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(54) Title: ENGINE FAN

(57) Abstract: A fan module (10) of a vehicle engine, the fixed shroud (12) of the module (10) receiving in a circular opening (16) a fan (14) rotating about a main axis (X), said opening (16) being circumvented by a peripheral wall (18) cylindrically extending in the downstream direction (DD) beyond the fan (14) toward a corner edge where said wall (18) angles radially and inwardly to extend toward a circular downstream edge. The downstream portion of the peripheral wall (18) forms an annular channel (C) opening in the upstream direction (UD), said channel (C) forming a continuous space to the gap (G) that is between the tips (22) of the blades (20) of the fan (14), said gap (G) being continuous, non-divided and non-partitioned.

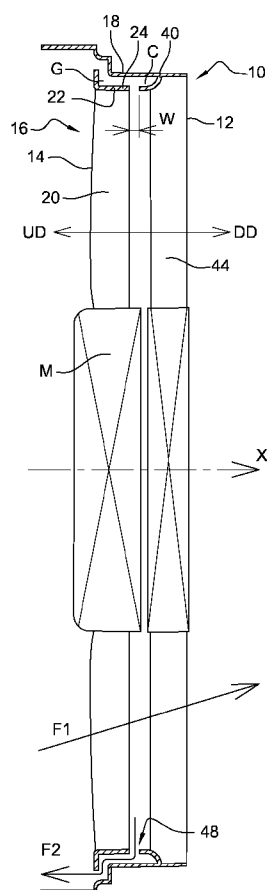


Fig. 1



PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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Engine Fan

5 TECHNICAL FIELD

The present invention relates to a fan module for cooling a vehicle engine. In particular the invention relates to the structure of the shroud.

BACKGROUND OF THE INVENTION

- 10 Engine fan modules are arranged in the front of a vehicle to generate an air stream that passes through heat exchangers cooling the engine's components. A peripheral back stream flows in the opposite direction as the main stream and passes in the gap between the tip of the blades of the fan and the surface of the opening shroud. To reduce such back flow features have been developed in the structure of the shroud.
- 15 US7478993 discloses a downstream profile of the shroud supposed to provide a Coanda effect. US5489186 discloses another downstream profile wherein flat surfaces, integral to the shroud, are arranged in the gap so that the structure is reinforced and, the back stream air flow is axially directed and cannot rotate within the gap. Other fan modules are known from US2003161728, DE4414893 and WO9506822.
- 20 Developments are required to further improve the efficiency of the fan module.

SUMMARY OF THE INVENTION

- Accordingly, it is an object of the present invention to provide a fan module of a vehicle engine. The module comprises a fixed shroud that receives in an opening a fan
- 25 rotating about a main axis. The opening may be circular. The opening is circumvented by a peripheral wall extending in the downstream direction, relative to the main air flow, beyond the fan toward a corner edge where the wall reorients radially and inwardly to extend toward a circular downstream edge. The reorientation of the peripheral wall may be done smoothly, for instance in a curve, or abruptly with an angle. The downstream
- 30 portion of the peripheral wall forms an annular channel opening in the upstream direction. The channel forms a continuous space to the gap that is between the tips of the blades of the fan and the peripheral wall. The gap is continuous, non-divided and non-partitioned.
- In an embodiment, the channel is also free of obstacles forming a continuous, non-divided and non-partitioned annular space.
- 35 It may happen that due to structural parts for instance, the channel may be interrupted.

In another embodiment, reinforcement ribs may be formed and confined in the channel. The ribs do not form in the gap.

Furthermore, a 360° aperture is formed between downstream outer edge of the fan and the downstream edge of the peripheral wall so that the annular channel is downstream said 360° aperture and, in operation of the module a peripheral counter air stream is able to enter the gap and the channel through said 360° aperture.

5 The diameters of the downstream outer edge of the fan and of the downstream edge of the peripheral wall may be equal so that the circular edge faces the very tips of the blades. In another embodiment, the diameter of the circular edge is smaller than the outer diameter of the fan. In yet another embodiment, the diameter of the circular edge is larger than the outer diameter of the fan.

