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

(11) **EP 1 515 105 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
20.10.2010 Bulletin 2010/42

(51) Int Cl.:
F28D 1/04 *(2006.01)* ***F28F 9/02*** *(2006.01)*

(21) Application number: **04460028.6**

(22) Date of filing: **28.06.2004**

(54) **An integrated heat exchanger and a method of assembling thereof**

Wärmetauscher und Herstellungsverfahren

Echangeur de chaleur combiné et procédé de fabrication

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR

(30) Priority: **10.09.2003 GB 0321092**

(43) Date of publication of application:
16.03.2005 Bulletin 2005/11

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Description

[0001] The present invention relates to an integrated heat exchanger comprising at least two heat exchangers, each having a cooling core comprised of fins and tubes, two header tanks fluidly connected with reciprocal ends of cooling core tubes, where said heat exchangers are coupled and parallel to each other. The invention further relates to a method of assembling such a heat exchanger. JP-2002 257 494 discloses such a heat exchanger.

[0002] Integrated heat exchangers of this kind commonly form a vehicle CRFM (Condenser, Radiator, cooling Fan Module), where a condenser of the vehicle air conditioning system is connected in stacking direction to the engine cooling installation radiator. Examples of such modules are disclosed in U.S. Pat. No.:6,364,005, GB Pat. 2 371 505 or U.S. Pat. App. No. 10/350,360.

[0003] Typically radiator is coupled to condenser with end caps closing the header tank openings, by means of appropriate brackets or, as in GB Pat. 2 371 505, with a clinched seam, and then the whole unit is brazed in a furnace. The above methods form CRFMs which are inseparable units, disallowing to detach previously coupled heat exchangers. If any of heat exchangers fails, e.g. gets leak, the whole CRFM needs to be dismounted and then repaired or replaced.

[0004] It is thus the object of the present invention to provide an integrated heat exchanger of the type mentioned above, having a simple construction, resistant to vibrations generated e.g. during the engine operation; which is separable and allows to detach particular heat exchangers forming the integrated module, even if the module is mounted to the vehicle chassis.

[0005] According to the present invention there is provided an integrated heat exchanger, where the top ends of the header tanks of the primary heat exchanger are provided with top end caps having projections with openings adapted to receive the top ends of the header tanks of at least one secondary heat exchanger; the bottom ends of the header tanks of the primary heat exchanger are provided with bottom end caps having projections with sockets adapted to receive the bottom ends of the header tanks of at least one secondary heat exchanger; where the bottom ends of the header tanks of at least one secondary heat exchanger are supported on a retaining rings resting in sockets of the projections of the bottom end caps; and the top ends of the header tanks of at least one secondary heat exchanger, are locked by retaining plugs pushed upwardly into the openings of the projections of the top end caps.

[0006] Preferably the primary heat exchanger is a radiator of a vehicle cooling system and the secondary heat exchanger is a condenser of a vehicle air conditioning system.

[0007] Preferably the retaining rings and the retaining plugs are made of resilient material, advantageously plastic.

[0008] Such mounting system eliminates possible displacements of particular elements, compensates dimensional manufacturing tolerances of the condenser and the radiator, and provides an amortization effect during the engine operation. The system enables also thermal stresses compensation caused by coolant temperature differences in particular heat exchangers.

[0009] In another aspect of the present invention there is provided a method of assembling integrated heat exchanger comprising the steps of

(i) preliminary assembling and brazing the primary heat exchanger providing the header tanks thereof with top end caps having projections with openings adapted to receive the top ends of the header tanks of at least one secondary heat exchanger, and with bottom end caps having projections with sockets adapted to receive the bottom ends of the header tanks of at least one secondary heat exchanger;

(ii) preliminary assembling and brazing at least one secondary heat exchanger;

(iii) placing the retaining rings into sockets of the bottom end caps;

(iv) inserting the top ends of header tanks of the secondary heat exchanger at an acute angle into openings in projections of the top end caps;

(v) rotating the secondary heat exchanger to the position substantially parallel to the primary heat exchanger;

(vi) lowering the secondary heat exchanger so as to lock ends of its header tank into appropriate retaining rings resting in the sockets of the projections of the bottom end caps; and

(vi) locking the top ends of the header tanks of the secondary heat exchanger with retaining plugs pushed upwardly into the openings of the projections of the top end caps.

[0010] To detach the secondary heat exchanger one should simply perform the above steps in reverse order, i.e. unlock the retaining plugs, displace the secondary heat exchanger upward and turn its bottom side away of the primary heat exchanger, finally displace it downward.

