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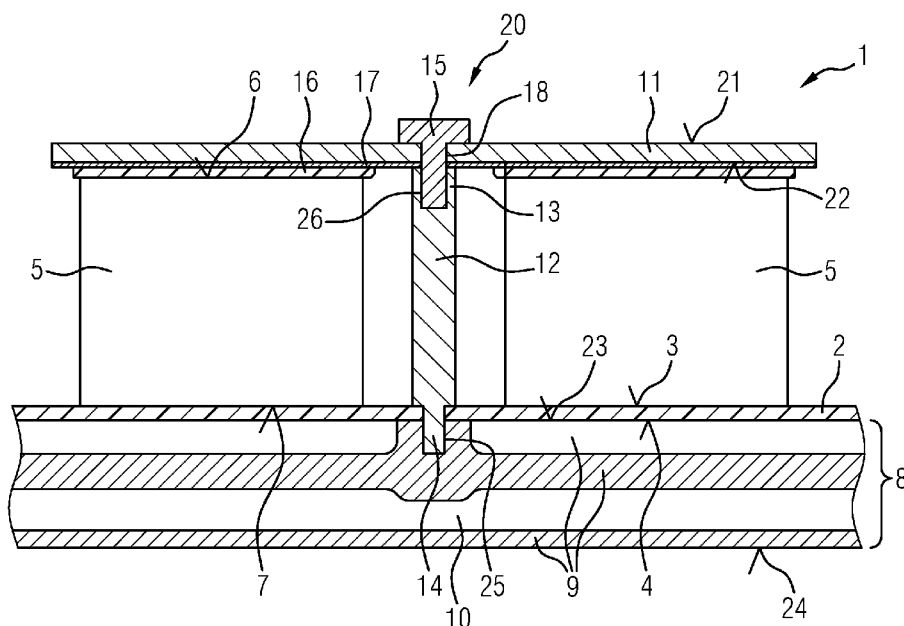
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(54) Title: ELECTRONIC ASSEMBLY AND HIGH VOLTAGE BOX WITH AN ELECTRONIC ASSEMBLY

FIG 1



(57) Abstract: An electronic assembly (1) comprising - a substrate (2) having a first main surface (3) and a second main surface (4), - at least one electronic component (5) having a first main surface (6) and a second main surface (7), the electronic component (5) being arranged with its second main surface (7) on the first main surface (3) of the substrate (2), and external contacts on the second main surface (7) of the at least one electronic component (5) being electrically conductively connected to contact surfaces on the first main surface (3) of the substrate (2); - a cooling structure comprising a liquid cooler (8) having a housing (9) in which at least one cooling channel (10) is formed in which a cooling liquid is guided, the housing (9) having a first main surface (23) and a second main surface (24) and its first main surface (23) being disposed adjacent to the second main surface (4) of the substrate (2), the cooling structure further comprising a thermally conductive body (11) disposed on the first main surface (6) of the at least one electronic component (5),

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RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
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wherein the thermally conductive body (11) is thermally conductively, but electrically insulatedly connected to the first main surface (6) of the electronic component (5), said thermally conductive body (11) being in contact with at least one thermally conductive spacer (20), said thermally conductive spacer (20) extending through said substrate (2) into said housing (9) of the liquid cooler (8).

Specification

Electronic assembly and high voltage box with an electronic assembly

- 5 The present invention relates to an electronic assembly and a high-voltage box for an electrically driven vehicle comprising such an assembly.

In the case of electronic assemblies which experience high losses during operation, for example because they comprise power semiconductor components and/or
10 electromechanical components, efficient cooling is often important. Active or passive cooling concepts are known, wherein active cooling concepts often include a liquid cooler, which comprises a cooling liquid circling in cooling channels in thermal contact with the components to be cooled.

- 15 There is a need for cooling concepts for different arrangements of electronic components.

It is therefore a task of the present invention to specify an electronic assembly in which electronic components with particularly high cooling requirements are
20 connected to cooling structures in a particularly effective manner.

Advantageous embodiments and further embodiments are subjects of the dependent claims.