10 More specifically, the peripheral wall extending from the corner edge to the circular edge may form a quadrant, or a quarter of circle.

In another embodiment, the peripheral wall extending from the corner edge to the circular edge is frustoconical with apex upstream the fan.

15 The fan may be provided with an outer cylindrical ring joining the tips of the blades. In this case, the gap is the space between said ring and the peripheral wall. The portion of the ring that joins the tips of the blades may be cylindrical or may have another profile such as a conical or curved shape.

20 Furthermore the shroud is provided with at least one stator-arm radially extending and integrally connecting the peripheral wall between the corner edge and the circular edge externally of the annular channel.

The peripheral wall may be cylindrical or comprise a cylindrical portion, especially the portion facing the tips of the blades or, may have another profile such as a conical or curved shape.

25 BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is now described by way of example with reference to the accompanying figures.

Figure 1 is section of a fan module.

30 Figure 2 and 3 are detailed views in section of a fan and shroud presenting details of different embodiments of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As well-known and represented in figure 1, a fan module 10 comprises a fixed shroud 12 and a revolving fan 14, the fan and shroud being generally moulded in plastic.

35 The shroud 12 is of a general rectangular shape and has a large circular opening 16 delimited by a peripheral wall 18. The fan 14 is received in the opening 16, driven in

rotation about a main axis X by an electric motor M. The fan 14 comprises blades 20 which tips 22 are close to the peripheral wall 18. Furthermore, the tips 22 of the blades 20 are integrally connected by a circular ring 24 but, in alternative embodiments, this latter feature is not present. To avoid any interference, an annular gap G is accommodated
5 between the ring 24, or the very tip 22 of the blades 20, and the peripheral wall 18 of the opening 16.

In operation, the fan 14 generates a main air stream F1 flowing in the downstream direction DD, from upstream the fan 14, on the left of figure 1, to downstream the fan 14, on the right on figure 1 and, a counter air stream F2 flows inside
10 the annular gap G in the opposite upstream direction UD.

To better control said counter air stream F2 and optimize the aerodynamic efficiency and acoustic performance of the fan module 10, a first embodiment is now described in reference to figure 2.

The fan 14 is provided with a circular ring 24 joining the tips 22 of its blades
15 20. As can be seen on the figure, the ring 24 has a central cylindrical section 26 covering the blades 20 and an upstream section 28 extending outwardly in a disc portion perpendicularly to the central section 26. Other profiles are possible such as a cylindrical profile only.

The peripheral wall 18 of the opening 16 extends from an upstream edge 32, on
20 the left of the figure, to a downstream edge 34, on the right of the figure. Between said edges 32, 34, the peripheral wall 18 extends in an upstream portion 36, comprising a series of faces forming steps so to follow the profile of the ring 24. Said upstream portion 36 continues in a central portion 38 that is cylindrical and that axially X extends downstream the fan 14 until a corner edge 40. Finally, after the corner edge 40, the
25 peripheral wall 18 angles abruptly extending radially inwardly into a downstream portion 42 until the downstream edge 34. As can be observed on the embodiment represented on the figure, the section in the axial plan of the figure of the downstream portion 42, at the corner edge 40 the wall 18 abruptly angles radially and inwardly to extend toward a circular downstream edge 34. The downstream portion 42 forms a quadrant 44 with
30 radius R substantially equal to the width of the gap G, the centre of said quadrant 44 being located upstream the corner 34. The circular portion formed by the quadrant 44 is followed by a short straight portion so that, the downstream edge 34 faces the downstream edge of the ring or of the blade, and forms into the gap G a 360° opening 48 of width W.

35 As can be observed on the figure, the downstream portion 42 defines a circular channel C open in the upstream direction UD. The channel C is in continuity to the gap

G, and is positioned downstream the 360° opening 48 while the main part of gap G is upstream the 360° opening 48.

