Abstract: A ducted fan for a VTOL vehicle includes a substantially cylindrical duct having an inlet at an upper end and an outlet at a lower end, a propulsion unit inside the duct, between the inlet and the outlet, and at least one group of control vanes located above the inlet a distance equal to at least one-quarter vane chord length, while a related method includes the steps of (a) shaping the inlet of the duct to have a diameter equal to or less than a diameter of the duct proximate the outlet, and (b) locating a first group of inlet vanes a distance above the inlet as a function of duct inlet diameter, and still another method creates side forces and rolling moments through the use of cambered vanes.

Fig. 3a
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC(B): B64C 29/00 (2010.01)
USPC: 244/23D
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)
IPC(B): B64C 29/00 (2010.01)
USPC: 244/23D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched additional USPC: 244/23A; 244/12.1

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PubWEST (USPT, PGPB, EPAB, JPA); Google Patents, Google, Google Scholar, aeroS, inel, vanes, outlet vanes, duct, ducted, fans, chord, YTOI, Vertical Take Off and Landing, vehicle, cylindrical, fans, vanes, sidewalks, rolling, motion, chord length, chord position, duct angle, pitch, yaw, center of gravity, YOELi (inventor), urban aeronautics, etc

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 6,561,456 B1 (Devine) 13 May 2003 (13.05.2003): Figs 4-6, 8 10; col 5, ln 22-28; col 6, ln 32-44, col 7, ln 29-30</td>
<td>1-20</td>
</tr>
<tr>
<td>Y</td>
<td>US 6,808,140 B2 (Moeller) 26 October 2004 (26.10.2004): Figs 1a-1c, col 7, ln 31-43; claim 9</td>
<td>8, 13, 17-20</td>
</tr>
<tr>
<td>A</td>
<td>US 3,179,352 A (Peterson) 20 April 1965 (20.04.1965), entire document</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>US 4,917,332 A (Patterson, Jr.) 17 April 1990 (17.04.1990), entire document</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>US 4,828,203 A (Clifton et al.) 09 May 1989 (09.05.1989), entire document</td>
<td>14</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

- 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 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
  "Z" document member of the same patent family

Date of the actual completion of the international search
28 September 2010 (28.09.2010)

Date of mailing of the international search report
30 SEP 2010

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-3201

Form PCT/ISA/210 (second sheet) (July 2009)

Authorized officer: Lee W. Young
PCT Deputy: 571-272-4200
PCT DSP: 571-272-7774
INTERNATIONAL SEARCH REPORT

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).

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:

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.

Group I: Claims 1-20 directed to a ducted fan for a VTOL vehicle.

Group II: Claims 21-22 directed to a ducted fan.

-Please see continuation below-

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.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)
Box III, Unity of Invention lacking:

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because under PCT Rule 13.2 they lack the same or corresponding technical features for the following reasons:

Groups II does not include the special technical feature of locating the vanes at a distance above the inlet of Group I.

Groups I does not include the special technical feature of fixing of one end of the vane relative to the duct and the opposite end of the vane to a movable actuator of Group II.

The shared technical features of Groups I-II fail to make a contribution over the prior art of US 2008/0054121 A1 (Yoeli), at Fig. 17 as follows: Yoeli discloses a ducted fan for a VTOL vehicle comprising: a substantially cylindrical duct 1703 having an inlet at an upper end and an outlet at a lower end (See Fig. 17) and an air mover unit 1716; and at least one row of adjustable control vanes 1718 located proximate the inlet (para [0137]).

Neither of the special technical features are common to the other group. Therefore, unity of invention is lacking.