- 25 According to an aspect of the invention, an electronic assembly is disclosed comprising a substrate having a first main surface and a second main surface and comprising at least one electronic component having a first main surface and a second main surface. The electronic component is arranged with its second main surface on the first main surface of the substrate and external contacts on the
30 second main surface of the electronic component are electrically conductively connected to contact surfaces on the first main surface of the substrate.

The electronic assembly further comprises a cooling structure comprising a liquid cooler having a housing in which at least one cooling channel is formed in which a
35 cooling liquid is guided. The housing has a first main surface and a second main surface. Its first main surface is disposed adjacent to the second main surface of the substrate.

The cooling structure further comprises a thermally conductive body disposed on the first main surface of the at least one electronic component. The thermally conductive body may be disposed directly on the first main surface of the at least one electronic component. However, it is often advantageous to provide a thermal interface material (TIM) and/or an electric isolation between the thermally
5 conductive body and the at least one electronic component as described below.

The thermally conductive body is thermally conductively, but electrically insulatingly connected to the first main surface of the electronic component. The thermally
10 conductive body is in contact with at least one thermally conductive spacer, said thermally conductive spacer extending through said substrate into said housing of the liquid cooler.

By the spacer extending through the substrate into the housing of the liquid cooler it
15 is understood that at least a part of the spacer is surrounded by material of the housing and thus in close thermal contact with the housing. It is possible to provide a bore or an opening in the housing into which a part of the spacer extends.

The electronic assembly has the advantage that it enables cooling of the at least
20 one electronic component not only from one main surface, but from both main surfaces. For this purpose, the first main surface of the component is also connected to the cooling liquid via the cooling structure, while the second main surface is connected via the substrate to the liquid cooler. Heat is thus not only dissipated via the second main surface of the electronic component, which is
25 electrically conductive and thermally connected to the substrate via metallic contact surfaces that conduct heat well. Rather, a second heat conduction path to the liquid cooler is provided via the first main surface of the electronic component.

The first main surface and second main surface are typically referred to here as
30 opposing main surfaces of a cuboid or rather sheet-like body.

According to an embodiment of the invention, the thermally conductive body is formed as a metal sheet. It may be formed of aluminum alloy. Such a metal sheet is easy to manufacture, easy to assemble and conducts heat well.
35

According to the embodiments of the invention, a plurality of electronic components is disposed on the first main surface of the substrate, and the thermally conductive body is in contact with a plurality of electronic components. According to this

embodiment, the thermally conductive body provides a heat path not only for one electronic component, but for several electronic components on the same substrate.

According to an embodiment of the invention, a thermal interface material (TIM) is disposed between the main surface of the at least one electronic component and the thermally conductive body. Thermal interface materials are used to improve the heat transfer from an electronic component to an adjacent element. They may be applied in the form of e.g. a paste or a tape or an adhesive film or a pad. In addition to increasing the heat transfer, they also compensate for tolerances between components.

An electrically insulating film may be disposed between the first main surface of the at least one electronic component and the thermally conductive body. The electrically insulating film provides electric isolation between the electronic component and the thermally conductive body and is advantageous in particular with power components.

If a thermal interface material and an electrically insulating film are combined, the thermal interface material may be applied directly to the first main surface of the at least one electronic component, while the electrically insulating film may be applied to the second main surface of the thermally conductive body which is then brought into contact with the thermal interface material on the surface of the electronic component.

The thermally conductive spacer may be formed of a metal, in particular of an aluminum alloy, which conducts heat very well and is relatively lightweight.

According to an embodiment of the invention, the thermally conductive spacer comprises a screw and a rod having an upper end and a lower end, the lower end extending into the housing of the liquid cooler and the rod having an axial bore at the upper end into which this screw is threadable so that the screw extends through an opening in the thermally conductive body into the rod.

The axial bore at the upper end may comprise an internal thread corresponding to a thread of the screw. However, it may be advantageous if the bore does not comprise an internal thread, but if a self-tapping, in particular a thread-cutting screw is used. This has the advantage, that, if the bore has the same diameter as the lower end,

the lower end of one rod is prevented from threading itself into the bore at the upper end of the next rod in a feeding line.