Other geometries than a quadrant may be chosen for channel C, geometries that would not require an abrupt angle of the wall 18 at the corner edge 40. The abrupt reorientation done by the peripheral wall and forming the corner edge 40, can, in other embodiments, be much smoother than as represented on the figures. For instance, the peripheral wall could form a continuous semi-circular U-turn.

Multiple further geometrical alternatives can be derived from this first embodiment. For instance, as detailed above, the tips 22 of the blades 20 may be free without connecting ring. Also, the quadrant 44 may not follow an exact quarter of circle and, may not be followed by a short straight portion.

As can also be observed on the figure, the shroud 12 comprises radially extending arms 50, usually identified as stators 50 and which are integrally formed joining the outer face of the quadrant 44. These arms are integral to the shroud and can be single-moulded in plastic material. Importantly enough to be underlined in this description, in the present embodiment the gap G and the channel C extend all around the fan 14 in a continuous space non-divided or non-interrupted or non-partitioned by, for instance reinforcement ribs or other partitioning walls.

In certain non-represented specific embodiments, it may happen that the channel is interrupted on an angular portion, this to enable packaging with other structural part.

In operation, the air passes through the fan 14 then a minor peripheral portion forms the counter air stream F2 that enters through the opening 48 into the gap G and channel C. Therein the stream F2 flows and revolves into the gap G and channel C prior to exiting upstream.

A second embodiment is now described by way of differences to the first embodiment and in reference to figure 3.

In the second embodiment, the downstream portion 42 forms a frustoconical portion with apex on the main axis X upstream the fan 14. The diameter of downstream edge 34 is smaller than the diameter of the ring 24 so the very tips 22 of the blades 20 face the inside of the gap G.

In a non-represented alternative the diameter of downstream edge 34 is larger than the diameter of the ring 24 so the downstream edge 34 faces the inside of the channel C.

Furthermore, as can be observed in this second embodiment, small reinforcement ribs 52 are integrally formed and confined inside the channel C, joining the

downstream portion 42 to the central portion 38. The portion of the gap G that is upstream the 360° opening 48 remains a continuous space non-divided or interrupted or non-partitioned by the ribs 52.

5 In the present description, the following references have been utilized:

- 10 fan assembly
- 12 fixed shroud
- 14 revolving fan
- 16 opening
- 18 peripheral wall
- 20 blades
- 22 tips of the blades
- 24 ring connecting the blades
- 26 cylindrical portion
- 28 disc portion
- 30 downstream edge of ring or of the blade
- 32 upstream edge of the peripheral surface
- 34 downstream edge
- 36 upstream portion
- 38 central portion
- 40 corner edge
- 42 downstream portion
- 44 quadrant portion
- 46 frustoconical portion
- 48 360°-opening in the gap
- 50 stator
- 52 reinforcement ribs

