(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 598 049 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.01.2020 Bulletin 2020/04

(51) Int Cl.:
F28D 9/00 (2006.01) *F28F 9/007* (2006.01)

(21) Application number: **18184518.1**

(22) Date of filing: **19.07.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Valeo Termico S.A.**
50011 Zaragoza (ES)

(72) Inventors:
- **PENA, Dario**
  50011 Zaragoza (ES)
- **BRUNA, Pedro**
  50011 ZARAGOZA (ES)
- **SEBASTIAN, Daniel**
  50011 ZARAGOZA (ES)
- **LABORDA, Juan**
  50011 ZARAGOZA (ES)

(74) Representative: **Metz, Gaëlle**
Valeo Systèmes Thermiques
8, rue Louis Lormand
CS 80517 La Verrière
78322 Le Mesnil Saint Denis Cedex (FR)

(54) REINFORCED HEAT EXCHANGER COMPRISING A STACK OF PLATES

(57) The heat exchanger (2) comprises a stack of plates (4) comprising a lower plate (20) onto which the other plates (22) are stacked.

The heat exchanger (2) also comprises a fixation plate (6) and a reinforcement plate (8) between the fixation plate (6) and the lower plate (20). The reinforcement plate (8) has reinforcing elements (24) obtained from a cut and fold of the reinforcement plate (8) material.

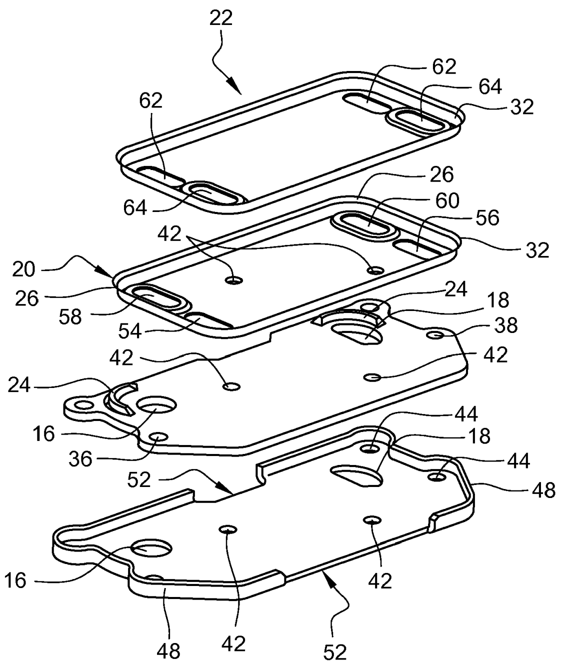

Fig. 3

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] In the field of heat exchangers for automotive vehicles, it is known to use heat exchangers comprising stack of plates for the circulation of two fluids alternately between the adjacent pairs of plates. Such heat exchangers are used for example as oil coolers for the oil of the engine. The oil and coolant circulate along respective sides of each intermediate plate of the stack of plates.

[0002] The heat exchanger may also comprise a fixation plate for fixation of the stack of plates into the automotive vehicle. The stack of plates is for example soldered to the fixation plate which is itself fastened to the vehicle, for example with screws.

[0003] A reinforcement plate between the fixation plate and the stack of plates is also known from US2007084809-A and EP2267390-A.

[0004] However, these designs are costly and may still be improved in terms of mechanical resistance.

[0005] An aspect of the invention relates to a heat exchanger comprising a stack of plates comprising a lower plate onto which the other plates are stacked, and the heat exchanger also comprises a fixation plate and a reinforcement plate between the fixation plate and the lower plate, wherein the fixation plate has reinforcing elements obtained from a cut and fold of the reinforcement plate material.

[0006] The reinforcing elements thus obtained bring reinforcement while still allowing flexibility. Also, the process allows controlled position and shape of the reinforcing elements, with a reasonable cost.

[0007] It was also found that having reinforcing elements around only two corners is optimal.

