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(71) Applicant *(for all designated States except US)*: **VALEO KLIMASYSTEME GmbH** [DE/DE]; Werner-von-Siemens-Strasse 6, 96476 Bad Rodach (DE).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **GESELL, Bodo** [DE/DE]; Frankfurter Strasse 32, 64850 Schaafheim (DE). **GORCHS, Marius** [DE/DE]; Mühldamm 9, 96450 Coburg (DE). **SONDERMANN, Mark** [DE/DE]; Akazienweg 10, 96479 Weitramsdorf (DE).

(74) Agent: **VIEILLEVIGNE, Sebastien**; Valéo Systémes Thermiques, Service Propriété Industrielle, 8, rue Louis Lormand, La Verrière BP 513, F-78321 Le Mesnil Saint Denis (FR).

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(54) **Title**: FAN MOTOR COOLING

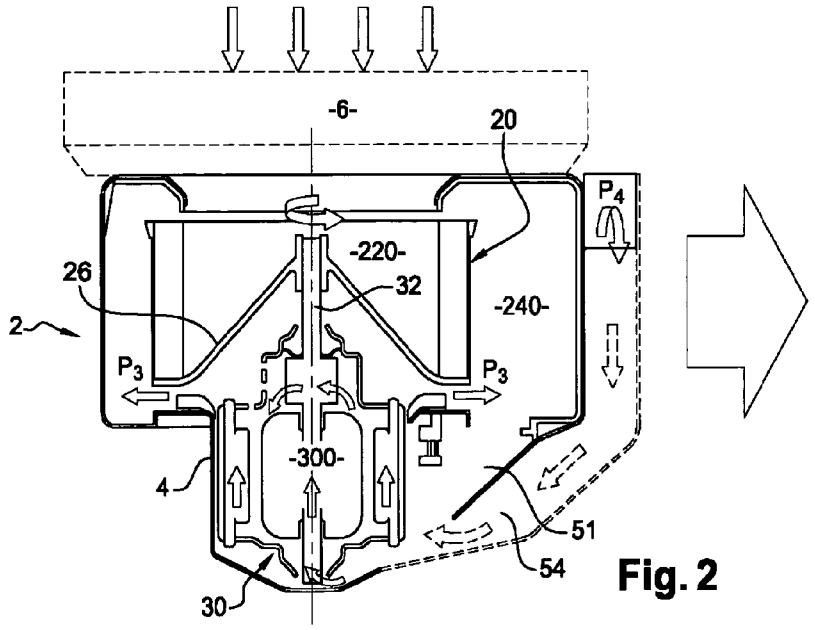

Fig. 2

(57) **Abstract**: The present invention relates to a fan, in particular for a heating, ventilation and/or air-conditioning system of a vehicle, comprising a housing (10), an electric motor (30) which drives an impeller (20) in order to increase the pressure of air from a suction- side volume (2) in a pressure-increasing volume (4) and discharge said air to a pressure-side volume (6), with the electric motor (30) being accommodated in a motor volume (8) of the housing, wherein the fan is characterized in that the housing (10) comprises an air guiding section (12) which connects the motor volume (8) to the suction-side volume (2) while bypassing the pressure-increasing volume (4).

WO 2012/163384 A1

Fan motor cooling

[0001] The present invention relates to a fan, and in particular to a fan for a heating, ventilation and/or air-conditioning system of a vehicle.

[0002] Conventional fans of this type comprise a housing which is usually produced from plastic and which is conventionally also referred to as a spiral housing. Situated in the housing is an electric motor which drives an impeller in order to increase the pressure of air. The air, originating for example from a fresh air / recirculated air discharge device, conventionally passes via an air filter to a suction-side volume, from where said air is pressurized by means of the impeller in a pressure-increasing volume before subsequently being discharged to a pressure-side volume. To be able to install the fan as a structural unit in a motor vehicle, and in order to protect the electric motor, the latter is conventionally held in a motor volume of the housing, usually in such a way that the motor comes to rest below the impeller.

[0003] The requirements which have become ever more stringent in recent years and the simultaneously decreasing available installation space has in recent years led to the motor volume being designed such that air can circulate around or through the motor in order to cool the latter. The air conveyed by the fan and in particular the impeller is often used for this purpose, by virtue of a part of the pressurized air being conducted from the pressure-side volume to the motor, with the air passing back into the pressure-increasing volume after cooling the motor.

[0004] The applicant has found that, in certain configurations, the motor of the fan is not adequately cooled. Furthermore, the applicant has observed that metal particles released from the motor can have an adverse effect on the downstream elements of the heating and air-conditioning system, such as the heat exchanger and the evaporator, and can in particular lead to early corrosion therein.

[0005] There is accordingly a demand for an improved fan of the type specified in the introduction which can counteract the abovementioned disadvantages.

[0006] According to the invention, therefore, a fan, in particular for a heating, ventilation and/or air-conditioning system of a vehicle, comprising a housing, an electric motor which drives an impeller in order to increase the pressure of air from a suction-side volume in a pressure-increasing volume and discharge said air to a pressure-side volume, with the electric motor being accommodated in a motor volume of the housing, is improved in that the housing comprises an air guiding section which connects the motor volume to the suction-side volume while bypassing the pressure-increasing volume. In other words, the air which is used for cooling the electric motor is no longer supplied, or is at least supplied only to a considerably reduced extent, to the pressure-increasing volume, but rather said air is conducted in a specific duct to the suction-side volume of the fan, or is sucked into said volume by means of the relatively low pressure prevailing there.

[0007] By means of the arrangement according to the invention, it is possible firstly for more or less the entire pressure difference between the pressure-side volume and suction-side volume to be utilized, with it particularly advantageously also being possible for the air used for cooling the electric motor to be conducted back to the suction-side volume upstream of the air filter which is provided in any case, such that any metal particles generated can be filtered out in an effective manner.

