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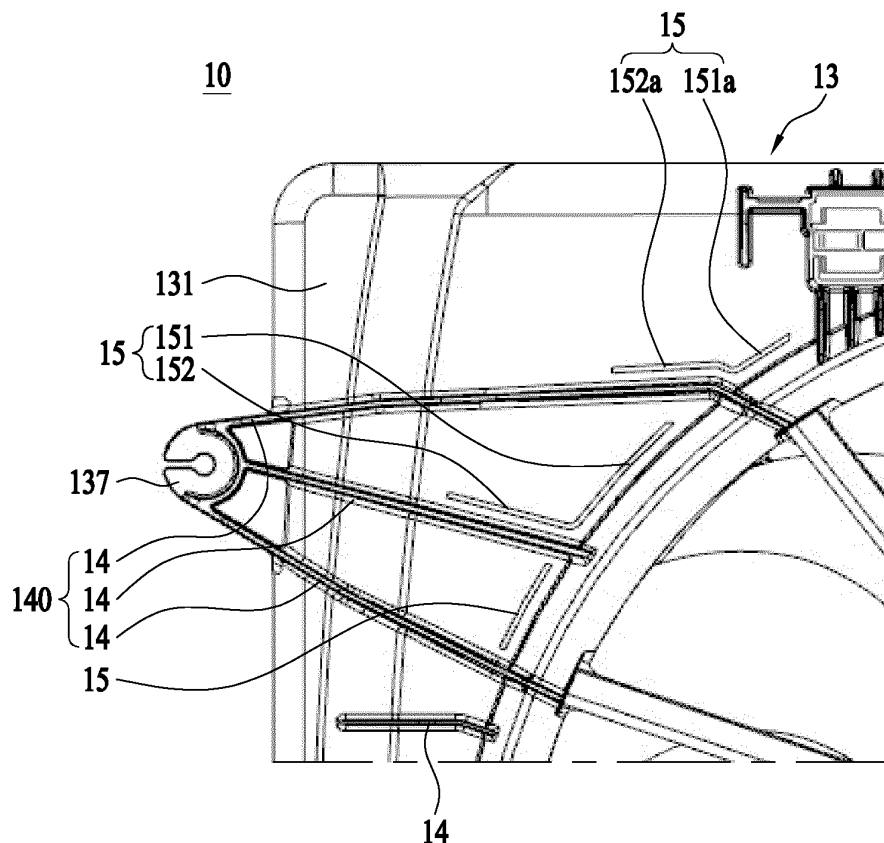
(71) Applicant: **Robert Bosch GmbH**
70442 Stuttgart (DE)

(72) Inventors:
• **Lee, Sangyeon**
30077 Bugang-myon Sejong City (KR)
• **Lee, Sunghwa**
30077 Bugang-myon Sejong City (KR)
• **Kim, Sihun**
30077 Bugang-myon Sejong City (KR)

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

(57) The present disclosure provides a shroud comprising slots formed on a plenum in order to decrease noise and vibration occurring on the shroud of a cooling fan assembly which is used for cooling a vehicle engine or a battery.

FIG. 4



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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.

Disclosure of Invention

Technical Goals

[0007] The present disclosure 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

[0008] According to an aspect of the present disclosure, there is provided a shroud including a plenum and

an opening to secure an area for airflow by rotation of a fan, characterized in that the shroud further includes slots formed on plenum.

[0009] According to another aspect, there is provided the shroud, wherein opening is provided in a circular shape, and slots include an arc slot formed along a part of the opening's circumference.

[0010] According to another aspect, there is provided the shroud, wherein the shroud further includes a rib formed on plenum, and the slot further includes a rib slot formed along a rib.

[0011] According to another aspect, there is provided the shroud, wherein slots provided between adjacent two ribs, or adjacent to the outside of the two adjacent ribs.

[0012] According to another aspect, there is provided the shroud, wherein slot includes an arc slot and a rib slot such that one end of arc slot is connected to one end of rib slot.

[0013] According to another aspect, there is provided the shroud, wherein an arc slot and a rib slot are connected to each other at an acute angle close to a right angle, at a right angle, or at an obtuse angle.

