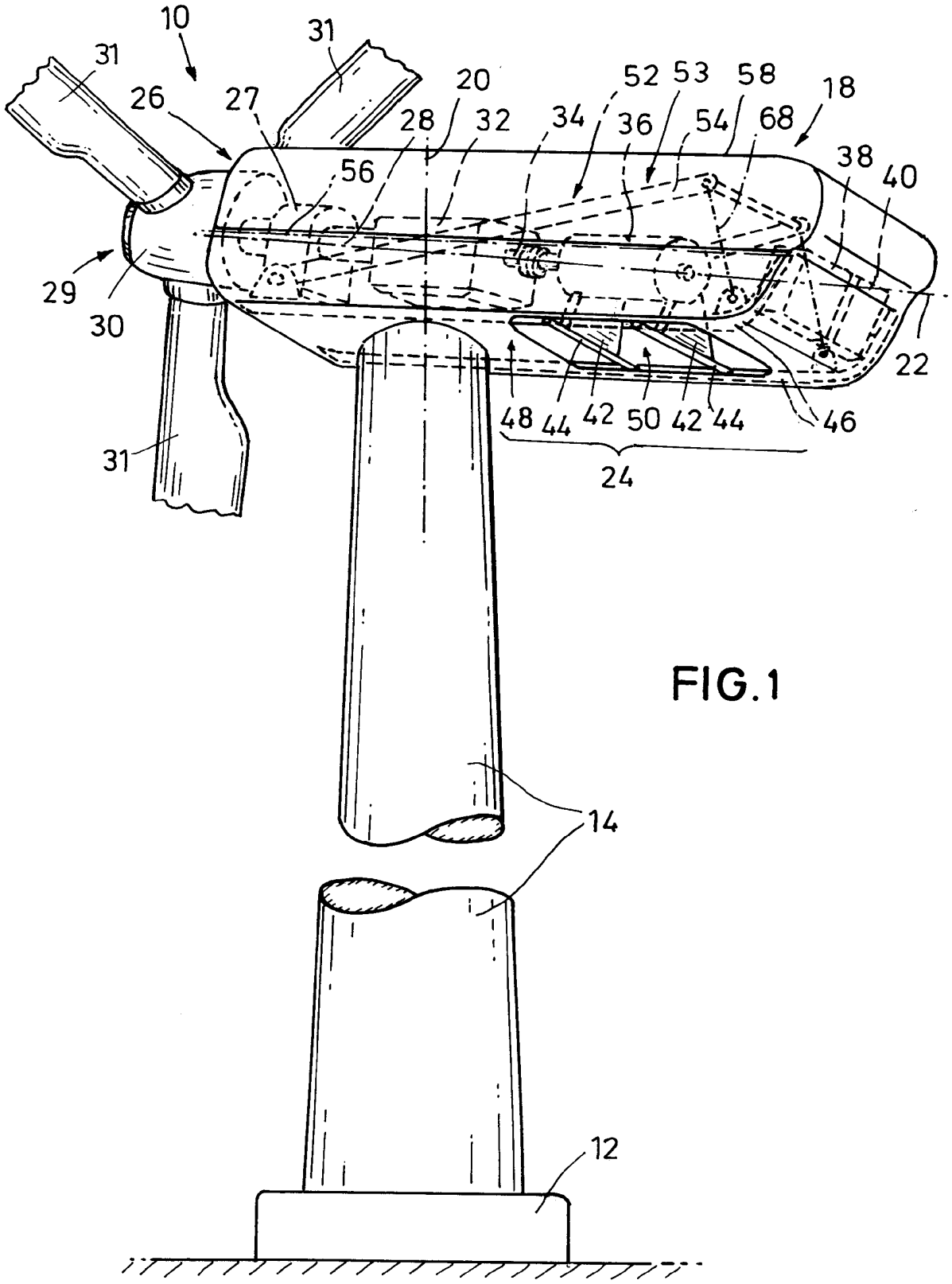


FIG.1

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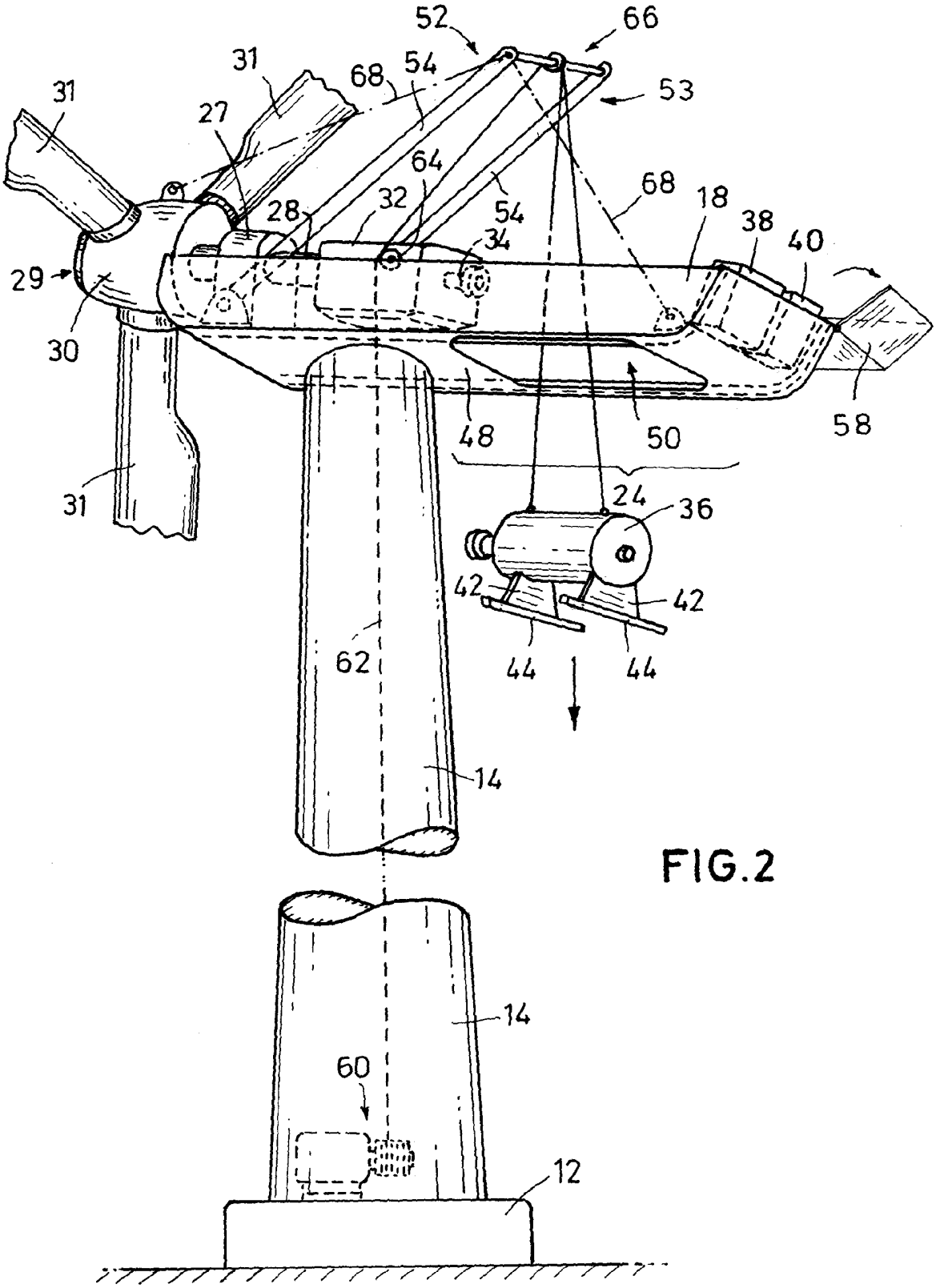


FIG.2

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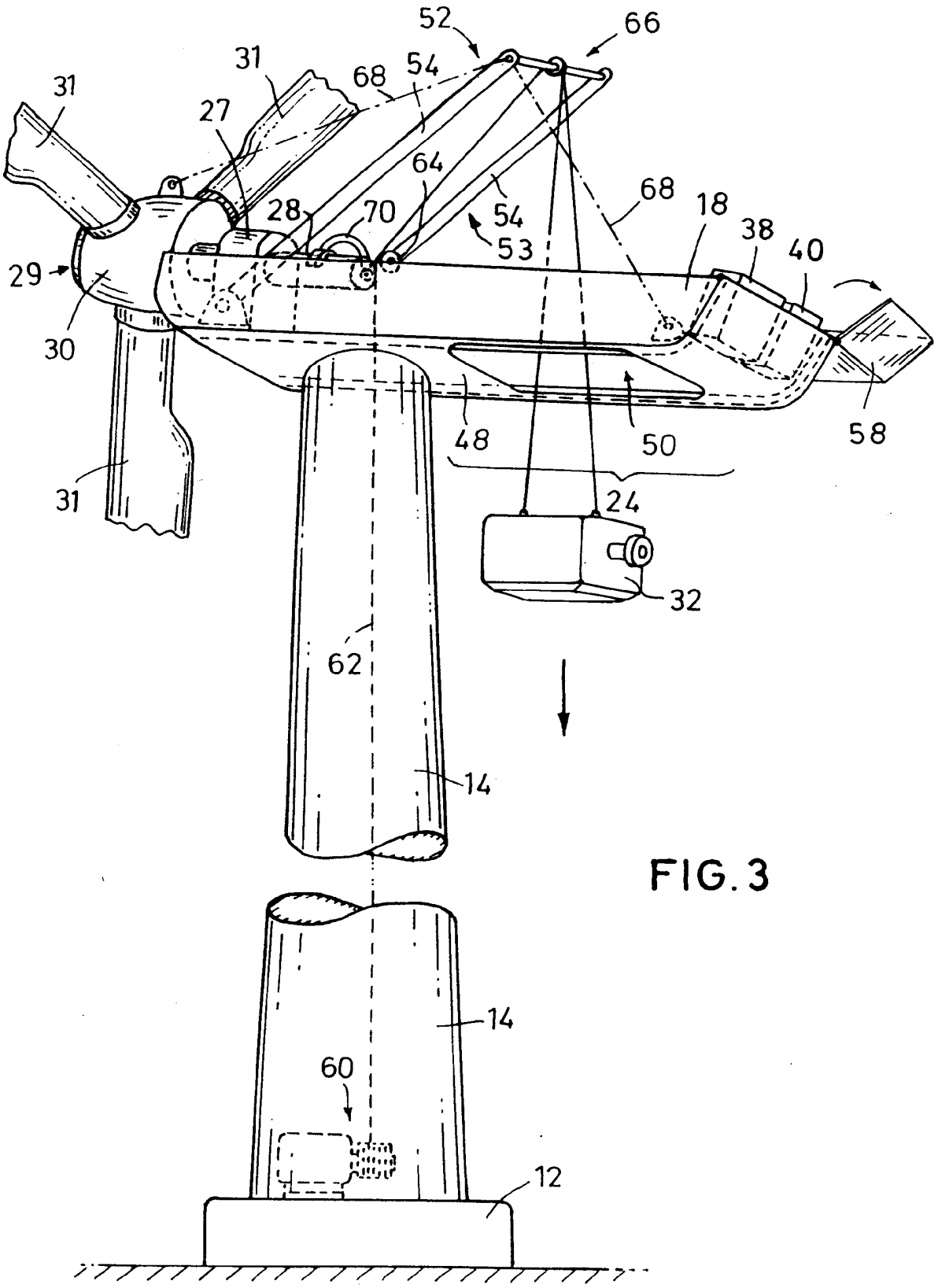


FIG. 3

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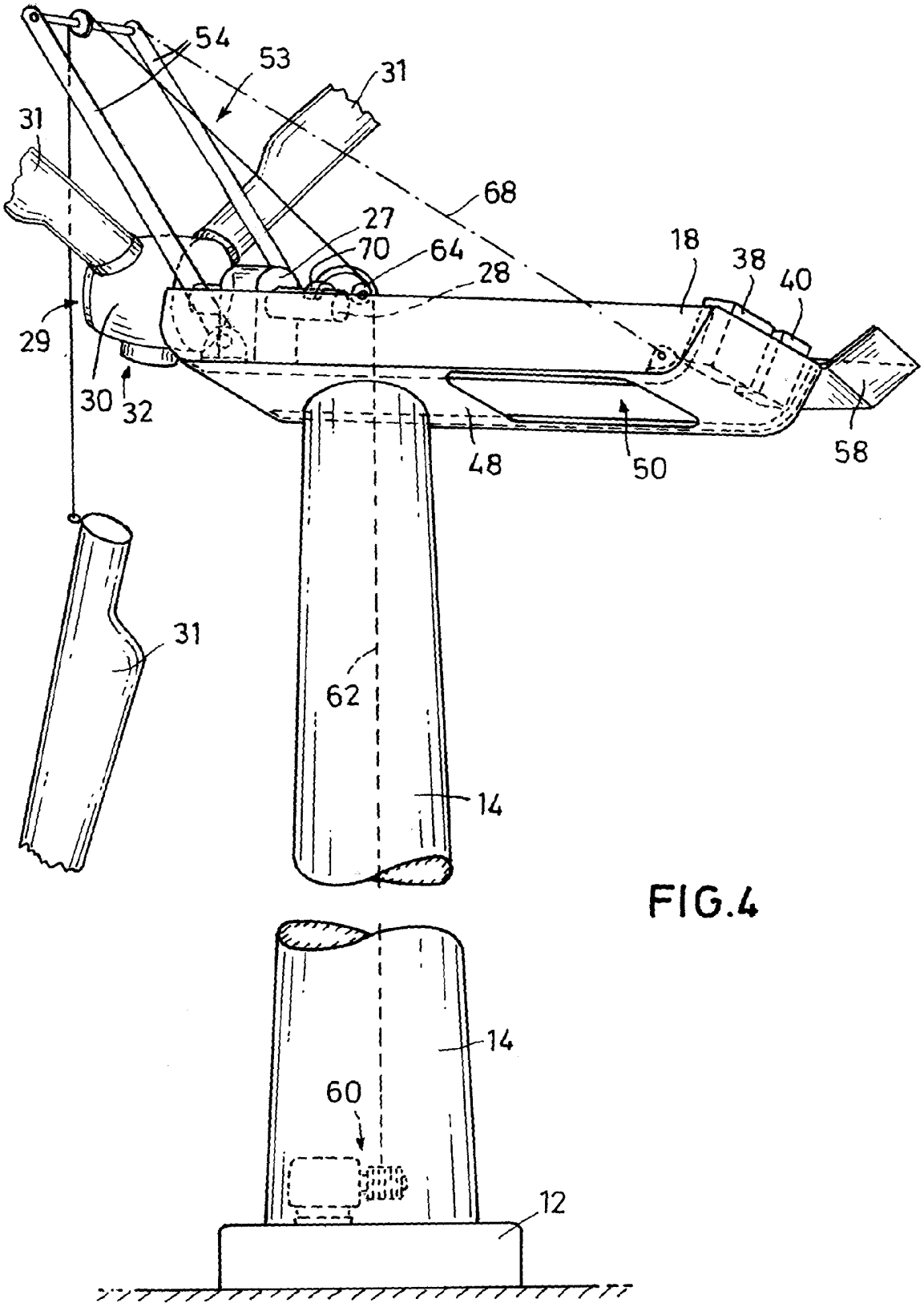


FIG.4

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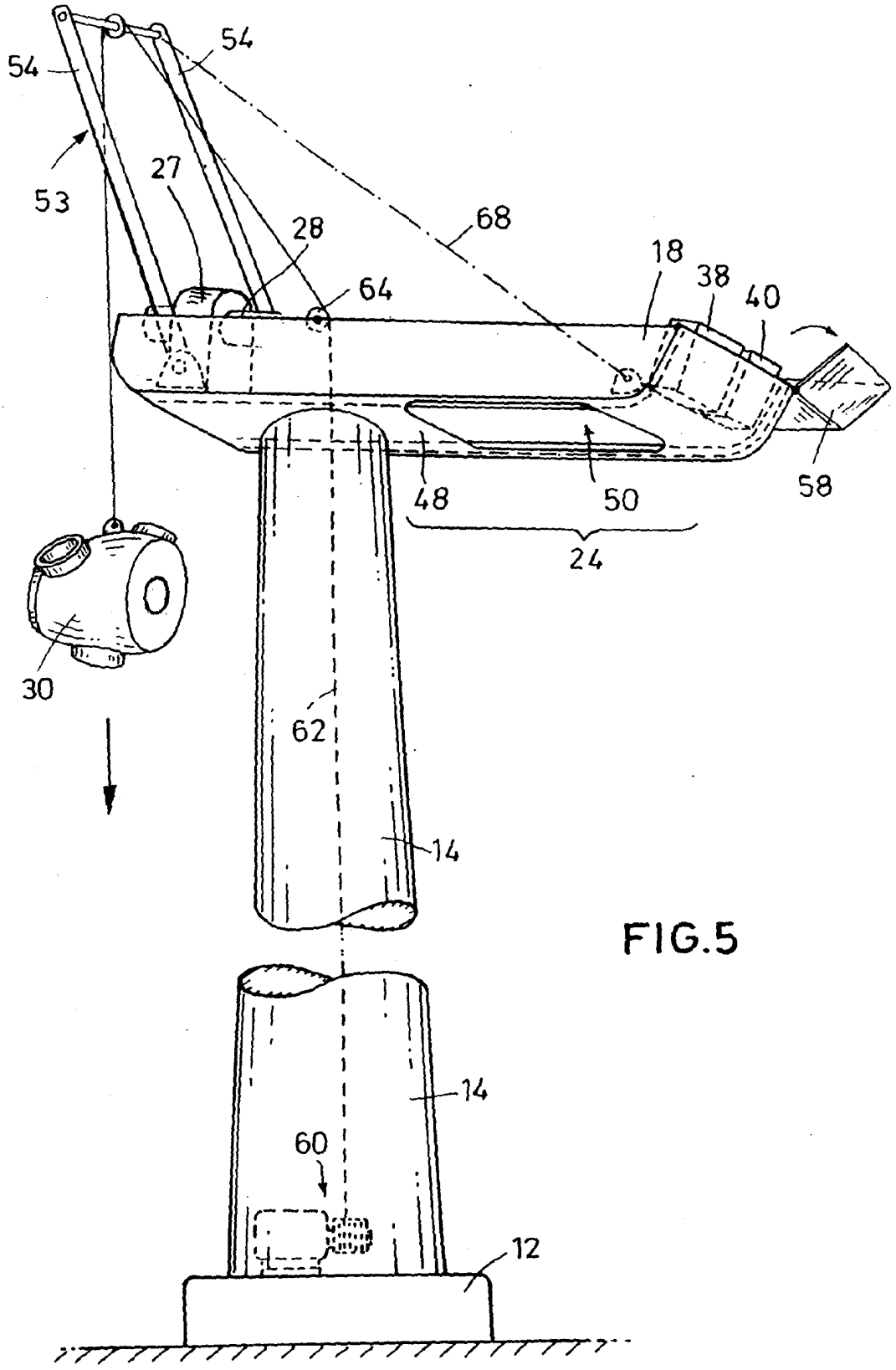


FIG.5

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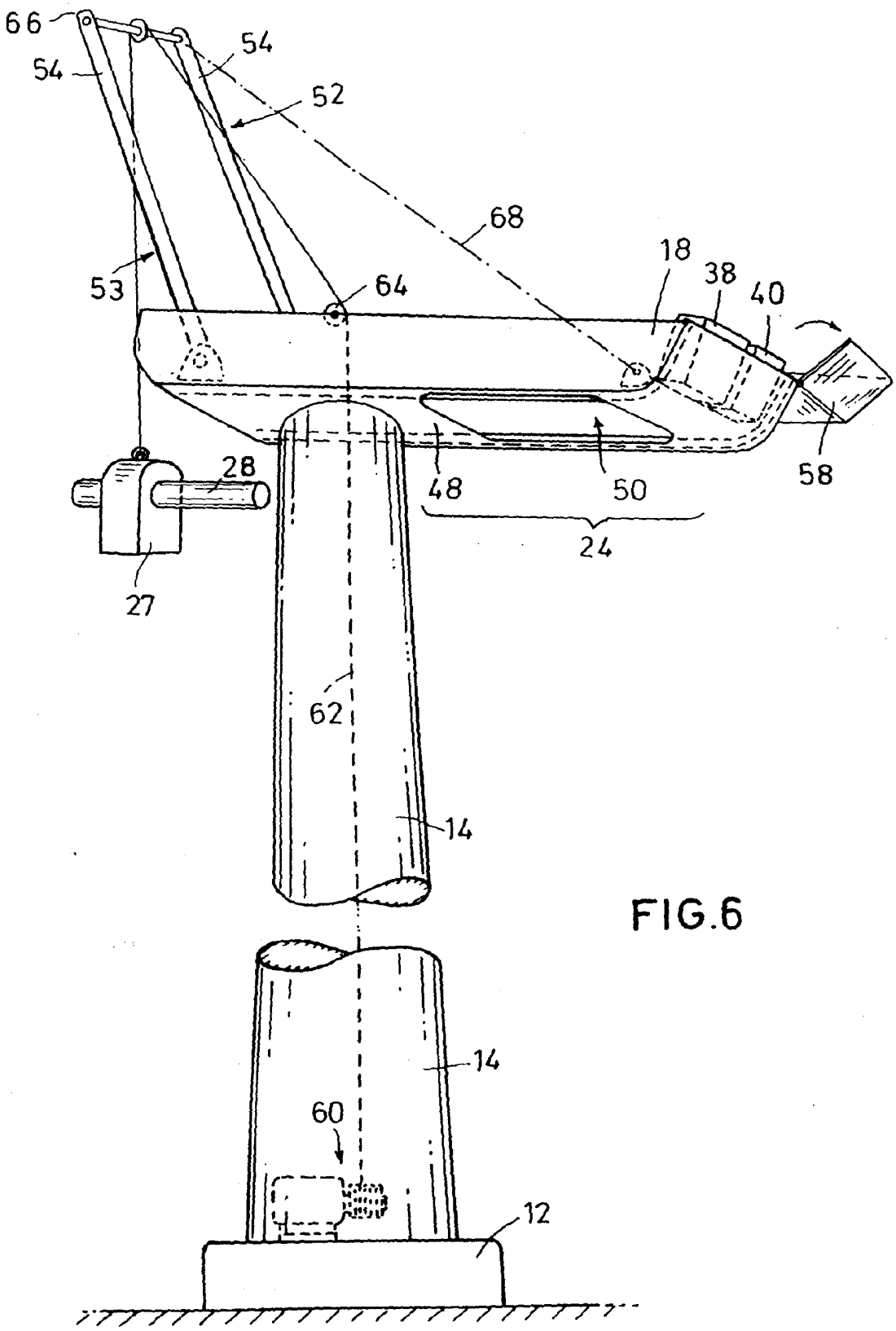


FIG.6

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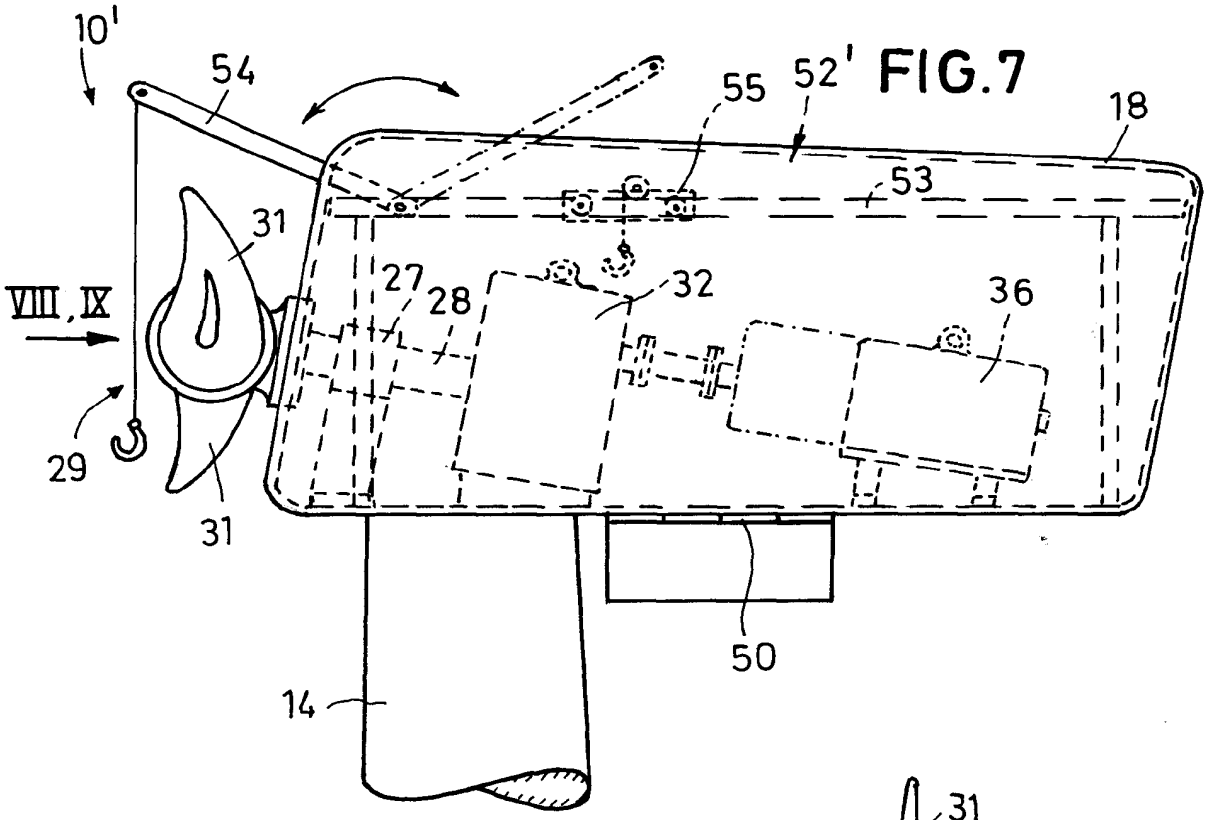


FIG.7

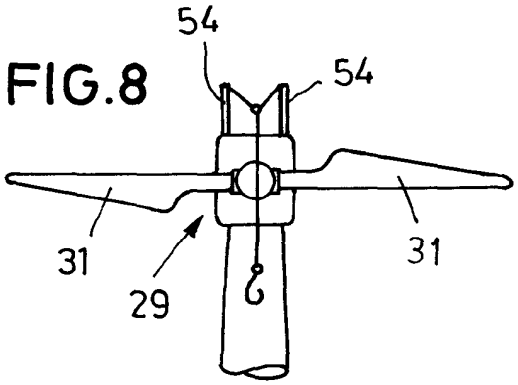


FIG.8

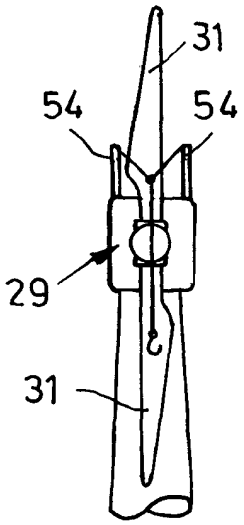


FIG.9

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ABSTRACT:

The wind power plant has an on-board crane (52) on a mounting (53), which has a load receiver (62). The mounting can move along the machinery casing (18), carrying e.g. the generator (36) or the transmission (32). There is an aperture (50) in the bottom of the machinery casing part (24) which projects radially from the tower (14).

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(54) Method and apparatus for replacing objects mounted on horizontal shafts in elevated locations

(57) An apparatus (400) for stabilizing a shaft (402) in an essentially horizontal position while an anchoring object (300) at one end (602) of the shaft is replaced without removal of an object (104) at the opposite end (604) of the shaft that would otherwise tend to destabilize the shaft from its essentially horizontal position includes a half-spool member (401) configured to clamp above and around the shaft to resist torque around a rotor (104), under supports (500) configured to attach to the half-spool member and clamp an underside of the shaft below the half-spool member, and a hydraulic or mechanical brake (518) configured to resist torque on the shaft when the brake is engaged.

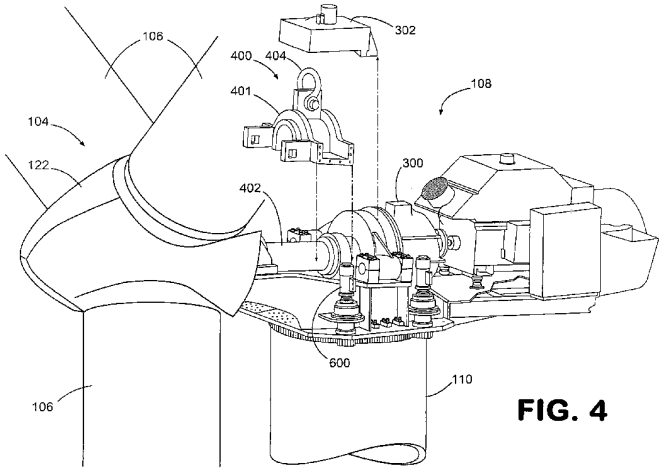


FIG. 4

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Description

[0001] This invention relates generally to the servicing of apparatus in elevated locations. The methods and apparatus are particularly useful for servicing wind turbine generators, and more particularly to methods and apparatus that assist in the removal replacement of gearboxes in wind turbine generators without requiring the removal of blades from the wind turbine generator. However, the methods and apparatus described herein are not limited to servicing of wind turbines, and can be used to replace various types of objects on horizontal shafts in elevated locations.

[0002] Generally, a wind turbine includes a rotor having multiple blades. The rotor is mounted within a housing or nacelle positioned on top of a truss or tubular tower. Utility grade wind turbines (i.e., wind turbines designed to provide electrical power to a utility grid) can have large rotors (e.g., 30 or more meters in diameter). Blades on these rotors transform wind energy into a rotational torque or force that drives one or more generators. In many wind turbine configurations, these generators are rotationally coupled to the rotor through a gearbox. The gearbox is or can be used to step up the inherently low rotational speed of the turbine rotor for the generator to efficiently convert mechanical energy to electrical energy. The electrical energy so produced is fed into a utility grid.

[0003] Although they are built to be quite reliable, gearboxes are mechanical devices that experience wear while in use. Also, even though gearboxes are mounted in a housing or nacelle and thus are protected from direct exposure to the elements, gearboxes can indirectly experience stress from extreme environmental conditions because of their coupling to large rotors. Thus, it will come as no surprise that gearboxes in wind turbines require occasional replacement.

[0004] In at least one known method for replacing a gearbox in a wind turbine, a crane is required to lift the gearbox out of an open nacelle. However, removing the gearbox also removes the object holding the end of the main shaft in place. In a typical wind turbine in a wind farm, a large rotor is fastened to the other end of the main shaft. This rotor has several long, heavy blades attached to a hub, so to prevent the main shaft from bending or the rotor from becoming tilted, the blades have to be removed from the rotor before the gearbox is removed. The sheer size of the wind turbines makes servicing difficult and expensive, as at the 65 to 80 meter height of some wind turbines used in generator farms, a large crane is required. Two cranes are required in some cases, because the entire rotor set must be removed in some cases and brought to the ground. A second crane is used to grab the bottom blade of the rotor and to "tail it out," i.e., make it flat in the air so that it can be set on the ground.

[0005] In some present wind turbine designs, the secondary bearing is the gearbox. A rotor having a mass of 76,000 pounds (34,466Kg) produces an upward lift of about 56,000 pounds (25,400Kg) at the gearbox.

[0006] Thus, known methods of replacement or servicing of a gearbox in a wind turbine are expensive and labor-intensive.

[0007] Some aspects of the present invention therefore provide a method for replacing a first object in an apparatus at an elevated location, wherein the first object anchors a first end of an essentially horizontal shaft in the apparatus and wherein a weight of a second object at a second, opposite end of the shaft tends to destabilize the shaft from its essentially horizontal position when the first object is not present. The method includes lifting a shaft-restraining member or members to the apparatus, fastening the shaft-restraining member or members to the apparatus to thereby restrain the shaft from tilting when the first object is removed from the apparatus, removing the first object from the apparatus with the shaft-restraining member or members fastened to the apparatus, re-anchoring the first end of the shaft with a replacement object, and removing the shaft-restraining member or members from the apparatus after the shaft is re-anchored by the replacement object.

[0008] In another aspect, the present invention provides an apparatus for stabilizing a shaft in an essentially horizontal position while an anchoring object at one end of the shaft is replaced without removal of an object at the opposite end of the shaft that would otherwise tend to destabilize the shaft from its essentially horizontal position. The apparatus includes a half-spool member configured to clamp above and around the shaft to resist torque around the rotor, under supports configured to attach to the half-spool member and clamp an underside of the shaft below the half-spool member, and a hydraulic or mechanical brake configured to resist torque on the shaft when the brake is engaged.

[0009] In yet another aspect, the present invention provides an apparatus for stabilizing a shaft in an essentially horizontal position while an anchoring object at one end of the shaft is replaced without removal of an object at the opposite end of the shaft that would otherwise tend to destabilize the shaft from its essentially horizontal position. The apparatus includes a half-spool member having a mounting ear or flange configured to attach to a mounting flange of a bearing or journal of the shaft, and a semi-annular member configured to mount between and attach to an end of the half-spool member and a flange or hub of the shaft. The half-spool member and the semi-annular member are configured to bolt together, and the semi-annular member is configured to bolt to a flange of the shaft.

[0010] It will thus be seen that various configurations of the present invention not only allow replacement of a heavy elevated object, e.g., a gearbox in a wind turbine, with only one crane, without removing the shaft that it is on or the hub or blades of a rotor at the opposite end of the shaft from the gearbox.

[0011] Various aspects and embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

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Figure 1 is a perspective view of a wind turbine ready to have a gearbox replaced.

Figure 2 is a flow chart representative of steps performed in some configurations of the present invention.

Figure 3 is a perspective view of a wind turbine in a partial stage of disassembly.

Figure 4 is a perspective view of the wind turbine of Figure 1 showing the removal of some of the components therein and the insertion of a shaft-restraining member as practiced in some configurations of the present invention.

Figure 5 is an exploded view of a portion of the wind turbine of Figure 4, showing mounting details of the shaft-restraining member shown in Figure 4 and additional shaft-restraining members.

Figure 6 is a perspective view of the wind turbine of Figure 4 showing the gearbox removed and an end of the shaft exposed.

Figure 7 is a partial perspective view of part of a shaft of a wind turbine, showing another configuration of shaft-restraining members (i.e., a rotor locks) of the present invention.

Figure 8 is a cross-sectional perspective view of the shaft, the shaft-restraining members, and a journal or bearing of the shaft of Figure 7.

Figure 9 is a cross-sectional view of a bolt configuration suitable for affixing a shaft-restraining member to a main bearing housing.

[0012] More than one Figure must be referenced simultaneously to achieve a complete understanding of certain aspects of the present invention. To assist the reader, where possible, the first digit of a reference numeral for an item matches the first figure number in which the corresponding item is first described (but not necessarily the first figure in which the item appears). All further references to that item use that same reference numeral, even when describing other figures.

[0013] In some configurations of the present invention, an object (sometimes referred to herein as a "first object") is replaced in an apparatus in an elevated location. The first object anchors a first end of an essentially horizontal rotatable shaft in the apparatus. Another object (sometimes referred to herein as a "second object") at a second, opposite end of the shaft is present and tends to destabilize the shaft from its essentially horizontal position when the first object is not present. Some configurations of the present invention provide a temporary stabilization of the horizontal shaft that permits replacement of the first object without removal of the second object during the replacement procedure. In some configurations of the present invention, the apparatus is a wind turbine, the first object is a gearbox of the wind turbine, and the replacement object is a replacement gearbox. In some configurations, a locking or clamping arrangement is provided that holds the horizontal main shaft at winds up to 25 meters per second, or over 50 miles per hour. However, in many configurations, for safety reasons, the replacement of the gearbox is limited to conditions in which winds are not more than 8 meters per second, or about 18 miles per hour. In addition, many wind turbine configurations in which gearboxes are replaced have three blades on their rotors. Some configurations of the present invention rotate the blades so that one blade is pointed straight down and the other blades are in a rabbit ear configuration. In addition, in some configurations of the present invention, the blades are pitched at an angle to avoid rotational torque on the rotor based upon the prevailing wind direction and/or the wind turbine itself is yawed for the same purpose.

[0014] More particularly and referring to Figure 1, flow chart 200 of Figure 2, and Figure 3, in some configurations of the present invention, a gearbox 300 of a wind turbine 100 is removed using a single crane 102 that is deployed 202 to a repair site. Wind turbine 100 comprises a rotor 104 having at least one blade 106. In the most common configuration, rotor 104 has three blades 106, but configurations of the present invention are not limited to rotor configurations having a specific number of blades. Wind turbine 100 also comprises a nacelle 108 that is mounted atop a tower 110. Nacelle 108 houses various mechanical and electrical components of wind turbine 100, including gearbox 300. Nacelle 108 comprises a cowling 112, a top portion 114 of which is removed 204 at least in part by maneuvering hook 116 on crane 102 to a handle, hook, or other protuberance or opening of top portion 114 configured for the purpose, and lifting top portion 114 off. In many configurations, in addition to the steps discussed herein, bolts are removed to uncap pillow blocks, and after the pillow blocks are removed, a transmission and a yaw motor are both removed.

[0015] Figure 3 is an illustration of nacelle 108 of wind turbine 100 with cowling top portion 114 removed. Other components of wind turbine 100 that interfere with the installation of a shaft-restraining collar (to be described below) are also removed, for example, oil cooler 302, as shown schematically in Figure 4. To provide better visibility of components within nacelle 108. the bottom portion 120 of cowling 112 has been omitted from Figure 3. However, it is not

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necessary to remove bottom portion 120 in many configurations of the present invention.

[0016] Referring to Figure 2 and Figure 4, a shaft-restraining member or members 400 is then lifted 206 into place using crane 102 and hook 116. A hole or a handle 404 can be provided in member or members 400 to facilitate lifting. In some configurations of the present invention, shaft-restraining member or members comprise a half-spool member 401 that is used to restrain rotating shaft 402 (sometimes referred to herein as "main shaft") from tilting from its horizontal position when gearbox 300 is removed from wind turbine 100 without the removal of rotor 104. In some configuration of the present invention and referring to Figure 5, shaft-restraining members 400 include under support members 500 that are mounted under main shaft 402. Half-spool member 401 and under support members 500 are configured in some configurations of the present invention to also inhibit rotation of shaft 402 due to wind on rotor 104 during at least a time before gearbox 300 is removed until after a replacement gearbox re-anchors shaft 402 in place.

[0017] Referring to Figures 2, 4, and 5, half-spool member 401 is fastened to wind turbine 100, for example, by bolting it 208 in place. For example, in some configurations of the present invention, half-spool member 401 includes mounting wings 502 on opposite sides, although only one mounting wing 502 is visible in Figure 5. Each mounting wing 502 is configured to receive a bolt 504 therethrough to slidably engage under support members 500 until they are adjusted into position to support an underside of main shaft 402 and bolts 504 tightened. (In some configurations, bolts 504 are tightened onto spacers that are not shown in the Figures so that main shaft 402 is supported underneath by curved sections of under support members 500.) Also, each mounting wing 502 in some configurations is held in place using a channel clamp 506 having a U-shaped channel 508 that attaches onto a bedplate (not explicitly shown in Figure 5) of wind turbine 100. Each channel clamp 506 is bolted to a respective mounting wing 502 at both ends of half-spool member 401. An additional stiffening plate 510 is bolted to flanges 512 protruding from spool ends 514 and 516 of half-spool member 401.

[0018] Hydraulic or mechanically operated friction brakes 518 are provided in some configurations to clamp main shaft 402 and thereby inhibit rotation of shaft 402. In some configurations, brakes 518 are provided on opposing brake support flanges 519 extending in an essentially axial direction from an end 516 of half-spool member 401. For example, brakes 518 comprise opposing cylinders each supported by one of the opposing brake support flanges 519. The hydraulic or mechanical clamping action of brakes 518 around main shaft 402 resists torque from rotor 104. (In some configurations, mechanical clamping action is or can be provided electromechanically.)

[0019] In some configurations, shaft-restraining members 400 are configured to allow for rotation of rotor 104 during high wind speed events that may occur during replacement of gearbox 300 to prevent damage to wind turbine 100 or the danger of heavy components that might shear off in such conditions. For example, surfaces 520 are Teflon(TM)-covered or provided with roller bearing surfaces in some configurations that allow rotation of shaft 402 above a predetermined torque.

[0020] In some configurations and referring to Figure 6, one or more yaw motors 600 are then secured 210 to main shaft 402 to prevent rotation of rotor 104. A yaw motor 600 may be located on each side of main shaft 402. Gearbox 300 is then removed 212 by uncoupling it from main shaft 402 and lowering it to the ground using crane 102. A replacement gearbox 300 is lifted using crane 102, put in place in nacelle 108 and attached 214 to main shaft 402, thereby re-anchoring first end 602 of shaft 402. Shaft-restraining member 400, which was fastened to wind turbine 100 to resist the tendency of shaft 402 to destabilize by tilting due to the weight of rotor 104 on second end 604 of shaft 402, is then removed 216 and lowered to the ground, using crane 102 as necessary. Top portion 114 of cowling 112 can then lifted up and reattached to complete the servicing of wind turbine 100.

[0021] In some configurations of the present invention and referring to Figures 7 and 8, shaft-restraining members are somewhat differently configured. For example, shaft-restraining members 700 in some configurations of the present invention comprise a somewhat differently configured half-spool member 701 having mounting ears or flanges 702 and a semi-annular member 704. Semi-annular member 704 is configured to mount between and fastened to an end 800 of half-spool member 701 using one or more bolts 802 tightened through holes 804 proximate the periphery of semi-annular member 704 and holes 806 through a periphery of end 800 of half-spool member 701. Semi-annular member 704 is also configured to mount onto a mounting flange 808 of shaft 402, or in some configurations, to hub 122 of rotor 104 (see Figure 1).

[0022] More particularly, in some configurations, mounting flange 808 of shaft 402 comprises a trumpeted section having countersunk holes 810 that accommodate the heads of bolts (not shown in Figure 8) that fasten hub 122 to flange 808. One or more of these bolts are removed and replaced with longer bolts 816 that are used to fasten semi-annular member 704 to mounting flange 808 on a side opposite hub 122 (not shown in Figure 8), but many bolts are not removed. These bolts do not interfere with semi-annular member 704 because their heads are recessed into countersunk holes. In other configurations, holes are countersunk in semi-annular member 704 rather than in mounting flange 808 to allow a side of semi-annular member 704 to firmly contact flange 808. In either type of configuration, hub 122 and blades 106 need not be removed during the replacement of gearbox 300.

[0023] In some configurations and referring to Figures 7 and 9, half-spool member 701 is placed over main shaft 402, and more particularly over journal or bearing 710. Mounting ears or flanges 702 of half-spool member 701 are configured

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to rest atop mounting flanges 706 of a journal or bearing 710 around main shaft 402. For example, internally threaded bolts 900 are threaded onto a threaded end of existing bolts 708 that extend beyond nuts 904 that fasten mounting flanges 706 to bedplate 902 (not shown in Figure 7). In this manner, half-spool member 701 is fastened to bedplate 902 of wind turbine 100. Slots 712 in mounting flanges 706 and in a cylindrical body portion 714 of half-spool member 701 provide clearance for gusset plates 716 of journal or bearing 710 to pass through.

[0024] By fastening semi-annular member 704 to mounting flange 806, half-spool member 701 to semi-annular member 704, and half-spool member 701 to mounting flanges 706 or to bolts 708 therein, shaft 402 is effectively restrained from tilting and its rotation effectively inhibited. Gearbox 300 can then be safely removed and replaced.

[0025] In some configurations and referring again to Figure 8, semi-annular member 704 also includes one or more axially extending protuberances 812 such as a tooth, a key, or a wedge (for simplicity hereinafter, the term "tooth" is used generically to refer to protuberance 812). Tooth 812 engages an appropriately shaped gap 814 in a circumference of mounting flange 808 to effectively inhibit rotation of shaft 402. Some configurations provide more than one tooth 812, each engaging an appropriately shaped notch 814. Some configurations include one or more teeth 812 in addition to bolts 812 to fasten semi-annular member 704 to flange 808. Some configurations have one or more teeth 812 and do not use bolts 812 to fasten semi-annular member 704 to flange 808.

[0026] It will thus be appreciated that various configurations of the present invention not only allow replacement of a heavy elevated object, e.g., a gearbox in a wind turbine, with only one crane, without removing the shaft that it is on or the hub or blades of a rotor at the opposite end of the shaft from the gearbox.

[0027] While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

PARTS LIST

[0028]

wind turbine	100
crane	102
rotor	104
blades	106
at least one blade	106
nacelle	108
tower	110
cowling	112
cowling top portion	114
hook	116
cowling bottom portion	120
hub	122
flow chart	200
deploy crane to repair site	202
remove cowling	204
lift prop shaft restraining collar	206
lift channel clamps into place with crane and attach with bolts	208
secure anti-rotation pin to prop shaft collar	210
uncouple gear box from prop shaft and lower to ground	212
reattach crane to new gear box, lift into place and attach to prop shaft	214
remove anti-rotation pin, remove channel clamps, remove restraining collar and lower respectively using crane	216
gearbox	300
oil cooler	302
shaft-restraining member or members	400
half-spool member	401
main or rotating shaft	402
hole or handle	404
under support members	500
mounting wings	502

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(continued)

bolts	504
channel clamp	506
U-shaped channel	508
stiffening plate	510
flanges	512
spool end	514
another spool end	516
brakes	518
opposing brake support flanges	519
surfaces	520
yaw motor	600
first end of shaft	602
second end of shaft	604
shaft-restraining members	700
half-spool member	701
mounting ears or flanges	702
semi-annular member	704
mounting flanges	706
mounting flanges	706
a journal or bearing	710
slots	712
cylindrical body portion	714
gusset plates	716
end of half spool member	800
bolts	802
holes	802
mounting flange	808
countersunk holes	810
tooth or protuberance	812
gap or notch	814
an appropriately shaped notch	814
longer bolts	816
internally threaded bolts	900
bedplate	902
nuts	904

Claims

1. A method for replacing a first object (300) in an apparatus (100) at an elevated location, wherein the first object anchors a first end (602) of an essentially horizontal shaft (402) in the apparatus and wherein a weight of a second object (104) at a second, opposite end (604) of the shaft tends to destabilize the shaft from its essentially horizontal position when the first object is not present, said method comprising:

   lifting (206) a shaft-restraining member or members (400) to the apparatus;
   fastening (208) the shaft-restraining member or members to the apparatus to thereby restrain the shaft from tilting when the first object is removed from the apparatus;
   removing (212) the first object from the apparatus with the shaft-restraining member or members fastened to the apparatus;
   re-anchoring (214) the first end of the shaft with a replacement object (300); and
   removing (216) the shaft-restraining member or members from the apparatus after the shaft is re-anchored by the replacement object.

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2. A method in accordance with Claim 1 wherein the shaft is a rotating shaft, and said method further comprises (210) inhibiting rotation of the shaft from a time before said removal of the first object and said re-anchoring of the first of the shaft.

3. A method in accordance with Claim 2 wherein said apparatus is a wind turbine (100), the first object is a gearbox (300), the second object is a rotor (104) of the wind turbine, and the replacement object is a replacement gearbox (300).

4. A method in accordance with Claim 3 wherein the apparatus is a wind turbine generator (100) having a rotor (104), said lifting the restraining member to the apparatus further comprises utilizing a crane (102) to lift at least one of the restraining members (400), and said replacing the first object is performed without removing the rotor from the wind turbine generator.

5. A method in accordance with any preceding Claim wherein the-shaft is a rotating shaft (402), the apparatus is a wind turbine (100), the first object is a gearbox (300), the second object is a rotor (104) of the wind turbine, the replacement object is a replacement gearbox (300), and the shaft-restraining member or members comprise a half-spool member (401), wherein said fastening the shaft-restraining member or members to the apparatus further comprises mounting half-spool member over the shaft and fastening the half-spool member to a bedplate (902) of the wind turbine.

6. An apparatus (400) for stabilizing a shaft (402) in an essentially horizontal position while an anchoring object (300) at one end (602) of the shaft is replaced without removal of an object (104) at the opposite end (604) of the shaft that would otherwise tend to destabilize the shaft from its essentially horizontal position, said apparatus comprising:

a half-spool member (401) configured to clamp above and around the shaft to resist torque around a rotor (104);
under supports (500) configured to attach to the half-spool member and clamp an underside of the shaft below the half-spool member; and
a hydraulic or mechanical brake (518) configured to resist torque on the shaft when the brake is engaged.

7. An apparatus in accordance with Claim 6 wherein at least said half-spool member and said under supports comprise surfaces (520) configured to allow rotation of the shaft above a predetermined torque.

8. An apparatus in accordance with Claim 6 or Claim 7 wherein said half-spool member comprises mounting wings (502), and said apparatus further comprises channel clamps (506) configured to clamp to a bed frame of the apparatus and bolt to said mounting wings.

9. An apparatus in accordance with any one of Claims 6 to 8 wherein said half-spool member further comprises:

mounting wings (502) on opposite sides of the half-spool member; and
opposing brake support flanges (519) extending axially from ends of the half-spool member;
and further wherein said brakes comprise opposing cylinders each supported by one of said opposing brake support flanges.

10. An apparatus (700) for stabilizing a shaft (402) in an essentially horizontal position while an anchoring object (300) at one end (602) of the shaft is replaced without removal of an object (104) at the opposite end (604) of the shaft that would otherwise tend to destabilize the shaft from its essentially horizontal position, said apparatus comprising:

a half-spool member (701) having a mounting ear or flange (702) configured to attach to a mounting flange (706) of a bearing or journal (710) of the shaft;
a semi-annular member (704) configured to mount between and attach to an end of the half-spool member (800) and a flange or hub (808) of the shaft;
said half-spool member and said semi-annular member configured to bolt together, and said semi-annular member configured to bolt to a flange of the shaft.

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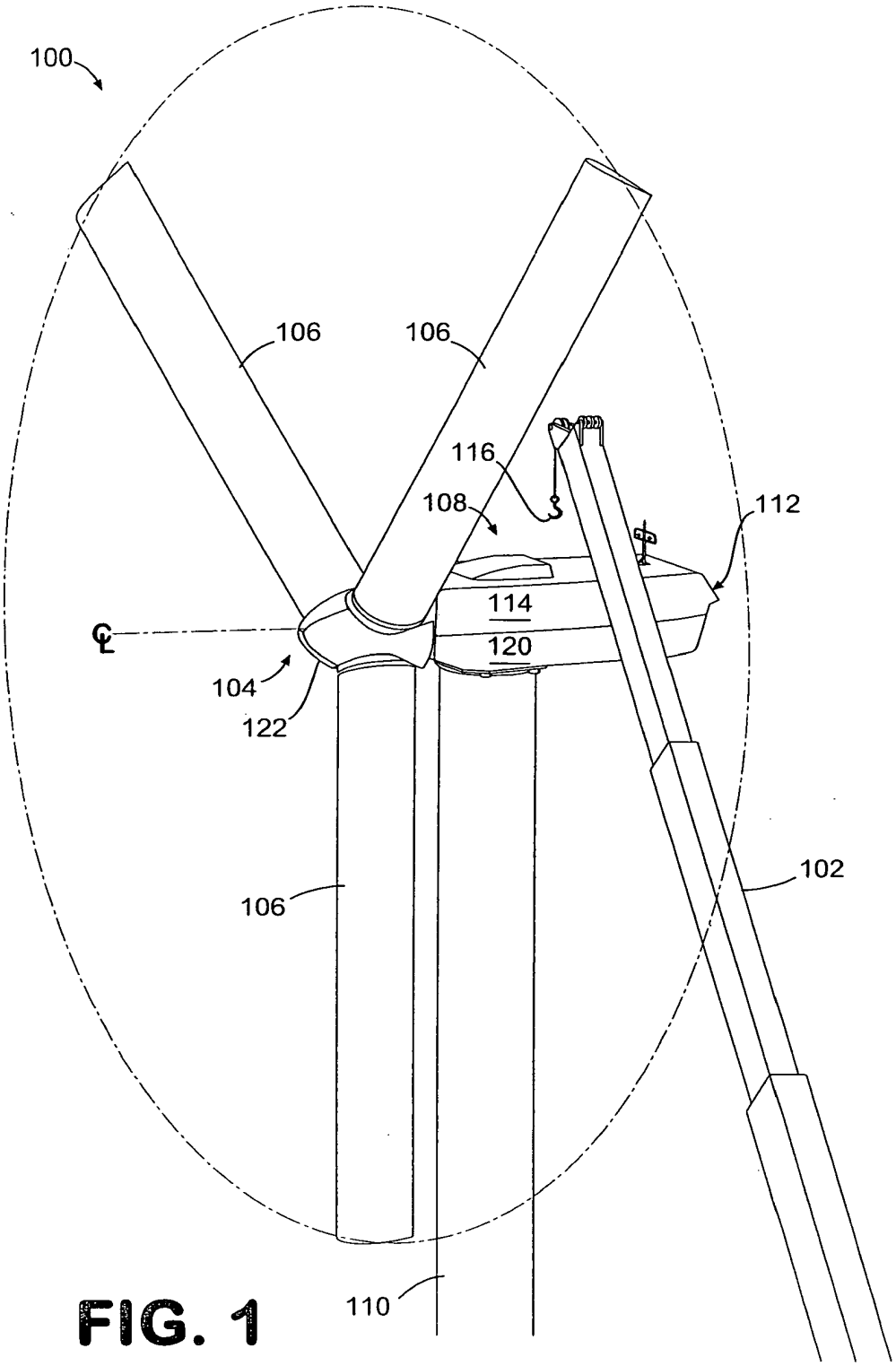


FIG. 1

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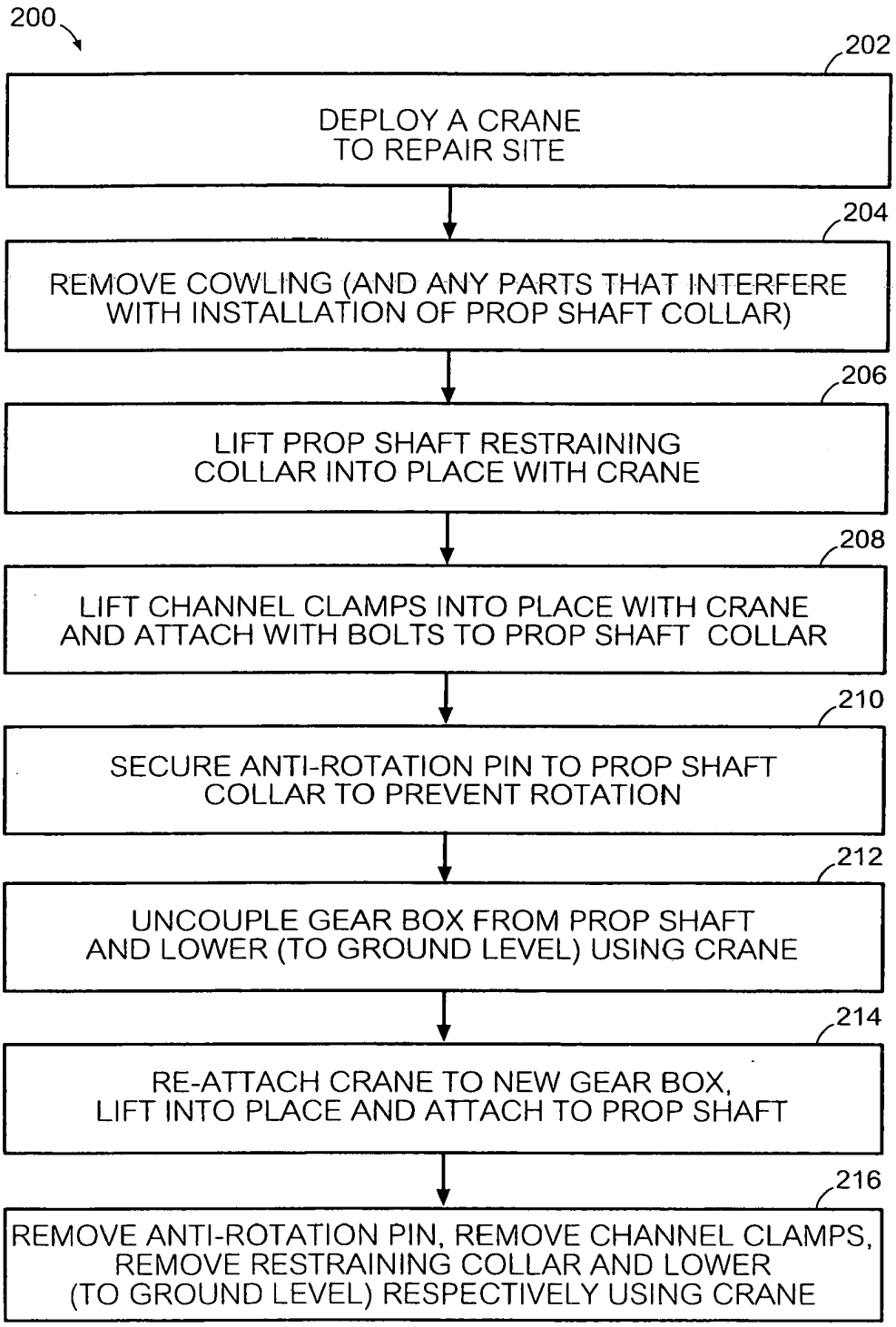


FIG. 2

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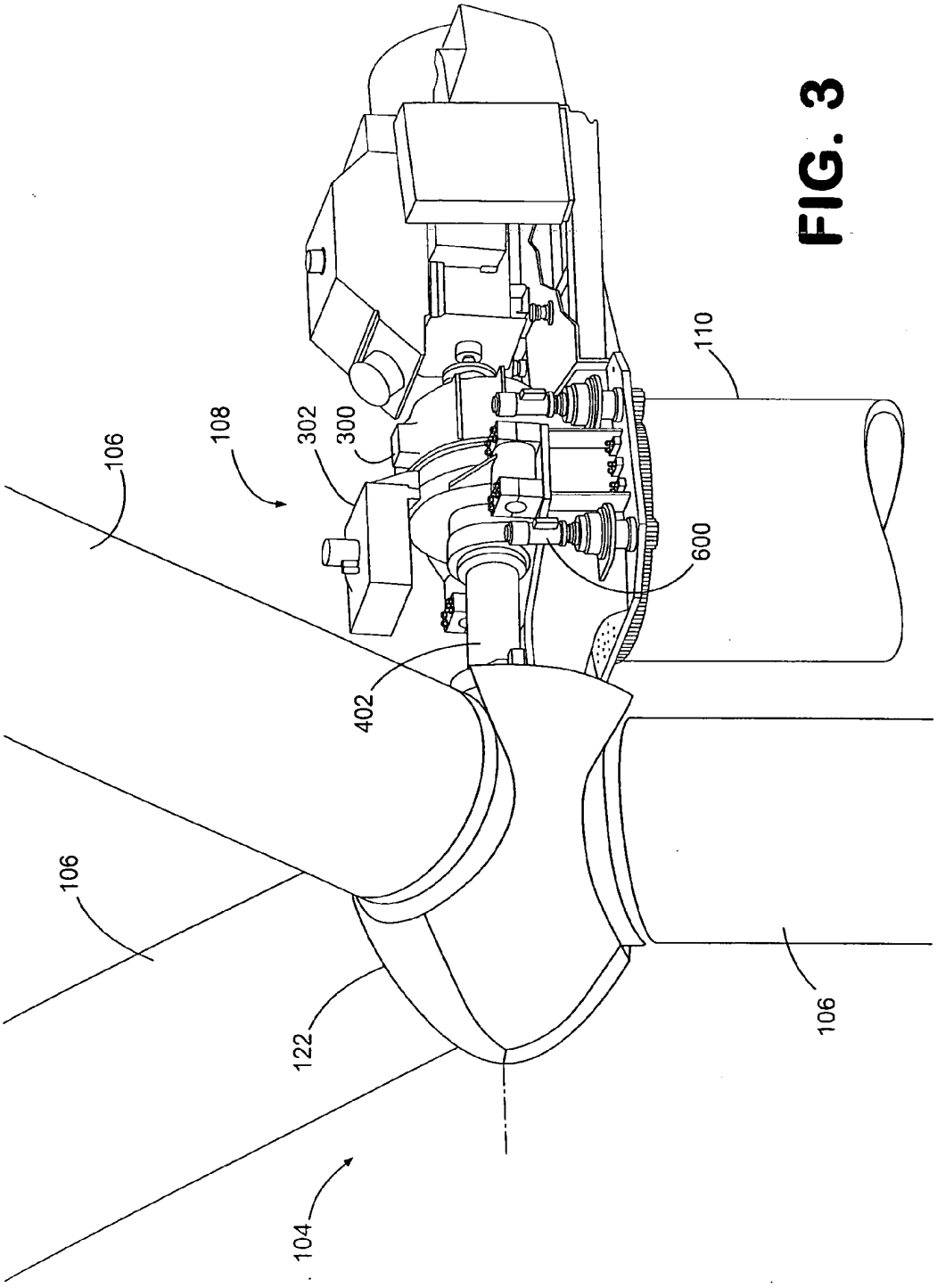


