

FULLY ENCLOSED SELF-VENTILATED ELECTRIC MOTOR

FIELD

[0001] The present application relates to the technical field of cooling of rail traction motors,
5 and in particular to a fully enclosed self-ventilated motor.

BACKGROUND

[0002] In order to prevent metal powder generated from the friction between the wheels and
the steel rails during the operation of rail vehicles, as well as brake shoe dust produced from
10 the wear of the brake shoe during braking from entering the motor and adhering to the surface
of the rotor of the permanent magnet motor, the permanent magnet motor typically requires a
fully enclosed structure.

[0003] The conventional permanent magnet motor with a fully enclosed, self-ventilated
cooling structure is cooled by ventilation through the stator ventilation duct. During operation,
15 the cooling air generated by an external fan mounted on the rotor enters the stator ventilation
duct from the non-drive end cover, flows axially along the stator ventilation duct to reach the
air outlet on the drive end cover or the intermediate end cover, and is then discharged from the
ventilation duct through the air outlet to carry away the heat from the motor. This conventional
fully enclosed, externally-ventilated and self-cooling permanent magnet motor relies solely on
20 the cooling air within the stator ventilation duct (there is only one heat dissipation channel) for
heat dissipation, which prevents effective dissipation of heat inside the motor, making the motor
prone to becoming an isothermal body. Heat inside the motor is mutually conducted and
radiated among various components therein, resulting in a high temperature at each of the stator
coil end, the permanent magnet, and the bearing. However, the temperature limits for the coil,
25 the bearing, and the permanent magnet are not the same, which restricts the increase of the
motor power, particularly for the motor characterized by a high torque density, a high power
density and a compact structure. In addition, in order to prevent irreversible demagnetization
of the permanent magnet mounted on the rotor in the permanent magnet motor currently applied
to the rail vehicles, rare-earth permanent magnet materials with a high temperature-resistance
30 level are commonly utilized.

[0004] A self-ventilated fully enclosed double-circulation air-cooled motor is disclosed in

CN202309380U. In addition to the conventional ventilation and cooling structure for the stator, a second cooling air path is provided inside the motor. The principle of the second cooling air path is that a ventilation fan is mounted on one side of the rotor core to carry the heat from the rotor to the stator through the internal circulating air, and then the heat is carried away via the first cooling air path. However, the second cooling air path is configured for circulation only within the motor, and the heat inside the motor fails to directly exchange with the external air for heat dissipation, thereby offering limited cooling effect on the rotor and bearing.

[0005] A fully enclosed main electric motor for a vehicle is disclosed in CN102356534B. In addition to the conventional ventilation and cooling structure for the stator, a second cooling air duct is provided on the non-drive end bearing side. The principle of the second cooling air duct is that a ventilation fan is mounted on the rotor core to draw in external air through the air inlet of the non-drive end bracket, and then discharge it through the air outlet of the non-drive end bracket, thereby directly cooling the non-drive end bearing and indirectly cooling the rotor. However, the rotor of the motor in this cooling solution still has a relatively high temperature, and it is mainly applied to the asynchronous motor. When used in the permanent magnet motor, there is a risk of high-temperature demagnetization for the permanent magnet mounted on the rotor.

[0006] A fully enclosed externally-ventilated electric motor is disclosed in CN1848620B. In addition to the conventional ventilation and cooling structure for the stator, a second cooling air path is provided inside of the rotor. The principle of the second cooling air path is that a ventilation fan (or a rotor-specific ventilation fan) is mounted on one side of the rotor, allowing the cooling air to enter through the air inlet of the non-drive end cover, flow through the ventilation duct that runs through the rotor core in the axial direction, then merge into the first cooling air path of the stator, and finally be discharged through air outlet at the non-drive end. However, in this cooling structure, the ventilation volume of the rotor through the second cooling air path is limited, preventing effective dissipation of heat from the rotor. Moreover, the heat from the rotor is carried away through the stator ventilation duct, which reduces the heat dissipation efficiency of the stator.

