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(54) **ELECTRICAL MOTOR VEHICLE COOLANT PUMP**

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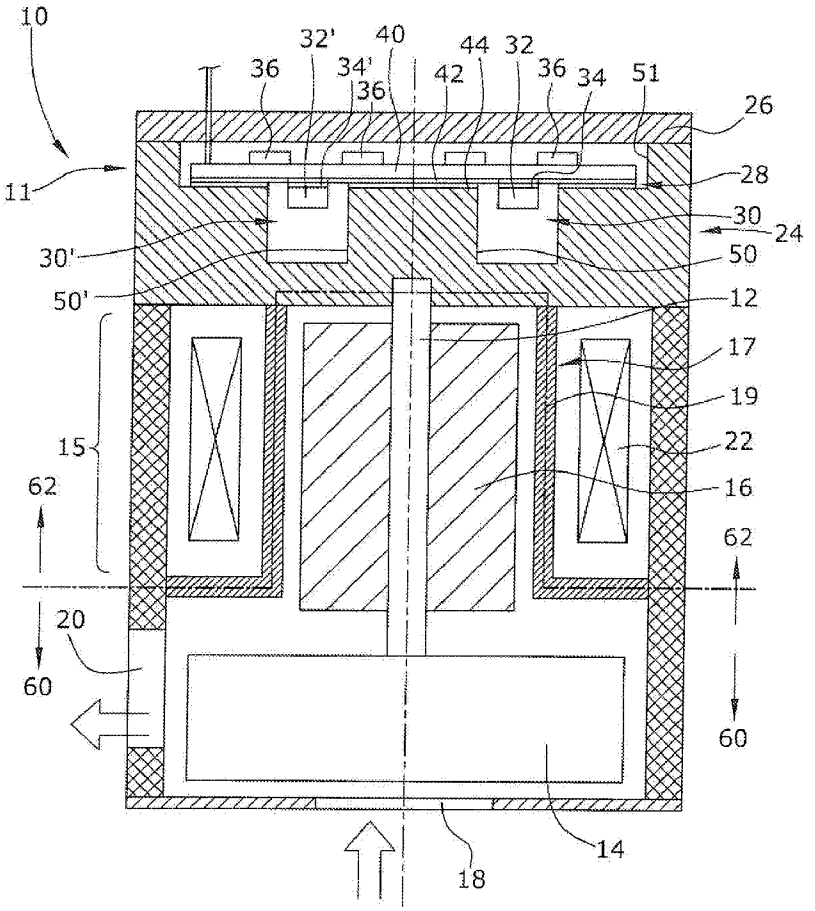
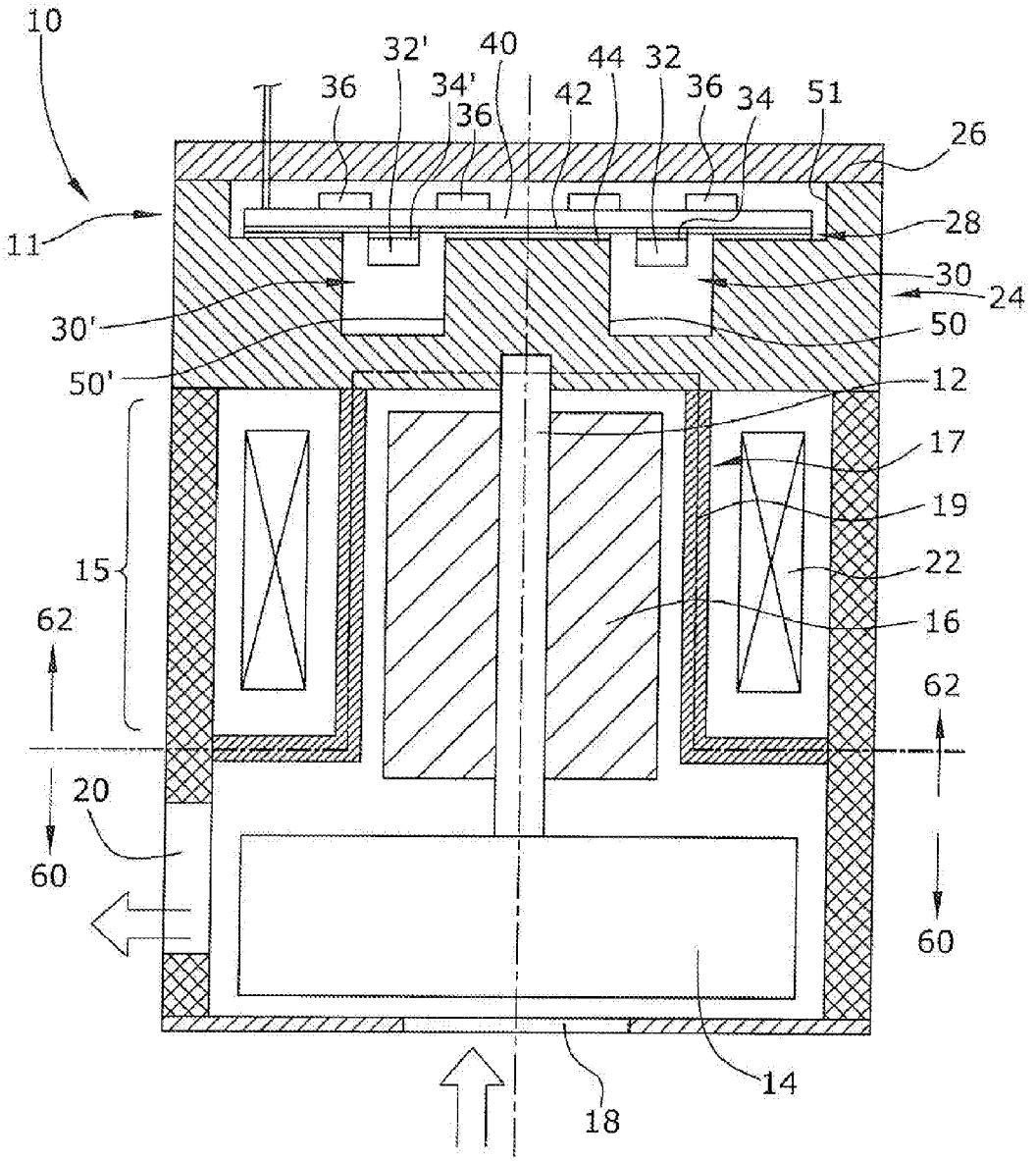
(57) **ABSTRACT**