5 According to these embodiments, the screw can be used to fasten the thermally conductive body to the rod. The screw is also used to press the thermally conductive body towards the electronic components and bring the thermally conductive body into close contact with the at least one electronic component.

10 According to an embodiment of the invention, a further substrate having a first main surface and the second main surface is arranged with its first main surface on the second main surface of the liquid cooler, and further electronic components are arranged on a second main surface of the further substrate.

15 In this case, both sides of the liquid cooler are used to mount electronic components. This arrangement can be advantageous, if a larger number of components should be cooled. The electronic components arranged on the further substrate may also be cooled from their second side as described above for the first substrate.

20 According to an embodiment of the invention, the at least one electronic component is configured as a power semiconductor component or as an electromechanical component. These kinds of components might have high losses and therefore generate a comparatively large amount of heat during operation.

25 According to an aspect of the invention, a high-voltage box for an electrically driven vehicle is provided, comprising at least one electronic assembly as described above, wherein the at least one electronic component is designed as a component of a DC/DC converter or an on-board charger of the vehicle.

30 Exemplary embodiments are shown in the figure. The only figure shows a cross-section through an electronic assembly according to an embodiment of the invention.

35 The electronic assembly 1 comprises two electronic components 5 with a first main surface 6 and a second main surface 7 which are arranged with their second main surfaces 7 on a first main surface 3 of a substrate 2. The electronic components 5 have external contacts which are not shown in the figure and which are electrically

conductively connected to contact surfaces on the first main surface 3 of the substrate 2.

5 The substrate 2 is arranged with its second main surface 4 on the first main surface 23 of the housing 9 of a liquid cooler 8. A further substrate with electronic components may be arranged on a second main surface 24 of the housing 9.

10 In the housing 9 of the liquid cooler 8, at least one cooling channel 10 is formed through which a cooling liquid is guided. The housing 9 of the liquid cooler aids may be of a diecast aluminium alloy. As the electronic components 5 are arranged with their second main surfaces 7 on the housing 9 of the liquid cooler 8, the second main surfaces 7 of the electronic components 5 are cooled by the liquid cooler 8.

15 In order to provide cooling of the first main surface 6 of the electronic components 5, the electronic assembly 1 further comprises a cooling structure comprising a thermally conductive body 11 arranged on the first main surface 6 of the electronic components 5 and thermally connecting the first main surfaces 6 of the electronic components 5 to the liquid cooler 8.

20 The cooling structure comprises the thermally conductive body 11 having a first main surface 21 and a second main surface 22. On the first main surfaces 6 of the electronic components 5, a thermal interface material 16 is arranged. Adjacent to the thermal interface material 16, an electrically insulating film 17 is provided on the second main surface 22 of the thermally conductive body 11. Hence, the thermally
25 conductive body 11 is thermally, but not electrically, coupled to the first main surfaces 6 of the electronic components 5.

The thermally conductive body 11 is in thermal contact with the liquid cooler 8 via a thermally conductive spacer 20 comprising a rod 12 and a screw 15. The rod 12 has
30 an upper end 13 with an axial bore 26, into which the screw 15 is threadable to fasten the thermally conductive body 11 to the rod 12 and to press the thermally conductive body 11 towards the electronic components 5. The screw 15 is a thread-cutting screw which cuts an internal thread into the bore 26 when first threaded into the bore 26.

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On the lower end 14, the rod 12 has a thread which corresponds to a threaded bore 25 in the housing 9 of the liquid cooler 8. Thus, the rod 12 of the spacer 20 extends

into the housing 9 of the liquid cooler 8 and provides a thermal path to transfer heat from the first main surfaces 6 of the electronic components 5 into the liquid cooler 8.

5 Hence, the spacer 20 extends through an opening 18 in the thermally conductive body 11 and a further opening in the substrate 2 into the housing 9. In the figure, only one spacer 20 is shown. However, the electronic assembly 1 may comprise a plurality of spacers 20 disposed next to the electronic components 5.