[0008] Even though it is preferable for the housing to comprise a further air guiding section which connects the pressure-side volume to the motor volume while bypassing the pressure-increasing volume, in order thereby to be able to utilize the entire pressure difference, it is alternatively likewise possible for the electric motor to be cooled only by means of the suction action of the suction side, by virtue of for example ambient air or else air from the pressure-increasing volume being sucked into the motor volume, in order for said air to be used in an effective manner for cooling the electric motor, and subsequently conducted back to the suction-side volume.

[0009] In a particularly simple design variant, the housing itself comprises a wall which serves as a partition between the motor volume and the pressure-increasing

volume, for example a wall which is substantially matched to the configuration of the impeller. To prevent an infiltration of moisture or dirt into the electric motor or into the motor volume, it is likewise possible in this configuration for the impeller to be designed in the manner of a screen in the region of the rotary axle, such that an at least partial overlap is provided with the wall arranged therebelow.

[0010] A particularly advantageous embodiment is provided, however, if the impeller itself at least partially defines the motor volume. If a closed impeller is provided, for example having a closed cone which connects the rotary axle to the blades of the impeller. In this embodiment, the infiltration of moisture and dirt is prevented in an effective manner, and a closed impeller, despite the fact that it is less desirable from a weight aspect, offers the advantage of providing high stability and connection rigidity.

[0011] To firstly as far as possible prevent any exchange of air between the motor volume and the pressure-increasing volume and secondly prevent the infiltration of liquid and/or dirt into the motor volume, it is preferable for the impeller to form a continuation, via a sealing device, with respect to at least one further wall which at least partially defines the motor volume. Here, as sealing devices, consideration is given in particular to so-called labyrinth seals, because the seal must permit high rotational speeds and should also provide adequate production tolerances.

[0012] In particular in the situation in which the impeller at least partially defines the motor volume, but not exclusively in this situation, it is advantageous for the impeller to have aerodynamically acting elements on the side facing toward the motor. Said aerodynamically acting elements may for example be air guiding blades which, when the impeller rotates, favour a flow through the electric motor, wherein the aerodynamic elements could also be designed so as to assist the air circulation effected by the pressure difference.

[0013] According to one preferred embodiment, the impeller is provided with a closed surface, for example in the form of a cone which is rotationally symmetrical with respect to the rotary axle and which widens toward the electric motor and which

particularly preferably has, at its base, a radius which is considerably greater than the radius of the electric motor. The closed surface can therefore, in the manner of a rotating screen, protect the electric motor from infiltrating moisture and/or dirt.

[0014] At least one air guiding section advantageously comprises a filter. If it is sought, for example, to utilize as great a pressure difference as possible, it would for example be possible to provide that the air guiding section which connects the motor volume to the suction-side volume while bypassing the pressure-increasing volume is connected, downstream of the main air filter, to the suction-side volume; it is then particularly advantageous to provide a specific air filter which for example generates a smaller pressure difference than the main air filter, and which is designed substantially to filter out metal particles which have possibly been released from the electric motor.

[0015] In a preferred embodiment of the fan according to the invention, a drainage device is additionally provided, in particular in order to allow any liquid which arises to be discharged from the pressure-increasing volume without the risk of contamination of the motor volume.

[0016] In a further preferred embodiment, the motor volume is designed so as to favour a flow through the motor. For this purpose, it would for example be possible for the base wall of the housing to be specially shaped or else to comprise air guiding elements which, for effective cooling of the electric motor, conduct the air along the motor axle, wherein a person skilled in the art will understand that even spiral air guidance through the electric motor may be provided.

[0017] Finally, it is preferable for the fan according to the invention to comprise a metal particle separating device. As such a device which is capable of separating metal particles, consideration is given in particular to a specially provided turbulence chamber, a specific filter or else a magnet device. Metal separation has proven to be particularly advantageous in particular for preventing copper particles, which are released during the operation of the electric motor, from reaching the evaporator, because the latter would otherwise be at increased risk of corrosion.

[0018] In summary, it can be stated that the solution according to the invention, as an alternative or else in addition to the previous treatment of air for cooling the electric motor by means of pressurized air from the pressure side of the fan, is aimed predominantly at sucking air from the motor volume to the suction-side volume such that practically no air passes from the motor volume into the pressure-increasing volume, which, aside from the advantages already described, also has the advantage that the pressure increase in the pressure-increasing volume can take place without parasitic flows, since the pressure-increasing volume receives air practically exclusively from the suction side, and discharges said air practically entirely to the pressure-side volume.

[0019] Further advantages and features of the present invention will emerge from the following description of some presently preferred embodiments, wherein the description merely serves as an example and is not restrictive and makes reference to the appended drawings, in which:

[0020] Figure 1 shows a schematic plan view of the spiral housing of a fan according to the invention.

[0021] Figure 2 shows a schematic sectional view of a first preferred embodiment of a fan according to the invention.

[0022] Figure 3 shows an embodiment slightly modified in relation to Figure 2.

[0023] Figure 4 shows an alternative embodiment in a schematic sectional view similar to Figures 2 and 3.

[0024] Figure 5 shows yet a further preferred embodiment in a similar illustration.

[0025] Figure 6 shows a further preferred embodiment of a fan according to the invention, again in a schematic sectional view.

[0026] Figure 7 shows yet a further preferred embodiment, in which in particular the flow through the motor to be cooled is favoured.

[0027] Figure 1 shows a schematic plan view of a fan for a heating, ventilation and/or air-conditioning system of a vehicle. The fan comprises a housing 10, which is conventionally an injection-moulded part and which is often also referred to as a spiral housing on account of its geometric shape. An impeller 20 is rotatably arranged in the housing 10, as indicated by the arrow. The impeller 20 is provided with peripheral blades (not illustrated), such that air passing centrally from above is accelerated radially outward via a suction-side volume 2 before being pressurized and accelerated in a pressure-increasing volume 4 by the rotation of the impeller, before finally leaving the fan via the pressure-side volume 6 as indicated by a double arrow. This design is entirely conventional and is well known to a person skilled in the art, as is the fact that an electric motor is situated below the fan impeller 20 in order to drive the impeller.