[0014] According to another aspect, there is provided the shroud, wherein a plurality of ribs form a rib group in which the ribs meet at one point; and a plurality of the rib groups are provided in the shroud, and if a size of a first rib group is bigger than a size of a second rib group, a total length of the slots formed corresponding to the first rib group is longer than a total length of the slots formed corresponding to the second rib group.

[0015] According to another aspect, there is provided the shroud, wherein a plurality of ribs form a rib group in which ribs meet at one point; a plurality of rib groups are provided in the shroud, and a motor connector is attached to or around one of rib groups; and a slot is not provided to one of rib groups with the motor connector attached.

[0016] According to another aspect, there is provided the shroud, wherein the arc slot and the rib slot are located between a first rib and a second rib; slots are connected to each other near the first rib; and the shroud further includes a margin area such that the arc slot does not extend to the second rib and may maintain a predetermined distance from the second rib.

[0017] According to another aspect, there is provided a cooling fan assembly including the shroud provided as above, a cooling motor and a fan coupled to shroud.

Effects

[0018] According to example embodiments, it is possible to decrease noise and vibration occurring in the shroud.

[0019] According to example embodiments, it is possible to maintain the stiffness of the shroud sufficiently despite the slots.

Brief Description of Drawings

[0020]

FIG. 1 illustrates a front perspective view of the cooling fan assembly related to the present disclosure. FIG. 2 illustrates a disassembled perspective view of the cooling fan assembly related to the present disclosure.

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

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

FIG. 5 illustrates a partial view of a shroud according to another embodiment related to the present disclosure.

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

[0021] 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 disclosure.

[0022] 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.

[0023] 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.

[0024] Opening 132 is generally formed in a circular shape, but may take various shapes such as a rectangle.

[0025] 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.

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] The present disclosure 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.

[0031] Slots 15 may be provided anywhere in plenum 131. Preferably, they are provided along an opening's circumference 1321. If slots 15 are provided along circumference 1321 of the opening, it is possible to 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.

[0032] Preferably, Slots 15 may be 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.

[0033] FIG. 4 illustrates an enlarged view of area A of FIG. 3.

[0034] 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.

[0035] 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 1mm to 3mm, and in particular 2mm.

[0036] Slots 15 may be formed along opening's circumference 1321, but may have a predetermined distance from opening's circumference 1321. In particular, when opening 132 is circular, slot 15 thus formed along circumference 1321 of the opening is defined as an arc slot 151.

[0037] Also, slots 15 may be formed along rib 14, but may have a predetermined distance from rib 14. Slot 15 formed along rib 14 is defined as a rib slot 152.

[0038] Slots 15 are preferably formed to be about 5mm 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.

[0039] One slot 15 may be configured to have arc slot 151 only, or rib slot 152 only. In addition, one slot 15 may be configured to have arc slot 151 and rib slot 152 together.

[0040] When one slot 15 includes both arc slot 151 and rib slot 152, one end of arc slot 151 and one end of rib slot 152 may be connected to each other, and the other end of arc slot 151 is 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.

[0041] 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.

[0042] FIG. 5 illustrates a partial view of a shroud 13

according to another embodiment related to the present disclosure.

[0043] Arc slot 151 and rib slot 152 may be 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.

[0044] 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.

[0045] FIG. 6 illustrates an enlarged view of area B of FIG. 3.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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 (specifically, 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.

[0050] Motor 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.

[0051] Such omission of slots 15 may be equally ap-

plied even when any structure, other than motor connector 135, is attached to increase the stiffness according to embodiments.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] 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.

[0057] FIG. 8 is a duty (%) - noise (dBA) graph of the cooling fan assembly related to the present disclosure.

[0058] 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.

[0059] The noise is reduced when the slot is provided, and in particular, the noise is reduced by 5dBA or more at 35% Duty.

