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F04D 29/602; F04D 29/668

(54) **SHROUD AND COOLING FAN ASSEMBLY HAVING THE SAME**

DECKBAND UND KÜHLVENTILATORANORDNUNG DAMIT

DÉFLECTEUR ET ENSEMBLE VENTILATEUR DE REFROIDISSEMENT LE COMPRENANT

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Description

Technical Field

[0001] This disclosure relates to a shroud and a cooling fan assembly including the shroud for cooling a vehicle engine or a battery.

Background Art

[0002] The driving force of a vehicle is generated from its engine or driving motor. An engine or a battery that supplies power to the driving motor generates a lot of heat. Thus, cooling of the engine or battery is one of the important factors to increase output efficiency, which may be implemented by a coolant and a radiator.

[0003] The cooling fan assembly serves to lower the temperature of the coolant by introducing outside air into the radiator for cooling an engine or a battery. The cooling fan assembly includes a cooling motor, a fan and a shroud. The fan is coupled to the cooling motor and rotates to form a cooling airflow. The shroud protects the cooling motor and the fan and serves as a connecting member that allows the cooling motor and fan to be coupled to the vehicle.

[0004] Vibration and noise occurring when the cooling fan assembly is driven are one of the challenges to be solved. The vibration and noise of the cooling fan assembly are mainly caused by the rotations of the fan and the cooling motor. In particular, when resonance occurs in the shroud due to cogging torque generated by the interaction between the rotor and the stator of the cooling motor, vibration and noise peaks increase.

[0005] As one of the approaches for reducing vibration and noise of the cooling fan assembly, a shroud design change may be considered. For this purpose, for example, noise generation has been conventionally suppressed by adding or reinforcing members, for example, by increasing the thickness of the shroud.

[0006] However, this method had the following problems: the weight of products was increased; the manufacturing cost of products was increased; and the stiffness of the cooling fan assembly was also increased through this method more than necessary.

[0007] Furthermore, reference is made to US 2012/321474 A1 which discloses a shroud according to the preamble of appended claim 1.

Disclosure of Invention

Technical Goals

[0008] The object is to reduce vibration and noise of a cooling fan assembly without adding or reinforcing members in the shroud to solve the previous problems as explained above.

Technical solutions

[0009] According to the present invention, there is provided a shroud according to appended claim 1. Further aspects of such a shroud are defined in the appended claims 2-6 and a cooling fan assembly comprising such a shroud is defined in appended claim 7.

Effects

[0010] According to the present invention, it is possible to decrease noise and vibration occurring in the shroud and to maintain the stiffness of the shroud sufficiently despite the slots.

Brief Description of Drawings

[0011]

FIG. 1 illustrates a front perspective view of the cooling fan assembly related to the present invention.

FIG. 2 illustrates a disassembled perspective view of the cooling fan assembly related to the present invention.

FIG. 3 illustrates a front view of the cooling fan assembly related to the present invention.

FIG. 4 illustrates an enlarged view of area A of FIG. 3.

FIG. 5 illustrates a partial view of a shroud according to an embodiment of the slots which is not according to the present invention.

FIG. 6 illustrates an enlarged view of area B of FIG. 3.

FIG. 7 illustrates frequency (Hz) - noise (dB) graphs according to a certain number of revolutions of the cooling fan assembly related to the present disclosure.

FIG. 8 is a duty (%) - noise (dBA) graph of the cooling fan assembly related to the present disclosure.

Best Mode for Carrying Out the Invention

[0012] FIG. 1, FIG. 2 and FIG. 3 are, respectively, a front perspective view, a disassembled perspective view and a front view of a cooling fan assembly 10 related to the present invention.

[0013] Cooling fan assembly 10 comprises a cooling motor 11, a fan 12 and a shroud 13, and shroud 13 comprises a plenum 131, an opening 132, stators 133, a barrel 134 and ribs 14.

[0014] Plenum 131 constitutes a frame of shroud 13 and is configured to be large enough to cover fan 12.

Plenum 131 may be provided in a plate shape, and particularly the front surface may include a flat area.

[0015] Opening 132 is formed in a circular shape.

[0016] A bracket 136 for coupling cooling motor 11 and fan 12 to shroud 13 is provided in the center of shroud 13. Cooling motor 11 and fan 12 may be coupled through screws 16, and the combination of cooling motor 11 and fan 12 may also be fixed to bracket 136 through screws 16. Stators 133 allow bracket 136 to be fixed on shroud 13 while securing the area of opening 132. Barrel 134 forms a wall along circumference 1321 of the opening on shroud 13. Barrel 134 as the wall provides an area in which stators 133 can be coupled, protects the side of fan 12 by wrapping it, and guides the airflow formed by fan 12.

[0017] Shroud 13 has preferably a light weight, but should have sufficient stiffness. The thin plate-shaped plenum 131 contributes to achieving a light weight of shroud 13, but, on the contrary, is disadvantageous in terms of stiffness. Ribs 14 increase the stiffness of this shroud 13. Ribs 14 may be walls protruding on plenum 131 in a vertical direction. In particular, ribs 14 may be configured to connect plenum 131 and barrel 134. One end of rib 14 may be connected to one end of stator 133 or provided on the same line such that rib 14 and stator 133 may serve as one frame.

[0018] As the number of ribs 14 increases, the stiffness of shroud 13 increases. The plurality of ribs 14 has the advantage of reducing vibration and noise occurring on shroud 13. However it is not necessary to increase stiffness beyond a certain range, and further too many ribs 14 increase the weight of shroud 13. Thus, it is preferable to have an appropriate number of ribs.

[0019] A plurality of ribs 14 may meet at one point to provide an area in which a fastening portion 137 is provided. Fastening portion 137 allows shroud 13 to be coupled to the radiator. Fastening portion 137 may be in the form of a hole for screw coupling, or may be in the form of a hook for snap-fit coupling.

[0020] Since the vibration and noise take the form of a wavelength, the vibration and noise generated from cooling motor 11 and fan 12 are transmitted to barrel 134 and plenum 131 through bracket 136 and stators 133. That is, vibration and noise will radiate outwardly from the center of shroud 13. In particular, since plenum 131 is a thin plate-shaped member, it has low stiffness and is more vulnerable to vibration and noise generation.