[0007] In summary, the designs in the existing patents involve incorporating a second cooling air path in addition to the above ventilation and cooling air path for the stator. That is, a dedicated ventilation fan is mounted on one side of the rotor core to carry the heat from the

rotor to the stator core via the internal circulating air, which is subsequently dissipated through the first cooling air path of the stator core. This additional second cooling air path only transfers the heat inside the motor to the stator core without directly exchanging heat with the external atmosphere for heat dissipation, resulting in limited cooling efficiency. Consequently, the temperature inside the motor remains relatively high, and the permanent magnet with a high temperature-resistance level is still required when employed in the permanent magnet motor.

[0008] In view of this, it is desired for those skilled in the art to provide a cooling structure that is applicable to a fully enclosed motor and achieves a better cooling effect on internal components of the motor.

SUMMARY

[0009] In order to address the above technical issues, a fully enclosed self-ventilated motor is provided according to the present application, which not only enables efficient ventilation and cooling for components such as the stator, the rotor, the bearing and the like, but also better adapts to the low-speed operating conditions of the vehicle by adjusting the volume of externally introduced cooling air. Moreover, the cooling structure for the fully enclosed self-ventilated motor is simple, facilitating application to an asynchronous motor or a permanent magnet traction motor.

[0010] The following technical solutions are provided according to the present application.

[0011] A fully enclosed self-ventilated motor includes a stator, a rotor, a front end cover, and a rear end cover. The rotor is arranged inside of the stator. The rotor includes a rotor core, a front rotor pressing ring, a rear rotor pressing ring, a rotating shaft, a front rotor interlayer and a rear rotor interlayer. The front rotor interlayer and the rear rotor interlayer are arranged at both ends of the rotor core, respectively. The stator includes a stator core, a stator winding, a front stator pressing ring, and a rear stator pressing ring. The front end cover and the rear end cover are respectively arranged at a front end and a rear end of a power structure composed of the stator and the rotor. The stator core is formed with a stator axial air duct extending through the stator core. The rotor is formed with a rotor inner air duct extending through the rotor. The front end cover is provided with an air outlet and a front end cover ventilation duct, and the rear end cover is provided with an air inlet and a rear end cover ventilation duct. The air inlet and the rear end cover ventilation duct of the rear end cover, the stator axial air duct and the front end

cover ventilation duct collectively constitute a first cooling air path. The air inlet of the rear end cover, the rotor inner air duct, and the air outlet of the front end cover collectively constitute a second cooling air path. Neither the first cooling air path nor the second cooling air path is in communication with the stator winding.

5 **[0012]** Preferably, the fully enclosed self-ventilating motor further includes an external fan, which is located at the air inlet of the rear end cover and is mounted on the rotating shaft at a rear end of the rotor core to rotate synchronously with the rotor. The external fan itself is provided with an air inlet.

[0013] Preferably, a filter screen is arranged at an air intake end of the external fan.

10 **[0014]** Preferably, the fully enclosed self-ventilated motor further includes a heat exchanger, which is arranged on an outer side of the stator, and an external air duct is formed between the heat exchanger and the stator. The front stator pressing ring is provided with a first internal ventilation duct, and the rear stator pressing ring is provided with a second internal ventilation duct. Each of the first internal air duct and the second internal air duct is configured to be in
15 communication with the interior of the motor and the external air duct. The rotor is further formed with a rotor outer air duct extending through the rotor. The first internal ventilation duct of the front stator pressing ring, the rotor outer air duct, the second internal ventilation duct of the rear stator pressing ring, and the external air duct collectively constitute a third cooling air path.

20 **[0015]** Preferably, a front ventilation cavity is formed between the front cover and the rotor core, and a rear ventilation cavity is formed between the rear cover and the rotor core. Both the front ventilation cavity and the rear ventilation cavity are located in the second cooling air path.

[0016] Preferably, a front bearing is arranged in the front end cover and is located at one side of the front ventilation cavity. A rear bearing is arranged in the rear end cover and is located at
25 one side of the rear ventilation cavity.