[0060] 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 a fan 12,
characterized in that said shroud 13 further comprises a slot 15 formed on said plenum 131.
2. The shroud 13 of claim 1, 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.
3. The shroud 13 of claim 2, 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.
4. The shroud 13 of claim 3, wherein said slot 15 is provided between adjacent two ribs 14, or adjacent to an outside of said two adjacent ribs 14.
5. The shroud 13 of claim 3, wherein 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.
6. The shroud 13 of claim 5, 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.
7. The shroud 13 of claim 3, 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.
8. The shroud 13 of claim 3, 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 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.
9. The shroud 13 of claim 5, 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 and 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. 5

10. A cooling fan assembly 10 comprising said shroud 13 according to any one of claims 1 to 9, a cooling motor 11, and a fan 12 coupled to said shroud 13. 10

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FIG. 1

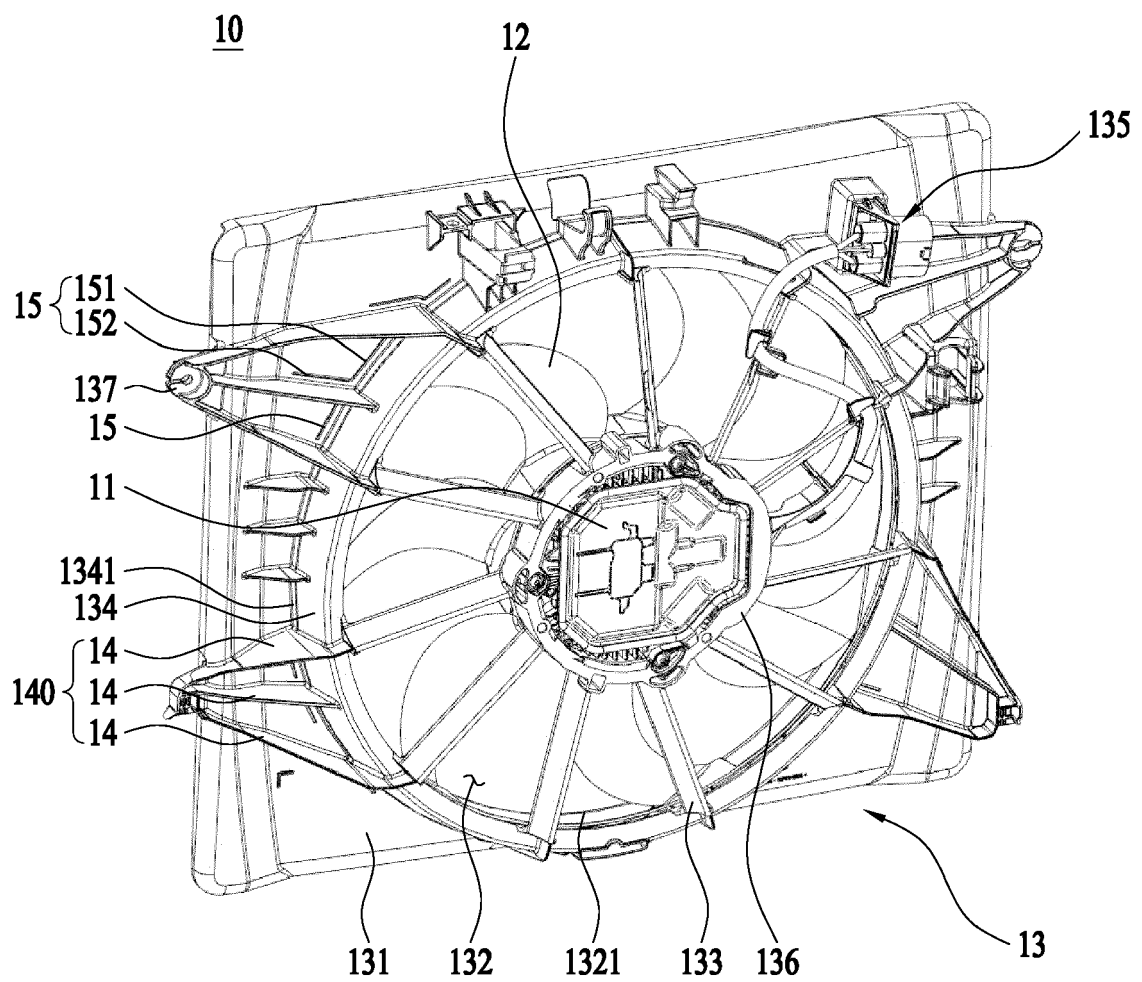


FIG. 2

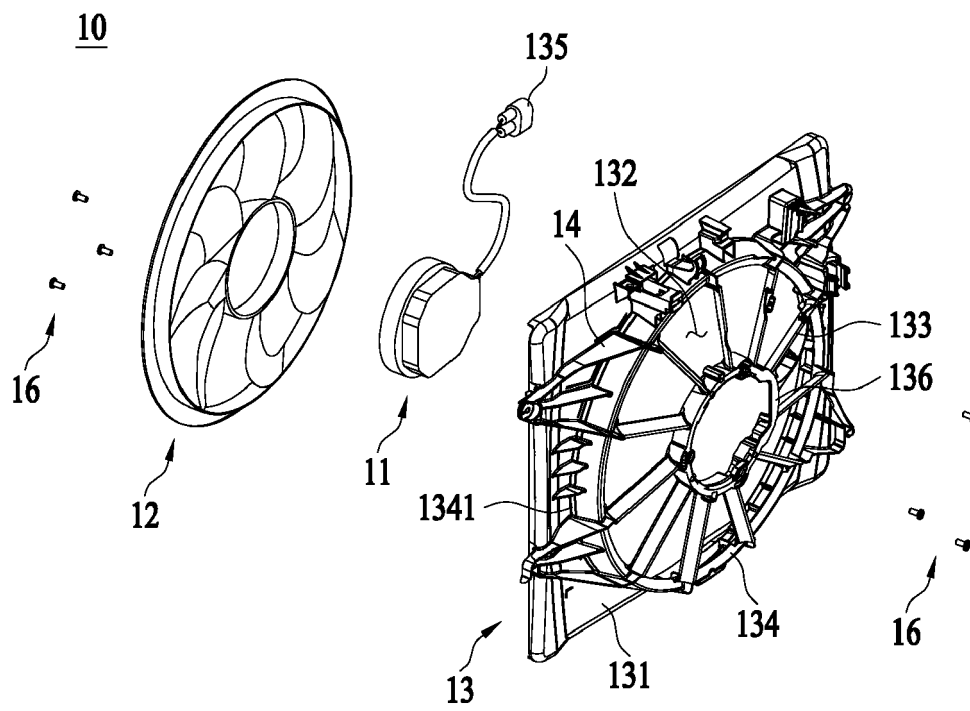


FIG. 3

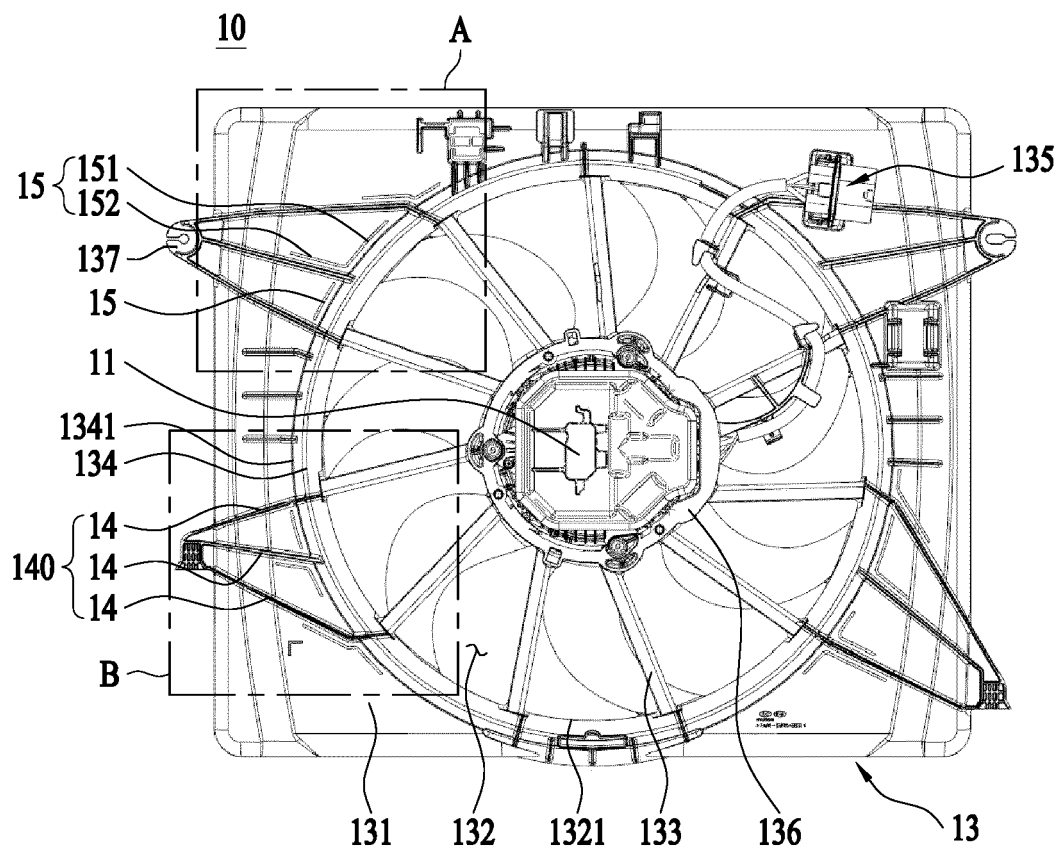


FIG. 4

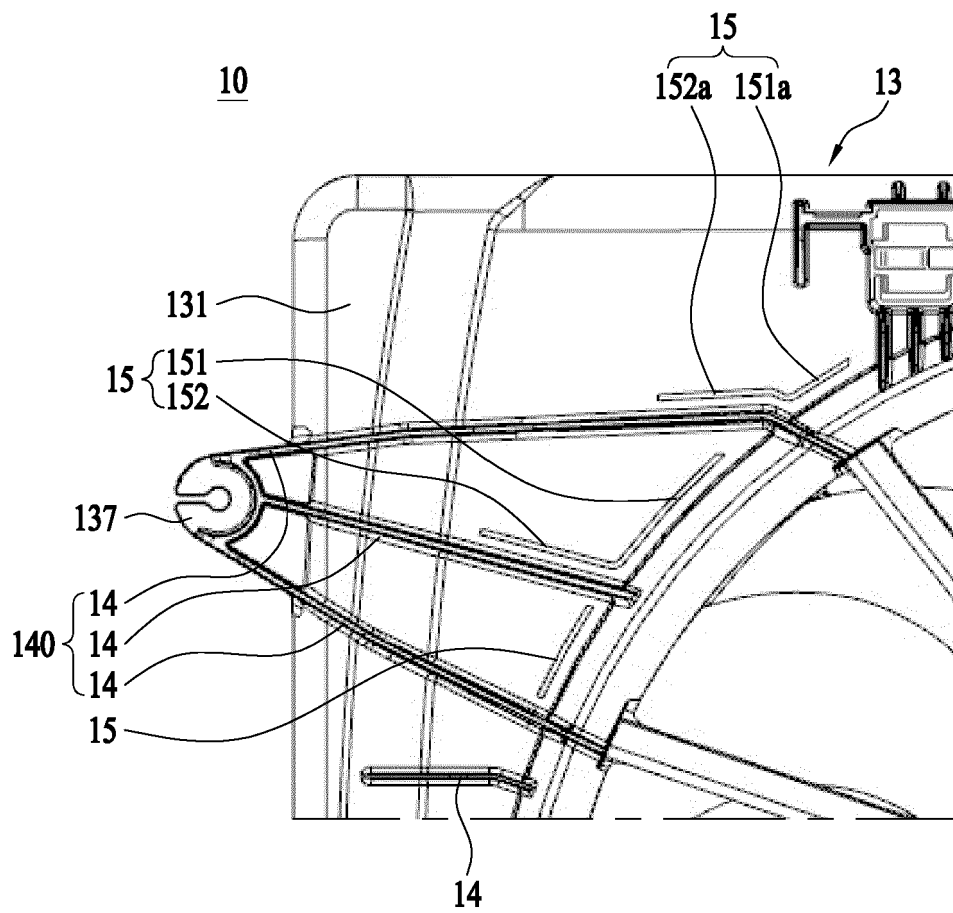


FIG. 5

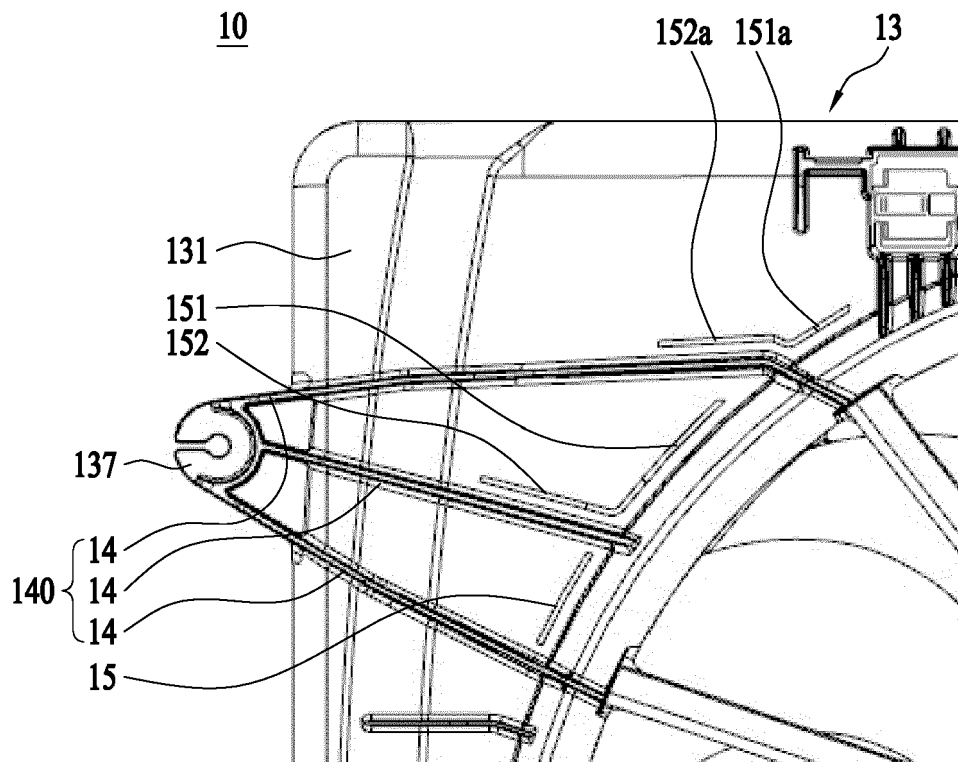


FIG. 6

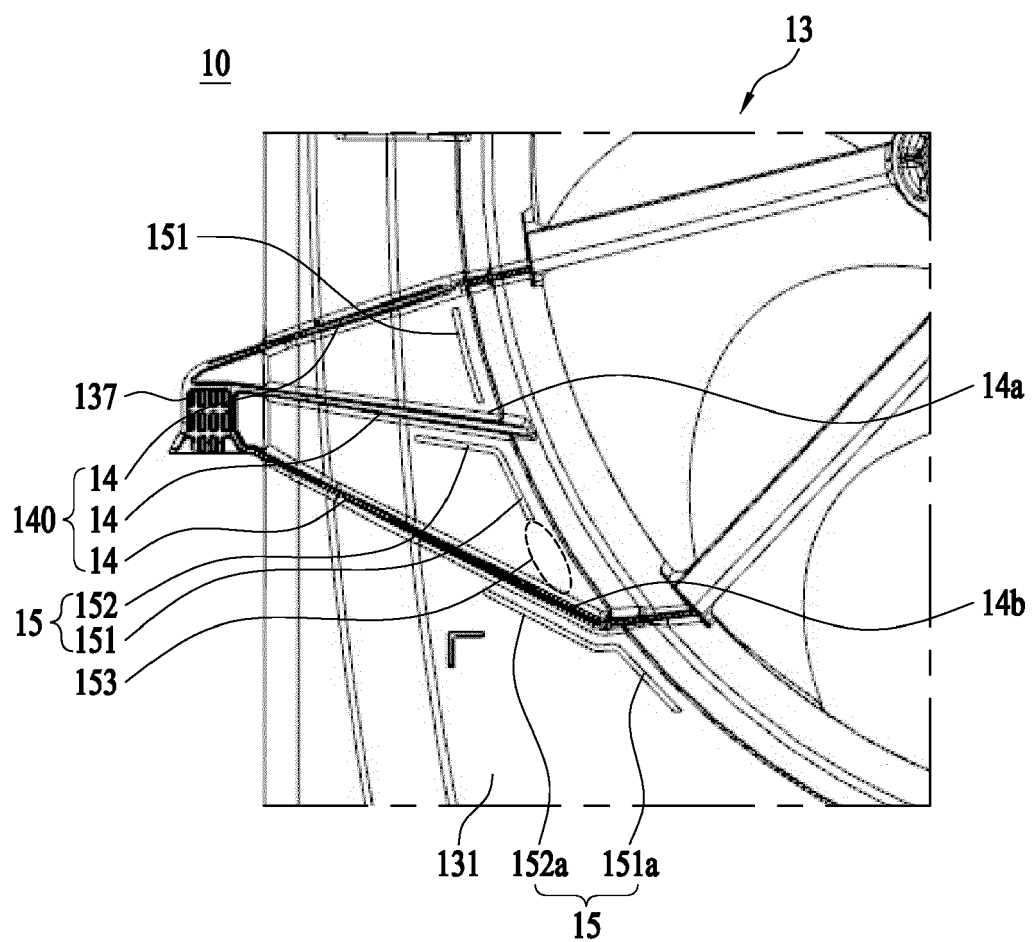


FIG. 7

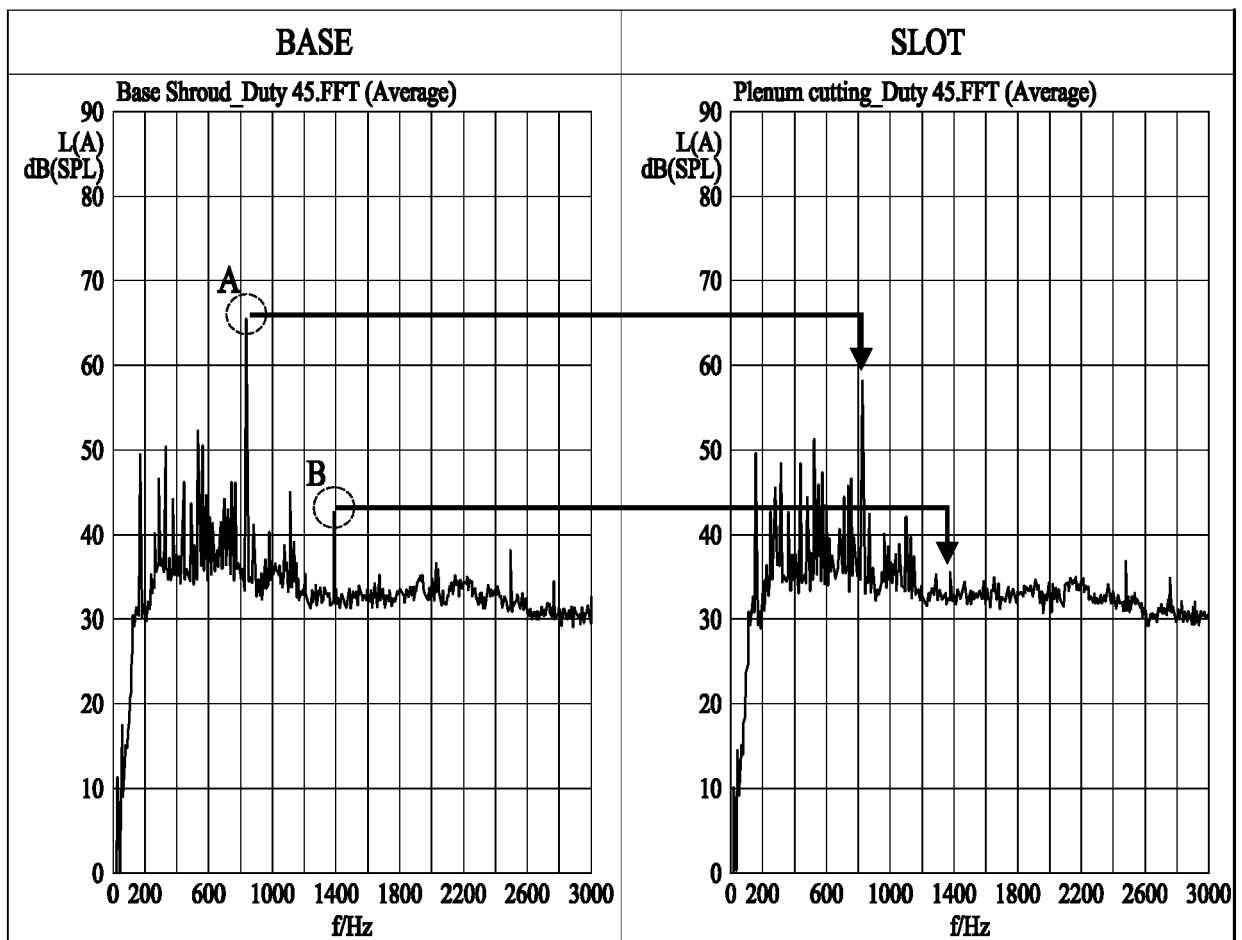