[0021] The present invention reduces vibration and noise through slots 15 formed in plenum 131. Slots 15 formed in plenum 131 weaken a transmission of the vibration and noise which are caused by fan 12 and cooling motor 11, especially by the cogging torque of cooling motor 11, to the outside through bracket 136 and stators 133. In other words, the vibration of plenum 131 is reduced by dispersing the cogging torque transmitted from cooling motor 11.

[0022] Slots 15 may be provided anywhere in plenum 131. According to the present invention, a slot is provided along an opening's circumference 1321. Slots 15 which

are provided along circumference 1321 of the opening more effectively minimize the transmission of vibration and noise from the center of shroud 13 to plenum 131. That is, plenum 131 is a thin plate-shaped member, and noise and vibration radiate outward from the center of shroud 13, so this may be blocked by slots 15 from the beginning.

[0023] According to the present invention, a slot 15 is formed along a part of opening's circumference 1321, and may be provided in a plurality of segmented shapes at an appropriate position and length.

[0024] FIG. 4 illustrates an enlarged view of area A of FIG. 3.

[0025] In particular, slots 15 may be provided between two adjacent ribs 14 or adjacent to the outside of two adjacent ribs 14. Since the area of shroud 13 in which ribs 14 are provided has relatively high stiffness, even if slots 15 slightly decrease the stiffness, the area of shroud 13 having ribs 14 and slots 15 may maintain appropriate stiffness.

[0026] Plenum 131 may be made of plastic, and in this case, plenum 131 may be injection molded by a mold. When plenum 131 is injection molded by a mold, slots 15 may also be formed together by the mold. Since the protrusions corresponding to slots 15 are included in the mold for forming plenum 131, slots 15 may be formed without a separate slot forming process. It is preferable for slots 15 to have a thinner width, but when slots 15 are molded through a mold process, the width is preferably 1 mm or more in order to secure the shape reliability of slots 15. Preferably, the width of slots 15 may be 1 mm to 3 mm, and in particular 2 mm.

[0027] Slot 15 is formed along opening's circumference 1321 and is defined as an arc slot 151.

[0028] Also according to the present invention, slot 15 is formed along rib 14 and is thus defined as a rib slot 152.

[0029] Slots 15 are preferably formed to be about 5 mm apart from opening 132 (more specifically, from barrel 134 from a design point of view) or ribs 14. That is, since barrel 134 forms the boundary of opening 132, slots 15 formed along opening's circumference 1321 may be treated as being formed along circumference 1341 of the barrel, and it may be understood that keeping a certain distance from circumference 1321 of the opening is to keep a certain distance from circumference 1341 of the barrel.

[0030] One slot 15 may be configured to have arc slot 151 only, or rib slot 152 only. According to the present invention, a slot 15 is configured to have arc slot 151 and rib slot 152 together.

[0031] According to the invention, for a slot 15 including both arc slot 151 and rib slot 152, one end of arc slot 151 and one end of rib slot 152 are connected to each other, and the other end of arc slot 151 is thus not connected to rib slot 152. This is to prevent the stiffness of shroud 13 from being excessively deteriorated by slots 15 being excessively provided in adjacent areas.

[0032] Rib slot 152 provided between adjacent two ribs

14 may be provided on a side having a larger angle among two sides made by intersection of rib 14 and opening's circumference 1321. This is because the effect of reinforcing stiffness by ribs 14 is less in the side having a larger angle than in the other side having a smaller angle, and thus, vibration and noise are more likely to occur in the side of a larger angle. That is, arc slot 151 and rib slot 152 provided between two adjacent ribs 14 may form an obtuse angle. In addition, arc slot 151a and rib slot 152a provided adjacent to the outside of two adjacent ribs 14 may also form an obtuse angle. On the other hand, like rib group 140 located at the lower right of FIG. 3, when the difference between the two angles created by one rib 14 and opening's circumference 1321 is small, arc slot 151 and rib slot 152 may be connected at a right angle or an acute angle close to a right angle.

[0033] FIG. 5 illustrates a partial view of a shroud 13 according to an embodiment of the slots which is not according to the present invention.

[0034] The in FIG.5 illustrated arc slot 151 and rib slot 152 are provided as separate slots 15 rather than in one slot 15 between two adjacent ribs 14 or adjacent to the outside of the two adjacent ribs 14. This means that arc slot 151 and rib slot 152 are provided to be spaced apart. The feature that arc slot 151 and rib slot 152 are spaced apart from each other has advantage for the stiffness of plenum 131.

[0035] Other features and effects regarding arc slot 151 and rib slot 152 provided as separate slots 15 are the same as those of one slot 15 including both arc slot 151 and rib slot 152.

[0036] FIG. 6 illustrates an enlarged view of area B of FIG. 3.

[0037] In one slot 15 provided between two adjacent ribs 14, wherein one end of arc slot 151 and one end of rib slot 152 are connected to each other, a margin area 153 may be formed such that the other end of arc slot 151 does not extend to another adjacent rib 14 and may maintain an appropriate distance with adjacent rib 14 to keep an appropriate stiffness of shroud 13. For example, margin area 153 may be formed in the vicinity of at least some of arc slots 151 of the plurality of slots 15 provided between two adjacent ribs 14, wherein one end of arc slot 151 and one end of rib slot 152 are connected to each other.

[0038] Referring to FIGS. 1 to 3, a plurality of ribs 14 may be gathered to form a rib group 140. Rib group 140 consists of at least two ribs 14 configured to be adjacent to each other, and in particular, may consist of three ribs 14. In one rib group 140, ribs 14 may be gathered at one point where fastening portion 137 may be positioned.

[0039] For example, rib group 140 may be located in four areas of upper left, lower left, upper right, and lower right of shroud 13 as shown in FIG. 3.