[0017] Preferably, the front end cover is provided with a front end cover annular boss A and a front end cover annular boss B, which is located inside of the front end cover annular boss A. A contact seal is formed between the front end cover annular boss A and the front stator pressing ring, and a non-contact seal is formed between the front end cover annular boss B and the front
30 rotor interlayer. A front end of the stator winding is located in a sealed cavity defined by the

front end cover annular boss A, the front end cover annular boss B, the stator core and the rotor core. The rear end cover is provided with a rear end cover annular boss A and a rear end cover annular boss B, which is located inside of the rear end cover annular boss A. A contact seal is formed between the rear end cover annular boss A and the rear stator pressing ring, and a non-
5 contact seal is formed between the rear end cover annular boss B and the rear rotor interlayer. A rear end of the stator winding is located in a sealed cavity defined by the rear end cover annular boss A, the rear end cover annular boss B, the stator core and the rotor core.

[0018] Preferably, the stator winding is located in the sealed cavities so that the stator winding is isolated from an external environment.

10 **[0019]** Preferably, each of the front rotor interlayer and the rear rotor interlayer is configured as an annular structure, and blades are arranged on the front rotor interlayer and/or the rear rotor interlayer.

[0020] Preferably, the fully enclosed self-ventilated motor is implemented as an asynchronous motor or a permanent magnet traction motor for a rail vehicle.

15 **[0021]** The present application has the following advantages compared with conventional technology.

[0022] Firstly, the structural design of the fully enclosed self-ventilated motor in the present application incorporates a first cooling air path and a second cooling air path. The first cooling air path is composed of the air inlet and the rear end cover ventilation duct of the rear end cover,
20 the stator axial air duct and the front end cover ventilation duct. The second cooling air path is composed of the air inlet of the rear end cover, the rotor inner air duct, and the air outlet of the front end cover. The stator, the rotor and the bearings are simultaneously cooled via the first cooling air path and the second cooling air path, resulting in a simple ventilation and cooling structure. Moreover, by adjusting the volume of externally introduced cooling air, this fully
25 enclosed self-ventilated motor may better adapt to low-speed operating conditions of the vehicle, thereby effectively enhancing the power density and the torque density of the motor. Furthermore, since neither the first cooling air path nor the second cooling air path is in communication with the stator winding, this fully enclosed self-ventilated motor may be applied to the traction motor for the rail vehicle operating in harsh and sandy environments, offering
30 high safety and versatility.

[0023] Secondly, to further enhance the efficient dissipation of internal heat from the motor into the external air, in addition to the first cooling air path and the second cooling air path, the fully enclosed self-ventilated motor according to the present application further incorporates a third cooling air path. The internal heat from the motor is brought to the external air duct via the third cooling air path, where it directly exchanges heat with the external air via the heat exchanger, significantly reducing the internal temperature of the motor.

[0024] Thirdly, in the fully enclosed self-ventilated motor according to the present application, a heat exchanger is provided in the third cooling air path, which improves the heat exchange efficiency between the heat inside and outside the motor, effectively lowering the internal temperature of the motor. When applied to a permanent magnet motor, the fully enclosed self-ventilated motor may effectively reduce the temperature of the permanent magnet and improve reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] In order to more clearly illustrate the technical solutions in the embodiments of the present application or in the relevant technology, the accompanying drawings required for the description of the embodiments or the conventional technology will be briefly explained below. Obviously, the accompanying drawings described below merely show some embodiments disclosed herein. Based on these accompanying drawings, other accompanying drawings can be obtained by those ordinary skilled in the art without any creative work.

[0026] FIG. 1 is a schematic structural view of a fully enclosed self-ventilated motor in a first embodiment of the present application;

[0027] FIG. 2 is a schematic structural view of a fully enclosed self-ventilated motor in a second embodiment of the present application;

[0028] FIG. 3 is a schematic structural view of a fully enclosed self-ventilated motor in a third embodiment of the present application;

[0029] FIG. 4 is a schematic structural view of an external air duct in the second embodiment of the present application;

[0030] FIG. 5 is a schematic structural view of an external air duct in the third embodiment of the present application;

[0031] FIG. 6 is a schematic structural view of the external air duct in the second embodiment of the present application;

[0032] FIG. 7 is a schematic structural view of the external air duct in the second embodiment of the present application;

5 **[0033]** FIG. 8 is a schematic structural view of a rotor axial air duct in the second embodiment of the present application;

[0034] FIG. 9 is a schematic structural view of the rotor axial air duct in the second embodiment of the present application.

