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(54) **HEAT EXCHANGER WITH REINFORCED HEADER PLATE**

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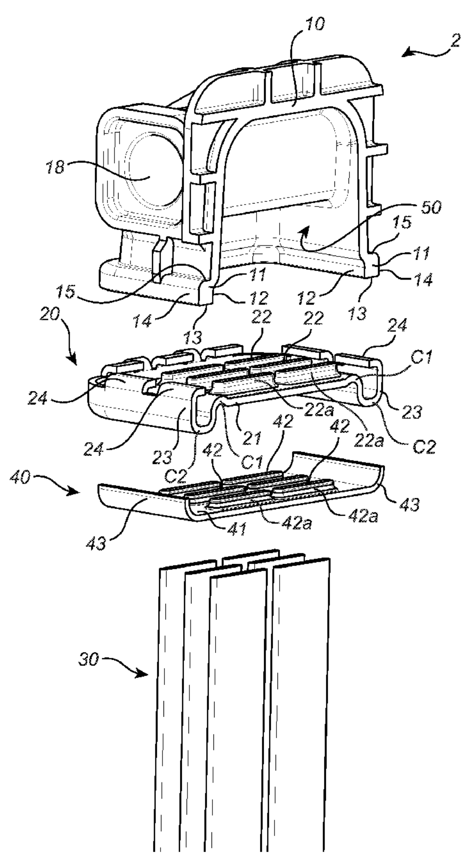
(57) **ABSTRACT**

The invention relates to a heat exchanger (**1**) comprising a coolant housing (**10**) and a header plate (**20**). The header plate (**20**) crimps around a border (**11**) of the coolant housing (**10**) by encompassing the border (**11**). The header plate (**20**) is provided with apertures (**22**), each aperture (**22**) receiving a tube (**30**) for guiding coolant from or to the closed cavity (**50**). The heat exchanger (**1**) further comprises a reinforcing plate (**40**) extending between two opposing crimped locations on the border (**11**) of the coolant housing (**10**), and extending on the outside of the header plate (**20**) in view of the closed cavity (**50**), wherein the reinforcing plate (**40**) is joined, at the opposing locations, to an outer surface portion of the header plate (**20**), and wherein the reinforcing plate (**40**) is provided with at least one aperture (**42**) embracing one or more of the tubes (**30**) received by the header plate (**20**).