FIG. 3

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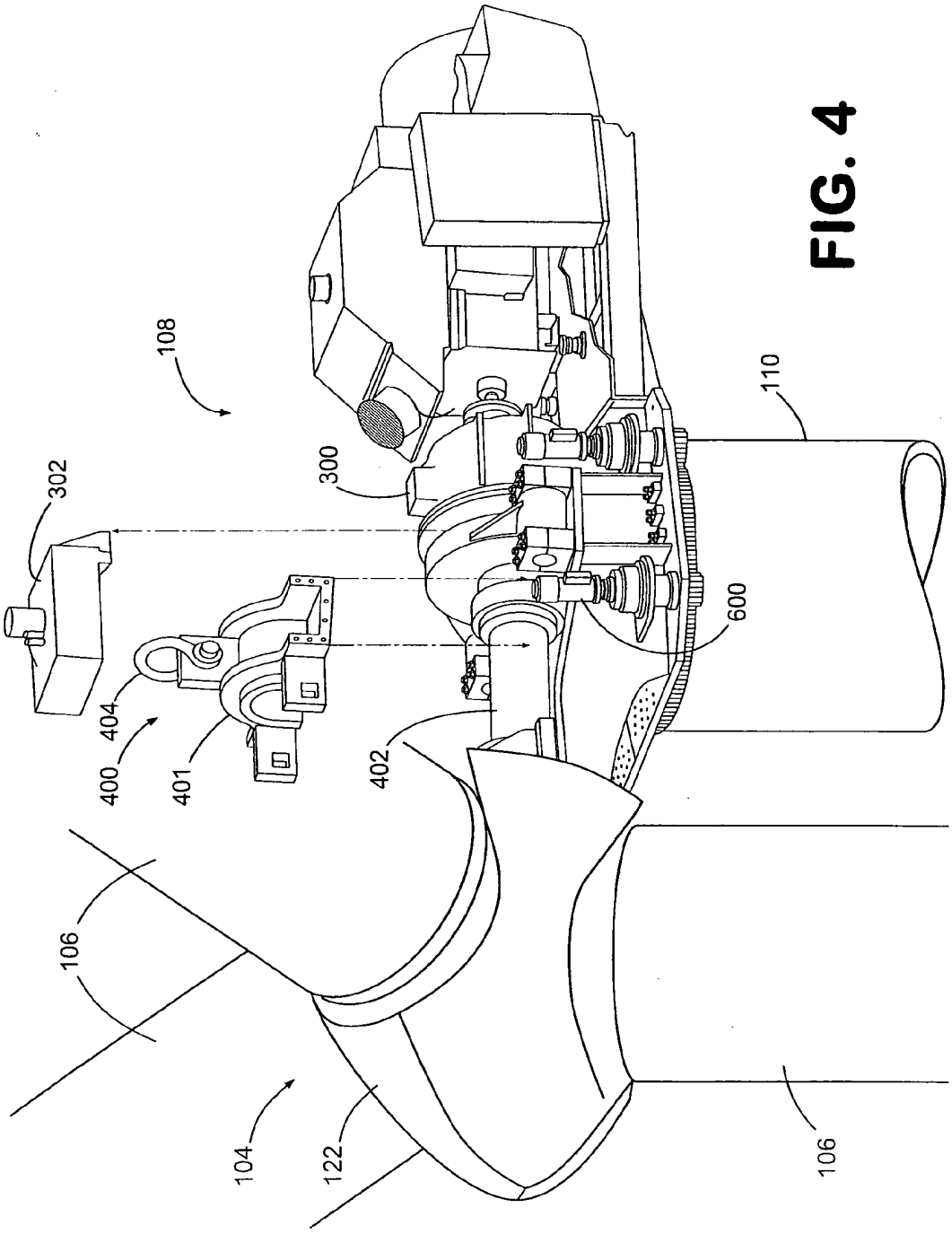


FIG. 4

LiftWerx Ex. 1006
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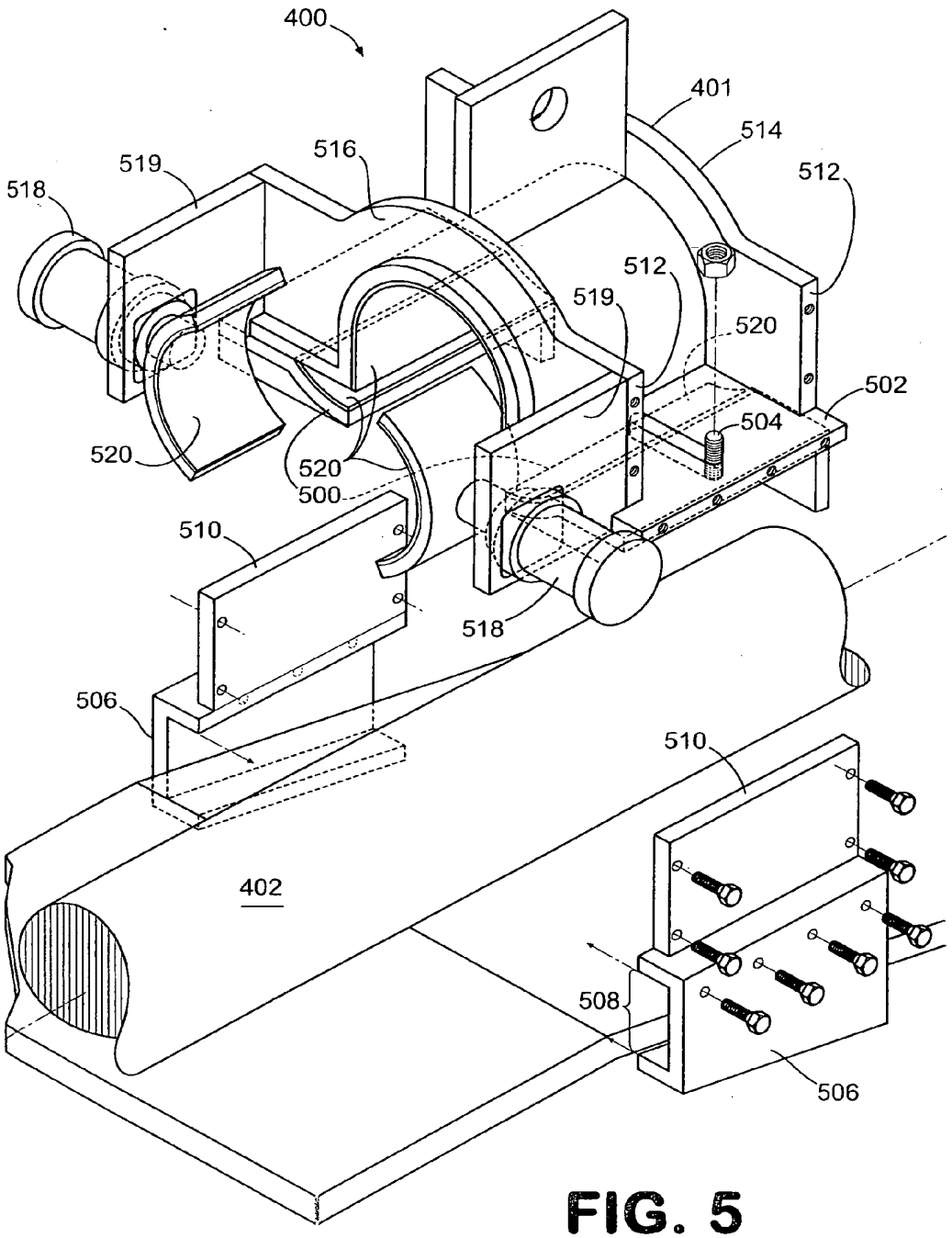


FIG. 5

LiftWerx Ex. 1006
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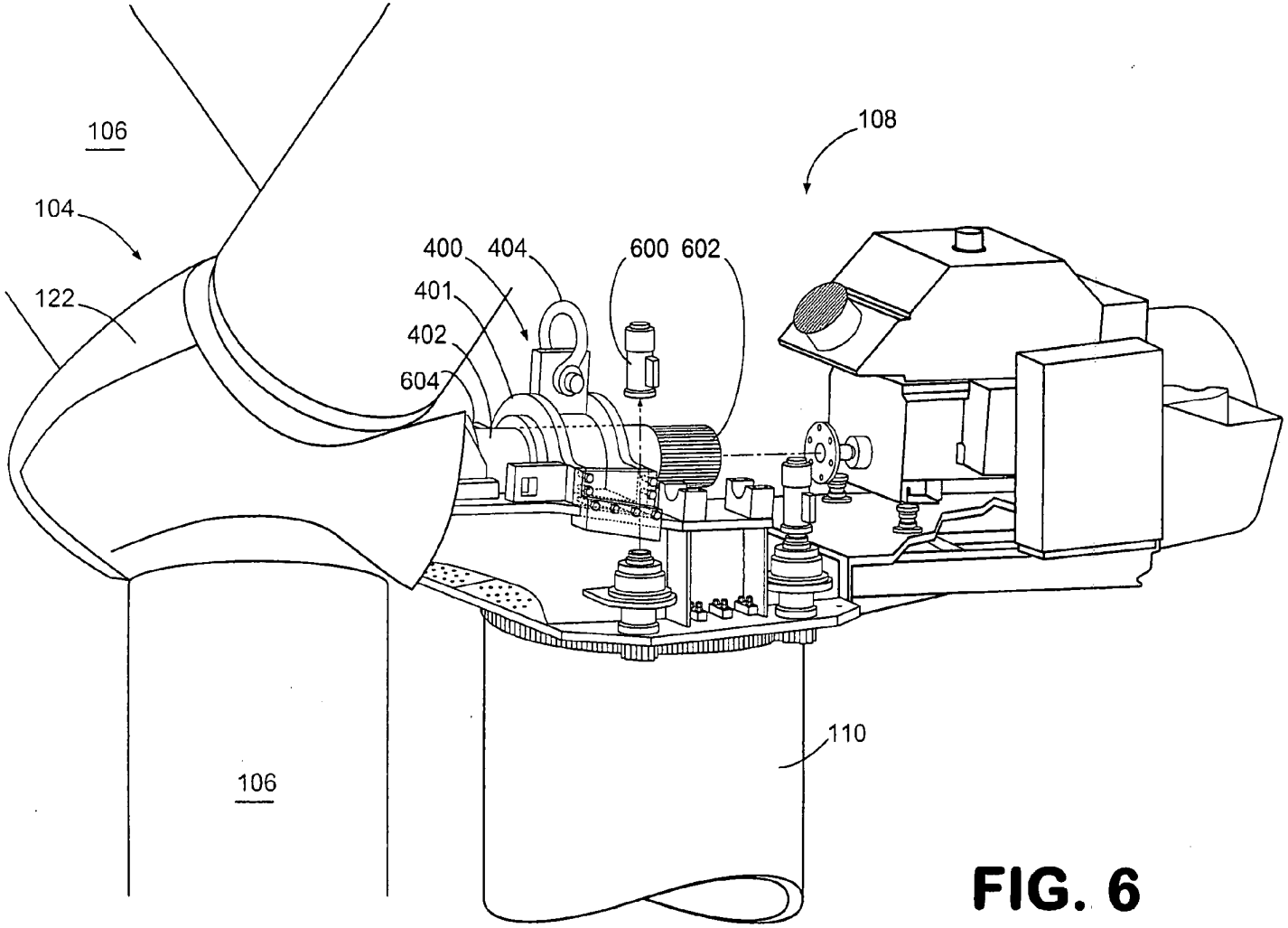


FIG. 6

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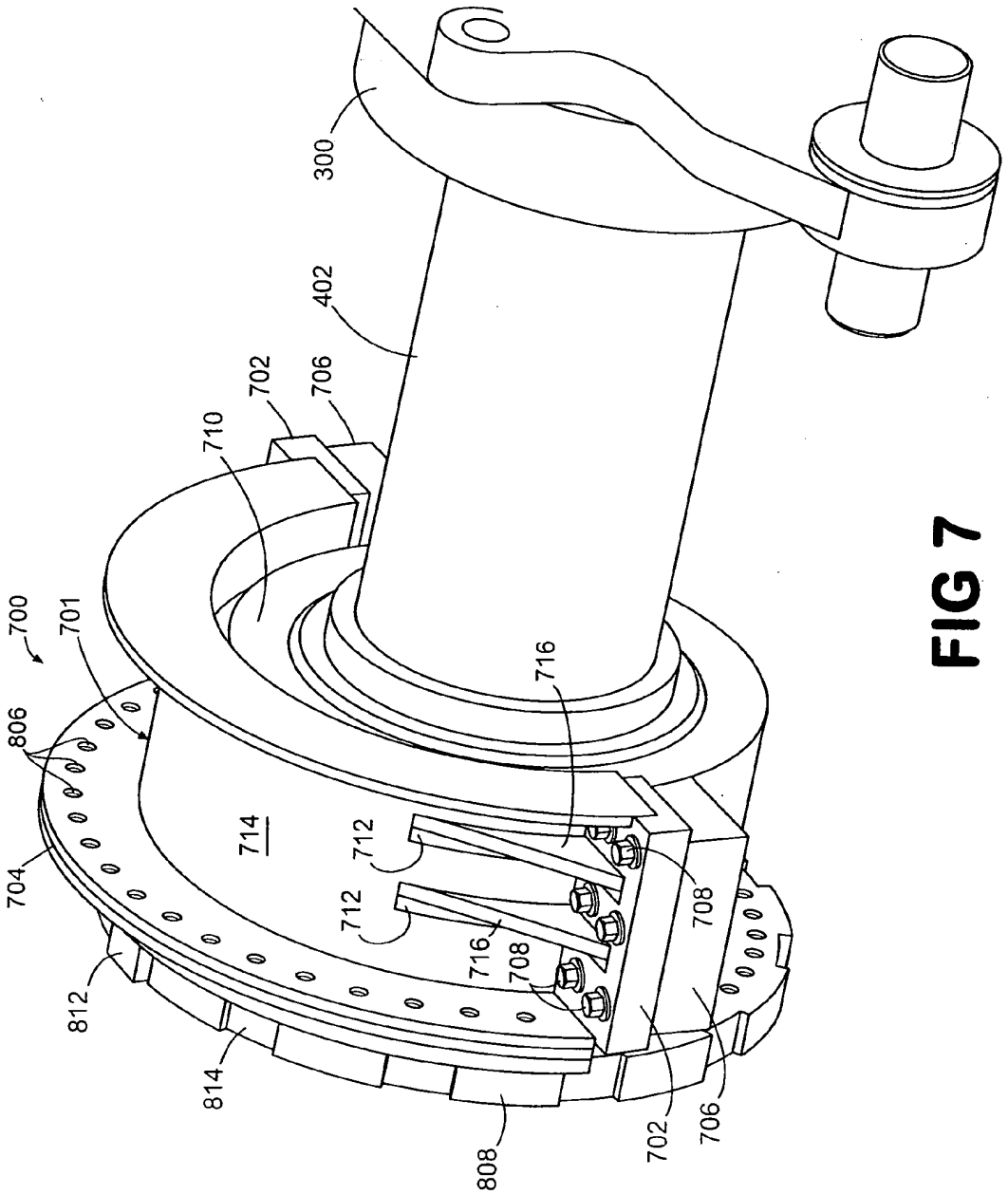


FIG 7

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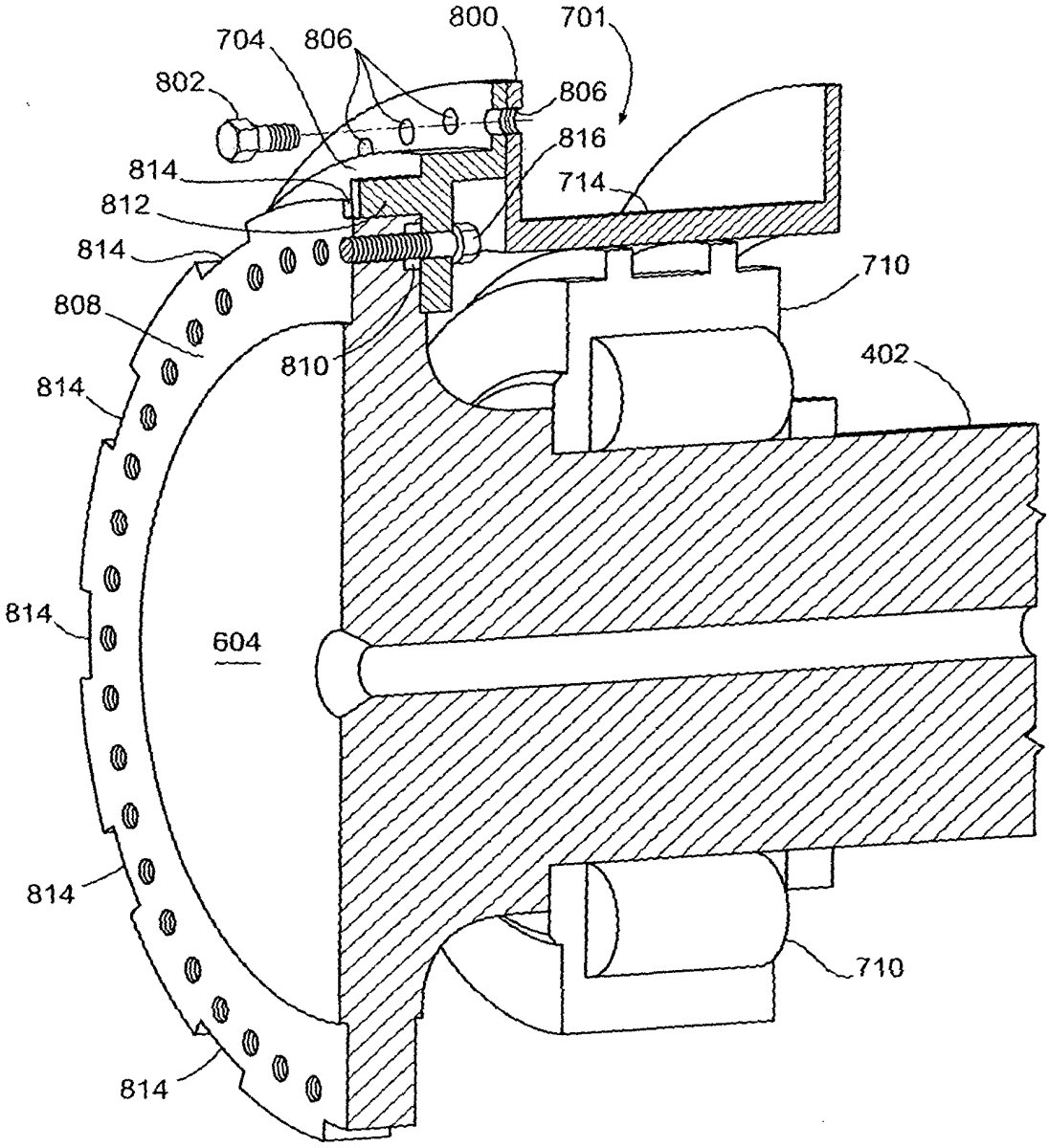


FIG 8

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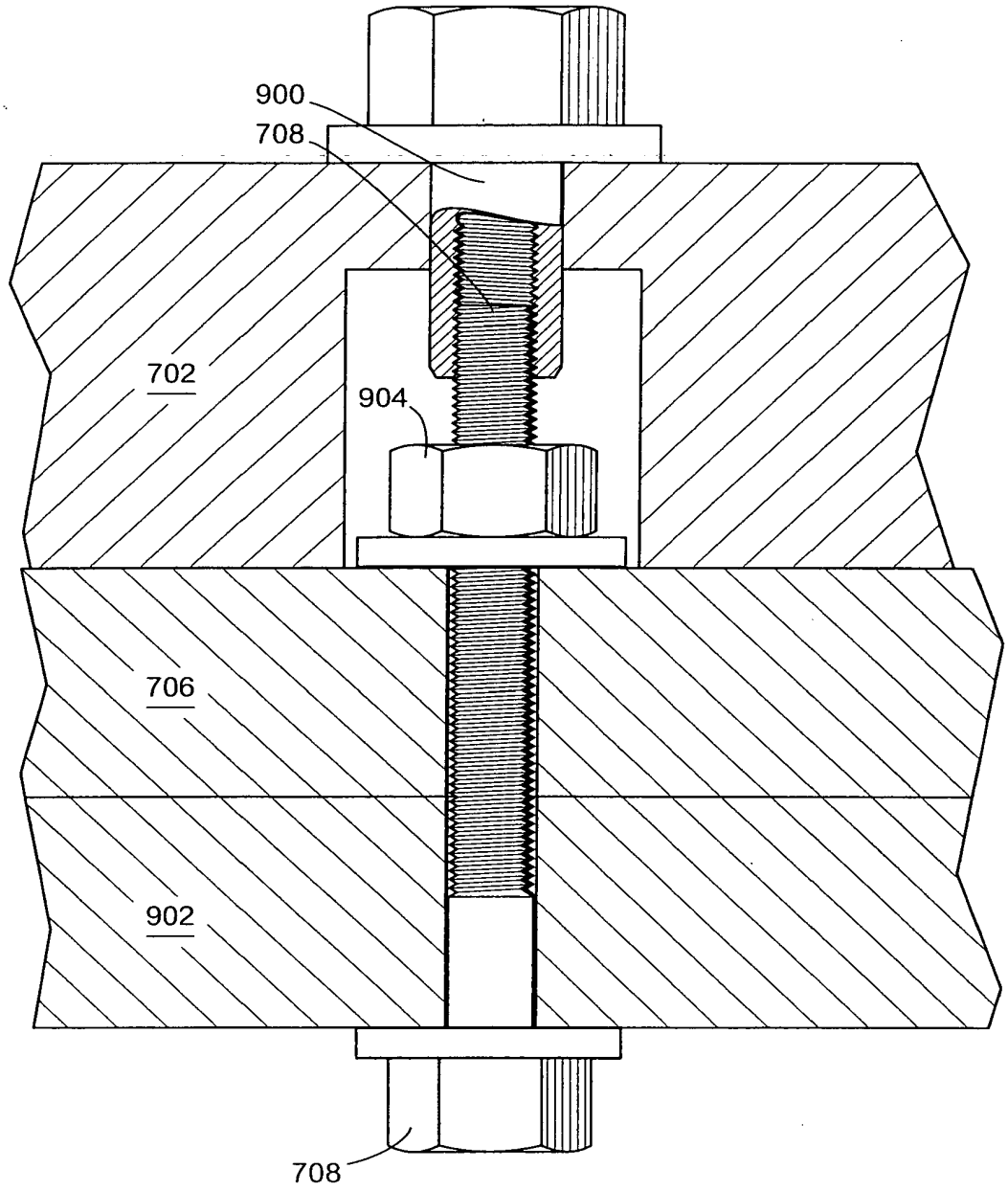


FIG 9

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PUB-NO: EP001748182A2
DOCUMENT-IDENTIFIER: EP 1748182 A2
TITLE: Method and apparatus for replacing a gearbox in a wind turbine
PUBN-DATE: January 31, 2007
PATENT-FAMILY-ID: 36922154

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APPL-NO: EP 06253865 A
APPL-DATE: July 24, 2006

PRIORITY-DATA:

PRIORITY-NO	PRIORITY-APPL-DATE
US 19076105 A	20050727

CPC-CURRENT:

TYPE	CPC/DATE
CPCI	F03D13/10 20160501
CPCI	F03D80/50 20160501
CPCA	F05B2230/61 20130101
CPCA	F05B2230/80 20130101
CPCA	Y10T29/4932 20150115
CPCA	Y10T29/49318 20150115
CPCA	Y10T29/49721 20150115
CPCA	Y10T29/4973 20150115
CPCA	Y10T29/49229 20150115
CPCA	Y02P70/523 20151101
CPCA	Y02E10/726 20130101

INT-CL-CURRENT:

TYPE	**IPC/DATE**
IPCP	F03D1/00 20060101

ABSTRACT:

An apparatus (400) for stabilizing a shaft (402) in an essentially horizontal position while an anchoring object (300) at one end (602) of the shaft is replaced without removal of an object (104) at the opposite end (604) of the shaft that would otherwise tend to destabilize the shaft from its essentially horizontal position includes a half-spool member (401) configured to clamp above and around the shaft to resist torque around a rotor (104), under supports (500) configured to attach to the half-spool member and clamp an underside of the shaft below the half-spool member, and a hydraulic or mechanical brake (518) configured to resist torque on the shaft when the brake is engaged.

EAST Search History

EAST Search History (Prior Art)

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S4	3491	F03D80/50.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/12 16:54
S5	26	F03D13/00.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/12 16:54
S6	1722	F05B2230/61.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/12 16:55
S7	379	F05B2240/60.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/12 17:03
S8	1351	F05B2230/80.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/12 17:09
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S56	618	Y10T279/1291.cpc. not Y10T279/1986,19,3462.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/19 14:45
S57	568	Y10T279/1291.cpc. not Y10T279/1986,19,3462.cpc. not B23B31/101,16,16287.cpc. not B23B2215/76.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/19 14:46
S58	38	F05B2230/80.cpc. and ((chuck$3 or brak$3) near20 (rotor or shaft))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/19 15:43
S59	149	F03D13/10.cpc. and (rotor near20 (brak$3 or clamp$3 or jaw))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/19 15:52
S60	86	F03D13/10.cpc. and (shaft near15 (brak$3 or clamp$3 or jaw))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/19 16:18
S61	31	S60 not S59	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/19 16:18
S62	27	F05B2230/80.cpc. and ((shaft) near15 (brak$3 or clamp$3 or jaw))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/19 16:24
S63	94	F03D80/50.cpc. and ((shaft) near15 (brak$3 or clamp$3 or jaw))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/19 16:29
S64	36	F05B2230/61.cpc. and ((shaft) near15 (brak$3 or clamp$3 or jaw))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/19 17:24
S65	1	(11/721844).APP.	USPAT; USOCR	OR	ON	2018/06/19 17:53
S66	2	JP-6154846-$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2018/06/20 13:23

			IBM_TDB			
S67	0	JP-S6154846-$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/20 13:23
S68	0	JPS-6154846-$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/20 13:23
S69	4	JP-61054846-$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/20 13:23
S70	0	dr-2771319-$	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 14:23
S71	2	fr-2771319-$	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 14:23
S72	1	"20020092395".pn.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 14:29
S73	1	de-4116621-$	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 14:46
S74	1	de-4116621-$	DERWENT	OR	ON	2018/06/20 14:49
S75	2	DE-19525309-$	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 15:42
S76	3	DE-1940609-$	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 15:42
S77	23	("1419786" | "2511930" | "3062104" | "3521526" | "4177701").PN. OR ("4631995").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/06/20 17:00
S78	105	F05B2230/61.cpc. and ((shaft or rotor) near15 (brak$3 or clamp$3 or jaw or lock$3))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 19:41
S79	37	F05B2230/61.cpc. and (((shaft or rotor) near15 (brak$3 or clamp$3 or jaw or lock$3)) with (actuat$3 or cylinder))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 19:42
S80	68	S78 not S79	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 19:49
S81	1637	F05B2230/61.cpc. not S78	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 20:00
S82	14	F05B2230/80.cpc. and (((shaft or rotor) near15 (brak$3 or clamp$3 or jaw or lock$3)) with (actuat$3 or cylinder))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 20:19
S83	65	F05B2230/80.cpc. and ((shaft or rotor) near15 (brak$3 or clamp$3 or jaw or lock$3))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 20:21
S84	0	S82 not S83	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 20:21

S85	51	S83 not S82	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 20:21
S86	65	F05B2230/80.cpc. and ((shaft or rotor) near15 (brak$3 or clamp$3 or jaw or lock$3))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 21:57
S87	1304	F05B2230/80.cpc. not S86	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 21:57
S88	94	F03D80/50.cpc. and ((shaft) near15 (brak$3 or clamp$3 or jaw))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 22:07
S89	3837	F03D80/50.cpc. not S88	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 22:07
S90	86	F03D13/10.cpc. and ((shaft) near15 (brak$3 or clamp$3 or jaw))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 22:38
S91	149	F03D13/10.cpc. and (rotor near20 (brak$3 or clamp$3 or jaw))	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 22:39
S93	6740	F03D13/10.cpc. not S91	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 22:46
S94	4781	F03D13/10.cpc. not S91 not F03D80/50.cpc. not F05B2230/61.cpc. not F05B2240/60.cpc. not F05B2230/80.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/20 22:47
S95	1	("7759815").PN.	US-PGPUB; USPAT	OR	ON	2018/06/20 23:03
S96	95	Y10S279/903.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 12:01
S98	1889	Y10T279/17752.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 12:01
S99	323	Y10T279/17666.cpc.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 12:01
S100	2	"4660840".pn.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 12:04
S101	3	"6105974".pn.	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 12:20
S102	33	S98 and S99	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 13:06
S103	52	Y10T279/17666.cpc. and (ball or roller)	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 13:13
S104	30	("2666352" | "2778652" | "2788216" | "2811366" | "3020058" | "3090614" | "3215010" | "3248120" | "3606968" | "4155563" | "4222577" | "4431202" | "4513980" | "4536000").PN. OR ("4623157").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/06/21 13:33
S105	9	("1882871" | "1882997" | "2463156" | "2543117").PN. OR ("4671520").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/06/21 13:33
S106	39	S104 or S105	US-PGPUB; USPAT; USOCR	OR	ON	2018/06/21 13:34
S107	52	("3583715" | "3658351").PN. OR ("3788658").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/06/21 14:27
S108	23	("1419786" | "2511930" | "3062104" | "3521526" | "4177701").PN. OR ("4631995").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/06/21 16:15
S109	2	"14056053"	US-PGPUB;	OR	ON	2018/06/21

			USPAT; FPRS			16:16
S110	4	"14056553"	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 16:17
S111	10	("1370705" | "3034631").PN. OR ("4177701").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/06/21 16:27
S112	1	(split near2 bearing) with (jaw and actuat$3)	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 17:48
S113	1272	(bearing) with (jaw and actuat$3)	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 17:49
S114	394	(bearing) with (jaw and actuat$3 and plate)	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 17:49
S115	576	(bearing) with ((jaw or mandrel) and actuat$3 and plate)	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 17:50
S116	1031	(bearing) with ((jaw or mandrel) and (actuat$3 or displac$5) and plate)	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 17:51
S118	62	S116 and (b23b$/$.cpc. or F05B$/$.cpc. or F03D$/$.cpc.)	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 18:00
S119	3	"15517288"	US-PGPUB; USPAT; FPRS	OR	ON	2018/06/21 19:00

EAST Search History (Interference)

< This search history is empty>

6/ 21/ 2018 10:41:47 PM
C:\ Users\ csu\ Documents\ EAST\ Workspaces\ 15517288.wsp

Bibliographic Data

Application No: 15/517,288

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [ ] Yes [✓] No [ ] Met After Allowance

Verified and Acknowledged: /CHWEN-WEI SU/ Examiner's Signature [ ] Initials

Title: MAIN SHAFT FIXTURE

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
04/06/2017	279	3722	400517-20003
RULE			

APPLICANTS

LIFTRA IP APS, Aalborg SV, DENMARK

INVENTORS

Per E. Fenger Terndrup, DENMARK

CONTINUING DATA

This application is a 371 of PCT/DK2015/000040 10/06/2015

FOREIGN APPLICATIONS

DENMARK PA 2014 00573 10/07/2014

DENMARK PA 2015 00527 09/04/2015

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07/14/2017

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STATE OR COUNTRY

DENMARK

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UNITED STATES

FILING FEE RECEIVED

$740

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2017-04-06
First Named Inventor	Per E. Fenger
Art Unit	
Examiner Name	
Attorney Docket Number	400517-20003

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7759815	B2	2010-07-20	Christensen	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	61-54846	JP	A	1986-03-19	Fujimoto	English Abstract attached	
	2	1 617 075	EP	A1	2006-01-18	Albers et al.	English Abstract attached	
	3	10 2006 013 539	DE	A1	2007-09-27	Tirdea	English Abstract attached	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2017-04-06
	First Named Inventor	Per E. Fenger
	Art Unit	
	Examiner Name	
	Attorney Docket Number	400517-20003

	4	2014/103018	WO	A1	2014-07-03	Nishida et al.	English Abstract attached	

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
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EXAMINER SIGNATURE

Examiner Signature	/CHWEN-WEI SU/	Date Considered	06/20/2018

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2017-04-06
First Named Inventor	Per E. Fenger
Art Unit	
Examiner Name	
Attorney Docket Number	400517-20003

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/david s safran/	Date (YYYY-MM-DD)	2017-04-06
Name/Print	David S. Safran	Registration Number	27,997

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15517288	FENGER, PER E.
	Examiner	**Art Unit**
	CHWEN-WEI SU	3722

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/22/2018								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	O								
	12	O								

LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102
Page 149 of 349

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15517288	FENGER, PER E.
	Examiner	Art Unit
	CHWEN-WEI SU	3722

CPC- SEARCHED		
Symbol	Date	Examiner
B23B 31/101, 16; 2260/008, 0082, 0085, 16287; 2215/76; Y10T 279/1986, 19, 3462, 1274, 1291, 17752, 17666, Y10S279/903 ;F05B 2230/61, 2240/60, 2230/80; F03D 80/50, 13/10.	6/21/2018	CS

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
Consulted Eric Gates, CPC searches given	6/14/2018	CS
Inventor search	6/21/2018	CS

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/CHWEN-WEI SU/ Examiner.Art Unit 3722	

LiftWerx Ex. 1006
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/517,288	04/06/2017	Per E. Fenger	400517-20003

CONFIRMATION NO. 1448

25570
Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102

PUBLICATION NOTICE



Title:MAIN SHAFT FIXTURE

Publication No.US-2017-0306930-A1
Publication Date:10/26/2017

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

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LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/517,288	04/06/2017		740	400517-20003	12	1

CONFIRMATION NO. 1448

FILING RECEIPT

25570
Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102



Date Mailed: 07/18/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)
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Applicant(s)
LIFTRA IP APS, Aalborg SV, DENMARK;

Assignment For Published Patent Application
LIFTRA IP APS, Aalborg SV, DENMARK

Power of Attorney: The patent practitioners associated with Customer Number 25570

Domestic Priority data as claimed by applicant
This application is a 371 of PCT/DK2015/000040 10/06/2015

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
DENMARK PA 2014 00573 10/07/2014 No Access Code Provided
DENMARK PA 2015 00527 09/04/2015 No Access Code Provided

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 07/14/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/517,288**

Projected Publication Date: 10/26/2017

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

MAIN SHAFT FIXTURE

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/517,288

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	140		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	240		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	12 minus 20 =	*	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x 210 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	740		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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United States Patent and Trademark Office
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P.O. Box 1450
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www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED INVENTOR	ATTY. DOCKET NO.
15/517,288	Per E. Fenger	400517-20003

25570
Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive
Suite 500
McLean, VA 22102

INTERNATIONAL APPLICATION NO.	
PCT/DK2015/000040	
I.A. FILING DATE	PRIORITY DATE
10/06/2015	10/07/2014

CONFIRMATION NO. 1448
371 ACCEPTANCE LETTER

OC000000092801841

Date Mailed: 07/18/2017

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office, in its capacity as a Designated / Elected Office (37 CFR 1.495), has ACCEPTED the above identified international application for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above. A Filing Receipt will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE "FILING DATE or 371(c) DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1) and (c)(2) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN BELOW.** The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363)

04/06/2017
DATE OF RECEIPT OF 35 U.S.C.
371(c)(1) and (c)(2) REQUIREMENTS

The following items have been received:

- Indication of Small Entity Status
- Copy of the International Application filed on 04/06/2017
- Copy of the International Search Report filed on 04/06/2017
- Preliminary Amendments filed on 04/06/2017
- Information Disclosure Statements filed on 04/06/2017
- Inventor's Oath or Declaration filed on 04/06/2017
- Request for Immediate Examination filed on 04/06/2017
- U.S. Basic National Fees filed on 04/06/2017
- Substitute Specification filed on 04/06/2017
- Authorize Access to Search Results filed on 04/06/2017
- Priority Documents filed on 04/06/2017
- Power of Attorney filed on 04/06/2017
- Authorization to Permit Access filed on 04/06/2017
- Application Data Sheet (37 CFR 1.76) filed on 04/06/2017

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Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

TONI M HOOD

Telephone: (571) 272-3654

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MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
15517288	

Applicant(s) Per Fenger

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	1		1			
2		1		1		
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Total Indep	1		1		0	
Total Depend	12	↵	11	↵	0	↵
Total Claims	13		12		0	

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DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

International application number:		**PCT/DK2015/000040**
International filing date:		**06 October 2015 (06.10.2015)**
Document type:		**Certified copy of priority document**
Document details:	Country/Office:	**DK**
	Number:	**PA 2014 00573**
	Filing date:	**07 October 2014 (07.10.2014)**
Date of receipt at the International Bureau:		**12 October 2015 (12.10.2015)**

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-*bis*)

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Document details: Country/Office: DK
Filing date: 07 Oct 2014 (07.10.2014)
Application number: PA 2014 00573

Date of availability of document: 12 Oct 2015 (12.10.2015)

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Kingdom of Denmark

Patent application No.:	PA 2014 00573
Date of filing:	7 October 2014
Applicant: (Name and address)	LIFTRA IP ApS Karlskogavej 12 DK-9200 Aalborg SV Denmark

Title: Hovedaksel-fikstur til vindmøller

IPC: (I): F 03 D 1/00 (2006.01), F 03 D 11/04 (2006.01)

This is to certify that the attached documents are exact copies of the above mentioned patent application as originally filed.

12 October 2015

Danish Patent and Trademark Office
Ministry of Economic and Business Affairs

General Director Jesper Kongstad

J Kongstad

Den foreliggende opfindelse angår et hovedaksel-fikstur til vindmøller til fiksering af hovedakslen på en vindmølle ved gennemførelse af montage- og reparationsarbejder på tunge dele af vindmøllen arrangeret i nacellen på vindmøller, hvilket fikstur opdelt i et antal sektioner for montering på stabile konstruktionsdele, der forefindes i en vindmølles nacelle, herunder nacellens bundramme.

Ved gennemførelse af montage og reparationsarbejder i nacellen på vindmøller, er der ofte behov for at foretage fiksering af vindmøllens hovedaksel, f.eks. ved skift og servicering af vindmølles gearkasse, generator, eller ved udskiftning af dennes hovedlejer, eller andre tunge konstruktionsdele der forefindes i nacellen på en vindmølle. Nævnte komponenter der er indbyrdes forbundne og forankrede til nacellens bundramme, er i samlet tilstand stabile, men når der skal foretages en adskillelse ved reparation og servicering af møllen, opstår der statisk ustabilitet og ubalance, der kan medføre at møllens konstruktionsdele beskadiges, derfor er der et behov for at fiksere vindmøllens hovedaksel.

Hidtil har det været nødvendigt at standse møllen, dvs. bremse denne af og fiksere rotoren med en rotorlås, og derefter montere et egentligt fikstur til fastholdelse af hovedakslen, hvorefter servicering af komponenterne i vindmøllens nacelle kan finde sted. Imidlertid er det uhensigtsmæssigt at skulle indstille driften af vindmøllen imens montage af hovedaksel-fiksturet finder sted, idet stilstand af vindmøllen i den tid der medgår til montage af fiksturet, medfører et ikke ubetydeligt driftstab i form af manglende produceret energi (strøm). Yderligere er de kendte hovedaksel-fiksturer relativt ufleksible i forhold til akselgeometri, hvilket betyder at der i praksis skal konstrueres og oplagres tilnærmelsesvis lige så mange forskellige fiksturer, som der forekommer forskellige akselgeometrier, hvilket er uhensigtsmæssigt. Desuden er anvendelse af selvophejsende kraner, hvis spil er placeret på jordoverfladen nær møllens tårn under udbredelse, idet anvendelsen heraf rummer store besparelser i omkostningsniveauet til servicering af vindmøller, idet anvendelse af store mobilkraner til håndtering af ovennævnte store og tunge komponenter, overflødiggøres. Dette medfører imidlertid behov for faciliteter til forankring af den selvophejsende kran med det jordbaserede spil i nacellen. Yderligere fordrer det selvophejsende spil dog tilstedeværelse af en letvægtskran, til

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ophejsning af kastetblokke m.m. der skal forankres på/i nacellen eller på vindmøllens vinger, hvilket stiller krav om faciliteter for montage af letvægtskranen.

Det er således opfindelsens formål at angive et hovedaksel-fikstur, der tilgodeser en mere universel anvendelse i forhold til akselgeometri, der endvidere ikke fordrer standsning og fiksering af vindmøllens hovedaksel.

Det er endvidere opfindelsens formål at angive et hovedaksel-fikstur der yderligere frembyder faciliteter for montage af en selvophejsende kran, med et jordbaseret spil.

Det er ved opfindelsen indset, at dette er muligt ved et hovedaksefikstur af den indledningsvist angivne art, som er kendetegnet ved, at hovedaksel-fiksturet omfatter i det mindste tre, fortrinsvist fire, i hovedsagen, omkring hovedakslens centerakse symmetrisk placerede, radialt forskydelige trykdorne, hvis imod hovedakslen vendende ender er forsynede med tryksko, og hvilke trykdorne er forskydelige imellem en passiv, tilbagetrukket position hvor trykskoene er lokaliseret i afstand fra aksel overfladen, og en aktiv fremskudt låsbar position hvor trykskoene er i anlæg med hovedakslen.

Herved opnås en betragtelig fleksibilitet med hensyn til hovedaksel-fiksturets anvendelse til fiksering af hovedaksler med forskellig geometri på vindmøller, idet alene graden af forskydeligheden af trykdornene og størrelsen af hovedaksel-fiksturet er begrænsende for anvendeligheden heraf. Hovedaksel-fiksturet er således både anvendeligt til fiksering af cylinderformede aksler med forskellige diametre, og til fiksering af aksler med konisk facon. Hovedaksel-fiksturet ifølge opfindelsen er flerdelt, og kan monteres på faste konstruktionsdele, fortrinsvist nacellens bundramme, mens vindmøllens rotor er i drift.

I den hensigt at kunne anvende et selvophejsende kran, med et jordbaseret spil sammen med hovedaksel-fiksturet ifølge opfindelsen, kan at dette omfatte monteringsfaciliteter for en selvophesjsende kran, hvis spil er placeret på jordoverfladen nær vindmøllens fod.

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Herved opnås den fordel, at etablering af faciliteter til fiksering af vindmøllens hovedaksel, samt etablering af monteringsfaciliteter for den selvophejsende kran med et jordbaseret spil, finder sted samtidigt, hvilket sparer arbejdsgange, og plads, hvilket er af stor vigtighed, idet pladsforholdene i nacellen i en vindmølle oftest er sparsomme, og yderligere, at såvel hovedaksel-fiksturet som monteringsfaciliteterne for en selvophejsende kran i nacellen, normalt benytter de samme faste konstruktionsdele i nacellen til forankring.

I den hensigt at sikre en let og hurtig etablering af den selvophejsende kran, hvilket fordrer ophejsning af kastetblokke med wirer hidrørende fra det jordbaserede spil med en letvægtskran, der monteres på stabile konstruktionsdele i nacellen, kan hovedaksel-fiksturet omfatte monteringsfaciliteter for en letvægtskran.

I den hensigt at sikre en hurtig fiksering af hovedakslen med hovedaksel-fiksturet ifølge opfindelsen, kan trykdornene være forsynede med aktuatorer for forskydning og fastholdelse af trykskoene i henholdsvis den passive position og den aktive position, alternativt en valgfri position imellem den passive og den aktive position. Herved opnås en tidsbesparelse ved forskydning af trykskoene imellem den passive position og den aktive position, trykket an imod hovedakslens overflade.

I en mere enkel udførelsesform af hovedaksel-fiksturet, ifølge opfindelsen, kan trykdornene udgøres af gevindskårne bolte hvis imod hovedakslen vendende frie ender er forsynede med trykskо, hvilke gevindskårne bolte samvirker med gevindskårne huller i relevante sektioner af fiksturet. Herved kan trykdornene med trykskoene ved manuel drejning af de gevindskårne bolte forskydes imellem den passive position og den aktive position.

I den hensigt at kunne fiksere rotoren på vindmøllen efter denne er bremset op, kan hovedaksel-fiksturet, ifølge opfindelsen omfatte en rotorlås, for fiksering af vindmøllens rotor.

I en foretrukket udførelsesform af rotorlåsen udgøres denne af en flange, hvis boltcirkel geometri modsvarer en boltcirkel geometri på rotoren, hvilken flange

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i enderne er fastgjort til den første ende af to parallelt med hovedakslen og på hver side af denne forløbende, første bjælkeformede konsoller tilhørende hovedaksel fiksturet, hvilke konsollers anden ende er drejeligt lejrede med horisontalt orienterede boltforbindelser, på andre konsoller tilhørende hovedaksel-fiksturet, der er forankrede til nacellens bundramme.

I den hensigt at kunne foretage udskiftning af akslens hovedleje, uden at være nødsaget til at afmontere hovedakslen, kan hovedaksel-fiksturet yderligere omfatte i det mindste en anden aktuator, imellem nacellens bundramme og den imod denne tilvendende side af de første bjælkeformede konsoller og nærmest rotorlåsen, hvilken anden aktuator er forskydelig imellem en første passiv yderposition og en aktiv yderposition hvorved flangeelementet forskydes vertikalt.

Herved opnås det, at hovedakslen kan hæves fra sit leje hængende i rotorlåsen, således at akslens hovedleje kan udskiftes eller serviceres uden at akslen skal fjernes fra nacellen.

Opfindelsen forklares nærmere i det følgende med henvisning til tegningen, hvor;

fig. 1 er et perspektivbillede af dele af en vindmølles nacelle, udvisende nacellens bundramme, vindmøllens hovedaksel, samt et hovedaksel-fikstur ifølge opfindelsen, med en letvægtskran og en selvophejsende kran monteret,

fig. 2 er et mere detaljeret perspektivbillede fra en anden vinkel af det i fig. 1 viste, hvor hovedakslen er gjort transparent, udvisende trykdorne med tryksko, tilhørende hovedaksel-fiksturet ifølge opfindelsen, og

fig. 3 er et mere detaljeret perspektivbillede fra en anden vinkel af det i fig. 1 viste, hvor hovedakslen er gjort transparent, udvisende aktuatorerne for hævning af hovedakslen.

I fig. 1 ses en bundramme 2 i en nacelle (ikke vist) på en vindmølle (ikke vist), hvor vindmøllens hovedaksel 4, med gearkasse 6 og rotoren 8 er vist, og hvor hovedaksel-fiksturet 10 ifølge opfindelsen er vist i monteret tilstand, bærende henholdsvis en letvægtskran 12 og en selvophejsende kran 14, med et jordbaseret spil (ikke vist). Bundrammen 2 er af hensyn til overskueligheden gjort transparent.

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Hovedaksel-fiksturet 10 er i den viste udførelsesform forankret på bundrammen 2 nær gearkassen 6 og nær rotoren 8, og omfatter en flerdelt ramme 14, der sammen med en derpå fastspændt tværdrager 16, omslutter et stykke af hovedakslen 4 imellem rotoren 8 og gearkassen 6. Den flerdelte ramme 14 er forankret på bundrammen 2.

I fig. 2 ses det i fig. 1 viste, men som ende-billede, set fra rotorsiden af akslen 4, og hvor rotoren 8 af hensyn til overskueligheden er gjort transparent. Som det fremgår af fig. 2 omfatter den flerdelte ramme 14 og tværdrageren 16 i alt 4 omkring hovedakslen 2 symmetrisk placerede trykdorne 18, med tryksko 20, der er bragt i anlæg med hovedakslen 4, for fastholdelse af denne.

Trykdornene 18, kan udgøres af hydraulisk drevne stempler hvis frie ender omfatter trykskoene 20.

Som det fremgår af fig. 3, omfatter hovedaksel-fiksturet 10, to parallelt forløbende første dragere 22 på hver side af hovedakslen 4, i hvis første ender, nærmest rotoren 8, er fastgjort rotorlås i form af et flangeelement 24, hvis hulcirkel 26 geometri er ligedannet med hulcirkel 28 geometrien på rotoren 8 over en del af rotorens periferi. Ved låsning af rotoren 8 bringes hullerne 7 i rotoren 8 og hullerne 9 i flangeelementet 24 til overlapning, hvorefter der indføres bolte gennem hullerne, der tilspændes med møtrikker, hvorefter rotoren 8 er fastholdt/låst af flangeelementet 24.

Den anden ende af de parallelt forløbende første dragere 22 er nærmest gearkassen 6 drejeligt forankret på horisontalt orienterede lejebolte 30, på en konsol 32, der er fastgjort til bundrammen 2. De parallelt forløbende første dragere 22 er indbyrdes forbundne med andre tværdragere 34, på hvilke ses konsolfaciliteter 23 for en selv ophejsende kran 14 med et jordbaseret spil (ikke vist).

Som det fremgår af fig. 3 og fig. 1, findes der imellem bundrammen 2 og de paralleltforløbende første dragere 22 en aktuator 36. Aktivering af aktuatoren 36 vil medføre en ændring af afstanden imellem bundrammen 2 og de første dragere 22, i hvilket flangeelementet 24 er ophængt, hvilket vil medføre at flangeelementet 24 og rotoren 8, og dermed hovedakslen 4 hæves, hvilket vil medføre, at det bliver muligt at udskifte hovedakslens leje 38, uden at være nødsaget til at hejse hoved-

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akslen 4 ned på jorden, hvilket er meget besparende, såfremt hovedaksellejet 38 skal repareres eller udskiftes.

I fig. 1 ses endvidere hvorledes hovedaksel-fiksturet 10 omfatter monteringsfaciliteter 40 for letvægtskranen 12.

Opfinderen har erkendt, at hovedaksel-fiksturet 10 kan antage andre udformninger en den foran beskrevne og i figuren viste, men det ændrer ikke på det opfinderiske aspekt der består i at angive et hovedaksel-fikstur 10 af den angivne art, der omfatter justerbare trykdorne 18 med tryksko 20, der medfører at fiksturet 10 bliver anvendeligt uanset geometrien af hovedakslen 4 på en vindmølle, og således, at dette kan monteres uden at fiksere rotoren 8, og yderligere at kombinere hovedaksel-fiksturet med faciliteter (40) montering af henholdsvis en letvægtskran 12, og en selvophejsende kran 14, med et jordbaseret spil, samt en rotorlås 24 og sluttelig at indrette hovedaksel-fiksturet 10 med aktuatorer 36, således at hovedakslen 4 og hovedaksellejet 38 kan hæves tilstrækkeligt fra dettes leje i nacellen til, at lejet kan serviceres eller udskiftes.

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KRAV

1. Hovedaksel-fikstur (10) til fiksering af hovedakslen (4) på en vindmølle ved gennemførelse af montage- og reparationsarbejder på tunge dele af vindmøllen arrangeret i nacellen på vindmøller, hvilket fikstur (10) opdelt i et antal sektioner for montering på stabile konstruktionsdele (2), der forefindes i en vindmølles nacelle, herunder nacellens bundramme (2), k e n d e t e g n e t v e d , at hovedaksel-fiksturet (10) omfatter i det mindste tre, fortrinsvist fire, i hovedsagen, omkring hovedakslens centerakse (11) symmetrisk placerede, radialt forskydelige trykdorne (18), hvis imod hovedakslen (4) vendende ender er forsynede med tryksko (20), og hvilke trykdorne (18) er forskydelige imellem en passiv, tilbagetrukket position hvor trykskoene (20) er lokaliseret i afstand fra hovedakslen (4) overfladen, og en aktiv fremskudt låsbar position hvor trykskoene (20) er i anlæg med hovedakslen (4).

2. Hovedaksel-fikstur (10), ifølge krav 1, k e n d e t e g n e t v e d , at dette omfatter monteringsfaciliteter for en selvophejsende kran (14), hvis spil er placeret på jordoverfladen nær vindmøllens fod.

3. Hovedaksel-fikstur (10), ifølge krav 1 eller 2, k e n d e t e g n e t v e d , at dette omfatter monteringsfaciliteter (40) for en letvægtskran (12).

4. Hovedaksel-fikstur (10), ifølge et hvilket som helst af kravene 1-3, k e n d e t e g n e t v e d , at trykdornene (18) er forsynede med aktuatorer til forskydning og fastholdelse af trykskoene (20) i henholdsvis den passive position og den aktive position, alternativt en valgfri position imellem den passive og den aktive position.

5. Hovedaksel-fikstur (10), ifølge et hvilket som helst af kravene 1-3, k e n d e t e g n e t v e d , at trykdornene (18) udgøres af gevindskårne bolte hvis imod hovedakslen vendende frie ender er forsynede med tryksko (20), hvilke gevindskårne bolte samvirker med gevindskårne huller i relevante sektioner af fiksturet (10).

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6. Hovedaksel-fikstur (10), ifølge et hvilket som helst af kravene 1-5, k e n d e t e g n e t v e d , at dette omfatter en rotorlås (24), for fiksering af vindmøllens rotor (8).

7. Hovedaksel-fikstur (10), ifølge et hvilket som helst af kravene 1-6, k e n d e t e g n e t v e d , at rotorlåsen (24) udgøres af et flangeelement, hvis boltcirkel geometri (26) modsvarer en boltcirkel geometri (28) på rotoren, hvilket flangeelement (24) i enderne er fastgjort til den første ende (21) af to parallelt med hovedaksien og på hver side af denne forløbende, første bjælkeformede konsoller (22) tilhørende hovedaksel fiksturet, hvilke konsollers (22) anden ende (23) er drejeligt lejrede med horisontalt orienterede boltforbindelser (30), på andre konsoller (39) tilhørende hovedaksel-fiksturet (10), der er forankrede på nacellens bundramme (2).

8. Hovedaksel-fikstur (10), ifølge krav 7, k e n d e t e g n e t v e d , at der imellem nacellens bundramme (2) og den imod denne tilvendende side (25) af de første bjælkeformede konsoller (22) og nærmest rotorlåsen (24), findes i det mindste en aktuator (36), hvilken aktuator (36) er forskydelig imellem en første passiv yderposition og en aktiv yderposition hvor flangeelementet (24) forskydes vertikalt.

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Sammendrag

Der angives et hovedaksel-fikstur (10) til fiksering af hovedakslen (4) på en vindmølle ved gennemførelse af montage- og reparationsarbejder på tunge dele af vindmøllen arrangeret i nacellen på vindmøller, hvilket fikstur (10) opdelt i et antal sektioner for montering på stabile konstruktionsdele (2), der forefindes i en vindmølles nacelle, herunder nacellens bundramme (2).

Hovedaksel-fiksturet (10) omfatter justerbare trykdorne (18) med tryksko (20), der medfører at fiksturet 10 bliver anvendeligt uanset geometrien af hovedakslen (4) på en vindmølle, og således, at dette kan monteres uden at fiksere rotoren (8). Hovedaksel-fiksturet (10) omfatter tillige faciliteter (40) montering af henholdsvis en letvægtskran (12), og en selvophejsende kran (14) med et jordbaseret spil, samt en rotorlås (24), der i kombination med til hovedaksel-fiksturet (10) hørende aktuatorer (38) imellem hovedaksel-fiksturet (10) og bundrammen (2), medfører, at det er muligt at forskyde hovedakslen (4) og hovedakselleiet (38) vertikalt fra dettes leje i nacellen til, at lejet kan serviceres eller udskiftes.