[0008] In particular embodiments, the heat exchanger may comprise one, several or any combination of the following technical features:

- the reinforcing elements are only one or more corners of the lower plate. Having reinforcing elements only in one of more of the corners bring reinforcement to the corners while also providing more elasticity to the rest of the lower plate. It is thus possible for the lower plate to follow slight deformations where constraints are not critical, thereby relieving constraints in the interface between the reinforcement plate and the lower plate.
- the reinforcing elements are only around two corners of the lower plate;
- for each reinforced corner, there is only one reinforcing element;
- the reinforcing elements are in contact with the lower plate;
- the reinforcing elements have a shape complementary to the shape of the lower plate;
- the height *h* of the reinforcing element, measured from the top planar surface of the fixation plate is preferably at least half the height *h*' of the peripheral edge of the lower plate, measured from the top main planar surface of the reinforcement plate;
- the reinforcing elements have their internal surface following the external surface of the lower plate;
- the reinforcing elements are continuous around the respective corners of the lower plate;
- the reinforcement plate has only two reinforcing elements;
- the reinforcement plate is a substantially planar plate;
- the reinforcement plate is a planar plate, except in the regions of the reinforcing elements;
- the plate has two holes for the circulation of fluid, the reinforcing elements being at proximity of the two holes;
- the two holes are respectively for the inlet and outlet of a fluid, in particular oil;
- the lower plate has corresponding holes in regards of the two holes for the circulation of fluid of the reinforcement plate, the two holes of the lower plate being respectively in the two corners of the lower plate that are reinforced by the reinforcing elements;
- the fixation plate has a planar surface receiving the fixation plate and a protrusion around the reinforcement plate;
- the protrusion is a peripheral edge of the fixation plate;
- the peripheral edge is present along at least 50% of the contour of the reinforcement plate;
- the fixation plate has two holes for the circulation of fluid in regards of the corresponding holes of the reinforcement plate;
- the fixation plate has holes for fixation of the heat exchanger into an automotive vehicle;
- the reinforcement plate has holes for fixation in regards of the corresponding holes of the reinforcement plate;
- the stack of plates define two circuits for two respective fluids, the circuits being configured so that the two fluids circulate alternately between the adjacent pairs of plates;
- each circuit flows along a respective side of each intermediate plate of the stack of plates;
- each intermediate plate of the stack of plates has holes for the circulation of two fluids through each intermediate plate;
- the lower plate has two holes respectively for the inlet and outlet of one of the two fluids, in particular oil;
- the end plate opposite to the lower plate has two holes respectively for the inlet and outlet of the second of the two fluids, in particular coolant;
- the heat exchanger is an oil cooler.

[0009] Another aspect of the invention relates to a process for making a heat exchanger comprising a stack of plates comprising a lower plate onto which the other plates are stacked, the heat exchanger also comprising a fixation plate, and a reinforcement plate between the fixation plate and the lower plate, the fixation plate having reinforcing elements and wherein the process comprises actions of cutting and folding the reinforcing elements from the material of the reinforcement plate.

[0010] In particular embodiments, the process may comprise one, several or any combination of the following characteristics:

- the cutting and folding of a reinforcing element are made in a single movement of a tool, in particular a cutting dye;
- the cutting and folding are made in a single step;
- all reinforcing elements made of the reinforcement plate made by cutting and folding are made in a single step.

[0011] Embodiments of the invention will now be described, by way of example, with reference to the following drawings, in which:

- Figure 1 is a perspective view of a heat exchanger according to an embodiment of the invention, comprising a stack of plates, a fixation plate and a reinforcement plate between the fixation plate and the stack of plates;
- Figure 2 is a perspective view of the reinforcement plate present in the heat exchanger of Figure 1;
- Figure 3 is a perspective view showing the fixation plate, the reinforcement plate and the lower plate of the stack of plates present in the heat exchanger of Figure 1, as well as on top of the lower plate, the first base plate of the stack of base plates;
- Figure 4 is a section view of the fixation plate, reinforcement plate and lower plate shown in Figure 3.

[0012] Figure 1 shows a heat exchanger 2 typically used for oil cooling. The heat exchanger comprises a stack of plates 4, a fixation plate 6 and a reinforcement plate 8 between the fixation plate 6 and the stack of plates 4.

[0013] The heat exchanger comprises a coolant inlet 10 and coolant outlet 12 going through the top end plate 14 of the stack of plates. The coolant is for example a water and glycol based liquid commonly used for engine cooling. On figures 2 & 3, an oil inlet 16 and an oil outlet 18 can also be seen through the lower plate 20 of the stack of plates 4, through the reinforcement plate 8 and through the fixation plate 6. The heat exchanger is thus intended to be used as an oil cooler, for example for cooling the oil of the engine of the automotive vehicle. However, the heat exchanger could also be used for heat exchange between other fluids, such as for example between water and glycol based liquid and a refrigerant such as for example 1234yf.

