

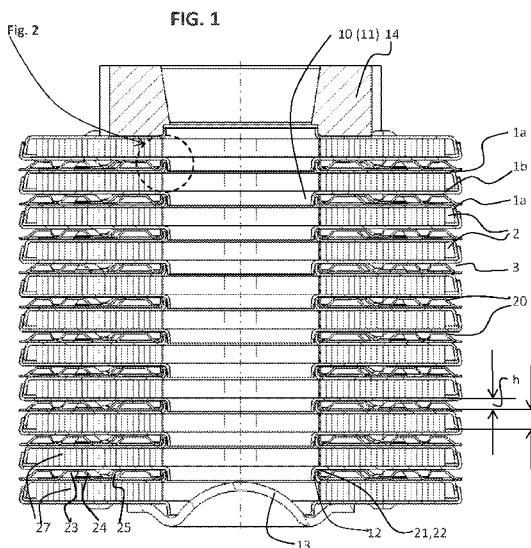


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(57) Abstract: A brazed heat exchanger having a stack of heat exchanger plates, each with an inflow hole and an outflow hole, that are arranged such that closed and open flow ducts for different media alternate in a stack direction. In the open flow ducts are two endpieces with a hole whose edge extends around the inflow hole or around the outflow hole respectively. The endpieces are deformed metal sheets with corrugations that form ducts. The metal sheets include flow openings for the medium flowing through the open flow ducts. The hole edges are deformed and have a height approximately corresponding to a height of the open flow duct, and are arranged close to a rim hole of the inflow hole or of the outflow hole.



BRAZED HEAT EXCHANGER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to German Patent Application No. 10 2014 005149, filed April 8, 2014, the entire contents of which are hereby incorporated by reference herein.

BACKGROUND

[0002] The present invention relates to a brazed heat exchanger which is arranged in a housing and which has a stack of heat exchanger plates.

[0003] Alternating closed and open flow ducts, and the arrangement of the stack in a housing, signify a specific generic type of heat exchangers, which differ from known heat exchangers without a housing and with exclusively closed flow ducts inter alia in that the heat exchangers discussed here have only two openings in the heat exchanger plates, whereas the other heat exchangers have at least four openings. Said openings in the plates of both generic types of heat exchangers provide inlet and outlet ducts extending vertically through the stack.

[0004] Endpieces are metal parts which are inserted into the flow ducts and which occupy only a small part of the flow ducts. The endpieces occupy only two opposite ends of the flow ducts. In the case of approximately rectangular heat exchanger plates, these are generally the relatively short sides of the plates or of the flow ducts formed by means of the plates.

[0005] A heat exchanger of the specific generic type is known from EP 470 200 B1. Said heat exchanger is situated in a housing (not shown in said document) with at least one inflow opening and one outflow opening for the medium flowing through the open flow ducts of the heat exchanger. In the known heat exchanger, the endpieces are solid metal plates, the thickness of which corresponds to the height of the flow ducts. The endpieces have been arranged in the open and in the closed flow ducts. The endpieces firstly considerably increase the weight of the heat exchanger, but secondly lead to an extremely stable heat exchanger which can be fastened in the housing in an advantageous manner using the solid endpieces. However, owing to the endpieces, the size of the heat-exchanging surface area is reduced.

[0006] Another heat exchanger of said generic type is known for example from EP 1 083 398 A1. Said heat exchanger has lamellae which are arranged both in the open flow ducts and in the closed flow ducts and which increase the efficiency of the heat exchange. In the case of said heat exchanger, a corrugated sheet-metal strip of circular form has been placed into the closed flow ducts so as to encircle said openings. Semicircular solid endpieces that have hitherto been provided are thus replaced. A more lightweight heat exchanger, which exhibits higher performance, is likewise realized.

[0007] The heat exchangers are brazed in a brazing furnace and subsequently inserted into the housing, in which they can perform their function per se.

SUMMARY

[0008] One object of the invention consists in providing an advantageous alternative which likewise realizes a relatively lightweight brazed heat exchanger in a housing, with high heat exchange performance, without the stability of the heat exchanger being significantly reduced, wherein the quality of the brazed connections should be ensured.

[0009] In one embodiment, the endpieces are deformed metal sheets with corrugations which form ducts, which metal sheets are provided with flow openings for the medium flowing through the open flow ducts. The sheet-metal thickness of the deformed metal sheets approximately corresponds to the sheet-metal thickness of the heat exchanger plates. In one exemplary embodiment, said thickness is approximately 0.2 – 0.5 mm. A deformed hole edge of the hole of the deformed metal sheet has a height approximately corresponding to a height of the open flow duct.

[0010] A braze gap of a size of approximately 0.2 mm is situated between the approximately vertically standing hall edge and the edge of the inflow hole or of the outflow hole respectively. Such braze gaps impart a capillary action on the molten braze. The edge of the inflow hole and of the outflow hole respectively has been deformed. Said edge has rim holes. The rim holes each point into the open flow ducts, in which the deformed metal sheets are situated. The rim hole of one plate of one plate pair is connected to a rim hole of the next plate of the next plate pair. The rim holes have been plugged one inside the other.