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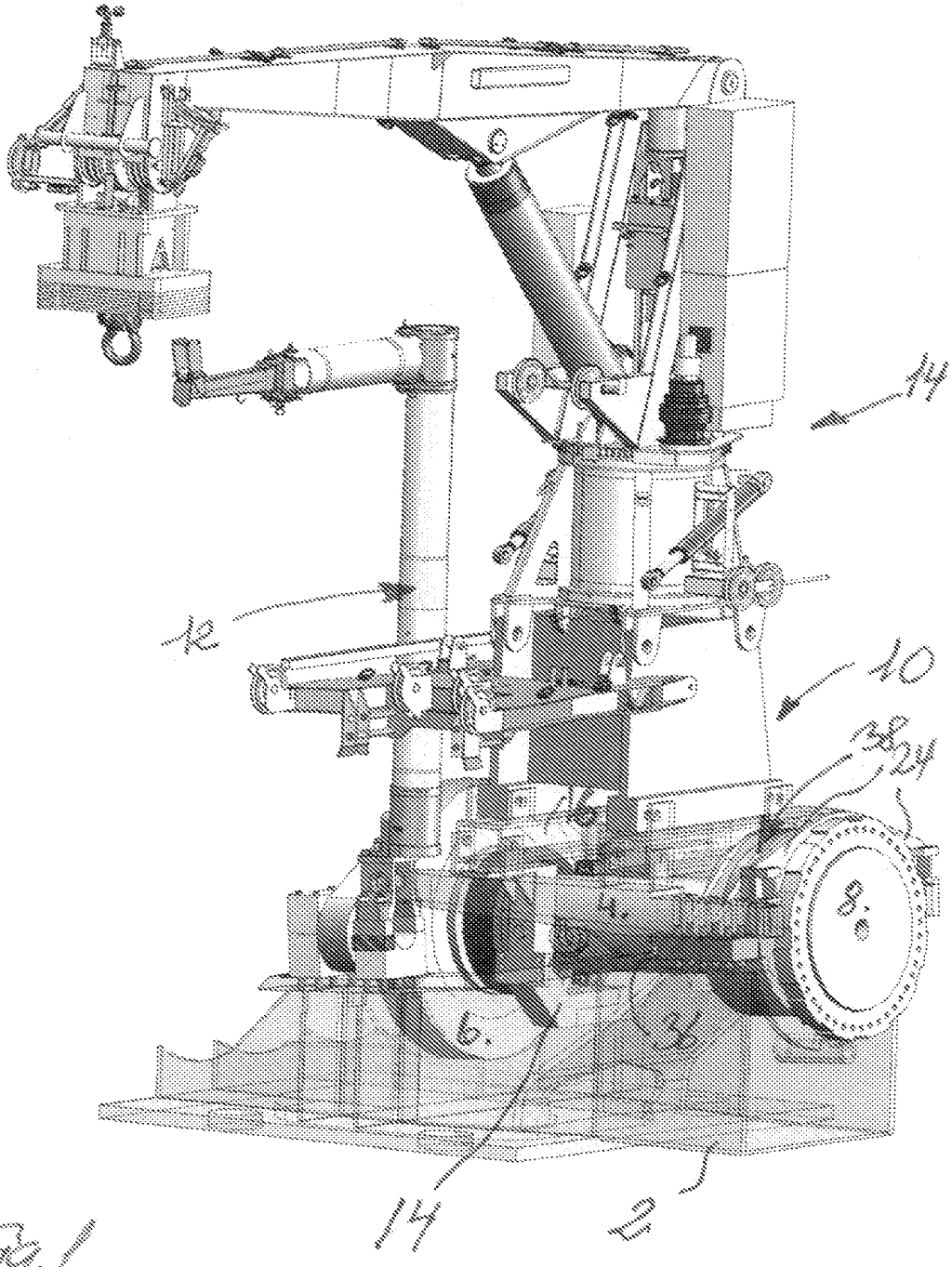


Fig. 1

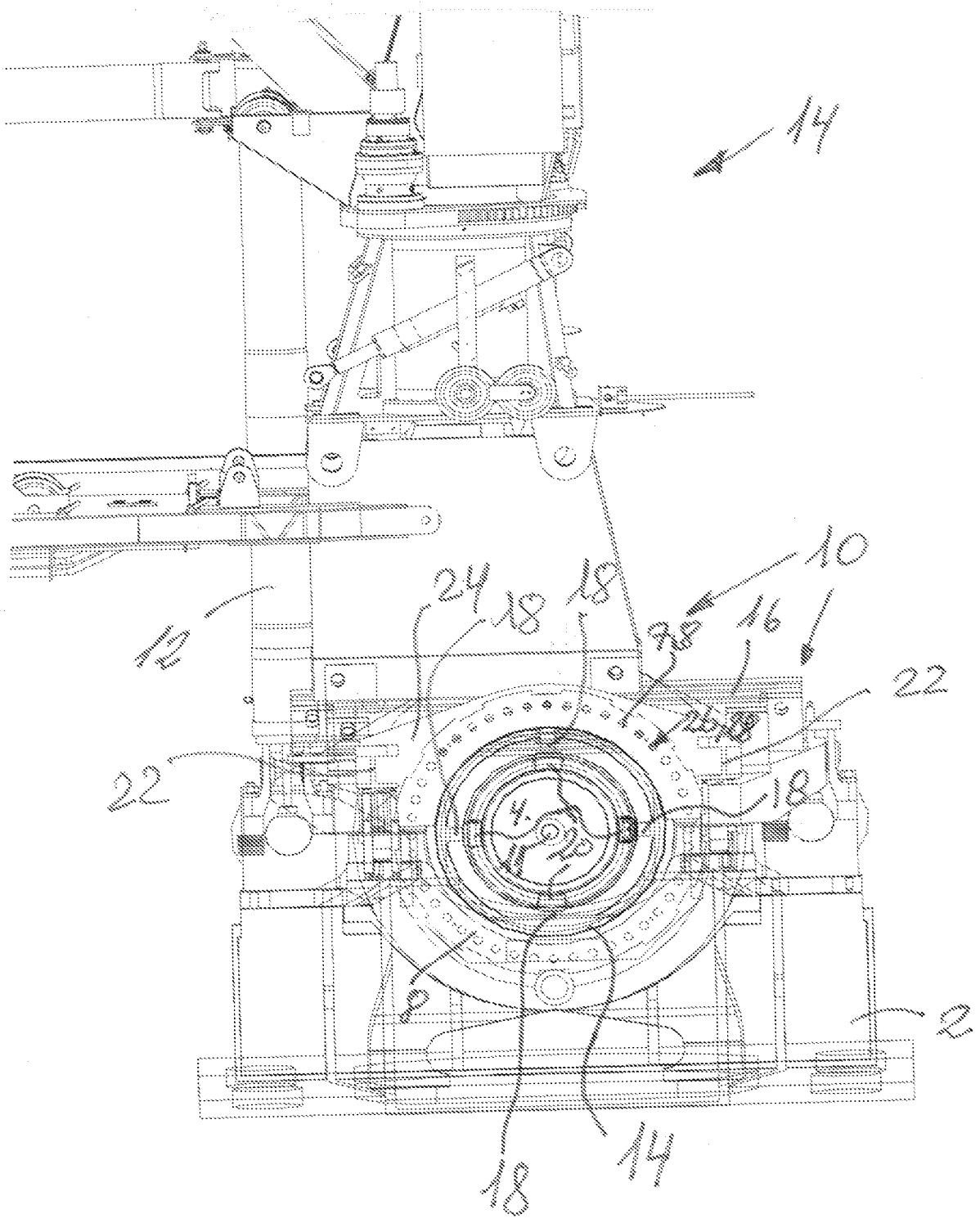


Fig. 2

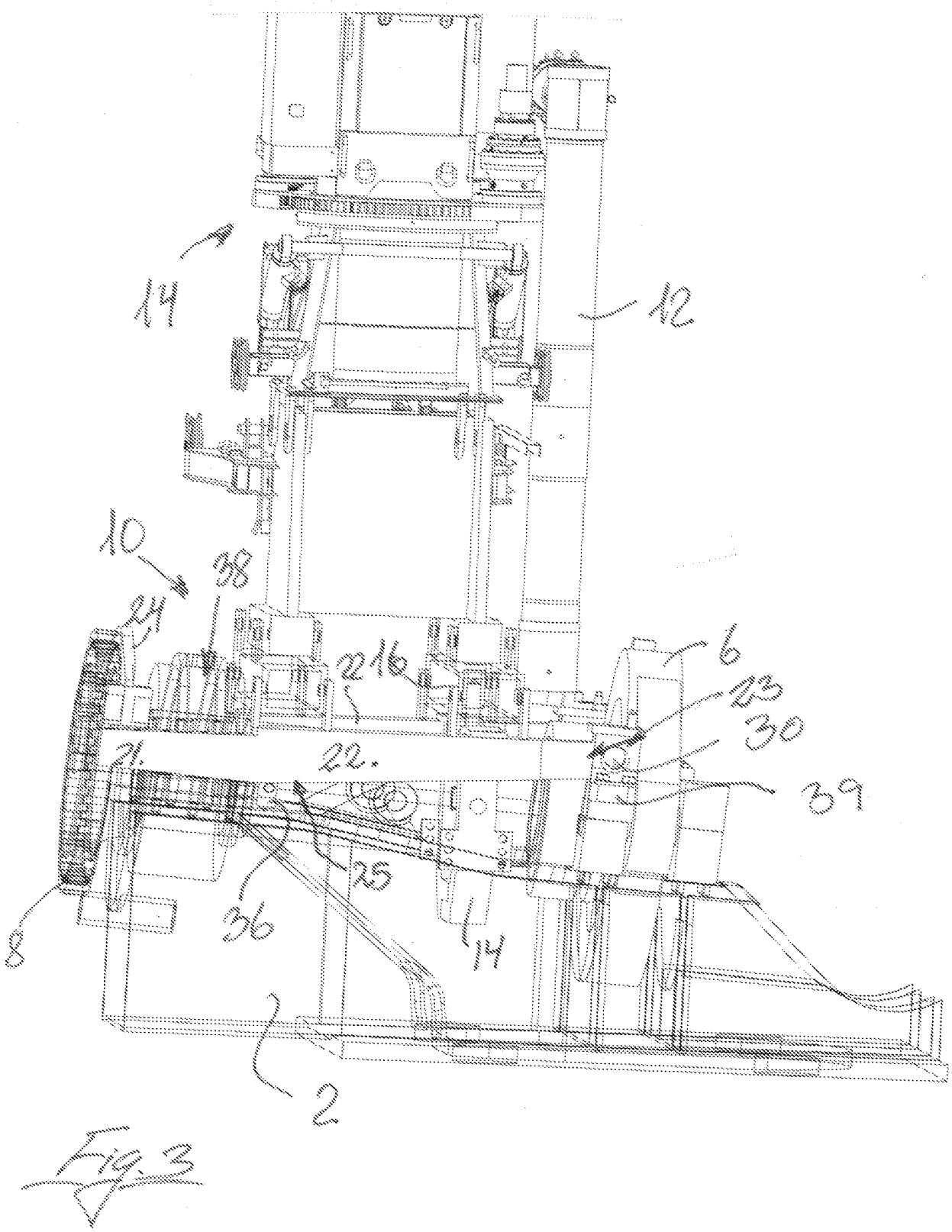


Fig. 3

PTO-1390 (06-13)
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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

Attorney Docket No.	U.S. Application No. (if known, see 37 CFR 1.5)
400517-20003	

International Application No.	International Filing Date	Priority Date Claimed
PCT/DK2015/000040	6 October 2015	7 October 2014; 4 September 2015

Title of Invention
MAIN SHAFT FIXTURE

First Named Inventor
Per E. Fenger

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☑ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received.
2. ☑ A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)).
3. An English language translation of the International Application (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))
   a. ☑ is attached.
   b. ☐ was previously filed in the international phase under PCT Rule 4.17(iv).

Items 5 to 8 below concern amendments made in the international phase.

PCT Article 19 and 34 amendments

5. ☐ Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)).
6. ☐ English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)).
7. ☐ English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).

Cancellation of amendments made in the international phase

8a. ☐ Do not enter the amendment made in the international phase under PCT Article 19.

8b. ☐ Do not enter the amendment made in the international phase under PCT Article 34.

NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).

The following items 9 to 17 concern a document(s) or information included.

9. ☑ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
10. ☑ A preliminary amendment.
11. ☑ An Application Data Sheet under 37 CFR 1.76.
12. ☑ A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b).
13. ☑ A power of attorney and/or change of address letter.
14. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821-1.825.
15. ☐ Assignment papers *(cover sheet and document(s))*. Name of Assignee: _____
16. ☐ 37 CFR 3.73(c) Statement *(when there is an Assignee)*.

This collection of information is required by 37 CFR 1.414 and 1.491-1.492. The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

U.S. APPLN. No. (if known – see 37 CFR 1.5)	INTERNATIONAL APPLICATION No.	ATTORNEY DOCKET No.
	PCT/DK2015/000040	400517-20003

17. [✓] Other items or information:

Mark-up Specification

The following fees have been submitted.	CALCULATIONS	PTO USE ONLY
18. [✓] Basic national fee (37 CFR 1.492(a)) **$280**	$ 280.00	
19. [✓] Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** All other situations **$720**	$ 720.00	
20. [✓] Search fee (37 CFR 1.492(b)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority ..... **$120** International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB ..... **$480** All other situations **$600**	$ 480.00	
TOTAL OF 18, 19, and 20 =	$ 1480.00	
[ ] Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). Fee for each additional 50 sheets of paper or fraction thereof **$400**	0	

Total Sheets	Extra Sheets	Number of each addition 50 or fraction thereof (round **up** to a whole number)	RATE
20 - 100 =	/ 50 =	0	x **$400**

$

Surcharge of **$140.00** for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).	$ 0	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	12 - 20 =	0	x **$80**	$ 0	
Independent claims	1 - 3 =	0	x **$420**	$ 0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$780**	$ 0	
Processing fee of **$140.00** for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)). +				$ 0	
TOTAL OF ABOVE CALCULATIONS =				$ 1480.00	
[✓] **Applicant asserts small entity status.** See 37 CFR 1.27. Fees above are reduced by ½.					
[ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Fees above are reduced by ¾. Applicant must attach form PTO/SB/15A or B or equivalent.					
TOTAL NATIONAL FEE =				$ 740.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property. +				$ 0	
TOTAL FEES ENCLOSED =				$ 740.00	
				Amount to be refunded:	$
				Amount to be charged:	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees.

c. ☑ The Director is hereby authorized to charge additional fees which may be required, or credit any overpayment, to Deposit Account No. 502478(400517-20003) as follows:

i. ☐ any required fee.

ii. ☐ any required fee except for excess claims fees required under 37 CFR 1.492(d) and (e) and multiple dependent claim fee required under 37 CFR 1.492(f).

d. ☑ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038. The PTO-2038 should only be mailed or faxed to the USPTO. However, when paying the basic national fee, the PTO-2038 may NOT be faxed to the USPTO.

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NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File)Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013, and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

NOTE 1: By providing this statement under 37 CFR 1.55 or 1.78, **this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA**.

NOTE 2: A U.S. national stage application may not claim priority to the international application of which it is the national phase. The filing date of a U.S. national stage application is the international filing date. See 35 U.S.C. 363.

Correspondence Address

☑ The address associated with Customer Number: 25570 **OR** ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone			
Email					

Signature		Date	April 6, 2017
Name (Print/Type)	David S. Safran	Registration No. (Attorney/Agent)	27,997

PTO/AIA/14 (11-15)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	400517-20003
	Application Number	
Title of Invention	MAIN SHAFT FIXTURE	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Per	E.	Fenger	

Residence Information (Select One) US Residency ● Non US Residency Active US Military Service

City	Terndrup	Country of Residence i	DK

Mailing Address of Inventor:

Address 1	Flougaardsvej 8		
Address 2			
City	Terndrup	**State/Province**	
Postal Code	9575	**Country** i	DK

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	25570		
Email Address	docketing@rmsc2.com	Add Email	Remove Email

Application Information:

Title of the Invention	MAIN SHAFT FIXTURE		
Attorney Docket Number	400517-20003	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	5	**Suggested Figure for Publication (if any)**	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	400517-20003
	Application Number	
Title of Invention	MAIN SHAFT FIXTURE	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	◯ Limited Recognition (37 CFR 11.9)
Customer Number	25570		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	a 371 of international	PCT/DK2015/000040	2015-10-06

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	400517-20003
	Application Number	
Title of Invention	MAIN SHAFT FIXTURE	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

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Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
PA 2014 00573	DK	2014-10-07	

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Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
PA 2015 00527	DK	2015-09-04	

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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
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Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

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Phone Number		Fax Number	
Email Address			

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Assignee Information including Non-Applicant Assignee Information:

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Organization Name	LIFTRA IP APS

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	Stationsmestervej 81		
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City	Aalborg SV	**State/Province**	
Country i	DK	Postal Code	9200
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Signature	/david s safran/			Date (YYYY-MM-DD)	2017-04-06
First Name	David S.	Last Name	Safran	Registration Number	27,997

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~~TITLE:~~ MAIN SHAFT FIXTURE

Background of the Invention

Field of the Invention

[0001] The present invention relates to a main shaft fixture for the fixing of a main shaft on a wind turbine during the execution of installation and repair work in heavy parts of a wind turbine arranged in a nacelle on wind turbines, with the fixture being divided up into a number of sections for installation on stable structural parts in a nacelle in a wind turbine, including the nacelle's bottom frame.

Description of Related Art

[0002] During ~~the execution of~~ installation and repair work on the nacelle of wind turbines there is often a need to perform fixing of the ~~wind turbine's~~ main shaft of the wind turbine, for example, with the replacement and servicing of a wind ~~turbine's~~turbine gear box, generator or with the replacement of its main bearing, or other heavy structural parts present in the nacelle of ~~a~~the wind turbine. The stated components, which are mutually conjoined and anchored to the nacelle's bottom frame, are stable in an assembled state, but when separation needs to be undertaken during repairs and servicing of the turbine, static instability and imbalance arises, which can lead to the turbine's structural parts being damaged, ~~hence~~so that there is a need to fix the wind ~~turbine's~~turbine main shaft.

[0003] German Patent Application DE 102006013539 A1 (NORDEX ENERGY GMBH) discloses a main shaft fixture for fixing the main shaft on a wind turbine during the execution of installation and repair work on heavy parts that are arranged in the nacelle on wind turbines, with the fixture being divided up into a number of sections for installation on stable structural parts that are found on a wind ~~turbine's~~turbine nacelle, including the ~~nacelle's~~ bottom frame of the nacelle.

[0004] Up to now it has been necessary to halt the turbine, i.e., brake it and fix the rotor with a rotor lock, and then mount an actual fixture to firmly hold the main shaft, subsequent to

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which servicing of the components in the wind ~~turbine's~~turbine nacelle is able to take place. However, it is inappropriate to have to halt the operation of the wind turbine while the mounting of the main shaft fixture is taking place, as the standstill of the wind turbine during the time that is spent to install the fixture involves a not insignificant operating loss in the form of a lack of energy produced (power). Furthermore, the known main shaft fixtures are relatively inflexible in relation to shaft geometry, which means that in practice nearly just as many different fixtures need to be built and stored as there are shaft geometries that exist, which is inappropriate. In addition, the use of self-hoisting cranes, whose winches are placed on the ground surface near the turbine's tower, is increasing, because the use of such involves large savings in the level of expenses for servicing of wind turbines since the use of large mobile cranes for handling the above-mentioned large and heavy components is made superfluous. This causes however a need for facilities for anchoring the self-hoisting crane with the ground-based winch in the nacelle. However, the self-hoisting winch requires furthermore the presence of a lightweight crane, for the hoisting of snatch blocks, etc., that are to be anchored on/in the nacelle or on the blades of the wind turbine, which poses requirements concerning the facilities for mounting the lightweight crane.

[0005] In the event of servicing in particular large wind turbines, it may however be inappropriate to block the main shaft's rotation with an actual rotor lock, but rather be appropriate to simply retain the shaft in position and permit a certain rotation of the shaft, which is possible by turning the blades/nacelle out of the wind so that the shaft via the effects of the wind on the blades only rotates very slowly, or not at all, whereby it is acceptable in terms of safety, to perform service work in the nacelle of the wind turbine concerned.

Summary of the Invention

[0006] ~~It~~ Thus, it is the purpose of the invention to specify a main shaft fixture that provide a more universal application in relation to shaft geometry, which moreover does not require halting and fixing of the wind ~~turbine's~~turbine main shaft, but which may however comprise the means for such.

[0007] It is further the purpose of the invention to provide a main shaft fixture that in addition offers facilities for the mounting of a self-hoisting crane, with a ground-based winch.

[0008] It is by the invention realized that this is possible by a main shaft fixture of the nature specified in the introduction, which is characterised by that the main shaft fixture comprises at least three radial displaceable pressure mandrels, substantially symmetrical located around the centre axis of the main shaft, the ends of said pressure mandrels facing the main shaft are furnished with a tap shoe, and said pressure mandrels being displaceable between a passive, withdrawn lockable position where the tap shoes are configured to be located at a distance from the surface of the main shaft and an advanced lockable position where the tap shoes are configured to be engaged with the main shaft.

[0009] Considerable flexibility is hereby attained with respect to the main shaft fixture's use for the fixing of main shafts with different geometries on wind turbines, since solely the degree of ~~movability~~mobility of the pressure mandrels and the size of the main shaft fixture pose limiting factors for the usability of such. The main shaft fixture is thus both usable for fixing of cylinder-shaped shafts with different diameters and for the fixing of shafts with conical shapes. The main shaft fixture according to the invention is multi-part, and may be mounted on permanent structural parts, preferably the bottom frame of the nacelle, while the rotor of the wind turbine is in operation.

[0010] With the intent of being able to use a self-hoisting crane with a ground-based winch together with the main shaft fixture according to the invention, it may comprise mounting facilities for a self-hoisting crane whose winch is placed on the ground surface ground near the foot of the wind turbine.

[0011] The advance thereof is that the establishment of facilities for the fixing of the wind turbine's main shaft, as well as the establishment of mounting facilities for the self-hoisting crane with a ground-based winch, take place simultaneously, which saves work processes, and space, which are of great importance, as the space in the nacelle in a wind turbine are most often narrow, and furthermore the main shaft fixture as well as the mounting

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facilities for a self-hoisting crane in the nacelle normally utilise the same permanent structural parts in the nacelle for anchoring.

[0012] With the intent of ensuring easy and rapid establishment of the self-hoisting crane, which requires the hoisting of snatch blocks with wires originating from the ground-based winch with a lightweight crane which is mounted on stable structural parts in the nacelle, the main shaft fixture may comprise mounting facilities for a lightweight crane.

[0013] For the purpose of securing the rapid fixing of the main shaft using the main shaft fixture according to the invention, the pressure mandrels may be provided with actuators for displacing and retaining the tap shoes in the passive position and the active position, respectively, alternatively in a selectable position between the passive and the active position.

[0014] Time is thereby saved in the displacement of the tap shoes between the passive position, and the active position pressed against the main shaft's surface.

[0015] In a more simple form of embodiment of the main shaft fixture according to the invention, the pressure mandrels may be comprised of threaded bolts whose free ends facing the main shaft are furnished with tap shoes, where the threaded bolts work together with threaded holes in relevant sections of the fixture. The pressure mandrels with the tap shoes are hereby displaced by manual turning of the threaded bolts between the passive position and the active position.

[0016] With the intent of being able to permit rotation of the main shaft during performance of servicing of a relevant wind turbine and in order to protect the main shaft and the main shaft fixture, a slide lining may exist between the opposing sides of the main shaft's surface and the tap shoes.

[0017] This enables the main shaft to be fixed in its position by the main shaft fixture, but with the main shaft being permitted to rotate without it being damaged due to the presence of the slide lining.

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[0018] In a first embodiment of the slide lining, this could ~~consist of~~comprise the free ends of tap shoes facing against the main shaft being furnished with slide plates, which in the active extended position are engaged with the main shaft.

[0019] In a further embodiment, the main shaft fixture may according to the invention comprise a multi-part slide plate working in conjunction with the main shaft to be mounted on the main shaft, where the multi-part slide plate in its mounted state on the main shaft cooperates with the tap shoes.

[0020] This enables the tap shoes on the main shaft fixture's pressure mandrel to slide directly on the multi-part slide plate, in the event of a possible rotation of the main shaft caused by the effects of wind on the blades. The tap shoes on the main shaft fixture's pressure mandrels may cooperate with the multi-part slide plate on the main shaft, with or without slideway linings on the opposing sides of the tap shoes facing the main shaft.

[0021] In a further embodiment of the main shaft fixture as per the invention, it may comprise a multi-part needle bearing, roller bearing, ball bearing, consisting of a, multi-part inner ring, fastened on the main shaft, and a therewith cooperating multi-part outer ring consisting a number of bowed sub segments according to the number of tap shoes mounted on the opposing side of the tap shoes facing the multi-part inner ring, which in the advanced active position of the pressure mandrels form the outer ring at a distance from the external periphery of the multi-part inner ring, and where a suitable number of needle rollers, rollers or balls are placed between the inner ring and outer ring, and where means are present for retaining the needles, rollers, or balls in position between the inner ring and outer ring.

[0022] An actual temporary bearing connection is hereby formed between the main shaft fixture and the main shaft, about which the main shaft is able to rotate.

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[0023] With the intent of being able to fix the rotor on the wind turbine after it has been braked to a stop, the main shaft fixture according to the invention, may comprise a rotor lock, for fixing the wind ~~turbine's~~turbine rotor.

[0024] In a preferred embodiment of the rotor lock, it is comprised of a flange, whose bolt circle geometry corresponds to a bolt circle geometry on the rotor, said flange element being fastened at the ends to the first end of two first beam-shaped brackets extending parallel with, and on each side of the main shaft, said beam shaped brackets belonging to the main shaft fixture, and where the other end of the brackets are pivotally mounted with horizontally oriented bolt connections, on other brackets belonging to the main shaft fixture, which are anchored on the bottom frame of the nacelle.

[0025] It is hereby achieved that the rotor can be fixed by introducing a bolt through one or more of the overlapping holes in the bolt circles on the flange fastened to the bottom frame and the bolt circle on the rotor, respectively.

[0026] With the intent of being able to perform replacement of the shaft's main bearing, without being forced to dismount the main shaft, the main shaft fixture may furthermore comprise at least a second actuator, between the nacelle's bottom frame and the opposing side of the first beam-shaped brackets facing such and the nearest rotor lock, where the other actuator is movable between a first passive outer position and an active outer position whereby the flange element is moved vertically.

[0027] This enables the main shaft to be able to be raised from its bearing hanging in the rotor lock, such that the main bearing of the shaft can be replaced or serviced without the necessity of removing the shaft from the nacelle.

[0028] The invention is explained in further detail in the following with reference to the ~~drawing, wherein;~~accompanying drawings.

Brief Description of the Drawings

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[0029] Fig. 1 is a perspective view of parts of a wind ~~turbine's~~turbine nacelle, presenting the ~~nacelle's~~nacelle bottom frame, the wind ~~turbine's~~turbine main shaft, and a main shaft fixture according to the invention, with a lightweight crane and a self-hoisting crane mounted,

[0030] Fig. 2 is a more detailed perspective view from another angle of what is shown in Fig. 1, where the main shaft is made transparent, presenting the pressure mandrel with tap shoe belonging to the main shaft fixture according to the invention,

[0031] Fig. 3 is a more detailed perspective view from another angle of what is shown in Fig. 1, presenting the actuators for raising the main shaft, where the main shaft is made transparent,

[0032] Fig. 4 is a detailed perspective view of the main shaft fixture for a wind turbine, where the tap shoes and the main shaft are furnished with slide plates, and

[0033] Fig. 5 is a detailed perspective view or the main shaft fixture for a wind turbine, where the slide plates are replaced by a multi-part needle bearing/roller bearing/ball bearing ~~consisting~~formed of a multi-part inner ring fastened to the main shaft and a therewith cooperating multi-part outer ring consisting of bowed ~~subsegments~~sub-segments of the number of tap shoes mounted on the opposing side of the tap shoes facing the inner ring.

Detailed Description of the Invention

[0034] ~~In~~ Fig. 1 shows a bottom frame 2 ~~is seen~~ in a nacelle (not shown) on a wind turbine (not shown), where the main shaft 4 of the turbine, with a gear box 6 and ~~the~~a rotor 8 ~~are shown~~, and where the main shaft fixture 10 according to the invention is shown in the mounted state, bearing a lightweight crane 12 and a self-hoisting crane 14 with a ground-based winch (not shown), respectively. The bottom frame 2 has for reasons of clarity been made transparent.

[0035] In the illustrated embodiment, the main shaft fixture 10 is ~~in the shown embodiment shown~~ anchored to the bottom frame 2 near the gear box 6 and near the rotor 8, and comprises a multi-part frame 14, which together with a cross member 16 fastened on it encloses a part of the main shaft 4 between the rotor 8 and the gear box 6. The multi-part frame 14 is anchored on the bottom frame 2.

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[0036] ~~In~~ Fig. 2 ~~is shown~~shows what ~~are~~is seen in Fig. 1, but ~~as~~in an end ~~picture~~view, seen from the rotor side of the shaft 4, and where the rotor 8 for reasons of clarity has been made transparent. As it appears from Fig. 2, the multi-part frame 14 and cross member 16 comprise in total four pressure mandrels 18 symmetrically placed around the main shaft 2, with tap shoes 20~~,~~ that are engaged onto the main shaft 4 in order to fix ~~such~~it in place.

[0037] The pressure mandrels 18 may be comprised of hydraulically driven pistons whose free ends comprise the tap shoes 20, but may also be executed in other manners, where they are moved manually between the active position where the tap shoes 20 are engaged with the main shaft 4 and the passive, withdrawn position.

[0038] As it appears from Fig. 3, the main shaft fixture 10 comprises two parallel passing first beams 22, one on each side of the main shaft 4~~,~~. In ~~the~~ first ends of ~~which,~~each first beam 22 nearest to the rotor 8, a rotor lock is fastened in the form of a flange element 24, the hole circle ~~26~~ geometry 26 of which is similar to the hole circle ~~28~~ geometry ~~on~~28 of the rotor 8 over ~~a~~ part of the periphery of the rotor. For locking of the rotor 8, the holes 7 in the rotor 8 and the holes 9 in the flange element 24 are brought to overlap, and subsequently, bolts are inserted through the overlapping holes, which are tightened with nuts, after which the rotor 8 is fixed/locked by the flange element 24.

[0039] The other end of the parallel passing first beams 22 ~~are~~(that nearest to the gear box 6) are pivotally anchored on horizontally oriented bearing bolt 30, on a bracket 32, which is fastened to the bottom frame 2. The parallel passing first beams 22 are mutually connected with second cross members 34, on which bracket facilities 23 are seen for a self-hoisting crane 14 with a ground-based winch (not shown).

[0040] As it appears in ~~fig. 3 and fig~~Figs. 1 ~~show~~& 3, an actuator 36 is located between the bottom frame 2 and the parallel passing first beams 22. Activation of the actuator 36 will result in a change of the distance between the bottom frame 2 and the first beams 22, in which the flange element 24 is suspended, which will cause the flange element 24 and the rotor 8 and thereby the main shaft 4 to be raised, which will result in the possibility to replace the

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main shaft's bearing 38 without the necessity of hoisting the main shaft 4 down to the ground, which is quite time-saving when the main shaft bearing 38 has to be repaired or replaced.

[0041] In Fig. 1, it is moreover shown how the main shaft fixture 10 comprises mounting facilities 40 for the lightweight crane 12.

[0042] ~~In~~ Fig. 4 ~~is shown~~shows an embodiment of the main shaft fixture according to the invention, which is specially suited for use for fixing the wind ~~turbine's~~turbine main shaft 4 in position on the nacelle, but where rotation of the main shaft 4 is possible, in the active position of the pressure mandrels/tap shoes (18, 20), engaged with the main shaft.

[0043] As shown in Fig. 4, a slideway lining 42, 44 is located between the opposing sides of the tap shoes 20 facing the surface of the main shaft 4.

[0044] The slideway may be comprised of slide plates 42 that are fastened to the opposing free ends of the tap shoes 20 facing the main shaft 4, which in their active advanced position are engaged with the main shaft 4, but which alternatively may comprise a multi-part slide plate 44 cooperative working with the main shaft 4, for mounting on the main shaft 4, said multi-part slide plate 44 in its mounted state on the main shaft 4 cooperates with the tap shoes 20. It must be stated that the presence of the multi-part slide plate 44 on the main shaft 4 does not necessarily exclude the presence of the slide plates 42 and the tap shoes 20.

[0045] In a further embodiment, the main shaft fixture 10 ~~consists~~is comprised of a multi-part needle bearing/roller bearing/ball bearing 46, ~~comprised~~formed of a multi-part inner ring 48 fastened on the main shaft as well as, a cooperating multi-part outer ring 50 ~~consisting~~formed of bowed ~~subsegments~~sub-segments 52 ~~of~~equal to the number of tap shoes mounted on the opposing side of the tap shoes 20 facing the inner ring 48, which in the advanced position of the pressure mandrels form the outer ring 50 at a distance from the outer periphery of the multi-part inner ring 48, and where an appropriate number of needle rollers, rollers, or balls 54 (in the shown embodiment rollers 54) are arranged between the inner ring 48

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and the outer ring 50, and where means (not shown) are present for retaining the needles/rollers or balls (54) in position between the inner ring 48 and outer ring 50.

[0046] The means mentioned for fastening of needle rollers/rollers/balls 54 may ~~consist~~be formed of cooperating edge delineators in opposing sides of the inner ring 48 and the outer ring 50, alternatively ~~of~~as a means ~~of~~for holding between which the needle rollers/rollers/balls 54 are fastened.

[0047] The presence of the slide lining 42, 44, alternatively the multi-part needle bearing, roller bearing, ball bearing 46, involves the main shaft 4 being permitted to rotate simultaneously with it being fixed in its position during servicing of the wind turbine, which can serve a purpose namely for larger wind turbines.

[0048] The inventor has recognised that the main shaft fixture 10 can assume other embodiments than disclosed in the preceding and shown in the figures, however such do not change the inventive aspect that ~~consists~~is comprised of specifying a main shaft fixture 10 of the given type that comprises adjustable pressure mandrels 18 with tap shoes 20, which causes the fixture 10 to be usable regardless of the geometry of the main shaft 4 on a wind turbine, and thus that such can be mounted without fixing the rotor 8 in place, and furthermore of combining the main shaft fixture with facilities 40 for mounting of a lightweight crane 12 and a self-hoisting crane 14 with a ground-based winch, respectively, as well as a rotor lock 24 and finally of furnishing the main shaft fixture 10 with actuators 36, enabling the main shaft 4 and the main shaft bearing 38 to be raised sufficiently from its bearing in the nacelle that it can be serviced or replaced.

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What is claimed is:

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CLAIMS

1. Main shaft fixture (10) for fixation of a main shaft (4) on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture (10) is divided up into a number of sections for mounting on stable structural parts (2) structural parts in a nacelle in a wind turbine, including the bottom frame (2) of the nacelle, c h a r a c t e r i s e d i n , that the main shaft fixture (10) comprises at least three radial displaceable pressure mandrels (18), substantially symmetrical located around the centre axis (11) of the main shaft, the ends of said pressure mandrels (18) facing the main shaft (4) are furnished with a tap shoe (20), and said pressure mandrels (18) being displaceable between a passive, withdrawn lockable position where the tap shoes (20) are configured to be located at a distance from the surface of the main shaft (4) and an advanced lockable position where the tap shoes (20) are configured to be engaged with the main shaft (4).

2. Main shaft fixture (10), according to claim 1, c h a r a c t e r i s e d i n , that it comprises mounting facilities for a self-hoisting crane (14), the winch of which is located on the ground surface near the foot of the wind turbine.

3. Main shaft fixture (10), according to claim 1 or 2, c h a r a c t e r i s e d i n , that it comprises mounting facilities (40) for a lightweight crane (12).

4. Main shaft fixture (10), according to any one of the claims 1-3, c h a r a c t e r i s e d i n , that the pressure mandrels (18) is provided with actuators for displacing and retaining the tap shoes (20) in the passive position and the active position, respectively, alternatively in a selectable position between the passive and the active position.

5. Main shaft fixture (10), according to any one of the claims 1-3, c h a r a c t e r i s e d i n , that the pressure mandrels (18) consists of threaded bolts whose opposing free ends facing the main shaft are furnished with tap shoes (20), and said threaded bolts cooperates with threaded holes in relevant sections of the fixture (10).

6. Main shaft fixture (10), according to any one of the claims 1-5, characterised by a slideway lining (42, 44) being located between the opposing sides of the surface of the main shaft and tap shoes.

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7. Main shaft fixture (10) according to claim 6, characterised in, that the slideway lining is configured so that of the opposing free ends of the tap shoes (20) facing the main shaft (4) are provided with a slide plate (42) which in the active advanced position is engaged with the main shaft (4).

8. Main shaft fixture (10) according to claim 6 or 7, characterised in, that it comprises a multi-part slide plate (44) cooperating with the main shaft (4) for mounting on the main shaft (4), where the multi-part slide plate (44) in its mounted position on the main shaft (4) is cooperating with the tap shoes (20).

9. Main shaft fixture (10) according to any one of the claims 1-5, characterised in, that it comprises a multi-part needle bearing, roller bearing, ball bearing (46) consisting of a multi-part inner ring (48) fastened to the main shaft (4), and a therewith cooperating multi-part outer ring (50) consisting of bowed subsegments (52) corresponding to the number of tap shoes, mounted on the opposing side of the tap shoes (20) facing the inner ring (48), which in the advanced active position of the pressure mandrels form the outer ring (50) at a distance from the outer periphery of the multi-part inner ring (48), and where an appropriate number of needle rollers, rollers, or balls (54) are arranged between the inner ring (48) and the outer ring (50), and where means are present for retaining the needles, rollers, or balls (54) in position between the inner ring (48) and outer ring (50).

10. Main shaft fixture (10), according to any one of the claims 1-9, characterised in, that it comprises a rotor lock (24) for fixation of the rotor (8) of the wind turbine.

11. Main shaft fixture (10), according to claim 10, characterised in, that the rotor lock (24) consists of a flange element, whose bolt circle geometry (26) corresponds to a bolt circle geometry (28) on the rotor, said flange element (24) being fastened at the ends to the first end (21) of two first beam-shaped brackets (22) extending parallel with, and on each side of the main shaft, said beam shaped

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brackets (22) belonging to the main shaft fixture, and where the other end (23) of the brackets (22) are pivotally mounted with horizontally oriented bolt connections (30), on other brackets (39) belonging to the main shaft fixture (10), which are anchored on the bottom frame (2) of the nacelle.

12. Main shaft fixture (10), according to claim 11, c h a r a c t e r i s e d i n , that at least one actuator (36) is located nearest the rotor lock (24) between the bottom frame (2) of the nacelle and the adjacent side (25) of the first beam-shaped brackets (22) facing the bottom frame (2), said actuator (36) is displaceable between a first passive outer position and an active outer position where the flange element (24) is displaced vertically.

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Abstract.

A main shaft fixture ~~(10) is disclosed~~ for fixing ~~in place~~ a main shaft ~~(4)~~ on a wind turbine during ~~execution of~~ installation and repair work on ~~the~~ heavy parts of the wind turbine ~~arranged~~nacelle, in the ~~nacelle of wind turbines,~~case where the fixture ~~(10)~~ is ~~divided up into a number of~~formed of several sections for mounting on stable structural parts ~~(2) that are found~~ in ~~a wind turbine's~~the nacelle, including the nacelle's bottom frame ~~(2)~~. The main shaft fixture ~~(10) comprises~~has adjustable pressure mandrels ~~(18)~~ with tap shoes ~~(20)~~, which cause the fixture ~~10~~ to be usable regardless of the ~~geometry of the~~turbine main shaft ~~(4) on a wind turbine, and~~geometry, such that it can be mounted without fixing the rotor ~~(8)~~. The main shaft fixture ~~(10)~~ also ~~comprises~~has facilities ~~(40)~~ for ~~the~~ mounting of a lightweight crane ~~(12)~~ and a self-hoisting crane ~~(14)~~ with a ground-based winch, respectively, as well as a rotor lock ~~(24),~~ which, in combination with ~~the~~ actuators ~~(36) belonging to main shaft fixture (10) between~~of the main shaft fixture ~~(10) and the bottom frame (2) makes it possible to displace~~, enables the main shaft ~~(4)~~ and the main shaft bearing ~~(38)~~to be sufficiently displaced vertically from its bearing in the nacelle ~~sufficiently~~ to service or replace the bearing.

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Abstract.

A main shaft fixture for fixing a main shaft on a wind turbine during installation and repair work on heavy parts of the wind turbine nacelle, in the case where the fixture is formed of several sections for mounting on stable structural parts in the nacelle, including the nacelle's bottom frame. The main shaft fixture has adjustable pressure mandrels with tap shoes, which cause the fixture to be usable regardless of the turbine main shaft geometry, such that it can be mounted without fixing the rotor. The main shaft fixture also has facilities for mounting of a lightweight crane and a self-hoisting crane with a ground-based winch, respectively, as well as a rotor lock which, in combination with actuators of the main shaft fixture, enables the main shaft and the main shaft bearing to be sufficiently displaced vertically from its bearing in the nacelle to service or replace the bearing.

What is claimed is:

MAIN SHAFT FIXTURE

Background of the Invention

Field of the Invention

[0001] The present invention relates to a main shaft fixture for the fixing of a main shaft on a wind turbine during the execution of installation and repair work in heavy parts of a wind turbine arranged in a nacelle on wind turbines, with the fixture being divided up into a number of sections for installation on stable structural parts in a nacelle in a wind turbine, including the nacelle's bottom frame.

Description of Related Art

[0002] During installation and repair work on the nacelle of wind turbines there is often a need to perform fixing of the main shaft of the wind turbine, for example, with the replacement and servicing of a wind turbine gear box, generator or with the replacement of its main bearing, or other heavy structural parts present in the nacelle of the wind turbine. The stated components, which are mutually conjoined and anchored to the nacelle's bottom frame, are stable in an assembled state, but when separation needs to be undertaken during repairs and servicing of the turbine, static instability and imbalance arises, which can lead to the turbine's structural parts being damaged, so that there is a need to fix the wind turbine main shaft.

[0003] German Patent Application DE 102006013539 A1 (NORDEX ENERGY GMBH) discloses a main shaft fixture for fixing the main shaft on a wind turbine during the execution of installation and repair work on heavy parts that are arranged in the nacelle on wind turbines, with the fixture being divided up into a number of sections for installation on stable structural parts that are found on a wind turbine nacelle, including the bottom frame of the nacelle.

[0004] Up to now it has been necessary to halt the turbine, i.e., brake it and fix the rotor with a rotor lock, and then mount an actual fixture to firmly hold the main shaft, subsequent to which servicing of the components in the wind turbine nacelle is able to take place. However, it is inappropriate to have to halt the operation of the wind turbine while the

mounting of the main shaft fixture is taking place, as the standstill of the wind turbine during the time that is spent to install the fixture involves a not insignificant operating loss in the form of a lack of energy produced (power). Furthermore, the known main shaft fixtures are relatively inflexible in relation to shaft geometry, which means that in practice nearly just as many different fixtures need to be built and stored as there are shaft geometries that exist, which is inappropriate. In addition, the use of self-hoisting cranes, whose winches are placed on the ground surface near the turbine's tower, is increasing, because the use of such involves large savings in the level of expenses for servicing of wind turbines since the use of large mobile cranes for handling the above-mentioned large and heavy components is made superfluous. This causes however a need for facilities for anchoring the self-hoisting crane with the ground-based winch in the nacelle. However, the self-hoisting winch requires furthermore the presence of a lightweight crane, for the hoisting of snatch blocks, etc., that are to be anchored on/in the nacelle or on the blades of the wind turbine, which poses requirements concerning the facilities for mounting the lightweight crane.

[0005] In the event of servicing in particular large wind turbines, it may however be inappropriate to block the main shaft's rotation with an actual rotor lock, but rather be appropriate to simply retain the shaft in position and permit a certain rotation of the shaft, which is possible by turning the blades/nacelle out of the wind so that the shaft via the effects of the wind on the blades only rotates very slowly, or not at all, whereby it is acceptable in terms of safety, to perform service work in the nacelle of the wind turbine concerned.

Summary of the Invention

[0006] Thus, it is the purpose of the invention to specify a main shaft fixture that provide a more universal application in relation to shaft geometry, which moreover does not require halting and fixing of the wind turbine main shaft, but which may however comprise the means for such.

[0007] It is further the purpose of the invention to provide a main shaft fixture that in addition offers facilities for the mounting of a self-hoisting crane, with a ground-based winch.

[0008] It is by the invention realized that this is possible by a main shaft fixture of the nature specified in the introduction, which is characterised by that the main shaft fixture comprises at least three radial displaceable pressure mandrels, substantially symmetrical

located around the centre axis of the main shaft, the ends of said pressure mandrels facing the main shaft are furnished with a tap shoe, and said pressure mandrels being displaceable between a passive, withdrawn lockable position where the tap shoes are configured to be located at a distance from the surface of the main shaft and an advanced lockable position where the tap shoes are configured to be engaged with the main shaft.

[0009] Considerable flexibility is hereby attained with respect to the main shaft fixture's use for the fixing of main shafts with different geometries on wind turbines, since solely the degree of mobility of the pressure mandrels and the size of the main shaft fixture pose limiting factors for the usability of such. The main shaft fixture is thus both usable for fixing of cylinder-shaped shafts with different diameters and for the fixing of shafts with conical shapes. The main shaft fixture according to the invention is multi-part, and may be mounted on permanent structural parts, preferably the bottom frame of the nacelle, while the rotor of the wind turbine is in operation.

[0010] With the intent of being able to use a self-hoisting crane with a ground-based winch together with the main shaft fixture according to the invention, it may comprise mounting facilities for a self-hoisting crane whose winch is placed on the ground surface ground near the foot of the wind turbine.

[0011] The advance thereof is that the establishment of facilities for the fixing of the wind turbine's main shaft, as well as the establishment of mounting facilities for the self-hoisting crane with a ground-based winch, take place simultaneously, which saves work processes, and space, which are of great importance, as the space in the nacelle in a wind turbine are most often narrow, and furthermore the main shaft fixture as well as the mounting facilities for a self-hoisting crane in the nacelle normally utilise the same permanent structural parts in the nacelle for anchoring.

[0012] With the intent of ensuring easy and rapid establishment of the self-hoisting crane, which requires the hoisting of snatch blocks with wires originating from the ground-based winch with a lightweight crane which is mounted on stable structural parts in the nacelle, the main shaft fixture may comprise mounting facilities for a lightweight crane.

[0013] For the purpose of securing the rapid fixing of the main shaft using the main shaft fixture according to the invention, the pressure mandrels may be provided with actuators for displacing and retaining the tap shoes in the passive position and the active

position, respectively, alternatively in a selectable position between the passive and the active position.

[0014] Time is thereby saved in the displacement of the tap shoes between the passive position, and the active position pressed against the main shaft's surface.

[0015] In a more simple form of embodiment of the main shaft fixture according to the invention, the pressure mandrels may be comprised of threaded bolts whose free ends facing the main shaft are furnished with tap shoes, where the threaded bolts work together with threaded holes in relevant sections of the fixture. The pressure mandrels with the tap shoes are hereby displaced by manual turning of the threaded bolts between the passive position and the active position.

[0016] With the intent of being able to permit rotation of the main shaft during performance of servicing of a relevant wind turbine and in order to protect the main shaft and the main shaft fixture, a slide lining may exist between the opposing sides of the main shaft's surface and the tap shoes.

[0017] This enables the main shaft to be fixed in its position by the main shaft fixture, but with the main shaft being permitted to rotate without it being damaged due to the presence of the slide lining.

[0018] In a first embodiment of the slide lining, this could comprise the free ends of tap shoes facing against the main shaft being furnished with slide plates, which in the active extended position are engaged with the main shaft.

[0019] In a further embodiment, the main shaft fixture may according to the invention comprise a multi-part slide plate working in conjunction with the main shaft to be mounted on the main shaft, where the multi-part slide plate in its mounted state on the main shaft cooperates with the tap shoes.

[0020] This enables the tap shoes on the main shaft fixture's pressure mandrel to slide directly on the multi-part slide plate, in the event of a possible rotation of the main shaft caused by the effects of wind on the blades. The tap shoes on the main shaft fixture's pressure mandrels may cooperate with the multi-part slide plate on the main shaft, with or without slideway linings on the opposing sides of the tap shoes facing the main shaft.

[0021] In a further embodiment of the main shaft fixture as per the invention, it may comprise a multi-part needle bearing, roller bearing, ball bearing, consisting of a, multi-part

inner ring, fastened on the main shaft, and a therewith cooperating multi-part outer ring consisting a number of bowed sub segments according to the number of tap shoes mounted on the opposing side of the tap shoes facing the multi-part inner ring, which in the advanced active position of the pressure mandrels form the outer ring at a distance from the external periphery of the multi-part inner ring, and where a suitable number of needle rollers, rollers or balls are placed between the inner ring and outer ring, and where means are present for retaining the needles, rollers, or balls in position between the inner ring and outer ring.

[0022] An actual temporary bearing connection is hereby formed between the main shaft fixture and the main shaft, about which the main shaft is able to rotate.

[0023] With the intent of being able to fix the rotor on the wind turbine after it has been braked to a stop, the main shaft fixture according to the invention, may comprise a rotor lock, for fixing the wind turbine rotor.

[0024] In a preferred embodiment of the rotor lock, it is comprised of a flange, whose bolt circle geometry corresponds to a bolt circle geometry on the rotor, said flange element being fastened at the ends to the first end of two first beam-shaped brackets extending parallel with, and on each side of the main shaft, said beam shaped brackets belonging to the main shaft fixture, and where the other end of the brackets are pivotally mounted with horizontally oriented bolt connections, on other brackets belonging to the main shaft fixture, which are anchored on the bottom frame of the nacelle.

[0025] It is hereby achieved that the rotor can be fixed by introducing a bolt through one or more of the overlapping holes in the bolt circles on the flange fastened to the bottom frame and the bolt circle on the rotor, respectively.

[0026] With the intent of being able to perform replacement of the shaft's main bearing, without being forced to dismount the main shaft, the main shaft fixture may furthermore comprise at least a second actuator, between the nacelle's bottom frame and the opposing side of the first beam-shaped brackets facing such and the nearest rotor lock, where the other actuator is movable between a first passive outer position and an active outer position whereby the flange element is moved vertically.

[0027] This enables the main shaft to be able to be raised from its bearing hanging in the rotor lock, such that the main bearing of the shaft can be replaced or serviced without the necessity of removing the shaft from the nacelle.

[0028] The invention is explained in further detail in the following with reference to the accompanying drawings.

Brief Description of the Drawings

[0029] Fig. 1 is a perspective view of parts of a wind turbine nacelle, presenting the nacelle bottom frame, the wind turbine main shaft, and a main shaft fixture according to the invention, with a lightweight crane and a self-hoisting crane mounted,

[0030] Fig. 2 is a more detailed perspective view from another angle of what is shown in Fig. 1, where the main shaft is made transparent, presenting the pressure mandrel with tap shoe belonging to the main shaft fixture according to the invention,

[0031] Fig. 3 is a more detailed perspective view from another angle of what is shown in Fig. 1, presenting the actuators for raising the main shaft, where the main shaft is made transparent,

[0032] Fig. 4 is a detailed perspective view of the main shaft fixture for a wind turbine, where the tap shoes and the main shaft are furnished with slide plates, and

[0033] Fig. 5 is a detailed perspective view or the main shaft fixture for a wind turbine, where the slide plates are replaced by a multi-part needle bearing/roller bearing/ball bearing formed of a multi-part inner ring fastened to the main shaft and a therewith cooperating multi-part outer ring consisting of bowed sub-segments of the number of tap shoes mounted on the opposing side of the tap shoes facing the inner ring.

Detailed Description of the Invention

[0034] Fig. 1 shows a bottom frame 2 in a nacelle (not shown) on a wind turbine (not shown), where the main shaft 4 of the turbine, with a gear box 6 and a rotor 8, and where the main shaft fixture 10 according to the invention is shown in the mounted state, bearing a lightweight crane 12 and a self-hoisting crane 14 with a ground-based winch (not shown), respectively. The bottom frame 2 has for reasons of clarity been made transparent.

[0035] In the illustrated embodiment, the main shaft fixture 10 is anchored to the bottom frame 2 near the gear box 6 and near the rotor 8, and comprises a multi-part frame 14, which together with a cross member 16 fastened on it encloses a part of the main shaft 4

between the rotor 8 and the gear box 6. The multi-part frame 14 is anchored on the bottom frame 2.

[0036] Fig. 2 shows what is seen in Fig. 1, but in an end view, seen from the rotor side of the shaft 4, and where the rotor 8 for reasons of clarity has been made transparent. As it appears from Fig. 2, the multi-part frame 14 and cross member 16 comprise in total four pressure mandrels 18 symmetrically placed around the main shaft 2, with tap shoes 20 that are engaged onto the main shaft 4 in order to fix it in place.

[0037] The pressure mandrels 18 may be comprised of hydraulically driven pistons whose free ends comprise the tap shoes 20, but may also be executed in other manners, where they are moved manually between the active position where the tap shoes 20 are engaged with the main shaft 4 and the passive, withdrawn position.

[0038] As it appears from Fig. 3, the main shaft fixture 10 comprises two parallel passing first beams 22, one on each side of the main shaft 4. In first ends of each first beam 22 nearest to the rotor 8, a rotor lock is fastened in the form of a flange element 24, the hole circle geometry 26 of which is similar to the hole circle geometry 28 of the rotor 8 over part of the periphery of the rotor. For locking of the rotor 8, the holes 7 in the rotor 8 and the holes 9 in the flange element 24 are brought to overlap, and subsequently, bolts are inserted through the overlapping holes, which are tightened with nuts, after which the rotor 8 is fixed/locked by the flange element 24.

[0039] The other end of the parallel passing first beams 22 (that nearest to the gear box 6) are pivotally anchored on horizontally oriented bearing bolt 30, on a bracket 32, which is fastened to the bottom frame 2. The parallel passing first beams 22 are mutually connected with second cross members 34, on which bracket facilities 23 are seen for a self-hoisting crane 14 with a ground-based winch (not shown).

[0040] As it appears in Figs. 1 & 3, an actuator 36 is located between the bottom frame 2 and the parallel passing first beams 22. Activation of the actuator 36 will result in a change of the distance between the bottom frame 2 and the first beams 22, in which the flange element 24 is suspended, which will cause the flange element 24 and the rotor 8 and thereby the main shaft 4 to be raised, which will result in the possibility to replace the main shaft's bearing 38 without the necessity of hoisting the main shaft 4 down to the ground, which is quite time-saving when the main shaft bearing 38 has to be repaired or replaced.

[0041] In Fig. 1, it is moreover shown how the main shaft fixture 10 comprises mounting facilities 40 for the lightweight crane 12.

[0042] Fig. 4 shows an embodiment of the main shaft fixture according to the invention, which is specially suited for use for fixing the wind turbine main shaft 4 in position on the nacelle, but where rotation of the main shaft 4 is possible, in the active position of the pressure mandrels/tap shoes (18, 20), engaged with the main shaft.

[0043] As shown in Fig. 4, a slideway lining 42, 44 is located between the opposing sides of the tap shoes 20 facing the surface of the main shaft 4.

[0044] The slideway may be comprised of slide plates 42 that are fastened to the opposing free ends of the tap shoes 20 facing the main shaft 4, which in their active advanced position are engaged with the main shaft 4, but which alternatively may comprise a multi-part slide plate 44 cooperative working with the main shaft 4, for mounting on the main shaft 4, said multi-part slide plate 44 in its mounted state on the main shaft 4 cooperates with the tap shoes 20. It must be stated that the presence of the multi-part slide plate 44 on the main shaft 4 does not necessarily exclude the presence of the slide plates 42 and the tap shoes 20.

[0045] In a further embodiment, the main shaft fixture 10 is comprised of a multi-part needle bearing/roller bearing/ball bearing 46, formed of a multi-part inner ring 48 fastened on the main shaft as well as, a cooperating multi-part outer ring 50 formed of bowed sub-segments 52 equal to the number of tap shoes mounted on the opposing side of the tap shoes 20 facing the inner ring 48, which in the advanced position of the pressure mandrels form the outer ring 50 at a distance from the outer periphery of the multi-part inner ring 48, and where an appropriate number of needle rollers, rollers, or balls 54 (in the shown embodiment rollers 54) are arranged between the inner ring 48 and the outer ring 50, and where means (not shown) are present for retaining the needles/rollers or balls (54) in position between the inner ring 48 and outer ring 50.

[0046] The means mentioned for fastening of needle rollers/rollers/balls 54 may be formed of cooperating edge delineators in opposing sides of the inner ring 48 and the outer ring 50, alternatively as a means for holding between which the needle rollers/rollers/balls 54 are fastened.

[0047] The presence of the slide lining 42, 44, alternatively the multi-part needle bearing, roller bearing, ball bearing 46, involves the main shaft 4 being permitted to rotate

simultaneously with it being fixed in its position during servicing of the wind turbine, which can serve a purpose namely for larger wind turbines.

[0048] The inventor has recognised that the main shaft fixture 10 can assume other embodiments than disclosed in the preceding and shown in the figures, however such do not change the inventive aspect that is comprised of specifying a main shaft fixture 10 of the given type that comprises adjustable pressure mandrels 18 with tap shoes 20, which causes the fixture 10 to be usable regardless of the geometry of the main shaft 4 on a wind turbine, and thus that such can be mounted without fixing the rotor 8 in place, and furthermore of combining the main shaft fixture with facilities 40 for mounting of a lightweight crane 12 and a self-hoisting crane 14 with a ground-based winch, respectively, as well as a rotor lock 24 and finally of furnishing the main shaft fixture 10 with actuators 36, enabling the main shaft 4 and the main shaft bearing 38 to be raised sufficiently from its bearing in the nacelle that it can be serviced or replaced.

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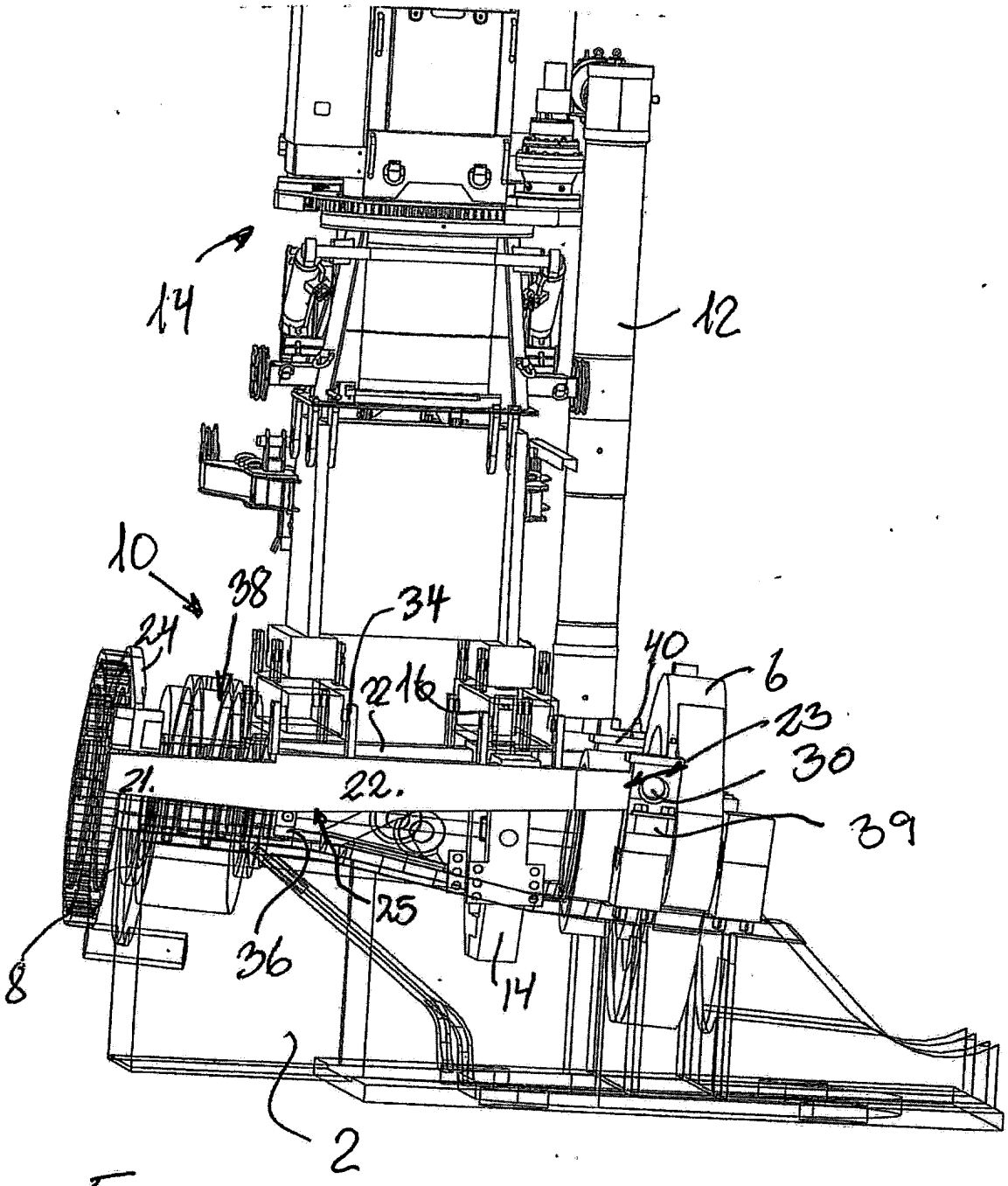


Fig. 3

REMARKS

By this Preliminary Amendment, claims have been amended to be in better form for initial U.S. national phase examination with no change in scope being intended. Likewise, a substitute specification and abstract are submitted herewith to conform them more closely to U.S. practice. Enclosed is a Replacement Sheet of Fig. 3. The amendments to the claims, specification, and abstract, do not add new matter to the application and are fully supported by the original disclosure. In this regard, a mark-up copy of the substitute specification and abstract is submitted herewith and from which the Examiner can confirm that no new matter has been added.

Respectfully submitted,

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In the Claims:

1. (Currently Amended) [[Main]] A main shaft fixture (10) for fixation of a main shaft (4) on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture (10) is divided up into a number of sections for mounting on stable structural parts (2) ~~structural parts~~ in a nacelle in a wind turbine, including the bottom frame (2) of the nacelle, ~~characterised in, that~~ wherein the main shaft fixture (10) comprises at least three radial displaceable pressure mandrels (18), substantially symmetrical located around [[the]] a centre axis (11) of the main shaft, [[the]] first ends of said pressure mandrels (18) ~~facing~~ face the main shaft (4) and are furnished with a tap shoe (20), and wherein said pressure mandrels (18) ~~being~~ are displaceable between a passive, withdrawn lockable position where the tap shoes (20) are configured to be located at a distance from the surface of the main shaft (4) and an advanced lockable position where the tap shoes (20) are configured to be engaged with the main shaft (4).

2. (Currently Amended) ~~Main~~ The main shaft fixture (10)[[,]] according to claim 1, ~~characterised in, that it comprises~~ further comprising mounting facilities for a self-hoisting crane ~~(14), the~~ having winch ~~of which is~~ located on [[the]] a ground surface near [[the]] a foot of the wind turbine.

3. (Currently Amended) ~~Main~~ The main shaft fixture (10)[[,]] according to claim 1, further comprising ~~or 2, characterised in, that it comprises~~ mounting facilities (40) for a lightweight crane (12).

4. (Currently Amended) ~~Main~~ The main shaft fixture (10)[[,]] according to claim 1, wherein ~~any one of the claims 1-3, characterised in, that~~ the pressure mandrels (18) [[is]] are provided with actuators for displacing and retaining the tap shoes (20) in the passive position and the active position, respectively, alternatively in a selectable position between the passive and the active position.

5. (Currently Amended) ~~Main~~ The main shaft fixture (10)[[,]] according to ~~any one of the claims 1-3, characterised in, that~~ claim 1, wherein the pressure mandrels (18) ~~consists~~ are comprised of threaded bolts [[whose]] having opposing free ends ~~facing~~ that face the main shaft and are furnished with tap shoes (20), and wherein said threaded bolts ~~cooperates~~ cooperate with threaded holes in ~~relevant~~ respective sections of the fixture (10).

6. (Currently Amended)) ~~Main~~ The main shaft fixture (10)[[,]] according to ~~any one of the claims 1-5, characterised in, that by~~ claim 1, wherein a slideway lining (42, 44) ~~being~~ is located between the opposing sides of the surface of the main shaft and tap shoes.