[0011] It is worth noting that bottom and top end caps may be mounted to the primary heat exchanger after brazing thereof.

[0012] The procedure described above may be also performed for each third and any subsequent heat exchanger of the integrated heat exchanger.

[0013] The method according to the present invention allows a reliable coupling a number of heat exchangers in uncomplicated way, at the same time avoiding additional operations of preassembling or positioning. Appli-

cation of only two pairs of end caps, provided with retaining plugs and retaining rings, permits to keep the right position of heat exchangers with respect to each other, wherein at the same time it is possible to detach such a connection, which is advantageous in servicing the integrated module, e.g. by replacing condenser that has failed.

[0014] The invention is presented below by way of exemplary embodiments in connection with the drawings on which:

Fig. 1 is a partially exploded axonometric view of a portion of an integrated vehicle CRFM module, made according to the present invention;

Fig. 2 is a side view of an integrated vehicle CRFM module of Fig. 1, illustrating the process of assembling thereof;

Fig. 3 is a side view of an integrated vehicle CRFM module of Fig. 1, after assembling thereof; and

Fig. 4 is an exploded axonometric view of another embodiment of the invention.

[0015] The portion of the integrated heat exchanger 1 according to one embodiment of the present invention is presented in Fig. 1, where the heat exchanger 1 forms an integrated vehicle CRFM module.

[0016] As shown, the heat exchanger 1 comprises in fact of two heat exchangers: the radiator 2 of the vehicle cooling system and the condenser 3 of the vehicle air conditioning systems. For the purpose of clarity, the drawing presents only top and bottom ends of the heat exchangers 2 and 3.

[0017] Radiator 2 comprises of two header tanks 21 (only one shown on the drawing) having a rectangular cross-section and fluidly connected with reciprocal ends of tubes 22, that along with cooling fins 23 located in regions between the tubes 22 form the radiator cooling core. Ends of tubes 22 are inserted in grooves 24.

[0018] The construction of the condenser 3 is similar. It comprises of two circular header tanks 31 fluidly connected with tubes 32 inserted into appropriate grooves 34. The tubes 32 and the cooling fins 33 located in regions between the tubes 32 form the condenser cooling core shown in part in the drawing.

[0019] Heat exchangers 2 and 3 are manufactured independently i.e. they are independently preassembled and brazed in a furnace. The open ends of the condenser 3 header tanks 31 are closed by the end caps 35 recessed inside the header tank 31 profile.

[0020] The open top end of the radiator 2 header tank 21 is closed by top end cap 4 and the bottom end by bottom end cap 5. The end caps 4 and 5 have been manufactured by a cup-ironing method and then brazed to the header tanks 21 in the course of brazing of the radiator 2. In the presented embodiment they additionally serve as separators closing the profiles of the header tanks 21. Top end caps 4 have projections 41 with openings 43, having a diameter greater than the diameter of the condenser 3 header tanks 31. On the other hand bottom end caps 5 have the similar projections 51 with sockets (not shown in the drawing).

[0021] The construction additionally comprise retaining plugs 42 shown in detached position and provided with a circumferential snap 45, and retaining rings 52 resting in sockets of the projections 51 of the bottom end caps 5. The plugs and the rings are made of plastic as single-unit elements.

[0022] Fig. 2 presents the process of assembling the integrated heat exchanger 1. The first step is to place the retaining rings 52 in the sockets of the bottom end caps. The retaining rings 52 have an inner diameter tight-fitted to the outer diameter of the circular header tanks 31 of the condenser 3. Next step is to insert the top ends of the condenser header tanks 31 at an acute angle into openings 43 in projections 41 of the top end caps 4. Then one should turn the condenser 3 to obtain its parallel position with respect to the radiator 2 cooling core and displace it down, so as to place ends of its header tanks 31 into retaining rings 52.

[0023] The last step of assembly process is presented in Fig. 3, showing the heat exchanger after its assembling, in partial cross-section with details of the retaining plug 42. As shown the top ends of the header tanks 31 of the condenser 3 are locked with the retaining plugs 42 pushed upwardly into the openings 43 of the projections 41 of the top end cap 4, until the circumferential snaps 45 lock behind the edges of the openings 43. The diameter of the opening 43 in projection 41 of the top end cap 4 is greater than the diameter of the second header tank 31 so as to enable the insertion of the header tanks 31 into the top end cap at a certain acute angle to the radiator cooling core. The plug 42 tightly fills the space between the wall of the opening and the wall of the header tank.

[0024] It is understood that to detach the condenser one should perform the above steps in reverse order, i.e. unlock the plugs 42, displace the condenser upward and turn its bottom side away of the radiator, finally displace it downward.

