(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 June 2020 (11.06.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/115253 A2

(51) International Patent Classification:
F28F 9/02 (2006.01) *H01M 10/6555* (2014.01)
F28F 9/26 (2006.01) *H01M 10/6557* (2014.01)

(21) International Application Number:
PCT/EP2019/083907

(22) International Filing Date:
05 December 2019 (05.12.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201811482316.3 05 December 2018 (05.12.2018) CN

(71) Applicants: **VALEO SYSTEMES THERMIQUES** [FR/FR]; ZA l'Agiot, 8 rue Louis Lormand, CS 80517 LA VERRIERE, 78322 LE MESNIL SAINT DENIS Cedex (FR). **VALEO AUTOMOTIVE AIR CONDITIONING (HUBEI) CO. LTD THERMAL POWERTRAIN BRANCH** [CN/CN]; No. 155, East Jiangjin Road, Hubei Province, Jingzhou City, 434000 (CN). **VALEO MANAGEMENT (SHANGHAI) CO. LTD.** [CN/CN]; 30th Floor, Building A, IBC Tower (New International Business Center), 391 Gui Ping Road, Caohejing Hi-Tech Par, Shanghai, 200233 (CN).

(72) Inventors: **SUN, Jianqi**; Valeo, Dongfangda Road 123#, Economic and Technological Development, Jingzhou City, Hubei Province, Shashi, China 434000 (CN). **LU, Chang**; Valeo, Dongfangda Road 123#, Economic and Technological Development, Jingzhou City, Hubei Province, Shashi, China 434000 (CN). **PAYEN, Bruno**; C/o Valeo Systemes Thermiques, Lieu dit le Pré Sec, CS 10016, 72210 LA SUZE SUR SARTHE (FR). **XIAO, Chao**; Valeo, Dongfangda Road 123#, Economic and Technological Development, Jingzhou City, Hubei Province, Shashi, China 434000 (CN).

(74) Agent: **TRAN, Chi-Hai**; VALEO SYSTEMES THERMIQUES, ZA l'Agiot, 8 rue Louis Lormand, CS 80517 La Verrière, 78322 LE MESNIL SAINT DENIS CEDEX (FR).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

(54) Title: MODULAR COLLECTOR TUBE AND BATTERY COOLER COMPRISING MODULAR COLLECTOR TUBE

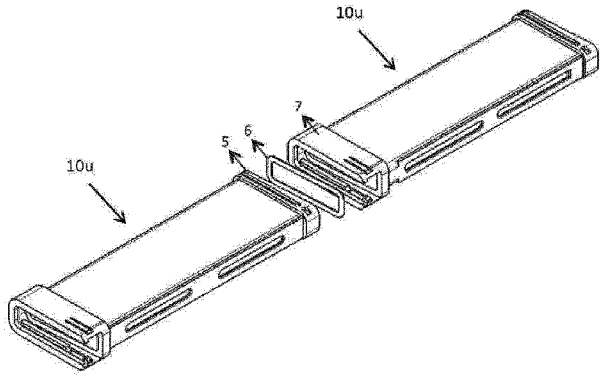

Fig. 2

(57) Abstract: A modular collector tube (10), characterized in that the modular collector tube (10) comprises at least two collector tube units (10u), the collector tube units (10u) are connected to each other by a connecting structure (4), and the connecting structure (4) comprises a male mating end (5) and a female mating end (7) respectively at two ends of the collector tube units (10u), wherein the collector tube units (10u), the male mating end (5) and the female mating end (7) each have a flat cross section, and wherein the female mating end (7) comprises a chamber (75) for receiving the male mating end (5), the chamber (75) has a lateral opening (70), and the male mating end (5) can be inserted into the chamber (75) via the lateral opening (70) in an insertion direction and locked inside the chamber (75) in a snap- fit manner.

WO 2020/115253 A2

[Continued on next page]

HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

Description

Modular collector tube and battery cooler comprising modular collector tube

Technical Field

The present invention relates to a modular collector tube and a battery cooler comprising the modular collector tube, the battery cooler being provided, for example, in a battery pack of a new energy vehicle.

Background Art

As new energy vehicles, especially pure electric vehicles, travel longer and longer, the number and energy density of battery modules are increasing. When operating in a configuration of high-power and enclosed battery units, the battery is highly prone to heat generation and non-uniform temperature, which will adversely affect the efficiency, reliability and service life of the battery. Therefore, a battery cooler is required to cool the operating battery to optimize the performance and service life of the battery.