7. (Currently Amended) ~~Main~~ The main shaft fixture (10) according to claim 6, ~~characterised in, that~~ wherein the slideway lining is configured so that [[of]] the opposing free ends of the tap shoes (20) facing the main shaft (4) are provided with a slide plate (42) which in the active advanced position is engaged with the main shaft (4).

8. (Currently Amended) ~~Main~~ The main shaft fixture (10) according to claim 6, further comprising ~~or 7, characterised in, that it comprises~~ a multi-part slide plate (44) cooperating with the main shaft (4) for mounting on the main shaft (4), where the multi-part slide plate (44) in [[its]] a mounted position on the main shaft (4) ~~is cooperating~~ cooperates with the tap shoes (20).

9. (Currently Amended) ~~Main~~ The main shaft fixture (10) according to ~~any one of the claims 1-5, characterised in, that it comprises~~ claim 1, further comprising a multi-part needle bearing, roller bearing, ball bearing (46) ~~consisting~~ comprised of a multi-part inner ring (48) fastened to the main shaft (4), and a therewith cooperating multi-part outer ring (50) ~~consisting~~ comprised of bowed sub-segments ~~subsegments~~ (52) corresponding to the number of tap shoes, mounted on the opposing side of the tap shoes (20) facing the inner ring (48), which in the advanced active position of the pressure mandrels form the outer ring (50) at a distance from the outer periphery of the multi-part inner ring (48), and where ~~an appropriate number~~ plurality of needle rollers, rollers, or balls (54) are arranged between the inner ring

(48) and the outer ring (50), and where means are present for retaining the needles, rollers, or balls (54) in position between the inner ring (48) and outer ring (50).

10. (Currently Amended) ~~Main~~ The main shaft fixture (10)[[,]] according to claim 1, further comprising ~~any one of the claims 1-9, characterised in, that it comprises~~ a rotor lock (24) for fixation of the rotor (8) of the wind turbine.

11. (Currently Amended) ~~Main~~ The main shaft fixture (10)[[,]] according to claim 10, ~~characterised in, that~~ wherein the rotor lock (24) ~~consists~~ is comprised of a flange element, ~~whose~~ with a bolt circle geometry (26) that corresponds to a bolt circle geometry (28) on the rotor, said flange element (24) being fastened at the ends to [[the]] a first end (21) of two first beam-shaped brackets (22) extending parallel with each other, and being located on each side of the main shaft, said beam shaped brackets (22) ~~belonging to~~ forming part of the main shaft fixture, and where ~~the other~~ a second end (23) of the brackets (22) [[are]] is pivotally mounted with horizontally oriented bolt connections (30)[[,]] on other brackets (39) ~~belonging to~~ that form parts of the main shaft fixture (10)[[,]] and which are anchored on the bottom frame (2) of the nacelle.

12. (Currently Amended) ~~Main~~ The main shaft fixture (10)[[,]] according to claim 11, ~~characterised in, that~~ wherein at least one actuator (36) is located nearest the rotor lock (24) between the bottom frame (2) of the nacelle and [[the]] an adjacent side (25) of the first beam-shaped brackets (22) facing the bottom frame (2), and wherein said at least one actuator (36) is displaceable between a first passive outer position and an active outer position [[where]] by which the flange element (24) is displaced vertically.

In the Specification:

Please replace the original specification and abstract with the substitute specification and substitute abstract submitted herewith.

Docket No. 400517-20003

IN THE UNITED STATES DESIGNATED/ELECTED OFFICE

In Re Patent Application of

Per E. Fenger

International Application No. PCT/DK2015/000040

International Filing Date: 6 October 2015

For: MAIN SHAFT FIXTURE

PRELIMINARY AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The following is presented for entry preliminary to calculation of the filing fee and entry into the National Phase of the above-captioned PCT application.

PTO-1390 (06-13)
Approved for use through 6/30/2013. OMB 0651-0021
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

Attorney Docket No.	U.S. Application No. (if known, see 37 CFR 1.5)
400517-20003	

International Application No.	International Filing Date	Priority Date Claimed
PCT/DK2015/000040	6 October 2015	7 October 2014; 4 September 2015

Title of Invention
MAIN SHAFT FIXTURE

First Named Inventor
Per E. Fenger

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☑ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received.
2. ☑ A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)).
3. An English language translation of the International Application (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))
   a. ☑ is attached.
   b. ☐ was previously filed in the international phase under PCT Rule 4.17(iv).

Items 5 to 8 below concern amendments made in the international phase.

PCT Article 19 and 34 amendments

5. ☐ Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)).
6. ☐ English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)).
7. ☐ English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).

Cancellation of amendments made in the international phase

8a. ☐ Do not enter the amendment made in the international phase under PCT Article 19.

8b. ☐ Do not enter the amendment made in the international phase under PCT Article 34.

NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).

The following items 9 to 17 concern a document(s) or information included.

9. ☑ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
10. ☑ A preliminary amendment.
11. ☑ An Application Data Sheet under 37 CFR 1.76.
12. ☑ A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b).
13. ☑ A power of attorney and/or change of address letter.
14. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821-1.825.
15. ☐ Assignment papers *(cover sheet and document(s))*. Name of Assignee: _____
16. ☐ 37 CFR 3.73(c) Statement *(when there is an Assignee)*.

This collection of information is required by 37 CFR 1.414 and 1.491-1.492. The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

U.S. APPLN. No. (if known – see 37 CFR 1.5)	INTERNATIONAL APPLICATION No.	ATTORNEY DOCKET No.
	PCT/DK2015/000040	400517-20003

17. [✓] Other items or information:

Mark-up Specification

The following fees have been submitted.	CALCULATIONS	PTO USE ONLY
18. [✓] Basic national fee (37 CFR 1.492(a)) **$280**	$ 280.00	
19. [✓] Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** All other situations **$720**	$ 720.00	
20. [✓] Search fee (37 CFR 1.492(b)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority ..... **$120** International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB ..... **$480** All other situations **$600**	$ 480.00	
TOTAL OF 18, 19, and 20 =	$ 1480.00	
[ ] Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). Fee for each additional 50 sheets of paper or fraction thereof **$400**	0	

Total Sheets	Extra Sheets	Number of each addition 50 or fraction thereof (round **up** to a whole number)	RATE
20 - 100 =	/ 50 =	0	x **$400**

$

Surcharge of **$140.00** for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).	$ 0	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	12 - 20 =	0	x **$80**	$ 0	
Independent claims	1 - 3 =	0	x **$420**	$ 0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$780**	$ 0	
Processing fee of **$140.00** for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)). +				$ 0	
TOTAL OF ABOVE CALCULATIONS =				$ 1480.00	
[✓] **Applicant asserts small entity status.** See 37 CFR 1.27. Fees above are reduced by ½.					
[ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Fees above are reduced by ¾. Applicant must attach form PTO/SB/15A or B or equivalent.					
TOTAL NATIONAL FEE =				$ 740.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property. +				$ 0	
TOTAL FEES ENCLOSED =				$ 740.00	
				Amount to be refunded:	$
				Amount to be charged:	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees.

c. ☑ The Director is hereby authorized to charge additional fees which may be required, or credit any overpayment, to Deposit Account No. 502478(400517-20003) as follows:

i. ☐ any required fee.

ii. ☐ any required fee except for excess claims fees required under 37 CFR 1.492(d) and (e) and multiple dependent claim fee required under 37 CFR 1.492(f).

d. ☑ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038. The PTO-2038 should only be mailed or faxed to the USPTO. However, when paying the basic national fee, the PTO-2038 may NOT be faxed to the USPTO.

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NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File)Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013, and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

NOTE 1: By providing this statement under 37 CFR 1.55 or 1.78, **this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA**.

NOTE 2: A U.S. national stage application may not claim priority to the international application of which it is the national phase. The filing date of a U.S. national stage application is the international filing date. See 35 U.S.C. 363.

Correspondence Address

☑ The address associated with Customer Number: 25570 **OR** ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone			
Email					

Signature		Date	April 6, 2017
Name (Print/Type)	David S. Safran	Registration No. (Attorney/Agent)	27,997

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2017-04-06
First Named Inventor	Per E. Fenger
Art Unit	
Examiner Name	
Attorney Docket Number	400517-20003

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7759815	B2	2010-07-20	Christensen	

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	1	61-54846	JP	A	1986-03-19	Fujimoto	English Abstract attached	
	2	1 617 075	EP	A1	2006-01-18	Albers et al.	English Abstract attached	
	3	10 2006 013 539	DE	A1	2007-09-27	Tirdea	English Abstract attached	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2017-04-06
	First Named Inventor	Per E. Fenger
	Art Unit	
	Examiner Name	
	Attorney Docket Number	400517-20003

	4	2014/103018	WO	A1	2014-07-03	Nishida et al.	English Abstract attached	

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2017-04-06
	First Named Inventor	Per E. Fenger
	Art Unit	
	Examiner Name	
	Attorney Docket Number	400517-20003

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/david s safran/	Date (YYYY-MM-DD)	2017-04-06
Name/Print	David S. Safran	Registration Number	27,997

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Espacenet

Bibliographic data: JPS6154846 (A) — 1986-03-19

ROLLER BEARING REPLACER OF MOTOR

Inventor(s): FUJIMOTO YOSHIMASA ± (FUJIMOTO YOSHIMASA)

Applicant(s): HITACHI LTD ± (HITACHI LTD)

Classification: - international: ***F16C35/06; F16C41/00; H02K15/00; H02K15/14; H02K5/173;*** (IPC1-7): F16C35/06; H02K15/02
- cooperative: **F16C35/062; F16C39/02; H02K15/0006;** F16C19/26; F16C2237/00; H02K5/1732

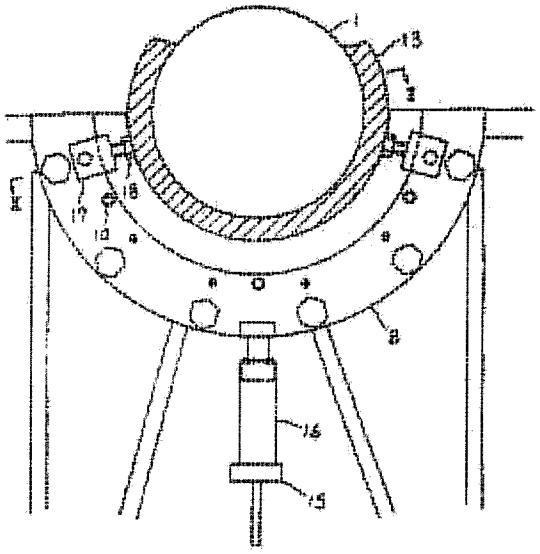
Application number: JP19840175023 19840824

Priority number (s): JP19840175023 19840824

Abstract of JPS6154846 (A)

PURPOSE:To enable to replace a roller bearing in a short time withoug disassembling the entirety by providing a lower half bearing cover capable of supporting a rotor weight, lifting it by a jack, retaining the horizontal displacement of the rotor and releasing the load of the bearing. CONSTITUTION:A body side lower half bearing cover 8 is formed to have a strength capable of supporting a rotor weight, in a structure capable of lifting by a jack, a jack seat 15 is provided on the lower portion of a bearing base, and formed in a structure for lifting the rotor through the cover 8 by the jack 16. A rotor shaft is lifted by the jack at the roller bearing exchanging time, and the horizontal displacement of the rotor shaft is suppressed by mounting shaft pushing fittings 17 and shaft pushing bolt 18 at both sides, completely removing the load of the bearings, filling push bolts in threaded holes 19, and pushing the outer race of the bearings to move it.

LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102



⑲日本国特許庁（JP）　⑪特許出願公開

⑫公開特許公報（A）　昭61－54846

⑤1Int.Cl.⁴	識別記号	庁内整理番号	⑬公開　昭和61年(1986)3月19日
H 02 K 15/02		7826－5H	
F 16 C 35/06		7127－3J	
41/00		7127－3J	審査請求　未請求　発明の数 1　（全3頁）

⑤4発明の名称　電動機のコロ軸受交換装置

⑳特　願　昭59－175023
㉒出　願　昭59(1984)8月24日

⑦2発明者　藤本　欣正　日立市幸町3丁目1番1号　株式会社日立製作所日立工場内
⑦1出願人　株式会社日立製作所　東京都千代田区神田駿河台4丁目6番地
⑦4代理人　弁理士　高橋　明夫　外2名

明　細　書

発明の名称　電動機のコロ軸受交換装置

特許請求の範囲

1．電動機本体側の下半軸受カバーを押し上げられる構造とし、回転子の重量に十分耐え得る強度をもつ軸受カバーと、

コロ軸受の荷重を完全に解除するため、ジヤツキで前記下半軸受カバーを介して前記回転子を押し上げるため、軸受台下部に設けた座と、前記回転子の水平方向の片寄りを押えるために、前記下半軸受カバーの水平方向の両側に取付けた金具と、

前記コロ軸受の外輪を押し出すために、前記下半軸受カバーに設けたネジ穴とを特徴とする電動機のコロ軸受交換装置。

発明の詳細な説明

〔発明の利用分野〕

本発明は電動機コロ軸受交換装置に係り、特に、電動機を据付状態で作業するのに好適な回転子重量受け下半軸受カバーに関する。

〔発明の背景〕

従来、コロ軸受をもつ電動機の軸受交換は、据付場所より回転子を解体し、別場所で作業するのが常で、この方法によると解体と再組立に相当な時間と工数が掛り、設備の停止時間を多く取らねばならない欠点があつた（実開昭52-60706号公報参照）。

〔発明の目的〕

本発明の目的は電動機を据付状態のまま全体を解体することなく、短時間でコロ軸受の交換を行なう、保守時間と工数の低減を図るコロ軸受交換装置を提供するにある。

〔発明の概要〕

本発明は電動機を据付状態のままでコロ軸受を容易に交換出来るようにするため、回転子重量を受け得る下半軸受カバーとし、ジヤツキで押し上げ、回転子の水平方向片寄りを押えてコロ軸受の荷重を解除して、軸受けの取り外し取付けが出来るようにしたものである。

〔発明の実施例〕

以下、本発明の一実施例を第1図、ないし第3

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図により傾斜据付電動機の直結側軸受を例に説明する。本体側下半軸受カバー８を回転子重量を受け得る強度をもつものとし、ジヤツキで押し上げられる構造とし、軸受台下部６にジヤツキ座１５を設け、ジヤツキ１６で下半軸受カバー８を介して回転子を押し上げられる構造とする。

第３図はコロ軸受交換時に回転子軸をジヤツキで押し上げた状態を示し、回転子軸の水平方向の片寄りを押えるため、軸押し金具１７と、軸押しボルト１８を両側に取付けコロ軸受の荷重を完全に解除し、ネジ穴１９に押しボルトを入れてコロ軸受外輪を押して取外すようにしたものである。

本実施例によれば、電動機を据付場所より解体することなく、コロ軸受の交換が可能となり、作業時間が短縮され、少人数で作業が出来る。なお、図中１は回転子軸、２はカツプリング、３は内輪、４は外輪、５は軸受台上部、７，９，１０は軸受カバー、１１，１２はグリースカバー、１３，１４は軸受スリーブである。

〔発明の効果〕

本発明によれば据付状態でカツプリングを抜くことが出来る場合に、電動機を据付場所より解体してコロ軸受の交換を行なう必要が無く、据付状態で、コロ軸受の交換ができ、短時間で、かつ、少人数で作業が出来る。

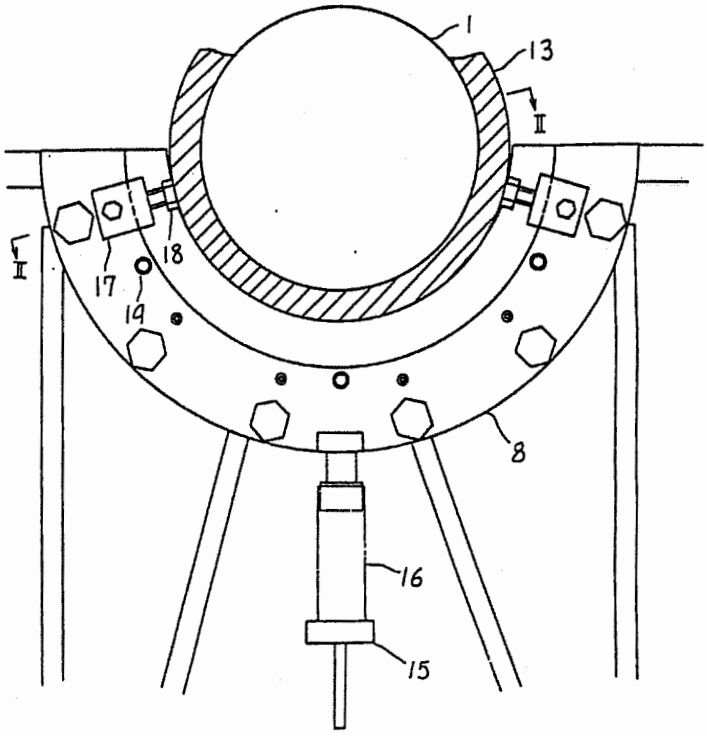
図面の簡単な説明

第１図は回転子軸を軸受カバーを介してジヤツキで押し上げ水平方向の調整要領を示した正面図、第２図は第１図のⅡ－Ⅱ矢視断面図、第３図はコロ軸受をもち傾斜据付電動機の直結側軸受の本発明の断面図である。

６…軸受台下部、８…本体側下半軸受カバー、１５…ジヤツキ受け座、１６…ジヤツキ、１７…軸押し金具、１８…軸押しボルト、１９…軸受外輪押しネジ穴。

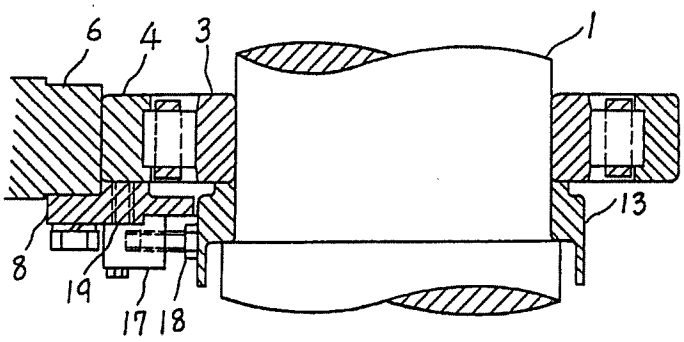
代理人　弁理士　高橋明夫

第１図

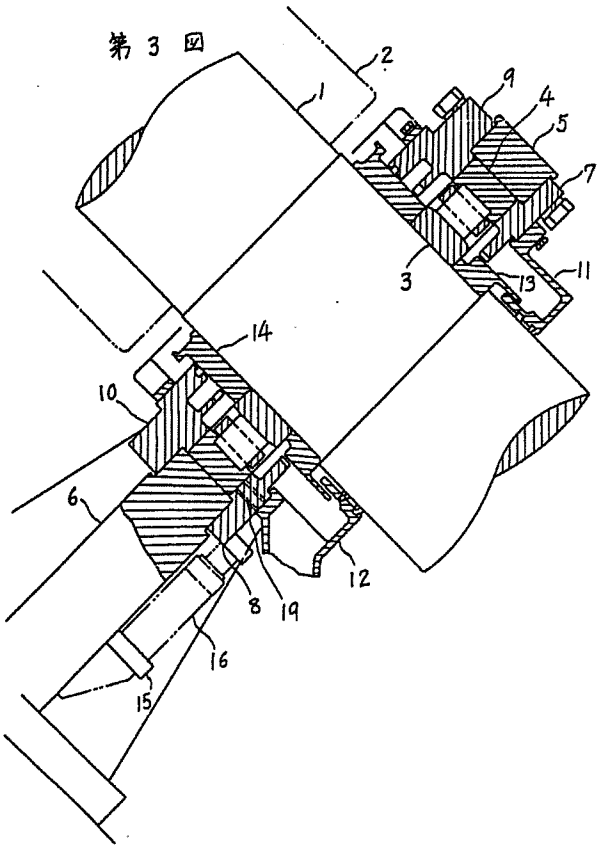


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第 2 図



第 3 図



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Espacenet

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Method and apparatus for changing a gearbox of a wind turbine

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Abstract of EP1617075 (A1)

The method is for the changeout of a transmission (4) of a wind power plant. The rotor shaft (5) during the transmission changeout is supported on the machine frame (2) so that during the changeout the rotor remains on the rotor shaft. Support is provided by a yoke (11) which directly before the transmission changeout is mounted between the rotor shaft and machine frame and then removed again after the changeout. Independent claims are also included for the following: (A) a device for the execution of maintenance work on the drive train of a wind power plant, especially for the changeout of the transmission; (B) a yoke for support of the rotor of a wind power plant during a transmission changeout; and (C) a use for a yoke which is to support the rotor of a wind power plant during a transmission changeout.

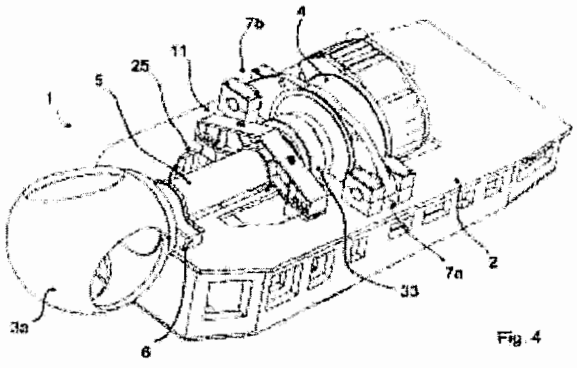


Fig. 4

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Bemerkungen:
Geänderte Patentansprüche gemäss Regel 86 (2) EPÜ.

(54) Verfahren und Vorrichtung zum Getriebetausch bei einer Windkraftanlage

(57) Verfahren zum Austausch eines Getriebes (4) einer Windkraftanlage, wobei die Windkraftanlage eine Rotorwelle (5) umfasst, die einen Rotor (3) mit dem auszutauschenden Getriebe (4) verbindet und die mittels eines rotorseitigen Rotorlagers (6) in einem Maschinenrahmen (2) drehbar gelagert ist, und wobei die Rotorwelle (5) während des Getriebetausches mittels einer getriebeseitigen Abstützung an dem Maschinenrahmen (2) abgestützt ist, so dass während des Getriebetausches ein Verbleiben des Rotors (3) an der Rotorwelle (5) gestattet ist. Der Erfindung liegt die Aufgabe zugrunde, ein derartiges Verfahren dahingehend weiter zu bilden, dass es sich auch auf solche Windkraftanlagen anwenden lässt, deren Rotorwelle teilweise auch in dem Getriebe (4) gelagert ist, wie beispielsweise bei Windkraftanlagen mit Dreipunkt-Lagerung der Rotorwelle (5). Gelöst wird diese Aufgabe dadurch, dass als Abstützung ein Joch (11) verwendet wird, welches unmittelbar vor dem Getriebetausch zwischen Rotorwelle (5) und Maschinenrahmen (2) montiert und unmittelbar nach dem Getriebetausch wieder entfernt wird. Mit dem offenbarten Verfahren ist es möglich, bei den meisten bestehenden Windkraftanlagen einen Getriebetausch durchzuführen, ohne dabei den Rotor (3) abnehmen zu müssen. Hierdurch werden Kosten eingespart. Desweiteren wird ein Joch (11) vorgestellt, welches sich in besonderer Weise für das vorgeschlagene Verfahren eignet.

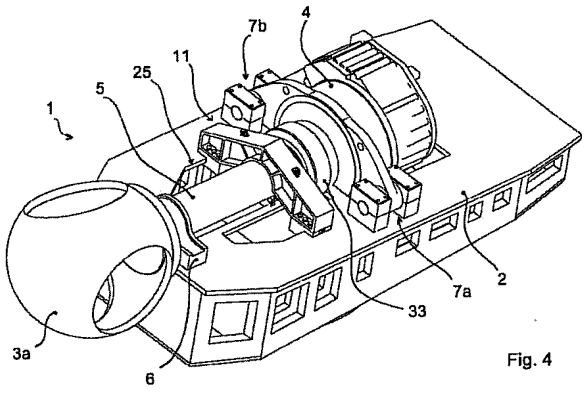


Fig. 4

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Beschreibung

[0001] Die vorliegende Erfindung betrifft ein Verfahren zum Austausch eines Getriebes einer Windkraftanlage, wobei die Windkraftanlage eine Rotorwelle umfasst, die einen Rotor mit dem auszutauschenden Getriebe verbindet und die mittels eines rotorseitigen Rotorlagers in einem Maschinenrahmen drehbar gelagert ist, und wobei die Rotorwelle während des Getriebetausches mittels einer getriebeseitigen Abstützung an dem Maschinenrahmen abgestützt ist, so dass während des Getriebetausches ein Verbleiben des Rotors an der Rotorwelle gestattet ist.

[0002] Ferner betrifft die Erfindung ein Joch mit einem Bügel, der vorzugsweise mittig eine Bucht aufweist. Dieses Joch eignet sich in besonderer Weise für die Durchführung des beschriebenen Verfahrens.

[0003] In der EP 1 101 936 A2 wird ein Verfahren zur Montage und zum Austausch von Hauptkomponenten in der Gondel einer Windkraftanlage offenbart. Seine Durchführung setzt einerseits einen modularisierten Triebstang und anderseits die Ausführung des Maschinenrahmens als eine bestimmte Fachwerkstruktur voraus. Die Hauptkomponenten, so auch das Getriebe, sind einzeln an unteren Längsträgern der Fachwerkstruktur befestigt. Auf den oberen Traversen des Fachwerks ist eine Laufkatze platziert, mittels welcher die Komponenten des Triebstranges einzeln herab oder empor gehoben werden können. Vorteilhafterweise entfällt durch die Verwendung der Laufkatze die Anmietung eines externen Mobilkranes, wenn das Getriebe bei der in der EP 1 101 936 A2 beschriebenen Windkraftanlage ausgetauscht werden muss.

[0004] Auch ist bei dieser Windkraftanlage während des Getriebetausches ein Verbleiben des Rotors auf der Rotorwelle gestattet. Letztere ist nämlich an zwei Punkten gelagert, rotorseitig in einem vorderen Rotorlager und getriebeseitig in einem hinteren Rotorlager. Das hintere Rotorlager nimmt das Moment auf, welches aus der Gewichtskraft des Rotors und der Stützweite der Rotorwelle resultiert. So fungiert das hintere Rotorlager als Abstützung, weswegen während eines Getriebetausches der Rotor an der Rotorwelle verbleiben kann, ohne dass das vordere Rotorlager ausbricht. Eine solche Situation ist in Figur 4 der vorgenannten Patentanmeldung gezeigt.

[0005] In jüngster Zeit werden mit auffälliger Häufigkeit Schäden an Windkraftanlagen bekannt, die möglicherweise auf Unsicherheiten in der Dimensionierung und der Betriebsführung zurückzuführen sind. Die Schäden betreffen unter anderem die Getriebe, die als Kernstück des Triebstrangs zwischen Rotor und Generator eingespannt und damit allseits negativen Einflüssen ausgesetzt sind. Die Konsequenz sind vorzeitige Ermüdung oder gar Totalausfall einzelner Komponenten der Getriebe wie insbesondere Räder und Lager. Bei besonders schweren Schadensfällen muss das gesamte Getriebe der Windkraftanlage ausgetauscht werden, da der Austausch einzelner beschädigter Komponenten des Getriebes unwirtschaftlich ist.

[0006] Sofern die Gondel der Windkraftanlage mit auszutauschendem Getriebe so gestaltet ist, wie es die vorgenannte Patentanmeldung vorschlägt, ist es dank des fachwerkartigen Maschinenrahmens und des modularen Aufbau des Triebstangs ohne weiteres möglich, das geschädigte Getriebe auszutauschen. Allerdings ist die Mehrzahl der bestehenden und besonders ausfallgefährdeten Windkraftanlagen nach einer anderen Lagerkonzeption gebaut, nämlich nach der so genannten Dreipunkt-Lagerung. Bei der Dreipunkt-Lagerung wird auf ein hinteres, getriebeseitiges Rotorlager verzichtet und stattdessen die Rotorwelle endseitig in dem Gehäuse des Getriebes gelagert. Das Getriebegehäuse ist wiederum über zwei Getriebestützen in dem Maschinenrahmen gelagert, die Getriebestützen sind beiderseits des Triebstrangs angeordnet. Da die Rotorwelle letztendlich in dem vorderen, rotorseitigen Rotorlager und in den beiden seitlichen Getriebestützen gelagert ist, spricht man von Dreipunkt-Lagerung.

[0007] Grundlegende Informationen zu unterschiedlichen Lagerkonzepten für die Rotorwelle einer Windkraftanlage finden sich in: Hau, Erich. Windkraftanlagen: Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Berlin, u. a., 3. Auflage 2003, Seiten 277 bis 283. Ein Triebstrang einer Windkraftanlage mit Dreipunkt-Lagerung ist auch in der Figur 1 der EP 1 101 936 A2 als Stand der Technik dargestellt.

[0008] Einer Windkraftanlage mit Dreipunkt-Lagerung kann das Getriebe nicht ohne weiteres entnommen werden: Da mit dem Getriebe die hintere Abstützung der Rotorwelle zwangsläufig entfernt wird, wäre diese nur noch in dem vorderen Rotorlager gelagert. Das vordere Rotorlager könnte das aus dem hohen Gewicht des Rotors resultierende Moment nicht halten, was ein Ausbrechen des Rotorlagers und ungünstigenfalls ein Herabstürzen des Rotors zur Folge hätte. Aus diesem Grunde muss bei Windkraftanlagen mit Dreipunkt-Lagerung zunächst der Rotor von der Rotorwelle entfernt und anschließend das Getriebe ausgetauscht werden. Auch bei der Erstmontage einer Windkraftanlage mit Dreipunkt-Lagerung wird der Rotor nach dem Getriebe montiert.

[0009] Das Abnehmen des Rotors ist stets mit besonderen Schwierigkeiten und hohen Kosten verbunden. Hierfür sind nämlich zwei Mobilkräne erforderlich, von denen der eine die abgeschlagene Nabe anhebt und der andere den Rotor in eine horizontale Position umschwenkt, damit er auf dem Boden abgelegt werden kann. Sofern lediglich ein Mobilkran zur Verfügung steht, müssten die Rotorblätter nacheinander von der Nabe abgelöst und einzeln herabgelassen werden. Erst danach kann die Nabe entfernt werden. Angesichts der großen Zahl von Dreipunkt-gelagerten Windkraftanlagen, bei denen aufgrund von vorzeitigem Verschleiß ein Getriebetausch notwendig ist, erscheinen die vorbeschriebenen Verfahren zum Austausch des Getriebes als unwirtschaftlich.

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[0010] Der vorliegenden Erfindung liegt daher die Aufgabe zugrunde, ein Verfahren zum Austausch des Getriebes einer Windkraftanlage nach der eingangs genannten Art so weiterzubilden, dass es auch auf bestehende Windkraftanlagen mit beliebiger Ausführung des Maschinenrahmens und beliebiger Lagerkonzeption anwendbar ist.

[0011] Gelöst wird diese Aufgabe dadurch, dass als Abstützung ein Joch verwendet wird, welches unmittelbar vor dem Getriebetausch zwischen Rotorwelle und Maschinenrahmen montiert und unmittelbar nach dem Getriebetausch wieder entfernt wird.

[0012] In der eben geschilderten Weise ist es erstmalig möglich, das beschädigte Getriebe einer Windkraftanlage auszutauschen, deren Rotorwelle zumindest teilweise im Gehäuse des Getriebes gelagert ist, ohne auf das Abnehmen des Rotors angewiesen zu sein. Die Kosten für die Demontage des beschädigten Getriebes und die Remontage des Austausch-Getriebes können durch das vorgeschlagene Verfahren nach ersten Schätzungen um bis zu 40% gesenkt werden.

[0013] Insbesondere eignet sich das Verfahren für Windkraftanlagen mit Dreipunkt-Lagerung, also dem Lagerkonzept, bei welchem die Rotorwelle ausschließlich in dem vorderen, rotorseitigen Rotorlager und dem beidseitig abgestützten Getriebe drehbar gelagert ist.

[0014] Zweckmäßig wird das Verfahren dadurch weiter gebildet, dass die Rotorwelle an dem Joch festgesetzt wird. Das Festsetzen erfolgt bevorzugt durch eine Schelle und verhindert, dass der Rotor eine Aufwärts-Nickbewegung ausführen und in Folge dessen die Rotorwelle aus dem Joch rutschen kann. Ebenso kann durch diese Maßnahme eine zusätzliche Sicherung gegen Verdrehen der Rotorwelle ermöglicht werden. Es muss nämlich sichergestellt sein, dass sich der Rotor während der Montagearbeiten nicht dreht. Dies wird in der Regel durch Einrasten der Rotorarretierung erreicht, mit welchen die meisten Windkraftanlagen ausgerüstet sind. Es ist jedoch nicht auszuschließen, dass die Rotorarretierung versagt, in diesem Fall kann eine zusätzliche Sicherheit durch die drehfeste Verbindung zwischen Rotorwelle und Joch erreicht werden.

[0015] Ein Joch, welches vorzüglich für die Durchführung des erfindungsgemäßen Verfahrens taugt, aber auch im Rahmen von anderen Wartungsarbeiten an dem Triebstrang einer Windkraftanlage einsetzen lässt, umfasst eine Schelle, die zweckmäßigerweise über Gewindestangen mit dem Bügel verbindbar ist, so dass eine Rotorwelle zwischen Bucht und Schelle eingelegt und durch Anziehen der Gewindestangen zwischen diesen Bauteilen festklemmbar ist.

[0016] Zur Gestaltung des Jochs wird vorgeschlagen, Bucht und Schelle zumindest abschnittsweise entlang der Peripherie eines gedachten Kreises verlaufen zu lassen. Der gedachte Kreis entspricht dabei dem Querschnitt der in der Regel runden Rotorwelle. Es wird weiter angeregt, zwei Gewindestangen vorzusehen, die sich jeweils tangential zu der Peripherie des Kreises erstrecken und Schelle und Bügel miteinander verbinden. Die tangentiale Anordnung der Gewindestangen führt zu einer gleichmäßigen Kraftverteilung am Umfang der Rotorwelle. Die Verbindung zwischen den Gewindestangen und dem Bügel bzw. der Schelle erfolgt einfachstenfalls mittels Muttergewinde, in welche die Gewindestangen eingeschraubt werden. Das Muttergewinde kann jeweils in das Joch oder die Schelle als Gewindebohrung eingeschnitten sein oder einfacher in Form einer Mutter vorgesehen werden. Anstelle von Gewindestangen können gegebenenfalls auch lange Schrauben verwendet werden. Dessen Köpfe würden dann auf einer Seite das Muttergewinde ersetzen.

[0017] Um sicher zu gehen, dass die Rotorwelle durch das Einspannen nicht beschädigt wird, sollten Bucht und Schelle an ihren Innenseiten mit einem Polsterbelag belegt werden. Oberflächliche Beschädigungen üben vor allem auf Wellen eine erhebliche Kerbwirkung aus, die wie Rotorwellen wechselnder Torsionsbelastung ausgesetzt sind.

[0018] Als Polsterbelag verwendet man günstigenfalls eine Kunststoffschicht, vorzugsweise aus Polyamid. Dieser Kunststoff ist recht preisgünstig und kann gut verarbeitet werden. Zudem ist er im Vergleich zu Stahl in einem hohen Maße verformbar, so dass er Maßabweichungen und Ausrichtungsfehler ausgleichen kann.

[0019] Zur einfachen und schnellen Montage des Jochs wird vorgeschlagen, den Bügel jeweils endseitig mit einem Fuß zu versehen, der jeweils eine nach unten gewandte Sohle aufweist. An diesen Sohlen ist jeweils ein Klemmschuh festzuschrauben, der seinerseits an dem Maschinenrahmen befestigt wird. Zur Montage des Jochs werden zunächst die beiden Klemmschuhe beiderseits der Rotorwelle an dem Maschinenrahmen befestigt und anschließend der Bügel von oben über die Welle auf die Klemmschuhe herabgesenkt. Nach Verschrauben der Sohlen mit den Klemmschuhen sitzt der Bügel fest, so dass nur noch die Schelle montiert werden muss.

[0020] Der Klemmschuh nimmt eine "Adapterfunktion" wahr, um das Joch auf unterschiedliche Maschinenrahmen anpassen zu können. Die Gestaltung des Klemmschuhs wird somit durch die Geometrie des Maschinenrahmens bestimmt. Viele Maschinenrahmen sind aus verschweißten Stahlplatten zusammengesetzt, die an ihren Stoßstellen überstehen. Auch gegossene Maschinenrahmen weisen solche Überstände auf. Zum Anbinden des Jochs am Maschinenrahmen mit Überständen empfiehlt es sich, den Klemmschuh U-förmig auszubilden, so dass er zwei Schenkel aufweist, zwischen denen ein Bestandteil eines Maschinenrahmens, wie beispielsweise eine überstehende Stahlplatte, festklemmbar ist.

[0021] Alternativ zu U-förmigen Klemmschuhen können auch T-förmige Klemmschuhe eingesetzt werden. Vor allem an gegossenen Maschinenrahmen mit Ober- und Untergurt lassen sich T-förmige Klemmschuhe vorzüglich zwischen den Gurten anbringen.

[0022] Der wesentliche Vorteil in der Verwendung der

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Klemmschuhe besteht darin, dass der Maschinenrahmen keine zusätzliche mechanische Bearbeitung aufweisen muss, um das Joch befestigen zu können. Es ist nämlich davon auszugehen, dass solche speziellen Bearbeitungen in der Regel nicht an dem Maschinenrahmen vorhanden sind.

[0023] Das Festklemmen des Klemmschuhs an dem Maschinenrahmen geschieht einfachstenfalls mit einer Befestigungsschraube.

[0024] Vorteilhafterweise wird das Joch mit einer Höheneinstellung versehen. Eine Höheneinstellung ist bei einigen Anlagen notwendig, um zum einen die möglichen Abweichungen des Maschinenrahmens zur Rotorwellenachse auszugleichen, zum anderen aber auch den Triebstrang anheben zu können, um eine unter Umständen notwendige Montagefreiheit zu erzielen.

[0025] Zur Höhenverstellung eignet sich vorzugsweise eine Keilanordnung. Eine solche umfasst eine schiefe Ebene, die in den sohlenseitigen Schenkel des Klemmschuhs eingearbeitet ist, einen Keil, der einerseits an der Sohle des Bügels und andererseits an der schiefen Ebene anliegt und ein Bolzen, mittels welchem der Keil zwischen den von Sohle und schiefer Ebene begrenzten Raum eintreibbar ist. Das Eintreiben des Keils wird am besten durch einen (Gewinde-)Bolzen bewerkstelligt, der durch Anziehen den Keil entlang der schiefen Ebene gegen die Sohle treibt.

[0026] Die Höhenverstellung erfolgt gleichmäßiger mit Hilfe von zwei Keilen, die auf zwei gegeneinander ansteigenden, schiefen Ebenen aufeinander zugetrieben werden. Bei der Höhenverstellung mittels Keilen entsteht ein Spalt zwischen Sohle und Klemmschuh; das Gewicht des Bügels lastet einzig auf den Keilen. Damit die zulässige Flächenpressungen des Keil und der Sohle beim Festschrauben des Klemmschuhs nicht überschritten werden, sollte der Spalt mit Futterblechen aufgefüllt werden.

[0027] Das erfindungsgemäße Verfahren sowie ein Ausführungsbeispiel des für das Verfahren bevorzugt zu verwendende Joch soll nun beschrieben und mit den Figurenzeichnungen illustriert werden. Es zeigen:

Fig. 1: Triebstrang einer Windkraftanlage mit Dreipunkt-Lagerung in perspektivischer Ansicht (Stand der Technik);

Fig. 2a bis e: Getriebetausch, symbolisch dargestellt;

Fig. 3: Joch;

Fig. 4: Triebstrang aus Figur 1 mit Joch.

[0028] Figur 1 zeigt den "langsamen" Abschnitt des Triebstrangs einer typischen Windkraftanlage der 1.5 MW-Klasse mit Dreipunkt-Lagerung. Der Triebstrang 1 ist in einem Maschinenrahmen 2 drehbar gelagert und erstreckt sich von einer Rotornabe 3a bis zu einem hier nicht dargestellten Generator. Der Rotor ist in Figur 1 nicht komplett dargestellt, er umfasst neben der Rotornabe 3a drei Rotorblätter, die an der Rotornabe 3a befestigt sind und sich radial von ihr fort erstrecken.

[0029] Kernstück des Triebstrangs 1 ist ein Getriebe 4, welches über eine Rotorwelle 5 mit der Rotornabe 3a verbunden ist. Die Rotorwelle 5 ist rotorseitig in einem Rotorlager 6 gelagert. Getriebeseitig ist die Rotorwelle 5 in dem Gehäuse des Getriebes 4 drehbar gelagert, welches wiederum über zwei Getriebestützen 7a, 7b im Maschinenrahmen 2 gelagert ist. Rotorlager 6 und die beiden Getriebestützen 7a, 7b bilden zusammen die Dreipunkt-Lagerung. Eine Generatorwelle 8 verlässt das Getriebe 4 abtriebseitig und ist markiert den Beginn des "schnellen" Abschnitts des Triebstangs 1, der sich zwischen Getriebe 4 und Generator erstreckt.

[0030] In Figur 2a ist derselbe Triebstrang 1 symbolisch dargestellt. Hierbei wurde auf die Symbolisierung der Rotornabe verzichtet, an Stelle dessen sind Rotorblätter des Rotors 3 direkt auf der Rotorwelle 5 befestigt angedeutet. Die Getriebestützen 7a, 7b sind vereinfachend als eine einheitliche Getriebestütze 7 dargestellt. Der Aufbruch im Getriebe 4 lässt erkennen, dass die Rotorwelle 5 in einem Planetenträger 9 des Getriebes mündet. Der Planetenträger 9 ist das Antriebsglied des Getriebes 4 und seinerseits in einem Planetenträgerlager 10 im Gehäuse des Getriebes 4 gelagert. Die getriebeseitige Lagerung der Rotorwelle 5 ergibt sich folglich aus dem Planetenträger 9, dem Planetenträgerlager 10, dem Gehäuse des Getriebes 4 und der Getriebestütze 7. Bei konkreten Windkraftanlagen sind Rotorwelle 5 und Planetenträger 9 über eine in den symbolischen Zeichnungen nicht dargestellte Spannscheibe, auch Schrumpfscheibe genannt, lösbar miteinander verbunden.

[0031] Bevor das Getriebe 4 ausgetauscht werden kann, wird ein Joch 11 zwischen Rotorwelle 5 und Maschinenrahmen 2 eingesetzt; vgl. Figur 2b. Das Joch 11 umfasst unter anderem einen Bügel 12, eine Schelle 13 und einen Klemmschuh 14, der an einem Fuß 15 des Jochs 11 festgesetzt ist. Die Rotorwelle 5 wird zwischen Bügel 12 und Schelle 13 festgesetzt, der Klemmschuh 14 an dem Maschinenrahmen 2 befestigt. Das Joch 11 wird in der folgenden Reihenfolge montiert: Klemmschuhe 14 an dem Maschinenrahmen 2, Bügel 12 auf den Klemmschuhen 14, Schelle 13 an dem Bügel 12.

[0032] Nach Montage des Jochs 11 (Figur 2b) wird der nicht dargestellte "schnelle" Abschnitt des Triebstranges jenseits der Generatorwelle 8 abgeschlagen. Dann wird die nicht symbolisierte Spannscheibe zwischen Rotorwelle 5 und Planetenträger 9 sowie die Getriebestütze 7 zwischen dem Gehäuse des Getriebes 4 und dem Maschinenrahmen 2 gelöst. Alsdann wird das Getriebe 4 mit einem Kran aus der Windkraftanlage entnommen, s. hierzu Figur 2c. Das Moment M, welches der Rotor 3 in Folge der Gravitation g auf die Rotorwelle 5 ausübt, wird über das Joch 11 auf den Maschinenrahmen 2 abgestützt. Somit wird verhindert, dass die Rotorwelle 5 aus dem Rotorlager 6 ausbricht. Da Bügel 12 und Schelle 13

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die Rotorwelle 5 allseitig umschließen, werden auch Momente N über das Joch 11 in dem Maschinenrahmen 2 eingeleitet, die aus einer aufwärts gerichteten Nickbewegung des Rotors 3 resultieren. Darüber hinaus unterstützt das Joch 11 mittels Bügel 12 und Schelle 13 eine nicht dargestellte Rotorarretierung, so dass der Rotor 3 nicht ungewollt drehen kann.

[0033] In Figur 2d wurde ein Austausch-Getriebe 16 im Triebstrang 1 eingesetzt. Dieses wird wiederum über die Spannscheibe mit der Rotorwelle 5 und über die Getriebestützen 7 mit dem Maschinenrahmen 2 verbunden. Nach erfolgter Montage des Austauschgetriebes 16 kann das Joch 11 - wie in Figur 2e gezeigt - entfernt werden. Die Generatorwelle 8 wird wieder an den "schnellen" Abschnitt des Triebstranges 1 angeschlossen.

[0034] Figur 3 zeigt eine bevorzugte Ausführungsform des Jochs 11. Hauptbestandteil des Jochs 11 ist sein Bügel 12. Der Bügel 12 ist als verrippte Schweißkonstruktion aus Stahlplatten ausgeführt. Mittig weist er eine halbkreisförmige Bucht 17 auf, deren Innenseite aus halbzylindrischen Rohrabschnitt besteht. Konzentrisch zu der Innenseite der Bucht 17 verläuft die Innenseite der Schelle 13, welche über Gewindestangen 18 mit dem Bügel 12 verbunden ist. Die Innenseiten der Bucht 17 und der Schelle 13 verlaufen somit abschnittsweise entlang der Peripherie eines gedachten Kreises 19, welcher den Querschnitt der Rotorwelle 5 beschreibt. Die Gewindestangen 18 erstrecken sich tangential zu diesem Kreis 19. Beidseitig sind sie durch Durchgangslöcher in Schelle 13 und Bügel 12 hindurchgesteckt und in Muttergewinde 20 eingeschraubt. Selbstverständlich ist es auch möglich, an Stelle einer Gewindestange eine lange Schraube zu verwenden, die dementsprechend nur einseitig in ein Muttergewinde eingeschraubt wird und an der anderen Seite mit ihrem Kopf an dem dort befindlichen Bauteil anliegt. Durch Anziehen der Muttergewinde 20 kann eine zwischen Bucht 17 und Schelle 13 eingelegte Rotorwelle in dem Joch 11 festgeklemmt werden. Sofern die Gewindestangen 18 wie in dem vorgestellten Ausführungsbeispiel nicht einseitig gelenkig gelagert sind, werden sich diese beim Anziehen entsprechend verformen. Damit die Rotorwelle beim Festsetzen nicht an ihren Oberflächen durch metallischen Kontakt mit Schelle 13 oder Bucht 17 beschädigt wird, werden deren Innenseiten mit einem Polsterbelag 21 aus Polyamid oder einem anderen geeigneten Kunststoff verkleidet. Das Polyamid gleicht auch mögliche belastungsbedingte Formänderungen der Schelle 13 aus.

[0035] Jeweils endseitig weist der Bügel 12 einen als Fuß 15 zu bezeichnenden Bereich auf, an deren Unterseiten sich jeweils eine Sohle 22 erstreckt. Mittels Schrauben 23 kann ein in diesem Ausführungsbeispiel U-förmig gestalteter Klemmschuh 14 an der Sohle 22 befestigt werden. Der Klemmschuh 14 weist aufgrund seiner U-Form zwei Schenkel 24a, 24b auf, die dafür bestimmt sind, einen Überstand-artigen Bestandteil 25 des Maschinenrahmens 2 zu umschließen und ihn über Befestigungsschrauben 26 einzuklemmen.

[0036] Zur Höhenverstellung des Bügels 12 sind in dem sohlenseitigen Schenkel 24a des Klemmschuhs 14 zwei schiefe Ebenen 27a, 27b eingearbeitet, die aufeinander zu ansteigen. Zusammen mit den Innenflächen des sohlenseitigen Schenkels 24a und der Sohle 22 begrenzen die schiefen Ebenen 27a, 27b einen Raum 28. In diesen Raum 28 können durch Anziehen eines Bolzens 30 Keile 29a, 29b eingetrieben werden. Damit die beiden Keile 29a, 29b entlang der schiefen Ebenen 27a, 27b aufeinander zu bewegt werden können, ist der innere Keil 29b mit einem Gewinde versehen, in welchem ein Gewinde des Bolzens 30 eingeschraubt ist. Der äußere Keil 29a hingegen verfügt über eine gewindefreie Durchgangsbohrung, durch welche der Schaft des Bolzens 30 hindurchgesteckt ist.

[0037] Beim Anziehen des Bolzens 30 bewegen sich die Keile 29a und 29b aufeinander zu und heben über den Bügel 12 und die Schelle 13 die Rotorwelle 5 an. Die Höhenverstellung wird durch einen Vorsprung 31 begrenzt, an den die Keile 29a, 29b letztendlich anschlagen. Nach erfolgter Höheneinstellung werden Futterbleche 32 zwischen Sohle 22 und Oberseite des Klemmschuhs 14 eingelegt. Durch Festziehen der Schrauben 23 wird der Bügel 12 fest mit dem Klemmschuh 14 verbunden.

[0038] Es ist auch möglich, auf den inneren Keil 29b zu verzichten und den Bolzen 30 stattdessen in ein Gewinde einzuschrauben, welches sich durch den Vorsprung 31 erstrecken müsste. Der einfach wirkende Keil 29a würde eine entsprechend höheres Anzugsmoment für den Bolzen 30 erfordern. Ebenso ist es denkbar, an Stelle eines U-förmigen Klemmschuhs 14 eine andere Ausführungsform, wie zum Beispiel eine T-förmige zu wählen, die an die Geometrie des Maschinenrahmens 2 angepasst ist.

[0039] Figur 4 zeigt den aus Figur 1 bekannten Abschnitt des Triebstrangs 1 einer Windkraftanlage mit montiertem Joch 11 in der soeben dargestellten Ausführungsform. Bisher unerwähnt bleib die hier gezeichnete Spannscheibe 33, welche die Rotorwelle 5 lösbar mit dem Planetenträger 9 verbindet.

[0040] Das Joch 11 wird wie folgt montiert: Zunächst werden die Klemmschuhe 14 auf dem jeweiligen Bestandteil des Maschinenrahmens aufgeschoben und durch Anziehen der Befestigungsschrauben 26 auf dem Maschinenrahmen festgesetzt. Anschließend wird der Bügel 12 auf die Rotorwelle 5 herabgelassen, so dass er mit den Sohlen 22 auf den Klemmschuhen 14 zu liegen kommt. Beim Einschwenken des Bügels 12 helfen Kranösen 34. Alsdann wird unterhalb der Rotorwelle 5 die Schelle 13 angesetzt und über die Gewindestangen 18 mit dem Bügel 12 verbunden. Danach wird über das Anziehen des Bolzens 30 die Höheneinstellung vorgenommen und der dabei entstehende Spalt zwischen Sohle 22 und Klemmschuh 14 mit den Futterblechen 32 verfüllt. Nach Einlegen der Futterbleche 32 wird durch Festziehen der Schrauben 23 der Bügel 12 an seinen Füßen 15 mit den Klemmschuhen 14 fest verbunden. Das Joch 11

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ist nun komplett montiert und kann die sonst über die Getriebestützen 7a, 7b an den Maschinenrahmen 2 weitergegebenen Gewichtsmomente des Rotors abstützen. Das Joch 11 macht es möglich, das Getriebe 4 komplett zu entfernen, ohne zuvor die Rotornabe 3a abnehmen zu müssen. Nach Montage des Austausch-Getriebes 16 wird das Joch 11 wieder entfernt.

Patentansprüche

1. Verfahren zum Austausch eines Getriebes (4) einer Windkraftanlage, wobei die Windkraftanlage eine Rotorwelle (5) umfasst, die einen Rotor (3) mit dem auszutauschenden Getriebe (4) verbindet und die mittels eines rotorseitigen Rotorlagers (6) in einem Maschinenrahmen (2) drehbar gelagert ist, und wobei die Rotorwelle (5) während des Getriebetausches mittels einer getriebeseitigen Abstützung an dem Maschinenrahmen (2) abgestützt ist, so dass während des Getriebetausches ein Verbleiben des Rotors (3) an der Rotorwelle (5) gestattet ist, **dadurch gekennzeichnet, dass** es sich bei der Abstützung um ein Joch (11) handelt, welches unmittelbar vor dem Getriebetausch zwischen Rotorwelle (5) und Maschinenrahmen (2) montiert und unmittelbar nach dem Getriebetausch wieder entfernt wird.

2. Verfahren nach Anspruch 1, wobei die Rotorwelle (5) der Windkraftanlage ausschließlich in dem Rotorlager (6) und in dem Getriebe (4) drehbar gelagert ist.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Rotorwelle (5) an dem Joch (11) festgesetzt wird.

4. Joch (11) mit einem Bügel (12), der vorzugsweise mittig eine Bucht (17) aufweist, **gekennzeichnet durch** eine Schelle (13), die mittels Gewindestangen (18) mit dem Bügel (12) verbindbar ist, dergestalt, dass eine zwischen Bucht (17) und Schelle (13) befindliche Rotorwelle (5) **durch** Anziehen der Gewindestangen (18) zwischen Bucht (17) und Schelle (13) festklemmbar ist.

5. Joch (11) nach Anspruch 4, **dadurch gekennzeichnet, dass** das Joch (11) mindestens zwei Gewindestangen (18) umfasst, wobei jede Gewindestange (18) einerseits in ein am Bügel (12) angeordnetes Muttergewinde (20) und andererseits in ein an der Schelle (13) angeordnetes Muttergewinde (20) einschraubbar ist, und wobei sich jede Gewindestange (18) tangential zu einem Kreis (19) erstreckt, dessen Peripherie zumindest abschnittsweise entlang der Bucht (17) und entlang der Schelle (13) verläuft.

6. Joch (11) nach einem der Ansprüche 4 bis 5, **dadurch gekennzeichnet, dass** die Bucht (17) und die Schelle (13) an ihren Innenseiten mit einem Polsterbelag (21) belegt sind.

7. Joch (11) nach Anspruch 6, **dadurch gekennzeichnet, dass** es sich bei dem Polsterbelag (21) um eine Kunststoffschicht, insbesondere aus Polyamid handelt.

8. Joch (11) nach einem der Ansprüche 4 bis 7, **dadurch gekennzeichnet, dass** der Bügel (12) endseitig jeweils einen Fuß (15) mit einer nach unten gewandten Sohle (22) aufweist, an welcher ein Klemmschuh (14) festschraubbar ist.

9. Joch (11) nach Anspruch 8, **dadurch gekennzeichnet, dass** der Klemmschuh (14) U-förmig ausgebildet ist und mithin zwei Schenkel (24a, 24b) aufweist, zwischen denen ein Bestandteil (25) eines Maschinenrahmens (2) festklemmbar ist.

10. Joch (11) nach Anspruch 8, **dadurch gekennzeichnet, dass** der Klemmschuh (14) T-förmig ausgebildet ist.

11. Joch (11) nach einem der Ansprüche 8 bis 10, **dadurch gekennzeichnet, dass** der Klemmschuh (14) eine Befestigungsschraube (26) aufweist, mittels welcher der Klemmschuh (14) an dem Maschinenrahmen (2) festklemmbar ist.

12. Joch (11) nach einem der Ansprüche 4 bis 11, **gekennzeichnet durch** eine Höhenverstellung.

13. Joch (11) nach Anspruch 12, **dadurch gekennzeichnet, dass** als Höhenverstellung in einem sohlenseitigen Schenkel (24a) des Klemmschuhs (14) mindestens eine schiefe Ebene (27a) eingearbeitet ist, dass der Klemmschuh (14) einen Keil (29a) umfasst, der einerseits an der Sohle (22) und andererseits an der schiefen Ebene (27a) anliegt, und dass der Keil (29a) mittels eines Bolzens (30) in einen von Sohle (22) und schiefer Ebene (27a) begrenzten Raum (28) eintreibbar ist.

14. Joch (11) nach Anspruch 13, **dadurch gekennzeichnet, dass** der Klemmschuh (14) zwei schiefe Ebenen (27a, 27b) und zwei Keile (29a, 29) umfasst, wobei die Keile (29a, 29b) durch Anziehen des Bolzens (30) aufeinander zu treibbar sind.

15. Joch (11) nach Anspruch 13 oder 14, **gekennzeichnet durch** mindestens ein Futterblech (32), welches in einen Spalt zwischen Sohle (22) und Klemmschuh (14) einlegbar ist, der bei Höhenverstellung des Jochs (11) entsteht.

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16. Verwendung eines Jochs (11) nach einem der Ansprüche 4 bis 15 in einem Verfahren nach einem der Ansprüche 1 bis 3.

Geänderte Patentansprüche gemäss Regel 86(2) EPÜ.

1. Verfahren zum Austausch eines Getriebes (4) einer Windkraftanlage, wobei die Windkraftanlage eine Rotorwelle (5) umfasst, die einen Rotor (3) mit dem auszutauschenden Getriebe (4) verbindet und die mittels eines rotorseitigen Rotorlagers (6) in einem Maschinenrahmen (2) drehbar gelagert ist, und wobei die Rotorwelle (5) während des Getriebetausches mittels einer getriebeseitigen Abstützung an dem Maschinenrahmen (2) abgestützt ist, so dass während des Getriebetausches ein Verbleiben des Rotors (3) an der Rotorwelle (5) gestattet ist, **dadurch gekennzeichnet, dass** es sich bei der Abstützung um ein Joch (11) handelt, welches unmittelbar vor dem Getriebetausch zwischen Rotorwelle (5) und Maschinenrahmen (2) montiert und unmittelbar nach dem Getriebetausch wieder entfernt wird, und dass die Rotorwelle (5) an dem Joch (11) festgesetzt wird.

2. Vorrichtung zur Durchführung von Wartungsarbeiten an dem Triebstrang einer Windkraftanlage, insbesondere zum Austausch des Getriebes der Windkraftanlage, genannt Joch (11), mit einem Bügel (12), der vorzugsweise mittig eine Bucht (17) aufweist, und mit einer Schelle (13), die mittels Gewindestangen (18) mit dem Bügel (12) verbindbar ist, dergestalt, dass eine zwischen Bucht (17) und Schelle (13) befindliche Rotorwelle (5) durch Anziehen der Gewindestangen (18) zwischen Bucht (17) und Schelle (13) festklemmbar ist.

3. Joch (11) nach Anspruch 2, **dadurch gekennzeichnet, dass** das Joch (11) mindestens zwei Gewindestangen (18) umfasst, wobei jede Gewindestange (18) einerseits in ein am Bügel (12) angeordnetes Muttergewinde (20) und andererseits in ein an der Schelle (13) angeordnetes Muttergewinde (20) einschraubbar ist, und wobei sich jede Gewindestange (18) tangential zu einem Kreis (19) erstreckt, dessen Peripherie zumindest abschnittsweise entlang der Bucht (17) und entlang der Schelle (13) verläuft.

4. Joch (11) nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** die Bucht (17) und die Schelle (13) an ihren Innenseiten mit einem Polsterbelag (21) belegt sind.

5. Joch (11) nach Anspruch 4, **dadurch gekennzeichnet, dass** es sich bei dem Polsterbelag (21) um eine Kunststoffschicht, insbesondere aus Polyamid handelt.

6. Joch (11) nach einem der Ansprüche 2 bis 5, **dadurch gekennzeichnet, dass** der Bügel (12) endseitig jeweils einen Fuß (15) mit einer nach unten gewandten Sohle (22) aufweist, an welcher ein Klemmschuh (14) festschraubbar ist.

7. Joch (11) nach Anspruch 6, **dadurch gekennzeichnet, dass** der Klemmschuh (14) U-förmig ausgebildet ist und mithin zwei Schenkel (24a, 24b) aufweist, zwischen denen ein Bestandteil (25) eines Maschinenrahmens (2) festklemmbar ist.

8. Joch (11) nach Anspruch 6, **dadurch gekennzeichnet, dass** der Klemmschuh (14) T-förmig ausgebildet ist.

9. Joch (11) nach einem der Ansprüche 6 bis 8, **dadurch gekennzeichnet, dass** der Klemmschuh (14) eine Befestigungsschraube (26) aufweist, mittels welcher der Klemmschuh (14) an dem Maschinenrahmen (2) festklemmbar ist.