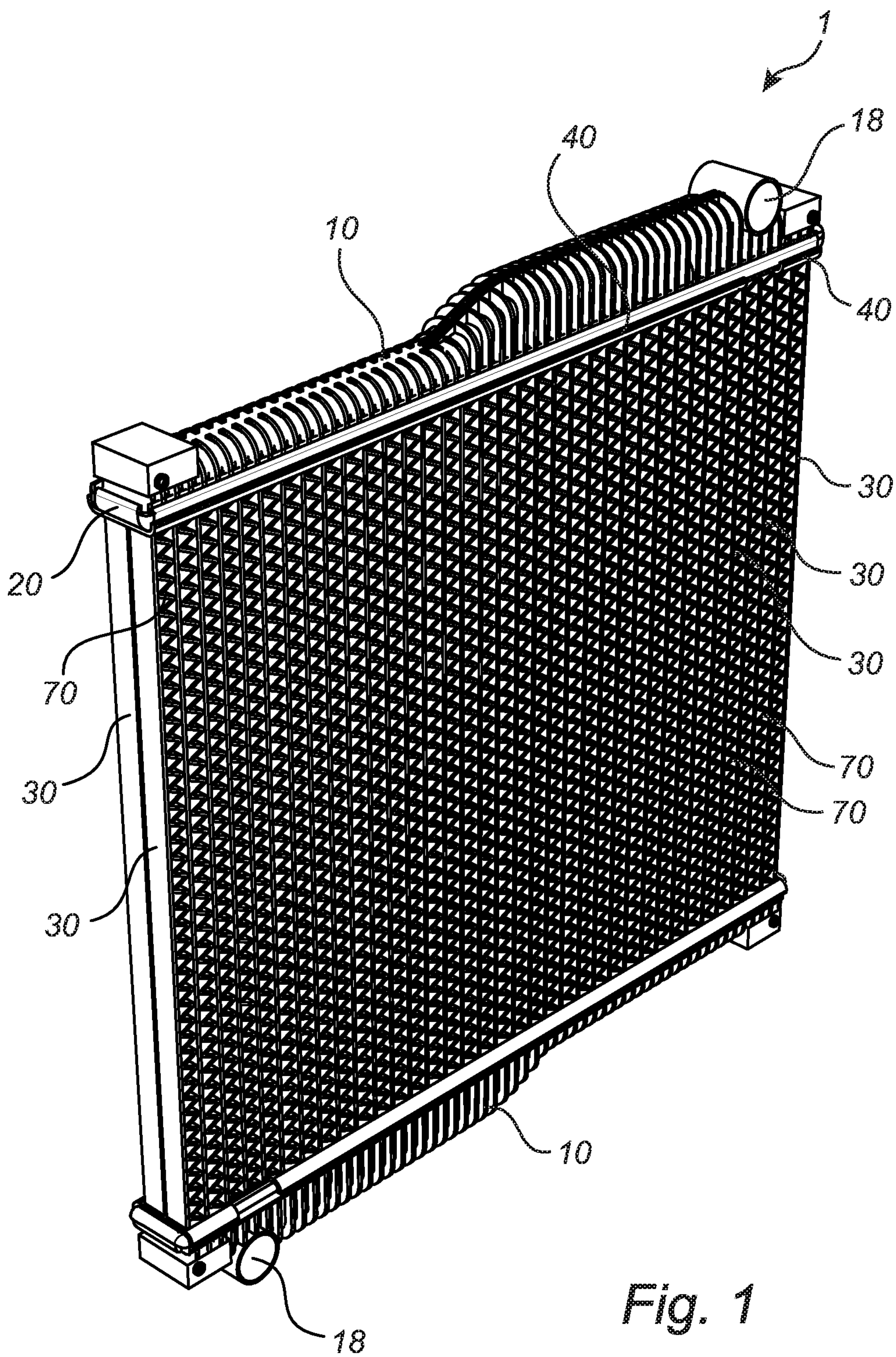


Fig. 1

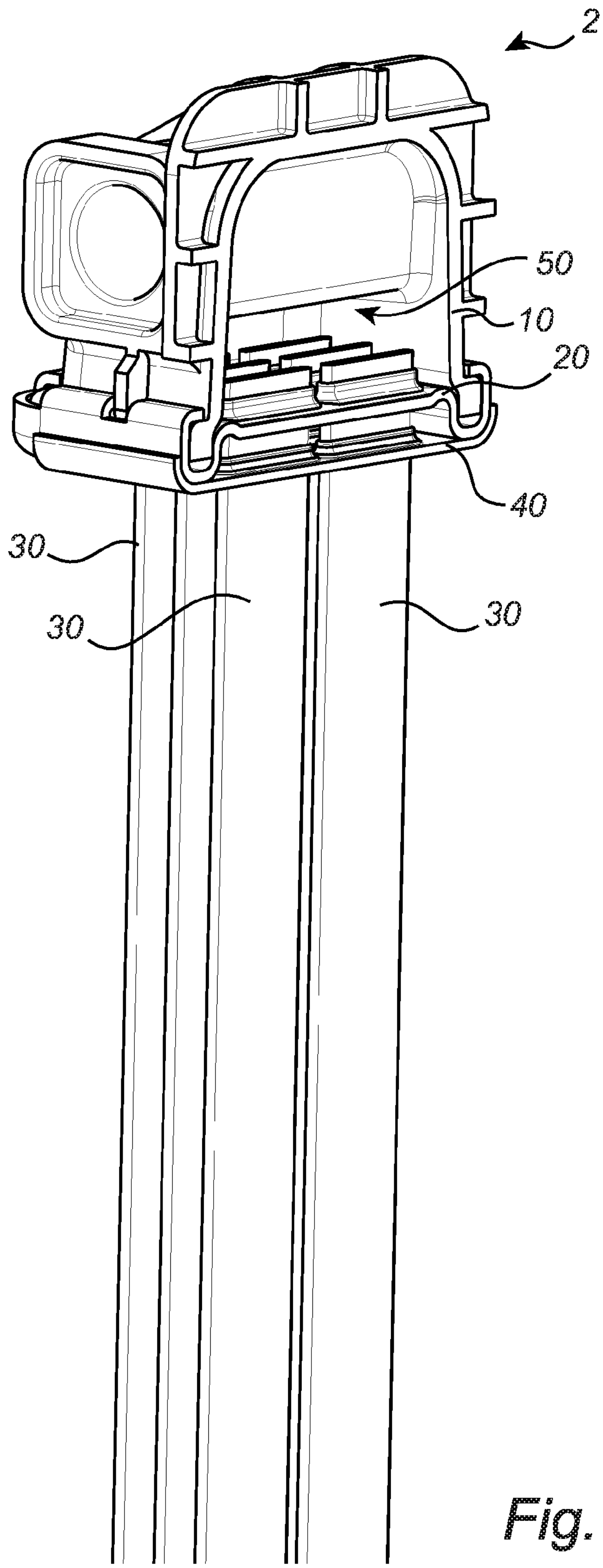


Fig. 2