[0040] The total length of the plurality of slots 15 corresponding to each rib group 140 may be longer as the size of rib group 140 is larger. The size means the area on plenum 131 occupied by rib group 140. That is, between

two rib groups 140, if a size of a first rib group 140 is bigger than a size of a second rib group 140, a total length of slots 15 formed corresponding to first rib group 140 is longer than a total length of slots 15 formed corresponding to second rib group 140. The larger rib group 140 may mean that the area of plenum 131 corresponding to rib group 140 is larger. The larger area of plenum 131 has a greater need to reduce vibration and noise through more or longer slots 15.

[0041] Motor electrical connector 135 may be attached to or around at least one of the plurality of rib groups 140. In this case, the stiffness of the relevant area may be reinforced by the attachment of motor connector 135, and therefore, vibration and noise reducing effects may be achieved without slots 15. Accordingly, slots 15 corresponding to rib group 140 on the side where motor connector 135 is provided may be omitted.

[0042] Such omission of slots 15 may be equally applied even when any structure, other than motor connector 135, is attached to increase the stiffness according to embodiments.

[0043] Rib group 140 of the area where the structure such as motor connector 135 is attached but slots 15 are not provided may be partly supplemented by slots 15 of another adjacent rib group 140. For example, as shown in FIG. 3, motor connector 135 is provided on the upper right, and thus four slots 15 may be provided to rib group 140 on the lower right while three slots 15 may be provided to each rib group 140 on the upper left and lower left.

[0044] FIG. 7 illustrates frequency (Hz) - noise (dB) graphs according to a certain number of revolutions of the cooling fan assembly related to the present invention.

[0045] The left graph is a test result of the cooling fan assembly without slots, and the right graph is a test result of the cooling fan assembly with the slots. Duty corresponds to the speed of rotation of the fan. For example, Duty 25% may correspond to about 875 rpm, and Duty 90% to about 2500 rpm. The graphs of FIG. 7 show the results of the case where the mean Duty is 45% corresponding to approximately 1325 rpm.

[0046] Referring to the graphs, there is at least one point where the noise level is relatively high compared to surrounding noise levels. The frequency corresponding to the at least one point is defined as the resonance frequency band of the cooling fan assembly. With respect to a plurality of resonance frequency bands in graphs of FIG. 7, the noise of the right graph for the case where slots are provided is reduced compared to that of the left graph for the case where slots are not provided. In particular, referring to Point A and Point B where the noise level is much higher than the surroundings, it can be found that the noise is significantly reduced.

[0047] FIG. 7 has graphs showing the results of the case where the mean Duty is 45%. It was confirmed that the technical effect of a similar trend was obtained in the cases of having different Duty values, which can be also found in FIG. 8.

[0048] FIG. 8 is a duty (%) - noise (dBA) graph of the cooling fan assembly related to the present invention.

[0049] FIG. 8 is a test result of measuring noise while maintaining the number of revolutions of the cooling fan assembly for a predetermined time, for example, 10 seconds. '600W Base' indicates a case where there is no slot, and '600W Slot' indicates a case where there is a slot.

[0050] The noise is reduced when the slot is provided, and in particular, the noise is reduced by 5dBA or more at 35% Duty.

[0051] Accordingly, it has been found that the slot brings about a noise reducing effect as shown in FIGS. 7 and 8.

Claims

1. A shroud (13) comprising a plenum (131) and an opening (132) to secure an area for airflow by rotation of an axial fan (12), wherein the plenum (131) constitutes a frame of the shroud (13) and is configured to be large enough to cover the fan (12), wherein that said shroud (13) further comprises a slot (15) formed on said plenum (131) and wherein said opening (132) is provided in a circular shape and said slot (15) comprises an arc slot (151) formed along a part of a circumference (1321) of said opening (132) and wherein said shroud (13) further comprises a rib (14) formed on said plenum (131), and said slot (15) further comprises a rib slot (152) formed along said rib (14), **characterized in that** said slot (15) comprises said arc slot (151) and said rib slot (152) such that one end of said arc slot (151) is connected to one end of said rib slot (152).
2. The shroud (13) of claim 1, wherein said slot (15) is provided between adjacent two ribs (14), or adjacent to an outside of said two adjacent ribs (14).
3. The shroud (13) of claim 1, wherein said arc slot (151) and said rib slot (152) are connected to each other at an acute angle close to a right angle, at a right angle, or at an obtuse angle.
4. The shroud (13) of claim 1, wherein a plurality of said ribs (14) forms a rib group (140) in which said plurality of ribs (14) meet at one point;

a plurality of said rib groups (140) is provided in said shroud (13); and
if a size of a first rib group (140) is bigger than a size of a second rib group (140), a total length of said slots (15) formed corresponding to said first rib group (140) is longer than a total length of said slots (15) formed corresponding to said second rib group (140), wherein the size means the area on the plenum (131) occupied by the rib

group (140).

5. The shroud (13) of claim 1, wherein a plurality of said ribs (14) forms a rib group (140) in which said ribs (14) meet at one point;

a plurality of said rib groups (140) is provided in said shroud (13), and a motor electrical connector (135) is attached to or around one of said rib groups (140); and
said slot 15 is not provided to said one of said rib groups (140).

6. The shroud (13) of claim 1, wherein said arc slot (151) and said rib slot (152) are located between a first rib (14) and a second rib (14), and said slots (151, 152) are connected to each other near said first rib (14); and said shroud (13) further includes a margin area (153) such that said arc slot (151) does not extend to said second rib (14) and maintain a predetermined distance from said second rib (14).
7. A cooling fan assembly (10) comprising said shroud (13) according to any one of claims 1 to 6, a cooling motor (11), and a fan (12) coupled to said shroud (13).