Different heat transfer media have a great influence on the heat transfer performance of a system. The heat transfer amount provided by the conventional air cooling is insufficient to meet the demand of high cooling capacity. In addition, the heat transfer coefficient between the air and the battery wall is low, and the cooling rate is low. Liquid-cooled battery modules are a preferred choice in terms of cooling efficiency.

For the connection between different components of the battery cooler, an integral brazing process is generally used for the existing liquid-cooled battery coolers, so that the production cost is high, and the internal cleanliness is difficult to control.

It is disclosed in the prior art that mechanical collector tubes are used, i.e., different components of a liquid-cooled battery cooler are mechanically connected. However, most of the existing mechanical

collector tubes have a circular cross section. On the one hand, the vertical height of a car is very valuable so that the vertical space of the battery pack is very limited, but the collector tubes with a circular cross section occupy a large vertical height. On the other hand, the collector tubes with a circular section have high pressure drop and is difficult to control the uniformity of flow.

Summary of the Invention

The present invention is intended to at least solve the above problems and to provide a modular collector tube having a flat cross section.

According to one aspect of the present invention, a modular collector tube is proposed, comprising at least two collector tube units, the collector tube units are connected to each other by a connecting structure, and the connecting structure comprises a male mating end and a female mating end respectively at two ends of the collector tube units, wherein the collector tube units, the male mating end and the female mating end each have a flat cross section, and wherein the female mating end comprises a chamber for receiving the male mating end, the chamber has a lateral opening, and the male mating end can be inserted into the chamber via the lateral opening in an insertion direction and locked inside the chamber in a snap-fit manner.

Preferably, the female mating end comprises resilient tabs each having a projection, the male mating end comprises locking slots that mate with the resilient tabs, and the projections are received in the locking slots, so that the male mating end is locked inside the chamber of the female mating end in the insertion direction.

Preferably, the projection of the resilient tab comprises a stop surface, the locking slot comprises a mating stop surface, and the stop surfaces abut against the mating stop surfaces of the locking slots, so that

the male mating end is locked inside the chamber of the female mating end in the insertion direction. Thus, the male mating end can be prevented from coming out of the chamber of the female mating end in a direction opposite the insertion direction.

Preferably, the male mating end comprises guiding recesses extending parallel to the insertion direction, and the female mating end comprises guiding ribs cooperating with the guiding recesses.

In addition to the guiding effect on the insertion process, the engagement of the guiding ribs of the female mating end with the guiding recesses of the male mating end can also achieve locking of the female mating end and the male mating end in a longitudinal direction of the collector tube unit, i.e., preventing the male mating end from coming out of the chamber of the female mating end in a direction perpendicular to the insertion direction.

According to one embodiment of the present invention, the guiding recesses are aligned with the locking slots of the male mating end in the insertion direction, and the guiding ribs of the female mating end are aligned with the projections of the resilient tabs in the insertion direction.

Preferably, the projection of the resilient tab comprises an inclined surface, the male mating end comprises a mating inclined surface at the end of the guiding recess, and the inclined surface is in sliding contact with the mating inclined surface.

According to one embodiment of the present invention, the connecting structure further comprises a sealing member, and the sealing member is pressed between the male mating end and the female mating end to achieve sealing connection between different collector tube units.

Advantageously, a longitudinal end surface of the male mating end extends obliquely relative to the insertion direction of the male mating end, a receiving surface of the chamber of the female mating end also extends

obliquely relative to the insertion direction of the male mating end, and the sealing member is pressed between the longitudinal end surface of the male mating end and the receiving surface of the chamber of the female mating end.

Since the sealing member is mounted between the male mating end and the female mating end in an interference-fit manner, the insertion process of the male mating end requires an operator to apply a certain magnitude of force. The oblique configuration of the longitudinal end surface of the male mating end and the receiving surface of the chamber of the female mating end can reduce the force required to insert the male mating end into the female mating end.

According to another aspect of the present invention, a battery cooler is proposed, comprising a liquid inlet tube, a liquid outlet tube, and cooling lines connected between the liquid inlet tube and the liquid outlet tube, wherein the liquid inlet tube and the liquid outlet tube are modular collector tubes according to any one of the preceding claims.

