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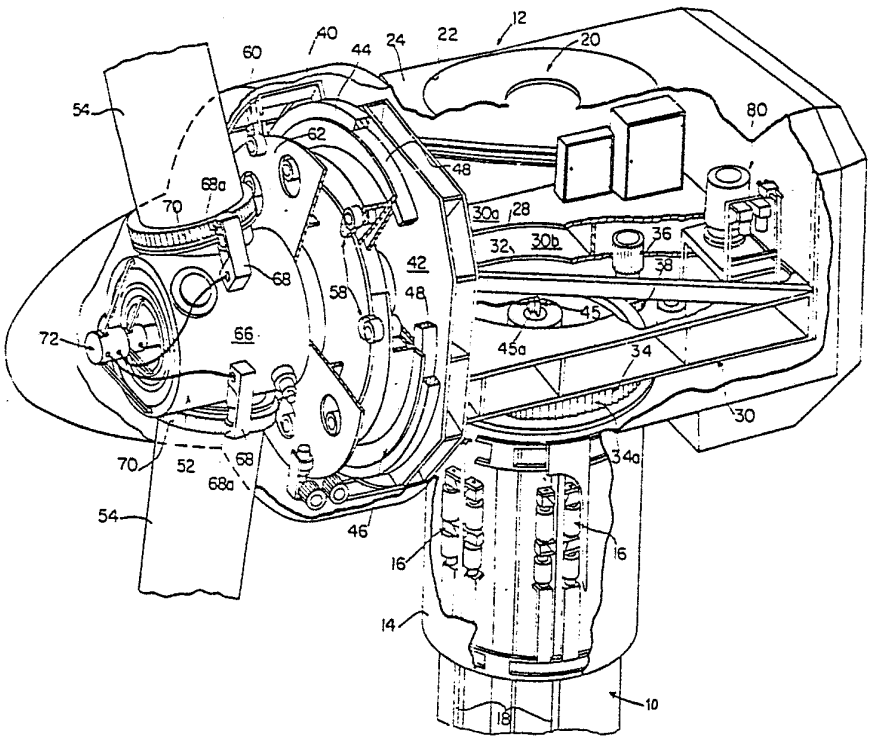
(57) Abstract

A wind driven power plant which enables a housing or gondola (12), containing the turbine-generator set (52; 46) and mounted, in use, at the top of a tower (10), to be lowered down the tower (10) to the ground for maintenance and/or repair purposes. The turbine (52) and generator (46) are mounted on the same side of the gondola (12) outboard of the tower (10) and an opening in the gondola in alignment with the tower (10) enables the gondola (12) to be lowered down the tower. The turbine (52) is mounted on a stub shaft and the generator (46) is of a short length, large diameter multi-pole type. Hydraulic climbing jacks (16) disposed on a sleeve (14) connected to the gondola (12) are used to raise and lower the gondola (12).



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WIND DRIVEN POWER PLANT

The present invention relates to wind driven power plants for generating electricity and, more particularly, to an improved power plant construction wherein maintenance and repair is greatly facilitated.

Conventional, horizontally mounted wind driven power plants basically comprise a bladed turbine and a generator which are journalled at opposite ends of a common horizontal shaft, with a gearbox also being arranged on this shaft for gearing up the rotational speed of the turbine shaft to a suitable higher r.p.m. for the generator. The generator, the gearbox and the turbine (with the exception of the blades) are all disposed inside of a common housing or so-called "gondola". The gondola is, in turn, mounted on the upper end of a support tower and through the provision of a slewing bearing assemble is enabled to rotate about the tower to provide the appropriate orientation relative to the wind direction.

When such a gondola is fitted onto the tower, it is impossible as a practical matter to take the unit down so as to enable, for example, maintenance work and/or repairs to the turbine, gearbox, or generator. In fact, the only way in which access can be gained to these components is to use scaffolding or the like, built up adjacent to the tower, to permit service personnel to climb up to the gondola.