Patentansprüche

1. Abdeckung (13), die ein Plenum (131) und eine Öffnung (132) zum Sichern eines Bereichs für eine Luftströmung durch Drehung eines Axialgebläses (12) umfasst, wobei das Plenum (131) einen Rahmen der Abdeckung (13) bildet und ausreichend groß ausgelegt ist, um das Gebläse (12) abzudecken, wobei die Abdeckung (13) ferner einen Schlitz (15) umfasst, der auf dem Plenum (131) gebildet ist, und wobei die Öffnung (132) in einer Kreisform bereitgestellt ist und der Schlitz (15) einen Bogenschlitz (151) umfasst, der entlang eines Teils eines Umfangs (1321) der Öffnung (132) gebildet ist, und wobei die Abdeckung (13) ferner eine Rippe (14) umfasst, die auf dem Plenum (131) gebildet ist, und der Schlitz (15) ferner einen Rippenschlitz (152) umfasst, der entlang der Rippe (14) gebildet ist, **dadurch gekennzeichnet, dass** der Schlitz (15) den Bogenschlitz (151) und den Rippenschlitz (152) umfasst, so dass ein Ende des Bogenschlitzes (151) mit einem Ende des Rippenschlitzes (152) verbunden ist.
2. Abdeckung (13) nach Anspruch 1, wobei der Schlitz (15) zwischen zwei benachbarten Rippen (14) oder benachbart zu einer Außenseite der zwei benachbarten Rippen (14) bereitgestellt ist.
3. Abdeckung (13) nach Anspruch 1, wobei der Bogen-

schlitz (151) und der Rippenschlitz (152) in einem spitzen Winkel, der beinahe einem rechten Winkel entspricht, in einem rechten Winkel oder in einem stumpfen Winkel miteinander verbunden sind.

4. Abdeckung (13) nach Anspruch 1, wobei eine Mehrzahl von Rippen (14) eine Rippengruppe (140) bildet, wobei sich die Mehrzahl von Rippen (14) an einem Punkt trifft;

wobei eine Mehrzahl der Rippengruppen (140) in der Abdeckung (13) bereitgestellt ist; und wobei, wenn eine Größe einer ersten Rippengruppe (140) größer als eine Größe einer zweiten Rippengruppe (140) ist, eine Gesamtlänge der Schlitze (15), die entsprechend der ersten Rippengruppe (140) gebildet sind, länger ist als eine Gesamtlänge der Schlitze (15), die entsprechend der zweiten Rippengruppe (140) gebildet sind, wobei die Größe den Bereich auf dem Plenum (131) bezeichnet, der von der Rippengruppe (140) eingenommen wird.

5. Abdeckung (13) nach Anspruch 1, wobei eine Mehrzahl der Rippen (14) eine Rippengruppe (140) bildet, wobei sich die Rippen (14) an einem Punkt treffen;

wobei eine Mehrzahl der Rippengruppen (140) in der Abdeckung (13) bereitgestellt ist, und ein elektrischer Motorverbinder (135) an oder um eine der Rippengruppen (140) herum angebracht ist; und wobei der Schlitz 15 nicht an der einen der Rippengruppen (140) bereitgestellt ist.

6. Abdeckung (13) nach Anspruch 1, wobei der Bogenschlitz (151) und der Rippenschlitz (152) zwischen einer ersten Rippe (14) und einer zweiten Rippe (14) angeordnet sind, und die Schlitze (151, 152) nahe der ersten Rippe (14) miteinander verbunden sind; und wobei die Abdeckung (13) ferner einen Randbereich (153) umfasst, so dass sich der Bogenschlitz (151) nicht zu der zweiten Rippe (14) erstreckt und einen vorbestimmten Abstand von der zweiten Rippe (14) beibehält.

7. Kühlgebläseanordnung (10), die die Abdeckung (13) nach einem der Ansprüche 1 bis 6, einen Kühlmotor (11) und ein Gebläse (12) umfasst, das mit der Abdeckung (13) gekoppelt ist.

Revendications

1. Déflecteur (13) comprenant un plénum (131) et une ouverture (132) pour assujettir une zone d'écoulement d'air par rotation d'un ventilateur axial (12),

dans lequel le plénum (131) constitue un cadre du déflecteur (13) et est configuré pour être suffisamment grand pour recouvrir le ventilateur (12), dans lequel ledit déflecteur (13) comprend en outre une fente (15) formée sur ledit plénum (131) et dans lequel ladite ouverture (132) est fournie sous une forme circulaire et ladite fente (15) comprend une fente en arc (151) formée le long d'une partie d'une circonférence (1321) de ladite ouverture (132) et dans lequel ledit déflecteur (13) comprend en outre une nervure (14) formée sur ledit plénum (131), et ladite fente (15) comprend en outre une fente de nervure (152) formée le long de ladite nervure (14), **caractérisé en ce que** ladite fente (15) comprend ladite fente en arc (151) et ladite fente de nervure (152) de telle sorte qu'une extrémité de ladite fente en arc (151) soit connectée à une extrémité de ladite fente de nervure (152).

2. Déflecteur (13) selon la revendication 1, dans lequel ladite fente (15) est fournie entre deux nervures (14) adjacentes, ou adjacente à l'extérieur desdites deux nervures (14) adjacentes.

3. Déflecteur (13) selon la revendication 1, dans lequel ladite fente en arc (151) et ladite fente de nervure (152) sont connectées l'une à l'autre à angle aigu proche d'un angle droit, à angle droit, ou à angle obtus.

4. Déflecteur (13) selon la revendication 1, dans lequel une pluralité desdites nervures (14) forme un groupe de nervures (140) dans lequel ladite pluralité de nervures (14) se rencontrent au niveau d'un point ;

une pluralité desdits groupes de nervures (140) est fournie dans ledit déflecteur (13) ; et si une taille d'un premier groupe de nervures (140) est supérieure à une taille d'un deuxième groupe de nervures (140), une longueur totale desdites fentes (15) formées correspondant audit premier groupe de nervures (140) est plus longue qu'une longueur totale desdites fentes (15) formées correspondant audit deuxième groupe de nervures (140), dans lequel la taille signifie la zone sur le plénum (131) occupée par le groupe de nervures (140).

5. Déflecteur (13) selon la revendication 1, dans lequel une pluralité desdites nervures (14) forme un groupe de nervures (140) dans lequel lesdites nervures (14) se rencontrent au niveau d'un point ;

une pluralité desdits groupes de nervures (140) est fournie dans ledit déflecteur (13), et un connecteur électrique de moteur (135) est attaché à ou autour de l'un desdits groupes de nervures (140) ; et

ladite fente 15 n'est pas fournie sur ledit un desdits groupes de nervures (140).