[0025] Fig. 4 shows another embodiment of the essential elements forming the integrated exchanger according to the present invention. Reference numerals denoting the same functional elements remain unchanged.

[0026] The socket 53 in the projection 51 of the bottom end cap 5 is defined by rounded vertical wall along the periphery of projection 51, and by a vertical protrusion 54 cut out in the projection 51 horizontal surface and then bent upwardly at straight angle. The diameter of the socket 53 is tightly fitted to the external diameter of the retaining ring 52, having internal wall adapted to receive the bottom end of the condenser.

[0027] The opening 43 in the projection 41 of the top end cap 4 is provided with internal thread 46 corresponding to the external thread 47 on the wall of the retaining

plug 42. In order to lock the retaining plug 42 in the opening 43 one should merely screw it down with a screwdriver placed in the appropriate recess 48 provided in the retaining plug 42.

[0028] The above embodiments of the heat exchanger according to the present invention are merely exemplary. The figures are not necessarily to scale, and some features may be exaggerated or minimized to show details of particular elements. A person skilled in the art shall easily note, in particular, that the integrated heat exchanger does not need to form a vehicle radiator condenser CRFM module; that the method enables assembling more than two heat exchangers in parallel; that the header tanks profiles may have any appropriate cross-sections i.e. oval, rectangular, double plated with seam, folded, etc.; that the end caps may be attached to the primary heat exchanger after its finishing; and the retaining plug may be provided with other types of locking arrangements. Other modifications of the invention are also possible, without departing from the spirit of invention and its scope of protection as indicated in appended claims.

Claims

1. An integrated heat exchanger, in particular a vehicle Condenser, Radiator, cooling Fan Module, comprising at least two heat exchangers, each having a cooling core comprised of fins and tubes, two header tanks fluidly connected with reciprocal ends of cooling core tubes, where said heat exchangers are coupled and parallel to each other, **characterised in that** top ends of the header tanks (21) of the primary heat exchanger (2) are provided with top end caps (4) having projections (41) with openings (43) adapted to receive the top ends of the header tanks (31) of at least one secondary heat exchanger (3); bottom ends of the header tanks (21) of the primary heat exchanger (2) are provided with bottom end caps (5) having projections (51) with sockets (53) adapted to receive the bottom ends of the header tanks (31) of at least one secondary heat exchanger (3); where the bottom ends of the header tanks (31) of at least one secondary heat exchanger (3) are supported on retaining rings (52) resting in sockets (53) of the projections (51) of the bottom end caps (5); and the top ends of the header tanks (31) of at least one secondary heat exchanger (3), are locked by retaining plugs (42) pushed upwardly into the openings (43) of the projections (41) of the top end caps (4).

2. An integrated heat exchanger as claimed in claim 1, **characterised in that** the primary heat exchanger (2) is a radiator of a vehicle cooling system and the secondary heat exchanger (3) is a condenser of a vehicle air conditioning system.

3. An integrated heat exchanger as claimed in claim 1 or 2, **characterised in that** the retaining rings (52) and the retaining plugs (42) are made of resilient material, preferably plastic.

4. An integrated heat exchanger as claimed in claim 1 or 2, **characterised in that** the retaining plugs (42) are provided with a circumferential snap (45) locking its positions in openings (43) of the projections (41) of the top end caps (4).

5. An integrated heat exchanger as claimed in claim 1 or 2, **characterised in that** the retaining plugs (42) are provided with an external thread (47) corresponding to the internal thread (46) in the openings (43) of the projections (41) of the top end caps (4).

6. A method of assembling an integrated heat exchanger as defined in claim 1 in particular a vehicle Condenser, Radiator, cooling Fan Module, comprising at least two heat exchangers, each having a cooling core comprised of fins and tubes, two header tanks fluidly connected with reciprocal ends of cooling core tubes, where said heat exchangers are coupled and parallel to each other, **characterised in that** it comprises the steps of

   (i) preliminary assembling and brazing the primary heat exchanger providing the header tanks thereof with top end caps having projections with openings adapted to receive the top ends of the header tanks of at least one secondary heat exchanger, and provided with bottom end caps having projections with sockets adapted to receive the bottom ends of the header tanks of at least one secondary heat exchanger;
   (ii) preliminary assembling and brazing at least one secondary heat exchanger;
   (iii) placing the retaining rings in the sockets of the bottom end caps;
   (iv) inserting the top ends of header tanks of the secondary heat exchanger at an acute angle into openings in projections of the top end caps;
   (v) rotating the secondary heat exchanger to the position substantially parallel to the primary heat exchanger;
   (vi) lowering the secondary heat exchanger so as to place ends of its header tanks into appropriate retaining rings resting in the sockets of the projections of the bottom end caps; and
   (vii) locking the top ends of the header tanks of the secondary heat exchanger with retaining plugs pushed upwardly into the openings of the projections of the top end caps.