[0011] It has been identified that such a design not only achieves the desired performance improvements and weight reduction but can also provide advantages in terms of manufacturing in the case of brazed heat exchangers.

[0012] The brazing process is performed in a brazing furnace, wherein a weight or a force acts on the heat exchanger during the brazing process. For this purpose, the heat exchanger must firstly be preassembled and prepared for the brazing process. It has been found that, in particular, the special hole edge design of the deformed metal sheet and the arrangement thereof close to the inflow hole or to the outflow hole respectively generates stability comparable to that obtained with solid endpieces. Furthermore, it is possible to produce sealed and durable brazed connections even though the surfaces to be brazed are considerably smaller than in the prior art.

[0013] A housing, in one embodiment, is a structure which at least substantially encompasses the brazed heat exchanger and which has at least one inlet for the medium flowing through the open flow ducts and with an outlet through which the medium passes after flowing through the open flow ducts. A housing of said type may accordingly likewise be regarded as a flow duct into which the stack of heat exchanger plates, with endpieces in the open flow ducts and with lamellae in the closed flow ducts, is inserted after the brazing process.

[0014] Closed flow ducts, in one embodiment, are flow ducts which are characterized by a sealed, closed connection extending in encircling fashion around the edges of in each case two heat exchanger plates and which have two holes in the heat exchanger plates, wherein one hole constitutes an inflow hole, and the other hole constitutes an outflow hole. The closed flow duct is situated in each case between the two plates that can be regarded as the above-mentioned plate pair.

[0015] Since the heat exchanger plates form a stack, inflow holes which are in alignment in the stack give rise to a vertical inflow duct extending through the stack, and the outflow holes in a streamlined configuration give rise to a vertical outflow duct extending through the stack.

[0016] To form the inflow duct, the inflow hole of one plate is connected in each case to the inflow hole of an adjacent plate of the next plate pair by virtue of an open flow duct arranged in

each case in between being bridged, so as to ensure the separation between the media. The same applies with regard to the outflow holes or with regard to the formation of the outflow ducts.

[0017] Since the corrugations provide a brazed connection to the in each case two plates that delimit an open flow duct, the desired stability is also attained, in particular around said inflow and outflow ducts.

[0018] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Figure 1 shows a cross section through an inlet or outlet duct of a heat exchanger according to an embodiment of the invention, without showing the housing;

[0020] Figure 2 shows a detail of an endpiece from Figure 1;

[0021] Figure 3 shows an endpiece, two of which are arranged in each open flow duct of the heat exchanger of Figure 1;

[0022] Figure 4 shows a perspective view of the heat exchanger of Figure 1 situated in a housing;

[0023] Figure 5 shows the heat exchanger from Figure 4, in which the upper plates are shown in an exploded illustration;

[0024] Figure 6 shows a longitudinal section through the heat exchanger situated in the housing of Figure 4;

[0025] Figure 7 shows a detail of a lamella situated in the closed flow ducts of a heat exchanger according to some embodiments;

[0026] Figure 8 shows details of relevance with regard to the brazing of the heat exchanger of Figure 1;

[0027] Figure 9 shows a further one of several possible alternative designs of a hole edge of the endpiece, similarly to Figure 2.

[0028] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the accompanying drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

DETAILED DESCRIPTION

[0029] The brazed heat exchanger of the embodiment shown, which is situated in a housing 40, is an oil cooler by means of which an oil, such as transmission oil, engine oil or the like, is cooled or adjusted to the appropriate temperature by means of cooling liquid. The oil flows through the closed flow ducts 2, and the cooling liquid flows through the housing 40 and the open flow ducts 3 of the oil cooler.

[0030] Other embodiments (not shown) may be provided which relate to charge-air cooling, exhaust-gas cooling or else to refrigerant cooling or refrigerant condensation or refrigerant evaporation, to name but a few further advantageous applications.

[0031] The brazed heat exchanger arranged in the housing 40 has a stack of heat exchanger plates 1a, 1b which are equipped with in each case one inflow hole 10 and one outflow hole 11. The housing 40 (Figures 4 – 6) can be closed by means of a cover (not shown) or the like. The housing 40 may however also be a so-called cavity of an engine or transmission housing, wherein the upper, open side points into the interior thereof. The plates 1a, 1b are arranged such that closed and open flow ducts 2, 3 for oil and for cooling liquid alternate in a stack direction. In the open flow ducts 3 only, there are arranged two endpieces 20 which each have a hole 21. The edge 22 of the hole 21 of one endpiece 20 extends around the inflow hole 10, and the edge of the hole 21 of the second endpiece 20 extends correspondingly around the outflow hole 11. This can be seen most clearly from Figures 1 and 3 in conjunction with Figure 4 or 5.