[0035] Reference numerals are listed as follows:

- | | | |
|----|--------------------------------------|---------------------------------------|
| 10 | 1. stator; | 11. stator core; |
| | 111. stator axial air duct; | 12. stator winding; |
| | 13. front stator pressing ring; | 131. first internal air duct; |
| | 14. rear stator pressing ring; | 141. second internal air duct; |
| | 2. rotor; | 21. rotor core; |
| 15 | 22. front rotor pressing ring; | 23. rear rotor pressing ring; |
| | 211. rotor inner air duct; | 212. rotor outer air duct; |
| | 24. front rotor interlayer; | 25. rear rotor interlayer; |
| | 26. rotating shaft; | 3. front end cover; |
| | 31. air outlet; | 32. front end cover ventilation duct; |
| 20 | 33. front end cover annular boss A; | 34. front end cover annular boss B; |
| | 4. rear end cover; | 41. air inlet; |
| | 42. rear end cover ventilation duct; | 43. rear end cover annular boss A; |
| | 44. rear end cover annular boss B; | 5. external fan; |
| | 51. filter screen; | 52. external fan air inlet; |
| 25 | 6. front ventilation cavity; | 7. rear ventilation cavity; |
| | 8. front bearing; | 9. rear bearing; |

10. heat exchanger;

101. external air duct.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0036] To enable those skilled in the art to better understand the technical solutions disclosed in the present application, the technical solutions in the embodiments of the present application are clearly and completely described below. Apparently, the embodiments described below are only some rather than all of the embodiments of the present application. Based on the embodiments of the present application, all other embodiments obtained by those ordinary skilled in the art without any creative work fall within the protection scope of the present application.

[0037] The first embodiment is described as follows.

[0038] As shown in FIG. 1, a fully enclosed self-ventilated motor is provided according to this embodiment of the present application, which is applicable for the asynchronous or permanent magnet traction motor for the rail vehicle. The fully enclosed self-ventilated motor includes a stator 1, a rotor 2, a front end cover 3, a rear end cover 4 and an external fan 5. The rotor 2 is arranged inside of the stator 1. The rotor 2 includes a rotor core 21, a front rotor pressing ring 22, a rear rotor pressing ring 23, a rotating shaft 26, a front rotor interlayer 24 and a rear rotor interlayer 25. The front rotor interlayer 24 and the rear rotor interlayer 25 are arranged at both ends of the rotor core 21, respectively. The stator 1 includes a stator core 11, a stator winding 12, a front stator pressing ring 13, and a rear stator pressing ring 14. The front end cover 3 and the rear end cover 4 are respectively arranged at a front end and a rear end of a power structure composed of the stator 1 and the rotor 2. The stator core 11 is provided with a stator axial air duct 111 extending through the stator core. Each of the rotor core 21, the front rotor pressing ring 22, and the rear rotor pressing ring 23 is provided with a rotor inner air duct 211 and a rotor outer air duct 212 (namely, an rotor axial air duct) extending through the rotor. The rotor inner air duct 211 and the rotor outer air duct 212 may be in any shape, and the number of the rotor inner air duct 211 may be more than two. The front end cover 3 is provided with an air outlet 31 and a front end cover ventilation duct 32, and the rear end cover 4 is provided with an air inlet 41 and a rear end cover ventilation duct 42. The air inlet 41 and the rear end cover ventilation duct 42 of the rear end cover 4, the stator axial air duct 111 and the front end cover ventilation duct 32 collectively constitute a first cooling air path. The air inlet 41 of the rear end

cover 4, the rotor inner air duct 211, and the air outlet 31 of the front end cover 3 collectively constitute a second cooling air path. Neither the first cooling air path nor the second cooling air path is in communication with the stator winding 12. The external fan 5 is located at the air inlet 41 of the rear end cover 4 and is mounted on the rotating shaft at a rear end of the rotor core 21 to rotate synchronously with the rotor 2. The external fan 5 may adopt centrifugal blades or axial-flow blades, and a filter screen 51 is arranged at an air intake end of the external fan 5.

