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Electric drive unit and vehicle comprising a corresponding electric drive unit

Abstract

The invention relates to an electric drive unit (**10**), in particular for a vehicle or motor vehicle, comprising an electric machine (**12**) and a transmission (**14**). The electric machine (**12**) is accommodated in a drive housing (**18**), and the transmission (**14**) is accommodated in a transmission housing (**20**), wherein the interior (**19**) of the drive housing (**18**) and the interior (**21**) of the transmission housing (**20**) are separated by a bearing wall (**22**), and at least one cooling channel (**24**) for cooling the electric machine (**12**) is formed on or in the drive housing (**18**). The electric drive unit (**10**) has an insert (**26**) which is designed and arranged such that a cavity (**28**) is produced in the drive housing (**18**) between the bearing wall (**22**) and the insert (**26**), and the cavity (**28**) is fluidically connected to the cooling channel (**24**). The invention also relates to a vehicle comprising a corresponding electric drive unit (**10**).

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
5293089	12/1993	Frister	310/64	H02K 5/203
5698912	12/1996	Rasch	475/161	H02K 9/19
6300693	12/2000	Poag	310/58	H02K 5/203
8922072	12/2013	Bott	310/52	H02K 15/14
9054565	12/2014	Fulton	N/A	H02K 9/19
10141798	12/2017	Rogginger	N/A	H02K 1/20
10516320	12/2018	Chamberlin	N/A	H02K 9/19
2009/0102298	12/2008	Savant	310/52	H02K 5/203
2018/0123409	12/2017	Rogginger	N/A	B02C 23/00

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
102014214724	12/2015	DE	N/A
3028888	12/2015	EP	N/A
2019062716	12/2018	JP	N/A
2014026874	12/2013	WO	N/A
2019240522	12/2018	WO	N/A
2020069744	12/2019	WO	N/A

OTHER PUBLICATIONS

Translation of International Search Report for Application No. PCT/EP2021/071719 dated Nov. 10, 2021 (2 pages). cited by applicant

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Background/Summary

BACKGROUND

(1) The invention relates to an electric drive unit, in particular for a vehicle or motor vehicle, as well as to a vehicle.

(2) An electric axle drive (eAxle) consists substantially of power electronics, an electric machine, and a transmission. In addition to the electric machine, the transmission also generates heat during operation, which must be dissipated as of a certain continuous outlet.

(3) Conventionally, the heat in the transmission is dissipated with a heat exchanger. When the electric machine is cooled with water, the oil in the transmission is not necessarily coupled to a heat exchanger.

(4) DE 10 2014 214 724 A1 discloses an electric machine having a cooling jacket consisting of an inner shell and an outer shell, wherein a cooling chamber configured as an annular gap is arranged between these shells. The inner shell and the outer shell are slid into one another for assembly, wherein the ring gap is sealed at its axial ends by adhesive connections.

SUMMARY

(5) According to the invention, an electric drive unit, in particular for a vehicle or motor vehicle, having an electric machine and a transmission is proposed. The electric machine is accommodated in a drive housing, and the transmission is accommodated in a transmission housing. The drive housing and the transmission housing can be integrally formed or can be formed as separate elements. An interior of the drive housing and an interior of the transmission housing are separated by a bearing wall. On or in (e.g. within) the drive housing(s), at least one cooling channel (e.g. in the form of a cooling jacket) is configured for cooling the electric machine. The electric drive unit comprises an insert designed and arranged so as to create a cavity in the drive housing between the bearing wall and the insert, wherein the cavity is fluidically connected to the cooling channel.

(6) “Fluidically connected” means a connection of two elements (or spaces) via which a fluid (gas, liquid) of an element (or space) can flow into the other and vice versa.

(7) The cavity formed by the insert thus becomes part of the cooling circuit and/or becomes a further cooling channel that cools the bearing wall. A cooling of the transmission via the transmission housing or the bearing wall can thus be realized.

(8) The insert can be inserted/pressed into the housing.

(9) The drive housing and transmission housing can be configured as housing portions that, when assembled, form a housing assembly or a housing. An integral configuration of the housing is also conceivable.

(10) The bearing wall can be formed in an end region of the drive housing facing the transmission housing (the drive housing has a bearing wall). The bearing wall can contain a bearing seat for a roller bearing (e.g. for storing the motor shaft), optionally also a sealing seat for a sealing ring, e.g. a radial shaft sealing ring. The bearing wall is in particular radially oriented (bearing wall arranged orthogonally to the central longitudinal axis of the electric machine or its motor shaft).

(11) The insert can be radially arranged in the drive housing, e.g. as a radially oriented insert washer.