The modular collector tube according to the present invention has at least the following advantages:

1. the collector tube units are connected to each other by a connecting structure to meet the processing requirements of battery coolers of different sizes, and the connecting structure, which is a plastic part, is convenient to process and high in degree of modularity and saves the cost; and

2. the modular collector tube has the cross section thereof designed to be flat, which not only ensures the vertical space of an electric vehicle battery pack, but also ensures sufficient space in the horizontal direction to meet the requirements of system flow distribution and pressure drop.

Brief Description of the Drawings

Through the following accompanying drawings, the present invention will be better understood by those skilled in the art, and the advantages of the present invention will be embodied more clearly. The drawings described herein are merely for illustration of the selected embodiments, not all possible embodiments, and are not intended to limit the scope of the present invention.

Fig. 1 shows, in a perspective view, a battery cooler comprising molecular collector tubes according to the present invention;

Fig. 2 shows, in an exploded view, a modular collector tube comprising two collector tube units;

Fig. 3 shows, in different views, a female mating end of the modular collector tube according to the present invention;

Fig. 4 shows, in different views, a male mating end of the modular collector tube according to the present invention; and

Fig. 5 shows, in cross-sectional view, the modular collector tube according to the present invention, in which the male mating end is inserted into the female mating end.

Detailed Description of Embodiments

In the following description of various exemplary structures according to the present invention, reference is made to the accompanying drawings. The accompanying drawings constitute a part of the present invention, and various exemplary embodiments of various aspects of the present invention are illustrated therein. It is understood that other specific arrangements of components and systems may be utilized, and structural and functional modifications may be made without departing from the scope of the present invention. Moreover, although the terms "upper", "lower", "left", "right" and the like may be used in the description to describe

various exemplary features and elements of the present invention, these terms are used herein for convenience, for example, exemplary orientations shown in the figures or orientations during typical use. Any content in the description should not be construed as requiring a particular three-dimensional orientation of the structure so as to fall within the scope of the present invention. In addition, readers should know that the drawings are not necessarily drawn to scale.

Fig. 1 shows a battery cooler according to one embodiment of the present invention. As shown in the figure, the battery cooler comprises a plurality of cooling lines 3, and a cooling liquid circulates in the cooling lines 3 and exchanges heat with battery modules near the cooling lines 3. The battery cooler further comprises a liquid inlet tube 1 and a liquid outlet tube 2, which are connected to ends of the plurality of cooling lines 3. The liquid inlet tube 1 distributes the inflowing cooling liquid into the cooling lines 3, and the liquid outlet tube 2 collects and discharges the cooling liquid from the cooling lines 3.

Advantageously, both the liquid inlet tube 1 and the liquid outlet tube 2 are modular collector tubes 10. In the context of the present invention, the so-called modular collector tube 10 means that the collector tube may be composed of at least two collector tube units 10u, and the different collector tube units 10u may be connected to each other by a connecting structure 4 to form a length-adaptive collector tube.

Different car manufacturers have different requirements for the sizes of battery modules. Accordingly, the size of the battery cooler needs to adapt to the change in size of the battery modules. The use of the modular collector tubes 10 has the advantages that the liquid inlet tube 1 and the liquid outlet tube 2 in the form of modular collector tubes 10 can meet different size requirements of battery modules by means of increasing or decreasing the number of connected

collector tube units 10u, thus allowing the battery cooler to be manufactured and assembled simply, quickly and economically.

Fig. 2 shows, in an exploded view, a modular collector tube 10 comprising two collector tube units 10u. The two collector tube units 10u are connected to each other by a connecting structure 4. The connecting structure 4 comprises a male mating end 5 at one end of each collector tube unit 10u and a female mating end 7 at the other end of each collector tube unit 10u. The male mating end 5 and the female mating end 7 constitute a part of the collector tube unit 10u. In particular, the collector tube unit 10u is made of plastic. According to one embodiment of the present invention, the collector tube unit 10u is integrally molded together with the male mating end 5 and the female mating end 7.

