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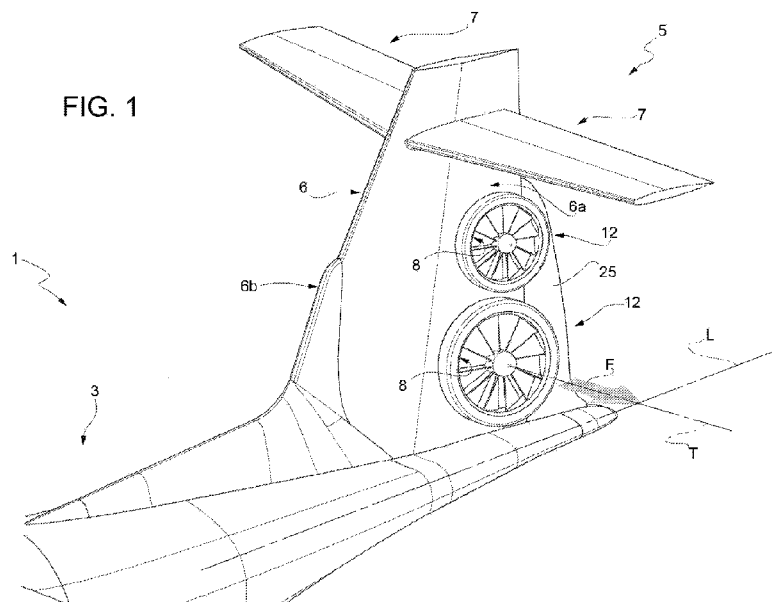
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(54) Title: FIXED-WING AIRCRAFT



(57) Abstract: A fixed-wing aircraft (1) provided with a fuselage (3) which extends along a longitudinal axis (L), a pair of wings, a propulsion system and a vertical stabilizer (5) provided with a vertical drift (6) fixed with respect to the fuselage (3). The drift (6) has a through seat (8) which houses at least one thrust generator (12) adapted to produce in a controllable manner an air flow (F) along a transverse axis (T) from a first side of the drift (6) or from a second side of the drift opposite the first one, producing aerodynamic forces which act on the opposite faces (6a, 6b) of the drift (6) and are used for the directional control of the aircraft (1).

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FIXED-WING AIRCRAFT

5 **CROSS-REFERENCE TO RELATED APPLICATIONS**

This patent application claims priority from Italian patent application no. 102020000004447 filed on 3/03/2020, the entire disclosure of which is incorporated herein by reference.

10 **TECHNICAL FIELD**

The present invention relates to a fixed-wing aircraft.

BACKGROUND OF THE INVENTION

As is known, fixed-wing aircraft are provided with aerodynamic control surfaces arranged on the wings and on
15 the stabilizers composed of movable surfaces (ailerons, flaps, spoilers, longitudinal elevators or elevators or horizontal rudders, rudders or lateral rudders, etc.) which allow generating aerodynamic forces intended to control the aircraft.

20 The operation principle on which the use of the movable surfaces is based is the variation of the aerodynamic characteristics (lift coefficients, drag, etc.) of the entire aerodynamic surface on which such movable parts intended for control are housed, through the variation of
25 the geometry of the profiles (basically, a change of the

camber) which allows controlling the aerodynamic forces as a function of the speeds of the aircraft.

In particular, the aerodynamic forces $\mathbf{F_a}$ are expressed by the equation:

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$$F_a = C_a \cdot S_{ref} \cdot Q_{dyn}$$

where $\mathbf{F_a}$ is the aerodynamic force, $\mathbf{C_a}$ is the aerodynamic coefficient, $\mathbf{S_{ref}}$ is the movable surface of reference and $\mathbf{Q_{dyn}}$ is the dynamic pressure.

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Based on such equation, the aerodynamic force $\mathbf{F_a}$ is function of the dynamic pressure $\mathbf{Q_{dyn}}$ in which the movable surface operates, i.e. is function of the airspeed with respect to the aircraft and of the air density.