(12) The electric drive unit can serve as an electric drive unit for a vehicle or motor vehicle, for example in the form of an electrical axis (“eAxle”). An application in mechanical engineering is also conceivable, for example as a power unit for a machine tool.

(13) According to a further development, the insert can be configured such that the cavity extends over the entire surface of the bearing wall facing the drive housing. The entire bearing wall can thus be cooled. The cooling of the bearing wall or the transmission housing or the transmission can be optimized. Only the region of the bearing seat and/or the sealing seat can be left unoccupied. The cavity can be circularly annular, for example.
(14) According to a further development, the cavity can be fluidically connected to the cooling channel by way of at least one channel. The channel can be formed by two intersecting passages, for example. A respective end of a passage can be fluidically sealed/closed by means of a sealing plug. Thus, no (additional) tubing is necessary. The passages can be produced by drilling/milling.
(15) Of course, it is also conceivable to realize the fluid connection between the cavity and the cooling channel by means of a (additional) tubing, which also represents a fluid channel and is in particular arranged outside the drive housing. The channel can comprise two (not intersecting) passages, wherein one of the passages opens from the outside into the cooling channel and the second channel opens from the outside into the cavity, wherein the tubing connects the two passages (e.g. outside of the housing) to one another.
(16) According to a further development, the insert can be manufactured by means of sheet reshaping, die casting, or extrusion pressing. Thus, the insert is simple and inexpensive to manufacture.
(17) According to a further development, the insert can be joined to the drive housing (sealingly) by means of gluing (insert glued), welding (insert welded) and/or pressing (insert pressed). An additional seal can thus be omitted.
(18) According to a further development, in the regions in which the insert contacts the drive housing, at least one (respective) seal can be arranged so as to seal the cavity against the (interior of) the drive housing(s). This can be realized by a seal injected onto the insert, for example an elastomeric seal (equivalent to a radial shaft sealing ring (RSSR)) or an O-ring.
(19) According to a further development, the insert can have a round, in particular circular, disk-like shape with a round, in particular circular, opening (in the middle). The insert can have an outer edge region and an inner edge region. The outer edge region and/or the inner edge region can be (sealingly) joined to the drive housing. The outer edge region can be in contact with an inner peripheral surface of the drive housing, for example. The inner edge region can be in contact with a bearing seat or a sealing seat of the bearing wall, for example.
(20) According to a further development, the cavity and the cooling channel can be fluidically connected in parallel. The parallel circuit here relates to a coolant flow or coolant flow channel.
(21) According to a further development, the cavity and the cooling channel can be fluidically connected in series. The series circuit relates here to a coolant flow or coolant flow channel.
(22) According to the invention, a vehicle, in particular a motor vehicle, is proposed having an electric drive unit according to the above embodiments. With respect to the advantages that can be achieved in this way, reference is made to the explanations regarding the electric drive unit. The measures described in connection with the electric drive unit can serve for the further configuration of the vehicle.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) An embodiment of the invention is explained below with reference to the accompanying drawings. The figures show:
(2) FIG. **1** a perspective view of an electric drive unit;
(3) FIG. **2** a perspective view of an insert;
(4) FIG. **3** an excerpt of a sectional view of a drive housing and a transmission housing;

(5) FIG. **4** an enlarged excerpt of a sectional view of the drive housing and the transmission housing according to FIG. **3**;
(6) FIG. **5** a channel between a cooling channel of the drive housing and a cavity in an alternative embodiment to FIG. **4**;
(7) FIG. **6** a schematic diagram of a fluid parallel circuit;
(8) FIG. **7** a schematic diagram of a fluid parallel circuit alternative to FIG. **6**;
(9) FIG. **8** a schematic diagram of a serial fluid circuit; and
(10) FIG. **9** a schematic diagram of a serial fluid circuit alternative to FIG. **8**.

