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(54) **Title:** SYSTEMS AND METHODS FOR FLUID TURBINE OPERATIONS

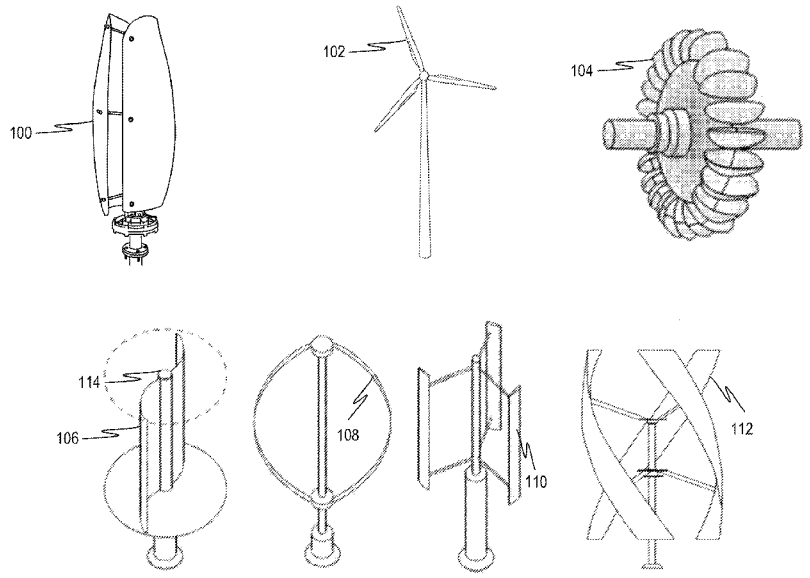

FIG. 1

(57) **Abstract:** System, methods, and computer readable medium are disclosed for altering orientation of fluid turbines within a cluster. Altering orientation of fluid turbines within a cluster includes a first turbine assuming a first orientation relative to a direction of fluid flow; a second turbine in proximity to the first turbine, and assuming a second orientation relative to the first orientation, wherein the first and/or second orientations are adjustable to mitigate interference with downstream turbine operation; a processor for receiving an indication that the first turbine imposes interference on the second turbine; based on the indication, determine a third orientation enabling the first and second turbines to produce greater aggregate electrical energy than would be produced with the first turbine in the first orientation and the second turbine in the second orientation; and transmit a signal for changing one of the first and second orientations to the third orientation.

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[Continued on next page]

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Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) **Date of publication of the international search report:**
22 August 2024 (22.08.2024)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US24/11337

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:
-***-Please See Supplemental Page-***-

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.:
1-20

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.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US24/11337

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. F03D 7/04 (2023.01)
ADD.
CPC - INV. F03D 7/048; F05B 2270/20
ADD. F03D 7/049

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)
See Search History document

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

Electronic database consulted during the international search (name of database and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/0234103 A1 (OBRECHT, J.) 21 August 2014; abstract; fig 1-4; para [0001]-[0030]	1-5, 10-20
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Y		6-9
Y	US 4,973,219 A (BRICKNER, L. ET AL.) 27 November 1990; abstract; fig 1	6-9
A	US 2018/0010576 A1 (INVENTUS HOLDINGS LLC) 11 January 2018; see entire document	1-20
A	US 2008/0083689 A1 (SCHROEDER, R.) 10 April 2008; see entire document	1-20

☐ 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
"D" document cited by the applicant in the international application
"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	Date of mailing of the international search report
28 May 2024 (28.05.2024)	JUN 21 2024
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US24/11337

-***-Continued From Box No. III: Observations where unity of invention is lacking-***-

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-20 are directed toward system for altering orientation of fluid turbines within a cluster.
Group II: Claims 21-41 are directed toward system for coordinating rotation of adjacent turbines.
Group III: Claims 42-60 are directed toward a flat-packable wind turbine assembly kit.

The special technical features of Group I include at least wherein at least one of the first orientation of the first fluid turbine and the second orientation of the second fluid turbine is selectively adjustable to mitigate interference with downstream turbine operation; at least one processor configured to: receive an indication that the first fluid turbine imposes the interference on the downstream operation of the second fluid turbine; based on the indication, determine a third orientation for one of the first fluid turbine and the second fluid turbine, the third orientation enabling the first fluid turbine and the second fluid turbine to produce a greater aggregate level of electrical energy than would be produced with the first fluid turbine in the first orientation and the second fluid turbine in the second orientation; and transmit a signal for changing one of the first orientation of the first fluid turbine and the second orientation of the second fluid turbine to the third orientation, thereby mitigating the interference on the downstream operation of the second fluid turbine.

The special technical features of Group II include at least calculating at least one rotational speed adjustment for at least one of the first fluid turbine and the second fluid turbine, to cause, at instantaneous times, the first open concave surface, the first convex surface, the second open concave surface, and the second convex surface to be simultaneously transverse to the direction of fluid flow; outputting at least one control signal embodying the rotational speed adjustment to thereby regulate rotation of at least one of the first fluid turbine and the second fluid turbine such that at the instantaneous times, the first open concave surface, the first convex surface, the second open concave surface, and the second convex surface are transverse to the direction of fluid flow.

The special technical features of Group III include at least at least one flat-packed bendable airfoil having an upper edge and a lower edge, and being configured to assume a predefined curvature upon assembly; a plurality of upper connecting elements distributed along the upper edge of the at least one flat packed bendable airfoil; a plurality of lower connecting elements distributed along the lower edge of the at least one flat-packed bendable airfoil; a flat-packed upper plate including an upper plurality of mating orifices distributed in a contour corresponding to the predefined curvature; and a flat-packed lower plate including a lower plurality of mating orifices distributed in the contour corresponding to the predefined curvature, such that upon assembly when the plurality of upper connecting elements are connected to the upper plurality of mating orifices and when the plurality of lower connecting elements are connected to the lower plurality of mating orifices, the at least one flat-packed bendable airfoil assumes the predefined curvature.

There are no common technical features shared by Groups I, II, and III. The common technical features share by Groups I & II are a first fluid turbine; a second fluid turbine. However, these common features are previously disclosed by US 2019/0085710 A1 to General Electric Company (hereinafter "GE"). GE discloses a first fluid turbine (first turbine rotor and airfoils for a gas stream; [0118]); a second fluid turbine (second turbine rotor and second airfoils for a gas stream; [0119]).

Since the common technical features are previously disclosed by the GE reference, these common features are not special and so Groups I-III lack unity.