The present invention relates to a drive motor for transverse mounting in a running gear of a rail vehicle with a motor housing (105.2) and a motor shaft (105.1), wherein the motor shaft (105.1) in the mounted state is oriented in a transverse direction of the running gear (103) and the motor housing (105.2) extends over a housing width in the transverse direction of the running gear (103). The motor housing (105.2), on its underside, has a flattened region (105.3), wherein the flattened region (105.3) extends over at least 50% of the housing width and the flattened region (105.3) in at least one peripheral region forms an edge (105.4, 105.5) running in the transverse direction.
DRIVE MOTOR FOR A RAIL VEHICLE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a drive motor for transversely arranged mounting in a running gear of a rail vehicle having a motor housing and a motor shaft, wherein the motor shaft, in the mounted state, is oriented in a transverse direction of the running gear and the motor housing extends over a housing width in the transverse direction of the running gear. The invention furthermore relates to a running gear with such a drive motor and a vehicle with such a running gear.

[0002] In modern rail vehicles which are operated at comparatively high nominal speeds, usually the problem occurs that, at particular points in the region of the running gear at which the air flow detaches from the vehicle components arranged there, flow conditions occur which, at high speeds, lead to a substantial increase in drag and substantial sound emissions. This is partly due to the fact that, downstream of the detachment point, a continuously widening shear layer forms. The wider this shear layer expands, the greater the associated drag. Furthermore, in this shear layer usually periodic formation pronounced vortices occurs (so-called Kelvin-Helmholtz instability) together with the associated sound emission.

[0003] If this shear layer hits running gear components such as, for example, the underside of a transversely installed conventional cylindrical drive motor, which protrudes downward beyond the wheel set shaft, further turbulence is induced which leads to an increase in drag and sound emissions.

SUMMARY OF THE INVENTION

[0004] The present invention is therefore based on the object of providing a drive motor, a running gear and a rail vehicle of the type cited initially which do not entail the above disadvantages or at least only to a lesser extent, and, in particular, in a simple manner allow a reduction in drag and sound emission.

[0005] The present invention is based on the technical teaching that, in a simple manner, a reduction in sound emissions in the region of the running gear and a reduction in drag of the vehicle are achieved if the motor housing in the mounted state on its underside has a flattened region which extends sufficiently far in the transverse direction of the running gear and which in at least one of its two peripheral regions forms an edge running in the transverse direction. Compared with conventional, substantially cylindrical motor housings, the flattened region has the advantage that, because of the flattening, the incident air flow can re-attach to the motor housing forming a boundary layer while the edge running in the transverse direction in the peripheral region causes a proper re-detachment of the flow if arranged on the trailing end of the flattened part during operation.

[0006] By the re-attachment and proper re-detachment of the flow it is achieved that, in the region of the motor, a shear layer only reforms behind the motor (in the direction of travel) and cannot expand again until there, so that over the region of the running gear, in total, a reduction in expansion of the shear layer is achieved. This leads to reduced sound emission and reduced drag.

[0007] It is evident that subsequent running gear components in the flow course can also be structured in the region of their underside such that the flow re-attaches there, so that, in total, a pronounced reduction in sound emission and drag results.

[0008] According to one aspect the invention therefore concerns a drive motor for transversely arranged mounting in a running gear of a rail vehicle having a motor housing and a motor shaft, wherein the motor shaft in the mounted state is oriented in the transverse direction of the running gear and the motor housing extends over a housing width in the transverse direction of the running gear. On its underside the motor housing has a flattened region, wherein the flattened region extends over at least 50% of the housing width and the flattened region, in at least one peripheral region, forms an edge running in the transverse direction.

[0009] The degree of reduction of sound emission and drag, firstly, depends on the width of the flattened region (i.e. its dimension in the transverse direction). Preferably the flattened region therefore extends over at least 70% of the housing width, preferably over at least 80% of the housing width, further preferably over at least 95% of the housing width.