7. A method as claimed in claim 6, **characterised in that** bottom and top end caps are mounted to the primary heat exchanger after brazing thereof.

8. A method as claimed in claim 6 or 7, **characterised in that** it the steps (ii) to (vi) are performed for each third and any subsequent heat exchanger of the integrated heat exchanger.

Patentansprüche

1. Integrierter Wärmetauscher, insbesondere ein Fahrzeug-Kondensator-, Radiator-, Kühlventilator-Modul, der zumindest zwei Wärmetauscher aufweist, die jeweils einen Kühlkern haben, der aus Rippen und Röhren besteht, wobei zwei Endkammern fluidmäßig mit beiderseitigen Enden von Kühlkernröhren verbunden sind, wobei die Wärmetauscher verbunden und zueinander parallel sind, **dadurch gekennzeichnet, dass** obere Enden der Endkammern (21) des primären Wärmetauschers (2) mit oberen Endkappen (4) versehen sind, die Vorsprünge (41) mit Öffnungen (43) haben, die ausgebildet sind, die oberen Enden der Endkammern (31) von zumindest einem sekundären Wärmetauscher (3) aufzunehmen; wobei untere Enden der Endkammern (21) des primären Wärmetauschers (2) mit unteren Endkappen (5) versehen sind, die Vorsprünge (51) mit Aufnahmesockeln (53) haben, die ausgebildet sind, die unteren Enden der Endkammern (31) von zumindest einem sekundären Wärmetauscher (3) aufzunehmen; wobei die unteren Enden der Endkammern (31) von zumindest einem sekundären Wärmetauscher (3) auf Halteringen (52) getragen werden, die sich in Aufnahmesockeln (53) der Vorsprünge (51) der unteren Endkappen (5) befinden; und die oberen Enden der Endkammern (31) von zumindest einem sekundären Wärmetauscher (3) durch Haltestöpsel (42) verriegelt sind, die von oben in die Öffnungen (43) der Vorsprünge (41) der oberen Endkappen (4) gedrückt sind.

2. Integrierter Wärmetauscher gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der primäre Wärmetauscher (2) ein Radiator eines Fahrzeugkühlsystems ist und der sekundäre Wärmetauscher (3) ein Kondensator einer Fahrzeugklimaanlage ist.

3. Integrierter Wärmetauscher gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Halteringe (52) und die Haltestöpsel (42) aus elastischem Material sind, vorzugsweise Kunststoff.

4. Integrierter Wärmetauscher gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Haltestöpsel (42) mit einer umfänglichen Einrastung (45) vorgesehen sind, die deren Positionen in den Öffnungen (43) der Vorsprünge (41) der oberen Endkappen (4) arretiert.

5. Integrierter Wärmetauscher gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Haltestöpsel (42) mit einem externen Gewinde (47) vorgesehen sind, das dem Innengewinde (46) in den Öffnungen (43) der Vorsprünge (41) der oberen Endkappen (4) entspricht.

6. Verfahren zum Herstellen eines integrierten Wärmetauschers gemäß Anspruch 1, insbesondere ein Fahrzeug-Kondensator-, Radiator-, Kühlventilator-Modul, der zumindest zwei Wärmetauscher aufweist, die jeweils einen Kühlern haben, der aus Rippen und Röhren besteht, wobei zwei Endkammern fluidmäßig mit beiderseitigen Enden von Kühlkernröhren verbunden sind, wobei die Wärmetauscher verbunden und zueinander parallel sind, **dadurch gekennzeichnet, dass** das Verfahren die Schritte aufweist