[0014] The stack of plates 4 of the heat exchanger is designed so that the two fluids circulate alternately between the adjacent pairs of plates. That is to say, each fluid circulates along respective sides of each intermediate plate 22 (also called "base plates") of the stack of plates 4. The base plates 22 have holes for the circulation of the two fluids through each plate.

[0015] This type of stack of plates 4 is commonly used and known to the person skilled in the art.

[0016] The reinforcement plate 8 shown more specifically on Figures 2 a 3, is a substantially planar plate having two reinforcing elements 24 around two corners 26 of the lower plate 20. These two reinforcing elements 24 shown more closely on Figure 4 are obtained by cutting and folding material from the reinforcement plate.

[0017] As show on Figure 4, the internal surface 28 of the reinforcing elements 24 contact the external surface 30 of the peripheral edge 32 of the lower plate 20. Preferably, the internal surface 28 of the reinforcing elements 24 have a shape that is complementary of the shape of the external surface 30 and thus in contact along the whole corner 26.

[0018] The height *h* of the reinforcing element 24, measured from the top planar surface 34 of the fixation plate 6 is preferably at least half the height *h'* of the peripheral edge 32 of the lower plate 20, measured from the top main planar surface 36 of the reinforcement plate 8.

[0019] The cutting and folding of a reinforcing element 24 are made preferably in a single movement of a cutting dye or any other adapted tool. Alternatively though, it is possible to make it in two steps with two different tools / apparatus. All reinforcing elements 24 of the reinforcement plate 8 made by cutting and folding are preferably made in a single step.

[0020] Preferably, there are reinforcing elements 24 around only two corners 26 of the lower plate 20, as can be seen on the figures. Alternatively, there could be four reinforcing elements 24 around each corner 26 of the lower plate 20 but this is a less preferred solution.

[0021] Preferably also, the reinforcing elements 24 are in one part (or "continuous") around their respective corners 26. That is to say that each corner 26 is reinforced by only one reinforcing element. It was found a more reliable reinforcement compared to having several reinforcing elements around a specific corner.

[0022] Preferably again, the reinforced corners are the one at proximity of the holes for fluid communication 16 and 18 for oil. If the inlet and outlet of water and glycol based coolant were also designed through the reinforcement plate 8 and fixation plate 6, which is also a possible alternative, then the reinforcing elements would be at proximity of the inlet & outlet for oil, and there would be no reinforcing elements at proximity of the inlet & outlet for water & glycol based coolant.

[0023] The reinforcement plate 8 has fixation holes 38 in regards of corresponding fixation holes of the fixation plate 6, in order to receive for example fixation screws intended to fasten the heat exchanger into the automotive vehicle. Alternatively, the reinforcement plate has no fixation hole and the fixation plate 6 is fastened to the automotive by holes that are external to the reinforcement plate.

[0024] The reinforcement plate 8 also has positioning protrusions 42, or more generally positioning elements, that cooperate with corresponding positioning elements 42 of the lower plate 20. In this specific example, the positioning elements 42 of the lower plate 20, the reinforcement plate 8 and the fixation plate 6, are protruding plots, the protruding plots of each of the plates 20, 6 and 8 being respectively identical.

[0025] The fixation plate 6 shown on figures 2, 3 & 4 is intended to receive the reinforcement plate and to fasten the heat exchanger 2 to the automotive vehicle thanks to fixation holes 44 in regards of the fixation holes 38 of the reinforcement plate 8. Fixation can be done with fixation screws or any other adapted fixation element such as bolts.

[0026] The fixation plate 6 has a top planar surface 34 (Figure 4) receiving the bottom planar surface 46 of the reinforcement plate, the two surfaces being in contact with each other. Alternatively, the fixation plate 6 and reinforcement plate 8 could have any other adapted geometry.

[0027] The fixation plate 6 has a peripheral edge 48 around the reinforcement plate 8 for reinforcement of the fixation plate 6.

[0028] Preferably, the peripheral edge 48 extends along substantially the whole contour of the reinforcement plate 6. In the figures, there are only two regions 52 where the peripheral edge 48 is not present, but the peripheral edge 48 is still present around at least 50% of the contour of the reinforcement plate 6.