[0010] In particularly favorable embodiments, the flattened region extends over substantially the entire housing width. It is evident, however, that in other variants of the invention the flattened region need not necessarily be configured to be continuous. Rather, the flattened region can be divided into separate flattened sections or subsections, respectively. In certain variants of the invention, the flattened region therefore has a plurality of flattened subsections which are spaced apart in the transverse direction.

[0011] Preferably the flattened region, in a peripheral region trailing in a direction of travel of the running gear, forms an edge running in the transverse direction. In addition or alternatively, it can be provided that the flattened region, in a peripheral region leading in a direction of travel of the running gear, forms an edge running in the transverse direction. If both peripheral regions are provided with such an edge, the defined flow detachment is naturally guaranteed irrespective of the direction of travel.

[0012] Preferably, the respective edge is formed as a sufficiently sharp flow detachment edge which guarantees a reliable, defined flow detachment. Preferably, in a sectional plane running perpendicular to the transverse direction, the motor housing, in the region of the edge running in the transverse direction, has a radius of curvature of less than 10 mm, preferably less than 5 mm, further preferably less than 2 mm.

[0013] The further dimensions of the flattened region can in particular be selected as a function of the nominal operating speed of the vehicle. In preferred variants of the invention, the motor housing defines a circumferential direction and a central plane which, in the mounted state, runs parallel to a height direction and the transverse direction of the running gear. The flattened region then extends in the circumferential direction over a circumferential angle of 20° to 90°, preferably 30° to 80°, further preferably 40° to 60°. Additionally or alternatively, the flattened region, in the circumferential direction, can extend over substantially the same circumferential angle to both sides of the central plane. In particular, a design symmetrical to the central plane can be provided.

[0014] Preferably, in the region of the edge running in the transverse direction, the flattened region is bordered by an adjacent region which is arranged and oriented, respectively, with respect to the flattened region such that it guarantees a gentle re-attachment of the flow or a defined re-detachment of the flow. Preferably, the adjacent region therefore extends in
the circumferential direction over a circumferential angle of 15° to 35°, preferably 20° to 30°, further preferably 25° to 30°.

[0015] Additionally or alternatively, the adjacent region runs substantially tangential to an adjacent outer circumference of the motor housing, leading to a particularly favorable housing design.

[0016] Additionally or alternatively, the adjacent region can be formed as a substantially planar surface, also leading to particularly favorable housing design.

[0017] Additionally or alternatively, the adjacent region can finally run inclined at an angle of inclination to the flattened region of 20° to 60°, preferably 30° to 50°, further preferably 40° to 45°, whereby a particularly gentle re-attachment of the flow or precisely defined re-detachment of the flow is guaranteed.

[0018] The flattened region (in a plane perpendicular to the motor shaft) can, in principle, have any arbitrary at least section-wise curved and/or at least section-wise polygonal sectional contour as long as re-attachment of the flow is guaranteed. In particularly preferred variants, not least because of the simple design, the flattened region is, however, formed as a substantially planar surface.

[0019] In preferred variants of the invention, in the region of a leading edge and in the region of a trailing edge, the flattened region is bordered by an adjacent region so that the benefits outlined above are achieved irrespective of the direction of travel. Preferably, the respective adjacent region runs substantially tangential to an adjacent outer circumference of the motor housing. Additionally or alternatively, the respective adjacent region can be formed as a substantially planar surface. Additionally or alternatively, here again, it can be provided that the respective adjacent region runs inclined at an angle of inclination to the flattened region of 20° to 60°, preferably 30° to 50°, further preferably 40° to 45°.

[0020] The present invention furthermore relates to a running gear with a drive motor according to the invention which drives a wheel unit of the running gear. The drive motor can, in principle, be arranged arbitrarily so that its underside cooperates or interferes with the air flow below the vehicle. In preferred variants, the wheel unit defines a wheel axis which is arranged, in a height direction of the running gear, at a first height level and the flattened region is arranged at a second height level which lies below the first height level.

[0021] The present invention furthermore relates to a rail vehicle with a running gear according to the invention. Preferably this is a rail vehicle for high speed traffic with a nominal operating speed above 250 km/h, in particular above 300 km/h, as here the benefits described above are particularly effective.