   (i) vorausgehendes Aufbauen und Löten des primären Wärmetauschers, Versehen dessen Endkammern mit oberen Endkappen, die Vorsprünge mit Öffnungen haben, die ausgebildet sind, die oberen Enden der Endkammern von zumindest einem sekundären Wärmetauscher aufzunehmen, und Versehen mit unteren Endkappen, die Vorsprünge mit Aufnahmesockeln haben, die ausgebildet sind, die unteren Enden der Endkammern von zumindest einem sekundären Wärmetauscher aufzunehmen;
   (ii) vorausgehendes Aufbauen und Löten zumindest eines sekundären Wärmetauschers;
   (iii) Platzieren der Halteringe in die Aufnahmesockel der unteren Endkappen;
   (iv) Einführen der oberen Enden der Endkammern des sekundären Wärmetauschers in einem spitzen Winkel in Öffnungen in Vorsprüngen der oberen Endkappen;
   (v) Rotieren des sekundären Wärmetauschers in die Position im Wesentlichen parallel zu dem primären Wärmetauscher;
   (vi) Herablassen des sekundären Wärmetauschers, um die Enden dessen Endkammern in geeignete Halteringe zu platzieren, die sich in den Aufnahmesockeln der Vorsprünge der unteren Endkappen befinden; und
   (vii) Verriegeln der oberen Enden der Endkammern des sekundären Wärmetauschers mit Haltestöpseln, die von oben in die Öffnungen der Vorsprünge der oberen Endkappen gedrückt werden.

7. Verfahren gemäß Anspruch 6, **dadurch gekennzeichnet, dass** untere und obere Endkappen an dem primären Wärmetauscher nach dessen Löten angebracht werden.

8. Verfahren gemäß Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** die Schritte (ii) bis (vi) für jeden

dritten und jeden nachfolgenden Wärmetauscher des integrierten Wärmetauschers durchgeführt werden.

Revendications

1. Échangeur de chaleur intégré, en particulier condenseur, radiateur, module ventilateur-refroidisseur pour véhicule, comprenant au moins deux échangeurs de chaleur ayant chacun un coeur de refroidissement constitué d'ailettes et de tubes, deux réservoirs collecteurs reliés de manière fluidique à des extrémités réciproques des tubes du coeur de refroidissement, tels que lesdits échangeurs de chaleur sont couplés et parallèles l'un à l'autre, **caractérisé en ce que** des extrémités supérieures des réservoirs collecteurs (21) de l'échangeur de chaleur primaire (2) sont pourvues de capuchons terminaux supérieurs (4) ayant des projections (41) avec des ouvertures (43) adaptées à recevoir les extrémités supérieures des réservoirs collecteurs (31) d'au moins un échangeur de chaleur secondaire (3) ; des extrémités inférieures des réservoirs collecteurs (21) de l'échangeur de chaleur primaire (2) sont pourvues de capuchons terminaux inférieurs (5) ayant des projections (51) avec des embases (53) adaptées à recevoir les extrémités inférieures des réservoirs collecteurs (31) au moins un échangeur de chaleur secondaire (3) ; dans lequel les extrémités inférieures des réservoirs collecteurs (31) d'au moins un échangeur de chaleur secondaire (3) sont supportées sur des bagues de retenue (52) reposant dans des embases (53) des projections (51) des capuchons terminaux inférieurs (5) ; et les extrémités supérieures des réservoirs collecteurs (31) d'au moins un échangeur de chaleur secondaire (3) sont verrouillées par des bouchons de retenue (42) poussés vers le haut jusque dans les ouvertures (43) des projections (41) des capuchons terminaux supérieurs (4).

2. Échangeur de chaleur intégré selon la revendication 1, **caractérisé en ce que** l'échangeur de chaleur primaire (2) est un radiateur d'un système de refroidissement pour véhicule, et l'échangeur de chaleur secondaire (3) est un condenseur d'un système de conditionnement d'air pour véhicule.

3. Échangeur de chaleur intégré selon la revendication 1 ou 2, **caractérisé en ce que** les bagues de retenue (52) et les bouchons de retenue (42) sont réalisés en matière élastique, de préférence en matière plastique.

4. Échangeur de chaleur intégré selon la revendication 1 ou 2, **caractérisé en ce que** les bouchons de retenue (42) sont pourvus d'un élément d'encliquetage circonférentiel (45) qui verrouille ses positions dans des ouvertures (43) des projections (41) des capuchons terminaux supérieurs (4).

5. Échangeur de chaleur intégré selon la revendication 1 ou 2, **caractérisé en ce que** les bouchons de retenue (42) sont pourvus d'un pas de vis externe (47) qui correspond au pas de vis interne (46) dans les ouvertures (43) des projections (41) des capuchons terminaux supérieurs (4).