10. Joch (11) nach einem der Ansprüche 2 bis 9, **gekennzeichnet durch** eine Höhenverstellung.

11. Joch (11) nach Anspruch 10, **dadurch gekennzeichnet, dass** als Höhenverstellung in einem sohlenseitigen Schenkel (24a) des Klemmschuhs (14) mindestens eine schiefe Ebene (27a) eingearbeitet ist, dass der Klemmschuh (14) einen Keil (29a) umfasst, der einerseits an der Sohle (22) und andererseits an der schiefen Ebene (27a) anliegt, und dass der Keil (29a) mittels eines Bolzens (30) in einen von Sohle (22) und schiefer Ebene (27a) begrenzten Raum (28) eintreibbar ist.

12. Joch (11) nach Anspruch 11, **dadurch gekennzeichnet, dass** der Klemmschuh (14) zwei schiefe Ebenen (27a, 27b) und zwei Keile (29a, 29) umfasst, wobei die Keile (29a, 29b) durch Anziehen des Bolzens (30) aufeinander zu treibbar sind.

13. Joch (11) nach Anspruch 11 oder 12, **gekennzeichnet durch** mindestens ein Futterblech (32), welches in einen Spalt zwischen Sohle (22) und Klemmschuh (14) einlegbar ist, der bei Höhenverstellung des Jochs (11) entsteht.

14. Verwendung eines Jochs (11) nach einem der Ansprüche 2 bis 13 in einem Verfahren nach Anspruch 1.

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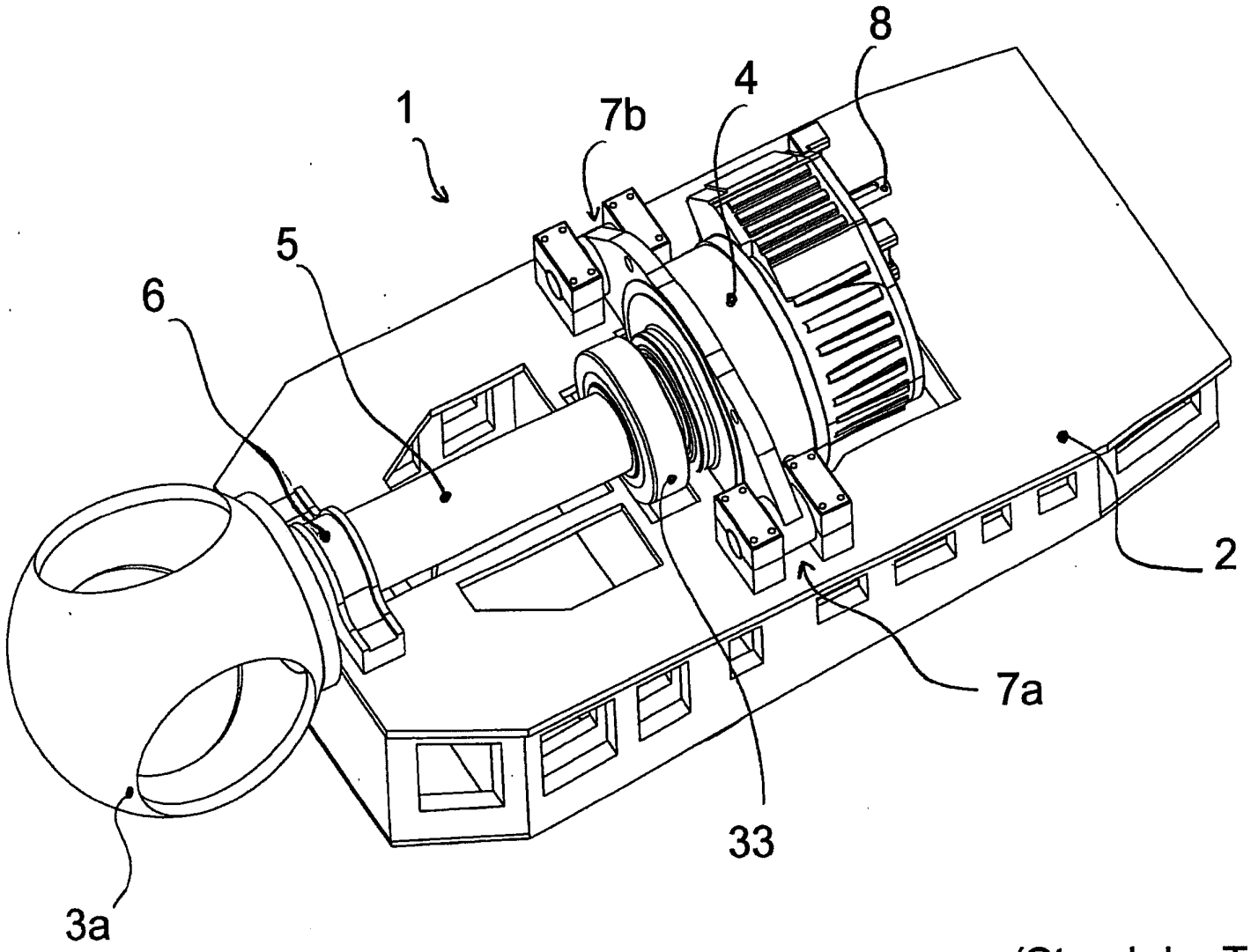


Fig. 1

(Stand der Technik)

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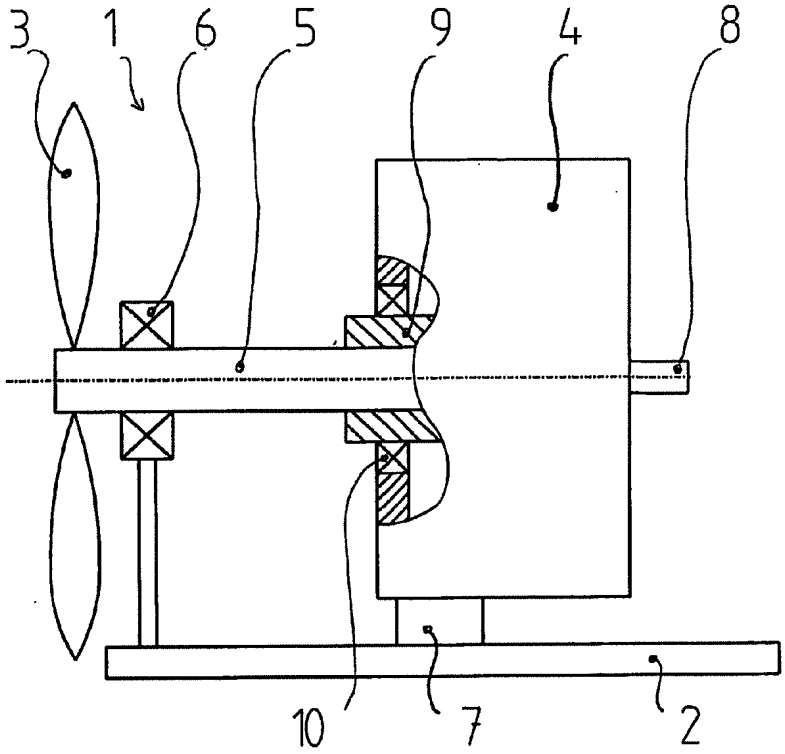


Fig. 2a

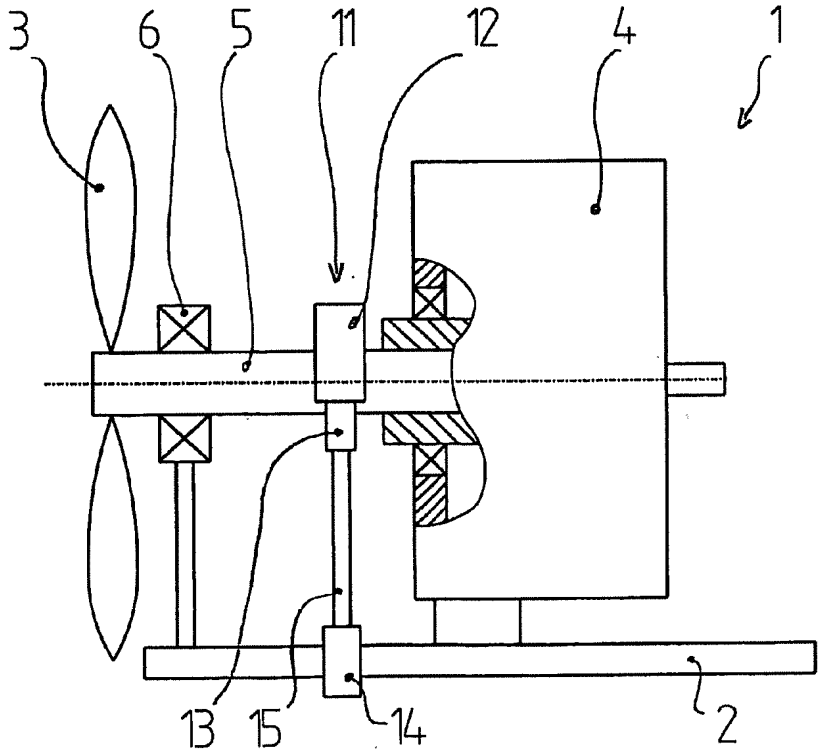


Fig. 2b

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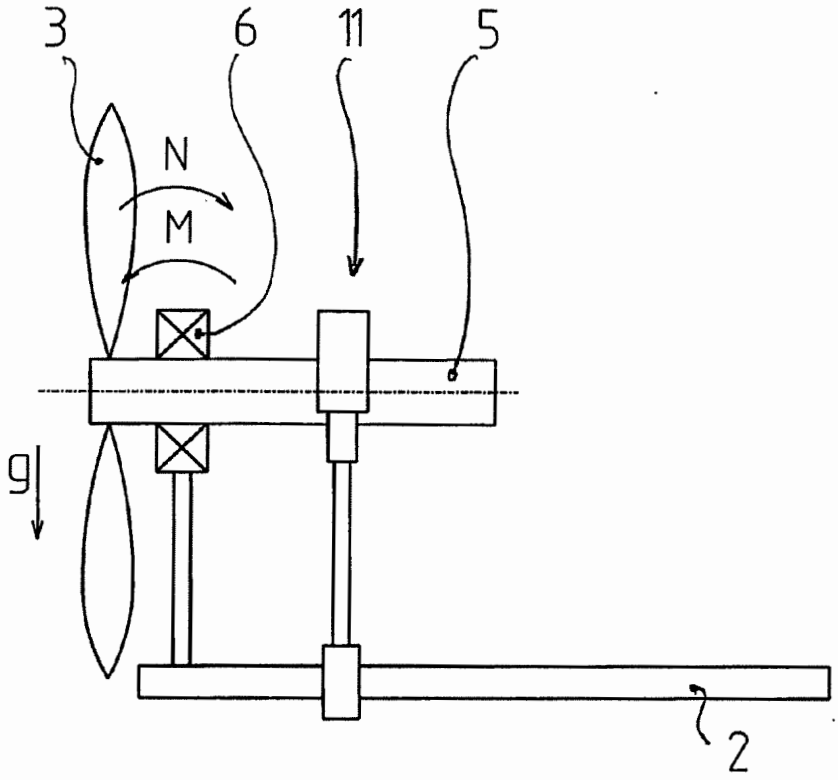


Fig. 2c

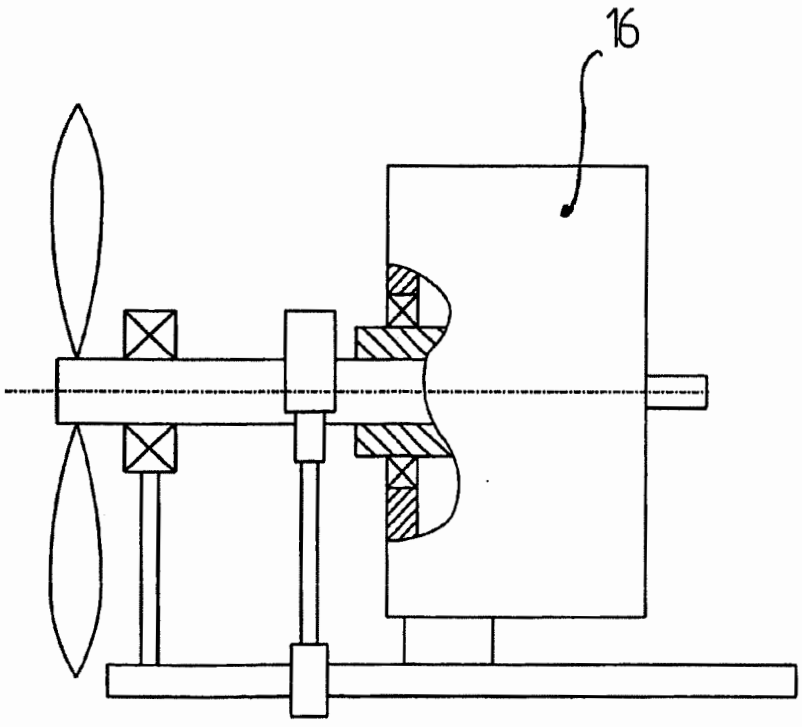


Fig. 2d

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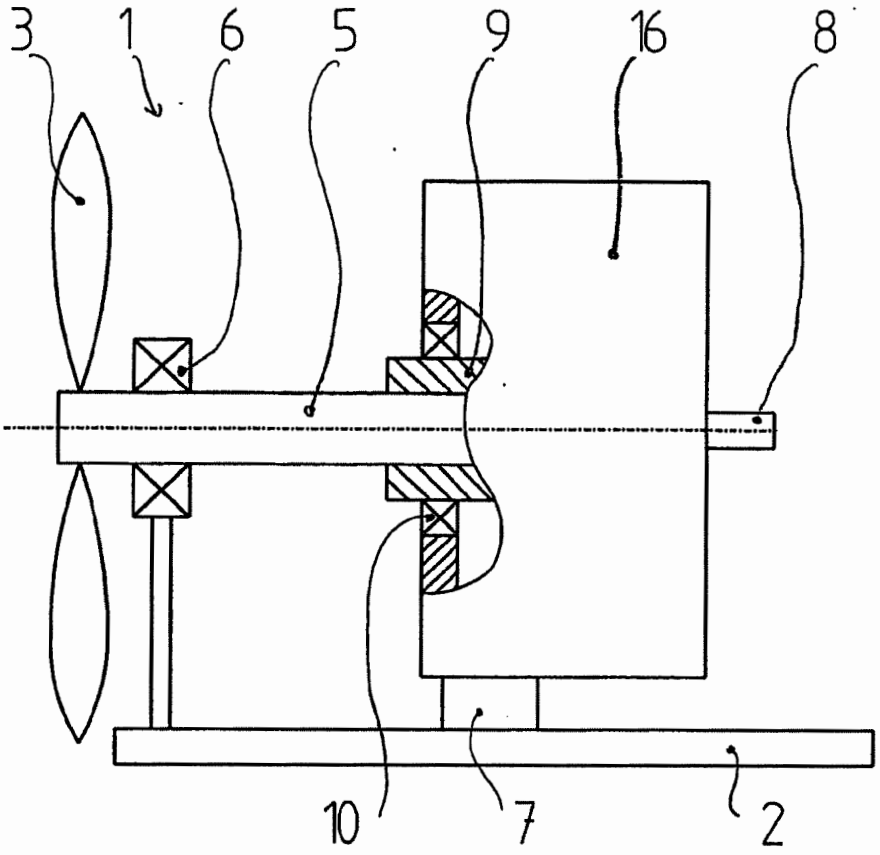


Fig. 2e

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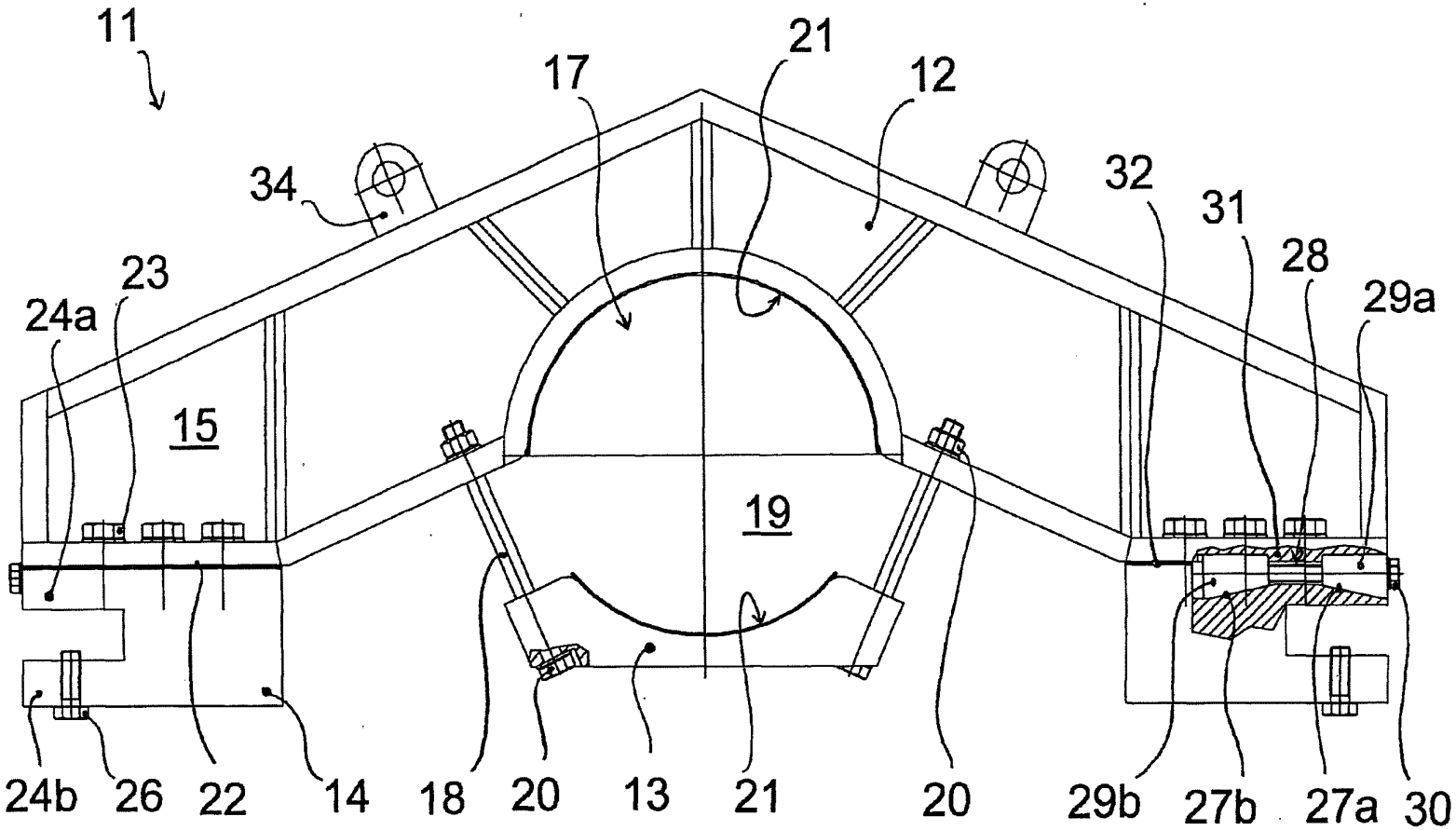


Fig. 3

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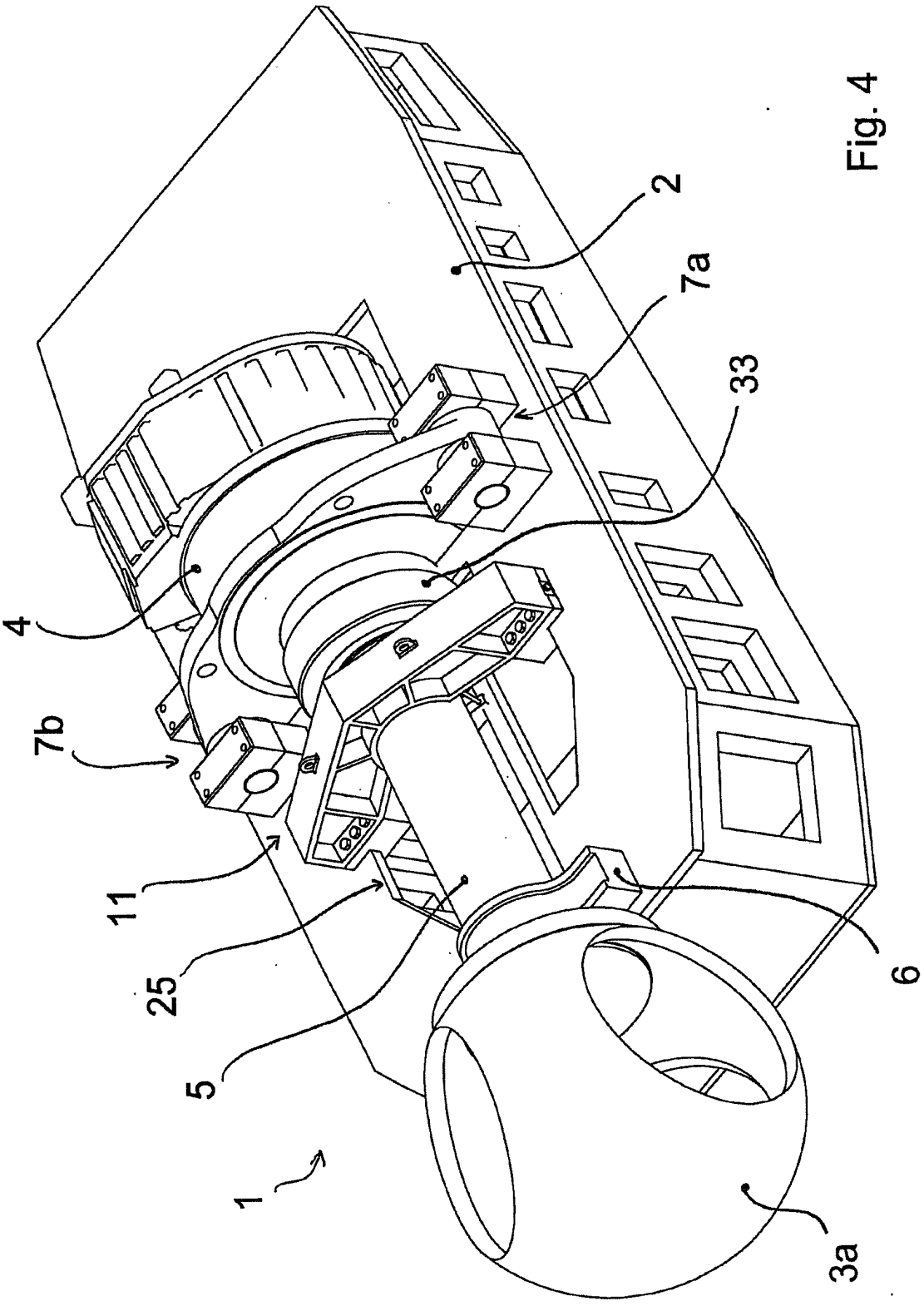


Fig. 4

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Europäisches Patentamt

EUROPÄISCHER RECHERCHENBERICHT

Nummer der Anmeldung
EP 04 01 6387

EINSCHLÄGIGE DOKUMENTE

Kategorie	Kennzeichnung des Dokuments mit Angabe, soweit erforderlich, der maßgeblichen Teile	Betrifft Anspruch	KLASSIFIKATION DER ANMELDUNG (Int.Cl.7)
X	US 158 976 A (PFAUTZ ET AL) 19. Januar 1875 (1875-01-19) * Seite 1, linke Spalte, Zeile 20 - rechte Spalte, Zeile 19 * * Abbildung 1 * -----	4	F03D1/00
A	US 2004/041407 A1 (PETTERSEN TOROLF ET AL) 4. März 2004 (2004-03-04) * Abbildungen 6,7 * -----	1-16	
A	EP 1 291 521 A (TURBOWINDS N V S A) 12. März 2003 (2003-03-12) * Abbildungen 6-11 * -----	1-16	

RECHERCHIERTE SACHGEBIETE (Int.Cl.7)

F03D

Der vorliegende Recherchenbericht wurde für alle Patentansprüche erstellt

Recherchenort	Abschlußdatum der Recherche	Prüfer
Den Haag	9. Dezember 2004	Steinhauser, U

KATEGORIE DER GENANNTEN DOKUMENTE

X : von besonderer Bedeutung allein betrachtet
Y : von besonderer Bedeutung in Verbindung mit einer anderen Veröffentlichung derselben Kategorie
A : technologischer Hintergrund
O : nichtschriftliche Offenbarung
P : Zwischenliteratur

T : der Erfindung zugrunde liegende Theorien oder Grundsätze
E : älteres Patentdokument, das jedoch erst am oder nach dem Anmeldedatum veröffentlicht worden ist
D : in der Anmeldung angeführtes Dokument
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& : Mitglied der gleichen Patentfamilie, übereinstimmendes Dokument

1 EPO FORM 1503 03.82 (P04C03)

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ANHANG ZUM EUROPÄISCHEN RECHERCHENBERICHT ÜBER DIE EUROPÄISCHE PATENTANMELDUNG NR. EP 04 01 6387

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten europäischen Recherchenbericht angeführten Patentdokumente angegeben.
Die Angaben über die Familienmitglieder entsprechen dem Stand der Datei des Europäischen Patentamts am
Diese Angaben dienen nur zur Unterrichtung und erfolgen ohne Gewähr.

09-12-2004

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Für nähere Einzelheiten zu diesem Anhang : siehe Amtsblatt des Europäischen Patentamts, Nr.12/82

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Espacenet

Bibliographic data: DE102006013539 (A1) — 2007-09-27

Rotor shaft support for wind powered generator has support frame to hold the shaft for access to the bearing and gearbox

Inventor(s): TIRDEA LIANA CHRISTINA [DE] ± (TIRDEA, LIANA CHRISTINA)

Applicant(s): NORDEX ENERGY GMBH [DE] ± (NORDEX ENERGY GMBH)

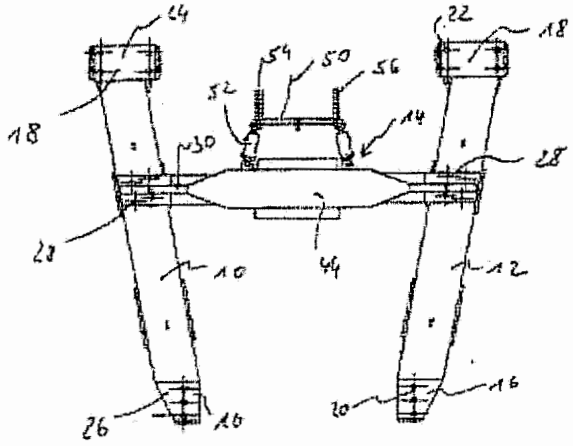
Classification: - international: ***F03D11/04***
- cooperative: **F03D13/20**; Y02E10/728

Application number: DE20061013539 20060324

Priority number(s): DE20061013539 20060324

Abstract of DE102006013539 (A1)

A rotor shaft support frame, for supporting the rotor shaft of a wind powered generator during maintenance and assembly has two support arms (10, 12) secured to the machine frame at each end via threaded fasteners. The frame includes a neoprene covered support platform onto which the end of the rotor shaft is located. The frame enables the rotor shaft to be supported while disengaged from the gearbox. The support arms are fitted an inclined position.



(19) Bundesrepublik Deutschland
Deutsches Patent- und Markenamt

(10) **DE 10 2006 013 539 A1** 2007.09.27

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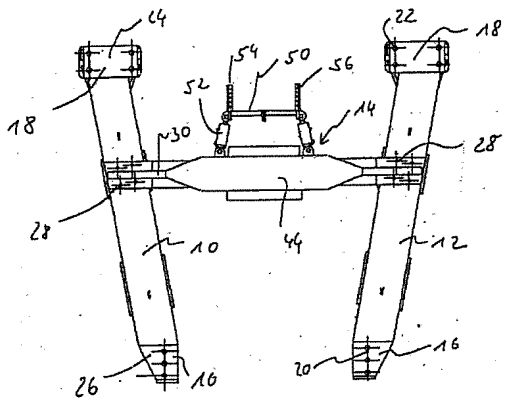
(56) Für die Beurteilung der Patentfähigkeit in Betracht gezogene Druckschriften:
DE20 2004 020317 U1
AT 4 03 189 B
EP 16 17 075 A1
EP 12 91 521 A1

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

Prüfungsantrag gemäß § 44 PatG ist gestellt.

(54) Bezeichnung: **Windenergieanlage mit einer Halteeinrichtung für eine Rotorwelle**

(57) Zusammenfassung: Windenergieanlage mit einem Maschinenträger und einem Getriebe, dessen Eingang mit einer Rotorwelle gekoppelt ist, die durch das Getriebe und mindestens ein separates Lager abgestützt ist, wobei ferner eine Halteeinrichtung vorgesehen ist, die die Rotorwelle in einer vorbestimmten Position hält, wenn eine Abstützung der Rotorwelle durch das Getriebe fehlt, die Halteeinrichtung weist mindestens zwei Träger und eine zwischen diesen angeordnete Rotorhalterung auf, wobei jeder Träger der Halteeinrichtung in mindestens zwei Bereichen sich auf dem Maschinenträger abstützt.



Beschreibung

[0001] Die vorliegende Erfindung betrifft eine Windenergieanlage mit einem Maschinenträger und einem auf diesem angeordneten Getriebe, dessen Eingang mit einer Rotorwelle gekoppelt ist. Die Rotorwelle wird durch das Getriebe und mindestens ein separates Lager gehalten.

[0002] Erich Hau, Windkraftanlagen, zweite überarbeitete und aktualisierte Auflage, Springer 1996, Seiten 242–247 beschreibt unterschiedliche Varianten der Rotorlagerung. So ist für eine Lagerwelle beschrieben, separate Lager vorzusehen. Ferner ist bekannt, eine Rotorlagerung vollständig im Getriebe oder auf einer stehenden, hohlen Achse vorzunehmen. Auch kann das hintere Lager in das Getriebe integriert und das vordere Lager als separates Lager ausgebildet sein. Das separate Lager für die Rotorwelle kann mit einem gesonderten Lagersockel auf einem Maschinenträger abgestützt sein. Der Maschinenträger kann in einem Maschinenhaus oder in eine lasttragende Maschinenhausvorderwand integriert sein. Die zuletzt genannten Lagerarten werden als Dreipunktlagerung bezeichnet, wobei die vordere Lagerung der Rotorwelle das Haupt- oder Rotorlager bildet und die hintere Lagerung durch das Getriebe übernommen wird, das sich seinerseits seitlich (links und rechts) auf dem Maschinenträger abstützt. Mit der Rotorwelle und dadurch mit dem Triebstrang verbunden und von diesem getragen ist der Rotor bestehend aus der Rotornabe und den Rotorblättern. Bei Wartungs- und Reparaturarbeiten am Triebstrang, zu denen das Getriebe demontiert werden muß, ist es erforderlich, den Rotor zusammen mit dem Triebstrang zu demontieren. Dies ist mit einem erheblichen Arbeitsaufwand verbunden.

[0003] EP 1 291 521 A1 schlägt vor, die Rotornabe mit dem Maschinenträger oder der vorderen Wand des Maschinenhauses zu verschrauben, so dass der Rotor an der Windenergieanlage verbleiben kann, während das Getriebe repariert und aus dem Maschinenhaus herausgehoben wird.

[0004] Aus AT 403 189 B ist eine Windenergieanlage mit einem Getriebe bekannt, dessen Eingang mit einer Rotorwelle gekoppelt ist, die ein separates Lager aufweist. Ferner ist dort zwischen Lager und Getriebe eine Halteeinrichtung vorgesehen, die die Rotorwelle in einer vorbestimmten Position halten kann, wenn sie montiert ist. Die Halteeinrichtung dient als Lager, das die Rotorwelle drehbar hält.

[0005] Aus EP 1 617 075 A2 ist eine Vorrichtung bekannt, die eine rotorseitig gelagerte Rotorwelle in einer Windenergieanlage bei einem Austausch des Getriebes hält. Die Vorrichtung besitzt ein Joch mit einem Bügel, der eine Bucht zur Aufnahme der Rotorwelle und eine Schelle zum Festklemmen der Rotorwelle zwischen Bucht und Schelle aufweist. Das Joch steht auf einem Maschinenträger, zwischen Rotorlager und Getriebe.

[0006] Der Erfindung liegt die Aufgabe zugrunde, mit einfachen Mitteln eine Möglichkeit zu schaffen, um bei einer Windenergieanlage Arbeiten am Getriebe ausführen zu können, ohne dabei den Triebstrang weitgehend demontieren zu müssen.

[0007] Erfindungsgemäß wird die Aufgabe durch eine Windenergieanlage mit den Merkmalen aus Anspruch 1 gelöst. Vorteilhafte Gestaltungen bilden die Gegenstände der Unteransprüche.

[0008] Die erfindungsgemäße Windenergieanlage weist einen Maschinenträger und ein Getriebe auf. Der Eingang des Getriebes ist mit einer Rotorwelle gekoppelt, die durch das Getriebe und mindestens ein separates Lager abgestützt ist. Für die Windenergieanlage ist eine Halteeinrichtung vorgesehen, die die Rotorwelle in einer vorbestimmten Position hält, wenn eine Abstützung der Rotorwelle durch das Getriebe fehlt. Die Halteeinrichtung weist mindestens zwei Träger auf, zwischen denen die Rotorhalterung angeordnet ist. Jeder der Träger der Halteeinrichtung stützt sich in mindestens zwei Bereichen auf dem Maschinenträger ab. Der Maschinenträger ist ein tragendes Bauteil in dem Maschinenhaus. Der besondere Vorteil der Halteeinrichtung liegt darin, dass diese in mindestens zwei Bereichen auf dem Maschinenträger aufliegt. Hierdurch wird ein Einsetzen der Halteeinrichtung erleichtert. Insbesondere stellt die Auflage in zwei Punkten sicher, dass die belastete Halteeinrichtung stabil steht.

[0009] Bevorzugt ist die Rotorhalterung zwischen den Abstützbereichen der Träger angeordnet. An der Rotorhalterung greift die von der Halteeinrichtung aufzunehmende Kraft an und wird durch die Abstützung in zwei Bereichen in den Maschinenträger geleitet.

[0010] Bevorzugt weist die Rotorhalterung eine Trägerplatte und mindestens einen Bügel auf, wobei der Bügel gemeinsam mit einer Ausnehmung in der Trägerplatte eine Rotorhalterung für die Rotorwelle bildet.

[0011] Die Rotorhalterung besteht aus mindestens zwei Teilen der Trägerplatte, die eine Aufnahme aufweist, und mindestens einem Bügel, der – mit der Trägerplatte verbunden – die Rotorwelle hält. Bevorzugt besitzt die Aufnahme an der Trägerplatte einen Flansch, der eine Anlagefläche für die Welle bildet. Auf diese Weise wird eine Beschädigung der Welle weitestgehend vermieden.

[0012] Zusätzlich ist die Anlagefläche mit einem Schutzmaterial ausgekleidet, wobei hier bevorzugt

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Neopren eingesetzt wird. Der Bügel besitzt ebenfalls eine Anlagefläche für die Welle.

[0013] Die Rotorhalterung besitzt zusätzlich einen Druckring, der mit der Halteeinrichtung verbunden ist. Der Druckring dient dazu, das gelöste Getriebe von der Rotorwelle zu schieben. Hierzu weist der Druckring bevorzugt Klötze zur Anlage an dem Getriebe auf, die gegenüber dem Druckring verschieblich angeordnet sind.

[0014] Zwischen dem Getriebe (Druckring) und der Trägerplatte sind bevorzugt zwei Hydraulikzylinder angebracht. Mittels dieser Zylinder wird das Getriebe zurückgedrückt. Die Zylinder erreichen bestimmten Hub, beispielsweise ungefähr 30 mm pro Hub. Das Getriebe wird also zunächst um den Hub gedrückt, dann werden die Zylinder zurück in ihre Nullposition gebracht. Anschließend wird ein Klotz, beispielsweise 30 mm breit, eingebracht. Dieser Schritt wird mehrfach wiederholt, bis das Getriebe von der Rotorwelle gelöst werden kann.

[0015] In einer bevorzugten Ausgestaltung liegt jeder Träger der Rotorhalterung an seinen Enden auf dem Maschinenträger auf, wobei bevorzugt die Enden der Träger mit Bohrungen versehen sind, so dass eine Befestigung an dem Maschinenträger erfolgen kann.

[0016] Eine bevorzugte Ausführung der erfindungsgemäßen Trägereinrichtung wird anhand der Figuren näher erläutert. Es zeigt:

[0017] Fig. 1 die Rotorhalterung in einer Draufsicht,

[0018] Fig. 2 eine perspektivische Ansicht einer Rotorhalterung und

[0019] Fig. 3 eine perspektivische Ansicht der auf die Welle montierten Rotorhalterung.

[0020] Fig. 1 zeigt zwei Träger **10**, **12**, zwischen denen eine Rotorhalterung **14** angeordnet ist. Die Träger **10**, **12** besitzen an ihren Enden **16**, **18** jeweils Durchgangsbohrungen, um über Bolzen verschraubt zu werden. An dem zum Rotorlager weisenden Ende der Halterung **16** sind drei Bohrungen vorgesehen, die sich ungefähr in Richtung der Rotorwelle erstrecken. An dem gegenüberliegenden Ende **18** des Trägers **12** sind vier in einem Rechteck zueinander angeordnete Bohrungen **22** vorgesehen. Der Träger **12** ist leicht schräg im Hinblick auf die Mittelachse der Rotorwelle angeordnet. Der zweite Träger **10** ist symmetrisch zur Mittelachse der Rotorwelle ebenfalls leicht schräg angeordnet, wobei die Bohrung an den Enden **24** und **26** spiegelsymmetrisch zu den Bohrungen an dem Träger **12** angeordnet sind.

[0021] Zwischen den Trägern **10** und **12** befindet sich die Rotorhalterung **14**, die über Bolzen **28** mit den Trägern **10** und **12** verbunden ist. Die Rotorhalterung **14** besitzt eine Trägerplatte **30**, die eine Ausnehmung mit einem Trägerflansch **32** besitzt. Der Trägerflansch **32** erstreckt sich ungefähr über 180° und ist als Anlagefläche für die zu haltende Rotorwelle vorgesehen. Der Trägerflansch **32** ist mit Neopren bei einer Dicke von ungefähr 4 mm ausgekleidet. Abgestützt wird der Anlageflansch **32** durch fünf Rippen **34**, die sich strahlenförmig von der Anlagefläche **32** zum äußeren Rand der Trägerplatte **30** erstrecken. Die am weitesten außen liegenden Rippen **36**, **38** gehen in Anlageflansche **40**, **42** für die Träger **10**, **12**, über. Am oberen Ende ist die Halteplatte **30** mit einer Querplatte **44** versehen, die zur Befestigung der inneren Rippen auf der Trägerplatte **30** dient.

[0022] Gehalten wird die Rotorwelle durch ein Paar von angesetzten Bügeln **46**, die mit der Trägerplatte verbunden werden. Die Bügel **46** sind auf ihrer Innenseite ebenfalls mit einer Neoprenbeschichtung versehen. Fixiert werden die Bügel **46** an der Trägerplatte über Bolzen **48**.

[0023] Auf einer Seite der Trägerplatte **30** ist ein Druckring **50** vorgesehen, der über Hydraulikzylinder **52** vor der Trägerplatte gehalten wird. Seitlich besitzt der Druckring **50** einen Stapel von Klötzen **54** und **56**, die an einer Hohlwelle des Getriebes anliegen. Über die Hydraulikzylinder **52** werden die Klötze **54**, **56** gegen die Hohlwelle **58** des Getriebes gedrückt und schieben das Getriebe von der Rotorwelle **60** (vgl. Fig. 3). Jeweils nach einem Hub eines Hydraulikzylinders **52** wird ein oder mehrere Klötze nachgelegt, um durch erneute Betätigung der Hydraulikzylinder **52** das Getriebe weiter zu verschieben.

[0024] Fig. 3 zeigt eine perspektivische Ansicht der erfindungsgemäßen Rotorhalterung auf einem Maschinenträger **59**.

Patentansprüche

1. Windenergieanlage mit einem Maschinenträger und einem Getriebe, dessen Eingang mit einer Rotorwelle gekoppelt ist, die durch das Getriebe und mindestens ein separates Lager abgestützt ist, wobei ferner eine Halteeinrichtung vorgesehen ist, die die Rotorwelle in einer vorbestimmten Position hält, wenn eine Abstützung der Rotorwelle durch das Getriebe fehlt, die Halteeinrichtung weist mindestens zwei Träger (**10**, **12**) und eine zwischen diesen angeordnete Rotorhalterung auf, **dadurch gekennzeichnet**, dass jeder Träger (**10**, **12**) der Halteeinrichtung in mindestens zwei Bereichen (**16**, **18**) sich auf dem Maschinenträger (**59**) abstützt.

2. Windenergieanlage nach Anspruch 1, dadurch gekennzeichnet, dass die Rotorhalterung zwischen den Abstützbereichen der Träger (**10**, **12**) angeordnet

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ist.

3. Windenergieanlage nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass die Rotorhalterung eine Trägerplatte (**30**) und mindestens einen Bügel (**46**) aufweist, wobei der Bügel (**46**) gemeinsam mit einer Ausnehmung in der Trägerplatte (**30**) eine Halteeinrichtung für die Rotorwelle bildet.

4. Windenergieanlage nach Anspruch 3, dadurch gekennzeichnet, dass die Aufnahme an der Trägerplatte (**30**) eine Anlagefläche für die Rotorwelle besitzt.

5. Windenergieanlage nach Anspruch 3 oder 4, dadurch gekennzeichnet, dass der Bügel (**46**) eine Anlagefläche für die Rotorwelle besitzt.

6. Windenergieanlage nach Anspruch 4 oder 5, dadurch gekennzeichnet, dass die Anlagefläche mit einem Schutzmaterial ausgekleidet ist.

7. Windenergieanlage nach Anspruch 6, dadurch gekennzeichnet, dass als Schutzmaterial Neopren vorgesehen ist.

8. Windenergieanlage nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, dass die Rotorhalterung mit einem Druckring (**50**) versehen ist, der über mindestens einen Hydraulikzylinder mit der Trägerplatte (**30**) verbunden ist.

9. Windenergieanlage nach Anspruch 1 bis 10, dadurch gekennzeichnet, dass jeder Träger (**10**, **12**) an seinen Enden auf dem Maschinenträger (**59**) aufliegt.

10. Windenergieanlage nach Anspruch 11, dadurch gekennzeichnet, dass jeder Träger (**10**, **12**) an seinem Ende Bohrungen aufweist, die zur Befestigung an dem Maschinenträger (**59**) dienen.

Es folgen 3 Blatt Zeichnungen

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Anhängende Zeichnungen

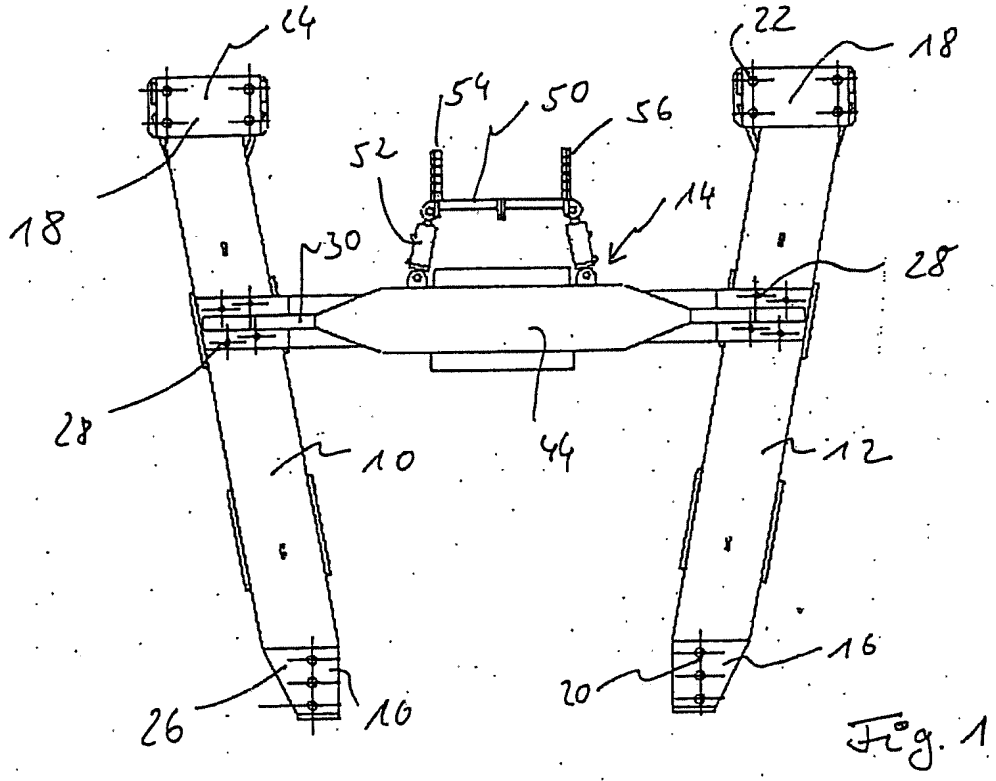


Fig. 1

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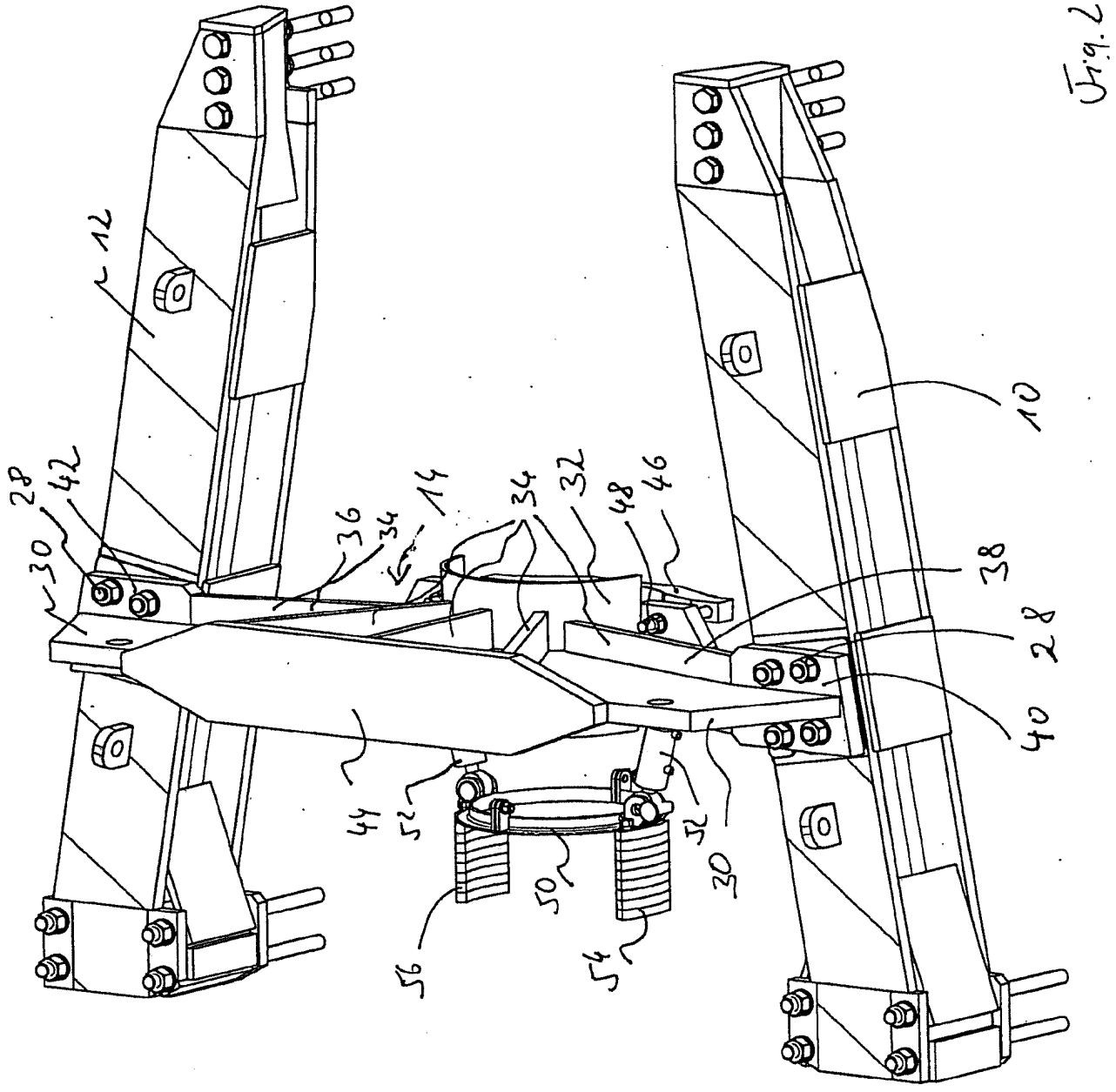


Fig. 2

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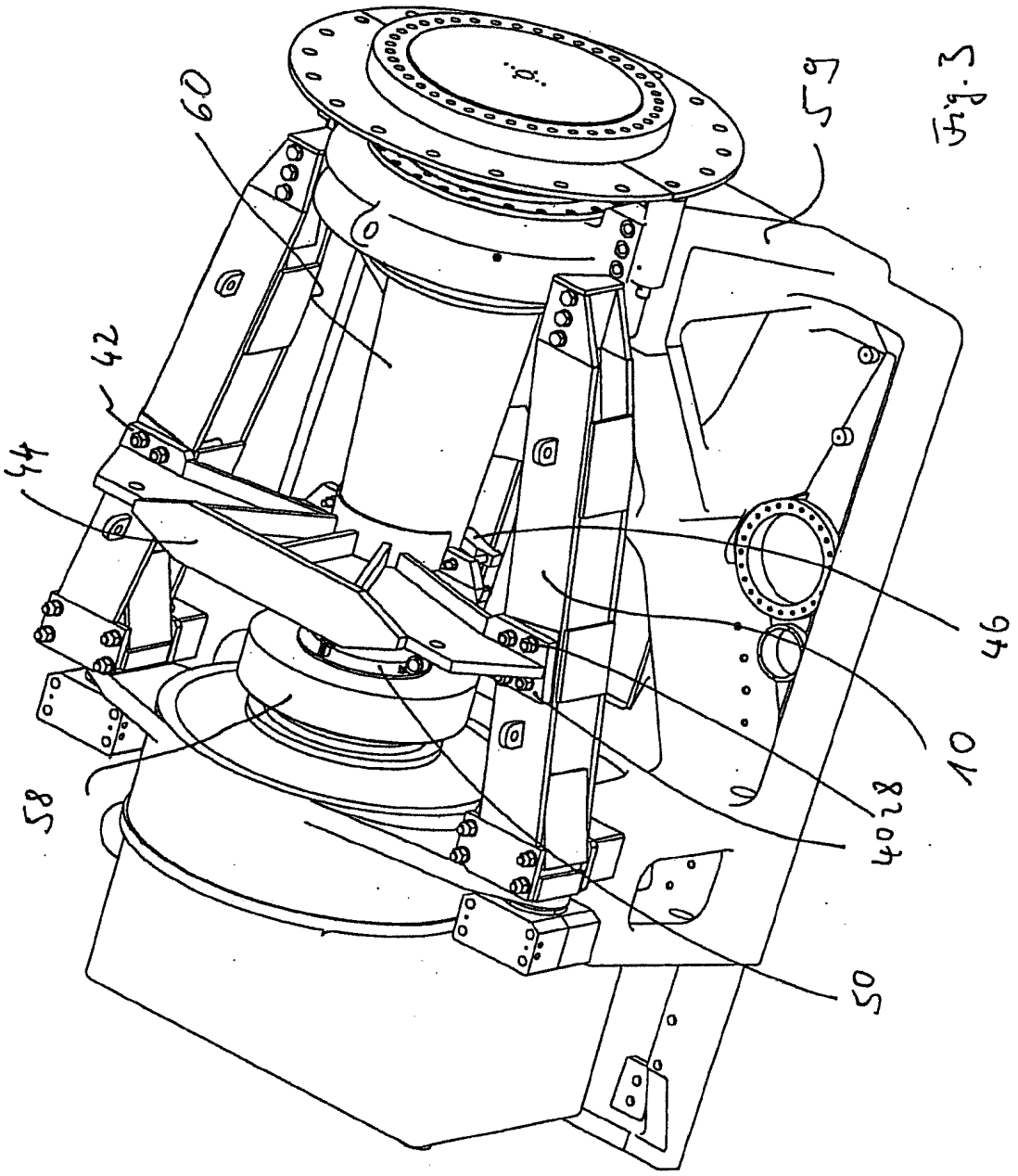


Fig. 3

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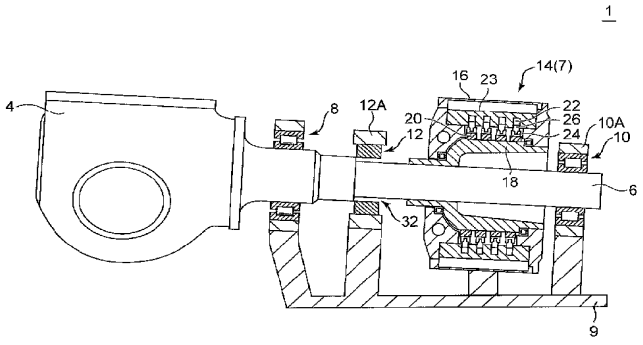
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— 国際調査報告（条約第 21 条(3)）

(54) **Title**: WIND POWER GENERATION DEVICE

(54) 発明の名称 : 風力発電装置



(57) **Abstract**: A wind power generation device comprises: a hub; a rotating shaft configured so as to rotate together with the hub; a front bearing for pivotably supporting the rotating shaft; a rear bearing for pivotably supporting the rotating shaft, the rear bearing being provided to a position separated farther from the hub than the front bearing; a driven unit provided between the front bearing and the rear bearing and configured so as to be driven by the rotating shaft; and an auxiliary bearing provided between the front bearing and the driven unit. The auxiliary bearing is configured so as to not support a load from the rotating shaft while the rear bearing is attached to the rotating shaft, and to assist the front bearing to pivotably support the rotating shaft when the rear bearing has been removed from the rotating shaft.