[0028] Figure 2 shows a schematic sectional view of a first embodiment of a fan according to the invention. Also shown in the sectional view are the housing 10 in which is situated the impeller 20 for discharging air from the suction-side volume 2 via the pressure-increasing volume 4 to the pressure-side volume 6. In a way which is likewise entirely conventional, an air filter 17 is situated upstream of the impeller, and an electric motor 30 provided for driving the impeller 20 is situated below the impeller. The motor 30 is situated in a motor volume 8 which, at its underside, is formed by the housing wall of the housing 10. In the embodiment illustrated here, the housing 10 comprises, below the impeller, substantially horizontally-running wall sections 11, 13, with the wall section 13 in particular defining the upper part of the motor volume 8. In the illustrated embodiment, the underside of the impeller 20 is formed with a closed, continuous base wall 22 which is angled similarly to the wall sections 11, 13. According to the invention, the motor volume 8 is connected to the suction-side volume 2 via an air guiding section 12, such that air which is heated by the motor 30 is not conducted back to the impeller from below, as is conventional in the prior art, but rather is conducted back to the suction-side volume while bypassing the pressure-increasing volume 4, as indicated by the double arrows. In the

embodiment illustrated, the air which is heated by the motor 30 is discharged upstream of the air filter 17, with a filter element 16 additionally being provided, as a result of which it would likewise be possible for the air heated by the motor to be supplied to the suction-side volume downstream of the air filter 17.

[0029] In the illustrated embodiment, a part of the air from the pressure-increasing volume and the pressure-side volume 4, 6 is conducted via an air guiding section 14 to the motor 30, as indicated by a double arrow in the drawing. The overall result is a circulation of air which can cool the motor 30 in a suitable way, wherein as is shown, the air circulation bypasses the volume of the impeller, that is to say in particular the pressure-increasing volume. It is thereby possible to provide a high level of air circulation and therefore effective motor cooling, wherein as a result of the air being conducted through at least one filter element 16 and/or 17, it is simultaneously possible to ensure that no metal particles, such as for example copper elements generated by abrasion in the motor, can leave the fan and pass into the pressure-side volume. As can be clearly seen, the motor 30 is also protected in an effective manner from infiltrating dirt and infiltrating moisture both by the closed impeller base surface 22 and also by the wall sections 11, 13, which provides an additional advantage. In this connection, it should be noted that the impeller 20 should advantageously be of sealed design with respect to an axle 35 which is driven by the motor 30.

[0030] The following Figures 3 to 7 in each case illustrate similar sectional views of different design variants, wherein recurring elements are provided with corresponding reference numerals, and a detailed description of these elements will not be repeated. For clearer illustration, the recurring elements are in part no longer identified, but it should be noted that features which have been described with regard to one embodiment may be applied correspondingly to the other preferred embodiments, wherein any desired combination of features of one embodiment with features of another embodiment should also be regarded as being disclosed.

[0031] In the design variant of Figure 3, the construction is substantially identical to that in Figure 2, wherein however the air guiding section 14 via which pressurized air

is supplied to the electric motor is designed explicitly as a duct formed by wall sections 15 and 17, such that the air supplied to the motor is extracted directly in the transition region between the pressure-increasing volume 4 and the pressure-side volume 6. By means of the configuration illustrated in Figure 3, in particular by means of the spacing of the walls 15, 17, it is possible for the air mass flow to be set in an effective manner, wherein by means of the duct-like design of the air guiding section 14 it is likewise possible in an effective manner to prevent moisture and/or dirt from being able to pass into the motor volume.

[0032] Figure 4 illustrates a further design variant, wherein in particular the partial elements illustrated here and indicated by the reference numerals 24 and 26 may likewise be used, as described below, in all the other embodiments described above and below. As before, the impeller is provided with a closed, continuous wall 22 which, in the embodiment shown, comprises a truncated cone and a peripherally encircling surface, wherein the surface could also be of conical design overall. A double-walled design in the region of the motor volume as in the preceding embodiments by means of the wall sections 11 and the impeller base 22 is not realized here, such that the unit as a whole can be of more lightweight design, and production by injection moulding is also made simpler. In this embodiment, therefore, the motor volume is defined substantially by the housing wall and the base wall 22 of the impeller.

[0033] A special feature of the design variant illustrated here is a sealing device indicated by the reference numeral 24. In the embodiment illustrated, said sealing device is a so-called labyrinth seal which permits a high rotational speed of the impeller and nevertheless prevents air from being able to pass out of the motor volume and back into the pressure-increasing volume, because it is desirable according to the invention for the air heated by the motor to be conducted to the suction-side volume. It is self-evident that use may be made of any desired seals which permit a high rotational speed of the impeller, wherein in practice, however, a labyrinth seal as illustrated here, by means of two projections on the wall section 13 and a projection downward from the base wall of the impeller 22, or vice versa, has proven to be particularly advantageous.

[0034] Furthermore, the design variant illustrated in Figure 4 comprises a drainage device 26. Since the base wall 22 of the impeller is a continuous closed surface, no water can pass to the motor, and instead, as a result of the rotational force and as a result of the conical configuration of the base wall, any water which enters is transported by the impeller base 22 outward, from where the water can be discharged by means of a drainage device to a drainage system which may be provided in the vehicle.

[0035] Figure 5 shows a further preferred embodiment of a fan according to the invention, wherein as in the design variant according to Figure 4, a sealing device 24 is likewise provided, which sealing device is however arranged at the peripheral edge in the design variant illustrated here, wherein it would likewise be possible for the seal to be provided between the impeller and a wall which delimits the pressure-increasing volume in radial extent, in contrast to the axial extent illustrated here, in which the projections which form the labyrinth seal extend parallel to the drive axle of the electric motor. In the variant illustrated here, two projections are provided on the impeller and one projection is provided on the wall.