In accordance with the invention, a wind driven power plant is provided which overcomes the disadvantages of the prior art discussed above and which, in particular, enables the housing or gondola with an associated turbine-generator set to be lowered to ground level as required to carry out maintenance and/or repair work.

To this end, the power plant of the invention dispenses with the gearbox between the turbine and the generator and provides for mounting of the turbine and generator on the same side of the mounting tower. The

gondola is provided with openings therein in the roof and flooring which are of a shape and dimension substantially corresponding to the shape and dimension of the outside of the tower, thereby enabling the gondola to slide or otherwise move down the tower to the ground level.

The power plant includes a number of further features of importance. For example, the generator is a multi-pole "bulb" generator of relatively short length and large diameter which enables placing of the generator on the same side of the tower as the turbine. The turbine itself is mounted on a stub shaft which projects outwardly from a mount provided by the gondola construction, rather than on a conventional shaft extending through the gondola. This permits the provision of the openings in the gondola referred to above by which the gondola may be lowered down the tower. Raising and lowering of the gondola is preferably effected by means of hydraulic climbing jacks which are operated from the ground through hydraulic hoses or through electrical or electronic means. Removable covers or hatches are provided for the openings for use under normal operating conditions in order to keep dirt and the like out of the system.

Other features and advantages of the invention will be set forth in, or apparent from, the detailed description of the preferred embodiments which follows.

Figure 1 is a perspective view of a first embodiment of the wind driven power plant of the invention; and

Figure 2 is a side elevation, partially in section, of second, similar embodiment.

Referring to Figures 1 and 2, while these figures illustrate slightly different embodiments of the invention, like elements are given the same reference numerals in the two figures and the two figures will be described together in that the construction and configuration of some of the components of the power plant of the invention are best seen and understood by viewing the two figures together. The basic components of the power plant of the invention

are the tower 10 and housing or gondola 12. The gondola 12 is mounted on the tower 10 by means of a mounting jacket or sleeve 14 which is adapted to slide along the outer surface of the tower 10. To this end, hydraulic climbing jacks 16 are arranged between the tower 10 and the jacket or sleeve 14 which enable movement of jacket 14 up and down tower 10 and which permit jacket 14 to be locked into position on tower 10. As shown in Figure 1, a plurality of the climbing jacks 16 are arranged circumferentially around the periphery of jacket 14 and suitable guides 18 are also provided as part of the climbing jack assembly to guide the sliding movement of jacket 14 along tower 10. Climbing jacks 16 can be operated from hydraulic oil hoses (not shown) which lead from jacks 16 to the ground although jacks 16 can also be operated by electrical or electronic signals from the ground.

As set forth above, an important feature of the wind power plant of the invention is the provision of an arrangement wherein the gondola can be lowered to the ground for maintenance and repair work. To this end, a removable hatch 20 is provided for an opening 22 in the roof 24 of the gondola housing and a removable floor panel 26 (see Figure 2) is provided for an opening 28 in the top portion 30a of a bottom floor 30 of gondola 12. The dimension and shape of the openings 24 and 28 are such that the tower 10 can pass therethrough. This, of course, applies a second opening 32 provided in the bottom portion 30b of the floor 30 within gondola 12, the point being that a continuous "opening" is provided through gondola 12 in alignment with tower 10 so that the gondola 12 can be lowered down tower 10 under the control of climbing jacks 16. As noted above, covers or hatches 20 and 26 prevent dirt and the like from entering gondola 12 under normal operating conditions.

An annular slewing bearing assembly 34 (seen best in Figure 2) is disposed between gondola 12 and jacket or sleeve 14 and serves to permit rotation of gondola 12.

The torque for rotating gondola 12 is supplied by a motor 36 which is fixedly supported by floor 30 of gondola 12 and is geared to bearing 34 through a gear which is indicated at 38 (see Figure 1) and which engages the fixed outer ring gear 34a of bearing 34, thereby providing for rotation of gondola 12 relative to jacket or sleeve 14 in the desired direction relative to the wind. The diameter of bearing assembly 34 is, of course, such that tower 10 can pass through the center of bearing assembly 34.

