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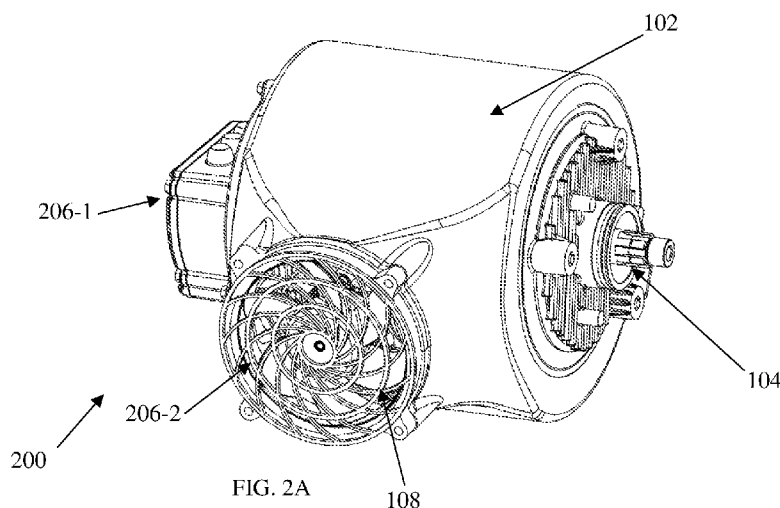
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(54) Title: A MOTOR ASSEMBLY FOR A VEHICLE



(57) Abstract: Examples for a motor assembly for a vehicle are disclosed. In one example, a motor assembly (200), comprising, a motor (104), a motor casing (102) to accommodate the motor (104), wherein the motor casing (102) comprises a first flow opening (206-1) and a second flow opening (206-2), and a forced circulation device (205) disposed at the first flow opening (206-1) to force air through the motor casing (102). The first flow opening (206-1) and the second flow opening (206-2) form a flow path (110) for passage of air through the motor casing (102), wherein the flow path (110) being substantially perpendicular to an axis of the motor (104).

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TITLE OF INVENTION

A MOTOR ASSEMBLY FOR A VEHICLE

5 TECHNICAL FIELD

[0001] The present subject matter relates, in general, to vehicles, and, in particular, to a motor assembly for a vehicle.

BACKGROUND

10 **[0002]** Electric vehicles (EVs), such as pure EVs or hybrid EVs, include a motor in their powertrain to provide propulsion to the electric vehicle. The motor, during its operation, may heat up and is required to be adequately cooled. In general, the motor is cooled by the flow of natural air.

[0003] Electric vehicles (EVs) have various components closely packaged in a chassis of the vehicle and, as a result, the components of such vehicles may face heating issues as the natural air circulation may be inadequate in cooling the components. In particular, the motor of the electric vehicle may be inadequately cooled owing to the close packaging of the surrounding components that may affect its performance. The issue of inadequate cooling may be amplified when the vehicle is slowed down that may further reduce the amount of air flowing naturally in the vicinity
15 of the motor, thus overheating and adversely affecting the performance of the vehicle. For instance, the temperature of the motor, owing to inadequate cooling, may increase to as high as about 160-180° C and, at such high temperatures, the magnets of the motor may get demagnetized permanently. As a result, the motor may stop working as well and may require replacement. The motor of the vehicle is the most expensive and delicate component of the vehicle. Therefore, any
20 damage to the motor, in effect, can increase the cost of ownership of the vehicle and may even require regular maintenance. The aim of the present subject matter is to reduce the chances of damage of the motor caused by overheating.

BRIEF DESCRIPTION OF DRAWINGS

30 **[0004]** The detailed description is provided with reference to the accompanying figures. It should be noted that the description and the figures are merely examples of the present subject matter and are not meant to represent the subject matter itself.

[0005] Fig. 1A illustrates a front-side view of a centrifugal fan assembly disposed along a motor assembly, in accordance with an example of the present subject matter.

[0006] Fig. 1B illustrates a rear-side view of the centrifugal fan assembly disposed along the motor assembly, in accordance with an example of the present subject matter.

[0007] Fig. 1C illustrates a cross-sectional top view of the centrifugal fan assembly disposed along the motor assembly through section B-B, in accordance with an example of the present subject matter.

[0008] Fig. 1D illustrates a cross-sectional side view of the centrifugal fan assembly disposed along the motor assembly through section C-C, in accordance with an example of the present subject matter.

[0009] Fig. 2A illustrates a side view of a forced circulation device disposed along the motor assembly, in accordance with an example of the present subject matter.

[0010] Fig. 2B illustrates a front view of the forced circulation device disposed along the motor assembly, in accordance with an example of the present subject matter.

[0011] Fig. 2C illustrates a cross-sectional view of the forced circulation device disposed along the motor assembly through section A-A of Fig. 2B, in accordance with an example of the present subject matter.

[0012] Throughout the drawings, identical reference numbers designate similar, but not necessarily identical, elements. The figures are not necessarily to scale, and the size of some parts may be exaggerated to more clearly illustrate the example shown. Moreover, the drawings provide examples and/or implementations consistent with the description; however, the description is not limited to the examples and/or implementations provided in the drawings.

DETAILED DESCRIPTION

[0013] The present subject matter relates to aspects of a motor assembly for a vehicle.

[0014] Conventionally, the size of the housing of the motor can be increased to solve the overheating issues. The increase in the size of the housing of the motor may provide sufficient space for the air to circulate and allow the components of the motor to be cooled. However, the increase in the size of the motor can cause packaging issues in accommodating other components of the vehicle on the chassis. In such a case, when the packaging of the components is modified, it can adversely affect the stability as well ride quality of the vehicle. In other cases, to maintain the packaging of the components, the chassis may have to be modified to accommodate the components of the vehicle, which can increase the cost of manufacturing of the vehicle, which may, ultimately, have to be borne by the customer.

[0015] The present subject matter discloses examples and aspects to *inter alia* address the above-mentioned problems. The present subject matter, in one example, relates to a vehicle. The

vehicle may be Electric vehicles (EVs), such as pure EVs or hybrid EVs. The vehicle of the present subject matter hereinbelow has been explained with respect to the EV. However, the implementations of the present subject matter may be implemented in variants of EV.

[0016] The vehicle of the present subject matter may have a motor assembly and a gear box, among other components of the vehicle. The motor assembly may be accommodated adjacent to the gear box to achieve different speed and torque configurations for the vehicle.

[0017] According to an aspect, the motor assembly of the present subject matter may have a motor, a motor casing and a forced circulation device. The motor of the present subject matter may be accommodated in a motor casing. In an example, the motor casing may be a cowl in which the motor is accommodate. The motor casing may act as a protective cover for the motor from the outer environment and may a plurality of flow openings. The flow openings may provide for inlet and outlet for the air to circulate from the motor casing across the body of the motor to cool the motor. In an example, the motor casing can have a first flow opening and a second flow opening. Further, a forced circulation device may be accommodated on the motor casing at one of the flow openings, such that the forced circulation device is accommodated outside the motor casing. During operation, the forced circulation device, when powered, may force air to circulate through the motor casing and across the motor to provide effective cooling of the motor. In another example, the forced circulation device may be indirectly connected to the motor casing, for example, using a channel. For instance, when a size of the forced circulation device is fairly large, and its weight cannot be borne by the motor casing, the forced circulation device can be mounted to the chassis or the body of the vehicle, and connected to the motor casing through the channel.