[0036] Furthermore, the design variant illustrated here comprises a separating device, in particular a metal particle separating device 38. In the embodiment illustrated, this is a baffle in which air, which could for example contain metal particles resulting from abrasion in the electric motor, is conducted in the manner of a cyclotron separator, such that the metal particles can be separated there. Alternatively, it would likewise be possible for a permanent magnet or other suitable metal separating devices to be provided here.

[0037] Finally, Figures 6 and 7 illustrate two further preferred embodiments, in which special refinements have been made in order to be able to further improve the flow around or through the motor, and therefore the cooling performance. In the variant of Figure 6, further aerodynamically acting elements 28 have been formed in particular on the underside of the impeller, such that as the impeller rotates, the existing air

circulation can be assisted, wherein it is also made possible for air to be targetedly directed towards the motor.

[0038] In the variant of Figure 7, a housing wall 19 is formed at one side to set the air circulation from the transition region between pressure-conducting volume and pressure-side volume via the air guiding section 14 to the motor volume 8 and onward via the air guiding section 12 to the suction-side volume 2, by means of which housing wall 19 the desired proportion of pressurized air can be conducted to the motor such that a suitable flow around or through the electric motor can be ensured by means of adjustments of a pressure-side air pressurization in conjunction with the suction-side action which is essential here. As a special feature of the embodiment illustrated in Figure 7, the housing wall 36 is aerodynamically designed so as to deflect the circulating motor cooling air such that the major part of the air flows through the electric motor. It should be noted that a wide variety of means which are familiar to a person skilled in the art may likewise be used, such as the specially shaped wall, in particular an air guiding element, baffle or the like.

[0039] Even though the present invention has been described above entirely with reference to different design variants, a person skilled in the art should recognize that various changes and modifications are possible within the scope of the claims; what is ultimately essential is a circulation of air around the motor, which can provide adequate cooling of said motor, by virtue of heated air being able to be sucked out of the motor volume as a result of the provision of an air guiding section which connects the motor volume to the suction-side volume while bypassing the pressure-increasing volume. This design particularly advantageously also permits improved handling of metal particles which may be released from the electric motor and which can lead to corrosion problems if they reach the evaporator and/or the heat exchanger. The particularly advantageous design of the motor volume which is closed off at the top additionally has an advantageous effect in that the electric motor can be protected in an effective manner from infiltrating dirt or moisture. Finally, the configuration according to the invention is also advantageous in that flow optimization is possible, because less turbulence occurs in the pressure-increasing volume since it is no longer possible, as was the case previously, for the air which is used for cooling the

motor to pass directly into the pressure-increasing volume or the volume of the impeller.

Claims

1. Fan, in particular for a heating, ventilation and/or air-conditioning system of a vehicle, comprising a housing (10), an electric motor (30) which drives an impeller (20) in order to increase the pressure of air from a suction-side volume (2) in a pressure-increasing volume (4) and discharge said air to a pressure-side volume (6), with the electric motor (30) being accommodated in a motor volume (8) of the housing, characterized in that the housing comprises an air guiding section (12) which connects the motor volume (8) to the suction-side volume (2) while bypassing the pressure-increasing volume (4).

2. Fan according to Claim 1, characterized in that the housing comprises a further air guiding section (14) which connects the pressure-side volume (6) to the motor volume (8) while bypassing the pressure-increasing volume (4).

3. Fan according to one of the preceding claims, characterized in that the impeller at least partially defines the motor volume (8).

4. Fan according to Claim 3, characterized in that the impeller forms a continuation, via a sealing device (24), with respect to at least one further wall (13) which at least partially defines the motor volume.

5. Fan according to Claim 3 or 4, characterized in that the impeller comprises aerodynamically acting elements (28) on the side facing toward the motor.

6. Fan according to one of the preceding claims, characterized in that the impeller is provided with a closed surface (22).

7. Fan according to one of the preceding claims, characterized in that at least one air guiding section contains a filter (16, 17).

8. Fan according to one of the preceding claims, characterized in that a drainage device (26) is provided.

9. Fan according to one of the preceding claims, characterized in that the motor volume (8) is designed so as to favour a flow through the motor.

10. Fan according to one of the preceding claims, characterized in that a metal particle separating device (38) is provided.

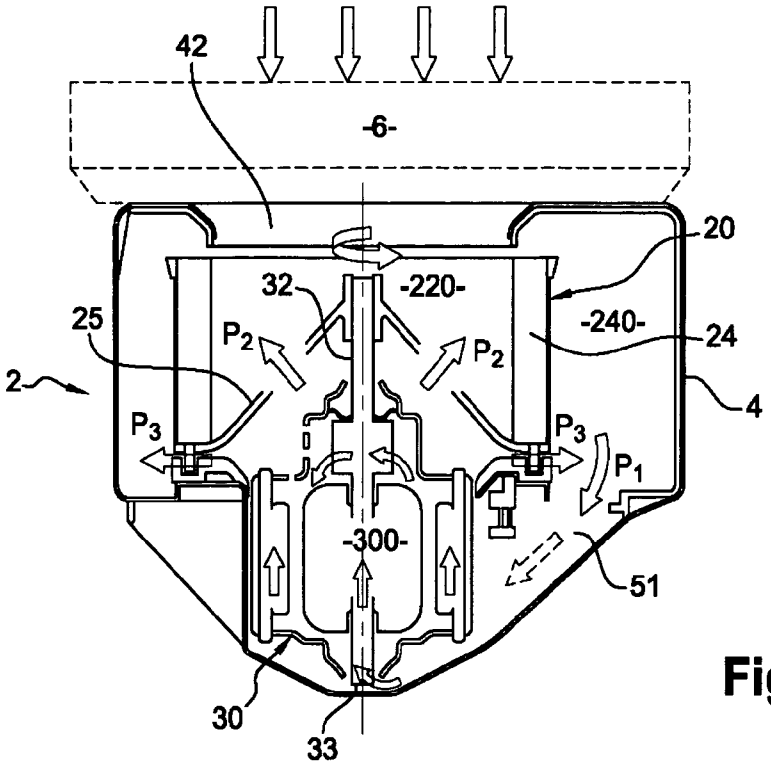
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Fig. 1