[0022] Further preferred embodiments of the invention become apparent from the dependent claims or the description below of preferred exemplary embodiments which refers to the enclosed drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1 is a schematic sectional view of part of a preferred embodiment of the rail vehicle according to the invention, with a preferred embodiment of the running gear according to the invention, with a preferred embodiment of the drive motor according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] With reference to FIG. 1, a preferred embodiment of the rail vehicle 101 according to the invention is described below. The rail vehicle 101 is the end wagon of a multiple unit vehicle for high speed traffic with nominal operating speeds above 250 km/h, namely vₓ=300 km/h to 380 km/h.

[0025] The vehicle 101 comprises a wagon body (indicated by contour 102) which, in the region of its two ends, in a conventional manner is supported on a running gear in the form of a bogie 103. It is evident, however, that the present invention can also be used in connection with other configurations in which the wagon body is supported on only one running gear.

[0026] For easier understanding of the explanations given below, in FIG. 1 a vehicle coordinate system x, y, z (specified by the wheel support plane of the bogie 103) is given in which the x coordinate designates the longitudinal direction, the y coordinate the transverse direction and the z coordinate the height direction of the rail vehicle 101 and bogie 103, respectively.

[0027] The bogie 103 is arranged in a running gear cut-out 104 of the wagon body 102 which, at its leading end, is limited by a leading wall 102.1. The running gear cut-out 104 is limited by skirts on both running gear sides.

[0028] The bogie 103, in a conventional manner, has two wheel units in the form of wheelsets 103.1 on which a bogie frame 103.2 is supported. Each wheelset 103.1 is driven via a gear (not shown) by a drive motor 105 which is mounted to be transversely arranged (i.e. with the motor shaft 105.1 running in the vehicle transverse direction) on the bogie frame 103.2.

[0029] In the present example, the motor 105 is mounted so that the motor shaft 105.1 lies at a height level (i.e. in the z direction) which lies in the region of axle 103.3. The motor housing 105.2 therefore protrudes downward beyond the axle 103.3.

[0030] The motor housing 105.2, at its underside protruding into the air flow, has a flattened region in the form of a substantially planar surface 105.3. The flattened region 105.3, at its leading periphery in the present direction of travel (here the positive x direction), has a first edge 105.4 running in the transverse direction (y direction) and, at its trailing periphery in the present direction of travel, has a second edge 105.5 running in the transverse direction.

[0031] The flattened region 105.3, in the region of the first edge 105.4, is bordered by a leading first adjacent region 105.6 and, in the region of the second edge 105.5, is bordered by a trailing second adjacent region 105.7. Each adjacent region is also formed as a substantially planar surface which merges tangentially into the otherwise substantially cylindrical outer contour of the motor housing 105.2.

[0032] It is evident, however, that in other variants of the invention, the outer contour of the motor housing lying outside the flattened region and the adjacent regions may have any other arbitrary design. It can, for example, have any arbitrary sectional contour which is at least section-wise curved and/or at least section-wise polygonal (in a plane perpendicular to the motor shaft).

[0033] The flattened region 105.3, in the present example, extends over substantially the entire housing width of the motor housing 105.2 (in the transverse direction). It is evident, however, that in other variants of the invention a smaller
proportion of the housing width can be provided with the flattening or correspondingly flattened subsections.

[0034] Each edge 105.4 and 105.5 is designed as a sufficiently sharp flow detachment edge which (as will be explained in more detail below) guarantees a reliable, defined flow detachment. To this end, the motor housing 105.2, in the present example, has a radius of curvature of approximately 2 mm in the region of the respective edge 105.4 and 105.5 in a sectional plane running perpendicular to the transverse direction (xz plane).