[0018] In addition to the above, in order to effectively circulate air through the flow path to avoid over heating depending on the motor that may be used in the vehicle, the speed, such as rotations per minute (RPM), of the forced circulation device may be increased or decreased as per the requirements at the time of assembling the motor casing in the vehicle. In another example, in order to attain efficient air circulation through the flow path, one or more forced circulation devices may be disposed at the flow openings. In operation, the forced circulation device cause forced air cooling of the motor by forcing air to enter through the one flow opening, pass over the motor, such as the cooling fins on the housing of the motor, and exit through the other flow opening. According to an example, the first flow opening may be an inlet through which the air may be forced to enter in the motor assembly and after providing efficient cooling to the motor, the air may exist through the second flow opening. In another example, the second flow opening may be the inlet through which the air may be forced to enter in the motor assembly and after providing efficient cooling to the motor, the air may exist through the first flow opening.

[0019] The forced circulation device may be a fan, for instance, a suction fan, a blower fan, a centrifugal fan assembly, and the like depending upon the size of the motor and requirements of cooling to avoid over heating. The direction of the flow path may be changed by implementing one of the above-mentioned forced circulation devices, to channelize air into the motor casing. For an instance, depending on the cooling requirements and the motor i.e., used in the vehicle, forced circulation device may be assembled in the motor assembly, in such an instance, the air may be forced to enter through the first flow opening and exit through the second flow opening. In another instance, depending on the cooling requirements and the motor i.e., used in the vehicle, in case it is established at the time of assembly that opposite direction of the flow path from the one i.e., mentioned above is required for effective cooling, the direction of the flow path may be changed by implementing a different forced circulation device, in such an instance, the direction of flow path may be changed and the air may be forced to enter through the second flow opening and exit through the first flow opening.

[0020] According to an example, the forced circulation device is the centrifugal fan assembly and the suction fan, in such an instance, flow path may be as such that the first flow opening may act as the inlet for air to enter the motor casing and the second flow opening may act as the outlet for air to exit the motor casing after circulating through the motor casing. According to another example, the forced circulation device is the blower fan, in such an instance, the second flow opening may be the inlet for the air to enter the motor casing and the first flow opening may be the outlet for the air to exit after circulating through the motor casing.

[0021] In an example, the first flow opening and the second flow opening may be positioned at opposite sides of the motor casing, such that the air may be allowed to circulate effectively from the casing through the motor and to the plurality of the openings. In an example, the first flow opening and the second flow opening positioned at the opposite ends of the motor casing may be designed as such that the air may circulate effectively to provide efficient cooling to the motor in the motor casing.

[0022] In an example, the first flow opening and the second flow opening of the motor casing may form a flow path through the motor casing for the air to circulate through the motor casing and the motor to provide cooling effectively. According to an aspect, the flow path of passage of air so formed by the first and second flow openings through the motor casing may be substantially perpendicular to an axis of motor in the motor casing. The first flow opening may have a first flow axis of the first flow opening which can be understood as the direction in which the air may move to and from the first flow opening. Similarly, the second flow opening may have a second flow axis of the second flow opening through which the air may flow to and from the second flow

opening. In an example, the first flow axis of the first flow opening and the second flow axis of the second flow opening may be in a non-parallel configuration with respect to each other.

[0023] The disclosure of the present subject matter through the above-mentioned aspects provides an independent motor assembly that may be easily detached from the other components of the vehicle. The motor assembly of the present subject matter provides a continuous air flow and ensures sufficient cooling as required without making significant changes to the motor. Through the aspects of the present disclosure, the motor of optimized size as required may be used and still efficient cooling may be achieved through the motor casing assembly of the present subject matter.

[0024] In view of the above exemplary embodiments and aspects, sufficient cooling is ensured to electric machines at low vehicle speed as the flow path of air circulation and the forced circulation device allows the air to circulate effectively. The motor assembly of the present subject matter through the various implementations of the forced circulation devices and air flow circulation paths, does not allow the temperature of the motor to exceed 120°C. The implementations of the present subject matter also does not consume a lot of power, since the control unit of the vehicle of the present subject matter controls the forced circulation device and powers it on only when there is a temperature threat. The temperature threat may arise when the temperature of the motor and the components surrounding the motor may start overheating up to a temperature above the predetermined safe temperature of the motor, such that the overheating may start adversely affecting and damaging the motor as well as the components surrounding the motor in the vehicle and thus affecting the working of the motor and the vehicle, because of the reasons as elaborated above. According to an example, the vehicle of the present subject matter may have a plurality of temperature sensors disposed of in the motor casing, for instance, at the first flow opening and the second flow opening, to measure the temperature of the incoming and outgoing air to and from the motor casing. The temperature sensors may be connected to the control unit to determine if there is temperature threat around the motor. The control unit, also operably connected to the forced circulation device, may control the forced circulation device after receiving feedback from the temperature sensors. This way, the vehicle may run continuously without thermal derating. Further, the motor assembly of the present subject matter achieves efficient cooling without substantially increasing the weight or size of the motor in this way, optimized size and weight of the motor can be achieved.

[0025] The above aspects are further illustrated in the figures and described in the corresponding description below. It should be noted that the description and figures merely illustrate principles of the present subject matter. Therefore, various arrangements that encompass

the principles of the present subject matter, although not explicitly described or shown herein, may be devised from the description and are included within its scope.

[0026] Fig. 1A illustrates a front-side view of a centrifugal fan assembly 105 disposed along a motor assembly 100, in accordance with an example of the present subject matter. Fig. 1B illustrates a rear-side view of the centrifugal fan assembly 105 disposed along the motor assembly 100, in accordance with an example of the present subject matter. Fig. 1C illustrates a cross-sectional top view of the centrifugal fan assembly 105 disposed along the motor assembly 100 through section B-B, in accordance with an example of the present subject matter. Fig. 1D illustrates a cross-sectional side view of the centrifugal fan assembly 105 disposed along the motor assembly 100 through section C-C, in accordance with an example of the present subject matter. For the sake of brevity, Figs. 1A-1D have been explained in conjunction with each other.

[0027] The present subject matter, in an example, in one example, relates to a vehicle (not shown). The vehicle may be Electric vehicles (EVs), such as pure EVs or hybrid EVs. The vehicle of the present subject matter hereinbelow has been explained with respect to the EV. However, the implementations of the present subject matter may be implemented in variants of EVs.