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For such reason, when the speed is low, the dynamic pressure $\mathbf{Q_{dyn}}$ considerably decreases and the aerodynamic force $\mathbf{F_a}$ can be insufficient for allowing the control of the aircraft.

For each aircraft, a minimum control speed $\mathbf{V_{MC}}$ is defined which represents the minimum forward speed threshold of the aircraft below which the actuating of the movable surfaces does not generate the sufficient magnitude of force necessary for controlling the aircraft.

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In particular, the vertical stabilizer comprises a fixed drift and a rudder which can be deflected with respect to

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the drift, acting as movable surface used for generating the aerodynamic control forces. As is known, in fact, the drift is the front fixed part of the vertical stabilizer. Its main function is to assure the directional stability, while the rudder is necessary for allowing the directional control.

The vertical stabilizer is sized (as extent of usable surface) so that its movable part (i.e. the rudder) allows generating a control force also for limited speeds of the aircraft (for example during the landing and take-off steps of the aircraft); therefore at higher speeds and up to the maximum operating speed, the rudder must be, in the almost totality of the aircraft, limited in its maximum deflection so as not to generate excessive control forces with respect to what actually necessary for the directional controllability of the aircraft (and consequently, so as not to exceed the limits of the structural sizing of the entire vertical stabilizer and of the zone of the fuselage where the same is housed).

The object of the present invention is to provide a fixed-wing aircraft provided with a vertical stabilizer which allows generating an aerodynamic force for the lateral control also at low (or at most null) longitudinal forward speed.

SUMMARY OF THE INVENTION

The aforementioned object is achieved by the present

invention as the latter relates to a fixed-wing aircraft of the type described in claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

To better understand the present invention, a preferred
5 embodiment is described in the following, by way of non-limiting example, with reference to the accompanying drawings, wherein:

Figure 1 illustrates the perspective view of the vertical stabilizer of an aircraft manufactured according to
10 the present invention;

Figure 2 illustrates a side view of the vertical stabilizer of Figure 1;

Figure 3 illustrates a section of the vertical stabilizer of Figure 2 manufactured according to the plane
15 A-A; and

Figure 4 illustrates a variant of the section of the vertical stabilizer of Figure 3.

DETAILED DESCRIPTION OF THE INVENTION

In Figures 1 and 2, reference numeral 1 indicates a
20 fixed-wing aircraft provided with a fuselage 3 which extends along a longitudinal axis L, a pair of wings (not illustrated), a propulsion system (not illustrated and of a known type, for example screw propellers driven by internal combustion or turbine engines or a turbojet propeller) and
25 a vertical stabilizer 5 composed of a traditional part

(drift) 6 fixed with respect to the fuselage 3.

In the illustrated example, on the upper edge of the drift 6, i.e. of the fixed part of the vertical stabilizer, also the horizontal stabilizer 7 is installed, in turn
5 composed of (fixed) longitudinal stabilizers and movable parts (elevators or longitudinal rudders).

The drift 6 has at least one through seat 8 which extends along an axis T transverse to the longitudinal axis L of the aircraft and opens onto opposite faces 6a, 6b of
10 the drift 6. In the illustrated example, the through seat 8 is of cylindrical shape.

According to the present invention, the seat 8 houses at least one thrust generator 12 adapted to produce in a controllable manner an air flow F along the axis T from a
15 first side of the drift 6 or from a second side of the drift 6 opposite the first one, producing aerodynamic forces which act on the opposite faces 6a, 6b of the drift 6 and are used for the directional control of the aircraft 1. The aerodynamic forces produced are substantially perpendicular
20 to the surface of the vertical stabilizer (drift 6).

In the example illustrated in Figures 1 and 2, two thrust generators 12 are present housed in respective seats 8. Obviously, the number and the arrangement of the seats
8/of the thrust generators 12 can be different from what
25 illustrated by way of example.