[0029] At last, the stack of plates 4 is made of identical base plates, an upper plate (not shown) and of the top end plate 14, as commonly known.

[0030] As shown on Figure 3, the lower plate 20, has two holes 54 & 56. There holes are inactive for the lower plate 20 because these holes do not have corresponding holes in the reinforcement plate 8 and in the fixation plate 6.

[0031] The lower plate 20 also has holes 58 & 60 for the circulation of oil.

[0032] The base plates 22 are all identical. They have holes 62 for the circulation of oil and holes 64 for the circulation of coolant.

[0033] Also, each base plate is turned 180 degrees in respect of the adjacent base plates. In this way, it is not necessary to make two different kinds of plates, as commonly known.

[0034] A first group of base plates are intended for the circulation of oil above the base plates 22. The holes 62 for the circulation of oil are in the same plane as the main planar surfaces of these plates and the holes 66 for the circulation of coolant are elevated so that they make a tight contact with the bottom planar surface of the base plate above, which is turned 180 degrees.

[0035] The second half of the base plates 22 of the stack of plates have holes 64 for coolant in the plane of the main planar surfaces of these base plates 22 and the holes for the circulation of oil 62 are elevated so that they make a tight contact with the bottom surface of the plates above. Coolant will circulate on the top side of this second type of base plate.

[0036] Importantly, each base plate 22 of the stack of plates 4, the lower plate 22 and the upper plate (not shown) having a peripheral edge 32 of an identical shape. The peripheral edge 32 of each plate receives the external surface of the peripheral edge 32 of the plate above in a tight manner. This design is also called a "tub" design wherein each tub plate receives the tub plate above in a tight manner along the peripheral edges 32.

[0037] The top end plate only has holes 66 & 68 for receiving the inlet & outlet of coolant. Alternatively, as explained above, the inlet & outlet of coolant could also be on the side of the fixation plate 6, in which case, there would be not circulation holes in the top end plate 14.

Claims

1. Heat exchanger (2) comprising a stack of plates (4) comprising a lower plate (20) onto which the other plates (22) are stacked, and the heat exchanger (2) comprises a fixation plate (6), and a reinforcement plate (8) between the fixation plate (6) and the lower plate (20), wherein the reinforcement plate (8) has reinforcing elements (24) obtained from a cut and fold of the reinforcement plate (8) material.

2. Heat exchanger (2) according to claim 1, wherein the reinforcing elements (24)vare only around one or more corners of the lower plate (20).

3. Heat exchanger (2) according to claim 1 or 2, wherein the reinforcing elements (24) are only around two corners of the lower plate (20).

4. Heat exchanger (2) according to any of the preceding claims, wherein the reinforcing elements (24) are in contact with the lower plate (20).

5. Heat exchanger (2) according to any of the preceding claims, wherein the reinforcing elements (24) have a shape complementary to the shape of the lower plate(20).

6. Heat exchanger (2) according to any of the preceding claims, wherein the reinforcement plate (8) is a substantially planar plate.

7. Heat exchanger (2) according to any of the preceding claims, wherein the reinforcement plate (8) has two holes (16, 18) for the circulation of fluid, the reinforcing elements (24) being at proximity of the two holes (16, 18).

8. Heat exchanger (2) according to the preceding claim, wherein the lower plate (20) has corresponding holes

(58, 60) in regards of the two holes (16, 18) for the circulation of fluid of the reinforcement plate (8), the two holes (58, 60) of the lower plate (20) being respectively in the two corners (26) of the lower plate (20) that are reinforced by the reinforcing elements (24).

9. Heat exchanger (2) according to any of the preceding claims, wherein the fixation plate (6) has a planar surface (34) receiving the reinforcement plate (8) and a protrusion (48) around the reinforcement plate (8).

10. Heat exchanger (2) according to claim 8 or 9, wherein the protrusion (48) is a peripheral edge of the fixation plate (6).

11. Heat exchanger (2) according to any of the preceding claims, wherein the stack of plates (4) define two circuits for two respective fluids, the circuits being configured so that the two fluids circulate alternately between the adjacent pairs of plates (22).

12. Heat exchanger (2) according to any of the preceding claims, wherein the heat exchanger (2) is an oil cooler.

13. Process for making a heat exchanger (2) comprising a stack of plates (4) comprising a lower plate (20) onto which the other plates (22) are stacked, the heat exchanger (2) also comprising a fixation plate (6), and a reinforcement plate (8) between the fixation plate (6) and the lower plate (20), the fixation plate (6) having reinforcing elements (24) and wherein the process comprises actions of cutting and folding the reinforcing elements (24) from the material of the reinforcement plate (8).