(57) 要約:

[続葉有]

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風力発電装置は、ハブと、前記ハブとともに回転するように構成された回転シャフトと、前記回転シャフトを軸支するためのフロント軸受と、前記フロント軸受よりも前記ハブから離れた位置に設けられ、前記回転シャフトを軸支するためのリア軸受と、前記フロント軸受と前記リア軸受の間に設けられ、前記回転シャフトによって駆動されるように構成された被駆動ユニットと、前記フロント軸受と前記被駆動ユニットとの間に設けられる補助軸受とを備え、前記補助軸受は、前記リア軸受が前記回転シャフトに取り付けられた状態では前記回転シャフトからの荷重を支持せず、前記リア軸受が前記回転シャフトから取り外されたときに前記フロント軸受を補助して前記回転シャフトを軸支するように構成されている。

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明　細　書

発明の名称 ： 風力発電装置

技術分野

[0001] 本開示は、風力発電装置に関する。

背景技術

[0002] 近年、環境意識の高まりから、再生エネルギー型発電装置として風力発電装置が注目されている。風力発電装置は、一般に、複数のブレードがハブに取り付けられたロータを有する。ロータは、陸上又は洋上に立設されたタワー上に位置するナセルに搭載される。この種の風力発電装置では、ブレードが風を受けてロータが回転し、ドライブトレインパート（Drive Train Part）によってナセル内に収納された発電機に伝達され、発電機において電力が生成されるようになっている。

[0003] 特許文献１には、ドライブトレインパートとして油圧ポンプ及び油圧モータを用いた風力発電装置が開示されている。この風力発電装置では、ロータの回転が回転シャフトを介して油圧ポンプに伝達される。油圧ポンプが回転シャフトによって駆動されることにより圧油を生成し、該圧油によって油圧モータを駆動するようになっている。そして、油圧モータに連結された発電機において、油圧モータから入力された回転エネルギーを電気エネルギーに変換して発電している。

先行技術文献

特許文献

[0004] 特許文献1：米国特許出願公開２０１０／００３２９５９号明細書

発明の概要

発明が解決しようとする課題

[0005] 特許文献１には、軸受及び油圧ポンプの幾つかの配置例が開示されている。しかしながら、油圧ポンプに代表される被駆動ユニット（回転シャフトによって駆動されるユニット）のメンテナンス性向上や、軸受荷重の軽減や、

軸受の構造簡素化などの目的に適うような軸受及び被駆動ユニットの配置については十分に確立されているとはいえない。

[0006] 本発明の少なくとも一実施形態の目的は、被駆動ユニットのメンテナンス性に優れるとともに軸受荷重が小さい風力発電装置を提供することである。また、本発明の他の実施形態の目的は、回転シャフトを軸支する軸受の構造が簡素な風力発電装置を提供することである。

課題を解決するための手段

[0007] 本発明の少なくとも一実施形態に係る風力発電装置は、少なくとも一本のブレードと、前記少なくとも一本のブレードが取り付けられるハブと、前記ハブとともに回転するように構成された回転シャフトと、前記回転シャフトを軸支するためのフロント軸受と、前記フロント軸受よりも前記ハブから離れた位置に設けられ、前記回転シャフトを軸支するためのリア軸受と、前記フロント軸受と前記リア軸受の間に設けられ、前記回転シャフトによって駆動されるように構成された被駆動ユニットと、前記フロント軸受と前記被駆動ユニットとの間に設けられる補助軸受とを備え、前記補助軸受は、前記リア軸受が前記回転シャフトに取り付けられた状態では前記回転シャフトからの荷重を支持せず、前記リア軸受が前記回転シャフトから取り外されたときに前記フロント軸受を補助して前記回転シャフトを軸支するように構成されたことを特徴とする。

[0008] 上記風力発電装置によれば、フロント軸受とリア軸受との間に被駆動ユニットを配置するようにしたので、回転シャフトの軸長を抑制しながら、比較的大きな軸受スパン（フロント軸受とリア軸受との間の距離）を確保することができる。よって、軸受荷重を低減することができる。

[0009] また、フロント軸受とリア軸受との間に配置された被駆動ユニットのメンテナンスを行う際、リア軸受を取り外す必要がある場合であっても、フロント軸受と補助軸受によって回転シャフトを軸支することができる。よって、フロント軸受に過度な荷重が加わることを防止しながら、被駆動ユニットのメンテナンス作業を容易に行うことができる。

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[0010] 一実施形態では、前記補助軸受は、前記回転シャフトと前記風力発電装置の静止部材との間において、前記リア軸受が前記回転シャフトに取り付けられた状態では前記回転シャフト又は前記静止部材の一方との間に隙間が形成されるように配置され、前記隙間の大きさは、前記リア軸受が前記回転シャフトから取り外されたときに前記補助軸受と前記回転シャフト又は前記静止部材の前記一方とが接触するように設定されている。

[0011] 一実施形態では、前記フロント軸受又は前記リア軸受の少なくとも一方がすべり軸受を含む。フロント軸受又はリア軸受の少なくとも一方に構造が簡素であるすべり軸受を用いることにより、風力発電装置の大型化への対応が可能になる。すなわち、風力発電装置の大型化によって軸受荷重は大きくなる傾向にあるが、風力発電装置の回転シャフトを軸支するための軸受として一般的に用いられている転がり軸受は、製造設備や製造技術の限界によってより一層の大型化は難しい場合がある。これに対し、すべり軸受は構造が比較的簡素であるため大型化が容易であり、大型の風力発電装置において想定される軸受荷重に耐えるような設計が可能である。

[0012] 一実施形態では、前記すべり軸受は、前記回転シャフトと前記すべり軸受のすべり面の間に供給される流体により前記回転シャフトを軸支するように構成された静圧軸受である。すべり軸受として静圧軸受を用いることにより、潤滑油として低粘度の油を使用する場合であっても、すべり軸受の負荷能力を高めることができる。また、すべり軸受をコンパクト化できる。

[0013] 一実施形態では、前記被駆動ユニットは油圧ポンプであり、前記流体は、前記油圧ポンプの作動油である。

[0014] 一実施形態では、前記すべり軸受のすべり面と前記回転シャフトとの間に保持され、ＶＧ１６０以上の粘度を有する潤滑油をさらに備える。粘度の高い潤滑油をすべり軸受のすべり面と回転シャフトの間に保持することにより、静圧軸受機構を設けることなく、すべり軸受のすべり面と回転シャフトの間に油膜を形成することができる。

[0015] 一実施形態では、前記すべり軸受のすべり面と前記回転シャフトとの間に

保持された潤滑用グリースをさらに備える。潤滑用グリースをすべり軸受のすべり面と回転シャフトの間に保持することにより、潤滑油供給用のポンプなどの構成が不要になり、潤滑系の構成が簡素化され、コストや重量の面で有利になる。

[0016] 一実施形態では、前記フロント軸受は前記すべり軸受であり、前記フロント軸受のハウジングの前記ハブ側の端部と前記フロント軸受の間に隙間が形成されている。

ロータに対する荷重（ロータの自重に起因した重力荷重や風荷重）は、ハブ中心近傍の荷重負荷点に作用する。この荷重負荷点は軸受支持点（フロント軸受の位置）からオーバハングしているため、軸受荷重としてのモーメント荷重に起因して、フロント軸受の片当たりが生じる場合がある。そこで、上述のように、フロント軸受（すべり軸受）のハウジングのハブ側の端部とフロント軸受との間に隙間を形成することで、フロント軸受のハブ側の端部の背面剛性が低下し、フロント軸受の片当たりが緩和される。したがって、片当たりに起因したフロント軸受の負荷能力の低下を抑制し、フロント軸受の高い負荷能力を確保することができる。

[0017] 一実施形態では、前記フロント軸受は前記すべり軸受であり、前記フロント軸受のハウジングの前記ハブ側の端部と前記フロント軸受の間に形成される前記隙間に前記ハウジングよりも剛性の低い部材が設けられている。

[0018] ハウジングよりも剛性の低い部材が前記隙間に設けられているため、フロント軸受のハブ側の端部の背面剛性が低下し、フロント軸受の片当たりを緩和できる。したがって、片当たりに起因したフロント軸受の負荷能力の低下を抑制し、フロント軸受の高い負荷能力を確保することができる。

[0019] 一実施形態では、前記フロント軸受は前記すべり軸受であり、前記フロント軸受と前記回転シャフトとの間に樹脂層が設けられている。樹脂層は剛性が低く外力に対して変形しやすいため、フロント軸受の片当たりが緩和される。したがって、片当たりに起因したフロント軸受の負荷能力の低下を抑制し、フロント軸受の高い負荷能力を確保することができる。

[0020] 一実施形態では、前記フロント軸受は前記すべり軸受であり、前記フロント軸受は、前記ハブ側の端部にスリットが形成されている。

[0021] 一実施形態では、前記フロント軸受は前記すべり軸受であり、前記フロント軸受のハウジングに対する前記フロント軸受の当接面は、少なくとも前記回転シャフトの軸方向において湾曲しており、前記フロント軸受に対する前記ハウジングの当接面は、少なくとも前記軸方向に湾曲しており、前記フロント軸受の前記当接面の反転形状である。

この場合、フロント軸受はハウジングに対して回動可能であるため、フロント軸受の片当たりが緩和される。したがって、片当たりに起因したフロント軸受の負荷能力の低下を抑制し、フロント軸受の高い負荷能力を確保することができる。

[0022] 一実施形態では、前記フロント軸受が前記すべり軸受を含み、前記リア軸受は、前記フロント軸受を支点とするモーメント荷重を支えるように構成されたスラスト軸受である。

[0023] 一実施形態では、前記リア軸受は、前記風力発電装置のタワーの周上であって前記フロント軸受から最も離れた位置に配置されている。この場合、フロント軸受とリア軸受の間の距離（軸受スパン）を大きくしつつ、リア軸受から荷重をタワーに直接的に伝達させることができる。

[0024] 本発明の少なくとも一実施形態に係る風力発電装置は、少なくとも一本のブレードと、前記少なくとも一本のブレードが取り付けられるハブと、前記ハブとともに回転するように構成された回転シャフトと、前記回転シャフトを軸支するための少なくとも一つのすべり軸受と、前記回転シャフトの軸方向に沿ったスラスト荷重を支えるための少なくとも一つのスラスト軸受とを備えることを特徴とする。

[0025] 上記風力発電装置によれば、回転シャフトを軸支する軸受として少なくとも一つのすべり軸受を用いるようにしたので、風力発電装置の大型化への対応が可能である。すなわち、すべり軸受は構造が比較的簡素であるため大型化が容易であり、大型の風力発電装置において想定される軸受荷重に耐える

ような設計が可能である。また、少なくとも一つのスラスト軸受を併用することで、すべり軸受では負担することが難しいスラスト荷重をスラスト軸受によって確実に受けることができる。

[0026] 一実施形態では、前記少なくとも一つのすべり軸受は、フロント軸受と、前記フロント軸受よりも前記ハブから離れた位置に配置されるリア軸受とを含む。

[0027] 一実施形態では、前記少なくとも一つのスラスト軸受は、１個の前記すべり軸受よりも前記ハブから離れた位置に配置され、前記１個の前記すべり軸受を支点とするモーメント荷重を支えるように構成されている。

発明の効果

[0028] 本発明の少なくとも一実施形態によれば、回転シャフトの軸長を抑制しながら、比較的大きな軸受スパン（フロント軸受とリア軸受との間の距離）を確保して軸受荷重を低減することができる。また、フロント軸受に過度な荷重が加わることを防止しながら、被駆動ユニットのメンテナンス作業を容易に行うことができる。

図面の簡単な説明

[0029] [図1]本発明の一実施形態に係る風力発電装置の全体構成を示す概略図である。

[図2]一実施形態に係る風力発電装置の部分断面図である。

[図3]一実施形態に係るリア軸受が回転シャフトから取り外された状態を示す断面図である。

[図4]一実施形態に係るリア軸受が回転シャフトから取り外されたときに補助軸受が回転シャフトと接触する状態を示す断面図である。

[図5]他の実施形態に係る風力発電装置の部分断面図である。

[図6]一実施形態に係るリア軸受が回転シャフトから取り外された状態を示す断面図である。

[図7]一実施形態に係るリア軸受が回転シャフトから取り外されたときに補助軸受が静止部材と接触する状態を示す断面図である。

[図8]他の実施形態に係る風力発電装置の部分断面図である。

[図9]図９（ａ）は、すべり軸受が静圧軸受であるときにすべり軸受が回転シャフトを軸支する状態を示す断面図であり、図９（ｂ）は、静圧軸受のポケット周辺の構成を示す断面図である。

[図10]一実施形態に係るフロント軸受がすべり軸受であるときのフロント軸受の構成を示す断面図である。

[図11]一実施形態に係るフロント軸受がすべり軸受であるときのフロント軸受の構成を示す断面図である。

[図12]一実施形態に係るフロント軸受がすべり軸受であるときのフロント軸受の構成を示す断面図である。

[図13]一実施形態に係るフロント軸受がすべり軸受であるときのフロント軸受の構成を示す断面図である。

[図14]一実施形態に係るフロント軸受がすべり軸受であるときのフロント軸受の構成を示す断面図である。

[図15]一実施形態に係るリア軸受とタワーの位置関係を示す概略図である。フロント軸受がすべり軸受であるときのフロント軸受の構成を示す断面図である。

[図16]一実施形態に風力発電装置の断面図である。

[図17]一実施形態に風力発電装置の断面図である。

発明を実施するための形態

[0030] 以下、添付図面に従って本発明の実施形態について説明する。ただし、この実施形態に記載されている構成部品の寸法、材質、形状、その相対的配置等は、特定的な記載がない限り本発明の範囲をこれに限定する趣旨ではなく、単なる説明例にすぎない。

[0031] 図１は、一実施形態に係る風力発電装置１の全体構成を示す概略図である。同図に示すように、一実施形態に係る風力発電装置１は、少なくとも一本のブレード２と、少なくとも一本のブレード２が取り付けられるハブ４と、ハブ４とともに回転するように構成された回転シャフト６と、回転シャフト

６によって駆動されるように構成された被駆動ユニット７と、被駆動ユニット７が収納されるナセル５と、ナセル５を支持するタワー１１を含む。一実施形態では、被駆動ユニット７は油圧ポンプである。他の実施形態では、被駆動ユニット７は発電機である。

[0032] 図２は、一実施形態に係る風力発電装置１の部分断面図である。図３は、一実施形態に係るリア軸受１０が回転シャフト６から取り外された状態における風力発電装置１の部分断面図であり、図４は、一実施形態に係るリア軸受１０が回転シャフト６から取り外されたときに補助軸受１２が回転シャフト６と接触する状態を示す断面図である。なお、図４に示す二点鎖線はリア軸受１０が回転シャフト６に取り付けられたときの回転シャフト６の位置を示す。

[0033] 図２に示すように、一実施形態に係る風力発電装置１は、回転シャフト６を軸支するためのフロント軸受８と、フロント軸受８よりもハブ４から離れた位置に設けられ回転シャフト６を軸支するためのリア軸受１０とを備える。フロント軸受８とリア軸受１０の間には、回転シャフト６によって駆動されるように構成された油圧ポンプ１４（被駆動ユニット７）が配置されている。また、フロント軸受８と被駆動ユニット７との間の位置には、補助軸受１２が設けられている。補助軸受１２はハウジング１２Ａを介してナセル台板９に支持され、リア軸受１０はハウジング１０Ａを介してナセル台板９に支持されている。

[0034] 油圧ポンプ１４は、ナセル台板９に支持されており、ステータ部１６と、回転シャフト６に連結されているロータ部１８とを含む。ステータ部１６とロータ部１８で囲まれた空間には、カム２０、複数のシリンダ２２を有するシリンダブロック２３、ローラ２４が取り付けられた複数のピストン２６が設けられている。一実施形態では、カム２０は、ロータ部１８の外周面上に設けられてロータ部１８とともに回転するように構成されている。各ピストン２６はカム２０に当接するローラ２４を介してリングカム２０によって駆動され、各シリンダ２２内を摺動するように構成されている。

[0035] 幾つかの実施形態では、補助軸受１２は、リア軸受１０が回転シャフト６に取り付けられた状態では回転シャフト６からの荷重を支持せず、リア軸受１０が回転シャフト６から取り外されたときにフロント軸受８を補助して回転シャフト６を軸支するように構成されている。

[0036] 一実施形態では、図２に示すように、リア軸受１０が回転シャフト６に取り付けられた状態では回転シャフト６との間に隙間３２が形成されるように配置されており、隙間３２の大きさは、リア軸受１０が回転シャフト６から取り外されたときに補助軸受１２と回転シャフト６とが接触するように設定されている。

[0037] 被駆動ユニット７としての油圧ポンプ１４は、上述のようにフロント軸受８とリア軸受１０の間に設けられており、メンテナンスを要する部品（リングカム２０、ローラ２４、ピストン２６など）を含む。これらの部品のメンテナンスを行う際、油圧ポンプ１４からメンテナンスの対象となる部品（メンテナンス対象部品）を取り外す必要が生じることがある。その場合に、油圧ポンプ１４からのメンテナンス対象部品の取り外し作業を容易に行うために、一時的にリア軸受１０を取り外すことがある。

[0038] このようにリア軸受１０を取り外す必要がある場合であっても、上述の実施形態に係る風力発電装置１の補助軸受１２は、リア軸受１０が回転シャフト６から取り外されたときにフロント軸受８を補助して回転シャフト６を軸支するように構成されているので、フロント軸受８と補助軸受１２によって回転シャフト６を軸支することができる。

図３に示す例示的な実施形態では、リア軸受１０が回転シャフト６から取り外されると、フロント軸受８によって拘束された回転シャフト６はフロント軸受８を支点として傾動する。その結果、図４に示すように、回転シャフト６は補助軸受１２に接近し、補助軸受１２と回転シャフト６との間の間隙３２（図２参照）が部分的に消滅し、補助軸受１２と回転シャフト６とが部分的に接触する。これは、上述したように、隙間３２の大きさが、リア軸受１０が回転シャフト６から取り外されたときに補助軸受１２と回転シャフト

６とが接触するように設定されているためである。補助軸受１２と回転シャフト６とが少なくとも部分的に接触すると、回転シャフト６はフロント軸受８と補助軸受１２とで軸支される。

なお、回転シャフト６からリア軸受１０が取り外されたときの回転シャフト６の傾動方向は、フロント軸受８の位置や、ブレード２及びハブ４の重量や、油圧ポンプ１４（被駆動ユニット７）の重量などに依存する。

[0039] 図２～４に示す例示的な実施形態によれば、フロント軸受８とリア軸受１０との間に被駆動ユニット７（油圧ポンプ１４）を配置するようにしたので、回転シャフト６の軸長を抑制しながら、比較的大きな軸受スパン（フロント軸受８とリア軸受１０との間の距離）を確保することができる。よって、軸受荷重を低減することができる。

また、フロント軸受８に過度な荷重が加わることを防止しながら、被駆動ユニット７（油圧ポンプ１４）のメンテナンス作業を容易に行うことができる。

[0040] 図５は、他の実施形態に係る風力発電装置１の部分断面図である。同図に示す例示的な実施形態では、風力発電装置１の補助軸受１２は、回転シャフト６上に設けられ、リア軸受１０が回転シャフト６に取り付けられた状態では静止部材（軸受箱）３０との間に隙間３３が形成されるように配置されている。隙間３３の大きさは、リア軸受１０が回転シャフト６から取り外されたときに補助軸受１２と静止部材（軸受箱）３０とが接触するように設定されている。

[0041] 図６は、一実施形態に係るリア軸受１０が回転シャフト６から取り外された状態を示す断面図であり、図７は、一実施形態に係るリア軸受１０が回転シャフト６から取り外されたときに補助軸受１２が静止部材３０と接触する状態を示す断面図である。なお、図７に示す二点鎖線はリア軸受１０が回転シャフト６に取り付けられたときの回転シャフト６及び補助軸受１２の位置を示す。

[0042] 図６に示す例示的な実施形態では、リア軸受１０が回転シャフト６から取

り外されると、フロント軸受８によって拘束された回転シャフト６はフロント軸受８を支点として傾動する。その結果、図７に示すように、回転シャフト６及び補助軸受１２は静止部材（軸受箱）３０に接近し、補助軸受１２と静止部材３０との間の間隙３３（図５参照）が部分的に消滅し、補助軸受１２と静止部材３０とが部分的に接触する。これは、上述したように、隙間３３の大きさが、リア軸受１０が回転シャフト６から取り外されたときに補助軸受１２と静止部材３０とが接触するように設定されているためである。補助軸受１２と静止部材３０とが少なくとも部分的に接触すると、回転シャフト６はフロント軸受８と補助軸受１２とで軸支される。

[0043] つまり、補助軸受１２は、リア軸受１０が回転シャフト６に取り付けられた状態では回転シャフト６からの荷重を支持せず、リア軸受１０が回転シャフト６から取り外されたときにフロント軸受８を補助して回転シャフト６を軸支するように構成されている。

[0044] 図８は、他の一実施形態に係る風力発電装置の部分断面図である。同図に示すように、一実施形態では、フロント軸受８又はリア軸受１０の少なくとも一方がすべり軸受を含む。フロント軸受８又はリア軸受１０の少なくとも一方に構造が簡素であるすべり軸受を用いることにより、風力発電装置１の大型化への対応が可能になる。すなわち、風力発電装置１の大型化によって軸受荷重は大きくなる傾向にあるが、風力発電装置１の回転シャフト６を軸支するための軸受として一般的に用いられている転がり軸受は、製造設備や製造技術の限界によってより一層の大型化は難しい場合がある。これに対し、すべり軸受は構造が比較的簡素であるため大型化が容易であり、大型の風力発電装置１において想定される軸受荷重に耐えるような設計が可能である。

[0045] 同図に示すように、一実施形態では、フロント軸受８はすべり軸受であり、リア軸受１０はフロント軸受８を支点とするモーメント荷重を支えるように構成されたスラスト軸受である。

[0046] 図９（ａ）は、すべり軸受３４が静圧軸受であるときにすべり軸受３４が

回転シャフト６を軸支する状態を示す断面図であり、図９（ｂ）は、静圧軸受のポケット周辺の構成を示す断面図である。図９（ａ）に示すように、一実施形態では、すべり軸受３４は、回転シャフト６とすべり軸受３４のすべり面３４Ａの間に供給される流体３６により回転シャフト６を軸支するように構成された静圧軸受である。すべり軸受３４として静圧軸受を用いることにより、潤滑油として低粘度の油を使用する場合であっても、すべり軸受３４の負荷能力を高めることができる。また、すべり軸受３４をコンパクト化できる。

[0047] 一実施形態では、回転シャフト６とすべり面３４Ａの間に供給される流体３６は、被駆動ユニット７としての油圧ポンプ１４の作動油である。図９（ａ）及び図９（ｂ）に示すように、該流体３６は油圧ポンプ１４からポケット３４Ｄに設けられた供給口３４Ｃを介してすべり軸受３４のすべり面３４Ａと回転シャフト６の間に供給され、回転シャフト６を軸支する。

[0048] 一実施形態では、すべり軸受３４のすべり面３４Ａと回転シャフト６との間において、ＶＧ１６０以上の粘度を有する潤滑油を保持する。粘度の高い潤滑油をすべり軸受３４のすべり面３４Ａと回転シャフト６の間に保持することにより、静圧軸受機構を設けることなく、すべり軸受３４のすべり面３４Ａと回転シャフト６の間に油膜を形成することができる。

[0049] 一実施形態では、すべり軸受３４のすべり面３４Ａと回転シャフト６との間において、潤滑用グリースを保持する。潤滑用グリースをすべり軸受３４のすべり面３４Ａと回転シャフト６の間に保持することにより、潤滑油供給用のポンプなどの構成が不要になり、潤滑系の構成が簡素化され、コストや重量の面で有利になる。

[0050] 図１０は、一実施形態に係るフロント軸受８の構成を示す断面図である。同図に示すように、一実施形態では、フロント軸受８はすべり軸受３４である。フロント軸受８のハウジング３４Ｂのハブ側の端部とフロント軸受８の間に隙間４０が形成されている。

[0051] ロータに対する荷重（ロータの自重に起因した重力荷重や風荷重）は、ハ

ブ中心近傍の荷重負荷点Ｇに作用する。この荷重負荷点Ｇは軸受支持点（フロント軸受８の位置）からオーバハングしているため、軸受荷重としてのモーメント荷重に起因して、フロント軸受８の片当たりが生じる場合がある。そこで、上述のように、フロント軸受８（すべり軸受３４）のハウジング３４Ｂのハブ側の端部とフロント軸受８との間に隙間４０を形成することで、フロント軸受８のハブ側の端部の背面剛性が低下し、フロント軸受８の片当たりが緩和される。したがって、片当たりに起因したフロント軸受８の負荷能力の低下を抑制し、フロント軸受８の高い負荷能力を確保することができる。

一実施形態では、フロント軸受８はすべり軸受３４であり、フロント軸受８のハウジング３４Ｂのハブ側とは反対側の端部とフロント軸受８の間に隙間が形成されている。被駆動ユニット７のメンテナンスの時に、回転シャフト６がフロント軸受８に片当たりすることを防止できる。

[0052] 図１１は、一実施形態に係るフロント軸受がすべり軸受であるときのフロント軸受の構成を示す断面図である。同図に示すように、一実施形態では、フロント軸受８はすべり軸受３４であり、フロント軸受８のハブ側の端部にスリット４１が形成されている。

[0053] 図１２は、一実施形態に係るフロント軸受８がすべり軸受３４であるときのフロント軸受８の構成を示す断面図である。同図に示すように、一実施形態では、フロント軸受８はすべり軸受３４であり、フロント軸受８のハウジング３４Ｂのハブ側の端部とフロント軸受８の間に形成される隙間４０にハウジング３４Ｂよりも剛性の低い部材４２が設けられている。

[0054] ハウジング３４Ｂよりも剛性の低い部材４２が隙間４０に設けられているため、フロント軸受８のハブ側の端部の背面剛性が低下し、フロント軸受８の片当たりを緩和できる。したがって、片当たりに起因したフロント軸受８の負荷能力の低下を抑制し、フロント軸受８の高い負荷能力を確保することができる。

[0055] 図１３は、一実施形態に係るフロント軸受８がすべり軸受３４であるとき

のフロント軸受８の構成を示す断面図である。一実施形態では、フロント軸受８はすべり軸受３４であり、フロント軸受８と回転シャフト６との間に樹脂層４４が設けられている。樹脂層４４は剛性が低く外力に対して変形しやすいため、フロント軸受８の片当たりが緩和される。したがって、片当たりに起因したフロント軸受８の負荷能力の低下を抑制し、フロント軸受８の高い負荷能力を確保することができる。

[0056] 図１４は、一実施形態に係るフロント軸受８がすべり軸受３４であるときのフロント軸受８の構成を示す断面図である。一実施形態では、フロント軸受８はすべり軸受３４であり、フロント軸受８のハウジング３４Ｂに対するフロント軸受８の当接面８Ｂは、回転シャフト６の軸方向において湾曲している。フロント軸受８の当接面８Ｂは、回転シャフト６の軸方向及びこれに直交する方向において湾曲した球面形状であってもよいし、回転シャフト６の軸方向のみにおいて湾曲した円筒形状であってもよい。フロント軸受８に対するハウジング３４Ｂの当接面３５は、軸方向に湾曲しており、フロント軸受８の当接面８Ｂの反転形状である。

[0057] この場合、フロント軸受８はハウジング３４Ｂに対して回動可能であるため、フロント軸受８の片当たりが緩和される。したがって、片当たりに起因したフロント軸受８の負荷能力の低下を抑制し、フロント軸受８の高い負荷能力を確保することができる。

[0058] 図１５は、一実施形態に係るリア軸受１０とタワー１１の位置関係を示す概略図である。同図に示すように、一実施形態では、リア軸受１０は、風力発電装置１のタワー１１の周上であってフロント軸受８から最も離れた位置に配置されている。この場合、フロント軸受８とリア軸受１０の間の距離（軸受スパン）を大きくしつつ、リア軸受１０から荷重をタワー１１に直接的に伝達させることができる。

[0059] 図１６は、一実施形態に風力発電装置１の断面図である。同図に示すように、一実施形態に係る風力発電装置１は、回転シャフト６を軸支するためのすべり軸受３４と、回転シャフト６の軸方向に沿ったスラスト荷重を支える

ためのスラスト軸受４６とを備える。すべり軸受３４及びスラスト軸受４６はそれぞれ静止部材３１を介してナセル台板に支持されている。

[0060] 回転シャフト６を軸支する軸受として少なくとも一つのすべり軸受３４を用いるようにしたので、風力発電装置１の大型化への対応が可能である。すなわち、すべり軸受３４は構造が比較的簡素であるため大型化が容易であり、大型の風力発電装置１において想定される軸受荷重に耐えるような設計が可能である。また、少なくとも一つのスラスト軸受４６を併用することで、すべり軸受３４では負担することが難しいスラスト荷重をスラスト軸受４６によって確実に受けることができる。

[0061] 図１７は、一実施形態に風力発電装置１の断面図である。同図に示すように、一実施形態に係る風力発電装置１は、フロント軸受８と、フロント軸受８よりもハブ４から離れた位置に配置されるリア軸受１０と、フロント軸受８とリア軸受１０の間に設けられるスラスト軸受４６とを含む。フロント軸受８及びリア軸受１０はすべり軸受３４である。同図に示すように、一実施形態では、スラスト軸受４６は、すべり軸受３４であるフロント軸受８よりもハブ４から離れた位置に配置され、フロント軸受８を支点とするモーメント荷重を支えるように構成されている。

[0062] 以上説明したように、本発明の少なくとも一実施形態に係る風力発電装置１は、回転シャフト６の軸長を抑制しながら、比較的大きな軸受スパン（フロント軸受８とリア軸受１０との間の距離）を確保して軸受荷重を低減することができる。また、フロント軸受８に過度な荷重が加わることを防止しながら、被駆動ユニット７のメンテナンス作業を容易に行うことができる。

[0063] 以上、本発明の実施形態について詳細に説明したが、本発明はこれに限定されず、本発明の要旨を逸脱しない範囲において、各種の改良や変形を行ってもよいのはいうまでもない。

[0064] 例えば、図１６及び１４に示す例示的な実施形態におけるすべり軸受３４を、図９～１４で説明した構成としてもよい。具体的には一実施形態では、図１６及び１４におけるすべり軸受３４は、図９に示すように、回転シャフ

ト６とすべり軸受３４のすべり面３４Ａの間に供給される流体３６により回転シャフト６を軸支するように構成された静圧軸受である。一実施形態では、回転シャフト６とすべり面３４Ａの間に供給される流体３６は、被駆動ユニット７としての油圧ポンプ１４の作動油である。一実施形態では、すべり軸受３４のすべり面３４Ａと回転シャフト６との間において、ＶＧ１６０以上の粘度を有する潤滑油を保持する。一実施形態では、すべり軸受３４のすべり面３４Ａと回転シャフト６との間において、潤滑用グリースを保持する。

[0065] 一実施形態に係るすべり軸受３４では、図１０に示すように、ハウジング３４Ｂのハブ側の端部とすべり軸受３４の間に隙間４０が形成されている。一実施形態に係るすべり軸受３４では、図１１に示すように、すべり軸受３４のハブ側の端部にスリット４１が形成されている。一実施形態に係るすべり軸受３４では、ハウジング３４Ｂのハブ側とは反対側の端部とすべり軸受３４の間に隙間が形成されている。

[0066] 一実施形態に係るすべり軸受３４では、図１２に示すように、ハウジング３４Ｂのハブ側の端部とすべり軸受３４の間に形成される隙間４０にハウジング３４Ｂよりも剛性の低い部材４２が設けられている。一実施形態に係るすべり軸受３４では、図１３に示すように、すべり軸受３４と回転シャフト６との間に樹脂層４４が設けられている。

[0067] 一実施形態に係るすべり軸受３４では、図１４に示すように、ハウジング３４Ｂに対するすべり軸受３４の当接面は、回転シャフト６の軸方向において湾曲している。すべり軸受３４の当接面は、回転シャフト６の軸方向及びこれに直交する方向において湾曲した球面形状であってもよいし、回転シャフト６の軸方向のみにおいて湾曲した円筒形状であってもよい。すべり軸受３４に対するハウジング３４Ｂの当接面３５は、軸方向に湾曲しており、すべり軸受３４の当接面の反転形状である。

符号の説明

[0068] １ 風力発電装置

２　ブレード
４　ハブ
５　ナセル
６　回転シャフト
７　被駆動ユニット
８　フロント軸受
１０　リア軸受
１１　タワー
１２　補助軸受
１４　油圧ポンプ
１６　ステータ部
１８　ロータ部
２０　リングカム
２２　シリンダ
２４　ローラ
２６　ピストン
３０、３１　静止部材
３２　隙間
３４　すべり軸受
３４Ａ　すべり面
３４Ｂ　ハウジング
３４Ｃ　供給口
３４Ｄ　ポケット
３６　流体
４０　隙間
４１　スリット
４２　剛性の低い部材
４４　樹脂層

４６　　スラスト軸受

請求の範囲

［請求項1］ 少なくとも一本のブレードと、

前記少なくとも一本のブレードが取り付けられるハブと、

前記ハブとともに回転するように構成された回転シャフトと、

前記回転シャフトを軸支するためのフロント軸受と、

前記フロント軸受よりも前記ハブから離れた位置に設けられ、前記回転シャフトを軸支するためのリア軸受と、

前記フロント軸受と前記リア軸受の間に設けられ、前記回転シャフトによって駆動されるように構成された被駆動ユニットと、

前記フロント軸受と前記被駆動ユニットとの間に設けられる補助軸受とを備え、

前記補助軸受は、前記リア軸受が前記回転シャフトに取り付けられた状態では前記回転シャフトからの荷重を支持せず、前記リア軸受が前記回転シャフトから取り外されたときに前記フロント軸受を補助して前記回転シャフトを軸支するように構成されたことを特徴とする風力発電装置。

［請求項2］ 前記補助軸受は、前記回転シャフトと前記風力発電装置の静止部材との間において、前記リア軸受が前記回転シャフトに取り付けられた状態では前記回転シャフト又は前記静止部材の一方との間に隙間が形成されるように配置され、

前記隙間の大きさは、前記リア軸受が前記回転シャフトから取り外されたときに前記補助軸受と前記回転シャフト又は前記静止部材の前記一方とが接触するように設定されたことを特徴とする請求項１に記載の風力発電装置。

［請求項3］ 前記フロント軸受又は前記リア軸受の少なくとも一方がすべり軸受を含むことを特徴とする請求項３に記載の風力発電装置。

［請求項4］ 前記すべり軸受は、前記回転シャフトと前記すべり軸受のすべり面の間に供給される流体により前記回転シャフトを軸支するように構成

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された静圧軸受であることを特徴とする請求項３に記載の風力発電装置。

［請求項5］　前記被駆動ユニットは油圧ポンプであり、

前記流体は、前記油圧ポンプの作動油であることを特徴とする請求項４に記載の風力発電装置。

［請求項6］　前記すべり軸受のすべり面と前記回転シャフトとの間に保持され、ＶＧ１６０以上の粘度を有する潤滑油をさらに備えることを特徴とする請求項３に記載の風力発電装置。

［請求項7］　前記すべり軸受のすべり面と前記回転シャフトとの間に保持された潤滑用グリースをさらに備えることを特徴とする請求項３に記載の風力発電装置。

［請求項8］　前記フロント軸受は前記すべり軸受であり、

前記フロント軸受のハウジングの前記ハブ側の端部と前記フロント軸受の間に隙間が形成されていることを特徴とする請求項３乃至７の何れか一項に記載の風力発電装置。

［請求項9］　前記隙間に前記ハウジングよりも剛性の低い部材が設けられていることを特徴とする請求項８に記載の風力発電装置。

［請求項10］　前記フロント軸受は前記すべり軸受であり、

前記フロント軸受は、前記ハブ側の端部にスリットが形成されていることを特徴とする請求項３乃至７の何れか一項に記載の風力発電装置。

［請求項11］　前記フロント軸受は前記すべり軸受であり、

前記フロント軸受と前記回転シャフトとの間に樹脂層が設けられていることを特徴とする請求項３乃至１０の何れか一項に記載の風力発電装置。

［請求項12］　前記フロント軸受は前記すべり軸受であり、

前記フロント軸受のハウジングに対する前記フロント軸受の当接面は、少なくとも前記回転シャフトの軸方向において湾曲しており、

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前記フロント軸受に対する前記ハウジングの当接面は、少なくとも前記軸方向に湾曲しており、前記フロント軸受の前記当接面の反転形状であることを特徴とする請求項３乃至１１の何れか一項に記載の風力発電装置。

［請求項13］ 前記フロント軸受が前記すべり軸受を含み、

前記リア軸受は、前記フロント軸受を支点とするモーメント荷重を支えるように構成されたスラスト軸受であることを特徴とする請求項３乃至１２の何れか一項に記載の風力発電装置。

［請求項14］ 前記リア軸受は、前記風力発電装置のタワーの周上であって前記フロント軸受から最も離れた位置に配置されていることを特徴とする請求項１乃至１３の何れか一項に風力発電装置。

［請求項15］ 少なくとも一本のブレードと、

前記少なくとも一本のブレードが取り付けられるハブと、

前記ハブとともに回転するように構成された回転シャフトと、

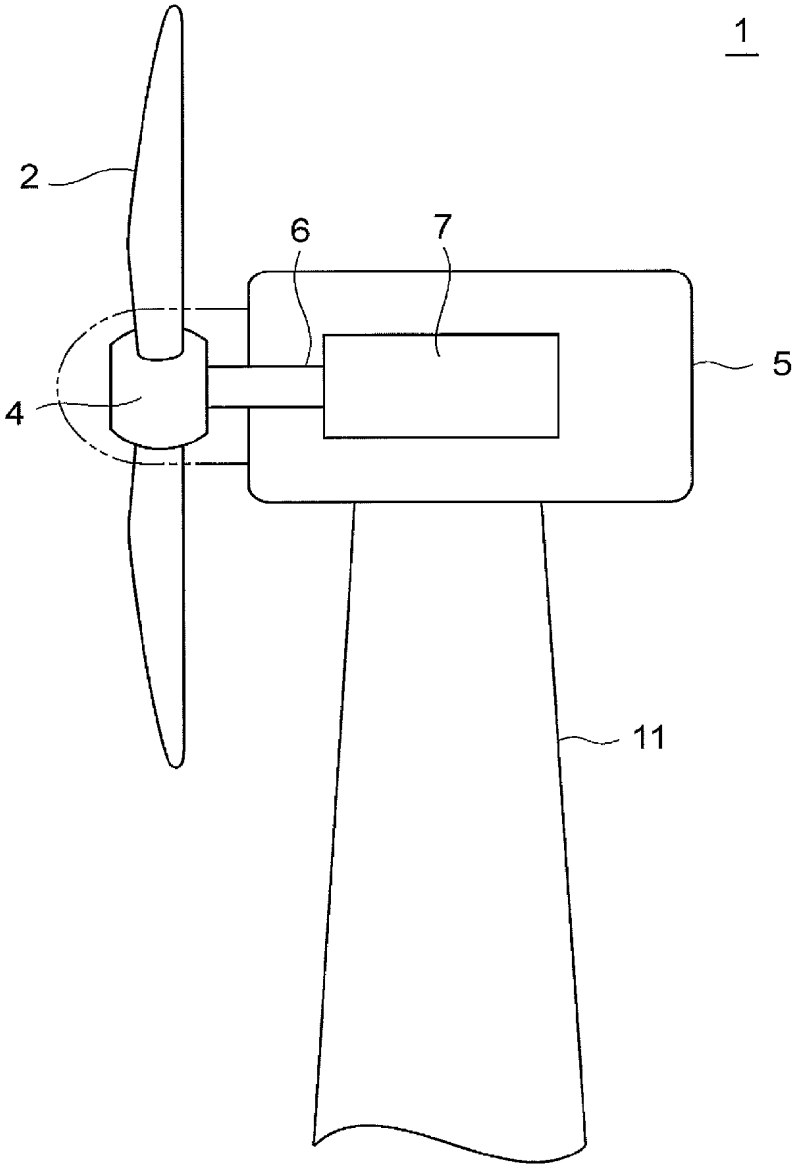
前記回転シャフトを軸支するための少なくとも一つのすべり軸受と、

前記回転シャフトの軸方向に沿ったスラスト荷重を支えるための少なくとも一つのスラスト軸受とを備えることを特徴とする風力発電装置。

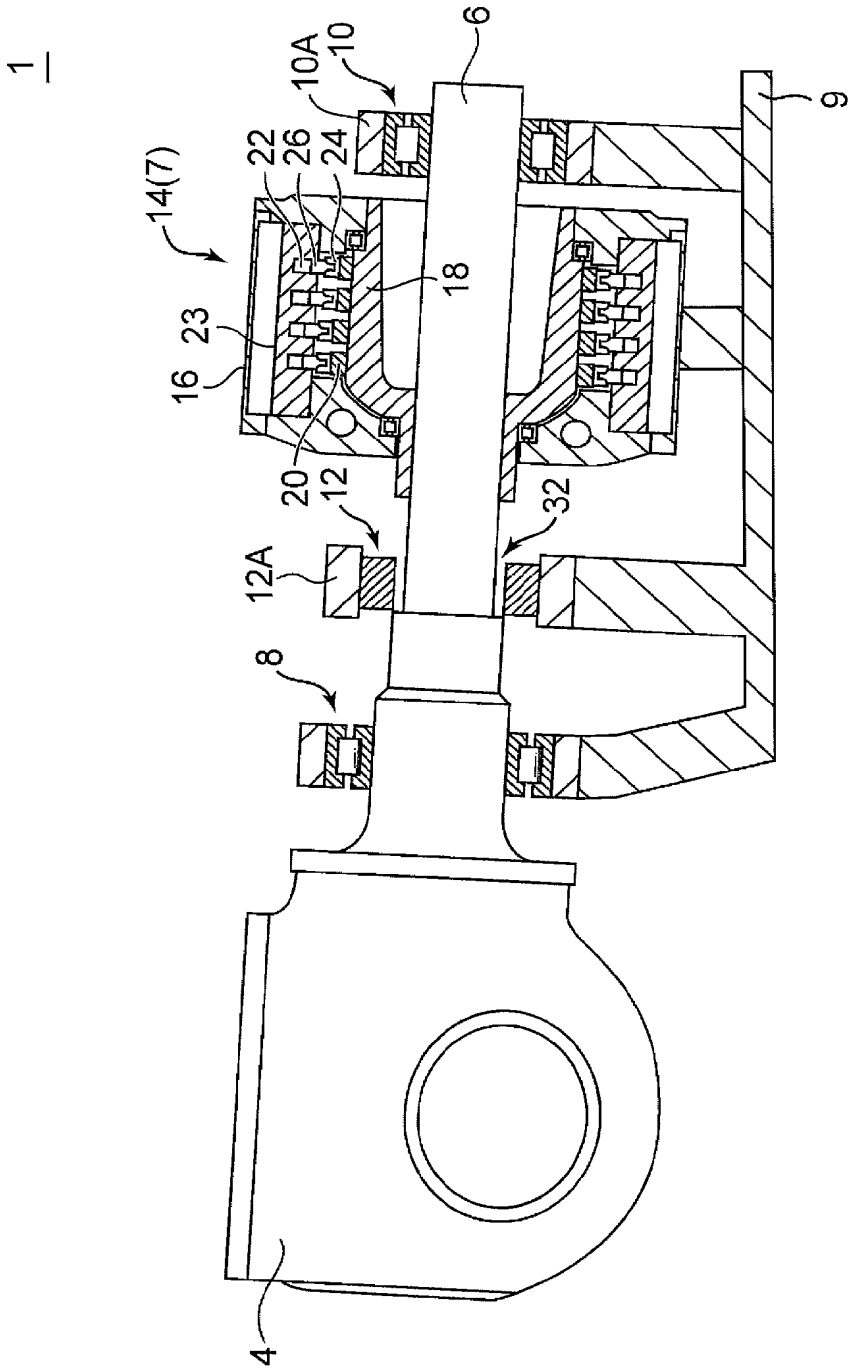
［請求項16］ 前記少なくとも一つのすべり軸受は、フロント軸受と、前記フロント軸受よりも前記ハブから離れた位置に配置されるリア軸受とを含むことを特徴とする請求項１５に記載の風力発電装置。

［請求項17］ 前記少なくとも一つのスラスト軸受は、１個の前記すべり軸受よりも前記ハブから離れた位置に配置され、前記１個の前記すべり軸受を支点とするモーメント荷重を支えるように構成されたことを特徴とする請求項１５に記載の風力発電装置。

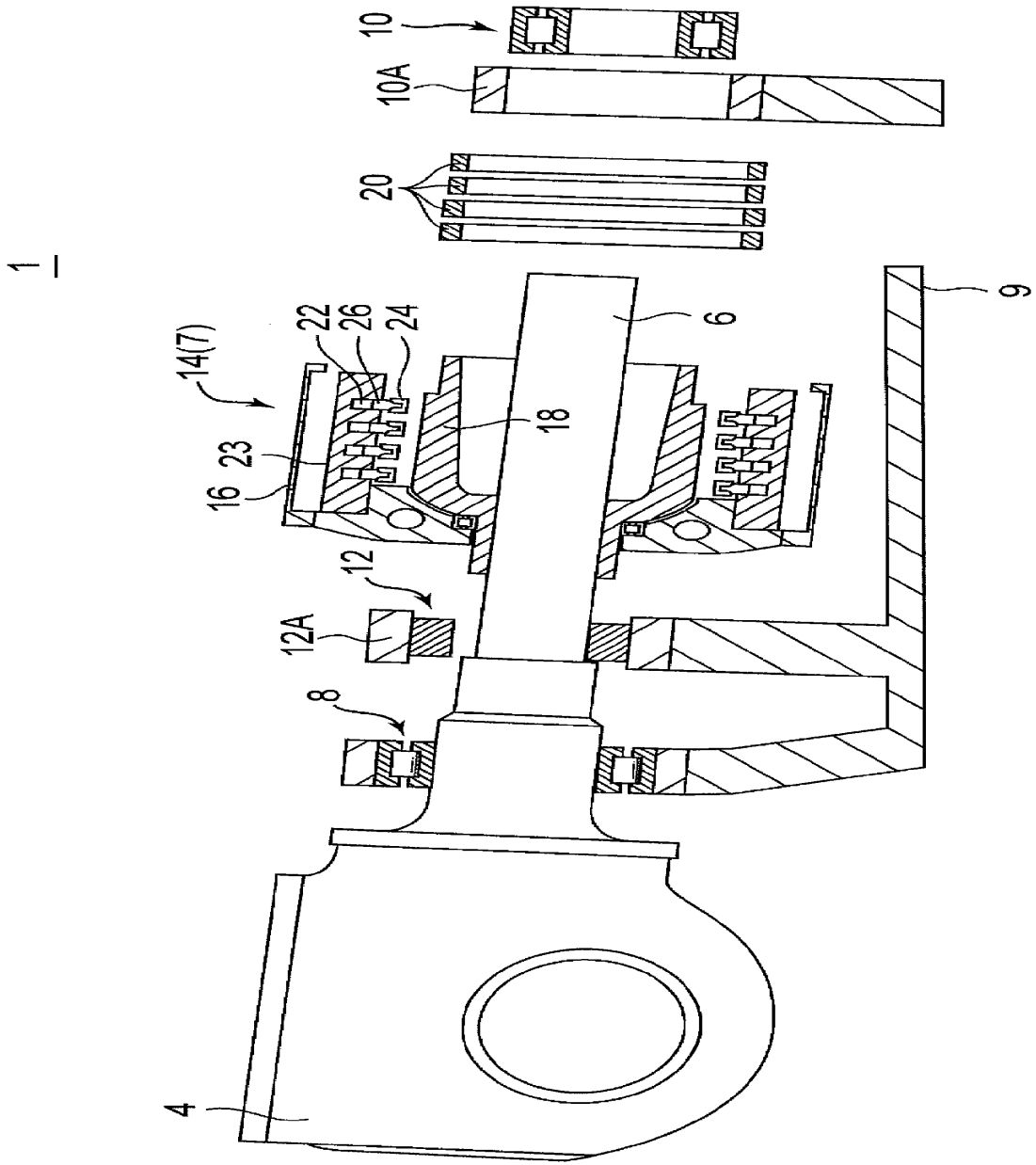
[図1]



[図2]

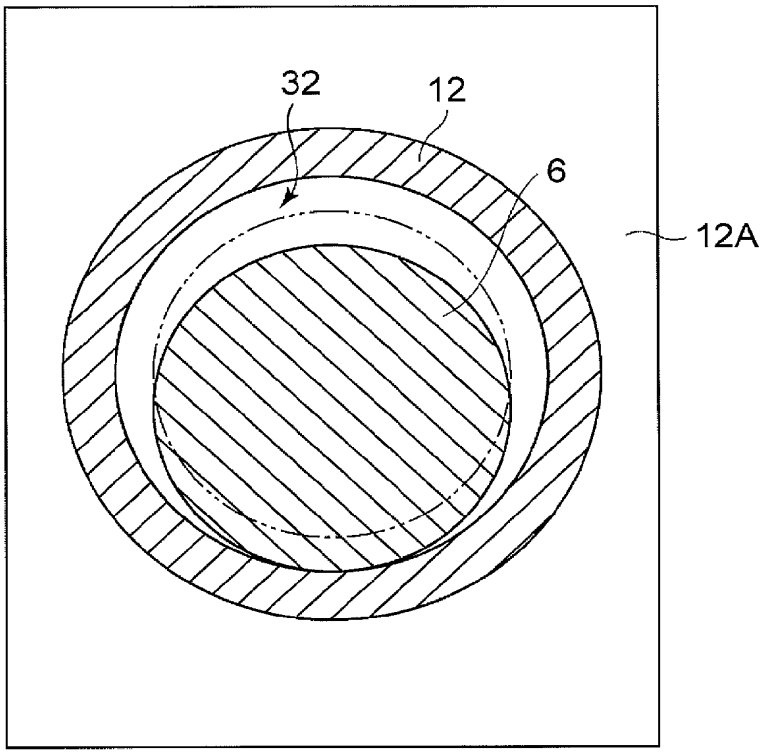


[図3]

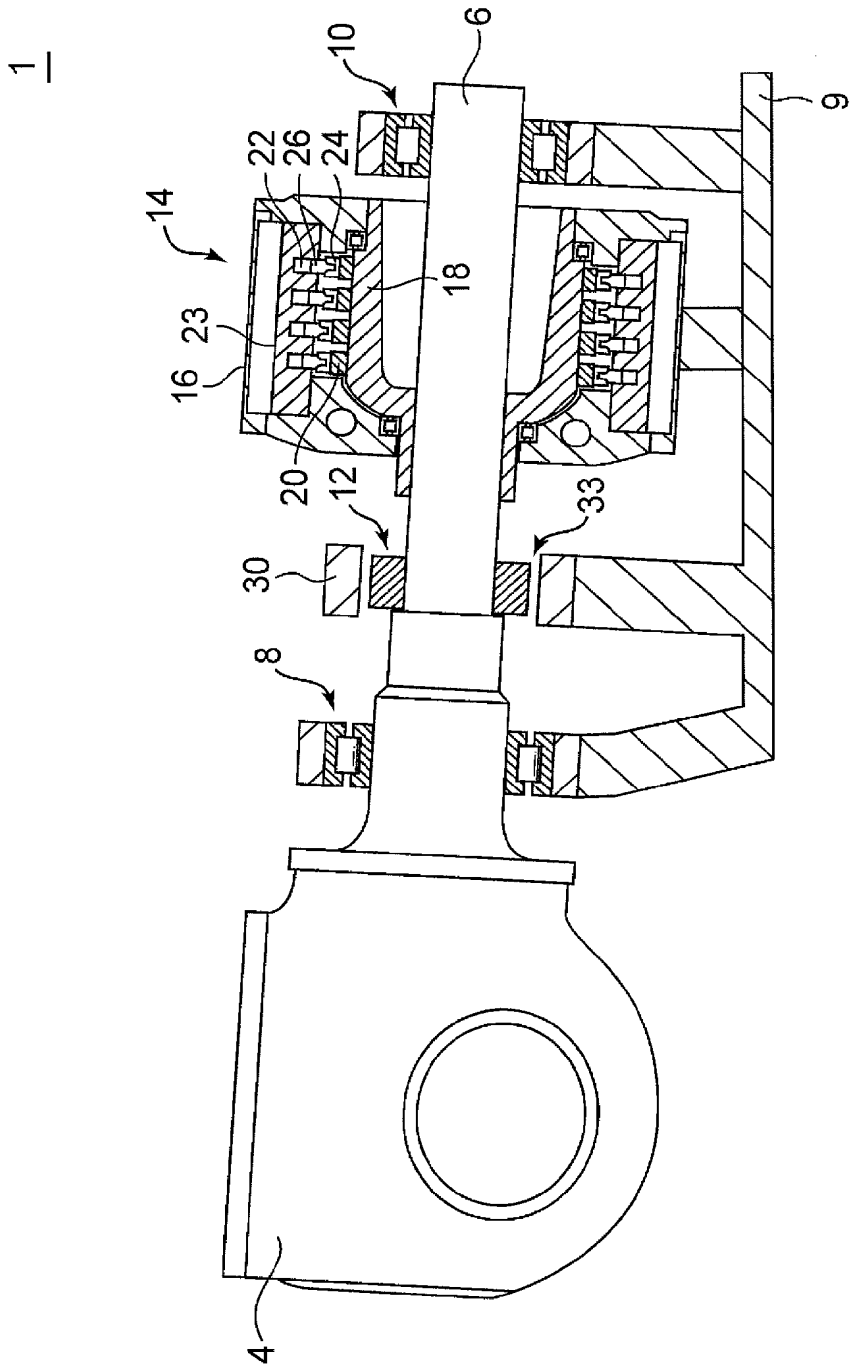


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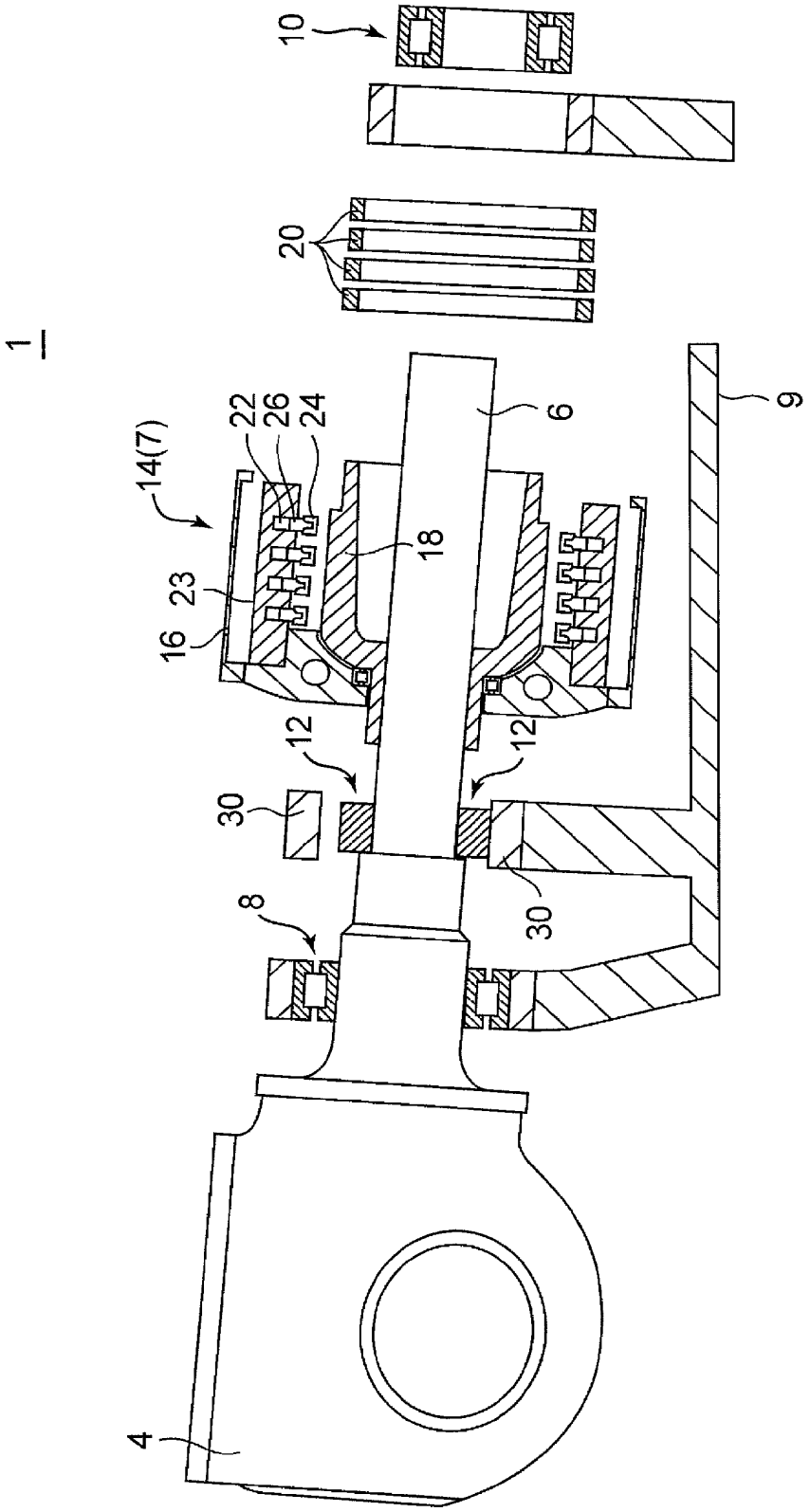
[図4]



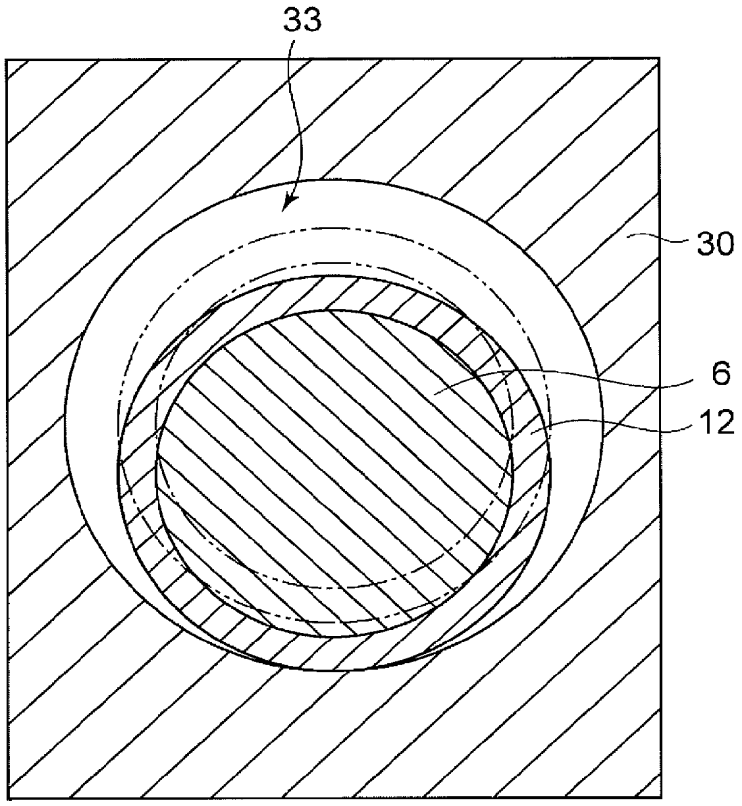
[図5]



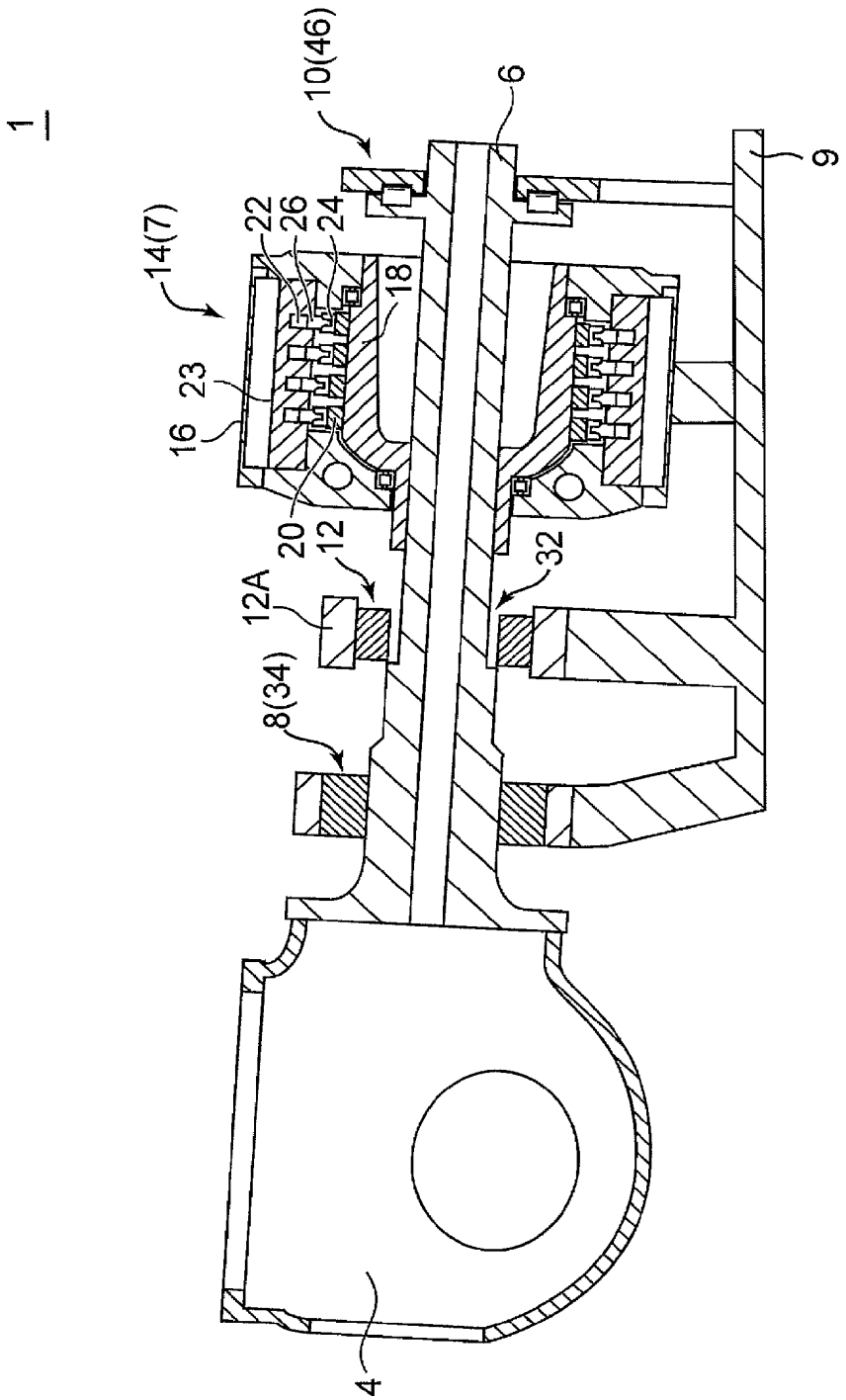
[図6]



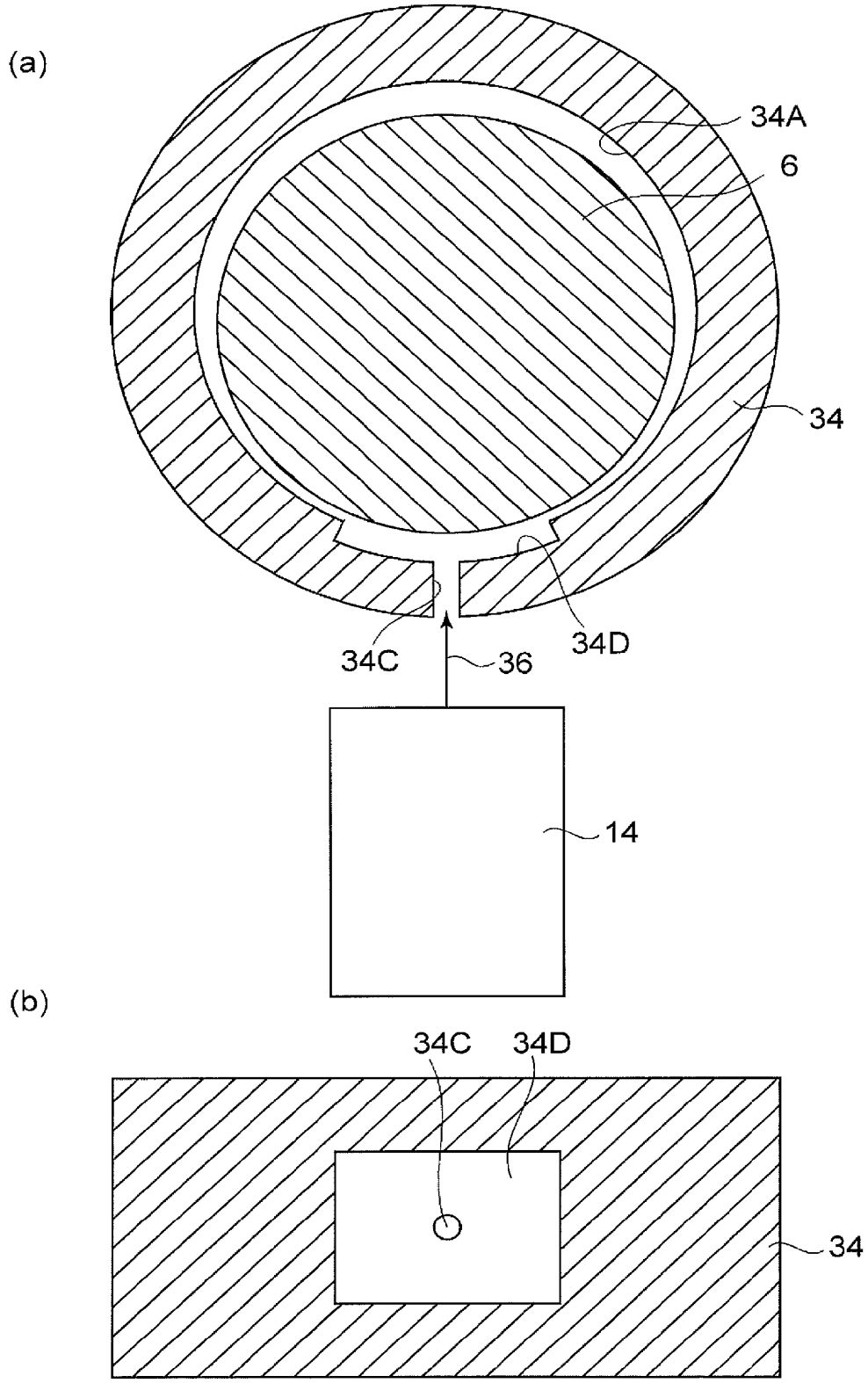
[図7]