Mounted inside of gondola 12 within an outboard portion 40 of the gondola housing is a mounting base 42 which supports the stator windings 44 of a generator generally denoted 46. Generator 46 also includes a rotor winding 48 mounted on a rotor 50 and nested within stator windings 44. As noted above, the generator 46 advantageously comprises a so-called "bulb" generator of short length and large diameter and including multiple poles, e.g., 108 pole pairs at a turbine speed of 28 r.p.m. Current is tapped off from the generator 46 in a conventional manner and supplied to the ground level through an electrical connector 45 which extends centrally along the tower 10 thereof. A plug, indicated at 45a and best seen in Figure 2, is disconnected when gondola 12 is lowered down tower 10.

The power plant of the invention also includes a turbine 52 with associated blades 54 mounted thereon. Turbine 52 includes a stub shaft 56 projecting outwardly of gondola mounting base 42. The rotor 50 of generator 46 is connected to the turbine shaft 56 through an elastic coupling or slip coupling, indicated at 58, which is adapted for taking up wind shocks from the turbine 52, thereby isolating generator 46 from these shocks. A disk brake, indicated at 60, and including a disk 62 on turbine shaft 56, provides braking of turbine 52.

The front portion 64 of the gondola serves to house a hub 66 for blades 54 which is coupled to shaft 56.

Corresponding pitch varying devices, individual to blades 54 and generally denoted 68, are also housed here, as shown in Figure 1. Devices 68 are of conventional construction and include drive gears 68a, which engage ring gears 70 mounted on blades 54 and which are rotated in response to electrical signals derived from a rotating contact arrangement 72 mounted on the end of turbine shaft 56, thereby controlling the pitch of blades 54 in accordance with the strength of the wind.

It will be understood that apart from certain exceptions noted above the turbine and generator are largely conventional in nature and operate in a conventional manner to produce electricity in response to the rotation of the turbine blades by the wind. The embodiments of Figures 1 and 2 are basically the same apart from minor design differences and the extension or expansion of the gondola, in the embodiment of Figure 1, in the opposite direction from the turbine-generator set so as to accommodate auxiliary operating equipment and storage capacity, indicated collectively at 80.

In operation, in order to provide for maintenance and/or repair of the power plant, covers 20 and 26 are removed and plug 45a is disconnected, and climbing jacks 16 are used to lower the entire gondola 12 with the associated turbine-generator set down tower 10 to ground level. As discussed above, this eliminates the need for the scaffolding used with conventional wind driven power plants.

Although the invention has been described in relation to exemplary embodiments thereof, it will be understood by those skilled in the art that variations and modifications can be effected in these exemplary embodiments without departing from the scope and spirit of the invention.

CLAIMS

1. A wind driven power plant comprising a housing, a bladed turbine supported by said housing; an electrical generator mounted within said housing and driven by said turbine; a tower for supporting said housing in an operative position above the ground; and means for movably mounting said housing on said tower such that said housing and the associated turbine and generator can be lowered down along said tower from said operative position to a position wherein maintenance and/or repair work can be carried out.

2. A power plant as claimed in claim 1 wherein said turbine and said generator are disposed in side-by-side relationship outboard of said tower on one side thereof.

3. A power plant as claimed in claim 1 or claim 2 wherein said housing includes means defining an opening therein in alignment with said tower through which the upper end of the tower passes as the housing is lowered.

4. A power plant as claimed in claim 3 wherein said means defining an opening is formed by a roof opening in a roof portion of said housing and by a floor opening in a floor portion of said housing, said housing including removable covers for said roof and floor openings.

5. A power plant as claimed in claim 3 wherein said mounting means includes a sleeve connected to said housing and including means for releasably securing said sleeve to said tower to permit movement of said sleeve and said housing along said tower.

6. A power plant as claimed in claim 5 wherein said securing means comprising a hydraulic climbing jack arrangement disposed between the sleeve and the tower.

7. A power plant as claimed in claim 5 wherein said housing is rotatably connected to said sleeve to enable rotation of said housing relative to said sleeve.