X main axis

F1 main air stream

F2 counter air stream

G annular gap

C channel

UD upstream direction

DD downstream direction

R radius of the quadrant
W width of the 360° opening
M electric motor

CLAIMS

1. Fan module (10) of a vehicle engine, the fixed shroud (12) of the module (10) receiving in an opening (16) a fan (14) rotating about a main axis (X), said opening (16)
5 being circumvented by a peripheral wall (18) extending in the downstream direction (DD) beyond the fan (14) toward a corner edge (40) where said wall (18) reorients radially and inwardly to extend toward a downstream edge (34) so that, the downstream portion (42) of the peripheral wall (18) forms an annular channel (C) opening in the upstream direction (UD), said channel (C) forming a continuous space to the gap (G) that is
10 between the tips (22) of the blades (20) of the fan (14) and the peripheral wall (18), said gap (G) being continuous, non-divided and non-partitioned and wherein,
a 360°aperture (48) is formed between the downstream outer edge (30) of the fan (14) and the downstream edge (34) of the peripheral wall (18) so that the annular channel (C) is arranged downstream said 360°aperture (48) and, in operation of the
15 module (10) a peripheral counter air stream (F2) is able to enter the gap (G) and the channel (C) through said 360°aperture (48).
2. Module (10) as set in the preceding claim wherein the channel (C) is also free of obstacles forming a continuous, non-divided and non-partitioned space.
20
3. Module (10) as set in claim 1 wherein reinforcement ribs (52) are formed and confined in the channel (C).
4. Module (10) as set in any of the preceding claim wherein the diameters of the
25 circular edge (34) and of the downstream outer edge (30) of the fan (14) are equal so that the edge (34) faces the very tips (22) of the blades (20).
5. Module (10) as set in any of the claims 1 to 4 wherein the diameter of the edge (34) is smaller than the downstream outer edge (30) of the fan (14).
30
6. Module (10) as set in any of the claims 1 to 3 wherein the diameter of the edge (34) is larger than the diameter of the downstream outer edge (30) of the fan (14).
7. Module (10) as set in any of the claims 4 to 6 wherein the portion of the
35 peripheral wall (18) extending from the corner edge (40) to the circular edge (34) forms a quadrant (44).

8. Module (10) as set in any of the claims 4 to 6 wherein the portion of the peripheral wall (18) extending from the corner edge (40) to the circular edge (34) forms a frustoconical portion (46), its apex being upstream the fan (14).
- 5 9. Module (10) as set in any of the preceding claim wherein the fan (14) is provided with a ring (24) joining the tips (22) of the blades (20), the gap (G) being between said ring (24) and the peripheral wall (18).
- 10 10. Module (10) as set in claim 8 wherein the portion (26) of the ring (28) that joins the tips of the blades (20) is cylindrical about the main axis (X).
11. Module (10) as set in claim 9 wherein the portion (26) of the ring (24) that joins the tips (22) of the blades (20) is non-cylindrical, said portion being for instance conical or curved.
- 15 12. Module (10) as set in any of the preceding claim wherein the shroud (12) is provided with at least one stator-arm (50) radially extending and integrally connecting the peripheral wall (18) between the corner edge (40) and the circular edge (34) externally of the annular channel (C).
- 20 13. Module (10) as set in any of the preceding claims wherein the peripheral wall (18) is cylindrical.
14. Module (10) as set in any claims 1 to 12 wherein the peripheral wall (18) is non-cylindrical, said wall being for instance conical or curved.
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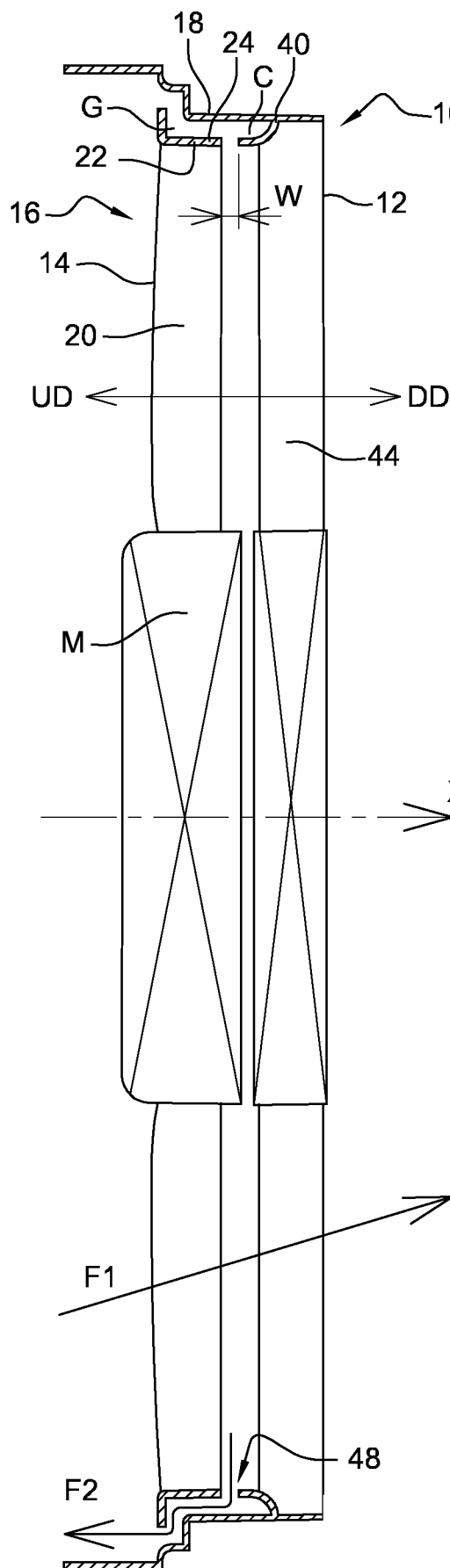