[0032] The endpieces 20 are deformed metal sheets with corrugations 24 that form ducts 23. The thickness of the metal sheets 20 corresponds approximately to the thickness of the heat exchanger plates 1a, 1b. Here, "corresponds" is to be understood to mean that the heat exchanger plates 1a, 1b may have for example a metal sheet thickness in the range from 0.2 – 0.5 mm. The thickness of the endpieces 20 could then for example even be 0.15 mm or 0.5 – 0.7 mm in order to still lie in the range intended to be covered by "corresponds". In this connection, it is also pointed out that the duct height of the open flow ducts 2 may, in a practical exemplary embodiment, be approximately 1.5 – 3 mm. The closed flow ducts 3 are approximately 2 – 4 mm high (Figure 1).

[0033] The ducts 23 of the endpieces 20 are provided with flow openings 25 for the cooling liquid flowing through the open flow ducts 3. The hole edge 22 is deformed and has a height h which approximately corresponds to a height of the open flow duct 3. Large tolerances should not be permitted with regard to said height h. The hole edge 22 is arranged sealingly, in encircling fashion, against a rim hole 12 of the inflow hole 10 or of the outflow hole 11 respectively. This is shown in Figures 2 and 3.

[0034] As is also shown in said figures, a braze gap 26 is situated between the approximately vertically standing hole edge 22 and the rim hole 12. The braze gap 26 may for example be 0.1 – 0.3 mm in size. During the brazing process, the braze gap 26 will, owing to its capillary action, fill with braze material and thus ensure sealed and durable connections.

[0035] By contrast to Figure 2, Figure 9 shows that the deformed hole edge 22 may also have an inwardly pointing bent flange 22a for further reinforcement. Reference signs not shown in Figure 9 may be gathered from Figure 2. In Figures 2 and 9, the hole edge 22 extends upward from the heat exchanger plate 1b, which is at the bottom in the image, to the upper plate 1a. In further embodiments that are not shown, the hole edge 22 extends from top to bottom.

[0036] With regard to the said rim holes 12 at the inflow hole 10 and at the outflow hole 11, it can be seen from Figures 1 and 2 that said rim holes engage into one another and bear against one another in opposite directions. As can be seen, the rim holes 12 connect the closed flow ducts 2 to one another and, at the same time, each bridge the open flow ducts 3 arranged in between.

[0037] Furthermore, it can be seen from Figure 3 that the ducts 23 of the endpieces 20 have different duct lengths. Some of the ducts 23 are provided with a curvature. In the exemplary embodiment shown, the curvature corresponds approximately to a curvature of the hole edge 22. Other, in particular shorter ducts 23 do not have a curvature. The direction and form of the ducts 23 may be adapted on a case-by-case basis.

[0038] Some of the ducts 23 are of arcuate form. They extend around a center situated approximately in the middle of the hole 21. The ducts 23 have a flow opening 25 at the start of the ducts 23 and another flow opening 25 at the end of the ducts. In embodiments that are not shown, the ducts 23 have been provided with more than two flow openings 25, for example in the flanks of the undulations 24.

[0039] It is of note that the longest of the ducts 23 is situated close to the hole edge 22 and extends around the major part of the circumference thereof. In this way, in the edge region of the holes – together with the deformed hole edge 22 described above – adequate stability is provided, which is expedient in particular during the course of the brazing process in order to prevent the so-called collapse of the plates 1a, 1b under the action of the brazing temperature.

[0040] The open and closed flow ducts 2, 3 are formed from pairs of heat exchanger plates 1a, 1b. The closed flow ducts 2 are situated within the plate pairs. The open flow ducts 3 are arranged between the plate pairs.

[0041] The closed flow ducts 2 are completely filled with a lamella 27 (Figures 5 – 7). The corrugated lamellae 27 have offset incisions in the corrugation flanks and have two openings which correspond to the inflow hole 10 and to the outflow hole 11 respectively.

[0042] The open flow ducts 3 are provided, at least outside the regions occupied by the endpieces 20, with studs 32 formed into the heat exchanger plates 1a, 1b, or with similar turbulence elements.

[0043] The studs 32 are formed with a height approximately half that of the open flow duct 3, with opposite studs 32 being supported and connected by brazing. In embodiments that are not

shown, the studs 32 have a height corresponding to the duct height, such that said studs can be supported on the opposite planar plate 1a or 1b.

[0044] The solid heat exchanger of the exemplary embodiment is composed of a suitable high-grade steel. In embodiments that are not shown, an aluminium alloy or some other steel is used as material. For the brazing of high-grade steel, use is often made of braze foils or braze pastes, because the coating of high-grade steel sheets with braze containing Cu or Ni is at present associated with high costs.

[0045] It can be seen from Figure 8 that, between one side of the endpieces or of the deformed metal sheet 20 and one heat exchanger plate 1a, there is situated a braze foil 33 which approximately corresponds to the circumference of the metal sheet 20. It can also be seen that, between the other side of the deformed metal sheet 20 and the other heat exchanger plate 1b of the next pair, there is arranged another braze foil 34 which extend approximately over the entire heat exchanger plate 1b, including the second deformed metal sheet 20. In embodiments that are not shown, the said braze paste is used instead of the braze foil 33.

[0046] To save on expensive braze material, the inventors have formed voids in the other braze foil 34 at the locations at which no brazed connection is provided. The corresponding voids are denoted by the reference sign 35.