14. Process according to claim 1, wherein the cutting and folding of a reinforcing element (24) are made in a single movement of a tool.

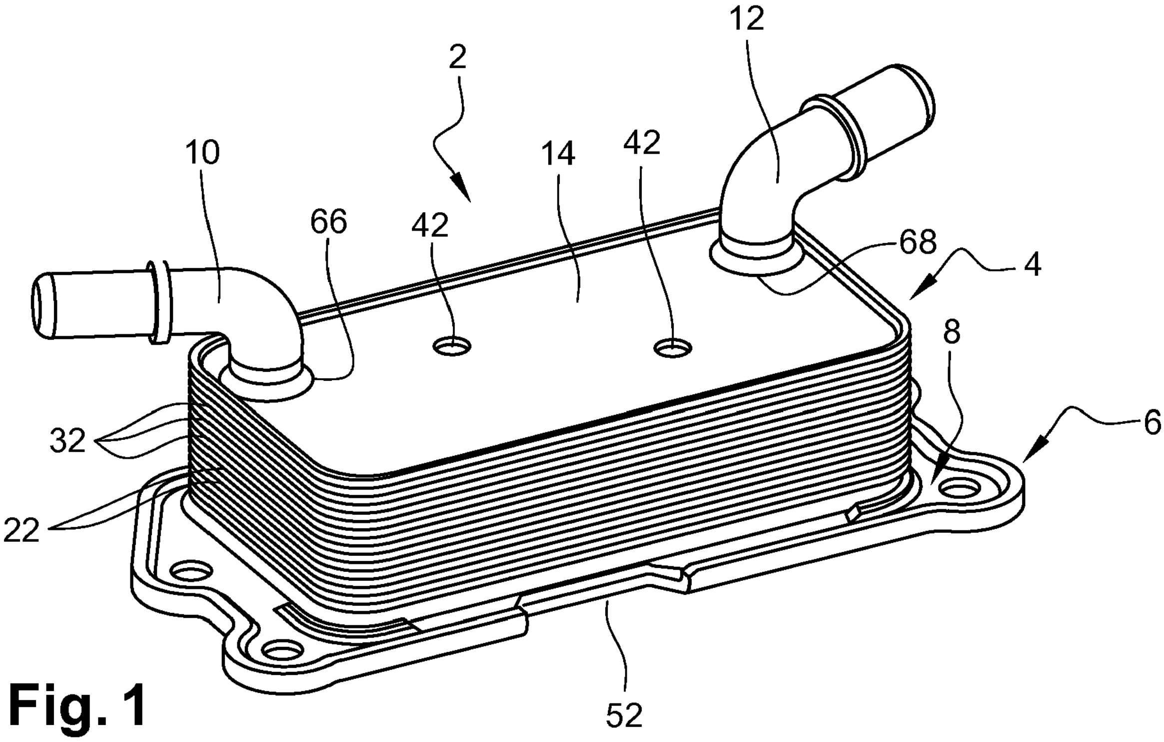

Fig. 1