DETAILED DESCRIPTION

(11) In FIG. **1**, the electric drive unit bears the overall reference number **10**. For example, the electric drive unit **10** can be configured as an eAxle or form part of an eAxle.
(12) The electric drive unit comprises an electric machine **12** and a transmission **14**. The electric machine **12** is accommodated in a drive housing **18** and the transmission **14** is accommodated in a transmission housing **20**. In the present case, the transmission housing **20** is formed from two parts. The first part **11** of the transmission housing **20** is formed integrally with the drive housing **18**. A second part **13** of the transmission **20** is connected (sealingly) to the first part **11** of the transmission **20** by means of screw **15**.
(13) FIG. **2** shows a perspective view of an insert **26**. The insert **26** can be manufactured by means of sheet reshaping, die casting, or extrusion pressing.
(14) In the present case, the insert **26** has a circular disc-like shape with a circular opening **40** in the middle. The insert **26** has an outer edge region **42** and an inner edge region **44**. In the present case, the outer edge region **42** and the inner edge region **44** each have a seal **45**, by way of example. The seals **45** are arranged circumferentially on the inner and outer edge regions **42**, **44**, respectively.
(15) FIG. **3** shows an excerpt of a sectional view of a drive housing **18** and a transmission housing **20**. An interior **19** of the drive housing **18** and a partial interior **21** of the transmission housing **20** are depicted. The two interiors **19**, **21** are separated by a bearing wall **22**. Within the drive housing **18**, a cooling channel **24** is provided in the form of a cooling jacket for cooling the electric machine **12**. A bearing seat and/or sealing seat **27** is configured on the bearing wall **22** in order to receive a rolling bearing and/or a sealing ring, for example a radial shaft sealing ring (not shown).
(16) The insert **26** is arranged in the drive housing **18**. This is configured and arranged such that a cavity **28** is created in the drive housing **18** between the bearing wall **22** and the insert **26**. The cavity **28** is fluidically connected to the cooling channel **24**. In FIG. **3**, this fluid connection is not shown for reasons of clarity.
(17) In the present case, the insert **26** is configured such that the cavity **28** extends over the entire surface of the bearing wall **22** facing the drive housing **18** (radially outside of the bearing seat and/or sealing seat **27**). This cools the entire bearing wall **22**.
(18) FIG. **4** shows an enlarged excerpt of a sectional view of the drive housing **18** and the transmission housing **20** according to FIG. **3**. The region marked in FIG. **3** with a dashed line is shown enlarged.
(19) In the present case, the cavity **28** is fluidically connected to the cooling channel **24** by way of a channel **30**. The channel **30** is formed by means of two intersecting passages **32**, **34**. A respective end of a passage **32**, **34** is fluidically sealed/closed by means of a sealing plug **36**. The cavity **28** thus becomes part of the cooling circuit and/or becomes a further cooling channel that cools the bearing wall **22**. The passages **32**, **34** can be produced in a simple and cost-effective manner by drilling/milling.
(20) In the present case, the insert **26** contacts the drive housing **18** with its outer edge region **42** and its inner edge region **44**. In the regions where the insert **26** contacts the drive housing **18**, a seal **38** is arranged so as to seal the cavity **28** against the interior of the drive housing **18**.
(21) FIG. **5** shows the channel **30** between the cooling channel **24** of the drive housing **18** and the cavity **28** in an alternative embodiment to FIG. **4**. By contrast to the embodiment example shown in

FIG. **4**, the passages **32**, **34** do not intersect. No end of the passages **32**, **34** is sealed with a sealing plug **36**. The passage **32** leads from the cooling channel **24** to the outside of the drive housing **18**. The passage **34** also leads from the cavity **28** to the outside of the drive housing **18**. A tube connection **33** is provided outside the drive housing **18**, which fluidically connects the two passages **32**, **34** and thus the cavity **28** and the cooling channel **24** to one another.

(22) FIG. **6** shows a schematic diagram of a fluid parallel circuit. Accordingly, the elements shown are only indicated schematically. A coolant is introduced into the coolant channel **24** of the drive housing **18** through an inlet opening **46**. In the present case, the coolant channel **24** is configured as a cooling jacket. The coolant channel **24** is fluidically connected to the cavity **28** via two channels **30** (more than two channels **30** are also conceivable). Thus, the coolant from the coolant channel **24** enters the cavity **28** through the channels **30** and back out of the cavity **28** into the coolant channel **24**. The coolant introduced through the inlet opening **46** therefore flushes through the coolant channel **24** and the cavity **28** before being discharged at an outlet opening **48**, which is also fluidically connected to the coolant channel **24**. Preferably, the inlet opening **46** and the outlet opening **48** are located on opposite sides of the drive housing **18**. The coolant can be directed proportionally from the inlet opening **46** via the channel **30** (below in FIG. **6**) and the channel **30** (above in FIG. **6**) to the outlet opening **48**.

(23) FIG. **7** shows a schematic diagram of a fluid parallel circuit in an alternative to FIG. **6**. Analogously to FIG. **6**, the elements shown are only indicated schematically. By contrast to the embodiment example shown in FIG. **6**, the inlet opening **46** and the outlet opening **48** each open into the cavity **28**. The coolant introduced into the cavity **28** by the inlet opening **46** then also flushes through the cavity **28** and the coolant channel **24** before being discharged at the outlet opening **48**. Again, the inlet opening **46** and the outlet opening **48** are preferably located on opposite sides of the drive housing **18**.