According to one preferred embodiment of the present invention, the collector tube unit 10u, the male mating end 5 and the female mating end 7 each have a flat cross section. The roughly rectangular flat cross section of the female mating end 7 has upper and lower longer sides and left and right shorter sides. Similarly, the roughly rectangular flat cross section of the male mating end 5 also has upper and lower longer sides and left and right shorter sides. Compared with a collector tube of a circular cross section, the collector tube of the flat cross section not only reduces the vertical space in an electric vehicle battery pack occupied by the collector tube, but also improves the pressure drop and flow uniformity in the collector tube.

As shown in Fig. 2, the two collector tube units 10u are placed end to end, that is, the male mating end 5 of the first collector tube unit 10u is arranged opposite the female mating end 7 of the second collector tube unit 10u. By means of inserting the male mating end 5 into the female mating end 7, a mechanical connection between the two collector tube units 10u can be achieved. Furthermore, the connecting structure 4 further comprises

a sealing member 6, which is used to form a sealing connection between the male mating end 5 and the female mating end 7.

Although only two collector tube units 10u are shown in Fig. 2, it is apparent that the modular collector tube 10 may comprise more than two collector tube units 10u. Each of the collector tube units 10u has the same structure and comprises a male mating end 5 at one end and a female mating end 7 at the other end. Two adjacent collector tube units 10u are connected end to end, and the sealing member 6 is disposed between the two adjacent collector tube units 10u to connect more than two collector tube units 10u.

The connecting structure 4 of the collector tube unit 10u according to the present invention will be described in detail below with reference to Figs. 3 to 5.

Fig. 3 shows, in a top view and a perspective view, a female mating end 7 of a collector tube unit 10u according to the present invention. Fig. 4 shows, in a top view and a perspective view, a male mating end 5 of a collector tube unit 10u according to the present invention.

According to one exemplary embodiment of the present invention, as shown in Fig. 3, the female mating end 7 comprises a chamber 75 for receiving the male mating end 5. The chamber 75 has a lateral opening 70 on one side. The lateral opening 70 is advantageously provided at one of the short sides of the female mating end 7. The male mating end 5 can be inserted into the chamber 75 via the lateral opening 70 in the insertion direction and locked inside the chamber 75, for example, in a snap-fit manner.

To lock the male mating end 5 inside the chamber 75, the female mating end 7 may comprise resilient tabs 71 each having a projection 72. The resilient tabs 71 are, for example, two resilient tabs 71, in the form of a cantilever structure, respectively disposed at the upper and lower long sides of the female mating end 7. The projections 72 of the resilient tabs 71 project into the interior of the chamber 75 of the female mating end 7 to

form a resilient snap joint. Preferably, the resilient tabs 71 are disposed near the lateral opening 70 of the female mating end 7 and further away from the other short side where the lateral opening 70 is not formed.

Correspondingly, as shown in Fig. 4, according to one exemplary embodiment of the present invention, the male mating end 5 may comprise locking slots 52 that mate with the projections 72 of the resilient tabs 71. The locking slots 52 are provided, for example, at the upper and lower long sides of the male mating end 5, respectively. By receiving the projections 72 in the locking slots 52, the male mating end 5 can be locked inside the chamber 75 of the female mating end 7 in the insertion direction.

Preferably, a guiding mechanism may also be provided for the insertion of the male mating end 5 to the female mating end 7. According to one exemplary embodiment of the present invention, the male mating end 5 may comprise guiding recesses 53 which extend parallel to the insertion direction, and the female mating end 7 may comprise guiding ribs 73 which also extend parallel to the insertion direction and cooperate with the guiding recesses 53. The guiding recesses 53 are respectively provided, for example, at the upper and lower long sides of the male mating end 5, and the guiding ribs 73 are respectively provided, for example, at the upper and lower long sides of the female mating end 7.

Preferably, the guiding recesses 53 are aligned with the locking slots 52 of the male mating end 5 in the insertion direction, and the guiding ribs 73 of the female mating end 7 are aligned with the projections 72 of the resilient tabs 71 in the insertion direction. Thereby, at the beginning of insertion, the projections 72 of the resilient tabs 71 of the female mating end 7 first slide along the guiding recesses 53 of the male mating end 5 to guide the insertion of the male mating end 5. As the male mating end 5 is further inserted into the interior of the chamber 75 of the female mating end 7, the guiding ribs 73 of the female mating end 7 engage

with the guiding recesses 53 of the male mating end 5, and the insertion of the male mating end 5 is continuously guided until the final locked state.