Fig. 1

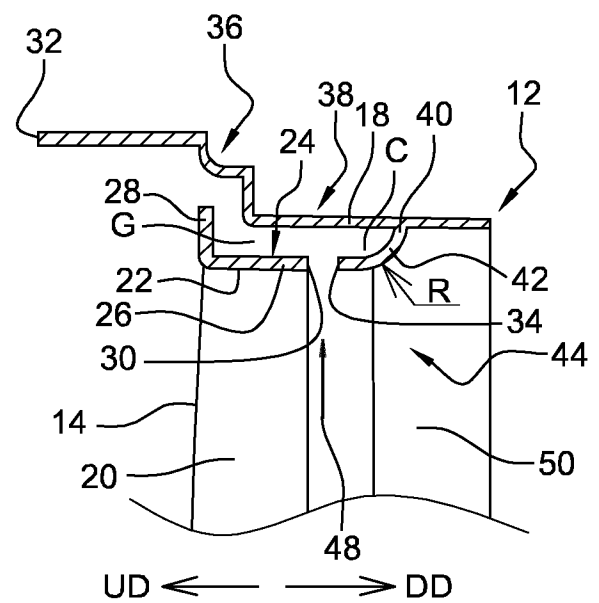


Fig. 2

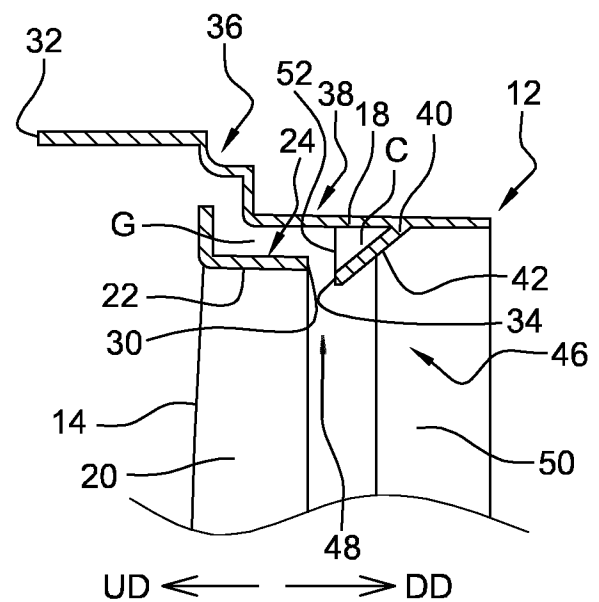


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/076640

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04D29/16
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)
F04D F01P

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/161728 A1 (CHO KYUNG-SEOK [KR] ET AL) 28 August 2003 (2003-08-28) the whole document figures 5,8A -----	1,2,4, 7-14
X	DE 44 14 893 A1 (GEIGER PLASTIC VERWALTUNG [DE]) 9 November 1995 (1995-11-09) figure 2 -----	1,2,4, 7-14
X	US 2006/147304 A1 (CHO KYUNGSEOK [KR] ET AL) 6 July 2006 (2006-07-06) figure 4 -----	1,5
X	WO 95/06822 A1 (AIRFLOW RES & MFG [US]) 9 March 1995 (1995-03-09) figure 7 -----	1,3,6



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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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