In the illustrated example, each thrust generator 12 comprises at least one fan provided with rotating blades 15 rotating around the axis T under the thrust of a motor 16 (Figure 3) and configured to produce the air flow F from opposite sides of the drift 6.

Typically, the motor 16 is a motor of electric type, which can be supplied by different sources, among which:

a) any type of accumulator installed on board the aircraft;

b) electric power present on board the aircraft obtained, for example, from the turbine engine of the engines specifically dedicated to the propulsion of the aircraft or from the solar or photovoltaic panels installed on the aircraft;

c) the sources a) and b) used simultaneously.

The electric motor 16 can be installed in proximity to the hub 20 (Figure 3) of the blades (and supported, together with the hub of the fan, to the cylindrical tube by means of suitable structural radial elements not illustrated) or can be installed at a distance from the hub and connected to the hub by means of a transmission 17 (Figure 4).

According to a first embodiment, the fan 12 comprises a hub 20 movable under the thrust of the motor 16 and a plurality of blades 21 (at least two, obviously the number can be different) which extend radially from the hub 20 and

are fixed with respect to the hub 20. The motor 16 is adapted to cause the rotation of the hub 20 according to first and second angular directions opposite to each other so as to create the aerodynamic forces which act on the opposite sides
5 of the drift 6.

According to a further embodiment, the fan 12 comprises a hub 20 movable under the thrust of the motor 16 and a plurality of blades 21 which extend radially from the hub 20 and are angularly movable with respect to the hub 20 around
10 respective blade axes which extend radially from the hub 20.

A further device is provided (of a known type and not shown) adapted to modify the angular position of each blade 21 with respect to the blade axis so as to create the aerodynamic forces which act on the opposite sides of the
15 drift 6. In such case, the motor 16 must cause the rotation of the hub in a single angular direction.

The thrust generator 12 can entirely replace the rudder or (Figure 1) a rudder 25 angularly movable with respect to the drift 6 can be provided and having smaller dimensions
20 than a rudder belonging to a drift having equivalent dimensions and without thrust generators 12.

The activation/deactivation of the thrust generator(s) 12 is carried out in the cockpit and the transmission of the command can occur both via material lines (electrical cables
25 or of other type) and wirelessly (output of electromagnetic

signals of Wi-Fi type).

The thrust generator 12 can develop control forces in all flight conditions and in particular also in conditions of low or null forward speed of the aircraft.

5 According to a further embodiment, with reference to Figure 4, the thrust generator 12 can be manufactured with a higher level of complexity so as to increase the magnitude of the thrust produced and can comprise:

10 a first fan 28 provided with first rotating blades 29 rotating around the transverse axis T under the thrust of the motor 16 according to a first rotation direction; and

15 a second fan 30 facing the first fan 28, provided with rotating blades 31 rotating around the transverse axis T under the thrust of the motor 16 according to a second rotation direction opposite the first.

20 The first blades 28 and the second blades 30 have opposite blade inclinations so that the first blades and the second blades rotating counter to each other produce an air flow from a first side or from a second side of the drift 6 based on the rotation direction of the motor 16. The motor 16 is connected to the fans 28 and 30 by means of the transmission 17 which comprises a shaft 40 which carries at one of its ends a bevel gear 41 which is coupled to bevel gears 42 and 43 facing each other, having axis coaxial to the axis T and respectively fixed to the hub 25 44, 45 of the fan 28 and 30.

CLAIMS

1.- Fixed-wing aircraft (1) provided with a fuselage (3) which extends along a longitudinal axis (L), a pair of wings, a propulsion system and a vertical stabilizer (5) provided with a drift (6) fixed with respect to the fuselage (3),

characterized in that said drift (6) has a through seat (8) which extends along an axis (T) transverse to the longitudinal axis (L) and opens onto opposite faces (6a,6b) of the drift (6);

said seat (8) houses at least one thrust generator (12) adapted to produce in a controllable manner an air flow (F) along said transverse axis (T) from a first side of said drift (6) or from a second side of said drift opposite the first one, producing aerodynamic forces which act on the opposite faces (6a,6b) of the drift (6) and are used for the directional control of said aircraft (1).