In addition to the guiding effect on the insertion process, the engagement of the guiding ribs 73 of the female mating end 7 with the guiding recesses 53 of the male mating end 5 can also achieve locking of the female mating end 7 and the male mating end 5 in the longitudinal direction of the collector tube unit 10u, i.e., preventing the male mating end 5 from coming out of the chamber 75 of the female mating end 7 in a direction perpendicular to the insertion direction.

The connecting structure 4 of the modular collector tube 10 may further comprise a sealing member 6, and the sealing member 6 is configured to be pressed between the male mating end 5 and the female mating end 7.

According to one exemplary embodiment of the present invention, the connecting structure 4 further comprises a sealing member 6, and the sealing member 6 is configured to be pressed between a longitudinal end surface 54 of the male mating end 5 and a receiving surface 74 of the chamber 75 of the female mating end 7. However, the sealing member 6 according to the present invention is not limited to the placement mentioned above, and it is conceivable to dispose the sealing member 6 at other positions between the male mating end 5 and the female mating end 7, for example, corresponding recesses are provided in other opposite surfaces of the male mating end 5 and the female mating end 7 to receive the sealing member 6.

Preferably, the longitudinal end surface 54 of the male mating end 5 extends obliquely relative to the insertion direction of the male mating end 5, and the receiving surface 74 of the chamber 75 of the female mating end 7 also extends obliquely relative to the insertion direction of the male mating end 5. The sealing member 6 is configured to be pressed between the longitudinal end surface 54 of the male mating end 5 and

the receiving surface 74 of the chamber 75 of the female mating end 7. Since the sealing member 6 is mounted between the male mating end 5 and the female mating end 7 in an interference-fit manner, the insertion process of the male mating end 5 requires an operator to apply a certain magnitude of force. The oblique configuration of the longitudinal end surface 54 of the male mating end 5 and the receiving surface 74 of the chamber 75 of the female mating end 7 can reduce the force required to insert the male mating end 5 into the female mating end 7.

Fig. 5 shows, in a cross-sectional form, the male mating end 5 and the female mating end 7, which cooperate with each other in the final locked state.

The projection 72 of the resilient tab 71 of the female mating end 7 may comprise a stop surface 72b and an inclined surface 72a. The stop surface 72b extends in a direction perpendicular to the long side of the female mating end 7. Alternatively, the projection 72 of the resilient tab 71 may comprise a transition surface extending in a direction parallel to the long side of the female mating end 7 between the stop surface 72b and the inclined surface 72a.

The locking slot 52 of the male mating end 5 may comprise a mating stop surface 52b that extends in a direction perpendicular to the long side of the male mating end 5. The male mating end 5 comprises a mating inclined surface 53a at one end, close to the locking slot 52, of the guiding recess 53. Alternatively, the male mating end 5 may comprise a transition section, which is flush with the upper surface of the male mating end 5, between the mating inclined surface 53a of the guiding recess 53 and the mating stop surface 52b of the locking slot 52. In the cross-sectional view of Fig. 5, the mating inclined surface 53a of the guiding recess 53, the transition section, and the mating stop surface 52b of the locking slot 52 present the shape of a local protrusion.

During the insertion of the male mating end 5 into the female mating end 7, the projections 72 of the resilient tabs 71 slide along the guiding recesses 53 of the male mating end 5 until the inclined surfaces 72a of the projections 72 of the resilient tabs 71 engage with the mating inclined surfaces 53a of the guiding recesses 53. As the male mating end 5 continues to be inserted, the resilient tabs 71 deflect from initial positions thereof and bend in a direction opposite the chamber 75 of the female mating end 7. The inclined surfaces 72a of the projections 72 of the resilient tabs 71 are in sliding contact with the mating inclined surfaces 53a of the guiding recesses 53, and then the transition surfaces of the projections 72 of the resilient tabs 71 are in sliding contact with the transition sections of the male mating end 5, until the local protrusions formed by the mating inclined surfaces 53a of the guiding recesses 53, the transition sections, and the mating stop surfaces 52b of the locking slots 52 move over the projections 72 of the resilient tabs 71 in the insertion direction. The resilient tabs 71 return to the original positions thereof, and the projections 72 of the resilient tabs 71 are received in the locking slots 52. At this time, the male mating end 5 and the female mating end 7 reach the final locked state. The stop surfaces 72b of the projections 72 of the resilient tabs 71 abut against the mating stop surfaces 52b of the locking slots 52, thereby preventing the male mating end 5 from coming out of the chamber 75 of the female mating end 7 in a direction opposite the insertion direction.