[0028] The vehicle of the present subject matter may have a motor assembly 100 and a gear box 101, among other components of the vehicle. The motor assembly 100 may be accommodated adjacent to the gear box 101 to achieve different speed and torque configurations of the vehicle.

[0029] According to an aspect, the motor assembly 100 of the present subject matter may have a motor 104, a motor casing 102 and a forced circulation device. The motor 104 of the present subject matter may be accommodated in a motor casing 102 in which the motor 104 may be accommodated in a motor housing 103. The motor 104 may be mounted to gear box 101 and a rotor shaft of the motor 104 may be driven through external/internal spline in gear box 101 to transmit power to the vehicle. In an example, the motor casing 102 may be a cowl in which the motor 104 is accommodated. The motor casing 102 may act as a cover and may act as a protective cover for the motor 104 accommodated in the motor housing 103 and may have a plurality of flow openings. The flow openings may provide for inlet and outlet for the air to circulate from the motor casing across the body of the motor 104 to cool the motor. In an example, the motor casing 102 may have a first flow opening 106-1 and a second flow opening 106-2. In the implementations shown in FIG. 1A-1D, the first flow opening 106-1 may act as the inlet for air to enter the motor casing 102. The second flow opening 106-2 may act as the outlet for air to exit the motor casing 102 after circulating through the motor casing 102. In another implementations, the first flow opening 106-1 may be the outlet for the air to exit after circulating through the motor casing 102 and the second flow opening 106-2 may be the inlet for the air to enter the motor casing 102.

[0030] In the present implementations, the forced circulation device may be at least one centrifugal fan assembly 105. The centrifugal fan assembly 105 may be indirectly disposed adjacent to the first flow opening 106-1, such that the centrifugal fan assembly 105 is accommodated outside the motor casing 102. The centrifugal fan assembly 105 may have a fan and a fan motor, that may be accommodated in the centrifugal fan housing 109 of the centrifugal fan assembly 105. The fan motor may be a less-capacity motor, that may be powered by the motor 104, to power the fan of the centrifugal fan assembly 105. The fan motor may be attached to the motor 102. In another example, the centrifugal fan assembly 105 may be indirectly connected to the motor casing 102 through a channel (not shown). In an example, as also illustrated in Fig. 1A-1D, one or more centrifugal fan assemblies 105 may be implemented in the motor assembly 100, as per the requirements for cooling the motor 104, type of the vehicle, size of the motor i.e., assembled in the vehicle or the like.

[0031] In this example, the first flow opening 106-1 and the second flow opening 106-2 of the motor casing 102 may form a flow path 110. The flow path 110 may be for the air to circulate through the motor casing 102 and the motor 104 to provide cooling effectively. In another example, the first flow opening 106-1 have a first flow axis of the first flow opening 107-1 through which the air may move to and from the first flow opening 106-1. The second flow opening 106-2 may have a second flow axis of the second flow opening 107-2 through which the air may flow to and from the second flow opening 106-2. In an example, the first flow axis of the first flow opening 107-1 and the second flow axis of the second flow opening 107-2 may be in a parallel configuration with respect to each other, as shown in Fig. 1C. As indicated in Fig. 1C and 1D, the respective section plane B-B and section place C-C coincides with the first flow axis of the first flow opening 107-1 and the second flow axis of the second flow opening 107-2. As indicated in Fig. 1C and 1D, the first flow axis of the first flow opening 107-1 may be in a parallel configuration with respect to the second flow axis of the second flow opening 107-2. In another example, the flow path 110 of passage of air through the motor casing 102 may be substantially perpendicular to an axis of motor accommodated in the motor casing 102.

[0032] The centrifugal fan assembly 105 may be powered whenever there is a temperature threat, i.e., when the temperature of the motor 104 increases above the predetermined safe temperature of the motor 104 and is overheating. The temperature threat may arise when the temperature of the motor 104 and the components surrounding the motor 104 in the vehicle may start over heating up to a temperature that may start adversely affecting and damaging the motor 104 as well as the components surrounding the motor in the vehicle and thus affecting the working of the motor 104 and the vehicle. The centrifugal fan assembly 105 may allow forced air cooling,

as the air would be forced to enter through the first flow opening 106-1. The air would pass through the first flow axis of the first flow opening 107-1 through the centrifugal fan housing 109 and to the motor casing 102 and may pass across cooling fins on the housing of the motor 104 i.e., accommodated in the motor casing 102 and thus provide effective cooling to the motor 104 and thus exit through the second flow opening 106-1 by passing through the second flow axis of the second flow opening 107-2. Accordingly, the temperature of the motor 104 will come into the predetermined safe operational range of the motor 104 which will reduce the chances of any damage to the motor 104 of the vehicle. In such an instance, the motor assembly 100 along with the centrifugal fan assembly 105 of the present implementations, does not allow the temperature around the motor 104 to exceed 120°C by forcefully and efficiently passing the air through the flow path 110, as illustrated in Fig. 1D.

[0033] The implementations of centrifugal fan assembly 105 as suggested above may be implemented and assembled based on the requirements for cooling and the motor 104 that may be implemented.

[0034] In addition to the above, at the time of manufacturing and the assembling of the motor assembly 100, size, shape and diameter of the first flow opening 106-1 and the second flow opening 106-2 of the motor casing 102 may be designed such that, depending on the size and type of fan, a speed of air moving through the motor casing 102 be adjusted based on the cooling to be achieved. In other words, the first flow opening 106-1 and the second flow opening 106-2 may be designed such that the flow rate of the air entering passing through the flow path 110 may have sufficient contact time with the motor 104 to adequately cool the motor 104. Therefore, the size, shape and diameter of the first flow opening 106-1 and the second flow opening 106-2 of the motor casing may be designed based on various factors, such as size of the centrifugal fan assembly 105 that is used, the type of motor 104 that is used in the vehicle, the size of the motor 104 that is used in the vehicle i.e., also dependent on the type of the vehicle in which the motor is assembled, for instance, the vehicle is 2W, 3W, 4W, and the like.

[0035] According to an aspect, the vehicle may have a plurality of temperature sensors (not shown) disposed in the motor casing 102, for instance, at the first flow opening 106-1 and the second flow opening 106-2, to measure the temperature of the incoming and outgoing air to and from the motor casing 102. For instance, the temperature sensors may be connected to a control unit (not shown) to determine if the temperature of the motor is such that the motor 104 is overheating. The control unit, also operably connected to the centrifugal fan assembly 105, may control the centrifugal fan assembly 105 after receiving feedback from the temperature sensors. For instance, in case the motor 104 is overheating, the control unit may increase the speed of the

fan of the centrifugal fan assembly 105 to provide greater cooling to the motor 104. In other cases, if the motor 104 is sufficiently cooled, the control unit may lower the speed of the fan and, in certain cases, even shut down the fan in case the motor 104 is adequately cooled and does not require any cooling at a given point in time. This way, the centrifugal fan assembly 105 may not be connected to power continuously and may only be powered when there is a temperature threat to the motor 104.