(24) FIG. **8** shows a schematic diagram of a fluid serial circuit. Analogous to FIG. **6** and FIG. **7**, the elements shown are merely indicated schematically. Here, the coolant is introduced through the inlet opening **46** into the coolant channel **24** of the drive housing **18** and discharged from the exit opening **48** arranged on the cavity **28**. Analogously to FIGS. **6** and **7**, the coolant channel **24** is configured as a cooling jacket. The coolant channel **24** is fluidically connected to the cavity **28** via the channel **30**. Thus the coolant enters the coolant channel **24**, flushes through it, enters the cavity **28** via the channel **30**, flushes through it, and is discharged from the cavity **28** through the exit opening **48**.

(25) FIG. **9** shows a schematic diagram of a fluid serial circuit in an alternative to FIG. **8**. Analogously to FIGS. **6** to **8**, the elements shown are only indicated schematically. By contrast to the embodiment example shown in FIG. **8**, the inlet opening **46** is arranged on the cavity **28** and the outlet opening **48** is arranged on the cooling channel **24**. Thus, the coolant is introduced into the cavity **28** through the inlet opening **46**. The cavity **28** is fluidically connected to the cooling channel **24** via the channel **30**. Analogously to FIGS. **6** to **8**, the coolant channel **24** is configured as a cooling jacket. Thus the coolant enters the cavity **28**, flushes through it, enters the coolant channel **24** via the channel **30**, flushes through it, and is discharged from the coolant channel **24** through the exit opening **48**.

(26) Preferably, in the embodiment examples shown in FIGS. **6** to **9**, the outlet opening **48** is arranged at the top of the drive housing **18**, such that the coolant does not pass through the outlet opening until the entire cavity **28** and/or coolant channel **24** has been flushed due to gravity.

Claims

1. An electric drive unit (**10**) comprising an electric machine (**12**) and a transmission (**14**), wherein the electric machine (**12**) is accommodated in a drive housing (**18**), and the transmission (**14**) is accommodated in a transmission housing (**20**), wherein an interior (**19**) of the drive housing (**18**)

and an interior (**21**) of the transmission housing (**20**) are separated by a bearing wall (**22**), and at least one cooling channel (**24**) for cooling the electric machine (**12**) is formed on or in the drive housing (**18**), wherein the electric drive unit (**10**) has an insert (**26**) which is configured and arranged such that a cavity (**28**) is produced in the drive housing (**18**) between the bearing wall (**22**) and the insert (**26**), and the cavity (**28**) is fluidically connected to the cooling channel (**24**).

2. The electric drive unit (**10**) according to claim 1, wherein the insert (**26**) is configured such that the cavity (**28**) extends over an entire surface of the bearing wall (**22**) facing the drive housing (**18**).

3. The electric drive unit (**10**) according to claim 1, wherein the cavity (**28**) is fluidically connected to the cooling channel (**24**) by at least one channel (**30**).

4. The electric drive unit (**10**) according to claim 3, wherein the channel (**30**) is formed by two intersecting passages (**32**, **34**), and wherein a respective end of a passage (**32**, **34**) is fluidically sealed/closed by a sealing plug (**36**).

5. An electric drive unit (**10**) according to claim 1, wherein the insert (**26**) is made by sheet metal reshaping, die casting, or extrusion pressing.

6. The electric drive unit (**10**) according to claim 1, wherein the insert (**26**) is joined to the drive housing (**18**) by gluing, welding, and/or pressing.

7. The electric drive unit (**10**) according to claim 1, wherein, in regions in which the insert (**26**) contacts the drive housing (**18**), at least one seal (**38**) is arranged so as to seal the cavity (**28**) against the drive housing (**18**).

8. The electric drive unit (**10**) according to claim 1, wherein the insert (**26**) has a round shape with a round opening (**40**), wherein the insert (**26**) has an outer edge region (**42**) and an inner edge region (**44**), wherein the outer edge region (**42**) and/or the inner edge region (**44**) are joined to the drive housing (**18**).

9. The electric drive unit (**10**) according to claim 8, wherein the insert (**26**) has a circular disk-like shape with a circular opening (**40**).

10. The electric drive unit (**10**) according to claim 1, wherein the cavity (**28**) and the cooling channel (**24**) are fluidically connected in parallel to one another.

11. The electric drive unit (**10**) according to claim 1, wherein the cavity (**28**) and the cooling channel (**24**) are fluidically connected in series.

12. A vehicle having an electric drive unit (**10**) according to claim 1.

13. The electric drive unit (**10**) according to claim 1, wherein the electric drive unit is for a vehicle or motor vehicle.