[0035] The motor housing 105.2 defines a circumferential direction and a central plane 105.8 (containing the axis of the motor shaft 105.1) which, in the mounted state, runs parallel to the height direction and the transverse direction. The flattened region 105.3, in the present example, in the circumferential direction, extends over a circumferential angle of 40°, wherein it extends in the circumferential direction over substantially the same circumferential angle to both sides of the central plane 105.8. The flattened region 105.3 also runs parallel to the xy plane (and, hence, on a straight level track, parallel to the wheel support plane).

[0036] The two flat adjacent regions 105.6 and 105.7 each extend in the circumferential direction over a circumferential angle of 25°, wherein they run inclined at an angle of inclination to the flattened region 105.3 of 45°.

[0037] At the lower end of the leading wall 102.1, the outer skin of the wagon body 102 forms a detachment region in the form of a flow separation edge 102.2 at which the air flow (flowing over the underside of the wagon body 102 from the free vehicle end to running gear cut-out 104) detaches from the outer skin, i.e. the surface of the wagon body 102.

[0038] After detachment of the air flow, as a result of the different flow speeds in the running gear cut-out 104 and the gap below to the track bed, a so-called shear layer 106 forms. The flow conditions within the shear layer 106 are extremely unstable because of the speed differences, so that, apart from an expansion of the shear layer 106 in the vehicle height direction (z direction), in the further course of the flow periodic roll-up of vortices occurs.

[0039] This periodic vortex formation in conventional vehicles causes a substantial sound emission in this vehicle region. This is amplified when these vortices hit subsequent vehicle components, in particular components of the running gear such as, amongst others, the motor housing 105.2. As a result, these components are excited to vibration and hence also sound emission. Furthermore, a large expansion of the shear layer 106 causes a significant increase in the drag of the vehicle 101.

[0040] The design of the motor housing 105.2 described above causes a reduction in sound emission and drag of the vehicle 101 as will be described in detail below.

[0041] The leading, forward sloping (in the positive x direction in travel) adjacent region 105.6, firstly, causes a gentle re-attachment of the flow to the motor housing 105.2, where in the subsequent flattened region 105.3, thanks to its flattened design, a low resistance attached flow (forming a boundary layer) re-forms.

[0042] Only at the trailing second edge 105.5 does the flow detach, again forming a shear layer, wherein the inclination of the trailing second adjacent region 105.6 to the flattened region 105.3 prevents this flow being able to follow this change in direction of the sectional contour of the motor housing 105.2. As a result, a clearly defined detachment of the flow at the second edge 105.5 is guaranteed.

[0043] In total, the defined re-attachment at the flattened region 105.3 and the defined re-detachment of the flow, hence the section-wise interruption in the shear layer, in comparison with conventional designs with cylindrical motor underside, for example, substantially reduces the expansion of the shear layer 106 behind the motor 105 and, hence, both sound emission and drag.

[0044] The design symmetrical to the central plane 105.8 of the motor housing 105.2 entails the advantage that the defined re-attachment at the flattened region 105.3 and defined re-detachment of the flow are guaranteed also in the opposite direction of travel.

[0045] The present invention has been described above exclusively on the basis of a vehicle for multiple unit rail vehicles in high speed traffic. It is evident, however, that the invention can also be used in connection with other rail vehicles.

What is claimed is:
1. A drive motor for transversely arranged mounting in a running gear of a rail vehicle, comprising a motor housing and a motor shaft, wherein said motor shaft, in said mounted state, is oriented in a transverse direction of said running gear, and said motor housing extends over a housing width in said transverse direction of said running gear,

2. The drive motor according to claim 1, wherein said flattened region extends over at least 70% of said housing width,

3. The drive motor according to claim 1, wherein said flattened region at least one of extends over at least 80% of said housing width and extends over at least 95% of said housing width,

4. The drive motor according to claim 1, wherein said flattened region extends over substantially said entire housing width,

5. The drive motor according to claim 1, wherein said flattened region has a plurality of flattened subsections which are spaced apart in said transverse direction.

6. The drive motor according to claim 1, wherein said flattened region, in a peripheral region leading in a direction of travel of said running gear, forms an edge running in said transverse direction.

7. The drive motor according to claim 1, wherein said flattened region, in a peripheral region trailing in a direction of travel of said running gear, forms an edge running in said transverse direction.