[0039] The structural design of the fully enclosed self-ventilated motor in this embodiment incorporates a first cooling air path and a second cooling air path. The first cooling air path is composed of the air inlet 41 and the rear end cover ventilation duct 42 of the rear end cover 4, the stator axial air duct 111 and the front end cover ventilation duct 32. The second cooling air path is composed of the air inlet 41 of the rear end cover 4, the rotor inner air duct 211, and the air outlet 31 of the front end cover 3. The stator 1, the rotor 2, the front bearing 8 and the rear bearing 9 are simultaneously cooled via the first cooling air path and the second cooling air path, resulting in a simple ventilation and cooling structure. In addition, by adjusting the volume of externally introduced cooling air, particularly when increasing the airflow passing through the rotor 2, the heat dissipation effect for the motor during low-speed operation of the vehicle may be significantly enhanced. Moreover, since neither the first cooling air path nor the second cooling air path is in communication with the stator winding 12, this fully enclosed self-ventilated motor may be applied to the traction motor for the rail vehicle operating in harsh and sandy environments, offering high safety and versatility.

[0040] In this embodiment, the cooling air introduced by the external fan 5 is divided into two parallel cooling air paths to simultaneously cool the stator, the rotor and the bearings. This design addresses the issue of insufficient heat dissipation inside the motor, effectively enhancing the power density and the torque density of the permanent magnet motor. Moreover, when applied to reduce the temperature of the rotor 2 in the permanent magnet motor, permanent magnet materials with a low temperature-resistance level may be utilized.

[0041] In this embodiment, a front ventilation cavity 6 is formed between the front cover 3 and the rotor core 21, and a rear ventilation cavity 7 is formed between the rear cover 4 and the rotor core 21. Both the front ventilation cavity 6 and the rear ventilation cavity 7 are located in the second cooling air path.

[0042] The specific cooling process of the fully enclosed self-ventilated motor in this

embodiment is as follows.

[0043] Firstly, the external fan 5, mounted on the rotating shaft at the rear end of the rotor core 21, utilizes centrifugal blades to draw in external cooling air through the external fan air inlet 52. A part of the cooling air flows through the ventilation duct 42 of the rear end cover 4 and the axial stator ventilation duct 111 in sequence, and then is discharged through the front end cover ventilation duct 32. During the flow of the cooling air, the cooling air carries away the heat generated by the stator core 11 and the stator winding 12.

[0044] Secondly, the external fan 5, mounted on the rotating shaft at the rear end of the rotor core 21, utilizes centrifugal blades to draw in external cooling air through the external fan air inlet. Another part of the air flows through the air inlet 41 of the rear end cover 4, the rear ventilation cavity 7, the rotor inner air duct 211, and the front ventilation cavity 6 in sequence, and then is discharged through the air outlet 31 of the front end cover 3. During the flow of the cooling air, the cooling air carries away the heat radiated from the stator winding 12 to the end cover, as well as the heat generated by the rotor 2, the front bearing 8 and the rear bearing 9.

[0045] In this embodiment, a front bearing 8 is arranged in the front end cover 3 and is located at one side of the front ventilation cavity 6. A rear bearing 9 is arranged in the rear end cover 4 and is located at one side of the rear ventilation cavity 7.

[0046] In this embodiment, the front end cover 3 is provided with a front end cover annular boss A 33 and a front end cover annular boss B 34, which is located inside of the front end cover annular boss A 33. A contact seal is formed between the front end cover annular boss A 33 and the front stator pressing ring 13, and a non-contact seal is formed between the front end cover annular boss B 34 and the front rotor interlayer 24. A front end of the stator winding 12 is located in a sealed cavity that is defined by the front end cover annular boss A 33, the front end cover annular boss B 34, the stator core 11 and the rotor core 21. The rear end cover 4 is provided with a rear end cover annular boss A 43 and a rear end cover annular boss B 44, which is located inside of the rear end cover annular boss A 43. A contact seal is formed between the rear end cover annular boss A 43 and the rear stator pressing ring 14, and a non-contact seal is formed between the rear end cover annular boss B 44 and the rear rotor interlayer 25. A rear end of the stator winding 12 is located in a sealed cavity that is defined by the rear end cover annular boss A 43, the rear end cover annular boss B 44, the stator core 11 and the rotor core 21. The annular bosses, namely the front end cover annular boss A 33, the front end cover

annular boss B 34, the rear end cover annular boss A 43 and the rear end cover annular boss B 44 may be formed by integral casting with the end cover itself, or by other connection manners such as welding, interference connection or bolt connection.