[0036] In an instance, in order to effectively circulate air through the flow path 110 to avoid over heating depending on the motor 104 that may be used in the vehicle, the speed, such as rotation per minute (RPM) of the centrifugal fan assembly 105 may be increased or decreased as per the requirements at the time of assembling the motor casing 102 in the vehicle. In another example, in order to attain efficient cooling, one or more centrifugal fan assembly 105 may be disposed at the flow openings.

[0037] Fig. 2A illustrates a side view of a forced circulation device 205 disposed along the motor assembly 200, in accordance with an example of the present subject matter. Fig. 2B illustrates a front view of the forced circulation device 205 disposed along the motor assembly 200, in accordance with an example of the present subject matter. Fig. 2C illustrates a cross-sectional view of the forced circulation device 205 disposed along the motor assembly 200 through section A-A of Fig. 2B, in accordance with an example of the present subject matter. For the sake of brevity, Figs. 2A-2C have been explained in conjunction with each other.

[0038] According to an aspect, the motor assembly 200 of the present implementations, may have a motor 104, a motor casing 102 and a forced circulation device 205. The motor 104 of the present subject matter may be accommodated in a motor casing 102 in which the motor 104 may be accommodated in a motor housing 103. The motor 104 may be mounted to gear box 101 and a rotor shaft may be driven through external/internal spline in gearbox to transmit power to the vehicle. In an example, the motor casing 102 may be a cowl, in which the motor 104 is accommodated. The motor casing 102 may act as a protective cover for the motor 104 accommodated in the motor housing 103 and may have a plurality of flow openings. The flow openings may provide an inlet and an outlet for the air to circulate from the motor casing across the body of the motor. In an example, the motor casing 102 of the present implementations as illustrated in Fig. 2A-2C may include a first flow opening 206-1 and a second flow opening 206-2. The first flow opening 206-1 and the second flow opening 206-2 of the present implementations may be similar to the first flow opening 106-1 and the second flow opening 106-2, respectively, as illustrated in previous implementations of Fig. 1A-1D. In the implementations of FIG. 2A-2C at least one suction fan is implemented as the forced circulation device 205. Further, in the

implementations shown in Fig. 2A-2C, the first flow opening 206-1 may act as the inlet for air to enter the motor casing 102. The second flow opening 206-2 may act as the outlet for air to exit the motor casing 102 after circulating through the motor casing 102. In another implementations, at least one blower fan is used in place of the at least one suction fan, accordingly, the first flow opening 206-1 may be the outlet for the air to exit after circulating through the motor casing 102 and the second flow opening 206-2 may be the inlet for the air to enter the motor casing 102.

[0039] In the present implementations, the first flow opening 206-1 have a first flow axis of the first flow opening 207-1 through which the air may move to and from the first flow opening 206-1. The second flow opening 206-2 may have a second flow axis of the second flow opening 207-2 through which the air may flow to and from the second flow opening 206-2. In an example, the first flow axis of the first flow opening 207-1 and the second flow axis of the second flow opening 207-2 may be in a non-parallel configuration with respect to each other, as shown in Fig. 2B. As indicated in Fig. 2B and 2C, the section plane A-A coincides with the first flow axis of the first flow opening 207-1 and the second flow axis of the second flow opening 207-2. As indicated in Fig. 2B and 2C, the first flow axis of the first flow opening 207-1 and the second flow axis of the second flow opening 207-2 of the present implementations may be similar to the first flow axis of the first flow opening 107-1 and the second flow axis of the second flow opening 107-2, respectively, as illustrated in previous implementations of Fig. 1A-1D.

[0040] In the present implementations, the forced circulation device 205 may be one of a suction fan and a blower fan. The forced circulation device 205 may be disposed adjacent to the first flow opening 206-1. In an example, the forced circulation device 205 mounted in the motor assembly 200 may be covered by a grill 208.

[0041] In an instance, where the forced circulation device 205 is the suction fan, the forced circulation device 205 forces air to enter through the first flow opening 206-1. The forced circulation device 205 may force the air to enter and pass through the first flow axis of the first flow opening 207-1 and the flow path 110. The air will be circulated through the motor casing 102 and across the motor 104. The air may come across the cooling fins on the housing of the motor 104 and effectively cool the motor 104. The air after effectively cooling the motor 104 may exit through the second flow opening 206-2.

[0042] The implementations illustrated in Fig. 2A to 2C, illustrate the suction fan as the forced circulation device 205. However, the motor assembly 200 may have the blower fan as the forced circulation device 205. In such an instance, where the forced circulation device 205 is the blower fan, the forced circulation device 205 forces air to enter through the second flow opening 206-2. The forced circulation device 205 may force the air to enter and pass through the second flow axis

of the second flow opening 207-2 and the flow path 110. The air will be circulated through the motor casing 102 and across the motor 104. The air may come across the cooling fins on the housing of the motor the motor 104 and effectively cool the motor 104. The air after effectively cooling the motor 104 may exit through the first flow opening 206-1.

5 **[0043]** The implementations of forced circulation device 205 as suggested above may implemented and assembled based on the requirements for cooling and the motor 104 that may be implemented. The above-mentioned implementations, provide a change in the direction of flow path 110 to canalize the air from outside in the motor assembly 200.

10 **[0044]** According to an example, depending on the requirements of cooling the motor efficiently, the motor assembly 200 may accommodate at least two forced circulation device 205. For instance, the suction fan as the forced circulation device 205, may be disposed adjacent to the first flow opening 206-1 and, the blower fan as the forced circulation device 205 may be disposed adjacent to the second flow opening 206-2 in the same motor assembly 200. In such an instance, the blower fan as the forced circulation device 205 disposed adjacent to the second flow opening
15 206-2 may force air to enter through the second flow opening 206-2 and exit through the first flow opening 206-1 after circulating through the flow path 110. Similarly, the suction fan as the forced circulation device 205 disposed adjacent to the first flow opening 206-1 may force air to enter through the first flow opening 206-1 and exit through the second flow opening 206-2 after circulating through the flow path 110.

20 **[0045]** In addition to the above, at the time of manufacturing and the assembling of the motor assembly 200, size, shape and diameter of the first flow opening 206-1 and the second flow opening 206-2 of the motor casing 102 may be designed such that, depending on the size and type of fan, a speed of air moving through the motor casing 102 be adjusted based on the cooling to be achieved. In other words, the first flow opening 206-1 and the second flow opening 206-2 may be
25 designed such that the flow rate of the air entering passing through the flow path 110 may have sufficient contact time with the motor 104 to adequately cool the motor 104. Therefore, the size, shape and diameter of the first flow opening 206-1 and the second flow opening 206-2 of the motor casing may be designed based on various factors, such as size of the forced circulation device 205 that is used, the type of motor 104 that is used in the vehicle and the size of the motor 104 that is
30 used in the vehicle i.e., also dependent on the type of the vehicle in which the motor is assembled, for instance, the vehicle is 2W, 3W, 4W, and the like.