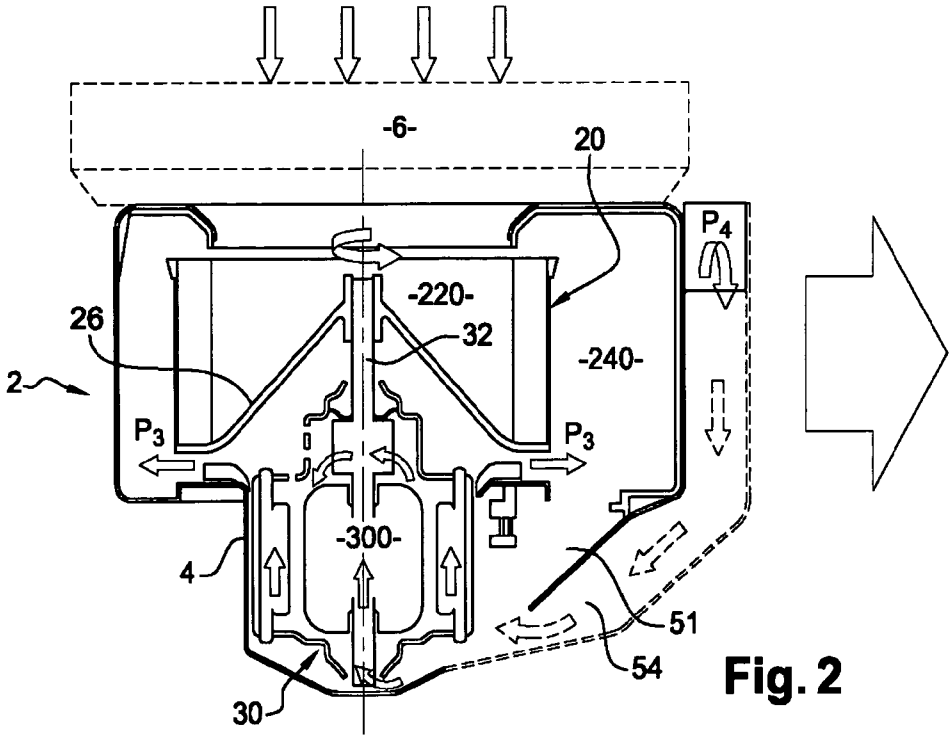
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Fig. 2

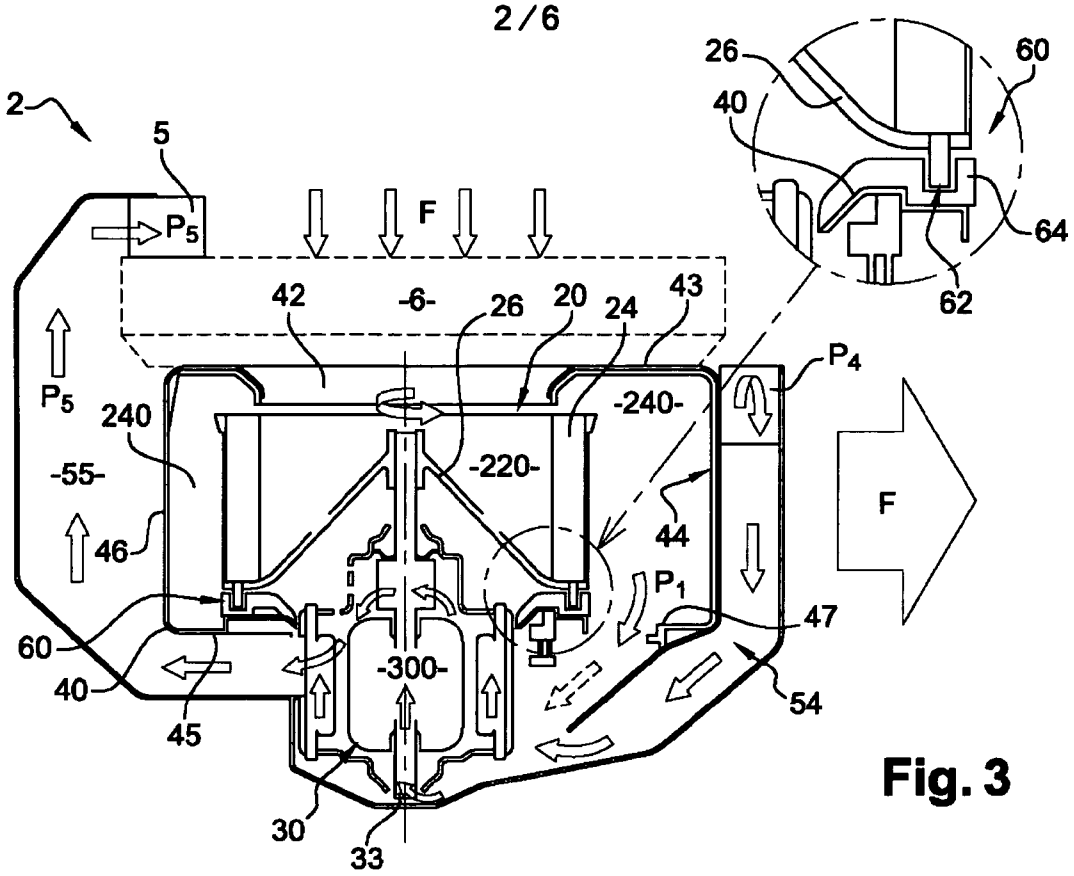
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Fig. 3