Patent claims

1. An electronic assembly (1) comprising
 - a substrate (2) having a first main surface (3) and a second main surface (4),
 - 5 - at least one electronic component (5) having a first main surface (6) and a second main surface (7), the electronic component (5) being arranged with its second main surface (7) on the first main surface (3) of the substrate (2), and external contacts on the second main surface (7) of the at least one electronic component (5) being electrically conductively connected to contact surfaces on the first main surface (3)
 - 10 of the substrate (2);
 - a cooling structure comprising a liquid cooler (8) having a housing (9) in which at least one cooling channel (10) is formed in which a cooling liquid is guided, the housing (9) having a first main surface (23) and a second main surface (24) and its first main surface (23) being disposed adjacent to the second main surface (4) of the
 - 15 substrate (2), the cooling structure further comprising a thermally conductive body (11) disposed on the first main surface (6) of the at least one electronic component (5), wherein the thermally conductive body (11) is thermally conductively, but electrically insulatedly connected to the first main surface (6) of the electronic component (5), said thermally conductive body (11) being in contact with at least
 - 20 one thermally conductive spacer (20), said thermally conductive spacer (20) extending through said substrate (2) into said housing (9) of the liquid cooler (8).
2. Electronic assembly (1) according to claim 1,
wherein the thermally conductive body (11) is formed as a metal sheet.
- 25 3. Electronic assembly (1) according to claim 1 or 2,
wherein a plurality of electronic components (5) is disposed on the first main surface (3) of the substrate (2), and the thermally conductive body (11) is in contact with a plurality of electronic components (5).
- 30 4. Electronic assembly (1) according to any one of claims 1 to 3,
wherein a TIM (16) is disposed between the first main surface (6) of the at least one electronic component (5) and the thermally conductive body (11).
- 35 5. Electronic assembly (1) according to any one of claims 1 to 4,
wherein an electrically insulating film (17) is disposed between the first main surface (6) of the at least one electronic component (5) and the thermally conductive body (11).

6. Electronic assembly (1) according to any of claims 1 to 5,
wherein the thermally conductive spacer (20) is formed of metal.

5 7. Electronic assembly (1) according to any one of claims 1 to 6,
wherein the thermally conductive spacer (20) comprises a screw (15) and a rod (12)
having an upper end (13) and a lower end (14), the lower end (14) extending into the
housing (9) of the liquid cooler (8) and the rod (12) having an axial bore (26) at the
upper end (13) into which the screw (15) is threadable so that the screw (15)
10 extends through an opening (18) in the thermally conductive body (11) into the rod
(12).