[0046] According to an aspect, the vehicle may have a plurality of temperature sensors (not shown) disposed in the motor casing 102, for instance, at the first flow opening 206-1 and the second flow opening 206-2, to measure the temperature of the incoming and outgoing air to and

from the motor casing 102. For instance, the temperature sensors may be connected to a control unit (not shown) to determine if the temperature of the motor is such that the motor 104 is overheating. The control unit, also operably connected to the forced circulation device 205, may control the forced circulation device 205 after receiving feedback from the temperature sensors.

5 For instance, in case the motor 104 is overheating, the control unit may increase the speed of the fan of the forced circulation device 205 to provide greater cooling to the motor 104. In other cases, if the motor 104 is sufficiently cooled, the control unit may lower the speed of the fan and, in certain cases, even shut down the fan in case the motor 104 is adequately cooled and does not require any cooling at a given point in time. This way, the forced circulation device 205 may not
10 be connected to power continuously and may only be powered when there is a temperature threat to the motor 104.

[0047] In addition to the above, in order to effectively circulate air through the flow path 110 to avoid over heating depending on the motor that may be used in the vehicle, the speed, such as rotations per minute (RPM), of the forced circulation device 205 may be increased or decreased
15 as per the requirements at the time of assembling the motor casing 102 in the vehicle. In another example, in order to attain efficient air circulation through the flow path 110, one or more forced circulation devices 205 may be disposed at the flow openings 206-1, 206-2. In operation, the forced circulation device 205 cause forced air cooling of the motor by forcing air to enter through the one flow opening, pass over the motor 104, such as the cooling fins on the housing of the motor, and
20 exit through the other flow opening.

[0048] The disclosure of the present subject matter through the above-mentioned aspects provides an independent motor assembly that may be easily detached from the other components of the vehicle. The motor assembly 100, 200 of the present subject matter provides a continuous air flow and ensures sufficient cooling as required without making significant changes to the motor
25 104. Through the aspects of the present disclosure, the motor 104 of optimized size as required may be used and still efficient cooling may be achieved through the motor assembly 100, 200 of the present subject matter.

[0049] In view of the above exemplary embodiments and aspects, sufficient cooling is ensured to electric machine at low vehicle speed as the flow path of air circulation and the forced circulation
30 device allows the air to circulate effectively. The motor assembly 100, 200 of the present subject matter through the various implementations of the forced circulation devices 105, 205 and air flow circulation paths, does not allow the temperature of the motor to exceed 120°C. The implementations of the present subject matter also does not consume a lot of power, since the control unit of the vehicle of the present subject matter controls the forced circulation device and

powers it on only when there is a temperature threat. This way, the vehicle may run continuously without thermal derating. Further, the motor assembly of the present subject matter achieves efficient cooling without substantially increasing the weight or size of the motor in this way, optimized size and weight of the motor can be achieved.

- 5 **[0050]** Although implementations of the motor assembly 100, 200 are described, it is to be understood that the present subject matter is not necessarily limited to the specific features of the systems or methods or other aspects described herein. Rather, the specific features are disclosed as implementations of the motor assembly 100, 200 of the vehicle.

CLAIMS:

1. A motor assembly (200), comprising:
 - a motor (104);
 - a motor casing (102) to accommodate the motor (104), wherein the motor casing (102)
 - 5 comprises a first flow opening (206-1) and a second flow opening (206-2); and
 - at least one forced circulation device (205) disposed at the first flow opening (206-1)
 - to force air through the motor casing (102),
 - wherein the first flow opening (206-1) and the second flow opening (206-2) form a
 - flow path (110) for passage of air through the motor casing (102), wherein the flow path (110)
 - 10 being substantially perpendicular to an axis of the motor (104).
2. The motor assembly (200) as claimed in claim 1, wherein the forced circulation device (205) is one of a suction fan and a blower fan.
- 15 3. The motor assembly (200) as claimed in claim 2, wherein the forced circulation device (205) is the blower fan, the forced circulation device (205) forces air to enter through the second flow opening (206-2) and exit through the first flow opening (206-1) after circulating through the flow path (110).
- 20 4. The motor assembly (200) as claimed in claim 2, wherein the forced circulation device (205) is the suction fan, the forced circulation device (205) forces air to enter through the first flow opening (206-1) and exit through the second flow opening (206-2) after circulating through the flow path (110).
- 25 5. The motor assembly (200) as claimed in claim 1, wherein a first flow axis of the first flow opening (207-1) is in a non-parallel configuration with respect to a second flow axis of the second flow opening (207-2).
6. The motor assembly (200) as claimed in claim 1, wherein the forced circulation device (205)
- 30 mounted in the motor assembly is covered by a grill (208).
7. A motor assembly (100), comprising:
 - a motor (104);

a motor casing (102) to accommodate the motor (104), wherein the motor casing (102) comprises a first flow opening (106-1) and a second flow opening (106-2); and

at least one centrifugal fan assembly (105) disposed on the motor casing (102) at the first flow opening (106-1) to force air therethrough;

5 wherein the first flow opening (106-1) and the second flow opening (106-2) form a flow path (110) for passage of air through the motor casing (102), wherein the flow path (110) being substantially perpendicular to an axis of the motor (104).

8. The motor assembly (100) as claimed in claim 7, wherein the centrifugal fan assembly (105)
10 comprises a fan and a fan motor, wherein the fan motor is connected to the motor (104).

9. The motor assembly (100) as claimed in claim 8, wherein the motor (104) provides power to the fan motor to power the fan of the centrifugal fan assembly (105).

15 10. The motor assembly (100) as claimed in claim 7, comprising a channel to connect the centrifugal fan assembly (105) to the first flow opening (106-1) of the motor casing (102).

11. The motor assembly (100) as claimed in claim 7, wherein a first flow axis of the first flow opening (107-1) is in a parallel configuration with respect to a second flow axis of the second
20 flow opening (107-2).

12. The motor assembly (100) as claimed in claim 7, wherein the centrifugal fan (105) is operably engaged with the motor (104) to be driven by the motor (104).