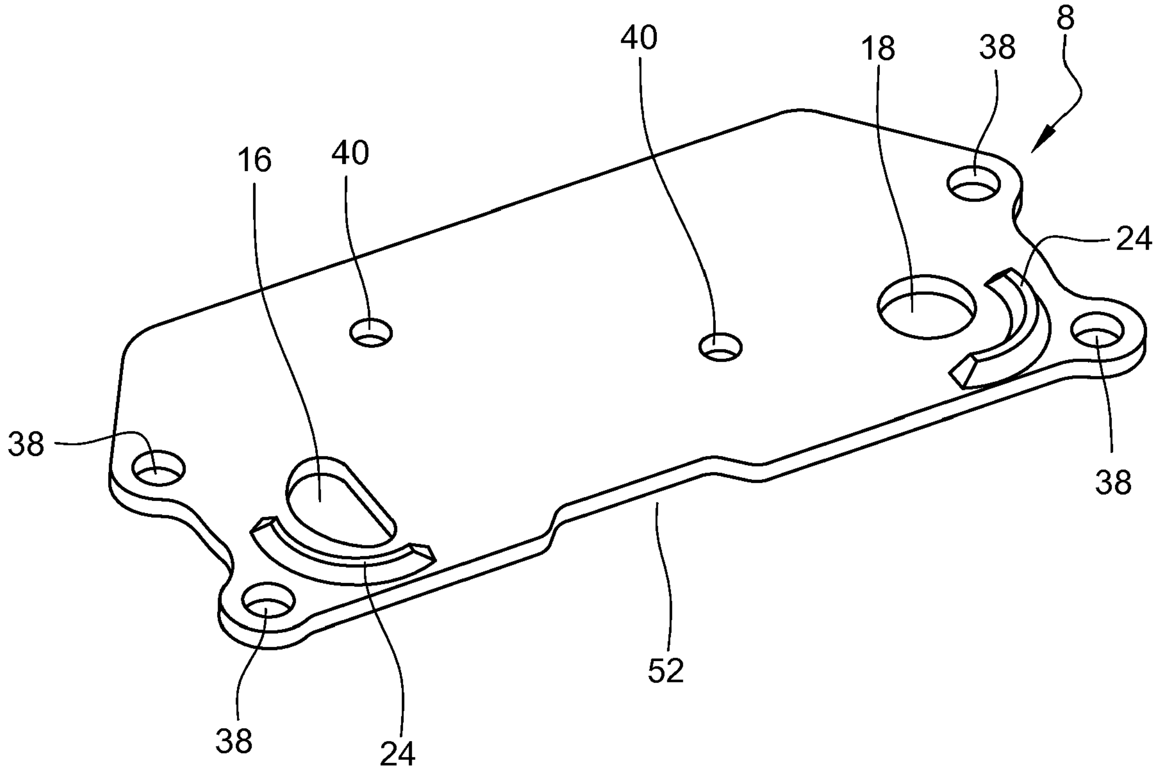

Fig. 2

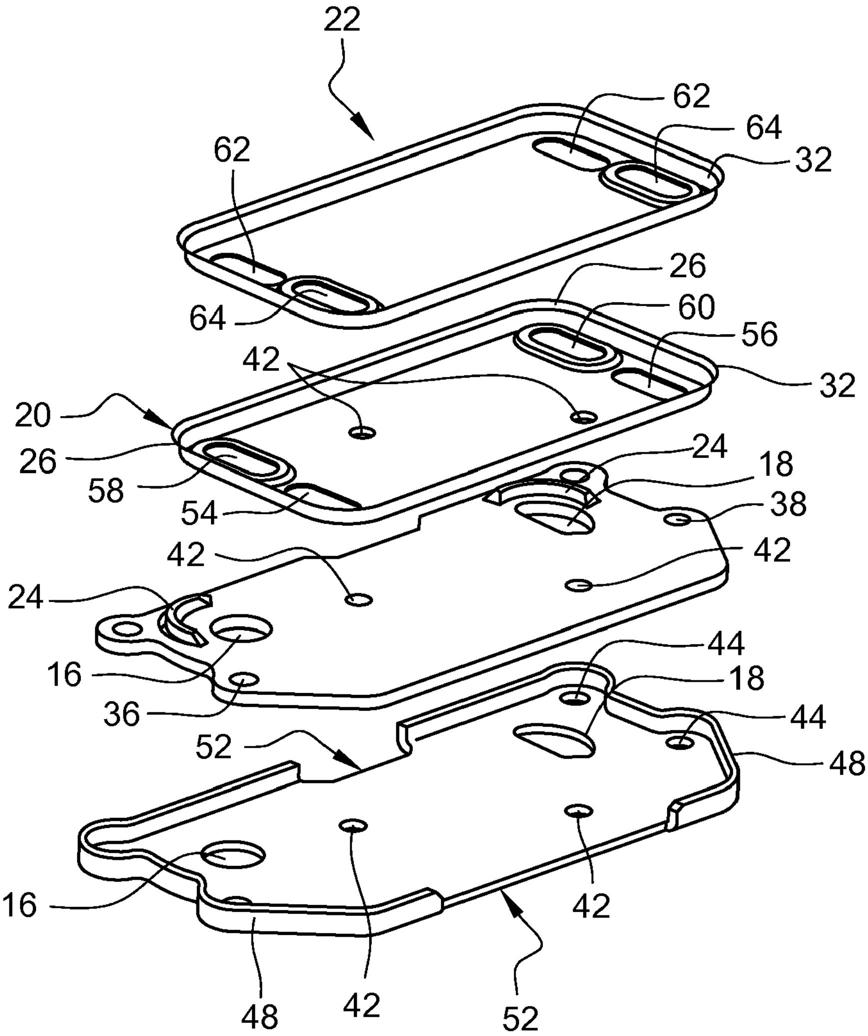
22
62
64
32
62
64
26
60
56
32
42
20
26
58
54
24
18
38
42
42
24
16
36
44
18
44
48
52
16
42
48
42
52