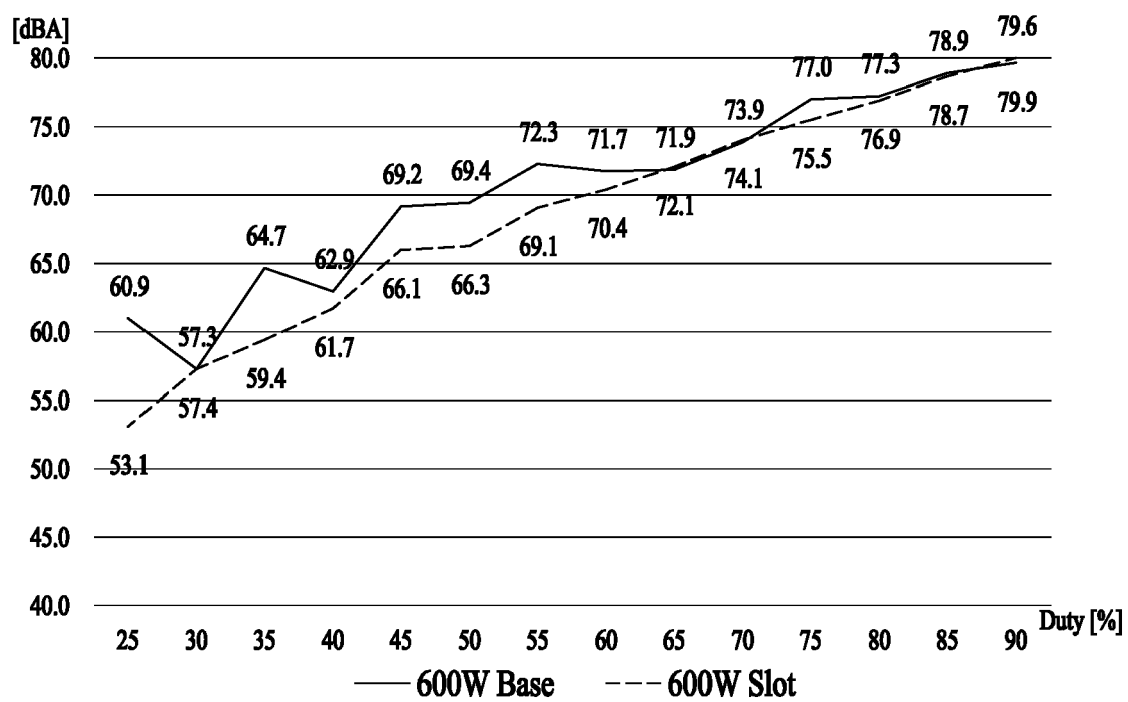


FIG. 8





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Application Number

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X	US 2015/198177 A1 (GABBIN GIULIANO [IT] ET AL) 16 July 2015 (2015-07-16)	1-4, 7, 8, 10	INV. F04D19/00
A	* paragraphs [0005] - [0007] *	5, 6, 9	F04D29/52 F04D29/58 F04D29/60 F04D29/66
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	* paragraphs [0004], [0015], [0016], [0019] *		
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			TECHNICAL FIELDS SEARCHED (IPC)
			F04D B60H B60K F01P
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		7 December 2022	De Tobel, David
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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