An electric coolant pump for a motor vehicle includes a wet section in which is arranged an impeller and a permanently magnetized motor rotor of an electronically commutated electromotor, a dry section in which is arranged an electric circuit board comprising a plurality of power semiconductors which each comprise a cooling lug, and a partition wall lying in a traverse plane. The partition wall is arranged to separate the wet section and the dry section. The plurality of power semiconductors are each arranged on a proximal side of the electric circuit board facing the partition wall. Each cooling lug is arranged on a cooling lug conductor strip. On a side of the partition wall facing the electric circuit board, the partition wall comprises a heat conductor which is configured to be electrically non-conductive. The heat conductor is arranged to rest directly on a respective cooling lug conductor strip.




10
32'
40
44
32
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42
36
34
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28
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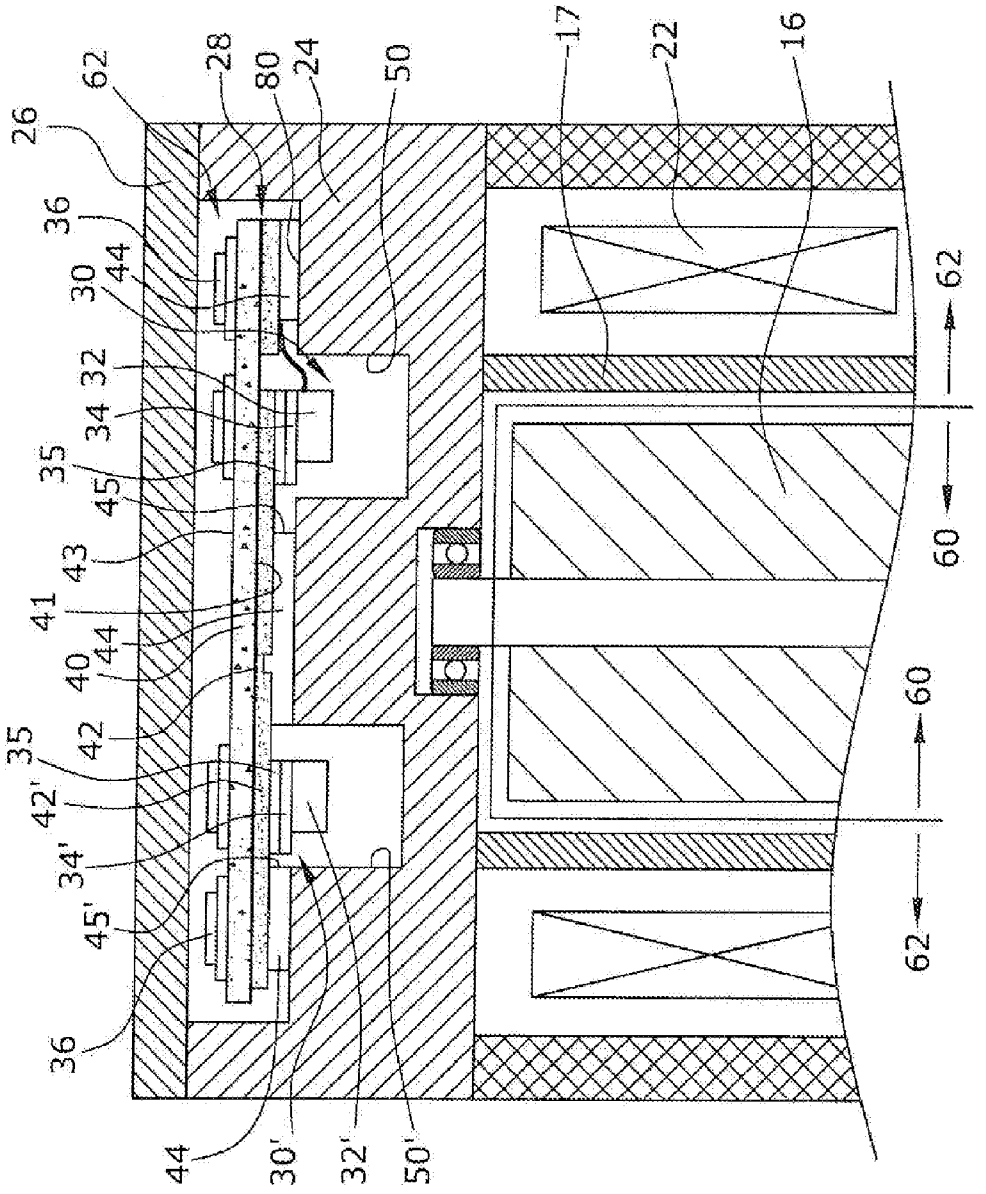
12
17
19
15
22
62
16
62
20
60
60
14
18

Fig. 1


62
28
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41
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62
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60
62