Fig. 3

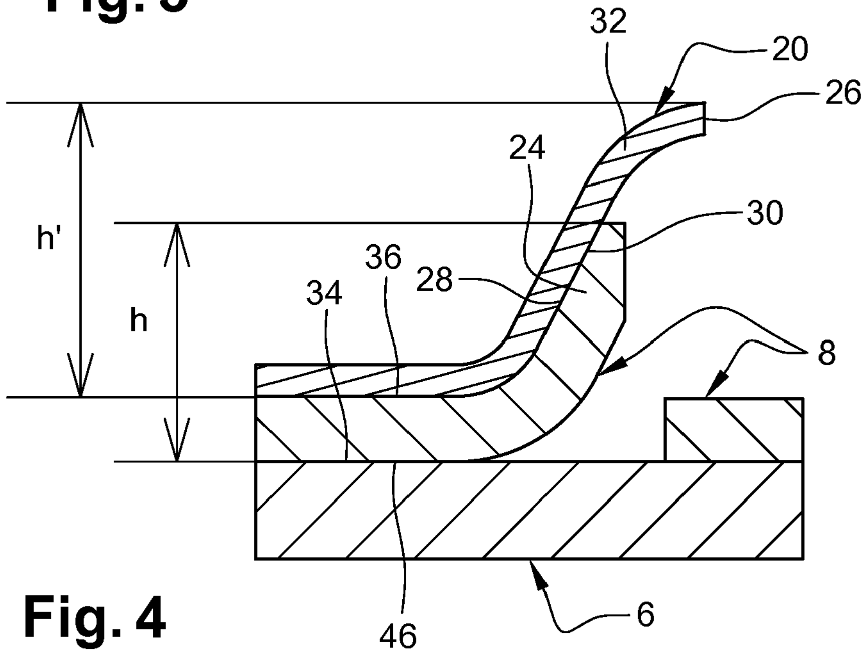
32
20
26
24
30
h'
h
36
28
34
8
46
6

Fig. 4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 18 4518

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	EP 2 963 374 A1 (EISENMANN BJÖRN [DE]) 6 January 2016 (2016-01-06) * paragraph [0018] - paragraph [0023]; figures 1-3 *	1-6, 11-14 8	INV. F28D9/00 F28F9/007
X	DE 10 2009 034752 A1 (MODINE EUROP GMBH [DE]; MODINE MFG CO [US]) 10 February 2011 (2011-02-10) * paragraph [0016] - paragraph [0017]; figures 1-4 *	1,6,7, 11-14	
Y,D	US 2007/084809 A1 (BRADU PASCAL [FR] ET AL) 19 April 2007 (2007-04-19) * paragraph [0029]; figures 9,10 *	8	
A,D	EP 2 267 390 A2 (BEHR GMBH & CO KG [DE]) 29 December 2010 (2010-12-29) * the whole document *	1-14	

TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	19 December 2018	Jessen, Flemming

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 18 4518

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-12-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2963374 A1	06-01-2016	DE 102014212942 A1	07-01-2016
		EP 2963374 A1	06-01-2016
		US 2016003554 A1	07-01-2016
DE 102009034752 A1	10-02-2011	NONE	
US 2007084809 A1	19-04-2007	CA 2624672 A1	12-04-2007
		CN 101317069 A	03-12-2008
		EP 1931932 A1	18-06-2008
		EP 3276291 A1	31-01-2018
		US 2007084809 A1	19-04-2007
		US 2012205069 A1	16-08-2012
		WO 2007038871 A1	12-04-2007
EP 2267390 A2	29-12-2010	DE 102009030095 A1	23-12-2010
		EP 2267390 A2	29-12-2010

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 2007084809 A **[0003]**
- EP 2267390 A **[0003]**