[0047] In this embodiment, each of the front rotor interlayer 24 and the rear rotor interlayer 25 is configured as a cylindrical structure. Blades, which may be those of an air circulation fan, are arranged on the front rotor interlayer 24 and/or the rear rotor interlayer 25. The front rotor interlayer 24 and the rear rotor interlayer 25 may be respectively fixed to the front rotor pressing ring 22 and the rear rotor pressing ring 23 by connection manners such as welding, interference fit or bolt connection.

[0048] The second embodiment is described as follows.

[0049] As shown in FIG. 2, the difference between the second embodiment and the first embodiment lies in that the fully enclosed self-ventilated motor further includes a heat exchanger 10. The heat exchanger 10 may be a simple arc-shaped tension plate (as shown in FIG. 4 and FIG. 5) or incorporate a finned structure (as shown in FIG. 6 and FIG. 7) to enhance the heat exchange efficiency. The heat exchanger may be made of steel or other materials with better thermal conductivity, such as copper or aluminum. The heat exchanger is fixed to an outer side of the stator 1 by welding or bolt connection, and the number of the heat exchanger may be one or more. An external air duct 101 is formed between the heat exchanger and the stator. The front stator pressing ring 13 is provided with a first internal air duct 131, and the rear stator pressing ring 14 is provided with a second internal air duct 141. Each of the first internal air duct 131 and the second internal air duct 141 is configured to be in communication with the interior of the motor and the external air duct 101. Each of the rotor core 21, the front rotor pressing ring 22 and the rear rotor pressing ring 23 is formed with a rotor inner air duct 211 and a rotor outer air duct 212 (namely, an rotor axial air ducts) extending through the rotor. The first internal ventilation duct 131, the rotor outer air duct 212, the second internal ventilation duct 141, and the external air duct 101 collectively constitute a third cooling air path. The rotor axial air duct includes the rotor inner air duct 211 and the rotor outer air duct 212. The rotor inner air duct 211 and the rotor outer air duct 212 may be formed as separate air ducts at different reference circles (as shown in FIG. 8). Alternatively, multiple air ducts at the same reference circle may be configured as inner air ducts and external air ducts respectively (as shown in FIG. 9). The air duct may be in any shape, and the number of air duct arranged in the circumferential

direction may be odd or an even. The remaining structures are the same as that in the first embodiment.

[0050] The third embodiment is described as follow.

5 **[0051]** As shown in FIG. 3, the difference between the third embodiment and the second embodiment lies in that the first cooling air path and the third cooling air path are retained, while the second cooling air path is eliminated, and the remaining structures are the same as that in the second embodiment.

10 **[0052]** The above description of the disclosed embodiments enables those skilled in the art to implement or practice the present application. Various modifications to these embodiments will be apparent to those skilled in the art. The general principles defined herein may be implemented in other embodiments without departing from the spirit or scope of the present application. Therefore, the present application will not be limited to the embodiments described herein, but should be conformed to the broadest scope consistent with the principle and novel features disclosed herein.

CLAIMS

1. A fully enclosed self-ventilated motor, comprising a stator (1), a rotor (2), a front end cover (3) and a rear end cover (4), wherein

5 the rotor (2) is arranged inside of the stator (1),

the rotor (2) comprises a rotor core (21), a front rotor pressing ring (22), a rear rotor pressing ring (23), a rotating shaft (26), a front rotor interlayer (24) and a rear rotor interlayer (25), wherein the front rotor interlayer (24) and the rear rotor interlayer (25) are respectively arranged at both ends of the rotor core (21),

10 the stator (1) comprises a stator core (11), a stator winding (12), a front stator pressing ring (13) and a rear stator pressing ring (14), wherein the front end cover (3) and the rear end cover (4) are respectively arranged at a front end and a rear end of a power structure composed of the stator (1) and the rotor (2),

15 the stator core (11) is formed with a stator axial air duct (111) extending through the stator core, and the rotor (2) is formed with a rotor inner air duct (211) extending through the rotor,

the front end cover (3) is provided with an air outlet (31) and a front end cover ventilation duct (32), and the rear end cover (4) is provided with an air inlet (41) and a rear end cover ventilation duct (42),

20 the air inlet (41) and the rear end cover ventilation duct (42) of the rear end cover (4), the stator axial air duct (111) and the front end cover ventilation duct (32) collectively constitute a first cooling air path, and the air inlet (41) of the rear end cover (4), the rotor inner air duct (211), and the air outlet (31) of the front end cover (3) collectively constitute a second cooling air path, and

25 both the first cooling air path and the second cooling air path are isolated from the stator winding (12).