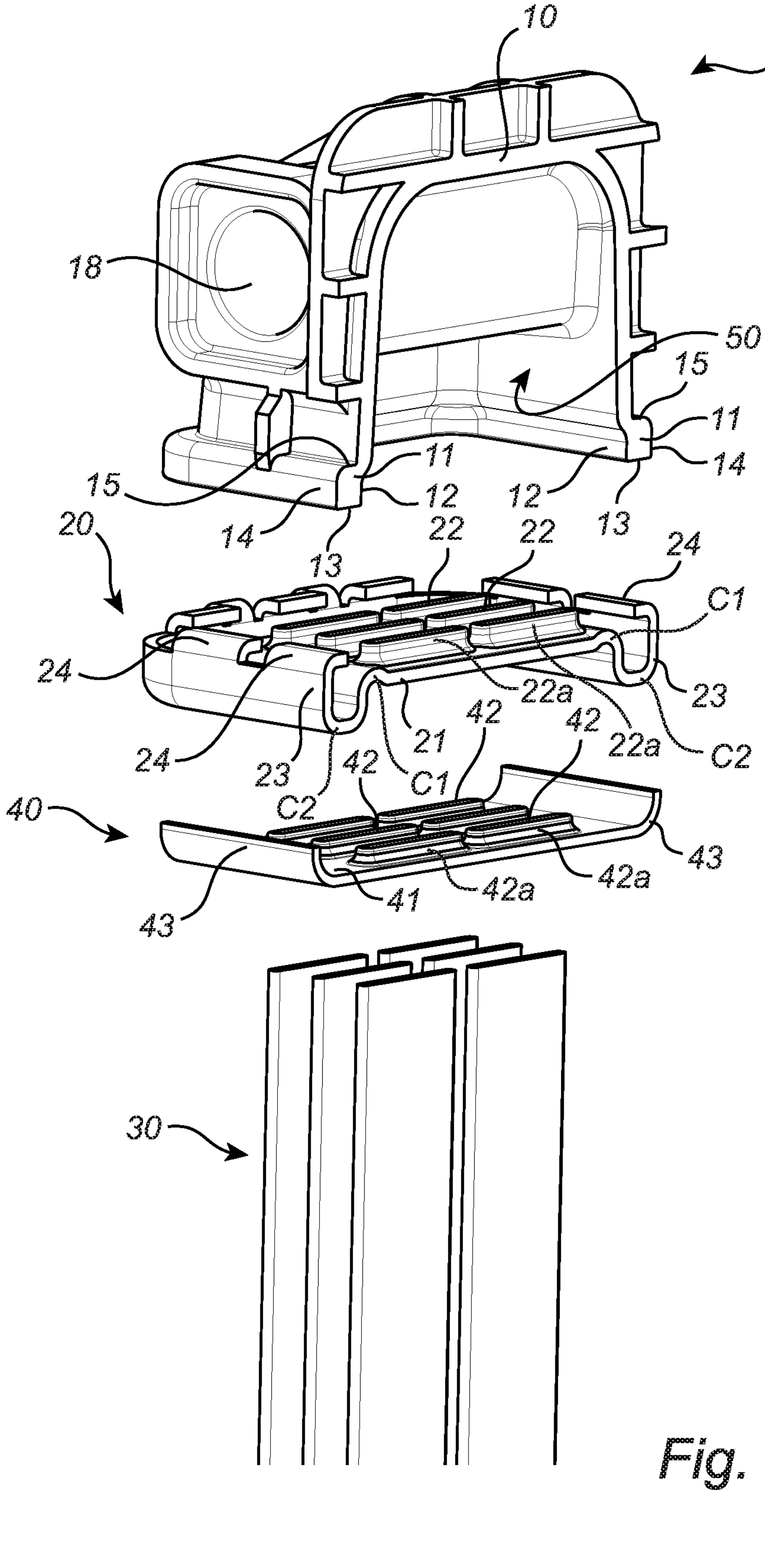
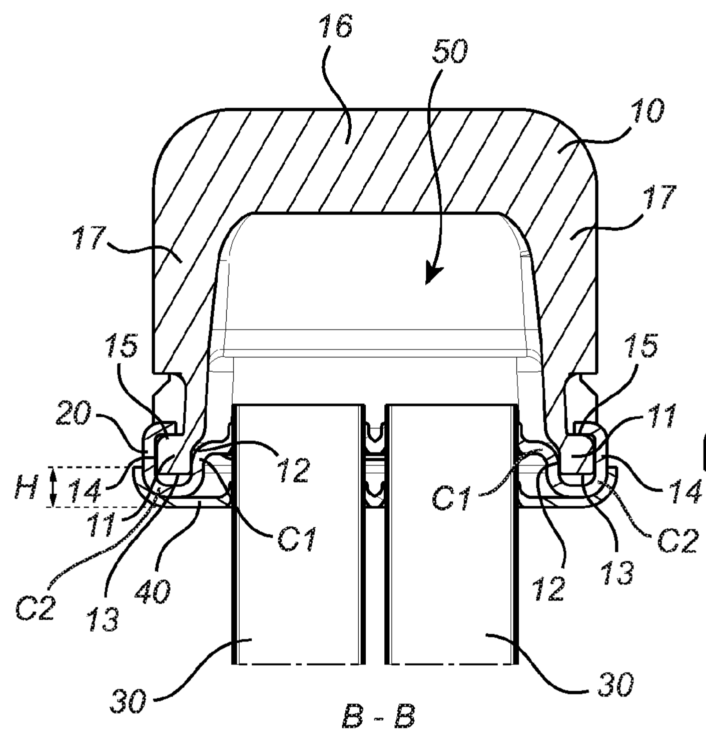


Fig. 3


16
50
10
17
17
15
15
20
11
H
14
12
C1
14
11
C1
C2
11
C2
13
40
12
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30
30
B - B