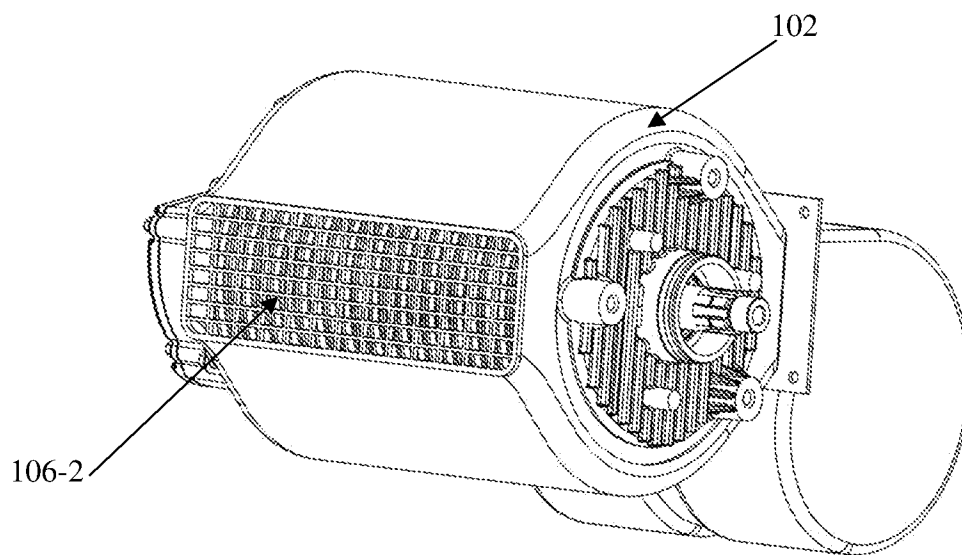
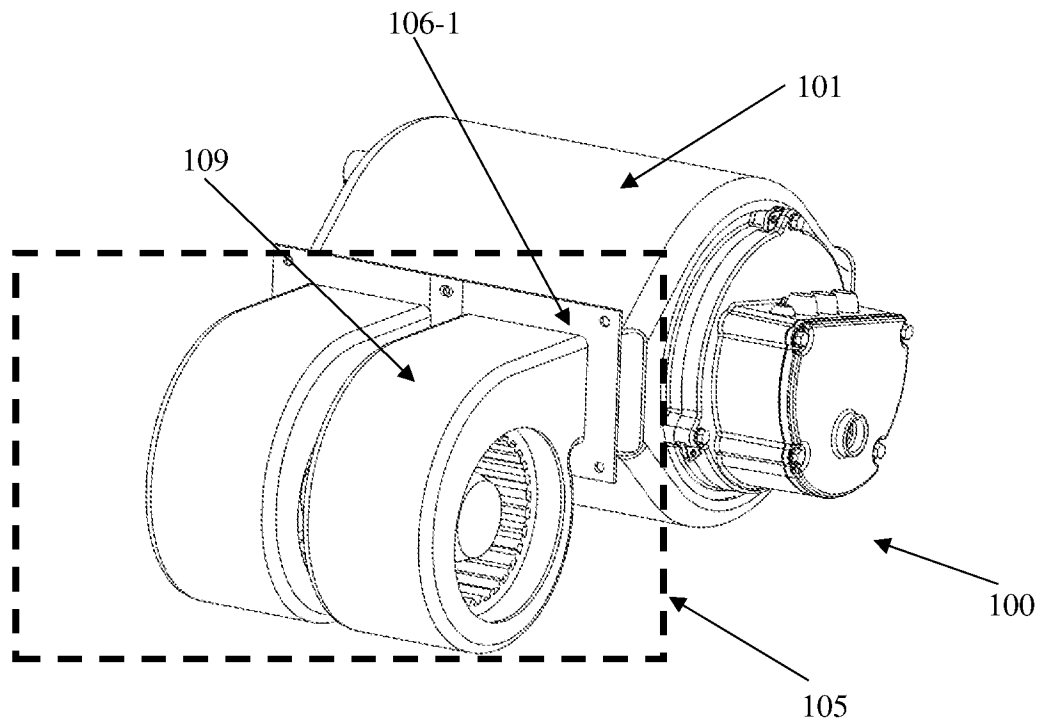
25 13. A vehicle comprising the motor assembly (100; 200) as claimed in any of the claims 1 to 12.

14. The vehicle as claimed in claim 13, wherein the motor assembly (100; 200) is adjacent to a gearbox (101).

30 15. The vehicle as claimed in claim 13, comprising:

a plurality of temperature sensors disposed in the motor casing (102), in the first flow opening (106-1; 206-2), and in the second flow opening (106-2; 206-2) to measure temperature threat; and

a control unit to control the forced circulation device (105; 205) based on inputs from one or more of the plurality of temperature sensors.