[0047] The formation of the stack is facilitated by the hole 21 in the endpieces and by the rim holes 12 that correspond therewith. The fact that the form of the lamellae 27 – with their two openings – is adapted to the form of the closed flow ducts 2 (Figure 5) is also conducive to easier stacking. On the stack there are often also situated connection flanges 14 which form an elongation of the inlet and the outlet duct 10, 11. On the other end of said ducts 10, 11 there are arranged closure disks 13. The stack of heat exchanger plates 1a, 1b, endpieces 20, lamellae 27, connection flanges 14 and closure pieces 13 is brazed in a brazing furnace. After the stack is brazed, it is inserted into the housing 40.

[0048] As can be seen from the said Figure 3, the deformed metal sheets 20 have been configured such that they can admit flow from opposite directions. In this case, the performance-increasing advantages are at least approximately maintained. This can also be explained on the

basis of Figure 4 or Figure 5. The housing 40 has multiple inlets and outlets 41 – 46. In a practical exemplary embodiment, these will generally not be provided. In general – but not always – there will be only a single inlet, for example 41, 42 or 43, and a single outlet 44, 45 or 46. It can be seen from Figure 4 that the endpieces 20 can admit flow or discharge flow in opposite directions indicated by means of the arrows, without their advantageous effect being impaired. Inlets and outlets on the housing 40 may also be arranged on the top and/or on the bottom, that is to say not in the plate plane as shown in Figures 4 and 5, but perpendicular thereto.

[0049] In each case two deformed metal sheets 20 arranged in an open flow duct 3 are of identical form. In the exemplary embodiment, their shape can be regarded as being approximately D-shaped. Circular metal sheets 20 are likewise possible. In general, the shape of said metal sheets is adapted to the plate geometry. The deformed metal sheets 20 have a region in which flow is admitted and a region in which flow is discharged. The metal sheets 20 are arranged such that, in each open flow duct 3, in the case of the metal sheet 20 arranged at the inlet side, the arcuate region of the D shape of said metal sheet 20 can be regarded as the region in which flow is admitted, and the approximately straight, terminating region can be regarded as the region in which flow is discharged. In the case of the metal sheet 20 arranged at the outlet side, the conditions are the opposite, because in the case of said metal sheet 20, the straight, terminating region constitutes the region in which flow is admitted, and the arcuate region constitutes, in this case, the region in which flow is discharged. The ducts 23, with flow openings 25, formed in the metal sheet 20 are now arranged such that approximately identical conditions with regard to pressure losses prevail at both metal sheets 20, even though these admit flow from opposite directions.

[0050] Various features and advantages of the invention are set forth in the following claims.

CLAIMS

What is claimed is:

1. A brazed heat exchanger configured to be received in a housing and configured to transfer heat between a first medium and a second medium, the brazed heat exchanger comprising:

a plurality of heat exchanger plates arranged to form a stack, each of the plurality of heat exchanger plates having a thickness and including an inflow hole and an outflow hole, the plurality of heat exchanger plates arranged in the stack to define a plurality of closed flow ducts between adjacent heat exchanger plates for the first medium and a plurality of open flow ducts between adjacent heat exchanger plates for the second medium, the closed and open flow ducts alternating in a stack direction of the plurality of heat exchanger plates; and

first and second endpieces in each of the plurality of open flow ducts,

wherein the first and second endpieces each include a metal sheet with corrugations that form ducts, each having a flow opening for the second medium flowing through the open flow ducts, the first and second endpieces each further include a hole having an edge that is deformed such that the edge has a height approximately corresponding to a height of the open flow ducts,

wherein the edge of each of the first endpieces extends around the inflow hole and the edge of each of the first endpieces is close to a rim hole of the inflow hole,

wherein the edge of each of the second endpieces extends around the outflow hole and the edge of each of the second endpieces is close to a rim hole of the outflow hole.

2. The brazed heat exchanger of claim 1, wherein the edge of each of the first endpieces is formed with a braze gap around the inflow hole, and wherein the edge of each of the second endpieces is formed with a braze gap around the outflow hole.

3. The brazed heat exchanger of claim 1, wherein the rim holes of the inflow hole and of the outflow hole of two of the plurality of heat exchanger plates forming one of the plurality of closed flow ducts engage into one another and bear against one another in opposite directions.

4. The brazed heat exchanger of claim 2, wherein the edge of each of the first and second endpieces is approximately vertically standing, wherein the braze gaps of the first and second endpieces are arranged between the approximately vertically standing edge and the rim hole.
5. The brazed heat exchanger of claim 1, wherein the ducts of the first and second endpieces have at least two different duct lengths.
6. The brazed heat exchanger of claim 1, wherein at least one of the ducts of the first and second endpieces has a curvature.
7. The brazed heat exchanger of claim 6, wherein the curvature corresponds approximately to a curvature of the edge and runs approximately concentric thereto.
8. The brazed heat exchanger of claim 6, wherein at least one of the ducts of the first and second endpieces are of arcuate form so as to extend around a center, with a flow opening at the start of the duct and a flow opening at the end of the duct.
9. The brazed heat exchanger of claim 1, wherein a longest of the ducts of the first and the second endpieces extends close to the edge and around a major part of a circumference thereof.
10. The brazed heat exchanger of claim 1, wherein the open and the closed flow ducts are formed from pairs of the heat exchanger plates, wherein the closed flow ducts are arranged within the plate pairs and the open flow ducts are arranged between the plate pairs.
11. The brazed heat exchanger of claim 1, wherein the closed flow ducts include lamella.
12. The brazed heat exchanger of claim 1, wherein the open flow ducts are formed outside regions occupied by the metal sheets with studs formed into the heat exchanger plates.