6. Déflecteur (13) selon la revendication 1, dans lequel ladite fente en arc (151) et ladite fente de nervure (152) sont situées entre une première nervure (14) et une deuxième nervure (14), et lesdites fentes (151, 152) sont connectées l'une à l'autre à proximité de ladite première nervure (14) ; et ledit déflecteur (13) inclut en outre une zone de marge (153) de telle sorte que ladite fente en arc (151) ne s'étende pas jusqu'à ladite deuxième nervure (14) et maintienne une distance prédéterminée avec ladite deuxième nervure (14).
7. Ensemble ventilateur de refroidissement (10) comprenant ledit déflecteur (13) selon l'une quelconque des revendications 1 à 6, un moteur de refroidissement (11), et un ventilateur (12) couplé audit déflecteur (13).

FIG. 1

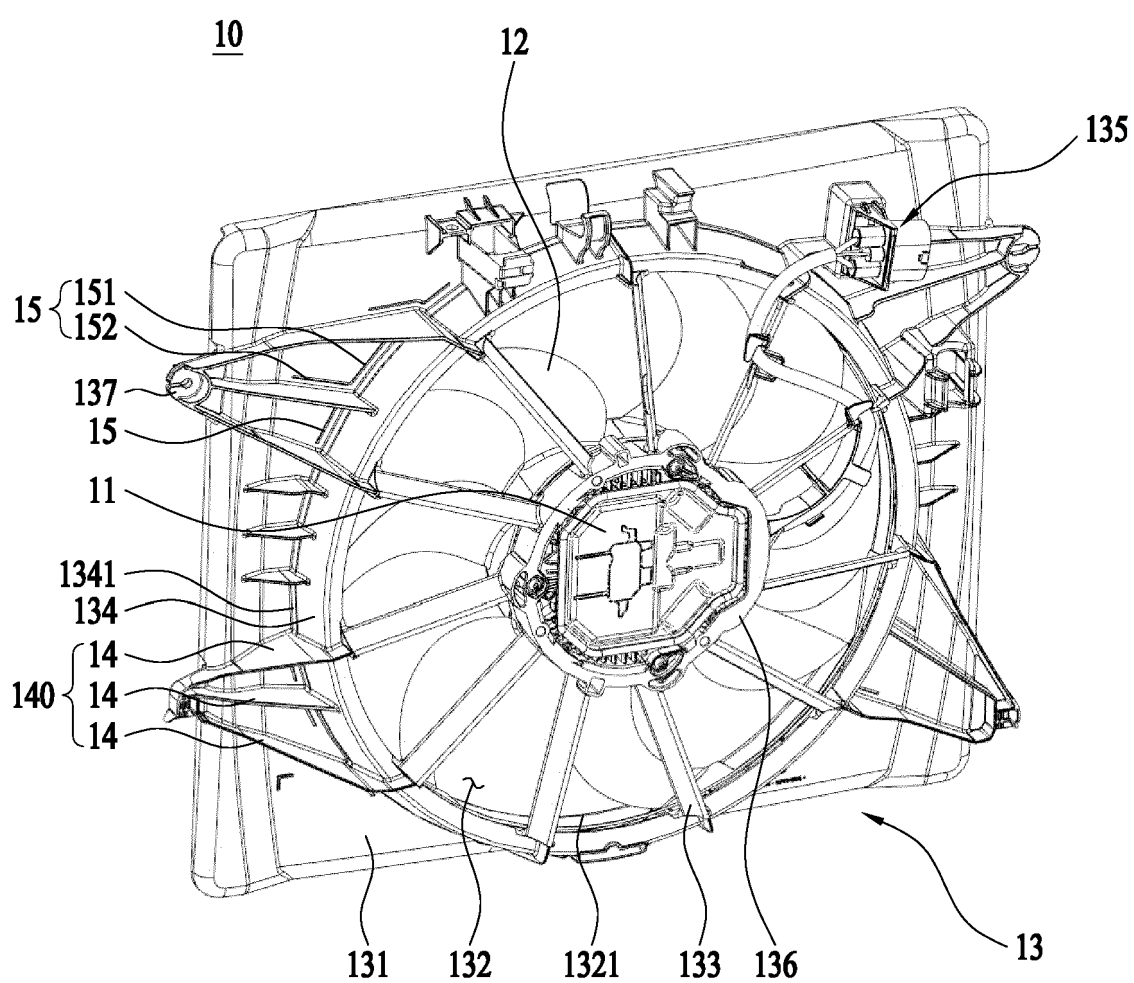


FIG. 2

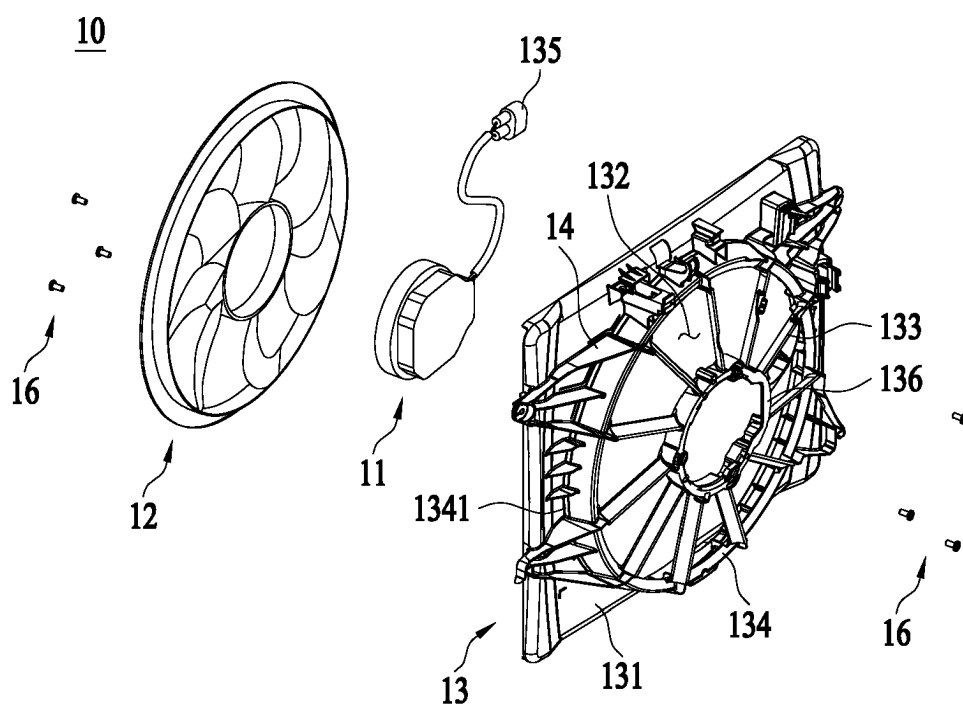


FIG. 3

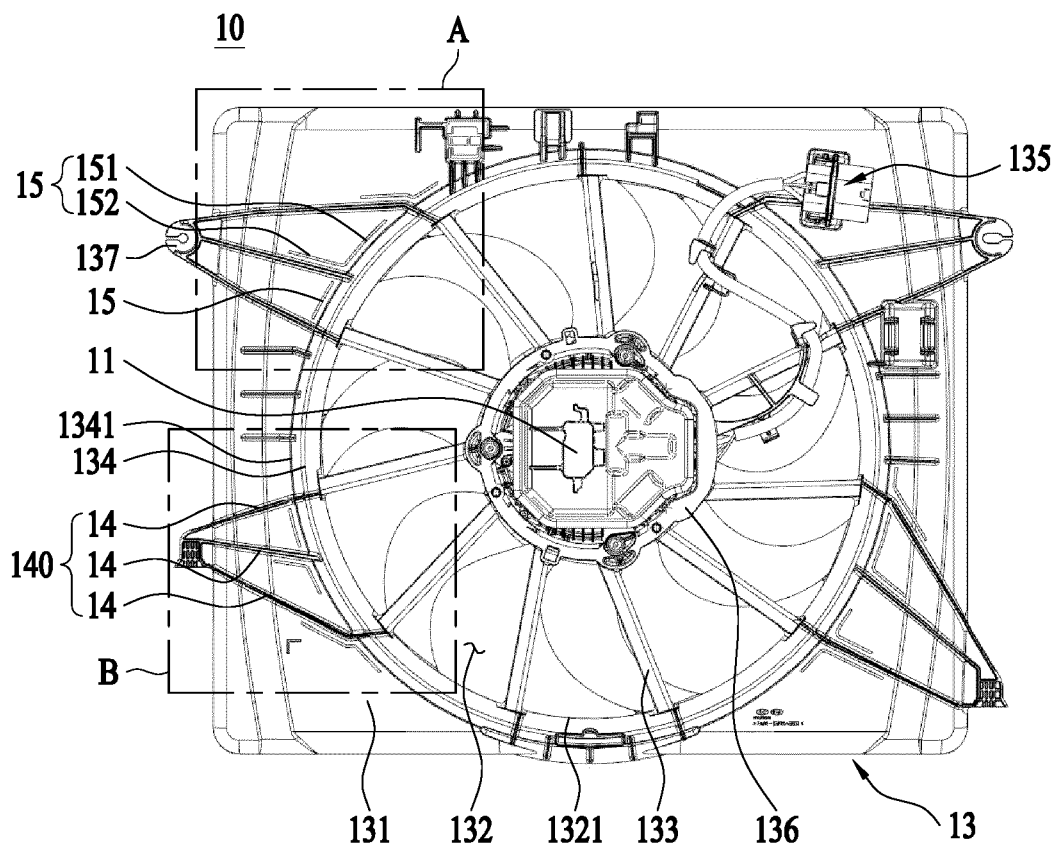


FIG. 4

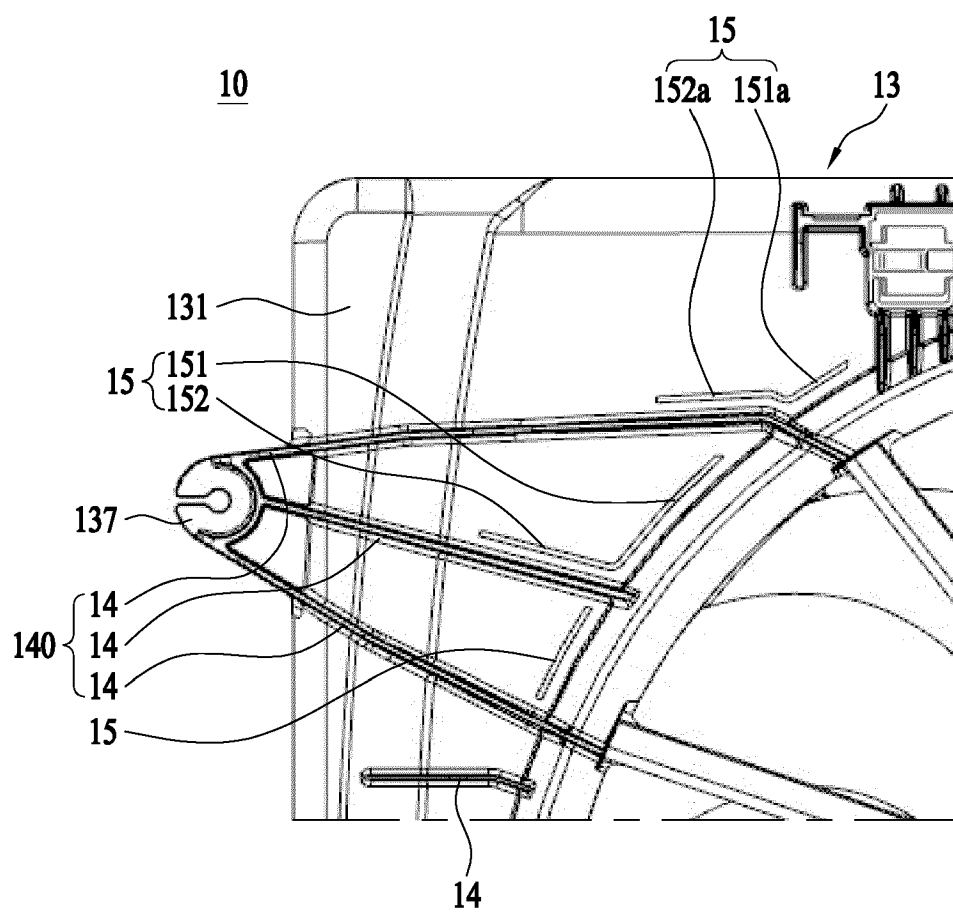