The modular collector tube according to the present invention has at least the following advantages:

1. the collector tube units are connected to each other by a connecting structure to meet the processing requirements of battery coolers of different sizes, and the connecting structure, which is a plastic part, is convenient to process and high in degree of modularity and saves the cost; and

2. the modular collector tube has the cross section thereof designed to be flat, which not only ensures the vertical space of an electric vehicle battery pack, but also ensures sufficient space in the horizontal direction to meet the requirements of system flow distribution and pressure drop.

The above detailed description of the embodiments of the present invention provided in conjunction with the accompanying drawings is not intended to limit the scope of protection of the present invention, but is merely illustrative of selected embodiments of the present invention. Based on the embodiments in the present invention, all other embodiments obtained by those of ordinary skill in the art without any inventive effort fall within the scope of protection of the present invention.

Claims

1. A modular collector tube (10), characterized in that the modular collector tube (10) comprises at least two collector tube units (10u), the collector tube units (10u) are connected to each other by a connecting structure (4), and the connecting structure (4) comprises a male mating end (5) and a female mating end (7) respectively at two ends of the collector tube units (10u), wherein the collector tube units (10u), the male mating end (5) and the female mating end (7) each have a flat cross section, and wherein the female mating end (7) comprises a chamber (75) for receiving the male mating end (5), the chamber (75) has a lateral opening (70), and the male mating end (5) can be inserted into the chamber (75) via the lateral opening (70) in an insertion direction and locked inside the chamber (75) in a snap-fit manner.

2. The modular collector tube (10) of claim 1, wherein the female mating end (7) comprises resilient tabs (71) each having a projection (72), the male mating end (5) comprises locking slots (52) that mate with the resilient tabs (71), and the projections (72) are received in the locking slots (52), so that the male mating end (5) is locked inside the chamber (75) of the female mating end (7) in the insertion direction.

3. The modular collector tube (10) of claim 2, wherein the projection (72) of the resilient tab (71) comprises a stop surface (72b), the locking slot (52) has a mating stop surface (52b), and the stop surfaces (72b) abut against the mating stop surfaces (52b) of the locking slots (52), so that the male mating end (5) is locked inside the chamber (75) of the female mating end (7) in the insertion direction.

4. The modular collector tube (10) of claim 2, wherein the male mating end (5) comprises guiding recesses (53) extending parallel to the insertion direction, and the female mating end (7) comprises guiding ribs (73) cooperating with the guiding recesses (53).

5. The modular collector tube (10) of claim 4, wherein the guiding recesses (53) are aligned with the locking slots (52) of the male mating end (5) in the insertion direction, and the guiding ribs (73) of the female mating end (7) are aligned with the projections (72) of the resilient tabs (71) in the insertion direction.

6. The modular collector tube (10) of claim 5, wherein the projection (72) of the resilient tab (71) comprises an inclined surface (72a), the male mating end (5) comprises a mating inclined surface (53a) at one end of the guiding recess (53), and the inclined surface (72a) is in sliding contact with the mating inclined surface (53a).

7. The modular collector tube (10) of any one of claims 1 to 6, wherein the connecting structure (4) further comprises a sealing member (6), and the sealing member (6) is configured to be pressed between the male mating end (5) and the female mating end (7).

8. The modular collector tube (10) of claim 7, wherein a longitudinal end surface (54) of the male mating end (5) extends obliquely relative to the insertion direction of the male mating end (5), a receiving surface (74) of the chamber (75) of the female mating end (7) also extends obliquely relative to the insertion direction of the male mating end (5), and the sealing member (6) is configured to be pressed between the longitudinal end surface (54) of the male mating end (5) and the receiving surface (74) of the chamber (75) of the female mating end (7).

9. A battery cooler, comprising a liquid inlet tube (1), a liquid outlet tube (2), and cooling lines (3) connected between the liquid inlet tube (1) and the liquid outlet tube (2), wherein the liquid inlet tube (1) and the liquid outlet tube (2) are the modular collector tubes (10) according to any one of the preceding claims.