6. Procédé d'assemblage d'un échangeur de chaleur intégré tel que défini dans la revendication 1, en particulier condenseur, radiateur, module ventilateur-refroidisseur pour véhicule, comprenant au moins deux échangeurs de chaleur ayant chacun un coeur de refroidissement constitué d'ailettes et de tubes, deux réservoirs collecteurs reliés sur le plan fluidique à des extrémités réciproques de tubes du coeur de refroidissement, dans lequel lesdits échangeurs de chaleur sont couplés et parallèles l'un à l'autre, **caractérisé en ce qu'**il comprend les étapes consistant à

   (i) assembler de façon préliminaire et braser l'échangeur de chaleur primaire en équipant les réservoirs collecteurs de celui-ci de capuchons terminaux supérieurs ayant des projections avec des ouvertures adaptées à recevoir les extrémités supérieures des réservoirs collecteurs d'au moins un échangeur de chaleur secondaire, et en les équipant de capuchons terminaux inférieurs ayant des projections avec des embases adaptées à recevoir les extrémités inférieures des réservoirs collecteurs d'au moins un échangeur de chaleur secondaire ;
   (ii) assembler de façon préliminaire et braser au moins un échangeur de chaleur secondaire ;
   (iii) placer les bagues de retenue dans les embases des capuchons terminaux inférieurs ;
   (iv) insérer des extrémités supérieures des réservoirs collecteurs de l'échangeur de chaleur secondaire sous un ange aigu jusque dans des ouvertures dans des projections des capuchons terminaux supérieurs ;
   (v) faire tourner l'échangeur de chaleur secondaire à la position sensiblement parallèle à l'échangeur de chaleur primaire ;
   (vi) abaisser l'échangeur de chaleur secondaire de manière à placer les extrémités des réservoirs collecteurs dans des bagues de retenue appropriées reposant dans les embases des projections des capuchons terminaux inférieurs ; et
   (vii) verrouiller les extrémités supérieures des réservoirs collecteurs de l'échangeur de chaleur secondaire avec des bouchons de retenue poussés vers le haut en entrant dans les ouvertures des projections des capuchons terminaux

supérieurs.

7. Procédé selon la revendication 6, **caractérisé en ce que** les capuchons terminaux inférieurs et les capuchons terminaux inférieurs sont montés sur l'échangeur de chaleur primaire après brasage de celui-ci.

8. Procédé selon la revendication 6 ou 7, **caractérisé en ce que** les étapes (ii) a (vi) sont exécutées pour un échangeur de chaleur sur trois et tous les échangeurs de chaleur ultérieurs de l'échangeur de chaleur intégré.