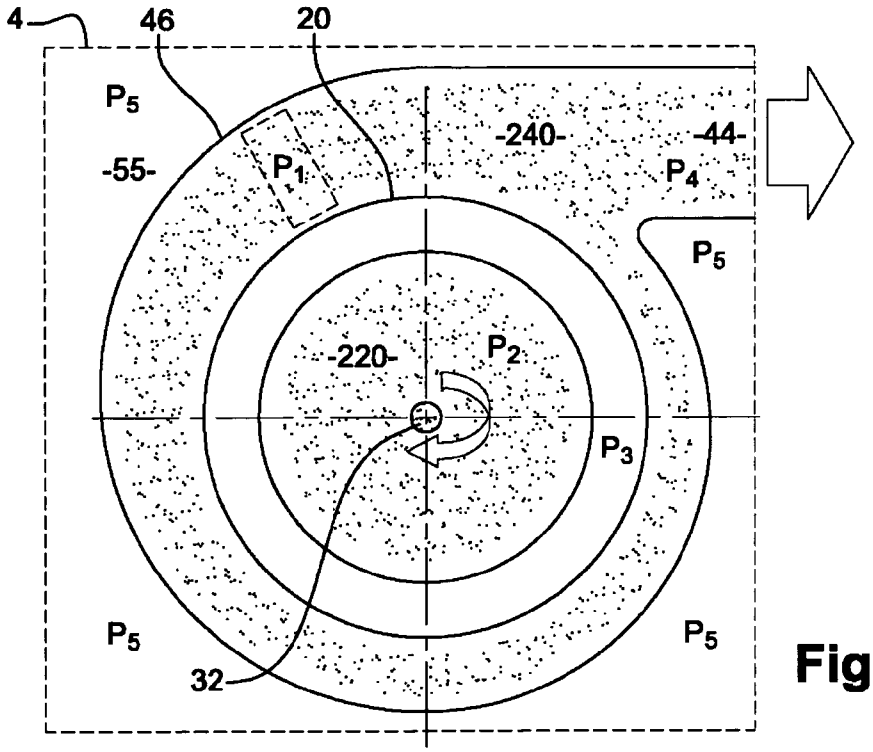
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Fig. 4

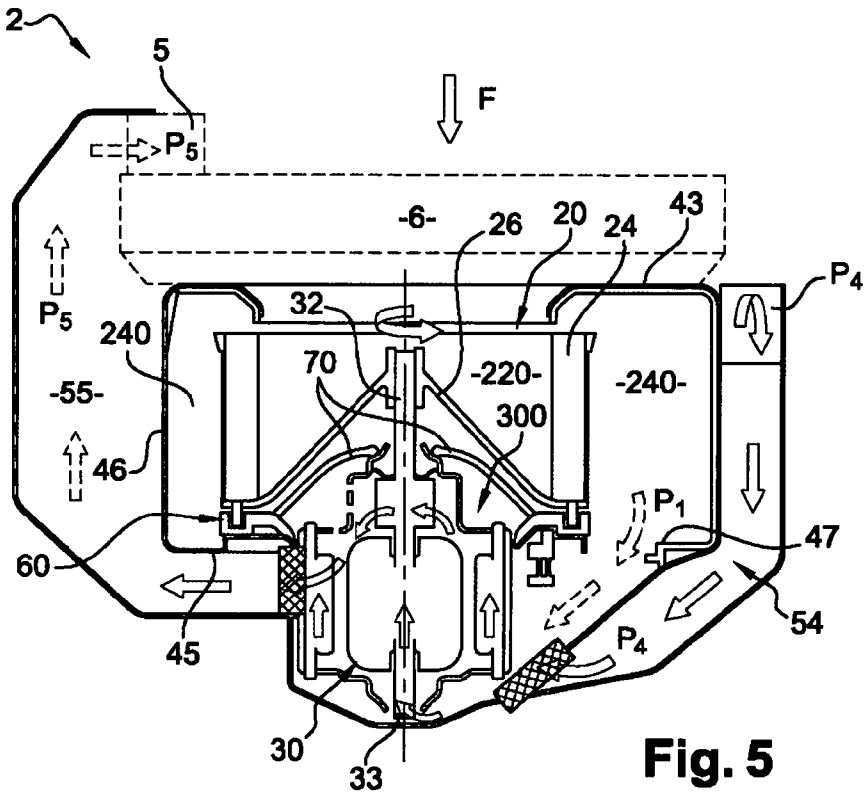
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Fig. 5

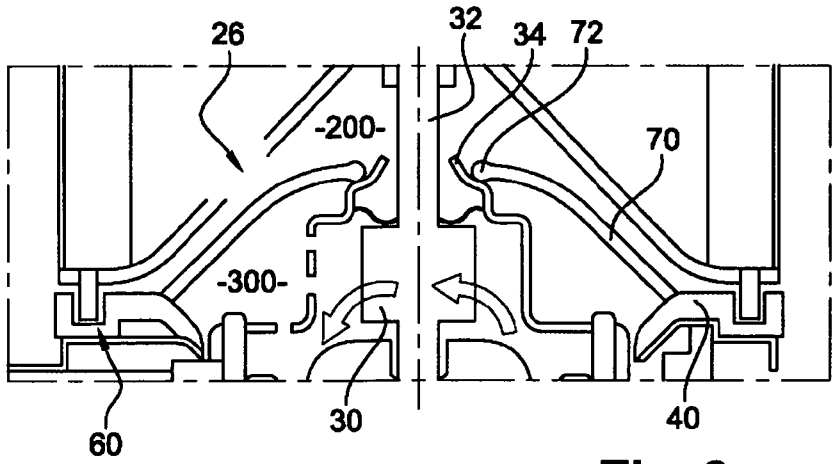
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Fig. 6