FIG. 5

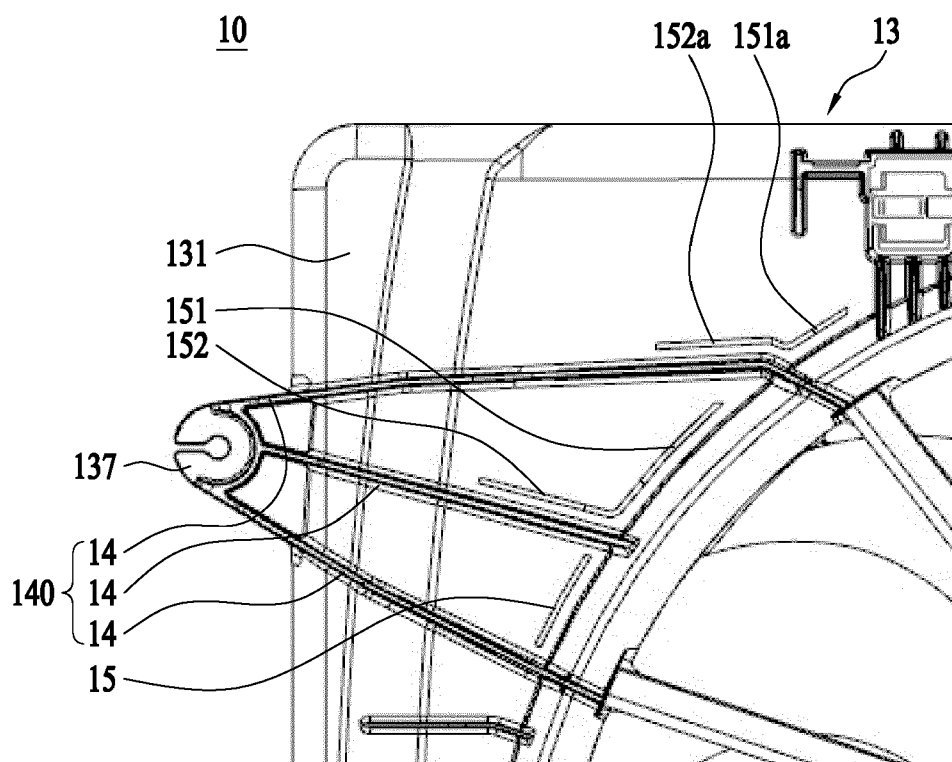


FIG. 6

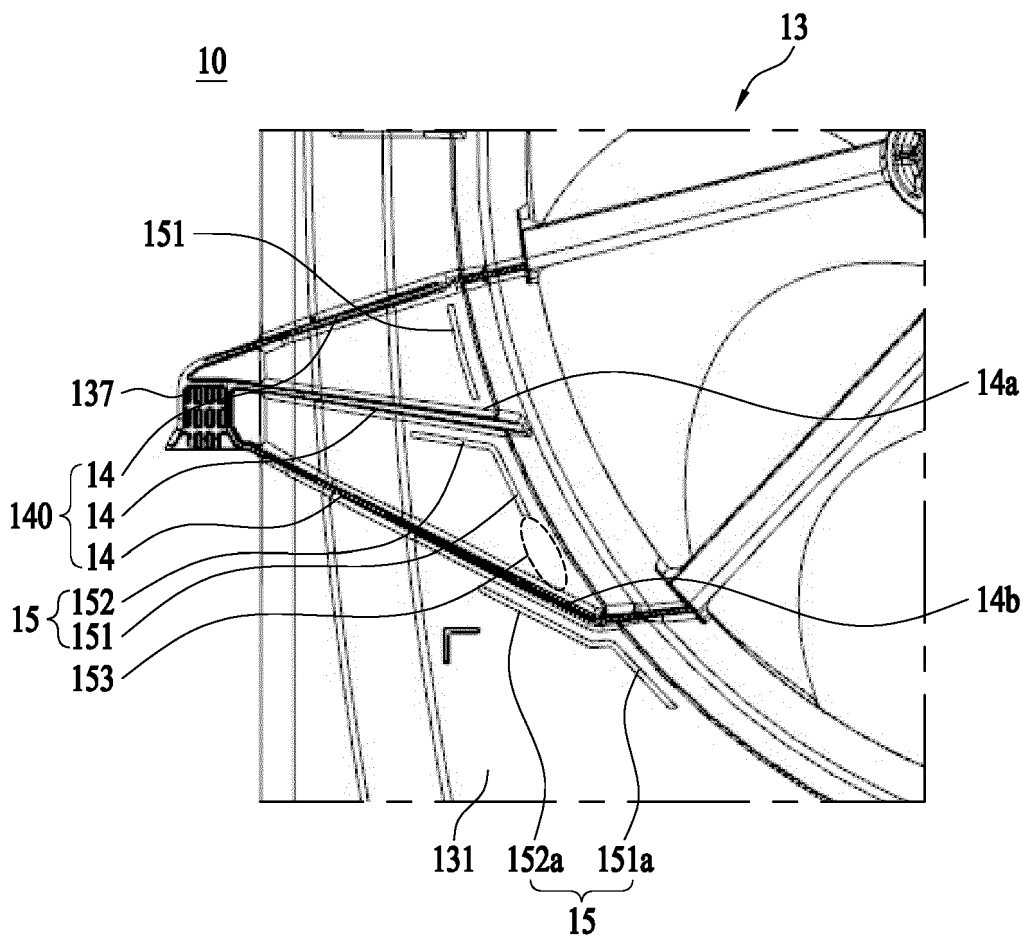


FIG. 7

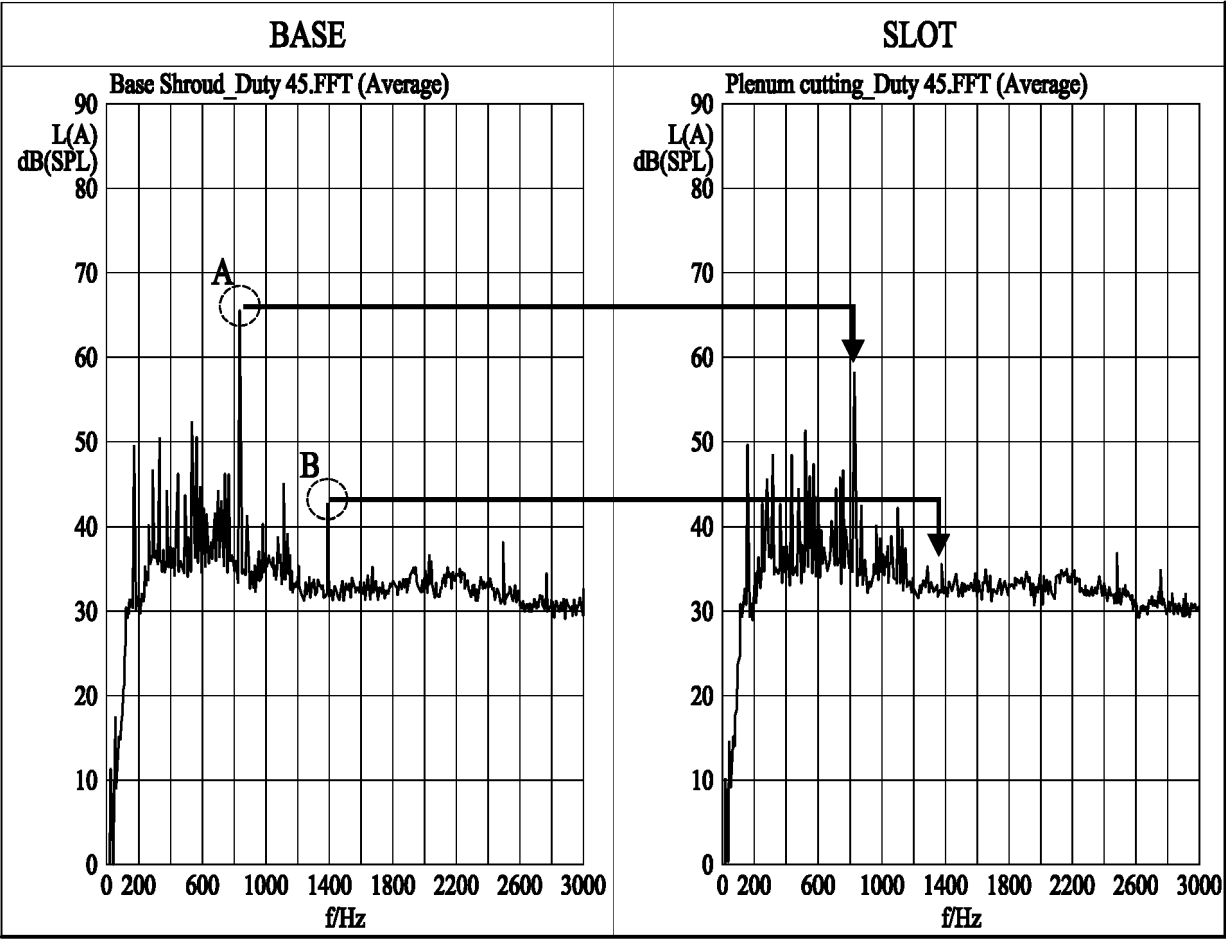
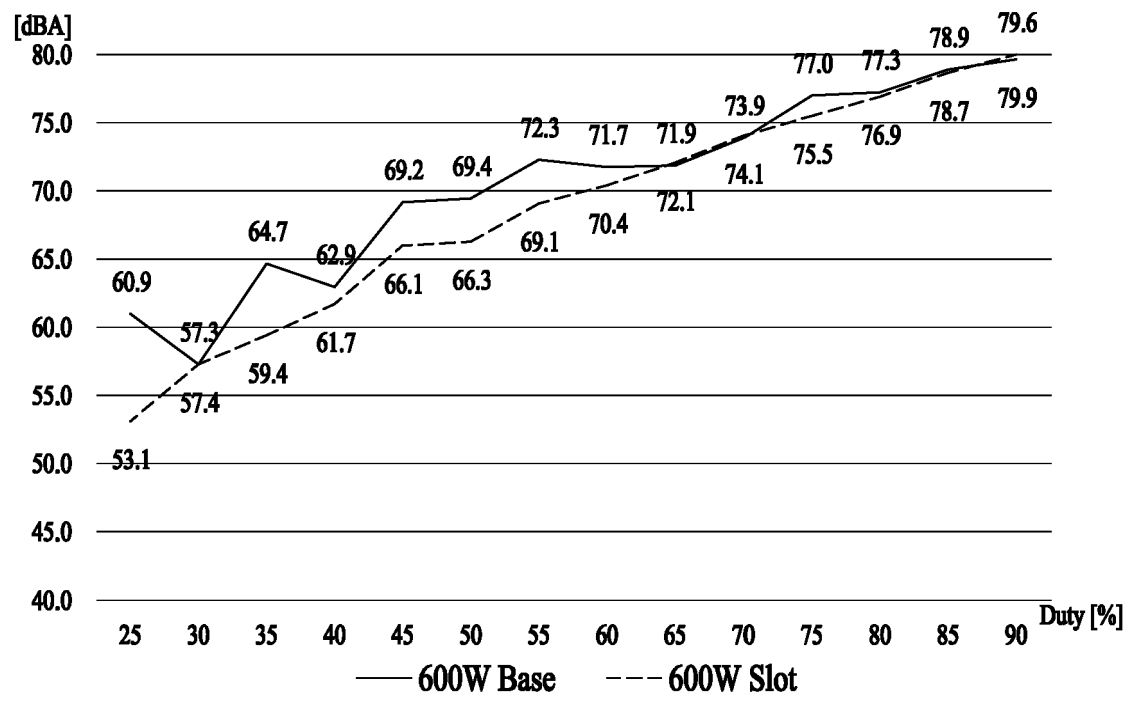


FIG. 8



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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