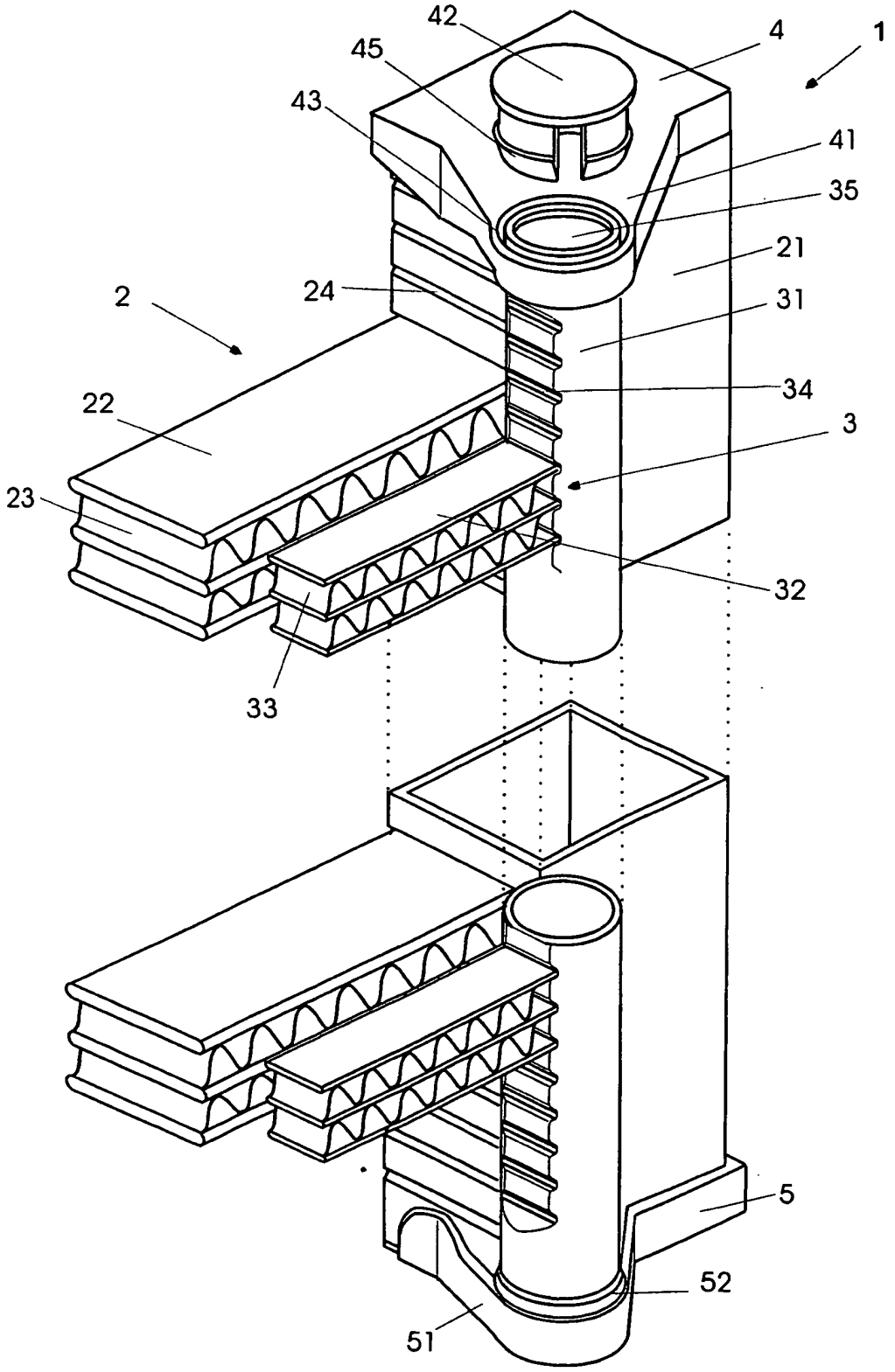

Fig 1

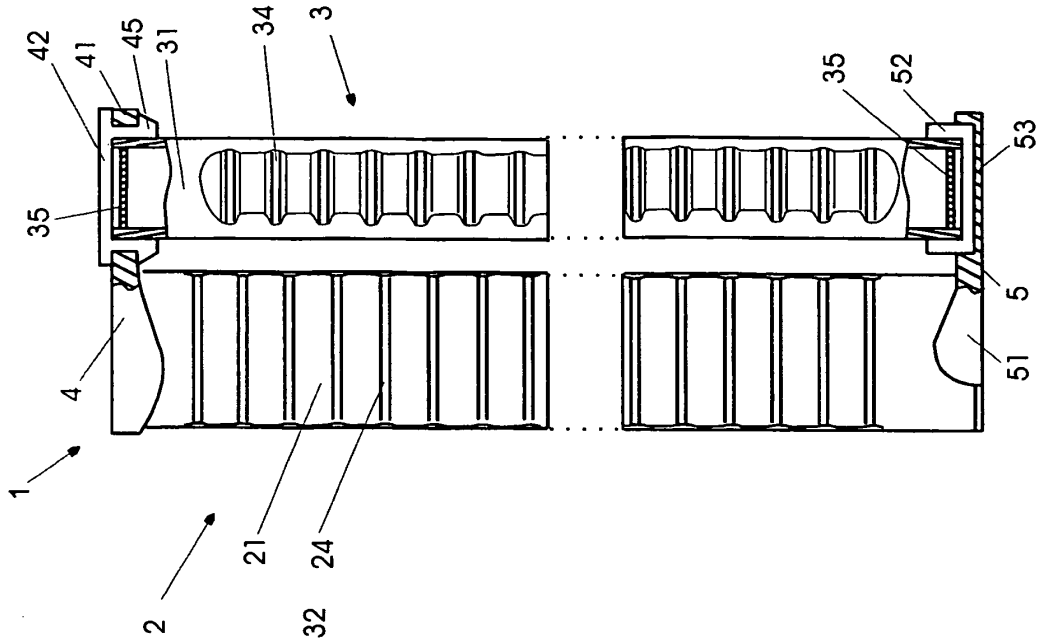
42
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Fig 3