2.- The aircraft according to claim 1, wherein said thrust generator (12) comprises at least a fan provided with rotating blades (15) rotating around said transverse axis (T) under the thrust of motor means (16) and configured to produce said air flow (F) from opposite sides (6a,6b) of said drift (6).

3.- The aircraft according to claim 2, wherein said fan

(12) comprises a hub (20) movable under the thrust of said motors (16) and a plurality of blades (21) which extend radially from said hub (20) and are fixed with respect to said hub (20); said motor means (16) being adapted to cause
5 the rotation of said hub (20) according to first and second angular directions opposite to each other to create the aerodynamic forces that act on the opposite sides of said drift (6).

4.- The aircraft according to claim 2, wherein said fan
10 (12) comprises a hub (20) movable under the thrust of said motors (16) and a plurality of blades (21) which extend radially from said hub (20) and are angularly movable with respect to said hub (20) around respective blade axes which extend radially from the hub (20); means furthermore being
15 provided adapted to modify the angular position of each blade (21) with respect to said blade axis to create the aerodynamic forces that act on opposite sides of said drift (6).

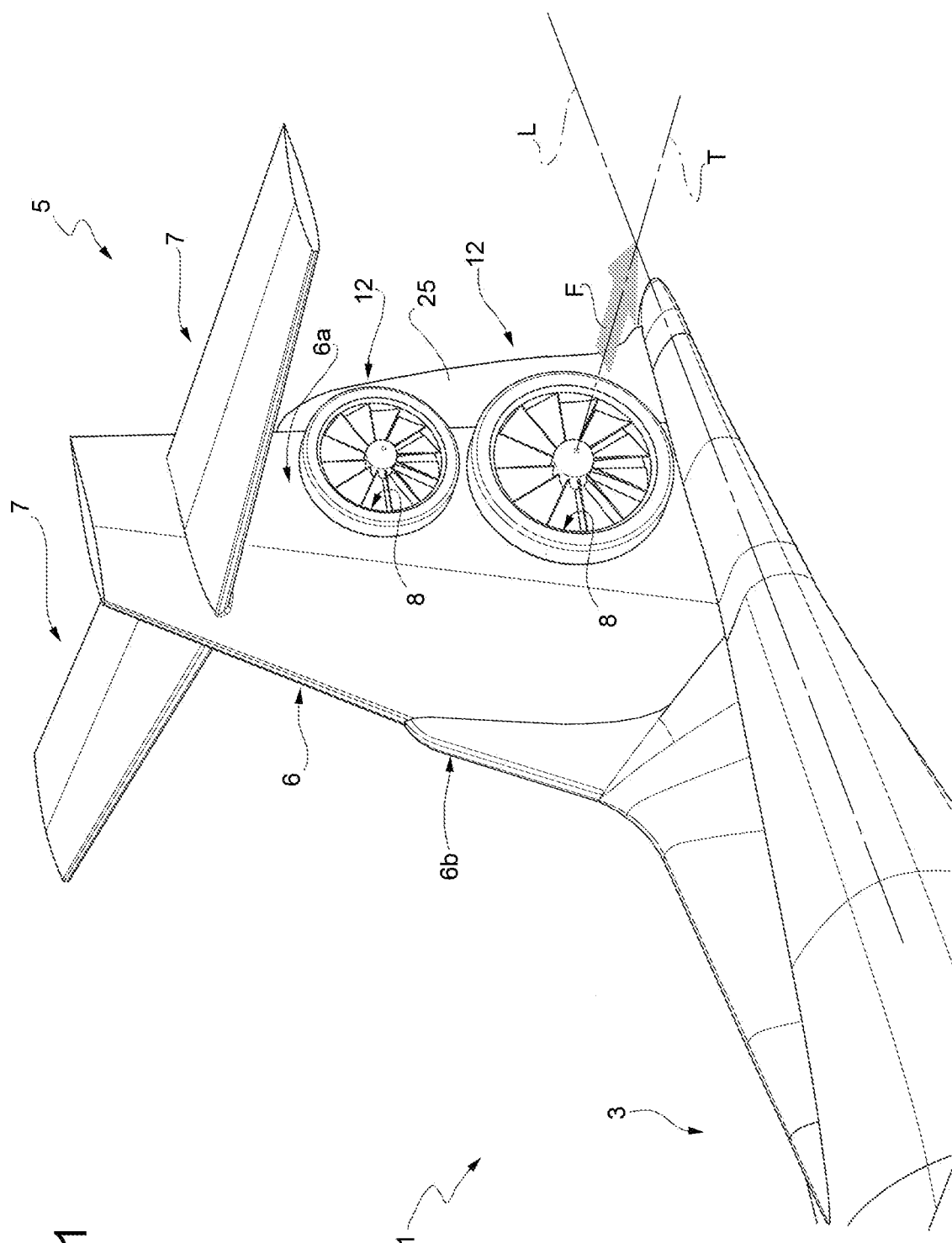
5.- The aircraft according to one of the claims from 2
20 to 4, wherein a rudder (25) is provided angularly movable with respect to the drift (6) and having smaller dimensions than a rudder belonging to a drift having equivalent dimensions without thrust generators (12).