Fig. 2

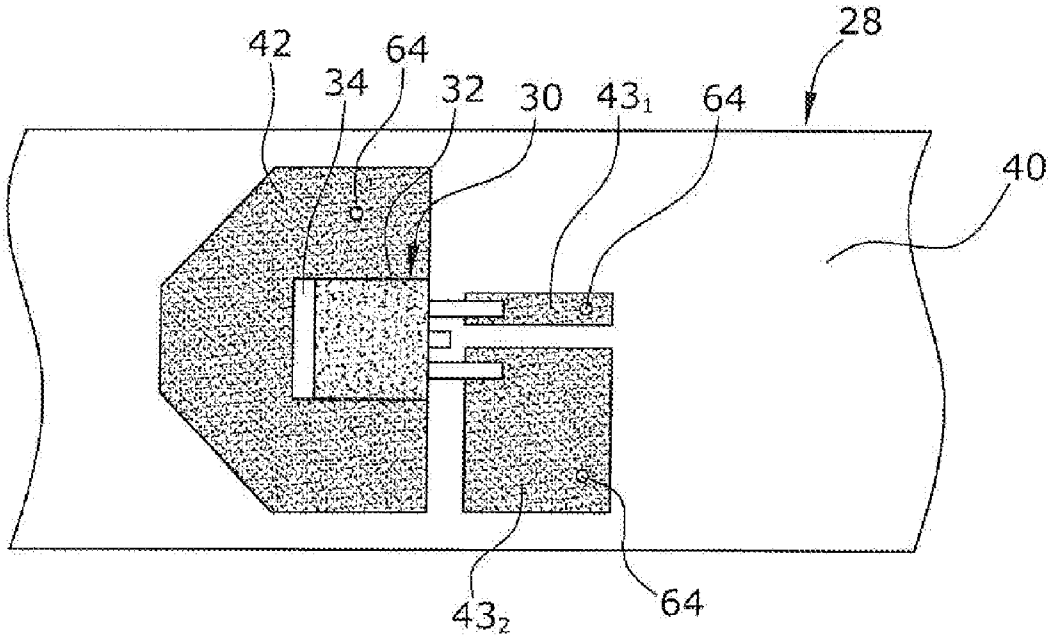

Fig. 3

ELECTRICAL MOTOR VEHICLE COOLANT PUMP

CROSS REFERENCE TO PRIOR APPLICATIONS

[0001] This application is a U.S. National Phase application under 35 U.S.C. §371 of International Application No. PCT/EP2011/062864, filed on Jul. 27, 2011 and which claims benefit to European Patent Application No. 11150865.1, filed on Jan. 13, 2011. The International Application was published in German on Jul. 19, 2012 as WO 2012/095192 A1 under PCT Article 21(2).

FIELD

[0002] The present invention relates to an electric motor vehicle coolant pump for supplying coolant to an internal combustion engine, wherein the brushless electromotor is commutated electronically.

BACKGROUND

[0003] An electric motor vehicle coolant pump having a brushless, electronically commutated electromotor as the drive motor, comprises control electronics and power semiconductors that can generate heat during operation. A coolant pump runs practically all the time, albeit at different speeds, during the operation of a motor vehicle internal combustion engine to be supplied with coolant. Under adverse conditions, for example, when the internal combustion engine is under full load, at low motor vehicle speed, and at high outside temperatures, the coolant pump must run under full load for extended periods. The significant thermal losses of the power semiconductors have to here be dissipated in a reliable manner to avoid the destruction of the power semiconductors.

[0004] DE 10 2007 054 060 describes an electric motor vehicle coolant pump with a brushless separating can electromotor, wherein the cooling lugs of the power semiconductors are in direct contact with the partition wall that separates the wet area from the dry area of the coolant pump. This may enable good heat dissipation from the power semiconductor; however, the cooling lug is not electrically connected directly with a conductor on the circuit board.

SUMMARY

[0005] An aspect of the present invention is to provide an electric motor vehicle coolant pump having an electronically commutated electromotor, wherein the power semiconductors are well cooled, and the cooling lugs of the power semiconductors are contacted directly with a conductor strip on the circuit board.

[0006] In an embodiment, the present invention provides an electric coolant pump for a motor vehicle which includes a wet section in which is arranged an impeller and a permanently magnetized motor rotor of an electronically commutated electromotor, a dry section in which is arranged an electric circuit board comprising a plurality of power semiconductors which each comprise a cooling lug, and a partition wall lying in a traverse plane. The partition wall is arranged to separate the wet section and the dry section. The plurality of power semiconductors are each arranged on a proximal side of the electric circuit board facing the partition wall. Each cooling lug is arranged on a cooling lug conductor strip. On a side of the partition wall facing the electric circuit board, the partition wall comprises a heat conductor which is configured to be electrically non-conductive. The heat conductor is arranged to rest directly on a respective cooling lug conductor strip.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention is described in greater detail below on the basis of embodiments and of the drawings in which:

[0008] FIG. **1** shows a schematic longitudinal section of a motor vehicle coolant pump having a partition wall and a circuit board with power semiconductors;

[0009] FIG. **2** shows an enlarged illustration of the partition wall and the circuit board of FIG. **1**; and

[0010] FIG. **3** shows a top plan view on the proximal side of the circuit board of the FIGS. **1** and **2**.

DETAILED DESCRIPTION

[0011] The coolant pump includes a wet section in which an impeller and a permanently magnetically, i.e., continuously, excited motor rotor of the electronically commutated electric motor are arranged. The coolant pump further has a dry section in which, among others, an electric circuit board is arranged which supports a plurality of power semiconductors with a respective cooling lug for each. The power semiconductors serve to directly drive the stator-side motor coils.