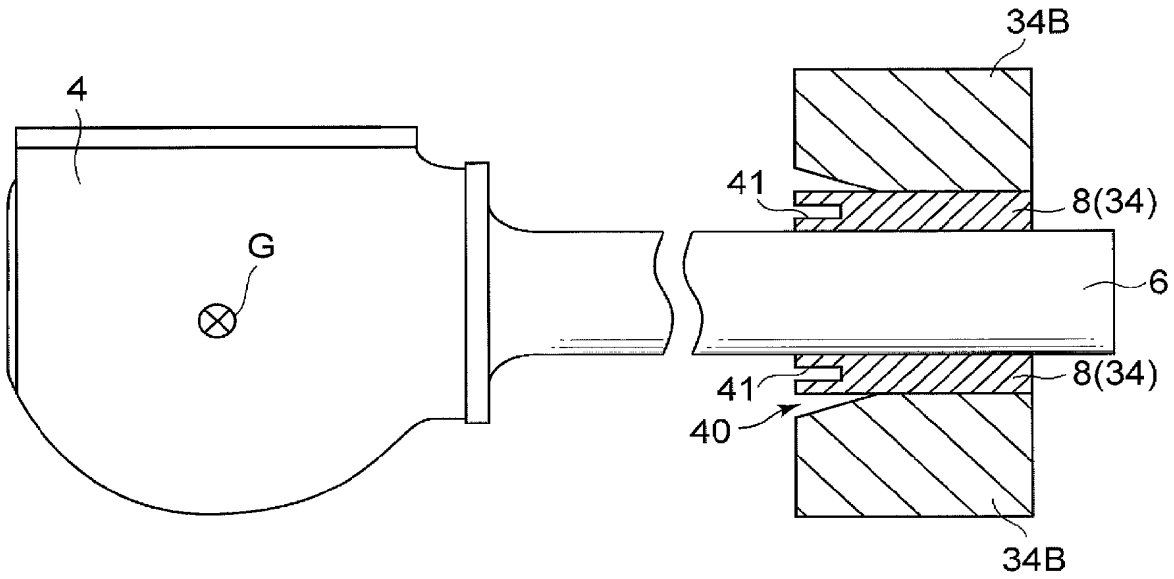
[図8]



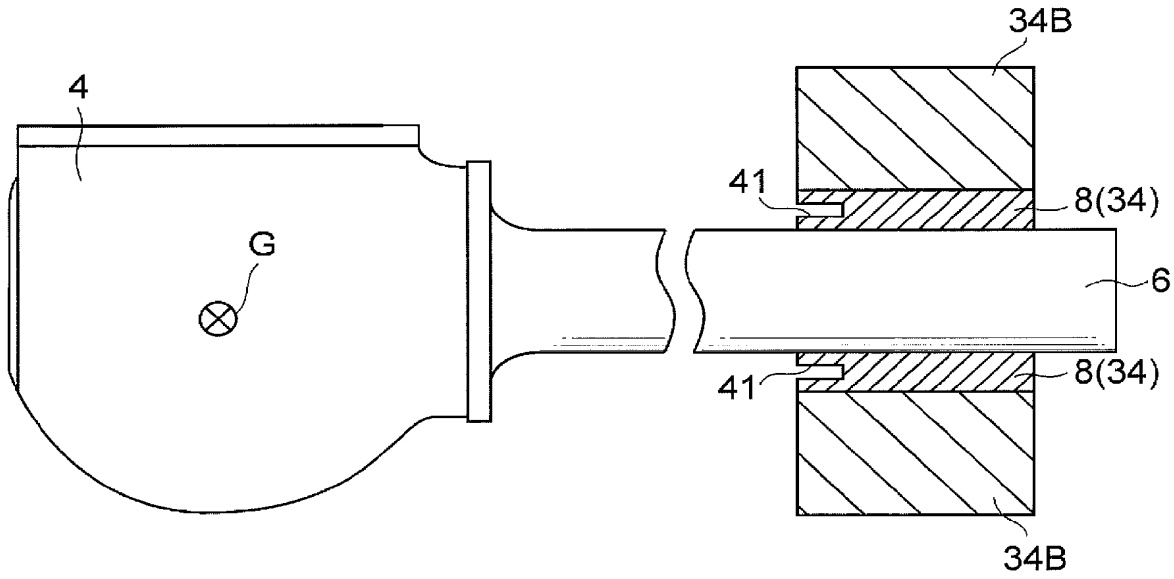
[図9]



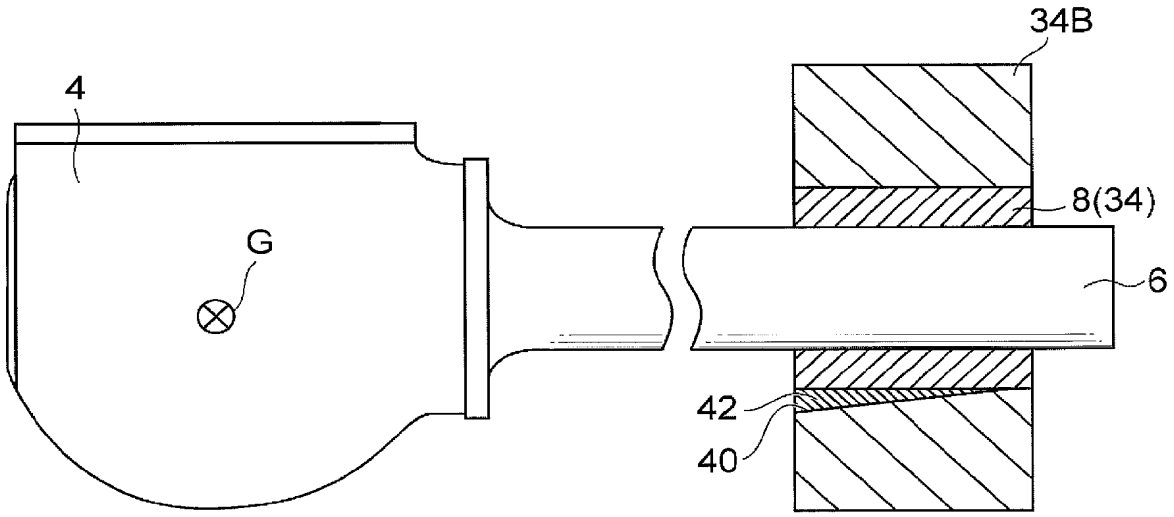
[図10]



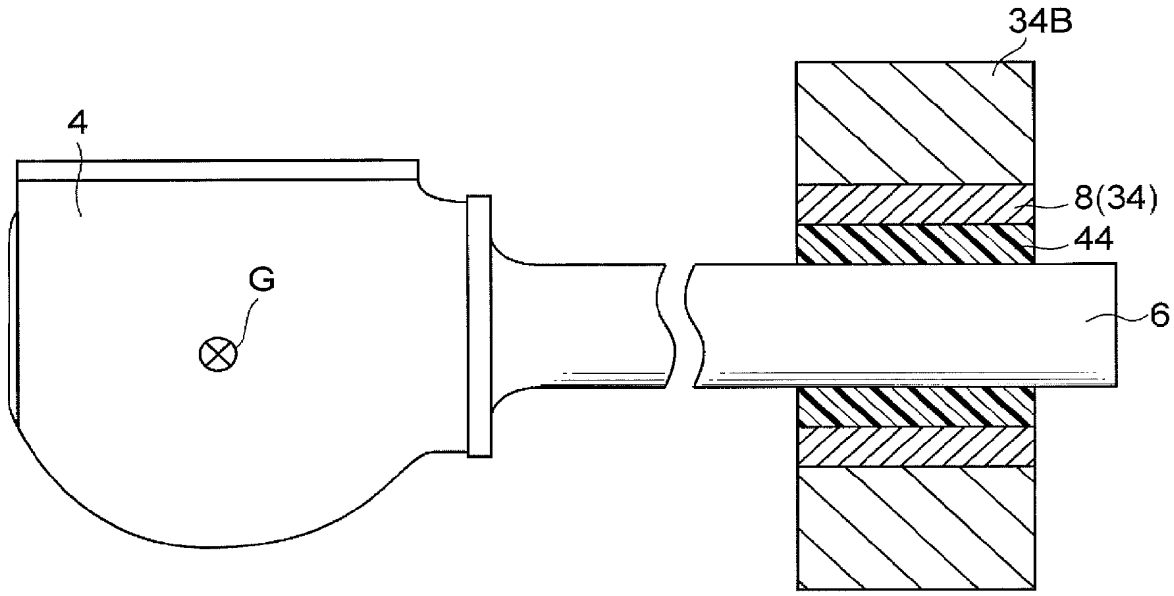
[図11]



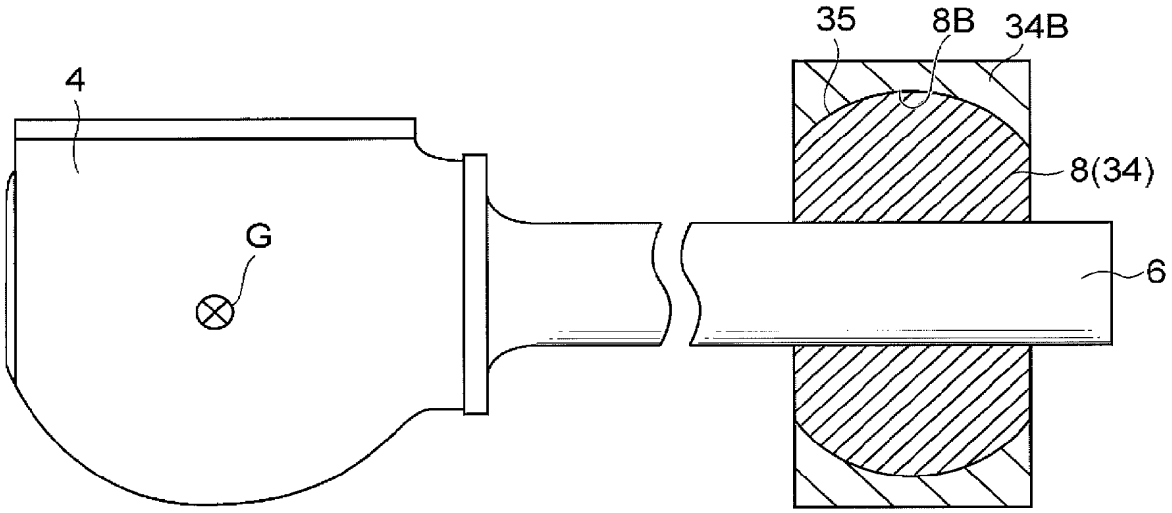
[図12]



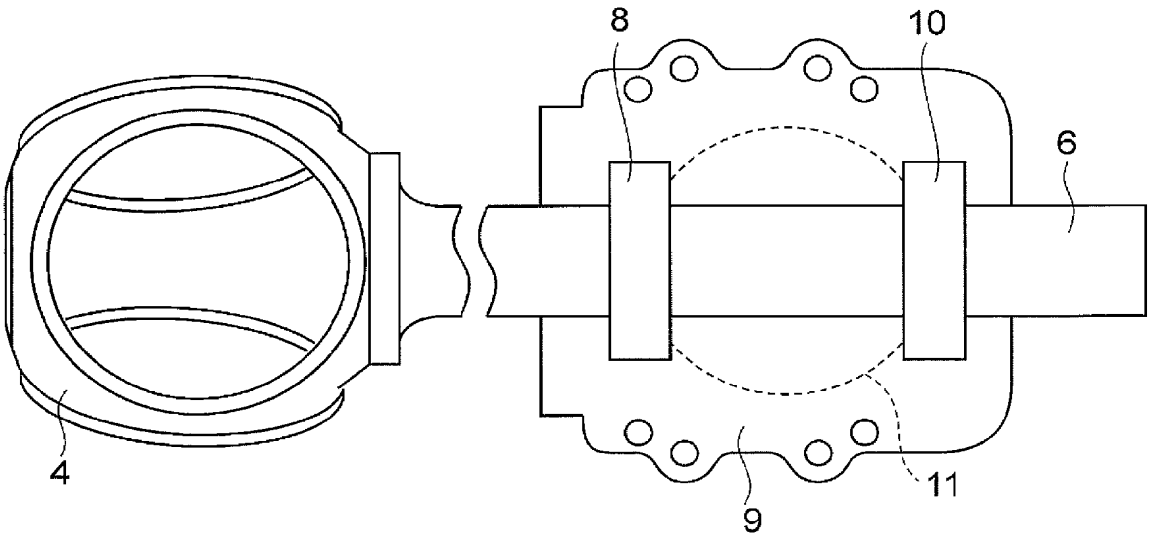
[図13]



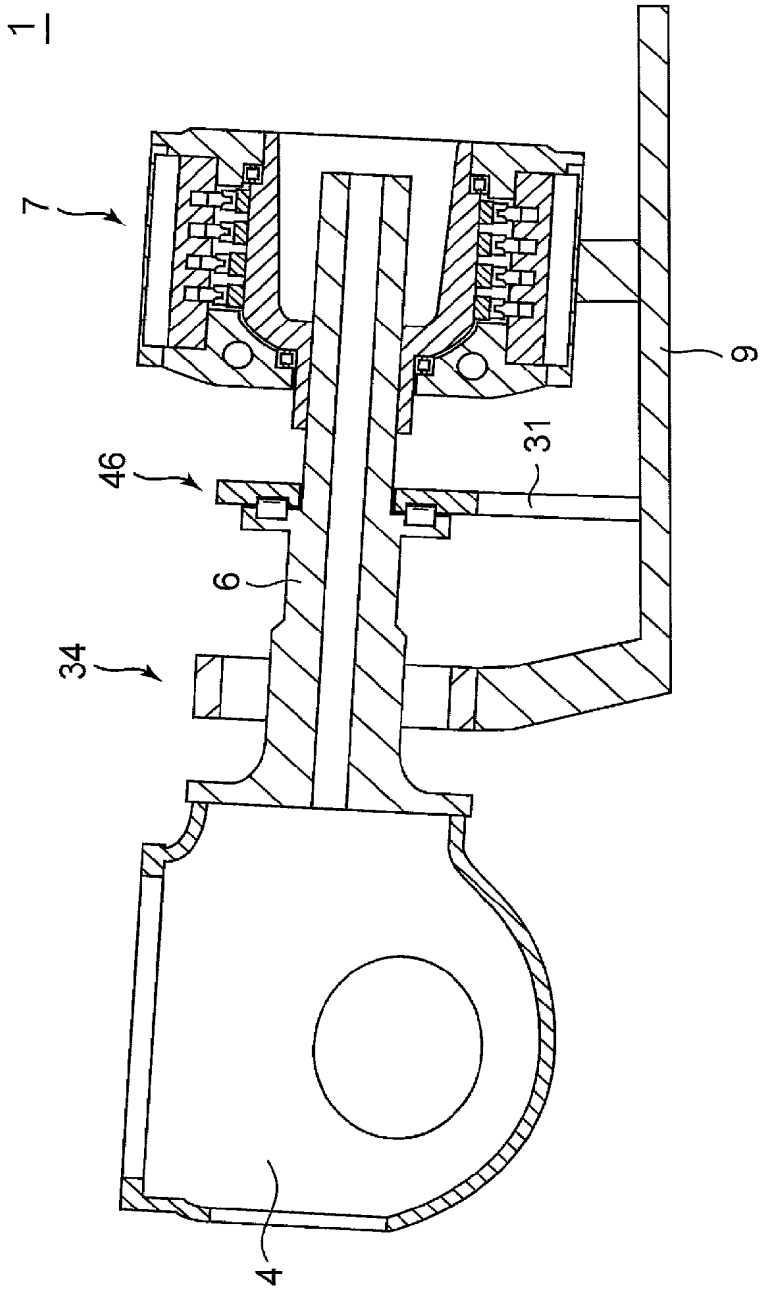
[図14]



[図15]

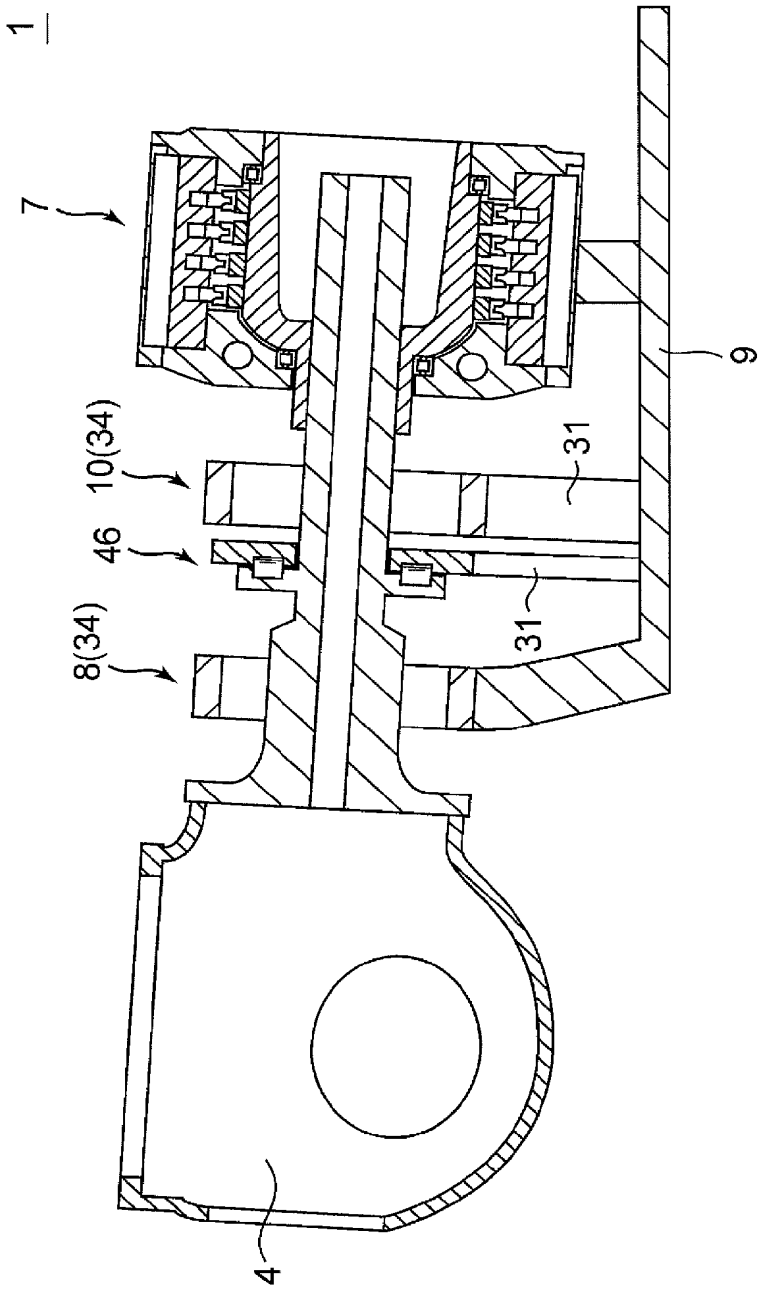


[図16]



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[図17]



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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/084092

A. CLASSIFICATION OF SUBJECT MATTER
F03D1/06(2006.01)i, *F03D11/00*(2006.01)i

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)
F03D1/06, F03D11/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2012-17735 A (THK Co., Ltd.), 26 January 2012 (26.01.2012), entire text; all drawings (Family: none)	1-17
A	US 2003/0080566 A1 (Markus BECKER et al.), 01 May 2003 (01.05.2003), entire text; all drawings & EP 1251306 A2 & DE 10119428 A1	1-17
A	JP 2011-163420 A (Mitsubishi Heavy Industries, Ltd.), 25 August 2011 (25.08.2011), entire text; all drawings (Family: none)	1-17

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 01 April, 2013 (01.04.13)	Date of mailing of the international search report 09 April, 2013 (09.04.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/084092

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012/0139242 A1 (George Albert GOLLER et al.), 07 July 2012 (07.07.2012), entire text; all drawings (Family: none)	1-17

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/084092

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The technical matter common to the invention of claim 1 and the invention of claim 15 is "at least one blade; a hub having the at least one blade attached thereto; a rotating shaft configured so as to rotate together with the hub; and at least one bearing for supporting the rotating shaft in a rotatable manner".

However, the common technical matter is a configuration normally provided to a blade wheel and makes no contribution over the prior art. Therefore, the common technical matter is not a special technical feature.

(Continued to extra sheet)

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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Continuation of Box No.III of continuation of first sheet(2)

Further, there is no other same or corresponding special technical feature between the invention of claim 1 and the inventions of claim 15.

Therefore, the following two inventions (invention groups) are involved in claims.

(Invention 1) the inventions of claims 1-14

(Invention 2) the inventions of claims 15-17

国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２０１２／０８４０９２

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　F03D1/06(2006.01)i, F03D11/00(2006.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　F03D1/06, F03D11/00

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２０１３年
日本国実用新案登録公報	１９９６－２０１３年
日本国登録実用新案公報	１９９４－２０１３年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
A	JP 2012-17735 A（ＴＨＫ株式会社）2012.01.26, 全文, 全図（ファミリーなし）	1-17
A	US 2003/0080566 A1 (Markus BECKER et al.) 2003.05.01, 全文, 全図 & EP 1251306 A2 & DE 10119428 A1	1-17
A	JP 2011-163420 A（三菱重工業株式会社）2011.08.25, 全文, 全図（ファミリーなし）	1-17
A	US 2012/0139242 A1 (George Albert GOLLER et al.) 2012.07.07, 全文, 全図（ファミリーなし）	1-17

☐　Ｃ欄の続きにも文献が列挙されている。

☐　パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「Ａ」特に関連のある文献ではなく、一般的技術水準を示すもの
「Ｅ」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「Ｌ」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「Ｏ」口頭による開示、使用、展示等に言及する文献
「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「Ｘ」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Ｙ」特に関連のある文献であって、当該文献と他の１以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「＆」同一パテントファミリー文献

国際調査を完了した日 ０１．０４．２０１３	国際調査報告の発送日 ０９．０４．２０１３
国際調査機関の名称及びあて先 日本国特許庁（ＩＳＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	特許庁審査官（権限のある職員）　３Ｏ　８９２２ 尾崎　和寛 電話番号　０３－３５８１－１１０１　内線　３３５８

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国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２０１２／０８４０９２

第Ⅱ欄　請求の範囲の一部の調査ができないときの意見（第１ページの２の続き）

法第8条第3項（ＰＣＴ17条(2)(a)）の規定により、この国際調査報告は次の理由により請求の範囲の一部について作成しなかった。

１．☐ 請求項 ＿＿＿＿＿＿＿＿ は、この国際調査機関が調査をすることを要しない対象に係るものである。
つまり、

２．☐ 請求項 ＿＿＿＿＿＿＿＿ は、有意義な国際調査をすることができる程度まで所定の要件を満たしていない国際出願の部分に係るものである。つまり、

３．☐ 請求項 ＿＿＿＿＿＿＿＿ は、従属請求の範囲であってＰＣＴ規則6.4(a)の第２文及び第3文の規定に従って記載されていない。

第Ⅲ欄　発明の単一性が欠如しているときの意見（第１ページの３の続き）

次に述べるようにこの国際出願に二以上の発明があるとこの国際調査機関は認めた。

請求項１に係る発明と請求項１５に係る発明の共通の技術的事項は「少なくとも一本のブレードと、前記少なくとも一本のブレードが取り付けられるハブと、前記ハブとともに回転するように構成された回転シャフトと、前記回転シャフトを軸支するための少なくとも一つの軸受」である。しかし、当該共通の技術的事項は、風車では通常具備する構成であり先行技術の域を出ないから特別な技術的特徴ではない。また、請求項１に係る発明と、請求項１５に係る発明との間に、ほかに同一の又は対応する特別な技術的特徴は存在しない。

したがって、請求の範囲には、以下に示す２つの発明（群）が含まれる。

（発明１）請求項１－１４に係る発明。

（発明２）請求項１５－１７に係る発明。

１．☐ 出願人が必要な追加調査手数料をすべて期間内に納付したので、この国際調査報告は、すべての調査可能な請求項について作成した。

２．☑ 追加調査手数料を要求するまでもなく、すべての調査可能な請求項について調査することができたので、追加調査手数料の納付を求めなかった。

３．☐ 出願人が必要な追加調査手数料を一部のみしか期間内に納付しなかったので、この国際調査報告は、手数料の納付のあった次の請求項のみについて作成した。

４．☐ 出願人が必要な追加調査手数料を期間内に納付しなかったので、この国際調査報告は、請求の範囲の最初に記載されている発明に係る次の請求項について作成した。

追加調査手数料の異議の申立てに関する注意

☐ 追加調査手数料及び、該当する場合には、異議申立手数料の納付と共に、出願人から異議申立てがあった。

☐ 追加調査手数料の納付と共に出願人から異議申立てがあったが、異議申立手数料が納付命令書に示した期間内に支払われなかった。

☐ 追加調査手数料の納付はあったが、異議申立てはなかった。

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Filer:	David Scott Safran/Kathleen McManus
Attorney Docket Number:	400517-20003

Filed as Small Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
BASIC NATIONAL STAGE FEE	2631	1	140	140
NATL STAGE SEARCH FEE - REPORT PROVIDED	2642	1	240	240
NATL STAGE EXAM FEE - ALL OTHER CASES	2633	1	360	360
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**740**

Electronic Acknowledgement Receipt

EFS ID:	28851649
Application Number:	15517288
International Application Number:	PCT/DK2015/000040
Confirmation Number:	1448
Title of Invention:	MAIN SHAFT FIXTURE
First Named Inventor/Applicant Name:	Per E. Fenger
Customer Number:	25570
Filer:	David Scott Safran/Kathleen McManus
Filer Authorized By:	David Scott Safran
Attorney Docket Number:	400517-20003
Receipt Date:	06-APR-2017
Filing Date:	
Time Stamp:	13:44:55
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$740
RAM confirmation Number	040717INTEFSW13453400
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Transmittal_DecPower_400517_20003.pdf	348132 add4aa1c05e0e35e894cbe0f9ec37d6d08ed7fe3	yes	6

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Power of Attorney	6	6
	Oath or Declaration filed	4	5
	Transmittal of New Application	1	3

Warnings:

Information:

2	Application Data Sheet	aia0014.pdf	1835761 927347da31b54b8d9fbb48e8e04c62b69ac8c05b	no	8

Warnings:

Information:

3	Documents submitted with 371 Applications	WO2016055065A1.pdf	1298589 d8868f4c8284f62e7c063c592d596726b1e64c49	no	23

Warnings:

Information:

4		PreliminaryAmendment_SubSpec_MarkupSpec_400517_20003.pdf	1478961 31f2001847fbe3a3c8129af40cf784d9d56411b9	yes	33

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	19	33

	Abstract		18		18
	Claims		17		17
	Specification		8		16
	Drawings-only black and white line drawings		7		7
	Applicant Arguments/Remarks Made in an Amendment		6		6
	Claims		3		5
	Specification		2		2
	Preliminary Amendment		1		1
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	updated_IDS.pdf	1050254 051063550aeef5e625921e8e37b0647e0359cf0f	no	4
Warnings:					
Information:					
6	Foreign Reference	JPS6154846A.pdf	144138 9d563bab7cac2912d8e3bc18f0dd99e3e39b13a7	no	5
Warnings:					
Information:					
7	Foreign Reference	EP1617075A1.pdf	789279 b1c7de4ecdf3312088131523b297023968c9714d	no	16
Warnings:					
Information:					
8	Foreign Reference	DE102006013539A1.pdf	358829 7eadb76496f2840bc4605ec00146b72db997863a	no	8
Warnings:					
Information:					

9	Foreign Reference	WO2014103018A1.pdf	1419407 2c43f7c068e51186929c84dd50a3c1f47196a112	no	43
Warnings:					
Information:					
10	Fee Worksheet (SB06)	fee-info.pdf	35092 0df0aaff3f2bbf86565655468d255231351a0550	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	8758442	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/80 (07-12)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office; U.S DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

■ Practitioners associated with Customer Number: 25570

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number

Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

■ The address associated with Customer Number: 25570

OR

☐	Firm or Individual Name		
	Address		
	City	State	Zip
	Country		
	Telephone	Email	

Assignee Name and Address: LIFTRA IP ApS
Stationsmestervej 81
DK-9200 Aalborg SV, Denmark

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be Filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of The practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	Per Fenger	Date	23-3-2017
Name	Per E. Fenger	Telephone	+45 96 600 300
Title	CEO		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive, Suite 500
McLean, Virginia 22102

ASSIGNMENT-DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Docket No. 400517-20003

Title of Invention	MAIN SHAFT FIXTURE

DECLARATION

As a below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ U.S. application or PCT international application number PCT/DK2015/000040 filed on 6 October 2015.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I have reviewed and understand the contents of the application, including the claims.

I am aware of the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in 37 CFR §1.56.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. §1001 by fine or imprisonment of not more than five (5) years, or both.

ASSIGNMENT

WHEREAS, the undersigned inventor(s) hereinafter referred to as the ASSIGNOR(S), has/have invented a certain improvement relating to the above identified invention.

AND WHEREAS, **LIFTRA IP ApS** whose post-office address is **Stationsmestervej 81, 9200 Aalborg SV, Denmark**, hereinafter known as the ASSIGNEE, is desirous of acquiring the entire right, title and interest for the United States and elsewhere throughout the world in and to said invention and application, including any and all divisions and continuations thereof, and any and all Letters Patent which may be granted thereon, including any and all renewals, reissues, and prolongations thereof.

NOW, THIS WITNESSETH that for good and valuable consideration, the receipt whereof is hereby acknowledged, said ASSIGNOR(S) hereby assign, sell and transfer to said ASSIGNEE, its assigns and legal representatives, the entire and exclusive right, title and interest in and to said invention and application, for the United States and elsewhere throughout the world including any and all divisions and continuations thereof, and any and all Letters Patent which may be granted therefor and all rights to sue for past and future infringement thereunder, said ASSIGNEE and its assigns and legal representatives to have, hold, exercise and enjoy the said invention and application, including any and all divisions and continuations thereof, and any and all Letters Patent which may be granted thereon, including any and all renewals, reissues and prolongations thereof, with all the rights, powers, privileges, and advantages in any ways arising from or pertaining thereto, for and during the term or terms of any and all such Letters Patent when granted, including any and all renewals, reissues, and prolongations thereof, for the use and benefit of said ASSIGNEE and its assigns and legal representatives in as ample and beneficial a manner to all intents and purposes as the said ASSIGNOR(S) might or could have held and enjoyed the same, if this assignment had not been made.

Roberts Mlotkowski Safran Cole & Calderon, P.C.
7918 Jones Branch Drive, Suite 500
McLean, Virginia 22102

AND said ASSIGNOR(S) hereby agree to execute all papers necessary to file applications in the United States and elsewhere throughout the world for said invention and to assign the same to said ASSIGNEE, or any assignee acquiring title to said invention, and to execute any other papers that may be needed in connection with filing said application and securing Letters Patent thereon.

AND said ASSIGNOR(S) authorize and request the Commissioner of Patents to issue Letters Patent on said application, and on any and all divisions and continuations thereof, to said ASSIGNEE, its assigns and legal representatives, in accordance herewith.

LEGAL NAME OF INVENTOR(S)

Inventor one: Per E. Fenger Date: 17-3-2017

Signature: Per Fenger

Inventor two: _____ Date: _____

Signature: _____

Inventor three: _____ Date: _____

Signature: _____

Inventor four: _____ Date: _____

Signature: _____

Digital Access Service
(DAS)

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CERTIFICATE OF AVAILABILITY OF A CERTIFIED PATENT DOCUMENT IN A DIGITAL LIBRARY

The International Bureau certifies that a copy of the patent application indicated below has been available to the WIPO Digital Access Service since the date of availability indicated, and that the patent application has been available to the indicated Office(s) as of the date specified following the relevant Office code:

Document details: Country/Office: DK
Filing date: 04 Sep 2015 (04.09.2015)
Application number: PA 2015 00527

Date of availability of document: 12 Oct 2015 (12.10.2015)

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LiftWerx Ex. 1006
LiftWerx USA Inc. v. Liftra IP ApS
IPR2026-00102

Kingdom of Denmark

Patent application No.:	PA 2015 00527
Date of filing:	4 September 2015
Applicant: (Name and address)	LIFTRA IP ApS Stationsmestervej 81 DK-9200 Aalborg SV Denmark

Title: Hovedakselfixstur til fiksering af hovedakslen på en vindmølle ved gennemførelse af montage- og reparationsarbejder

IPC: --

This is to certify that the attached documents are exact copies of the above mentioned patent application as originally filed.

12 October 2015

Danish Patent and Trademark Office
Ministry of Economic and Business Affairs

General Director Jesper Kongstad

J Kongstad

Den foreliggende opfindelse angår et hovedaksel-fixtur til vindmøller til fiksering af hovedakslen på en vindmølle ved gennemførelse af montage- og reparationsarbejder på tunge dele af vindmøllen arrangeret i nacellen på vindmøller, hvilket fixtur opdelt i et antal sektioner for montering på stabile konstruktionsdele, der forefindes i en vindmølles nacelle, herunder nacellens bundramme.

Ved gennemførelse af montage og reparationsarbejder i nacellen på vindmøller, er der ofte behov for at foretage fiksering af vindmøllens hovedaksel, f.eks. ved skift og servicering af vindmølles gearkasse, generator, eller ved udskiftning af dennes hovedlejer, eller andre tunge konstruktionsdele der forefindes i nacellen på en vindmølle. Nævnte komponenter der er indbyrdes forbundne og forankrede til nacellens bundramme, er i samlet tilstand stabile, men når der skal foretages en adskillelse ved reparation og servicering af møllen, opstår der statisk ustabilitet og ubalance, der kan medføre at møllens konstruktionsdele beskadiges, derfor er der et behov for at fiksere vindmøllens hovedaksel.

Hidtil har det været nødvendigt at standse møllen, dvs. bremse denne af og fiksere rotoren med en rotorlås, og derefter montere et egentligt fixtur til fastholdelse af hovedakslen, hvorefter servicering af komponenterne i vindmøllens nacelle kan finde sted. Imidlertid er det uhensigtsmæssigt at skulle indstille driften af vindmøllen imens montage af hovedaksel-fixturet finder sted, idet stilstand af vindmøllen i den tid der medgår til montage af fixturet, medfører et ikke ubetydeligt driftstab i form af manglende produceret energi (strøm). Yderligere er de kendte hovedaksel-fixturer relativt ufleksible i forhold til akselgeometri, hvilket betyder at der i praksis skal konstrueres og oplagres tilnærmelsesvis lige så mange forskellige fixturer, som der forekommer forskellige akselgeometrier, hvilket er uhensigtsmæssigt. Desuden er anvendelse af selvophejsende kraner, hvis spil er placeret på jordoverfladen nær møllens tårn under udbredelse, idet anvendelsen heraf rummer store besparelser i omkostningsniveauet til servicering af vindmøller, idet anvendelse af store mobilkraner til håndtering af ovennævnte store og tunge komponenter, overflødiggøres. Dette medfører imidlertid behov for faciliteter til forankring af den selvophejsende kran med det jordbaserede spil i nacellen. Yderligere fordrer det selvophejsende spil dog tilstedeværelse af en letvægtskran, til ophejs-

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ning af kastetblokke m.m. der skal forankres på/i nacellen eller på vindmøllens vinger, hvilket stiller krav om faciliteter for montage af letvægtskranen.

I tilfælde af servicering af navnlig større vindmøller, kan det imidlertid være uhensigtsmæssigt at blokere hovedakslens rotation ved en egentlig rotorlås, men hvor det blot er formålstjenligt at fastholde akslen i sin position og tillade en vis rotation af akslen, hvilket er muligt ved at dreje vingerne/nacellen ud af vinden, således at akslen ved vindpåvirkning på vingerne, kun roterer meget langsomt, eller slet ikke, hvorved det er acceptabelt rent sikkerhedsmæssigt at foretage servicearbejder i en aktuel vindmølles nacelle.

Det er således opfindelsens formål at angive et hovedaksel-fixtur, der tilgodeser en mere universel anvendelse i forhold til akselgeometri, der endvidere ikke fordrer standsning og fiksering af vindmøllens hovedaksel, men som dog kan omfatte midler dertil.

Det er endvidere opfindelsens formål at angive et hovedaksel-fixtur der yderligere frembyder faciliteter for montage af en selvophejsende kran, med et jordbaseret spil.

Det er ved opfindelsen indset, at dette er muligt ved et hovedaksefixtur af den indledningsvist angivne art, som er kendetegnet ved, at hovedaksel-fixturet omfatter i det mindste tre, fortrinsvist fire, i hovedsagen, omkring hovedakslens centerakse symmetrisk placerede, radialt forskydelige trykdorne, hvis imod hovedakslen vendende ender er forsynede med tryksko, og hvilke trykdorne er forskydelige imellem en passiv, tilbagetrukket position hvor trykskoene er lokaliseret i afstand fra aksel overfladen, og en aktiv fremskudt låsbar position hvor trykskoene er i anlæg med hovedakslen.

Herved opnås en betragtelig fleksibilitet med hensyn til hovedaksel-fixturets anvendelse til fiksering af hovedaksler med forskellig geometri på vindmøller, idet alene graden af forskydeligheden af trykdornene og størrelsen af hovedakselfixturet er begrænsende for anvendeligheden heraf. Hovedaksel-fixturet er således

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både anvendeligt til fiksering af cylinderformede aksler med forskellige diametre, og til fiksering af aksler med konisk facon. Hovedaksel-fixturet ifølge opfindelsen er flerdelt, og kan monteres på faste konstruktionsdele, fortrinsvist nacellens bundramme, mens vindmøllens rotor er i drift.

I den hensigt at kunne anvende et selvophejsende kran, med et jordbaseret spil sammen med hovedaksel-fixturet ifølge opfindelsen, kan at dette omfatte monteringsfaciliteter for en selvophesjsende kran, hvis spil er placeret på jordoverfladen nær vindmøllens fod.

Herved opnås den fordel, at etablering af faciliteter til fiksering af vindmøllens hovedaksel, samt etablering af monteringsfaciliteter for den selvophejsende kran med et jordbaseret spil, finder sted samtidigt, hvilket sparer arbejdsgange, og plads, hvilket er af stor vigtighed, idet pladsforholdene i nacellen i en vindmølle oftest er sparsomme, og yderligere, at såvel hovedaksel-fixturet som monteringsfaciliteterne for en selvophejsende kran i nacellen, normalt benytter de samme faste konstruktionsdele i nacellen til forankring.

I den hensigt at sikre en let og hurtig etablering af den selvophejsende kran, hvilket fordrer ophejsning af kastetblokke med wirer hidrørende fra det jordbaserede spil med en letvægtskran, der monteres på stabile konstruktionsdele i nacellen, kan hovedaksel-fixturet omfatte monteringsfaciliteter for en letvægtskran.

I den hensigt at sikre en hurtig fiksering af hovedakslen med hovedakselfixturet ifølge opfindelsen, kan trykdornene være forsynede med aktuatorer for forskydning og fastholdelse af trykskoene i henholdsvis den passive position og den aktive position, alternativt en valgfri position imellem den passive og den aktive position. Herved opnås en tidsbesparelse ved forskydning af trykskoene imellem den passive position og den aktive position, trykket an imod hovedakslens overflade.

I en mere enkel udførelsesform af hovedaksel-fixturet, ifølge opfindelsen, kan trykdornene udgøres af gevindskårne bolte hvis imod hovedakslen vendende frie ender er forsynede med tryksko, hvilke gevindskårne bolte samvirker med gevindskårne huller i relevante sektioner af fixturet. Herved kan trykdornene med

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trykskoene ved manuel drejning af de gevindskårne bolte forskydes imellem den passive position og den aktive position.

I den hensigt at kunne tillade rotation af hovedakslen under udførelse af servicering af en aktuel vindmølle og for at beskytte hovedakslen samt hovedakselfixturet, kan der imellem de tilvendende sider af hovedakslens overflade og trykskoene forekomme en glidebelægning.

Herved opnås det at hovedakslen fastholdes i sin position af hovedakselfixturet, men at det tillades at hovedakslen roterer, uden at denne beskadiges, grundet tilstedeværelsen glidebelægningen.

I en første udførelsesform af glidebelægningen kan denne bestå i, at de imod hovedakslen tilvendende frie ender af trykskoene er forsynede med glideplader, der i den aktive fremskudte position er i anlæg med hovedakslen.

I en yderligere udførelsesform kan hovedakselfixturet ifølge opfindelsen omfatte en med hovedakslen samvirkende, flerdelt glideplade for montage på hovedakslen, hvilken flerdelte glideplade i den monterede tilstand på hovedakslen samvirker med trykskoene.

Herved opnås det, at trykskoene på hovedakselfixturets trykdorne glider direkte på den flerdelte glideplade, ved en eventuel rotation af hovedakslen, forårsaget af vindpåvirkning af vingerne. Trykskoene på hovedakselfixturets trykdorne kan samvirke med den flerdelte glideplade på hovedakslen, med eller uden glidebelægninger på de imod hovedakslen tilvendende sider af trykskoene.

I en yderligere udførelsesform af hovedakselfixturet ifølge opfindelsen kan dette omfatte et flerdelt nåle-, rulle-, kugleleje bestående af en på hovedakslen fastgjort, flerdelt inder-ring, samt en dermed samvirkende flerdelt yder-ring bestående af et til trykskoenens antal krumme delsegmenter monteret på den imod inder-ringen tilvendende side af trykskoene, der i trykdornenes fremskudte aktive position danner yder-ringen i en afstand fra den udvendige periferi af den flerdelte

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inder-ring, hvor der imellem inder-ringen og yder-ringen er anbragt et passende antal nåleruller, ruller eller kugler, og hvor der forefindes midler til fastholdelse af nåleruller, ruller eller kugler i position imellem inder-ringen og yder-ringen.

Herved dannes en egentlig midlertidig lejeforbindelse imellem hovedakselfixturet og hovedakslen, hvorom hovedakslen kan rotere.

I den hensigt at kunne fiksere rotoren på vindmøllen efter denne er bremset op, kan hovedaksel-fixturet, ifølge opfindelsen omfatte en rotorlås, for fiksering af vindmøllens rotor.

I en foretrukket udførelsesform af rotorlåsen udgøres denne af en flange, hvis boltcirkel geometri modsvarer en boltcirkel geometri på rotoren, hvilken flange i enderne er fastgjort til den første ende af to parallelt med hovedakslen og på hver side af denne forløbende, første bjælkeformede konsoller tilhørende hovedaksel fixturet, hvilke konsollers anden ende er drejeligt lejrede med horisontalt orienterede boltforbindelser, på andre konsoller tilhørende hovedaksel-fixturet, der er forankrede til nacellens bundramme.

I den hensigt at kunne foretage udskiftning af akslens hovedleje, uden at være nødsaget til at afmontere hovedakslen, kan hovedaksel-fixturet yderligere omfatte i det mindste en anden aktuator, imellem nacellens bundramme og den imod denne tilvendende side af de første bjælkeformede konsoller og nærmest rotorlåsen, hvilken anden aktuator er forskydelig imellem en første passiv yderposition og en aktiv yderposition hvorved flangeelementet forskydes vertikalt.

Herved opnås det, at hovedakslen kan hæves fra sit leje hængende i rotorlåsen, således at akslens hovedleje kan udskiftes eller serviceres uden at akslen skal fjernes fra nacellen.

Opfindelsen forklares nærmere i det følgende med henvisning til tegningen, hvor;

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fig. 1 er et perspektivbillede af dele af en vindmølles nacelle, udvisende nacellens bundramme, vindmøllens hovedaksel, samt et hovedaksel-fixtur ifølge opfindelsen, med en letvægtskran og en selvophejsende kran monteret,

fig. 2 er et mere detaljeret perspektivbillede fra en anden vinkel af det i fig. 1 viste, hvor hovedakslen er gjort transparent, udvisende trykdorne med tryksko, tilhørende hovedaksel-fixturet ifølge opfindelsen,

fig. 3 er et mere detaljeret perspektivbillede fra en anden vinkel af det i fig. 1 viste, hvor hovedakslen er gjort transparent, udvisende aktuatorerne for hævning af hovedakslen,

Fig. 4 er et detaljeret perspektivbillede af hovedakselfixturet til en vindmølle, hvor trykskoene og hovedakslen er forsynet med glideplader, og

Fig. 5 er et detaljeret detaljeret perspektivbillede af hovedakselfixturet til en vindmølle, hvor glidepladerne er erstattet af flerdelt nåle-, rulle-, kugleleje bestående af en på hovedakslen fastgjort, flerdelt inder-ring, samt en dermed samvirkende flerdelt yder-ring bestående af et til trykskoenens antal krumme delsegmenter monteret på den imod inderringen tilvendende side af trykskoene.

I fig. 1 ses en bundramme 2 i en nacelle (ikke vist) på en vindmølle (ikke vist), hvor vindmøllens hovedaksel 4, med gearkasse 6 og rotoren 8 er vist, og hvor hovedaksel-fixturet 10 ifølge opfindelsen er vist i monteret tilstand, bærende henholdsvis en letvægtskran 12 og en selvophejsende kran 14, med et jordbaseret spil (ikke vist). Bundrammen 2 er af hensyn til overskueligheden gjort transparent.

Hovedaksel-fixturet 10 er i den viste udførelsesform forankret på bundrammen 2 nær gearkassen 6 og nær rotoren 8, og omfatter en flerdelt ramme 14, der sammen med en derpå fastspændt tværdrager 16, omslutter et stykke af hovedakslen 4 imellem rotoren 8 og gearkassen 6. Den flerdelte ramme 14 er forankret på bundrammen 2.

I fig. 2 ses det i fig. 1 viste, men som ende-billede, set fra rotorsiden af akslen 4, og hvor rotoren 8 af hensyn til overskueligheden er gjort transparent. Som det fremgår af fig. 2 omfatter den flerdelte ramme 14 og tværdrageren 16 i alt 4 omkring hovedakslen 2 symmetrisk placerede trykdorne 18, med tryksko 20, der er bragt i anlæg med hovedakslen 4, for fastholdelse af denne.

Trykdornene 18, kan udgøres af hydraulisk drevne stempler hvis frie ender omfatter trykskoene 20, men kan også være udført på andre måder, hvor disse

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forskydes manuelt imellem den aktive position, hvor trykskoene 20 er i anlæg med hovedakslen 4 og den passive, tilbagetrukne position.

Som det fremgår af fig. 3, omfatter hovedaksel-fixturet 10, to parallelt forløbende første dragere 22 på hver side af hovedakslen 4, i hvis første ender, nærmest rotoren 8, er fastgjort rotorlås i form af et flangeelement 24, hvis hulcirkel 26 geometri er ligedannet med hulcirkel 28 geometrien på rotoren 8 over en del af rotorens periferi. Ved låsning af rotoren 8 bringes hullerne 7 i rotoren 8 og hullerne 9 i flangeelementet 24 til overlapning, hvorefter der indføres bolte gennem hullerne, der tilspændes med møtrikker, hvorefter rotoren 8 er fastholdt/låst af flangeelementet 24.

Den anden ende af de parallelt forløbende første dragere 22 er nærmest gearkassen 6 drejeligt forankret på horisontalt orienterede lejebolte 30, på en konsol 32, der er fastgjort til bundrammen 2. De parallelt forløbende første dragere 22 er indbyrdes forbundne med andre tværdragere 34, på hvilke ses konsolfaciliteter 23 for en selv ophejsende kran 14 med et jordbaseret spil (ikke vist).

Som det fremgår af fig. 3 og fig. 1, findes der imellem bundrammen 2 og de paralleltforløbende første dragere 22 en aktuator 36. Aktivering af aktuatoren 36 vil medføre en ændring af afstanden imellem bundrammen 2 og de første dragere 22, i hvilket flangeelementet 24 er ophængt, hvilket vil medføre at flangeelementet 24 og rotoren 8, og dermed hovedakslen 4 hæves, hvilket vil medføre, at det bliver muligt at udskifte hovedakslens leje 38, uden at være nødsaget til at hejse hovedakslen 4 ned på jorden, hvilket er meget besparende, såfremt hovedaksellejet 38 skal repareres eller udskiftes.

I fig. 1 ses endvidere hvorledes hovedaksel-fixturet 10 omfatter monteringsfaciliteter 40 for letvægtskranen 12.

I fig. 4 ses en udførelsesform af hovedaksel-fixturet, ifølge opfindelsen, der er specielt egnet til anvendelse for fastholdelse af vindmøllens hovedaksel 4 i position i nacellen, men hvor rotation af hovedakslen 4 er mulig i trykdornenes/trykskoenes (18, 20) aktive position i anlæg med hovedakslen.

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Som det fremgår af fig. 4, findes der imellem de tilvendende sider af trykskoene 20 og overfladen af hovedakslen 4 en glidebelægning 42, 44.

Glidebelægningen kan udgøres af glideplader 42 der er fastgjort på de imod hovedakslen 4 tilvendende frie ender af trykskoene 20, der i den aktive fremskudte position er i anlæg med hovedakslen 4, men kan alternativt omfatte en med hovedakslen 4 samvirkende, flerdelt glideplade 44 for montage på hovedakslen 4, hvilken flerdelte glideplade 44 i den monterede tilstand på hovedakslen 4 samvirker med trykskoene 20. Det skal anføres, at tilstedeværelsen af den flerdelte glideplade 44 på hovedakslen 4 ikke nødvendigvis udelukker tilstedeværelsen af glidepladerne 42 på trykskoene 20.

I en yderligere udførelsesform består hovedakselfixturet 10 af et flerdelt nåle-, rulle-, kugleleje 46, bestående af en på hovedakslen fastgjort, flerdelt inder-ring 48, samt en dermed samvirkende flerdelt yder-ring 50 bestående af et til trykskoenens antal krumme delsegmenter 52 monteret på den imod inder-ringen 48 tilvendende side af trykskoene 20, der i trykdornenes fremskudte aktive position danner yder-ringen 50 i en afstand fra den udvendige periferi af den flerdelte inder-ring 48, og hvor der imellem inder-ringen 48 og yder-ringen 50 er anbragt et passende antal nåleruller/ ruller/ eller kugler 54 (i den viste udførelsesform ruller 54), og hvor der forefindes midler (ikke vist) til fastholdelse af nåleruller/ ruller/ kugler 54 i position imellem inder-ringen 48 og yder-ringen 50.

Nævnte midler til fastholdelse af nåleruller/ruller/kugler 54, kan bestå i, samvirkende kantafgrænsninger på tilvendende sider af inder-ringen 48 og yder-ringen 50, alternativt ved holdemidler, imellem hvilke nålerullerne/rullerne/kuglerne 54 fastspændes.

Tilstedeværelsen af glidebelægningen 42, 44, alternativt det flerdelte nåle-, rulle-, kugleleje 46, medfører at hovedakslen 4 tillades at rotere, med samtidigt at denne fastholdes i sin position under servicering af vindmøllen, hvilket kan være formålstjenligt, navnlig ved større vindmøller.

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Opfinderen har erkendt, at hovedaksel-fixturet 10 kan antage andre udformninger en den foran beskrevne og i figuren viste, men det ændrer ikke på det opfinderiske aspekt der består i at angive et hovedaksel-fixtur 10 af den angivne art, der omfatter justerbare trykdorne 18 med tryksko 20, der medfører at fixturet 10 bliver anvendeligt uanset geometrien af hovedakslen 4 på en vindmølle, og således, at dette kan monteres uden at fiksere rotoren 8, og yderligere at kombinere hovedaksel-fixturet med faciliteter (40) montering af henholdsvis en letvægtskran 12, og en selvophejsende kran 14, med et jordbaseret spil, samt en rotorlås 24 og sluttelig at indrette hovedaksel-fixturet 10 med aktuatorer 36, således at hovedakslen 4 og hovedaksellejet 38 kan hæves tilstrækkeligt fra dettes leje i nacellen til, at lejet kan serviceres eller udskiftes.

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KRAV

1. Hovedaksel-fixtur (10) til fiksering af hovedakslen (4) på en vindmølle ved gennemførelse af montage- og reparationsarbejder på tunge dele af vindmøllen arrangeret i nacellen på vindmøller, hvilket fixtur (10) opdelt i et antal sektioner for montering på stabile konstruktionsdele (2), der forefindes i en vindmølles nacelle, herunder nacellens bundramme (2), k e n d e t e g n e t v e d , at hovedaksel-fixturet (10) omfatter i det mindste tre, fortrinsvist fire, i hovedsagen, omkring hovedakslens centerakse (11) symmetrisk placerede, radialt forskydelige trykdorne (18), hvis imod hovedakslen (4) vendende ender er forsynede med tryksko (20), og hvilke trykdorne (18) er forskydelige imellem en passiv, tilbagetrukket position hvor trykskoene (20) er lokaliseret i afstand fra hovedakslen (4) overfladen, og en aktiv fremskudt låsbar position hvor trykskoene (20) er i anlæg med hovedakslen (4).

2. Hovedaksel-fixtur (10), ifølge krav 1, k e n d e t e g n e t v e d , at dette omfatter monteringsfaciliteter for en selvophejsende kran (14), hvis spil er placeret på jordoverfladen nær vindmøllens fod.

3. Hovedaksel-fixtur (10), ifølge krav 1 eller 2, k e n d e t e g n e t v e d , at dette omfatter monteringsfaciliteter (40) for en letvægtskran (12).

4. Hovedaksel-fixtur (10), ifølge et hvilket som helst af kravene 1-3, k e n d e t e g n e t v e d , at trykdornene (18) er forsynede med aktuatorer til forskydning og fastholdelse af trykskoene (20) i henholdsvis den passive position og den aktive position, alternativt en valgfri position imellem den passive og den aktive position.

5. Hovedaksel-fixtur (10), ifølge et hvilket som helst af kravene 1-3, k e n d e t e g n e t v e d , at trykdornene (18) udgøres af gevindskårne bolte hvis imod hovedakslen vendende frie ender er forsynede med tryksko (20), hvilke gevindskårne bolte samvirker med gevindskårne huller i relevante sektioner af fixturet (10).

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6. Hovedaksel-fixtur (10), ifølge et hvilket som helst af kravene 1-5, k e n d e t e g n e t v e d , at der imellem de tilvendende sider af hovedakslens overflade og trykskoene findes en glidebelægning (42, 44).

7. Hovedaksel-fixtur (10) ifølge krav 6, k e n d e t e g n e t v e d , at glidebelægningen består i, at de imod hovedakslen (4) tilvendende frie ender af trykskoene (20) er forsynede med en glideplade (42), der i den aktive fremskudte position er i anlæg med hovedakslen (4).

8. Hovedaksel-fixtur (10) ifølge krav 6 eller 7, k e n d e t e g n e t v e d , at det omfatter en med hovedakslen (4) samvirkende, flerdelt glideplade (44) for montage på hovedakslen (4), hvilken flerdelte glideplade (44) i den monterede tilstand på hovedakslen (4) samvirker med trykskoene (20).

9. Hovedaksel-fixtur (10) ifølge et hvilket som helst af kravene 1-5, k e n d e t e g n e t v e d , at det omfatter et flerdelt nåle-, rulle-, kugleleje (46) bestående af en på hovedakslen (4) fastgjort, flerdelt inder-ring (48), samt en dermed samvirkende flerdelt yder-ring (50) bestående af et til trykskoenens antal krumme delsegmenter (52) monteret på den imod inder-ringen (48) tilvendende side af trykskoene (20), der i trykdornenes fremskudte aktive position danner yder-ringen (50) i en afstand fra den udvendige periferi af den flerdelte inder-ring (48), hvor der imellem inder-ringen (48) og yder-ringen (50) er anbragt et passende antal nålerulle-r, ruller eller kugler (54), og hvor der forefindes midler til fastholdelse af nålerulle-r, ruller eller kugler (54) i position imellem inder-ringen (48) og yder-ringen (50).

10. Hovedaksel-fixtur (10), ifølge et hvilket som helst af kravene 1-9, k e n d e t e g n e t v e d , at dette omfatter en rotorlås (24), for fiksering af vindmøllens rotor (8).

11. Hovedaksel-fixtur (10), ifølge krav 10, k e n d e t e g n e t v e d , at rotorlåsen (24) udgøres af et flangeelement, hvis boltcirkel geometri (26) modsvarer en boltcirkel geometri (28) på rotoren, hvilket flangeelement (24) i enderne er fastgjort til den første ende (21) af to parallelt med hovedakslen og på hver side af

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denne forløbende, første bjælkeformede konsoller (22) tilhørende hovedaksel fixturet, hvilke konsollers (22) anden ende (23) er drejeligt lejrede med horisontalt orienterede boltforbindelser (30), på andre konsoller (39) tilhørende hovedakselfixturet (10), der er forankrede på nacellens bundramme (2).

12. Hovedaksel-fixtur (10), ifølge krav 11, k e n d e t e g n e t v e d , at der imellem nacellens bundramme (2) og den imod denne tilvendende side (25) af de første bjælkeformede konsoller (22) og nærmest rotorlåsen (24), findes i det mindste en aktuator (36), hvilken aktuator (36) er forskydelig imellem en første passiv yderposition og en aktiv yderposition hvor flangeelementet (24) forskydes vertikalt.

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Sammendrag

Der angives et hovedaksel-fixtur (10) til fiksering af hovedakslen (4) på en vindmølle ved gennemførelse af montage- og reparationsarbejder på tunge dele af vindmøllen arrangeret i nacellen på vindmøller, hvilket fixtur (10) opdelt i et antal sektioner for montering på stabile konstruktionsdele (2), der forefindes i en vindmølles nacelle, herunder nacellens bundramme (2).

Hovedaksel-fixturet (10) omfatter justerbare trykdorne (18) med tryksko (20), der medfører at fixturet 10 bliver anvendeligt uanset geometrien af hovedakslen (4) på en vindmølle, og således, at dette kan monteres uden at fiksere rotoren (8). Hovedaksel-fixturet (10) omfatter tillige faciliteter (40) montering af henholdsvis en letvægtskran (12), og en selvophejsende kran (14) med et jordbaseret spil, samt en rotorlås (24), der i kombination med til hovedaksel-fixturet (10) hørende aktuatorer (36) imellem hovedaksel-fixturet (10) og bundrammen (2), medfører, at det er muligt at forskyde hovedakslen (4) og hovedaksellejet (38) vertikalt fra dettes leje i nacellen til, at lejet kan serviceres eller udskiftes.