8. Electronic assembly (1) according to claim 7,
wherein the screw (15) is a self-tapping screw.

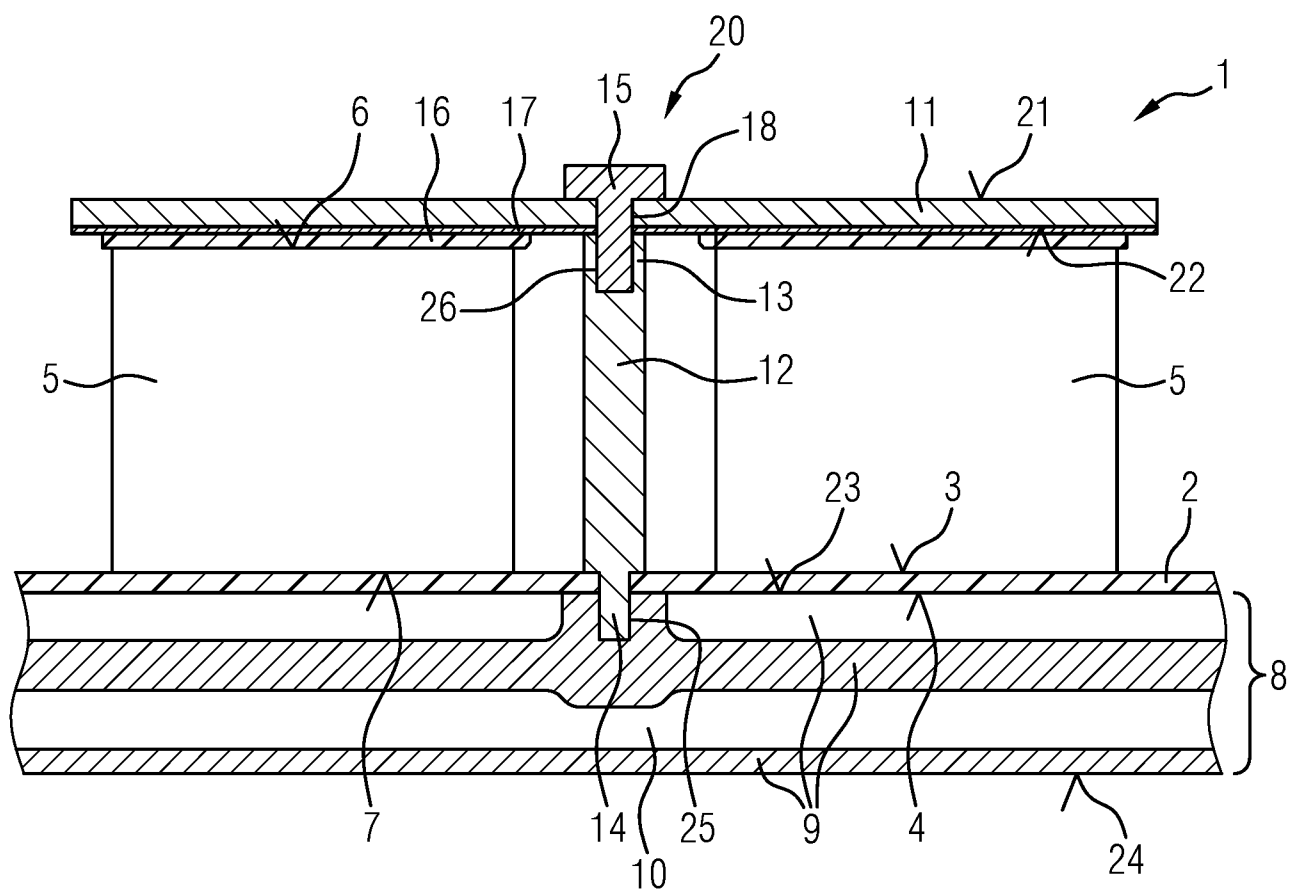
15 9. Electronic assembly (1) according to any one of claims 1 to 8,
wherein a further substrate having a first main surface and a second main surface is
arranged with its first main surface on the second main surface (24) of the liquid
cooler (8), and further electronic components are arranged on a second main
20 surface of the further substrate.

10. Electronic assembly (1) according to any one of claims 1 to 9,
wherein the at least one electronic component (5) is configured as a power
semiconductor component or as an electromechanical component.

25 11. A high-voltage box for an electrically driven vehicle, comprising at least one
electronic assembly (1) according to any one of claims 1 to 10, wherein the at least
one electronic component (5) is designed as a component of a DC/DC converter or
an on-board charger.

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FIG 1



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/067108

A. CLASSIFICATION OF SUBJECT MATTER INV. H05K7/20 H01L23/473 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H05K H01L Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2001/033477 A1 (INOUE SEIJI [JP] ET AL) 25 October 2001 (2001-10-25) paragraph [0277]; figures 57-59 paragraph [0310] - paragraph [0317] paragraph [0352] paragraph [0360] paragraph [0364] - paragraph [0370] paragraph [0378] - paragraph [0380] -----	1 - 11
A	US 2019/179381 A1 (DEDE ERCAN M [US] ET AL) 13 June 2019 (2019-06-13) paragraph [0015] - paragraph [0029]; figures 1-4 -----	1 - 11
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search 4 September 2024		Date of mailing of the international search report 20/09/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Steiner, Lisa

INTERNATIONAL SEARCH REPORT

Information on patent family members

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