8. The drive motor according to claim 1, wherein said motor housing, in said region of said edge running in said transverse direction, in a sectional plane running perpendicular to said transverse direction, has a radius of curvature of at least one of less than 10 mm, less than 5 mm and less than 2 mm.

9. The drive motor according to claim 1, wherein said motor housing defines a circumferential direction and a central plane which, in said mounted state, runs parallel to a height direction and said transverse direction of said running gear, wherein
said flattened region, in said circumferential direction, extends over a circumferential angle of at least one of 20° to 90°, 30° to 80° and 40° to 60°.

10. The drive motor according to claim 1, wherein said motor housing defines a circumferential direction and a central plane which, in said mounted state, runs parallel to a height direction and said transverse direction of said running gear, wherein said flattened region, in said circumferential direction, extends over substantially said same circumferential angle to both sides of said central plane.

11. The drive motor according to claim 1, wherein said flattened region, in said region of said edge running in said transverse direction, is bordered by an adjacent region, wherein said adjacent region extends in said circumferential direction over a circumferential angle of at least one of 15° to 35°, 20° to 30° and 25° to 30°,

12. The drive motor according to claim 1, wherein said flattened region, in said region of said edge running in said transverse direction, is bordered by an adjacent region, wherein said adjacent region runs substantially tangential to an adjacent outer circumference of said motor housing.

13. The drive motor according to claim 1, wherein said flattened region, in said region of said edge running in said transverse direction, is bordered by an adjacent region, wherein said adjacent region is formed as a substantially planar surface.

14. The drive motor according to claim 1, wherein said flattened region, in said region of said edge running in said transverse direction, is bordered by an adjacent region, wherein said adjacent region runs inclined at an angle of inclination to said flattened region of at least one of 20° to 60°, 30° to 50° and 40° to 45°.

15. The drive motor according to claim 1, wherein said flattened region is formed as a substantially planar surface.

16. The drive motor according to claim 1, wherein said flattened region, in said region of a leading edge and in said region of a trailing edge, is bordered by an adjacent region, wherein each adjacent region runs substantially tangential to an adjacent outer circumference of said motor housing.

17. The drive motor according to claim 1, wherein said flattened region, in said region of a leading edge and in said region of a trailing edge, is bordered by an adjacent region, wherein each adjacent region is formed as a substantially planar surface.

18. The drive motor according to claim 1, wherein said flattened region, in said region of a leading edge and in said region of a trailing edge, is bordered by an adjacent region, wherein each adjacent region runs inclined at an angle of inclination to said flattened region of at least one of 20° to 60°, 30° to 50° and 40° to 45°.

19. A running gear of a rail vehicle with a drive motor for transversely arranged mounting, driving a wheel unit of said running gear and comprising a motor housing and a motor shaft, wherein said motor shaft, in said mounted state, is oriented in a transverse direction of said running gear, and said motor housing extends over a housing width in said transverse direction of said running gear, wherein said motor housing, on its underside, has a flattened region, said flattened region extends over at least 50% of said housing width, and said flattened region, in at least one peripheral region, forms an edge running in said transverse direction.

20. The running gear according to claim 19, wherein said wheel unit defines a wheel axis which, in a height direction of said running gear, is arranged at a first height level, and said flattened region is arranged at a second height level which lies below said first height level.

21. A rail vehicle comprising a running gear with a drive motor for transversely arranged mounting, said drive motor driving a wheel unit of said running gear and comprising a motor housing and a motor shaft, wherein said motor shaft, in said mounted state, is oriented in a transverse direction of said running gear, and said motor housing extends over a housing width in said transverse direction of said running gear, wherein said motor housing, on its underside, has a flattened region, said flattened region extends over at least 50% of said housing width, and said flattened region, in at least one peripheral region, forms an edge running in said transverse direction.

22. The rail vehicle according to claim 21, wherein it is designed for high speed traffic with a nominal operating speed above 250 km/h, in particular above 300 km/h.

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