13. The brazed heat exchanger of claim 12, wherein the studs are formed with a height approximately half that of the open flow duct, with opposite studs being supported and connected by brazing.

14. The brazed heat exchanger of claim 1, wherein between one side of one of the first endpieces and one heat exchanger plate, there is situated a braze foil or paste which approximately corresponds to a circumference of said first endpiece.

15. The brazed heat exchanger of claim 14, wherein between the other side of said one of the first endpieces and an other heat exchanger plate, there is arranged another braze foil or paste which extends approximately over the entire other heat exchanger plate, including one of the second endpieces.

16. The brazed heat exchanger of claim 15, wherein the other braze foil or paste is situated at least at locations at which brazing is performed, wherein said braze foil or paste has voids at other locations where no brazing is performed.

17. The brazed heat exchanger of claim 1, wherein the metal sheets are configured so as to be able to admit flow from opposite directions.

18. A brazed heat exchanger configured to be received in a housing and configured to transfer heat between a first medium and a second medium, the brazed heat exchanger comprising:

a plurality of heat exchanger plate pairs arranged into a stack, open flow ducts arranged between adjacent ones of the heat exchanger plate pairs;

a vertical inflow duct extending through the stack at a first end of the stack and a vertical outflow duct extending through the stack at a second end of the stack, the vertical inflow and outflow ducts being fluidly connected by a closed flow duct within each of the heat exchanger plate pairs to allow for the first medium to flow between the vertical inflow and outflow ducts; and

a plurality of metal sheets provided within the open flow ducts at both the first end and the second end of the stack, each of the metal sheets being joined to adjacent ones of the heat exchanger plate pairs to provide structural support thereto,

wherein each of the plurality of metal sheets is provided with ducts to allow for flow of the second medium around the vertical inflow and outflow ducts.

19. The heat exchanger of claim 18, wherein the metal sheets are deformed to have corrugations corresponding in height to the open flow ducts arranged between adjacent ones of the heat exchanger plate pairs, the ducts provided within the metal sheets being defined by said corrugations.

20. The heat exchanger of claim 18, wherein each of the ducts provided within the metal sheets includes a flow opening at the start of the duct and a flow opening at the end of the duct, wherein at least some of said flow openings are in fluid communication with the open flow ducts arranged between adjacent ones of the heat exchanger plate pairs.