[0012] The wet section and the dry section are separated by an electrically conductive partition wall lying in a transverse plane. The partition wall can, for example, be made of an electrically conductive material, but can also be made of electrically non-conductive material, for example, a plastics material. A circuit board is arranged so as to lie in a transversal plane adjacent to the partition wall, wherein the power semiconductors are situated on the proximal side of the circuit board. The electric terminals of the power semiconductors, including the cooling lugs, which each also represent an electric terminal, are soldered to corresponding conductor strips on the circuit board.

[0013] Each of the cooling lugs of the power semiconductors is arranged on a respective individual conductor strip and is soldered thereto, i.e., the cooling lugs are electrically separated from each other. The conductor strips connected with the cooling lugs rest on the partition wall with their portions protruding beyond the surface of the respective cooling lug, wherein an electrically non-conductive heat conducting means is provided between the partition wall and the conductor strips, which electrically insulates the conductor strips from the partition wall, but conducts heat well. A heat conducting film, a heat conducting paste or a heat conducting adhesive are particularly suited as heat conducting means.

[0014] The conductor strip onto which the cooling lug is soldered must thus have a larger surface area than the cooling lug itself and/or than the area of the cooling lug connected with the conductor strip. Only the portion of the respective conductor strip extending beyond the cooling lug rests on the electrically non-conductive heat conducting means which in turn rests immediately on the partition wall. The wet section is provided on the side of the partition wall opposite the circuit board, which is the reason why the coolant circulating there can dissipate large heat quantities from the partition wall.

[0015] The heat flow of waste heat from the power semiconductor thus flows from its cooling lug via the conductor strip, onto which the cooling lug is soldered, and the electri-

cally non-conductive heat conducting means to the partition wall, from where the heat is dissipated by the coolant. In this manner, an effective cooling of the power semiconductors is possible, while the cooling lugs of the power semiconductors are each still electrically connected or soldered to an individual conductor strip of the circuit board.

[0016] On the side facing the circuit board, the partition wall can, for example, comprise a respective semiconductor recess for each semiconductor into which the semiconductor extends axially. The semiconductor recesses are necessary so that the base area of the partition wall can rest directly on the conductor strip with interposition of the heat conducting means. On the side of the circuit board facing the partition wall, only the power semiconductors are arranged and no other electronic components are provided. The entire control electronics for driving the power semiconductors can, for example, be arranged on the distal side of the circuit board, for example, the side averted from the partition wall. Corresponding through-holes are provided to make an electric connection between the proximal and the distal side, which through-holes, however, exclusively establish the electric contact and are not suited for heat transport.

[0017] In an embodiment of the present invention, the electromotor can, for example, comprise a separating can separating the wet section from a dry section in which, among others, the stator-side motor coils are arranged. The dry section, in which the motor coils are situated, may be separated from the dry section, in which the circuit board is located. The partition wall, lying in a transverse plane, is part of the separating can so that the partition wall is flown to and cooled directly by the coolant.

[0018] In an embodiment of the present invention, the surface area of the conductor strip can, for example, be at least twice, for example, at least three times, for example, at least five times, the size of the surface area of the respective cooling lug by which the same is fixed or soldered to the conductor strip. The larger the surface area of the power semiconductors is, the larger is the surface area for the dissipation of heat from the conductor strip and/or the larger the contact surface between the conductor strip and the heat conducting means or the partition wall can be.

[0019] The following is a detailed description of an embodiment of the present invention with reference to the drawing.

[0020] FIG. **1** is a schematic longitudinal section of an electrical motor vehicle coolant pump **10** that pumps a liquid coolant in a coolant circuit serving to cool an internal combustion engine (not illustrated). The coolant pump **10** comprises an electric brushless drive motor **15** which is commutated electronically.

[0021] The coolant pump **10** has a multi-part housing **11** divided internally by a separating can **17** into a wet section **60** and a dry section **62**. The separating can **17** is formed by a non-magnetic plastic sleeve jacket **19** of L-shaped cross section and an electrically conductive metal partition wall **24** which lies in a transverse plane.

[0022] The rotor located in the wet section **60** comprises a dual bearing shaft **12**, a magnetically permanently excited motor rotor **16** and a pump rotor **14** pumping coolant from an axial coolant inlet **18** to a radial coolant outlet **20**. In the dry section **62**, a plurality of stator coils **22** are arranged radially outside the motor rotor **16** and the cylindrical part of the sleeve jacket **19** and on the same axial position, the stator coils **22** being situated on the proximal side of the partition wall **24**.