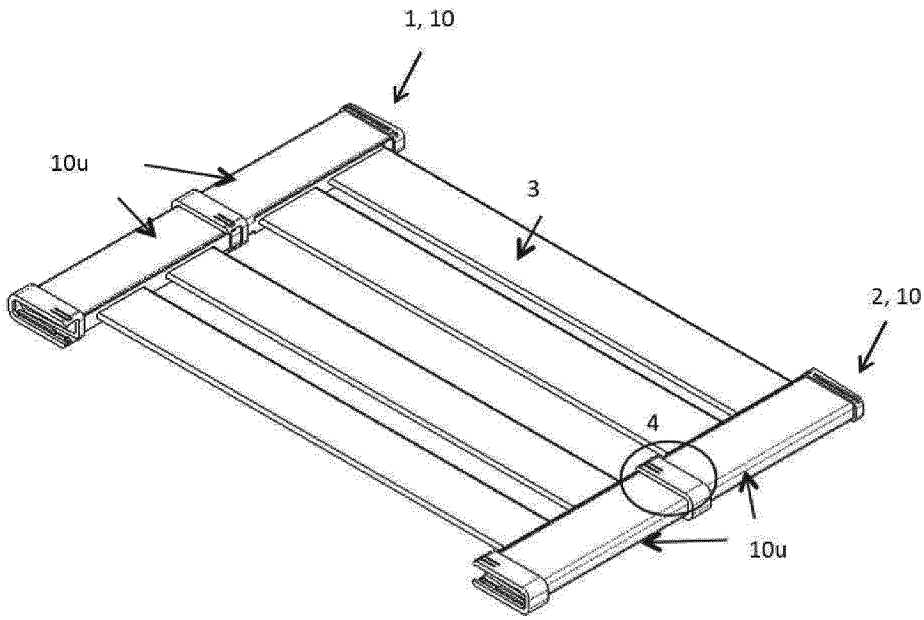

Fig. 1

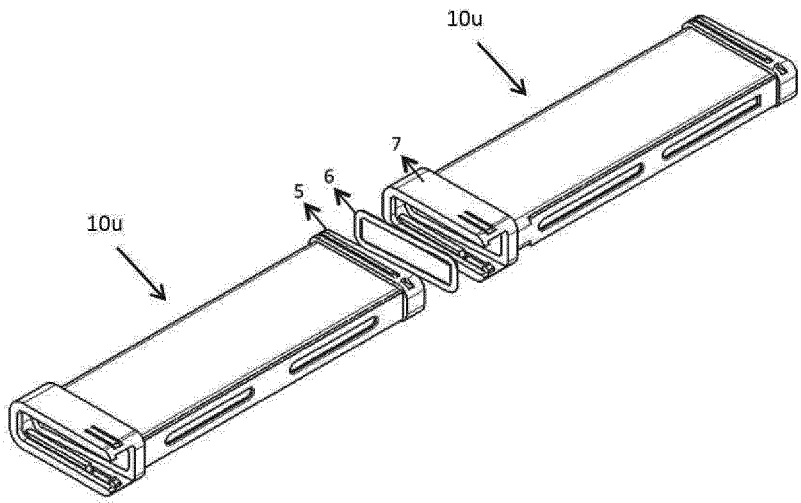

Fig. 2

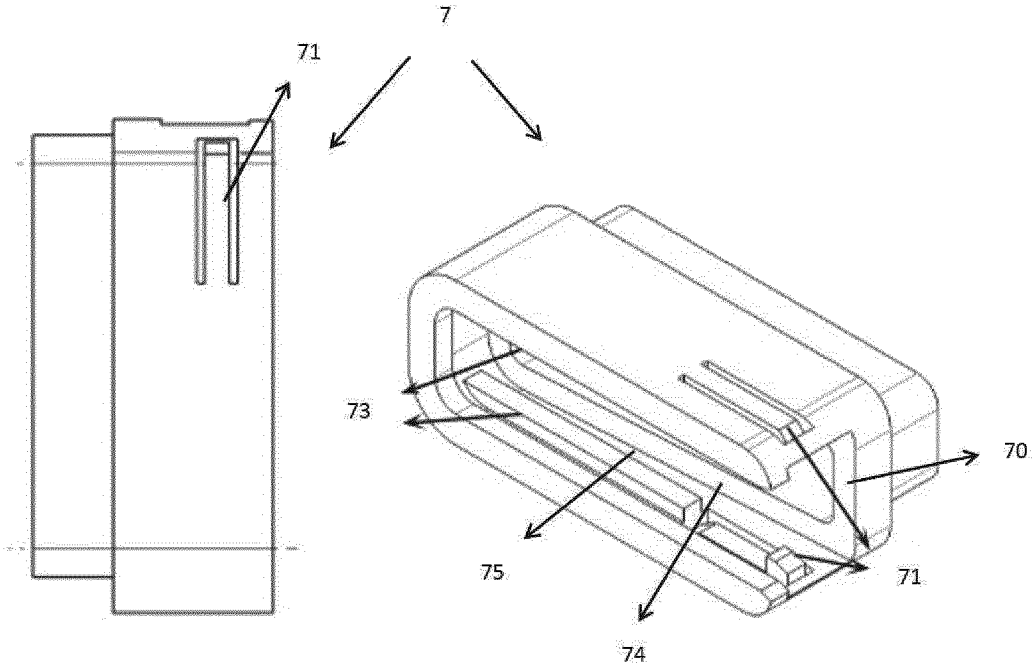