FIG. 1

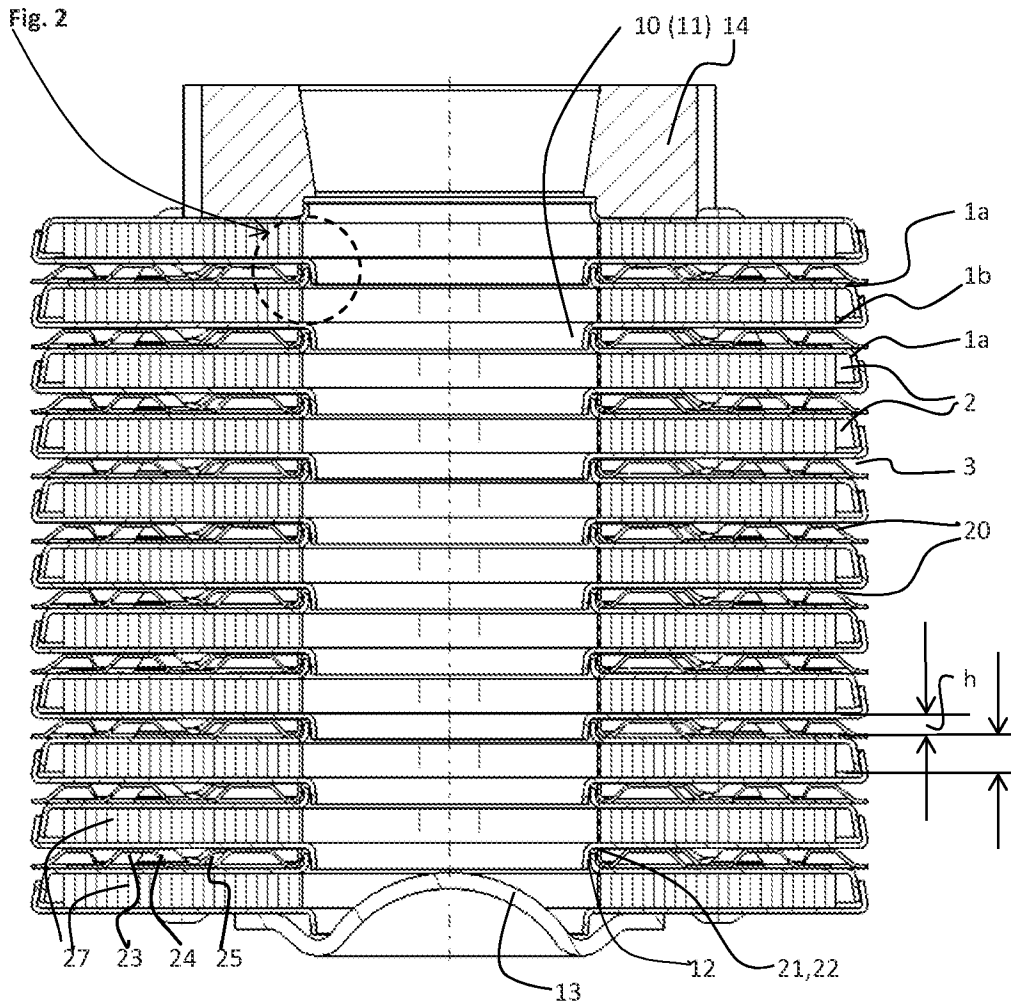


FIG. 2

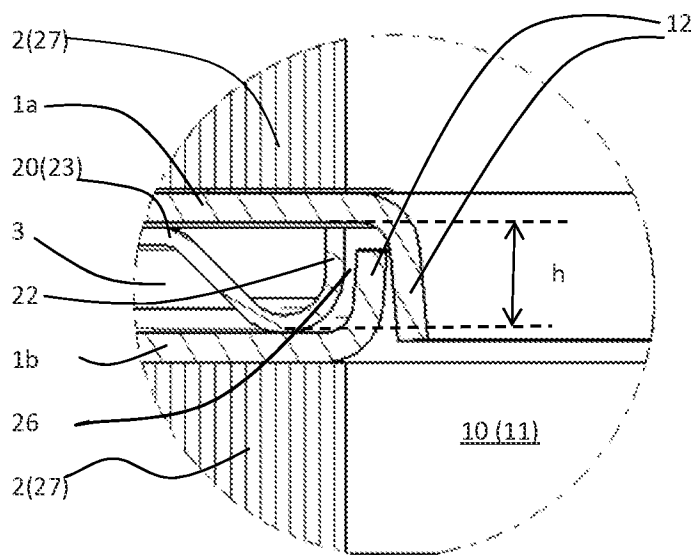


FIG. 3

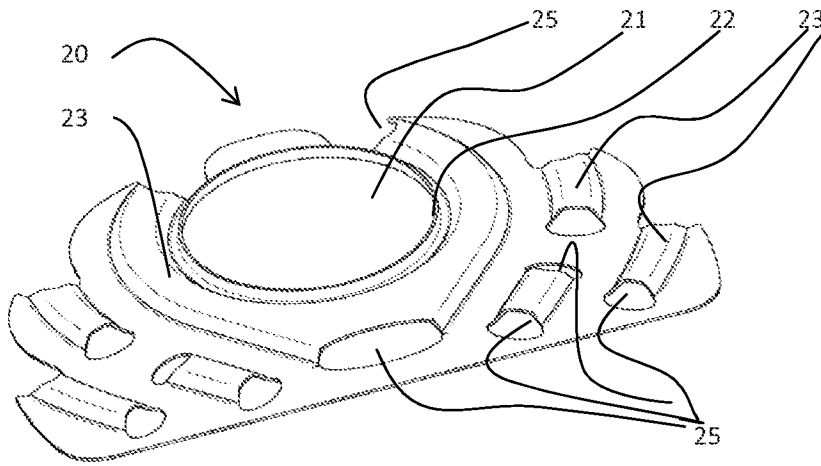


FIG. 4

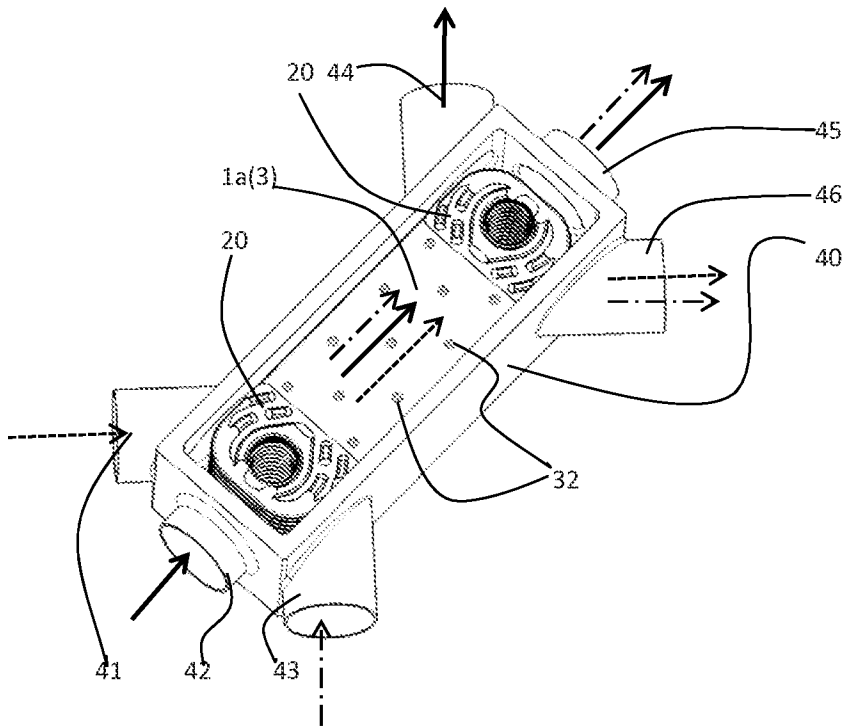


FIG. 5

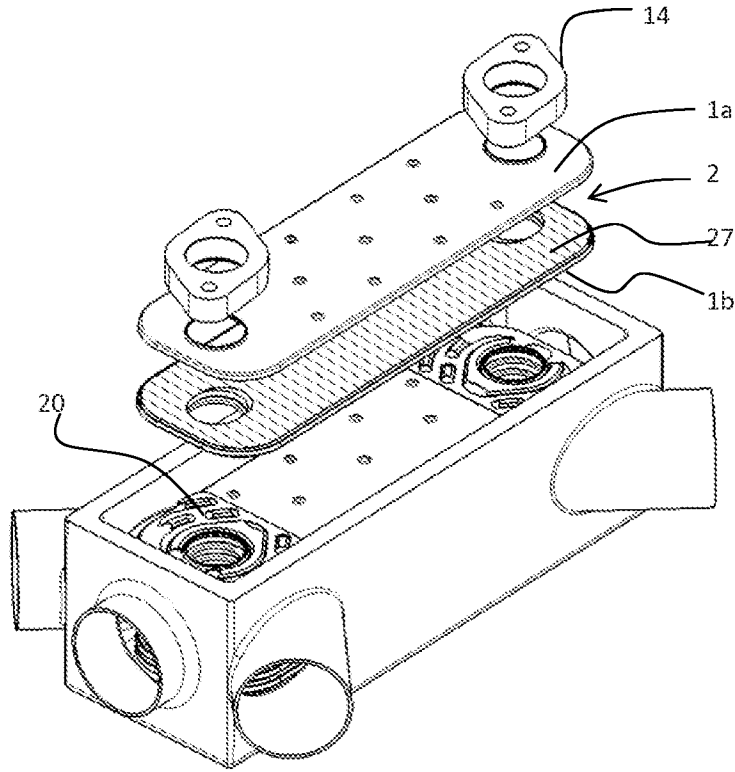


FIG. 6

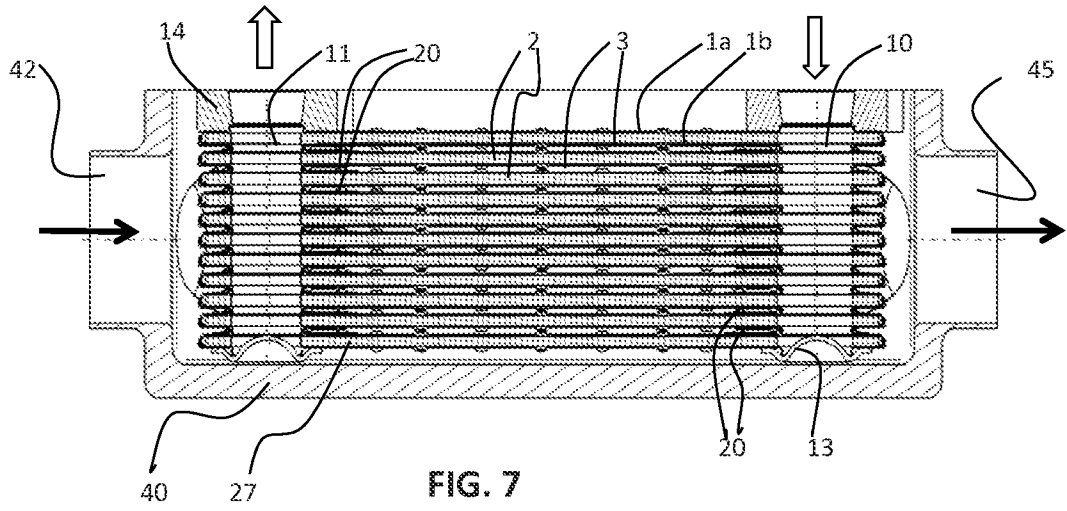


FIG. 7



FIG. 8

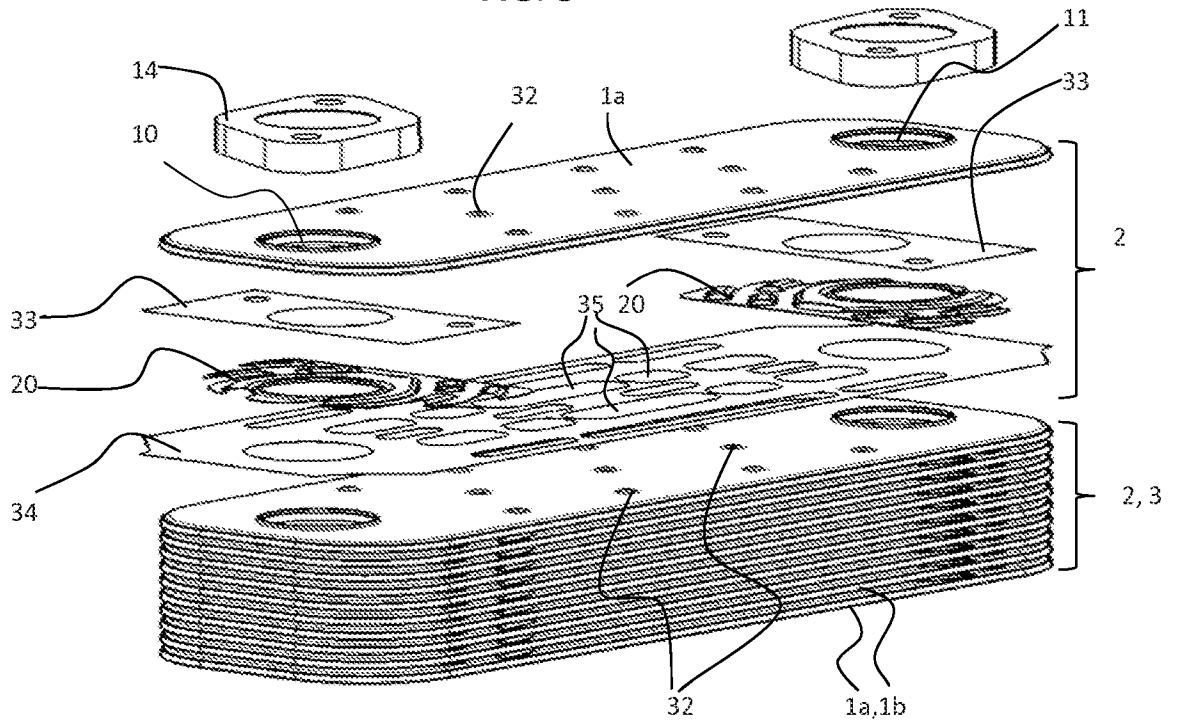
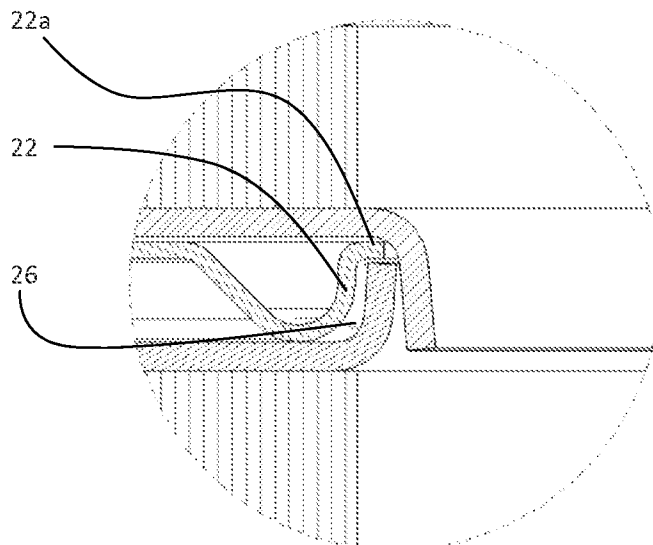


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/24838

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - F28F 3/02 (2015.01) CPC - F28F 3/02; B23K 1/0012 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) IPC(8) Classification(s): F28D 1/03, 9/00; B23K 1/00; F28F 