6.- The aircraft according to claim 1, wherein said
25 thrust generator (12) comprises:

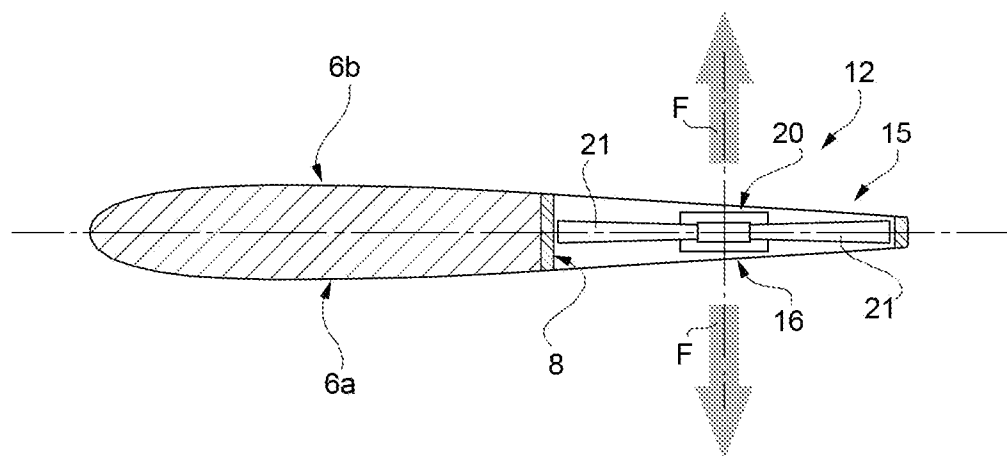
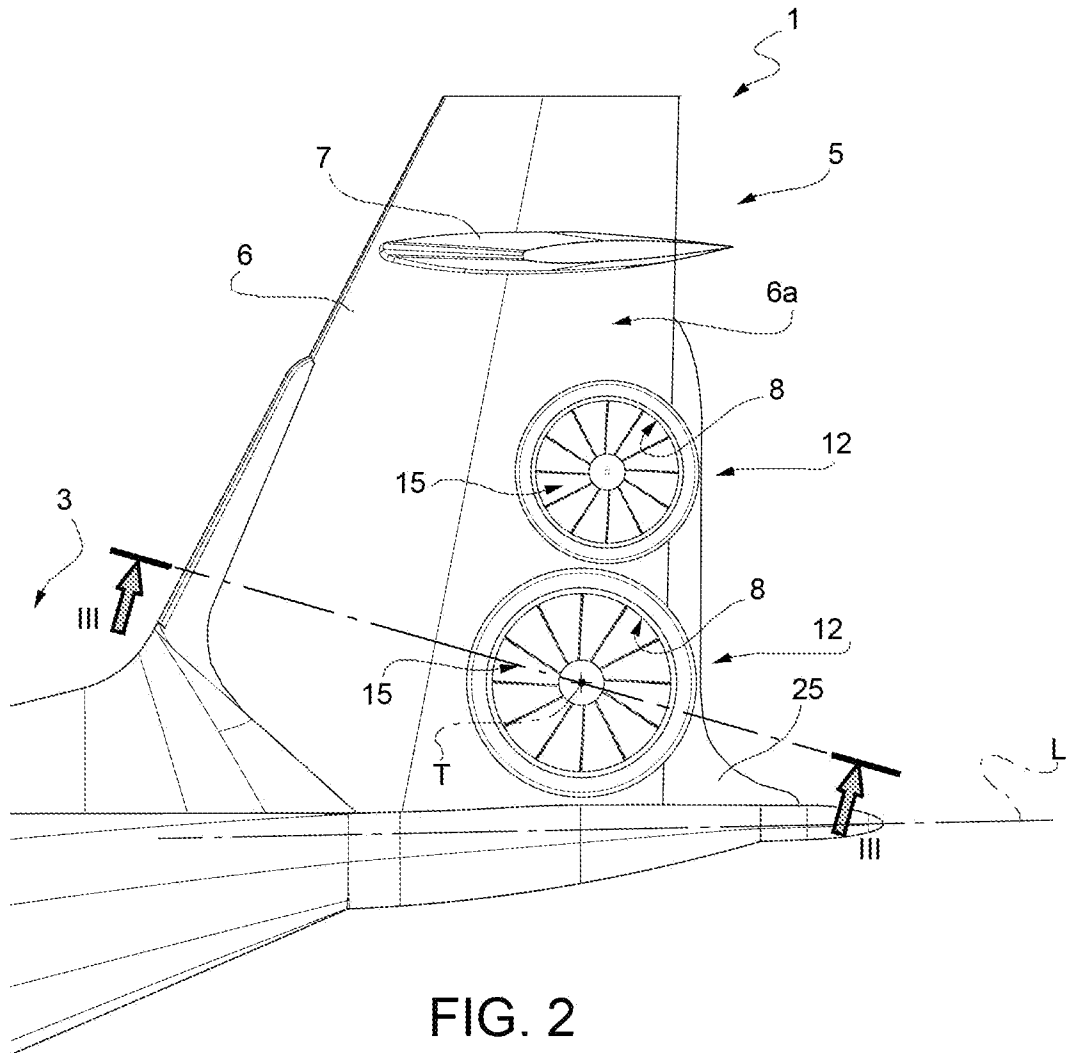
a first fan (28) provided with first rotating blades (29) rotating around said transverse axis (T) under the thrust of motor means according to a first rotation direction;