Fig. 3

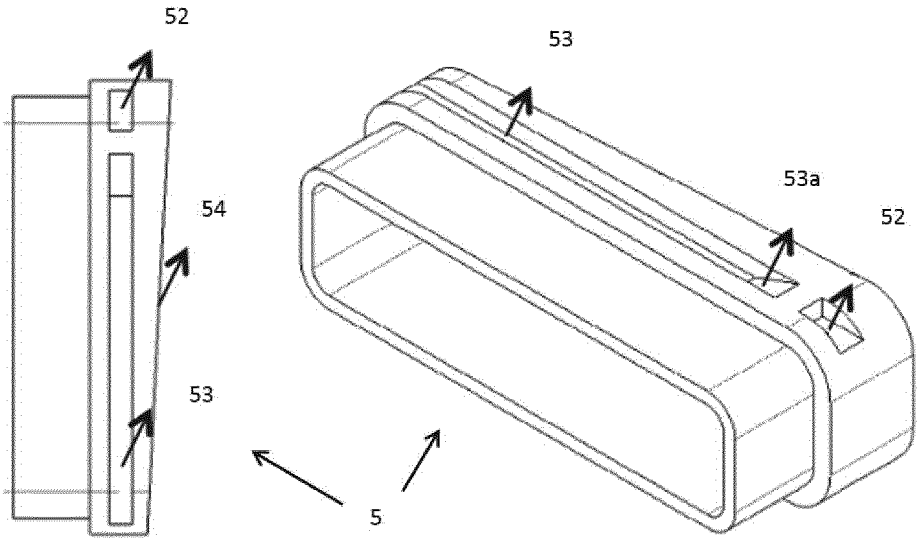

Fig. 4

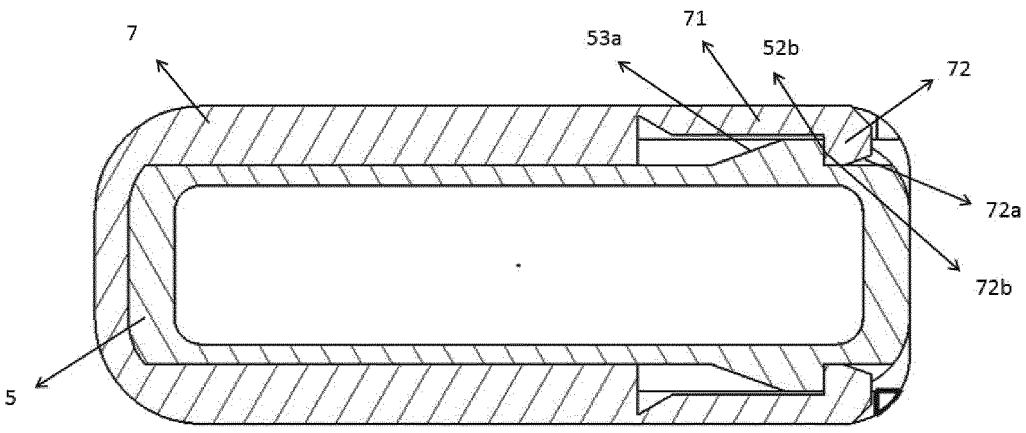

Fig. 5