2. The fully enclosed self-ventilated motor according to claim 1, further comprising an external fan (5), wherein the external fan (5) is located at the air inlet (41) of the rear end cover (4) and is mounted on the rotating shaft at a rear end of the rotor core (21) in such a manner as

to rotate synchronously with the rotor (2).

3. The fully enclosed self-ventilating motor according to claim 2, wherein a filter screen (51) is arranged at an air intake end of the external fan (5).

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4. The fully enclosed self-ventilated motor according to claim 1, further comprising a heat exchanger (10), wherein

the heat exchanger (10) is arranged on an outer side the stator, and an external air duct (101) is formed between the heat exchanger and the stator,

10 the front stator pressing ring (13) is provided with a first internal ventilation duct (131), and the rear stator pressing ring (14) is provided with a second internal ventilation duct (141), with each of the first internal air duct (131) and the second internal air duct (141) being in communication with interior of the motor and the external air duct (101),

15 the rotor (2) is further formed with a rotor outer air duct (212) extending through the rotor, and

the first internal ventilation duct (131) of the front stator pressing ring (13), the rotor outer air duct (212), the second internal ventilation duct (141) of the rear stator pressing ring (14), and the external air duct (101) collectively constitute a third cooling air path.

20 5. The fully enclosed self-ventilated motor according to any one of claims 1 to 4, wherein a front ventilation cavity (6) is formed between the front end cover (3) and the rotor core (21), and a rear ventilation cavity (7) is formed between the rear end cover (4) and the rotor core (21), with both the front ventilation cavity (6) and the rear ventilation cavity (7) being located in the second cooling air path.

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6. The fully enclosed self-ventilated motor according to claim 5, wherein a front bearing (8) is arranged in the front end cover (3) and is located at one side of the front ventilation cavity (6), and a rear bearing (9) is arranged in the rear end cover (4) and is located at one side of the rear ventilation cavity (7).

7. The fully enclosed self-ventilated motor according to any one of claims 1 to 4, wherein the front end cover (3) is provided with a front end cover annular boss A (33) and a front end cover annular boss B (34), which is located inside of the front end cover annular boss A (33), a contact seal is formed between the front end cover annular boss A (33) and the front stator pressing ring (13), and a non-contact seal is formed between the front end cover annular boss B (34) and the front rotor interlayer (24), with a front end of the stator winding (12) being located in a sealed cavity that is defined by the front end cover annular boss A (33), the front end cover annular boss B (34), the stator core (11) and the rotor core (21); and

wherein the rear end cover (4) is provided with a rear end cover annular boss A (43) and a rear end cover annular boss B (44), which is located inside of the rear end cover annular boss A (43), a contact seal is formed between the rear end cover annular boss A (43) and the rear stator pressing ring (14), and a non-contact seal is formed between the rear end cover annular boss B (44) and the rear rotor interlayer (25), with a rear end of the stator winding (12) being located in a sealed cavity defined by the rear end cover annular boss A (43), the rear end cover annular boss B (44), the stator core (11) and the rotor core (21).

8. The fully enclosed self-ventilated motor according to claim 7, wherein the stator winding (12) is located in the sealed cavities so that the stator winding (12) is isolated from an external environment.

9. The fully enclosed self-ventilated motor according to any one of claims 1 to 4, wherein each of the front rotor interlayer (24) and the rear rotor interlayer (25) is configured as an annular structure, and blades are arranged on the front rotor interlayer (24) and/or the rear rotor interlayer (25).

10. The fully enclosed self-ventilated motor according to any one of claims 1 to 4, wherein the fully enclosed self-ventilated motor is implemented as an asynchronous motor or a permanent magnet traction motor for a rail vehicle.