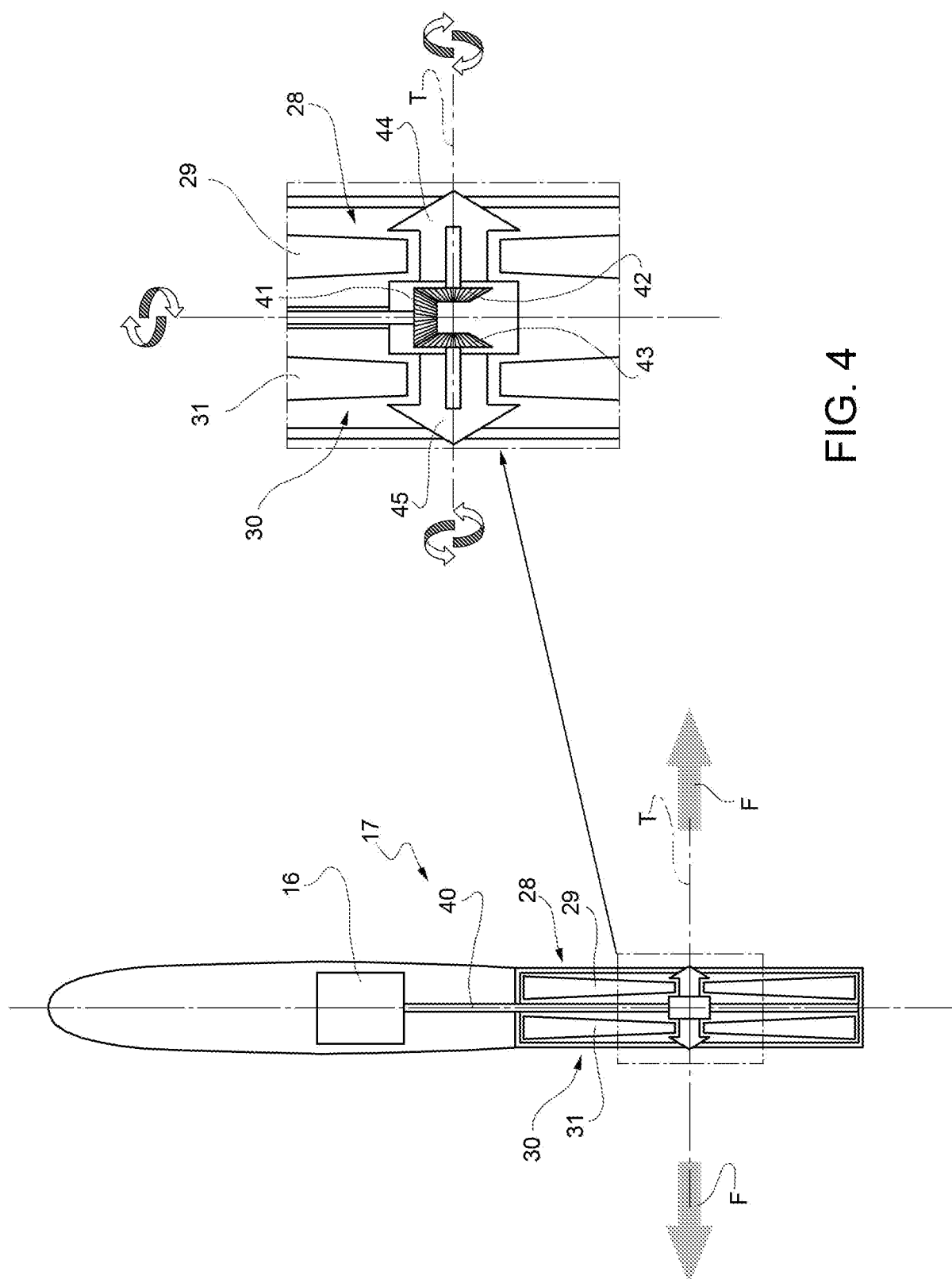
5 a second fan (30) facing the first fan (28), provided with rotating blades (31) rotating around said transverse axis (T) under the thrust of motor means according to a second rotation direction opposite the first;

said first blades and said second blades having opposite
10 blade inclinations so that the first blades and the second blades rotating counter to each other produce an air flow from a first side or a second side of said drift (6).



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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/062583

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64C5/06 B64C11/00 B64C15/14
ADD.

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)
B64C

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	abstract; claim 1; figures 1, 2 -----	1-6
Y	US 2017/349274 A1 (FENNY CARLOS [US] ET AL) 7 December 2017 (2017-12-07) abstract; figures 2, 5A, 5B, 6A, 6B paragraphs [0007], [0044] - [0047] -----	1-3,6
Y	JP 2009 090755 A (MITSUBISHI HEAVY IND LTD) 30 April 2009 (2009-04-30) abstract; figures 1-4 -----	1,2,4,5
A	US 6 382 556 B1 (PHAM ROGER N C [US]) 7 May 2002 (2002-05-07) abstract; figures 1, 2, 6, 7 ----- -/--	1-6

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/062583

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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