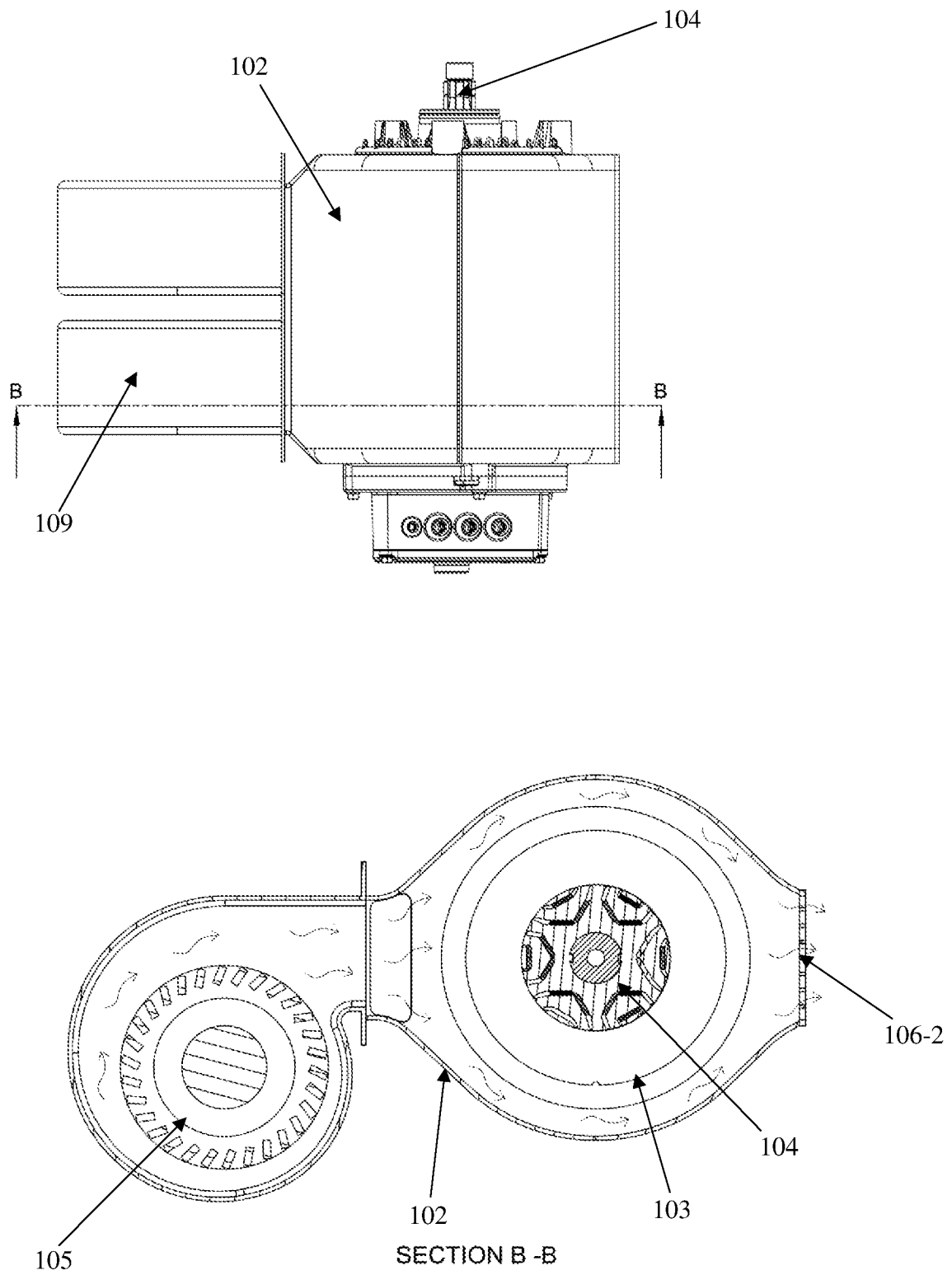
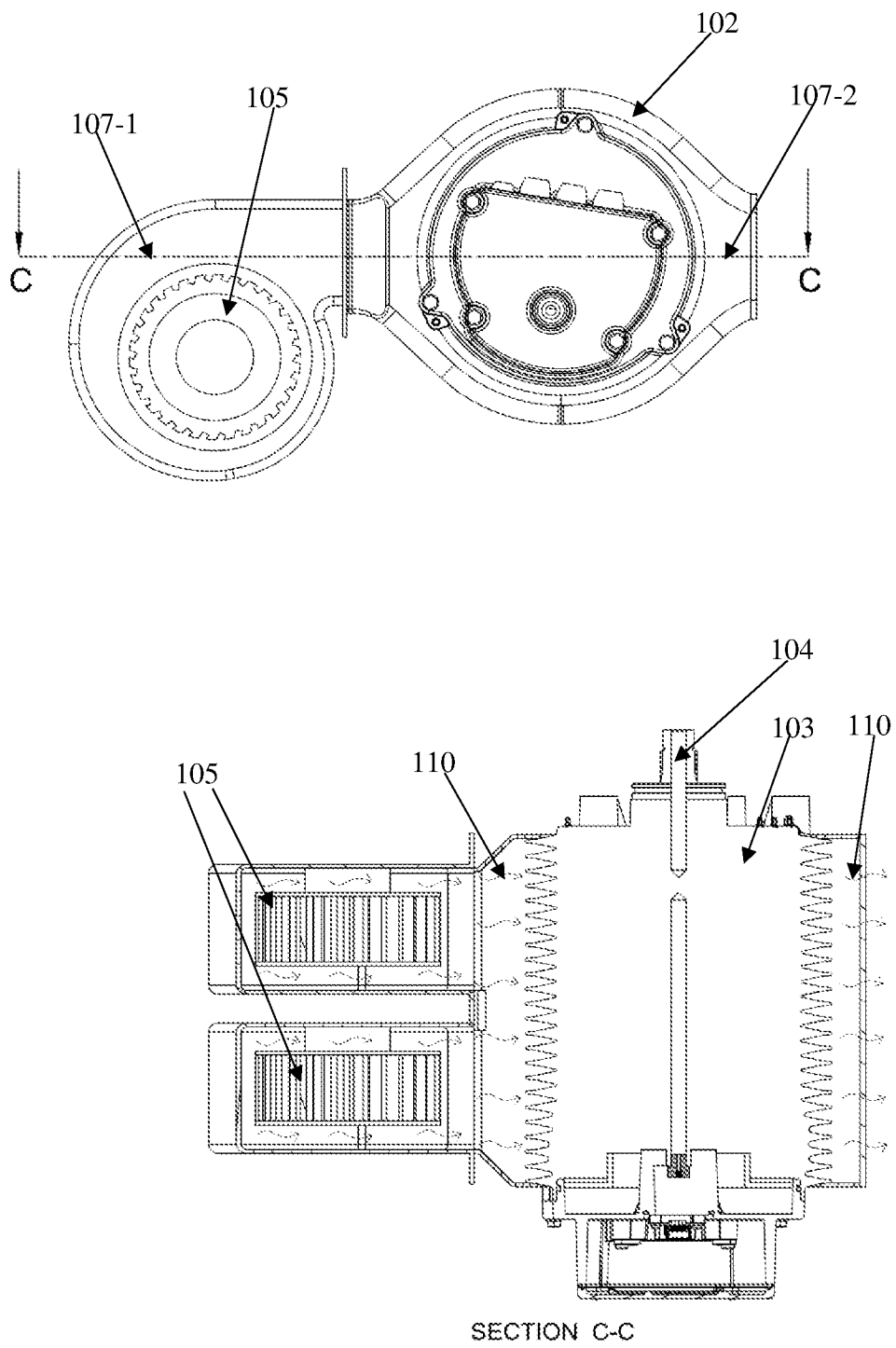
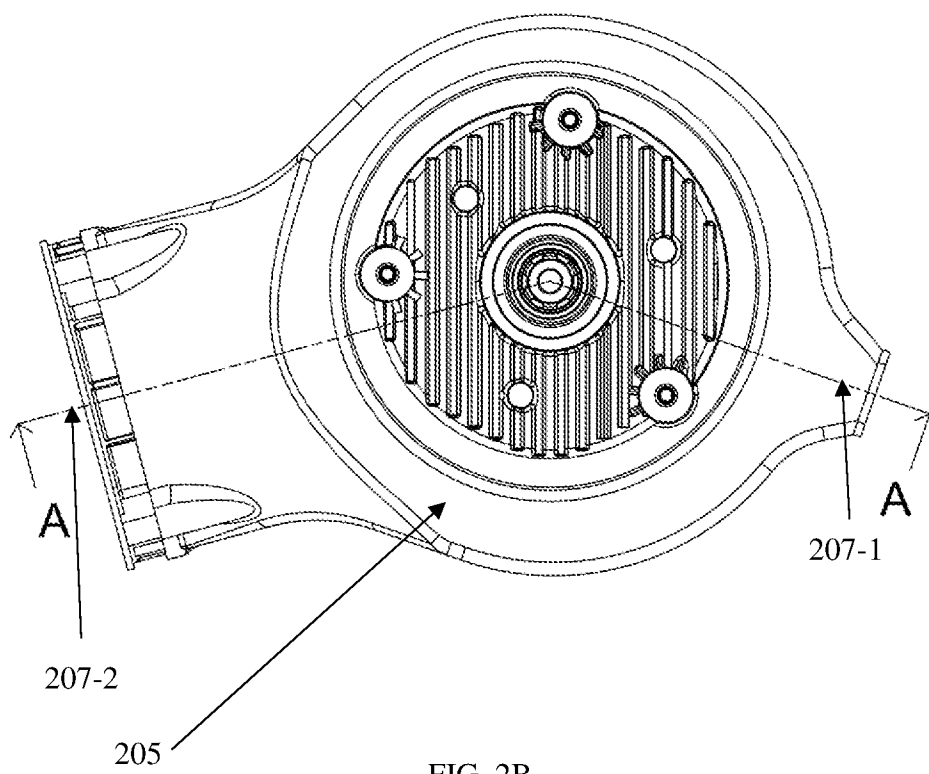
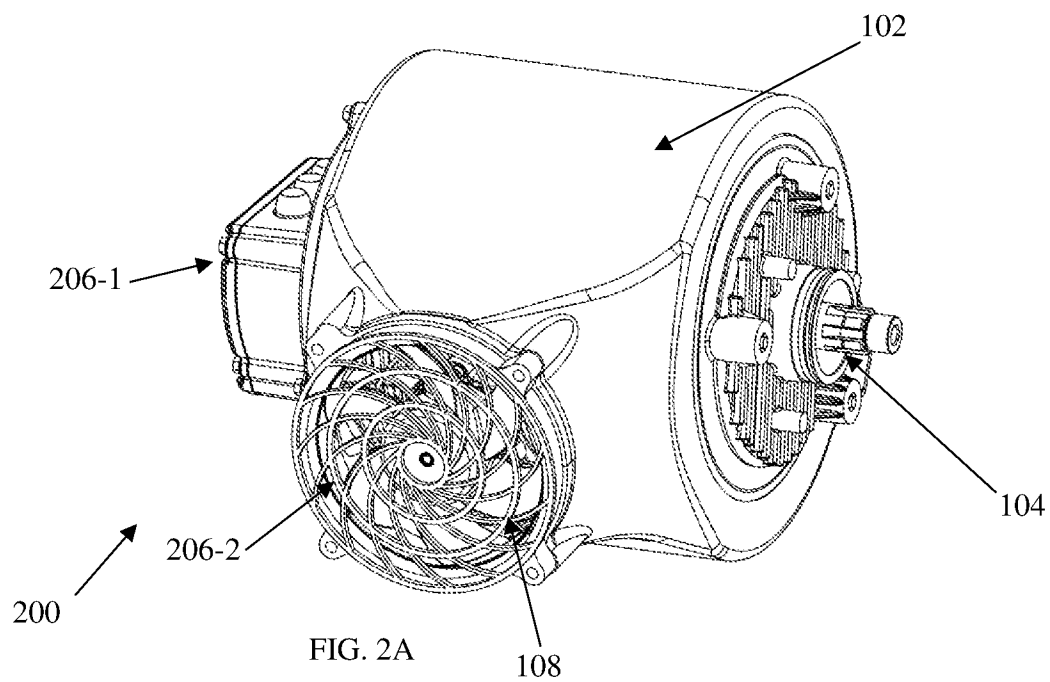