8. A power plant as claimed in claim 7 wherein

the rotatable connection between said housing and said sleeve is provided by a ring bearing assembly and the driving force for causing rotation of said housing is provided by a motor mounted on said housing and geared to said ring bearing assembly.

9. A power plant as claimed in claim 3 wherein said generator is connected to said turbine through a slip coupling so as to isolate the generator from wind shocks.

10. A power plant as claimed in claim 2 wherein said turbine is mounted on a stub shaft projecting from and supported by a portion of said housing.

11. A power plant as claimed in claim 2 wherein said generator comprises a multi-pole generator of small length and large diameter.

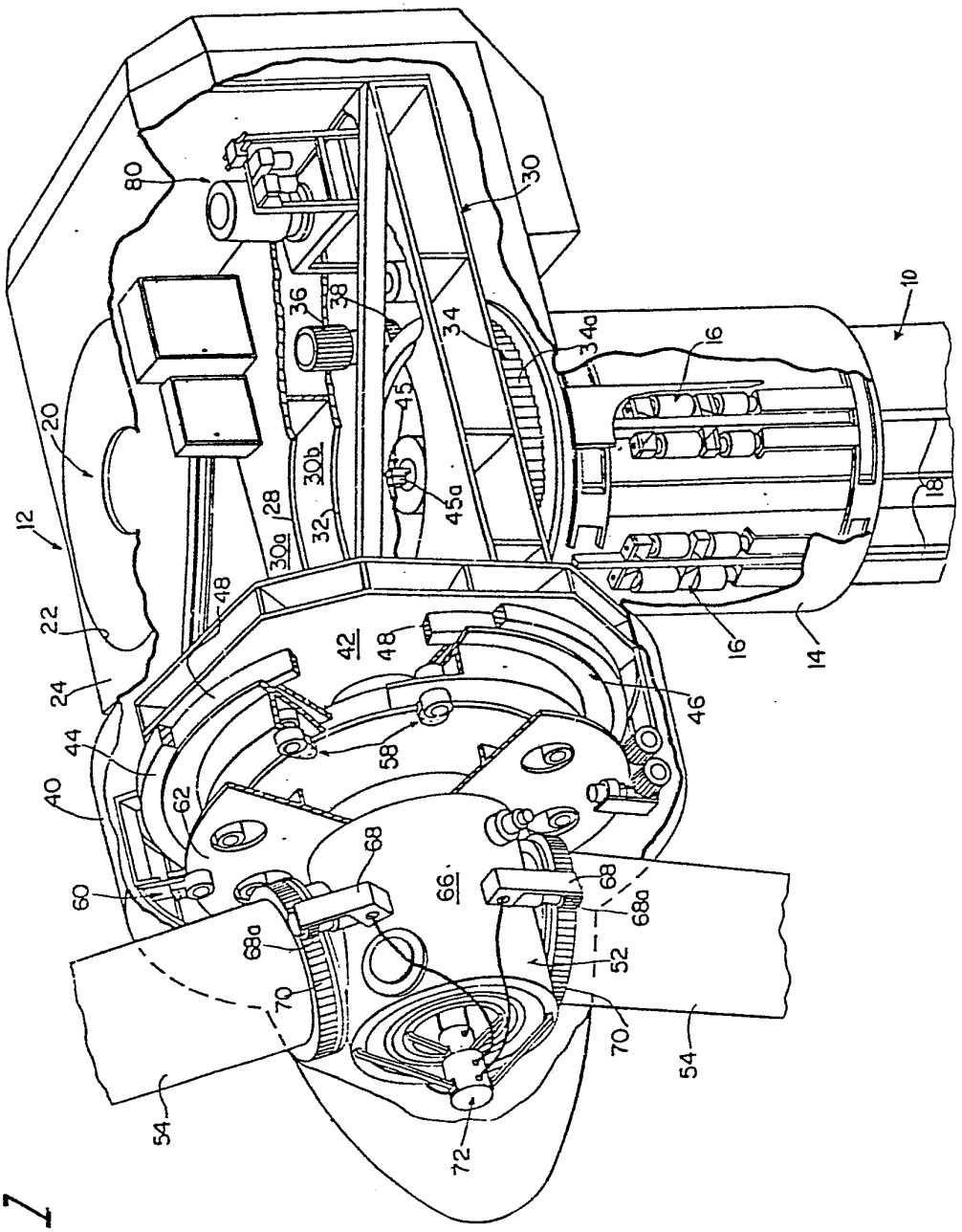
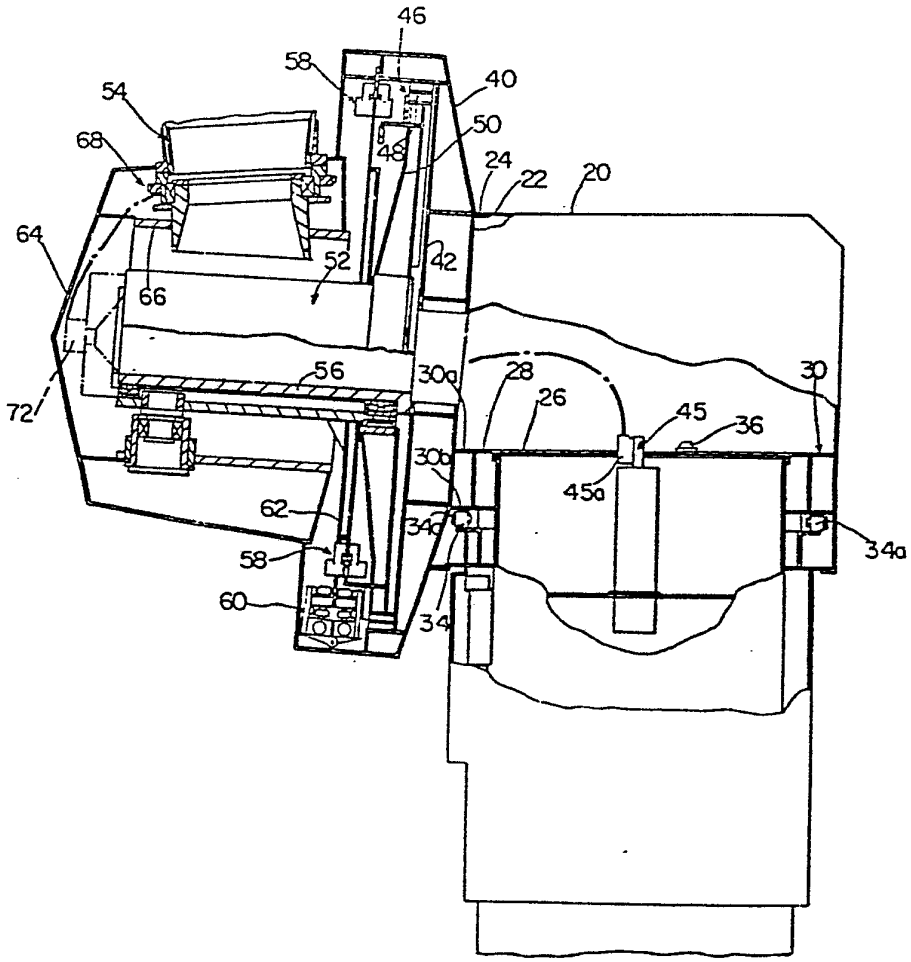


FIG. 1

Fig. 2



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE82/00212

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

F 03 D 11/04

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	F 03 D 11/00-11/04
National Cl	68c:3/19
US Cl	290:55

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
P	SE, B, 423 129 (G BOESTAD, B ENGSTRÖM) 19 April 1982	
A	DE, A, 736 454 (W DEUBERT) 6 May 1943	
X	DE, C, 2 735 299 (E BOGGE) 15 February 1979	

* Special categories of cited documents: [15]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
1982-09-14	1982 -09- 15

International Searching Authority [1]	Signature of Authorized Officer [11]
Swedish Patent Office	Christer Bengtsson