[0023] On the distal side of the partition wall **24**, an electric circuit board **28**, including all the electronics for driving the stator coils **22**, is provided in a circuit board chamber **51**. The circuit board **28** lies in a transverse plane and is mounted on both sides, wherein, on the distal side of the circuit board plate **40**, a plurality of control electronics elements **36** forming the control electronics **36** is soldered onto conductor strips, and wherein, on the proximal side of the circuit board **28**, only a plurality of identical power semiconductors **30**, **30'** are arranged which are driven by the control electronics **36** through corresponding through-holes **64**. The power semiconductors **30**, **30'** may be MOSFET transistors.

[0024] As can be seen in particular in FIG. **2**, the power semiconductors **30**, **30'** are mounted horizontally on the circuit board **28**, with each power semiconductor **30**, **30'** having a cooling lug **34** whose surface area is larger than the corresponding surface area of the semiconductor body **32**. Each cooling lug **34**, **34'** is an electric terminal of the power semiconductor and is respectively soldered with its entire surface onto a large-surface conductor strip **42**, **42'** by means of solder **35**.

[0025] The proximal side **41** of the circuit board **28** is covered with an electrically non-conductive heat conducting means **44** in the form of a heat conducting film which has corresponding openings **45**, **45'** only in the regions of the power semiconductors **30**, **30'**. The heat conducting means **44** rests on the distal side **80** of the partition wall **24** in a heat conductive manner, which partition wall **24** has corresponding recesses **50**, **50'** in the region of the power semiconductors **30**, **30'** and of the corresponding openings **45**, **45'** in the heat conducting means **44**, respectively, into which recesses **50**, **50'** the respective semiconductor bodies **32**, **32'** extend. The recesses **50**, **50'** are not continuous in the axial direction so that the partition wall **24** is completely liquid-tight.

[0026] In order to provide a good heat conduction or dissipation, the surface area of the conductor strips **42**, **42'** respectively is at least 4 to 5 times the surface area of the cooling lug **34**, **34'** of the respective power semiconductor **30**, **30'**. As can be seen in FIG. **3**, also the other terminals of the power semiconductor are soldered to corresponding conductor strips $\mathbf{43}_1$ and $\mathbf{43}_2$.

[0027] The circuit board chamber **51** is closed with a cover **26**.

[0028] The present invention is not limited to embodiments described herein; reference should be had to the appended claims.

What is claimed is:

1-5. (canceled)

6. An electric coolant pump for a motor vehicle, the electric coolant pump comprising:

a wet section in which is arranged an impeller and a permanently magnetized motor rotor of an electronically commutated electromotor;

a dry section in which is arranged an electric circuit board comprising a plurality of power semiconductors which each comprise a cooling lug; and

a partition wall lying in a traverse plane, the partition wall being arranged to separate the wet section and the dry section,

wherein,

the plurality of power semiconductors are each arranged on a proximal side of the electric circuit board facing the partition wall,

each cooling lug is arranged on a cooling lug conductor strip, and

on a side of the partition wall facing the electric circuit board, the partition wall comprises a heat conductor which is configured to be electrically non-conductive, the heat conductor being arranged to rest directly on a respective cooling lug conductor strip.

7. The electric coolant pump as recited in claim **6**, wherein, on the side of the partition wall facing the circuit board, the partition wall further comprises a recess for each of the plurality of power semiconductors, into which recess a respective power semiconductor is arranged to extend axially.

8. The electric coolant pump as recited in claim **6**, wherein the cooling lug conductor strip comprises a cooling lug conductor strip surface area and the cooling lug comprises a cooling lug surface area, wherein the cooling lug conductor strip surface area is at least twice the size of the cooling lug surface area.

9. The electric coolant pump as recited in claim **8**, wherein the cooling lug conductor strip surface area is at least three times the size of the cooling lug surface area.

10. The electric coolant pump as recited in claim **8**, wherein the cooling lug conductor strip surface area is at least five times the size of the cooling lug surface area.

11. The electric coolant pump as recited in claim **6**, wherein the electronically commutated electromotor comprises a separating can which is configured to separate the wet section from the dry section.

12. The electric coolant pump as recited in claim **6**, wherein the electric circuit board further comprises electric controls configured to drive the plurality of power semiconductors, the electric controls being arranged on a side of the circuit board averted from the partition wall.

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