FIG. 1C





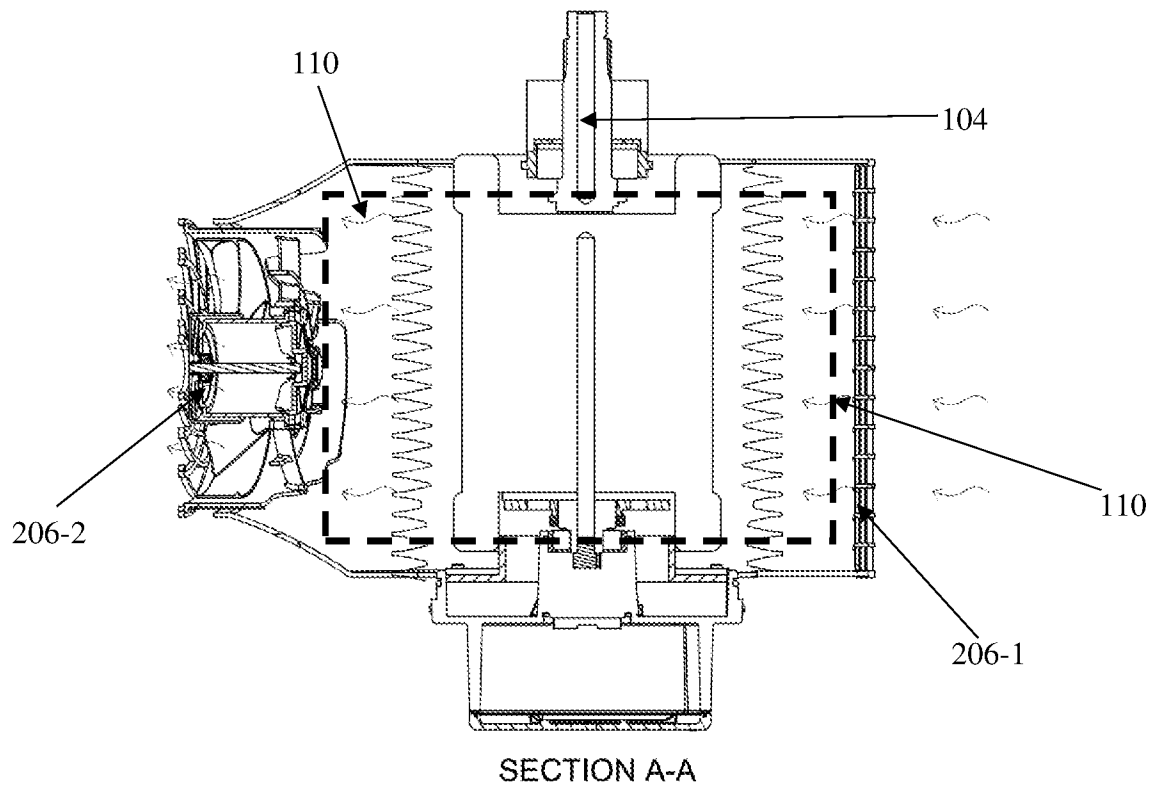


FIG. 2C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2024/050004

A. CLASSIFICATION OF SUBJECT MATTER
H02K9/04 Version=2024.01

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)

H02K

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

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

PatSeer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP3819148A1 GUIGNIER GILLES[FR]; RAGUIN BRUNO[FR] 12 May 2021 12.05.2021 Abstract, Fig. 01, Description para 0063, (Line 01-03); Description para 006, (Line 01-03); Description para 0010, (Line 05-10)	1-15
A	EP2109207A2 GRANER KLAUS[DE]; LIS JOHANN[DE] 14 October 2009 14.10.2009 Abstract, Fig. 01, Description para 0024, (Line 01-05); Description para 0010, (Line 03-08)	1-15

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"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

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Date of the actual completion of the international search

02-05-2024

Date of mailing of the international search report

02-05-2024

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2024/050004

Citation	Pub.Date	Family	Pub.Date
EP 3819148 A1	12-05-2021	CN 112787455 A	11-05-2021
		JP 2021078347 A	20-05-2021
EP 2109207 A2	14-10-2009	AU 2009201349 A	29-10-2009
		CN 101557143 A	14-10-2009
		DE 102008022105 A1	15-10-2009
		US 2009267426 A1	29-10-2009