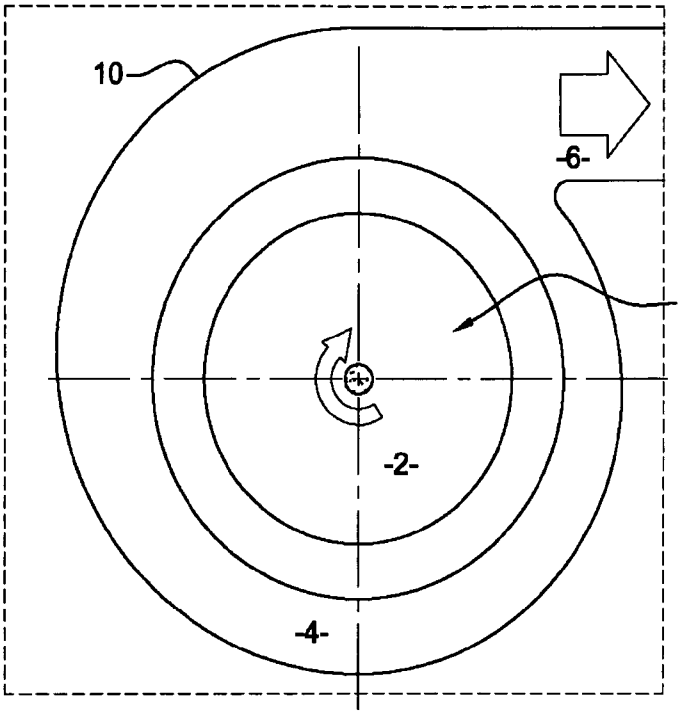

Fig. 7

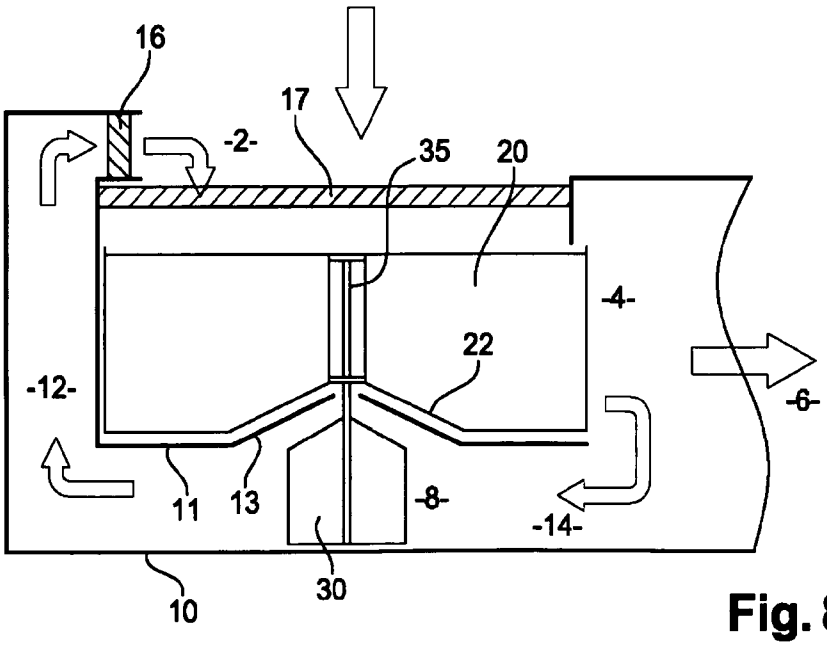

Fig. 8

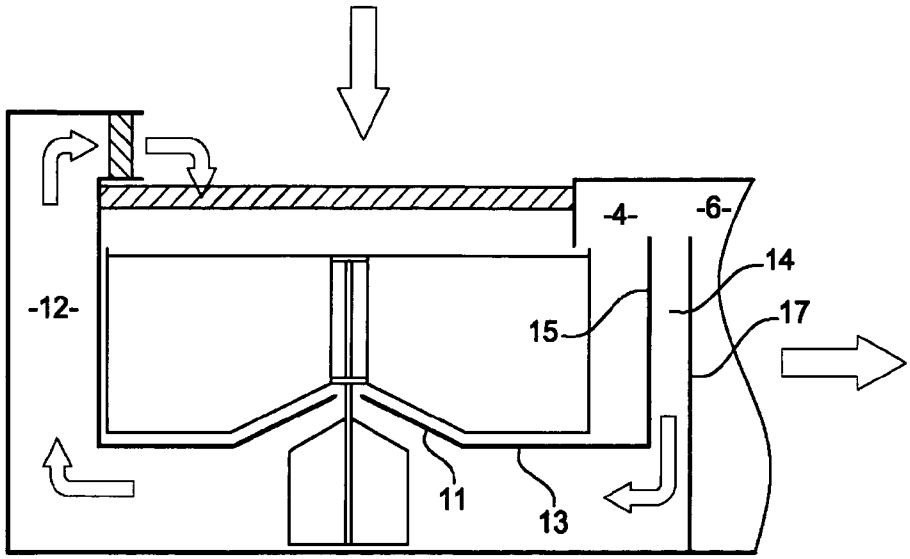

Fig. 9

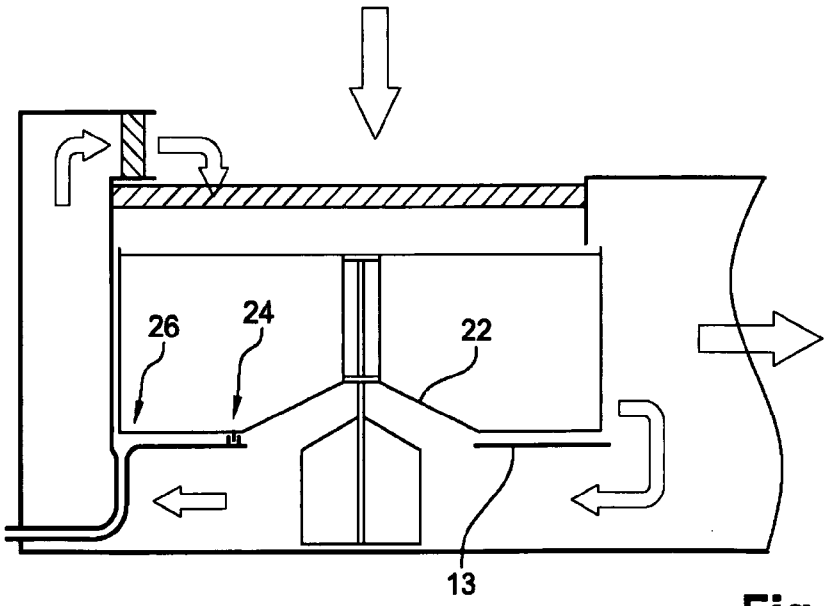

Fig. 10

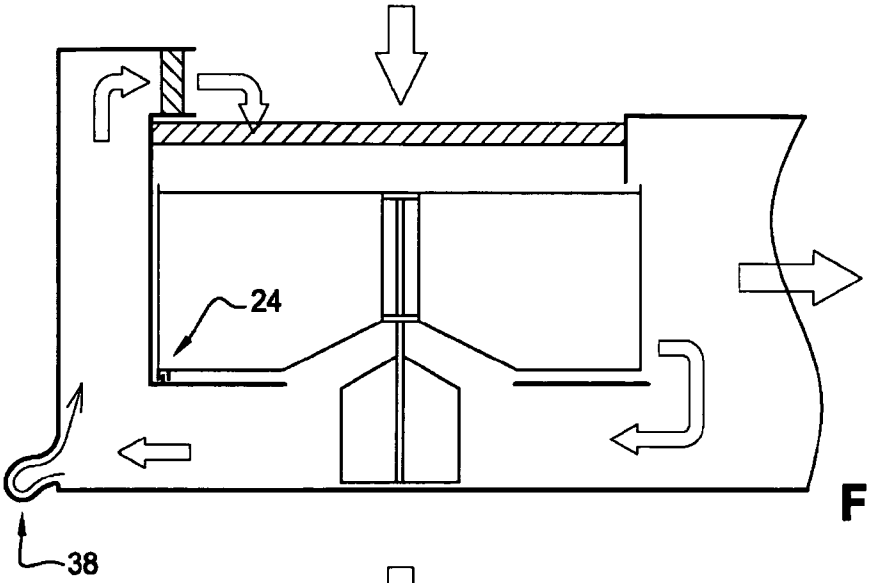

Fig. 11

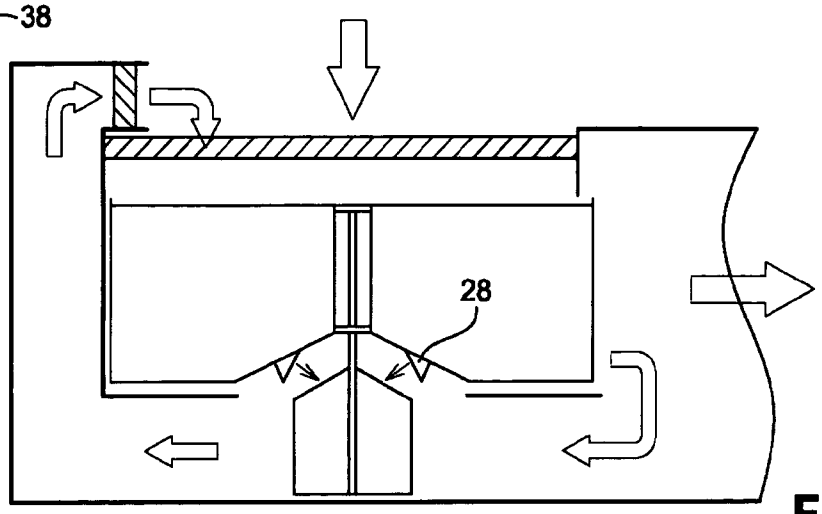

Fig. 12

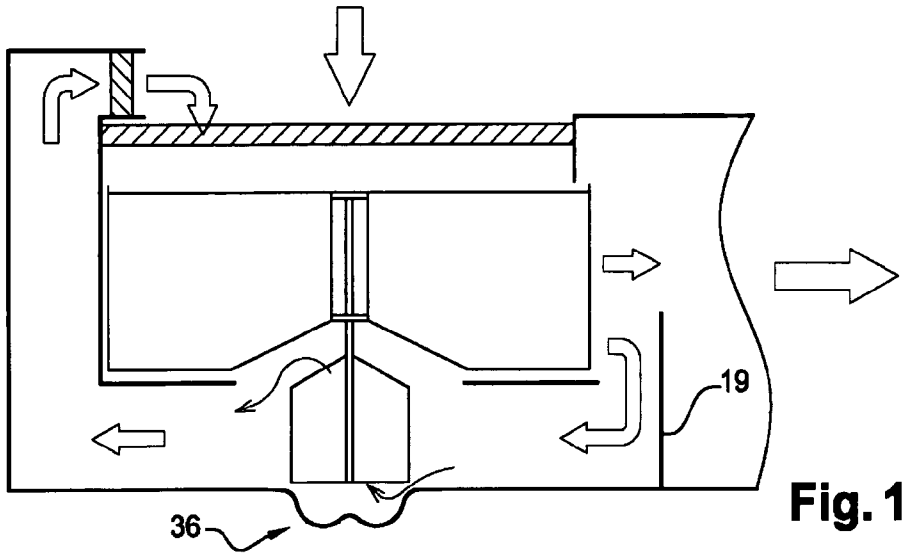

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/054342

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04D25/08 F04D29/58
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

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/152519 A1 (JARRAH YOUSEF [US] ET AL) 5 July 2007 (2007-07-05) paragraph [0017]; figure 4	1-5,7-10
X	US 2007/080590 A1 (VINSON WADE D [US] ET AL) 12 April 2007 (2007-04-12) paragraph [0016]; figure 1	1-5,7-10
X	EP 1 843 449 A1 (GEN ELECTRIC [US]) 10 October 2007 (2007-10-10) column 3, lines 9-11; figure 1 paragraph [0017]	1,7-10
X	FR 2 910 079 A1 (AIRFAN SOC PAR ACTIONS SIMPLIF [FR]) 20 June 2008 (2008-06-20) abstract; figure 3	1,2,7-10

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 May 2011	25/05/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	de Martino, Marcello

1

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/054342

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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