3/02, 3/06, 3/08, 3/10, 9/02, 21/08 (2015.01) CPC Classification(s): F28D 9/005; B23K 1/0012; Y10S 165/916; F28F 3/025, 9/0234; USPC Classification(s): 165/166, 167, 916 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) PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google; Google Scholar; ProQuest; IP.com; keywords: brazed, end plate, gap, space, hole, clearance, void, slit, slot, heat exchanger, radiator, flow, corrugation, wavy, undulated, sinusoidal, stack, paste, flow, sheet		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 6,341,649 B1 (JOSHI SM et al.) January 29, 2002; figures 2, 5, 7-9; column 1, lines 35-40; column 2, lines 40-50; column 3, lines 20-50	1-6, 10-11, 14-20 — 6-9, 12, 13
Y	US 2006/0115393 A1 (REINKE MJ et al.) June 1, 2006; figure 4; paragraph [0053]	6-9
Y	GB 2 026 676 A (IPRA S.p.A.) 6 February 1980; figure 3; page 2, lines 95-100; page 3, lines 20-35	12, 13
A	US 2003/0131979 A1 (KIM HK) July 17, 2003; entire document	1-20
A	US 2011/0011568 A1 (HAN SC et al.) January 20, 2011; entire document	1-20
A	US 2002/0139520 A1 (PINTO AE) October 3, 2002; entire document	1-20
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
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Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer <p align="center">Shane Thomas</p> PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774