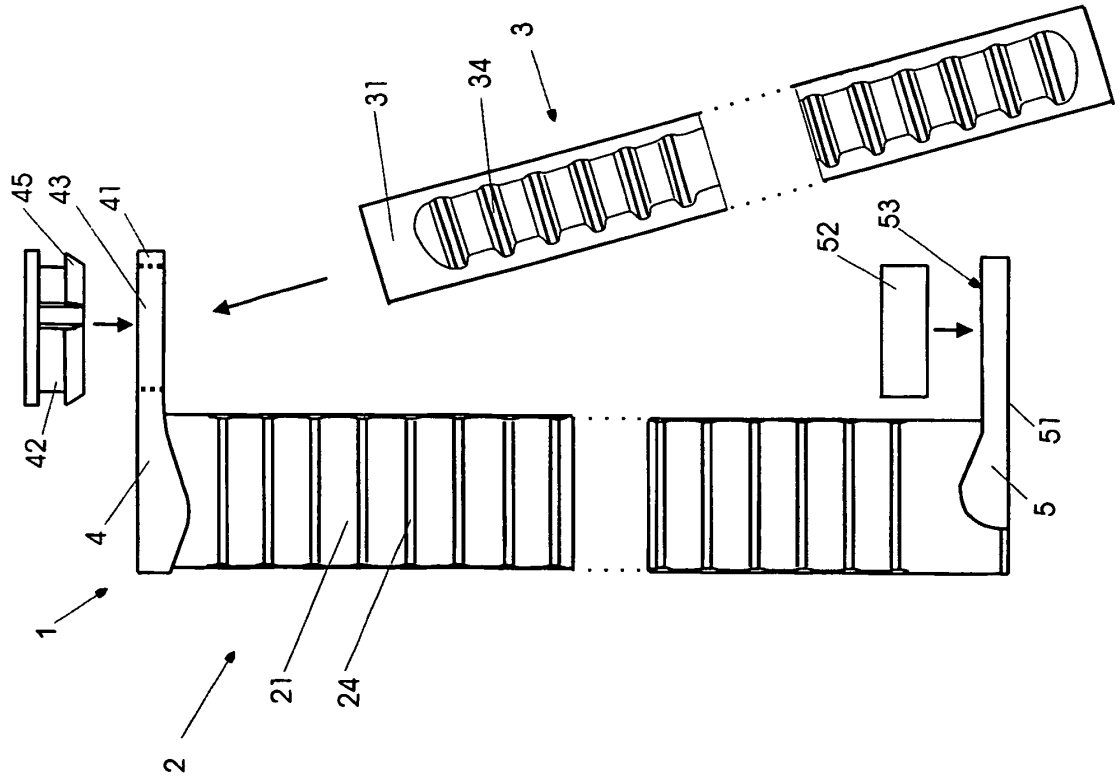
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Fig 2

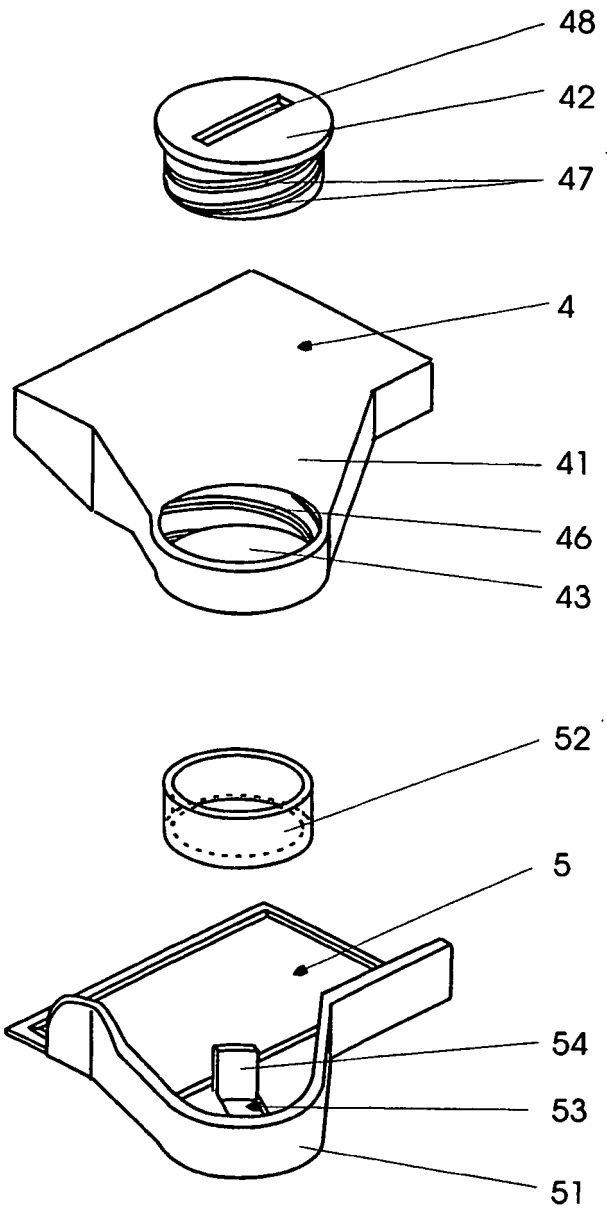

Fig 4

REFERENCES CITED IN THE DESCRIPTION

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