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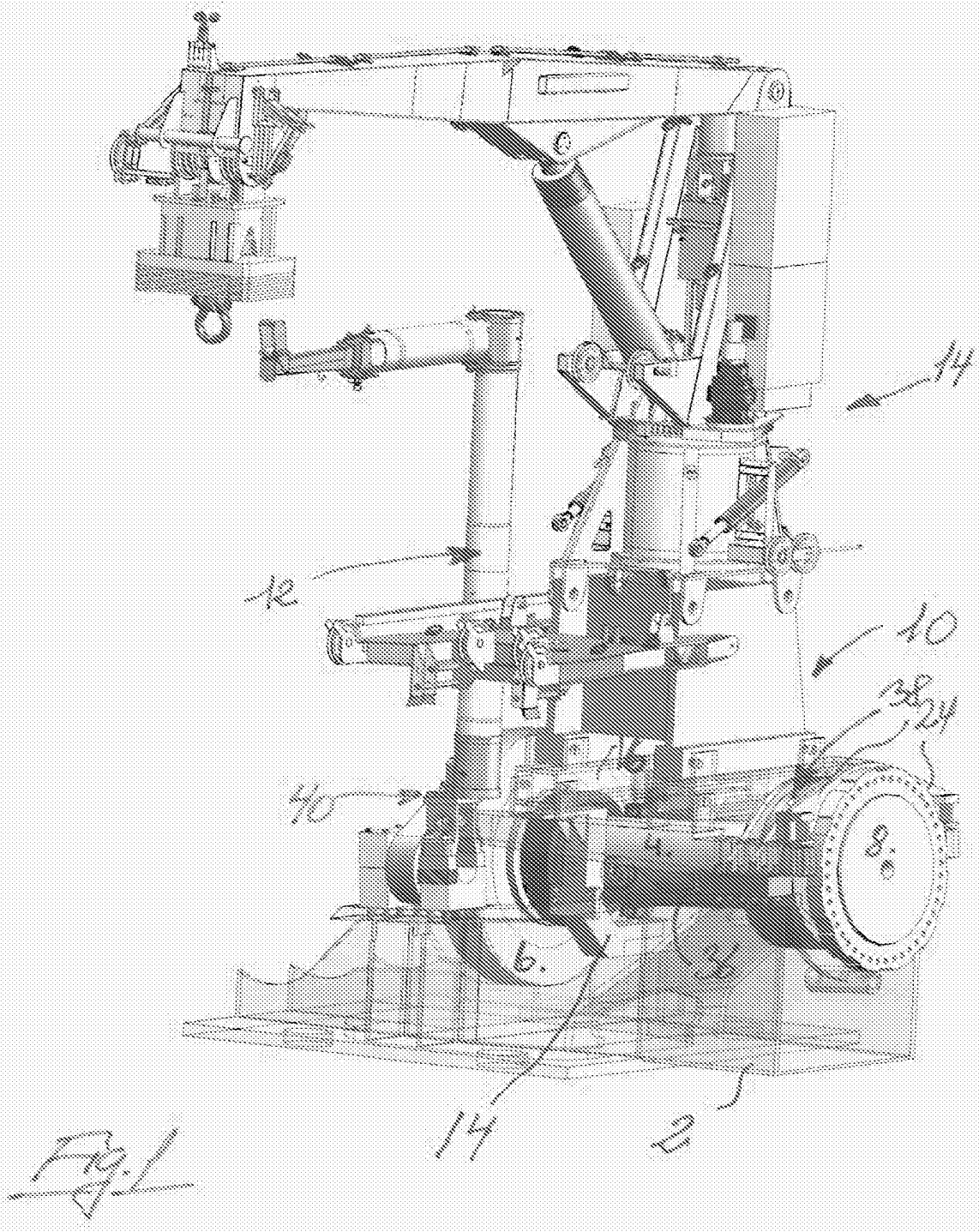


Fig. 1

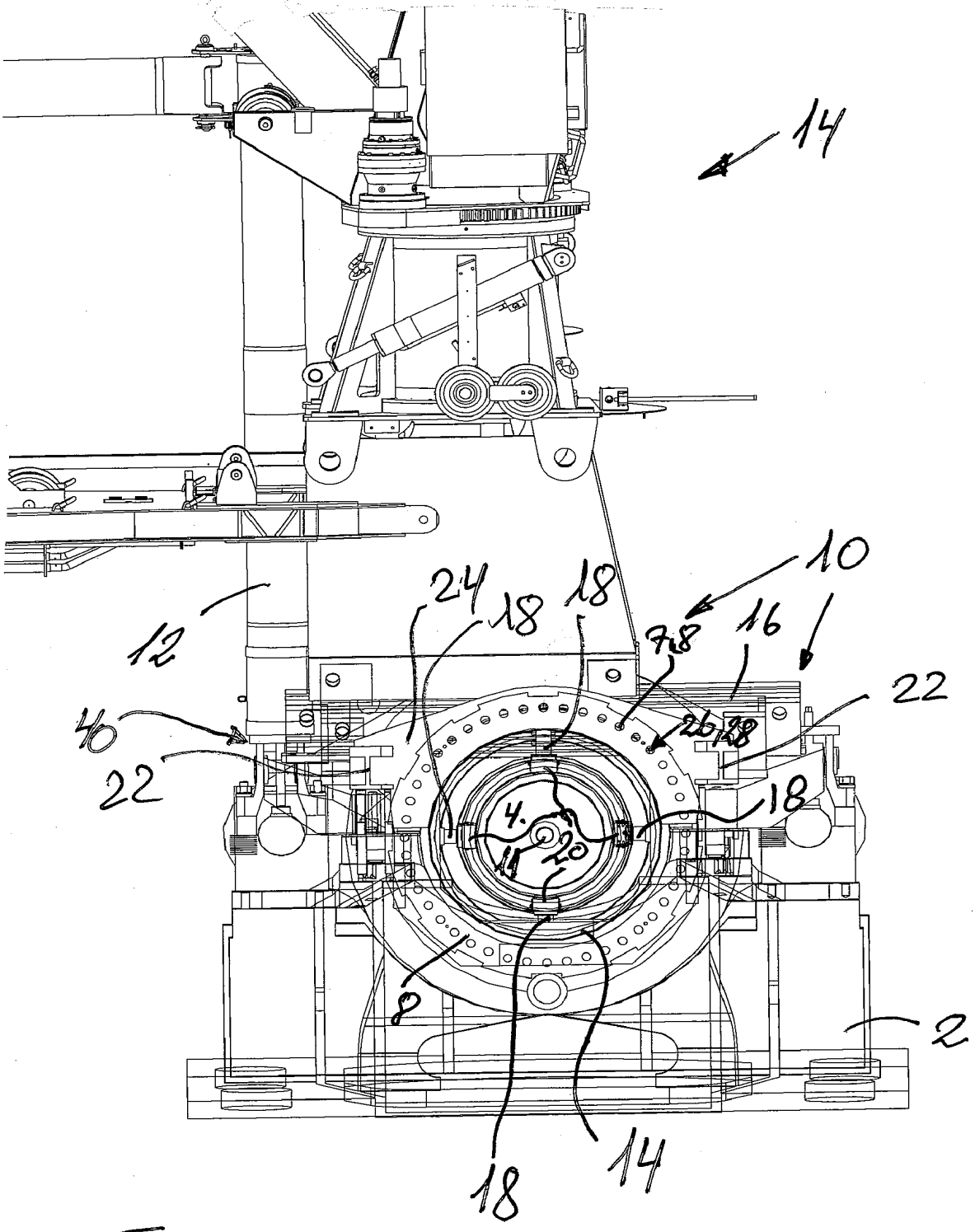


Fig.2

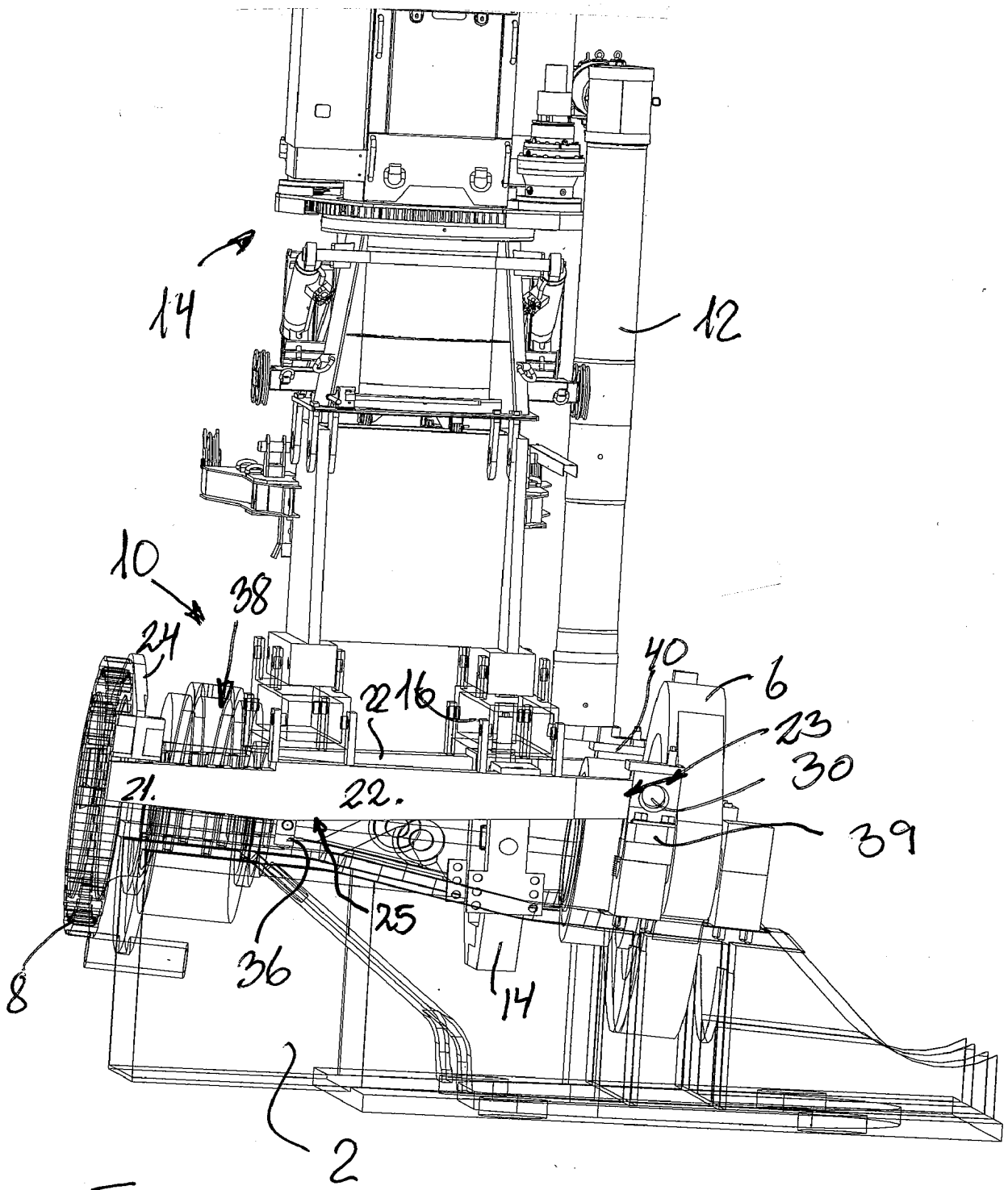


Fig. 3

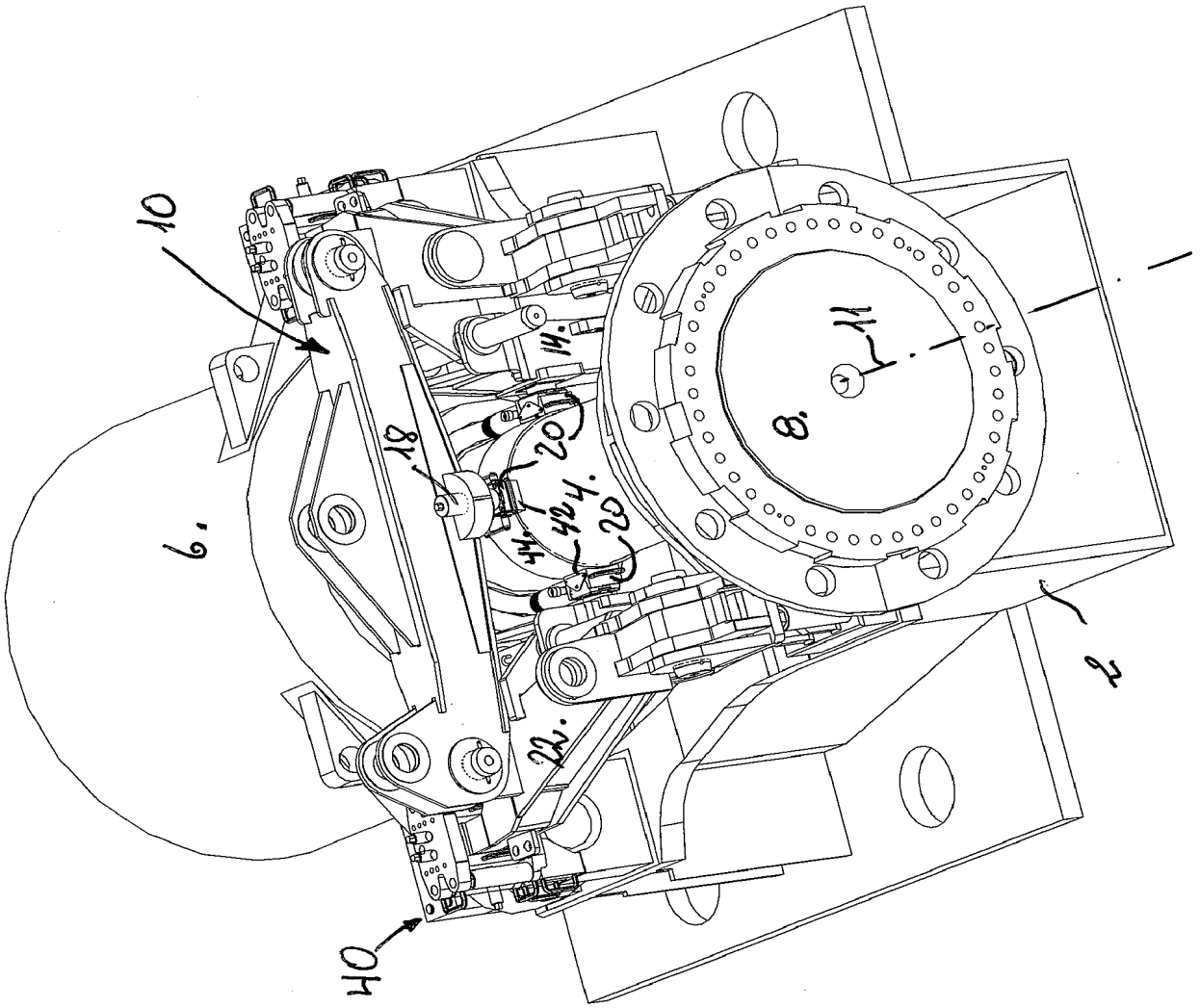


Fig. 4

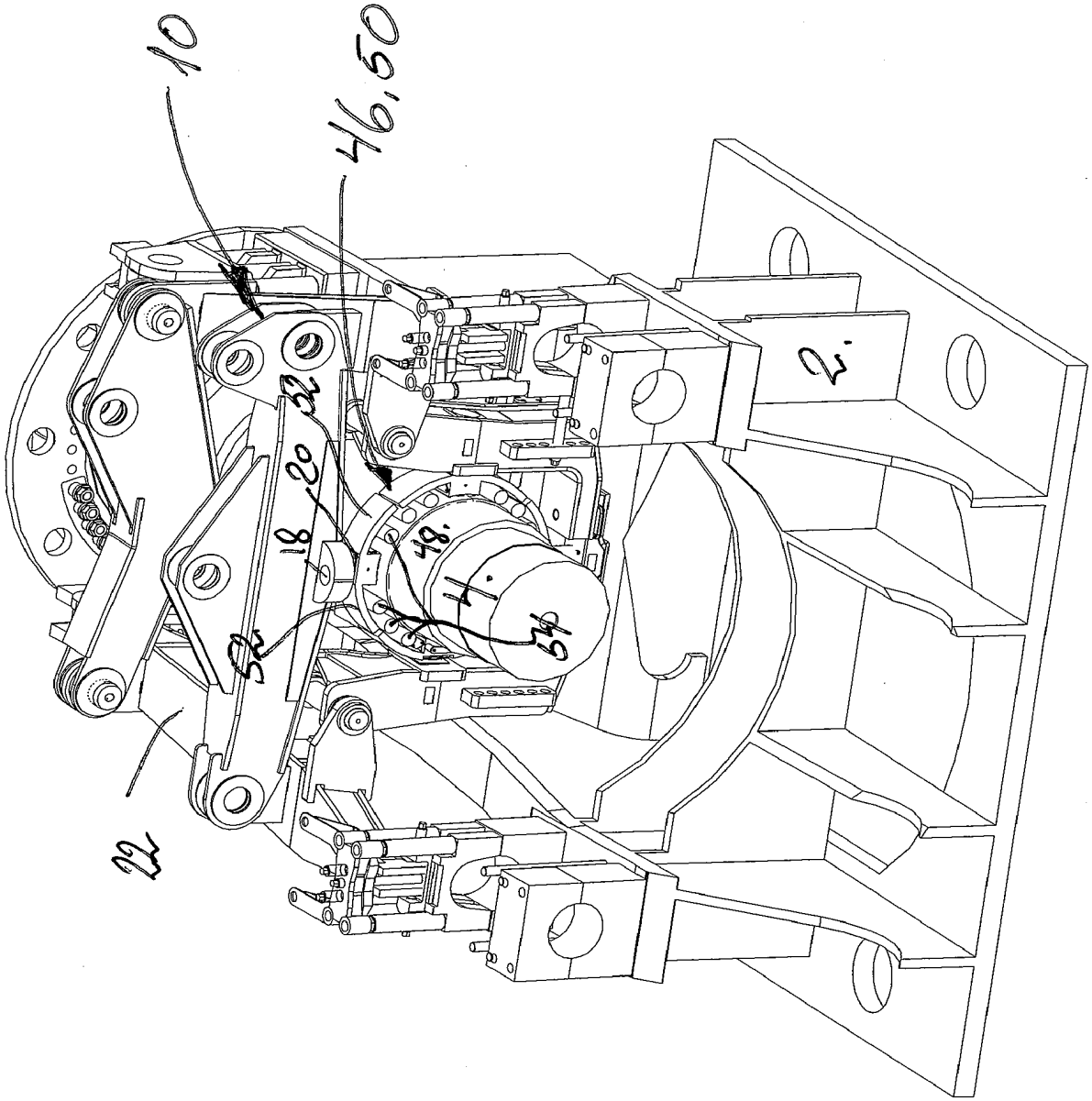


Fig. 5

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0-1	International Application No.	PCT/DK 2015/000040
0-2	International Filing Date	6 OKT. 2015
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0-4	**Form PCT/RO/101 PCT Request**	
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0-6	**Receiving Office (specified by the applicant)**	Danish Patent and Trademark Office (RO/DK)
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I	**Title of Invention**	MAIN SHAFT FIXTURE
II	**Applicant**	
II-1	This person is	Applicant only
II-2	Applicant for	All designated States
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II-6	State of nationality	DK
II-7	State of residence	DK
II-8	Telephone No.	96 600 300
II-10	e-mail	ip@liftra.dk
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III-1-1	This person is	Inventor only
III-1-3	Inventor for	All designated States
III-1-4	Name (LAST, First)	FENGER, Per E
III-1-5	Address	Flougaardsvej 8 9575 Terndrup Denmark
V	**DESIGNATIONS**	
V-1	**The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.**	
VI-1	**Priority claim of earlier national application**	
VI-1-1	Filing date	07 October 2014 (07.10.2014)
VI-1-2	Number	PA 2014 00573
VI-1-3	Country	DK
VI-2	**Priority claim of earlier national application**	
VI-2-1	Filing date	04 September 2015 (04.09.2015)
VI-2-2	Number	PA 2015 00527
VI-2-3	Country	DK
VI-3	**Priority document request** The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1 VI-2
VI-4	**Incorporation by reference :** where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.	
VII-1	**International Searching Authority Chosen**	Nordic Patent Institute (ISA/XN)

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VIII	Declarations	Number of declarations	
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VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	–	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	–	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	–	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	–	
IX	**Check list**	**Number of sheets**	**Electronic file(s) attached**
IX-1	Request (including declaration sheets)	4	✓
IX-2	Description	9	✓
IX-3	Claims	3	✓
IX-4	Abstract	1	✓
IX-5	Drawings	5	✓
IX-7	TOTAL	22	
	Accompanying Items	**Paper document(s) attached**	**Electronic file(s) attached**
IX-8	Fee calculation sheet	–	✓
IX-20	Figure of the drawings which should accompany the abstract	2	
IX-21	Language of filing of the international application	Danish	
X-1	Signature of applicant, agent or common representative	Per Fenger	
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(54) Title: MAIN SHAFT FIXTURE

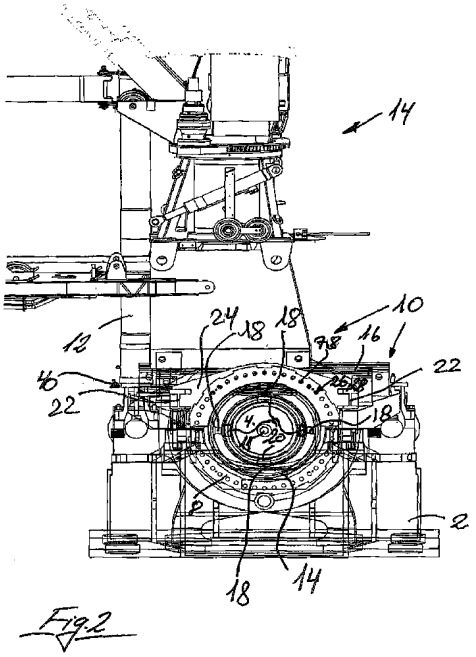


Fig.2

(57) Abstract: A main shaft fixture (10) is disclosed for fixing in place a main shaft (4) on a wind turbine during execution of installation and repair work on the heavy parts of the wind turbine arranged in the nacelle of wind turbines, where the fixture (10) is divided up into a number of sections for mounting on stable structural parts (2) that are found in a wind turbine's nacelle, including the nacelle's bottom frame (2). The main shaft fixture (10) comprises adjustable pressure mandrels (18) with tap shoes (20), which cause the fixture 10 to be usable regardless of the geometry of the main shaft (4) on a wind turbine, and such that it can be mounted without fixing the rotor (8). The main shaft fixture (10) also comprises facilities (40) for the mounting of a lightweight crane (12) and a self-hoisting crane (14) with a ground- based winch, respectively, as well as a rotor lock (24), which in combination with the actuators (36) belonging to main shaft fixture (10) between the main shaft fixture (10) and the bottom frame (2) makes it possible to displace the main shaft (4) and the main shaft bearing (38) vertically from its bearing in the nacelle sufficiently to service or replace the bearing.

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TITLE: MAIN SHAFT FIXTURE

The present invention relates to a main shaft fixture for the fixing of a main shaft on a wind turbine during the execution of installation and repair work in heavy parts of a wind turbine arranged in a nacelle on wind turbines, with the fixture being divided up into a number of sections for installation on stable structural parts in a nacelle in a wind turbine, including the nacelle's bottom frame.

During the execution of installation and repair work on the nacelle of wind turbines there is often a need to perform fixing of the wind turbine's main shaft, for example with the replacement and servicing of a wind turbine's gear box, generator or with the replacement of its main bearing, or other heavy structural parts present in the nacelle of a wind turbine. The stated components, which are mutually conjoined and anchored to the nacelle's bottom frame, are stable in an assembled state, but when separation needs to be undertaken during repairs and servicing of the turbine, static instability and imbalance arises, which can lead to the turbine's structural parts being damaged, hence there is a need to fix the wind turbine's main shaft.

DE 102006013539 A1 (NORDEX ENERGY GMBH) discloses a main shaft fixture for fixing the main shaft on a wind turbine during the execution of installation and repair work on heavy parts that are arranged in the nacelle on wind turbines, with the fixture being divided up into a number of sections for installation on stable structural parts that are found on a wind turbine's nacelle, including the nacelle's' bottom frame.

Up to now it has been necessary to halt the turbine, i.e. brake it and fix the rotor with a rotor lock, and then mount an actual fixture to firmly hold the main shaft, subsequent to which servicing of the components in the wind turbine's nacelle is able to take place. However, it is inappropriate to have to halt the operation of the wind turbine while the mounting of the main shaft fixture is taking place, as the standstill of the wind turbine during the time that is spent to install the fixture involves a not insignificant operating loss in the form of a lack of energy

produced (power). Furthermore, the known main shaft fixtures are relatively inflexible in relation to shaft geometry, which means that in practice nearly just as many different fixtures need to be built and stored as there are shaft geometries that exist, which is inappropriate. In addition, the use of self-hoisting cranes, whose winches are placed on the ground surface near the turbine's tower, is increasing, because the use of such involves large savings in the level of expenses for servicing of wind turbines since the use of large mobile cranes for handling the above-mentioned large and heavy components is made superfluous. This causes however a need for facilities for anchoring the self-hoisting crane with the ground-based winch in the nacelle. However, the self-hoisting winch requires furthermore the presence of a lightweight crane, for the hoisting of snatch blocks, etc., that are to be anchored on/in the nacelle or on the blades of the wind turbine, which poses requirements concerning the facilities for mounting the lightweight crane.

In the event of servicing in particular large wind turbines, it may however be inappropriate to block the main shaft's rotation with an actual rotor lock, but rather be appropriate to simply retain the shaft in position and permit a certain rotation of the shaft, which is possible by turning the blades/nacelle out of the wind so that the shaft via the effects of the wind on the blades only rotates very slowly, or not at all, whereby it is acceptable in terms of safety, to perform service work in the nacelle of the wind turbine concerned.

It thus is the purpose of the invention to specify a main shaft fixture that provide a more universal application in relation to shaft geometry, which moreover does not require halting and fixing of the wind turbine's main shaft, but which may however comprise the means for such.

It is further the purpose of the invention to provide a main shaft fixture that in addition offers facilities for the mounting of a self-hoisting crane, with a ground-based winch.

It is by the invention realized that this is possible by a main shaft fixture of the nature specified in the introduction, which is characterised by that the main shaft fixture comprises at least three radial displaceable pressure mandrels, substantially symmetrical located around the centre axis of the main shaft, the ends of said pressure mandrels facing the main shaft are furnished with a tap shoe, and said pressure mandrels being displaceable between a passive, withdrawn lockable position where the tap shoes are configured to be located at a distance from the surface of the main shaft and an advanced lockable position where the tap shoes are configured to be engaged with the main shaft.

Considerable flexibility is hereby attained with respect to the main shaft fixture's use for the fixing of main shafts with different geometries on wind turbines, since solely the degree of movability of the pressure mandrels and the size of the main shaft fixture pose limiting factors for the usability of such. The main shaft fixture is thus both usable for fixing of cylinder-shaped shafts with different diameters and for the fixing of shafts with conical shapes. The main shaft fixture according to the invention is multi-part, and may be mounted on permanent structural parts, preferably the bottom frame of the nacelle, while the rotor of the wind turbine is in operation.

With the intent of being able to use a self-hoisting crane with a ground-based winch together with the main shaft fixture according to the invention, it may comprise mounting facilities for a self-hoisting crane whose winch is placed on the ground surface ground near the foot of the wind turbine.

The advance thereof is that the establishment of facilities for the fixing of the wind turbine's main shaft, as well as the establishment of mounting facilities for the self-hoisting crane with a ground-based winch, take place simultaneously, which saves work processes, and space, which are of great importance, as the space in the nacelle in a wind turbine are most often narrow, and furthermore the main shaft fixture as well as the mounting facilities for a self-hoisting crane in the nacelle normally utilise the same permanent structural parts in the nacelle for anchoring.

With the intent of ensuring easy and rapid establishment of the self-hoisting crane, which requires the hoisting of snatch blocks with wires originating from the ground-based winch with a lightweight crane which is mounted on stable structural

parts in the nacelle, the main shaft fixture may comprise mounting facilities for a lightweight crane.

For the purpose of securing the rapid fixing of the main shaft using the main shaft fixture according to the invention, the pressure mandrels may be provided with actuators for displacing and retaining the tap shoes in the passive position and the active position, respectively, alternatively in a selectable position between the passive and the active position.

Time is thereby saved in the displacement of the tap shoes between the passive position, and the active position pressed against the main shaft's surface.

In a more simple form of embodiment of the main shaft fixture according to the invention, the pressure mandrels may be comprised of threaded bolts whose free ends facing the main shaft are furnished with tap shoes, where the threaded bolts work together with threaded holes in relevant sections of the fixture. The pressure mandrels with the tap shoes are hereby displaced by manual turning of the threaded bolts between the passive position and the active position.

With the intent of being able to permit rotation of the main shaft during performance of servicing of a relevant wind turbine and in order to protect the main shaft and the main shaft fixture, a slide lining may exist between the opposing sides of the main shaft's surface and the tap shoes.

This enables the main shaft to be fixed in its position by the main shaft fixture, but with the main shaft being permitted to rotate without it being damaged due to the presence of the slide lining.

In a first embodiment of the slide lining, this could consist of the free ends of tap shoes facing against the main shaft being furnished with slide plates, which in the active extended position are engaged with the main shaft.

In a further embodiment, the main shaft fixture may according to the invention comprise a multi-part slide plate working in conjunction with the main shaft to be mounted on the main shaft, where the multi-part slide plate in its mounted state on the main shaft cooperates with the tap shoes.

This enables the tap shoes on the main shaft fixture's pressure mandrel to slide directly on the multi-part slide plate, in the event of a possible rotation of the main shaft caused by the effects of wind on the blades. The tap shoes on the main shaft fixture's pressure mandrels may cooperate with the multi-part slide plate on the main shaft, with or without slideway linings on the opposing sides of the tap shoes facing the main shaft.

In a further embodiment of the main shaft fixture as per the invention, it may comprise a multi-part needle bearing, roller bearing, ball bearing, consisting of a, multi-part inner ring, fastened on the main shaft, and a therewith cooperating multi-part outer ring consisting a number of bowed sub segments according to the number of tap shoes mounted on the opposing side of the tap shoes facing the multi-part inner ring, which in the advanced active position of the pressure mandrels form the outer ring at a distance from the external periphery of the multi-part inner ring, and where a suitable number of needle rollers, rollers or balls are placed between the inner ring and outer ring, and where means are present for retaining the needles, rollers, or balls in position between the inner ring and outer ring.

An actual temporary bearing connection is hereby formed between the main shaft fixture and the main shaft, about which the main shaft is able to rotate.

With the intent of being able to fix the rotor on the wind turbine after it has been braked to a stop, the main shaft fixture according to the invention, may comprise a rotor lock, for fixing the wind turbine's rotor.

In a preferred embodiment of the rotor lock, it is comprised of a flange, whose bolt circle geometry corresponds to a bolt circle geometry on the rotor, said flange element being fastened at the ends to the first end of two first beam-shaped

brackets extending parallel with, and on each side of the main shaft, said beam shaped brackets belonging to the main shaft fixture, and where the other end of the brackets are pivotally mounted with horizontally oriented bolt connections, on other brackets belonging to the main shaft fixture, which are anchored on the bottom frame of the nacelle.

It is hereby achieved that the rotor can be fixed by introducing a bolt through one or more of the overlapping holes in the bolt circles on the flange fastened to the bottom frame and the bolt circle on the rotor, respectively.

With the intent of being able to perform replacement of the shaft's main bearing, without being forced to dismount the main shaft, the main shaft fixture may furthermore comprise at least a second actuator, between the nacelle's bottom frame and the opposing side of the first beam-shaped brackets facing such and the nearest rotor lock, where the other actuator is movable between a first passive outer position and an active outer position whereby the flange element is moved vertically.

This enables the main shaft to be able to be raised from its bearing hanging in the rotor lock, such that the main bearing of the shaft can be replaced or serviced without the necessity of removing the shaft from the nacelle.

The invention is explained in further detail in the following with reference to the drawing, wherein;

Fig. 1 is a perspective view of parts of a wind turbine's nacelle, presenting the nacelle's bottom frame, the wind turbine's main shaft, and a main shaft fixture according to the invention, with a lightweight crane and a self-hoisting crane mounted,

Fig. 2 is a more detailed perspective view from another angle of what is shown in fig. 1, where the main shaft is made transparent, presenting the pressure mandrel with tap shoe belonging to the main shaft fixture according to the invention,

Fig. 3 is a more detailed perspective view from another angle of what is shown in fig. 1, presenting the actuators for raising the main shaft, where the main shaft is made transparent,

Fig. 4 is a detailed perspective view of the main shaft fixture for a wind turbine, where the tap shoes and the main shaft are furnished with slide plates, and

Fig. 5 is a detailed perspective view or the main shaft fixture for a wind turbine, where the slide plates are replaced by a multi-part needle bearing/roller bearing/ball bearing consisting of a multi-part inner ring fastened to the main shaft and a therewith cooperating multi-part outer ring consisting of bowed subsegments of the number of tap shoes mounted on the opposing side of the tap shoes facing the inner ring.

In fig. 1 a bottom frame 2 is seen in a nacelle (not shown) on a wind turbine (not shown), where the main shaft 4 of the turbine, with gear box 6 and the rotor 8 are shown, and where the main shaft fixture 10 according to the invention is shown in the mounted state, bearing a lightweight crane 12 and a self-hoisting crane 14 with a ground-based winch (not shown), respectively. The bottom frame 2 has for reasons of clarity been made transparent.

The main shaft fixture 10 is in the shown embodiment shown anchored to the bottom frame 2 near the gear box 6 and near the rotor 8, and comprises a multi-part frame 14, which together with a cross member 16 fastened on it encloses a part of the main shaft 4 between the rotor 8 and the gear box 6. The multi-part frame 14 is anchored on the bottom frame 2.

In fig. 2 is shown what are seen in fig. 1, but as an end picture, seen from the rotor side of the shaft 4, and where the rotor 8 for reasons of clarity has been made transparent. As it appears from fig. 2, the multi-part frame 14 and cross member 16 comprise in total four pressure mandrels 18 symmetrically placed around the main shaft 2, with tap shoes 20, that are engaged onto the main shaft 4 in order to fix such in place.

The pressure mandrels 18 may be comprised of hydraulically driven pistons whose free ends comprise the tap shoes 20, but may also be executed in other manners, where they are moved manually between the active position where the

tap shoes 20 are engaged with the main shaft 4 and the passive, withdrawn position.

As it appears from fig. 3, the main shaft fixture 10 comprises two parallel passing first beams 22 on each side of the main shaft 4, in the first ends of which, nearest to the rotor 8, a rotor lock is fastened in the form of a flange element 24, the hole circle 26 geometry of which is similar to the hole circle 28 geometry on the rotor 8 over a part of the periphery of the rotor. Locking of the rotor 8, the holes 7 in the rotor 8 and the holes 9 in the flange element 24 are brought to overlap, and subsequently bolts are inserted through the overlapping holes, which are tightened with nuts, after which the rotor 8 is fixed/locked by the flange element 24.

The other end of the parallel passing first beams 22 are nearest to the gear box 6 are pivotally anchored on horizontally oriented bearing bolt 30, on a bracket 32, which is fastened to the bottom frame 2. The parallel passing first beams 22 are mutually connected with second cross members 34, on which bracket facilities 23 are seen for a self-hoisting crane 14 with a ground-based winch (not shown).

As it appears in fig. 3 and fig. 1 show, an actuator 36 is located between the bottom frame 2 and the parallel passing first beams 22. Activation of the actuator 36 will result in a change of the distance between the bottom frame 2 and the first beams 22, in which the flange element 24 is suspended, which will cause the flange element 24 and the rotor 8 and thereby the main shaft 4 to be raised, which will result in the possibility to replace the main shaft's bearing 38 without the necessity of hoisting the main shaft 4 down to the ground, which is quite time-saving when the main shaft bearing 38 has to be repaired or replaced.

In fig. 1 it is moreover shown how the main shaft fixture 10 comprises mounting facilities 40 for the lightweight crane 12.

In fig. 4 is shown an embodiment of the main shaft fixture according to the invention, which is specially suited for use for fixing the wind turbine's main shaft 4 in position on the nacelle, but where rotation of the main shaft 4 is possible, in the active position of the pressure mandrels/tap shoes (18, 20), engaged with the main shaft.

As shown in fig. 4, a slideway lining 42, 44 is located between the opposing sides of the tap shoes 20 facing the surface of the main shaft 4.

The slideway may be comprised of slide plates 42 that are fastened to the opposing free ends of the tap shoes 20 facing the main shaft 4, which in their active advanced position are engaged with the main shaft 4, but which alternatively may comprise a multi-part slide plate 44 cooperative working with the main shaft 4, for mounting on the main shaft 4, said multi-part slide plate 44 in its mounted state on the main shaft 4 cooperates with the tap shoes 20. It must be stated that the presence of the multi-part slide plate 44 on the main shaft 4 does not necessarily exclude the presence of the slide plates 42 and the tap shoes 20.

In a further embodiment, the main shaft fixture 10 consists of a multi-part needle bearing/roller bearing/ball bearing 46, comprised of a multi-part inner ring 48 fastened on the main shaft as well as, a cooperating multi-part outer ring 50 consisting of bowed subsegments 52 of the number of tap shoes mounted on the opposing side of the tap shoes 20 facing the inner ring 48, which in the advanced position of the pressure mandrels form the outer ring 50 at a distance from the outer periphery of the multi-part inner ring 48, and where an appropriate number of needle rollers, rollers, or balls 54 (in the shown embodiment rollers 54) are arranged between the inner ring 48 and the outer ring 50, and where means (not shown) are present for retaining the needles/rollers or balls (54) in position between the inner ring 48 and outer ring 50.

The means mentioned for fastening of needle rollers/rollers/balls 54 may consist of cooperating edge delineators in opposing sides of the inner ring 48 and outer ring 50, alternatively of a means of holding between which the needle rollers/rollers/balls 54 are fastened.

The presence of the slide lining 42, 44, alternatively the multi-part needle bearing, roller bearing, ball bearing 46, involves the main shaft 4 being permitted to rotate simultaneously with it being fixed in its position during servicing of the wind turbine, which can serve a purpose namely for larger wind turbines.

The inventor has recognised that the main shaft fixture 10 can assume other embodiments than disclosed in the preceding and shown in the figures, however such do not change the inventive aspect that consists of specifying a main shaft fixture 10 of the given type that comprises adjustable pressure mandrels 18 with tap shoes 20, which causes the fixture 10 to be usable regardless of the geometry of the main shaft 4 on a wind turbine, and thus that such can be mounted without fixing the rotor 8 in place, and furthermore of combining the main shaft fixture with facilities 40 for mounting of a lightweight crane 12 and a self-hoisting crane 14 with a ground-based winch, respectively, as well as a rotor lock 24 and finally of furnishing the main shaft fixture 10 with actuators 36, enabling the main shaft 4 and the main shaft bearing 38 to be raised sufficiently from its bearing in the nacelle that it can be serviced or replaced.

CLAIMS

1. Main shaft fixture (10) for fixation of a main shaft (4) on a wind turbine during execution of installation and repair work on heavy parts of a wind turbine, where the fixture (10) is divided up into a number of sections for mounting on stable structural parts (2) structural parts in a nacelle in a wind turbine, including the bottom frame (2) of the nacelle, c h a r a c t e r i s e d i n , that the main shaft fixture (10) comprises at least three radial displaceable pressure mandrels (18), substantially symmetrical located around the centre axis (11) of the main shaft, the ends of said pressure mandrels (18) facing the main shaft (4) are furnished with a tap shoe (20), and said pressure mandrels (18) being displaceable between a passive, withdrawn lockable position where the tap shoes (20) are configured to be located at a distance from the surface of the main shaft (4) and an advanced lockable position where the tap shoes (20) are configured to be engaged with the main shaft (4).

2. Main shaft fixture (10), according to claim 1, c h a r a c t e r i s e d i n , that it comprises mounting facilities for a self-hoisting crane (14), the winch of which is located on the ground surface near the foot of the wind turbine.

3. Main shaft fixture (10), according to claim 1 or 2, c h a r a c t e r i s e d i n , that it comprises mounting facilities (40) for a lightweight crane (12).

4. Main shaft fixture (10), according to any one of the claims 1-3, c h a r a c t e r i s e d i n , that the pressure mandrels (18) is provided with actuators for displacing and retaining the tap shoes (20) in the passive position and the active position, respectively, alternatively in a selectable position between the passive and the active position.

5. Main shaft fixture (10), according to any one of the claims 1-3, c h a r a c t e r i s e d i n , that the pressure mandrels (18) consists of threaded bolts whose opposing free ends facing the main shaft are furnished with tap shoes (20), and said threaded bolts cooperates with threaded holes in relevant sections of the fixture (10).

6. Main shaft fixture (10), according to any one of the claims 1-5, characterised by a slideway lining (42, 44) being located between the opposing sides of the surface of the main shaft and tap shoes.

7. Main shaft fixture (10) according to claim 6, c h a r a c t e r i s e d i n , that the slideway lining is configured so that of the opposing free ends of the tap shoes (20) facing the main shaft (4) are provided with a slide plate (42) which in the active advanced position is engaged with the main shaft (4).

8. Main shaft fixture (10) according to claim 6 or 7, c h a r a c t e r i s e d i n , that it comprises a multi-part slide plate (44) cooperating with the main shaft (4) for mounting on the main shaft (4), where the multi-part slide plate (44) in its mounted position on the main shaft (4) is cooperating with the tap shoes (20).

9. Main shaft fixture (10) according to any one of the claims 1-5, c h a r a c t e r i s e d i n , that it comprises a multi-part needle bearing, roller bearing, ball bearing (46) consisting of a multi-part inner ring (48) fastened to the main shaft (4), and a therewith cooperating multi-part outer ring (50) consisting of bowed subsegments (52) corresponding to the number of tap shoes, mounted on the opposing side of the tap shoes (20) facing the inner ring (48), which in the advanced active position of the pressure mandrels form the outer ring (50) at a distance from the outer periphery of the multi-part inner ring (48), and where an appropriate number of needle rollers, rollers, or balls (54) are arranged between the inner ring (48) and the outer ring (50), and where means are present for retaining the needles, rollers, or balls (54) in position between the inner ring (48) and outer ring (50).

10. Main shaft fixture (10), according to any one of the claims 1-9, c h a r a c t e r i s e d i n , that it comprises a rotor lock (24) for fixation of the rotor (8) of the wind turbine.

11. Main shaft fixture (10), according to claim 10, c h a r a c t e r i s e d i n , that the rotor lock (24) consists of a flange element, whose bolt circle geometry (26) corresponds to a bolt circle geometry (28) on the rotor, said flange element (24) being fastened at the ends to the first end (21) of two first beam-shaped brackets (22) extending parallel with, and on each side of the main shaft, said beam shaped brackets (22) belonging to the main shaft fixture, and where the other end (23) of the brackets (22) are pivotally mounted with horizontally oriented bolt connections (30), on other brackets (39) belonging to the main shaft fixture (10), which are anchored on the bottom frame (2) of the nacelle.

12. Main shaft fixture (10), according to claim 11, c h a r a c t e r i s e d i n , that at least one actuator (36) is located nearest the rotor lock (24) between the bottom frame (2) of the nacelle and the adjacent side (25) of the first beam-shaped brackets (22) facing the bottom frame (2), said actuator (36) is displaceable between a first passive outer position and an active outer position where the flange element (24) is displaced vertically.

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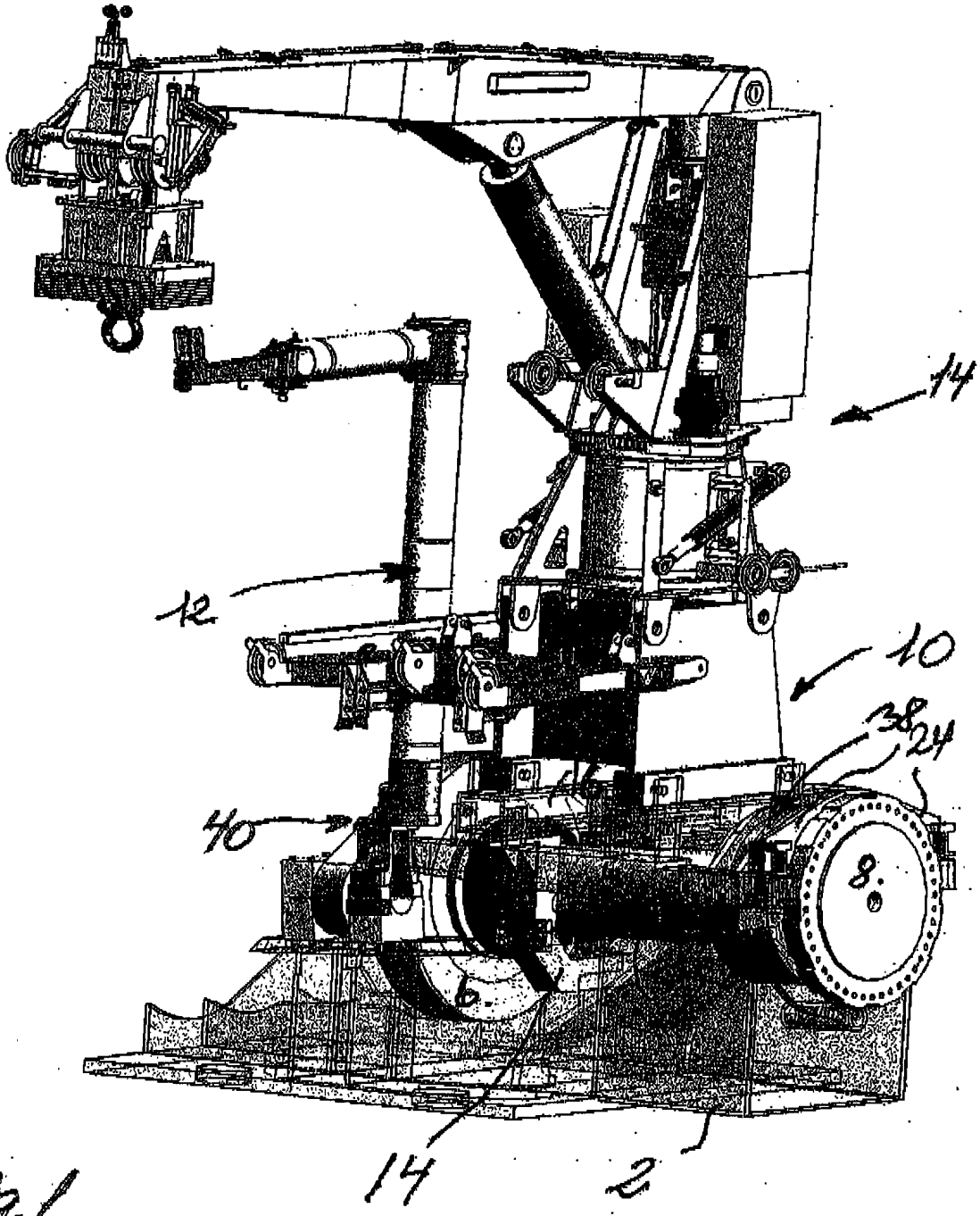


Fig. 1

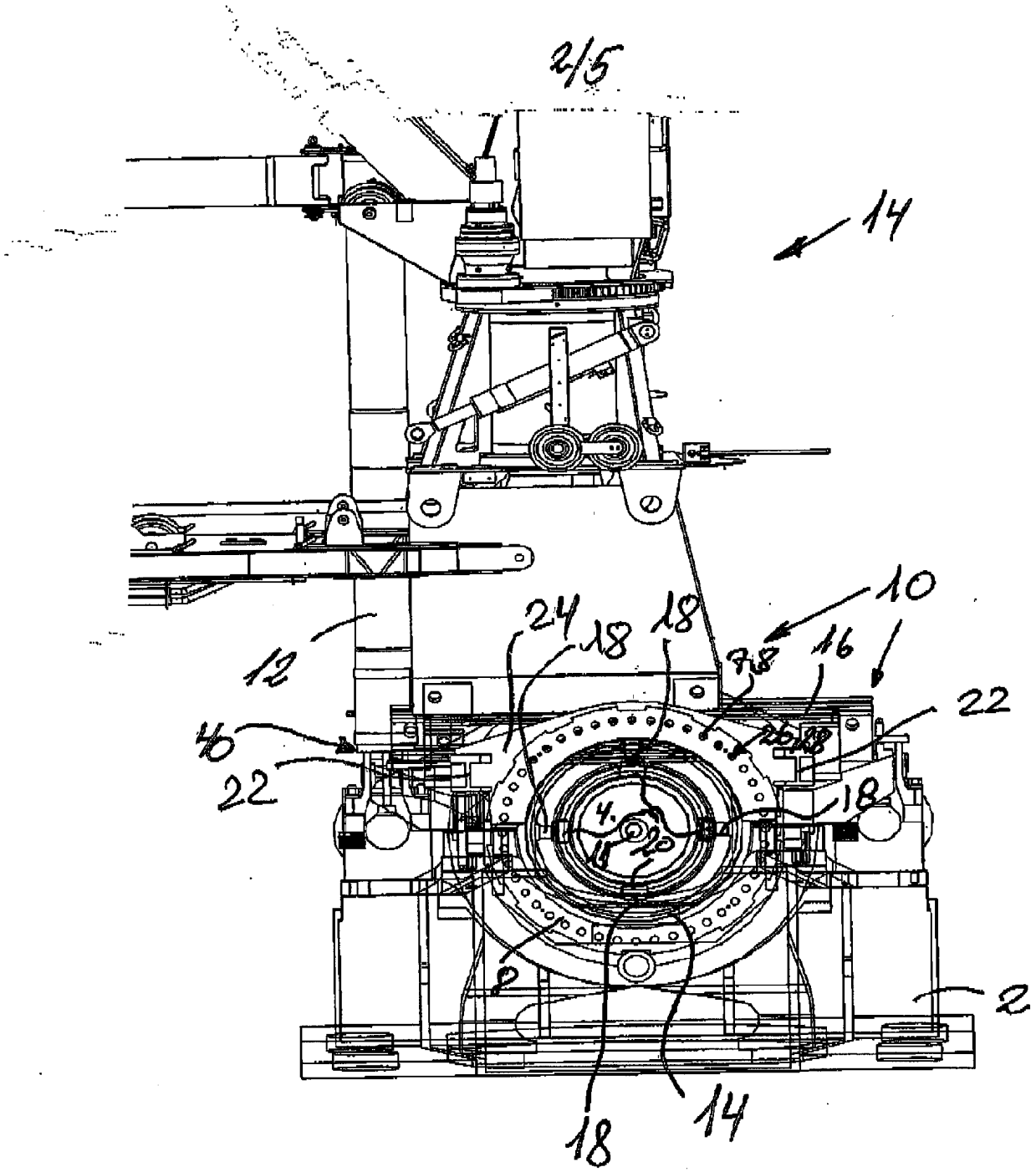


Fig.2

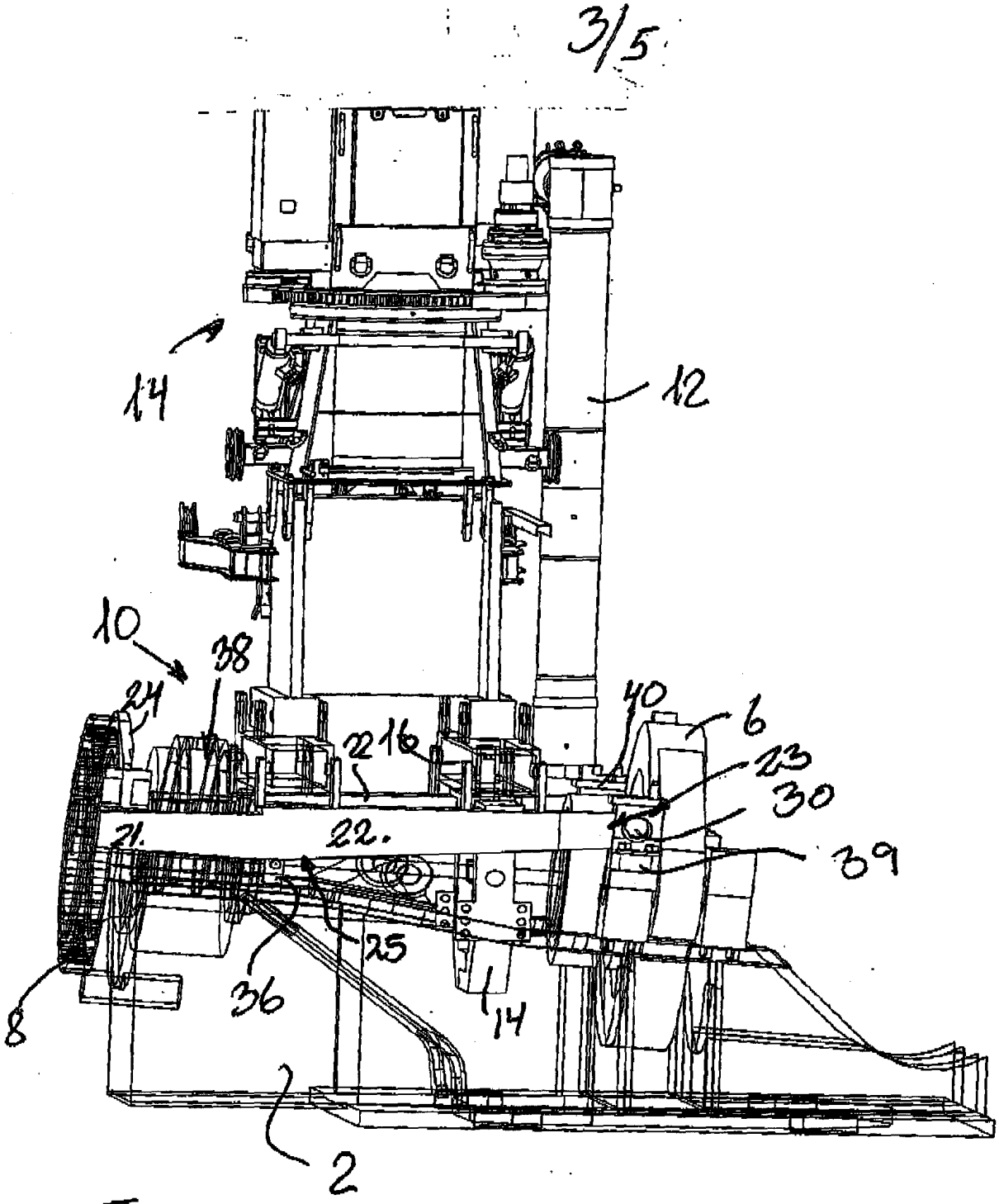


Fig. 3

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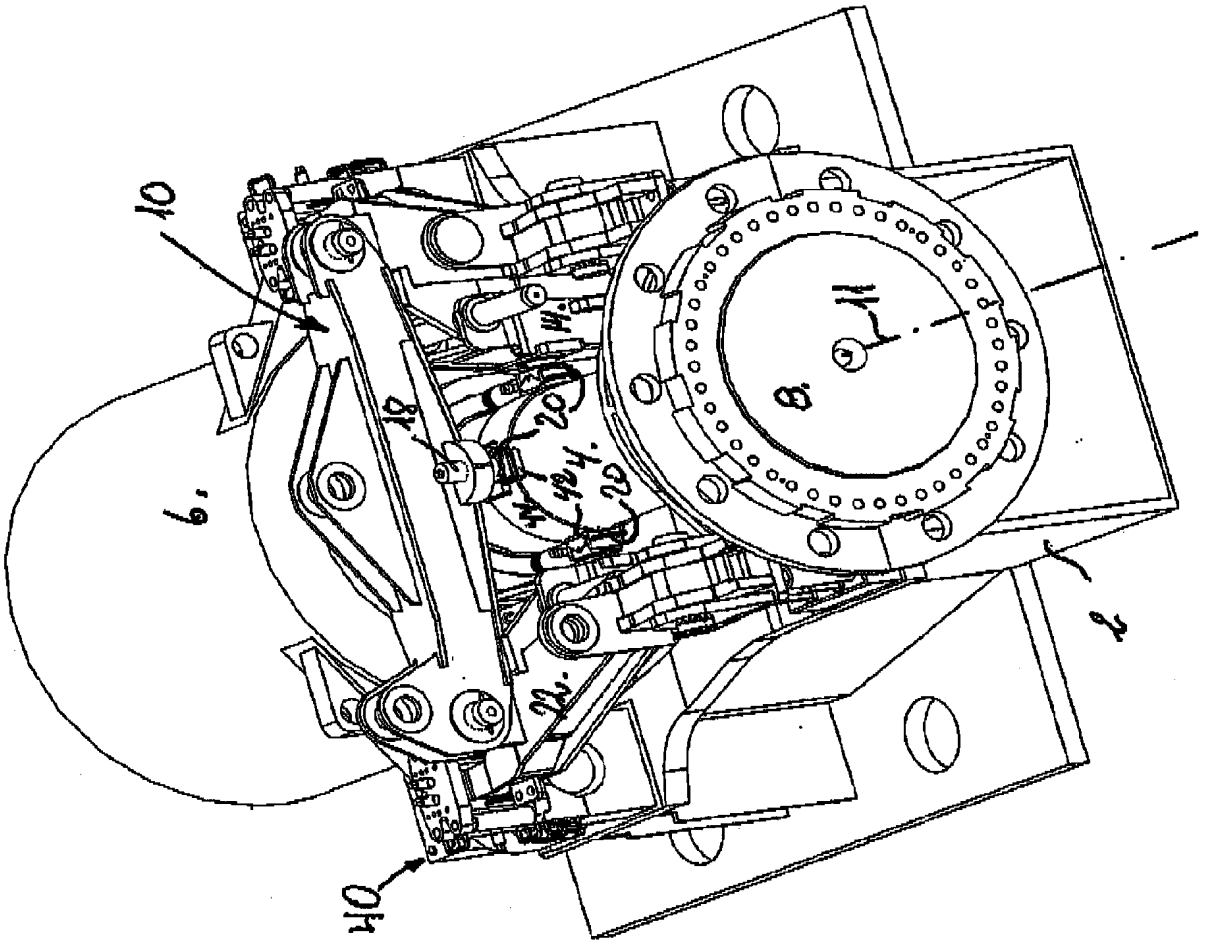


Fig. 4

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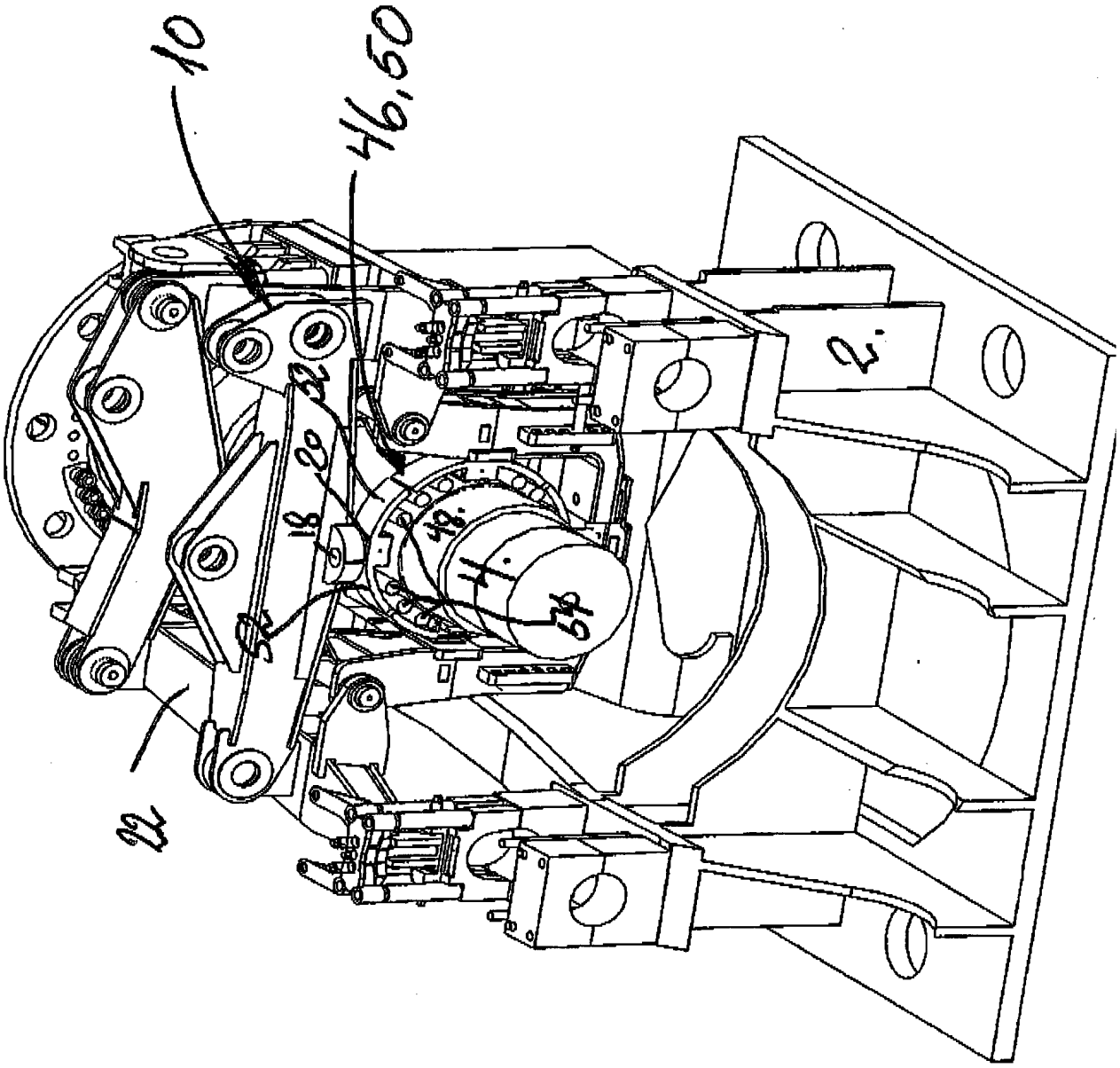


Fig. 1A