Fig. 4a

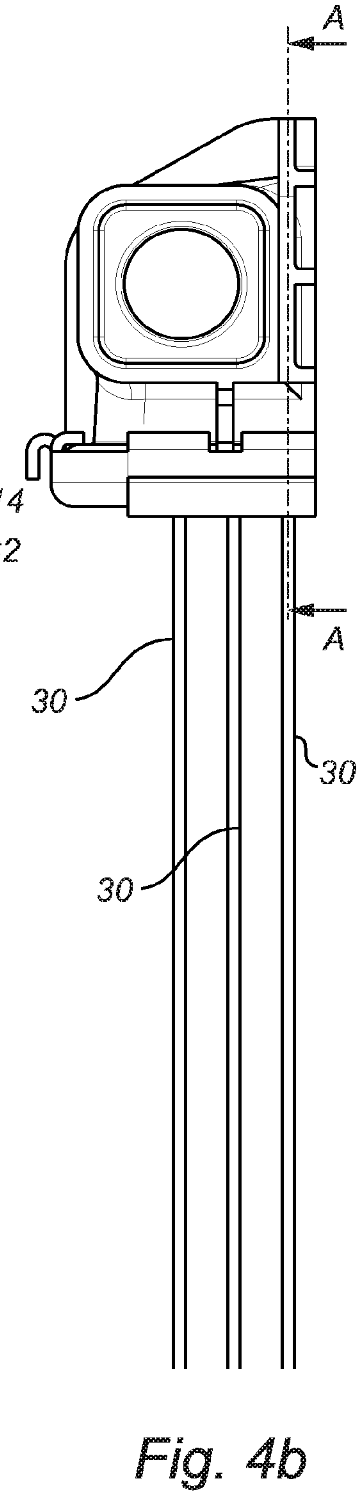
A
A
30
30
30

Fig. 4b

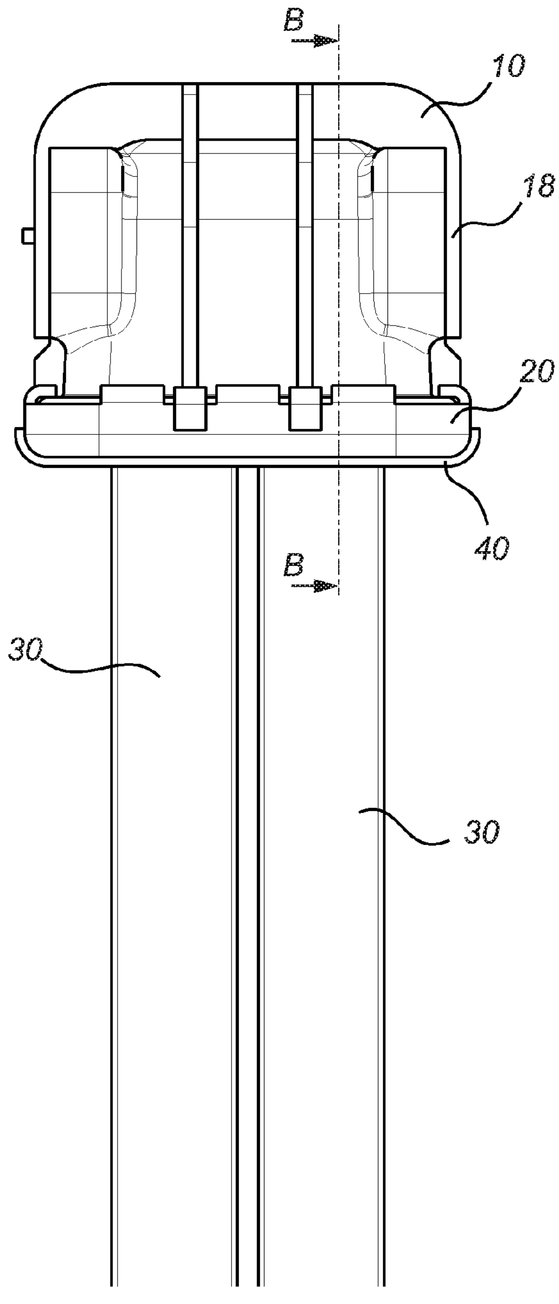

Fig. 5a

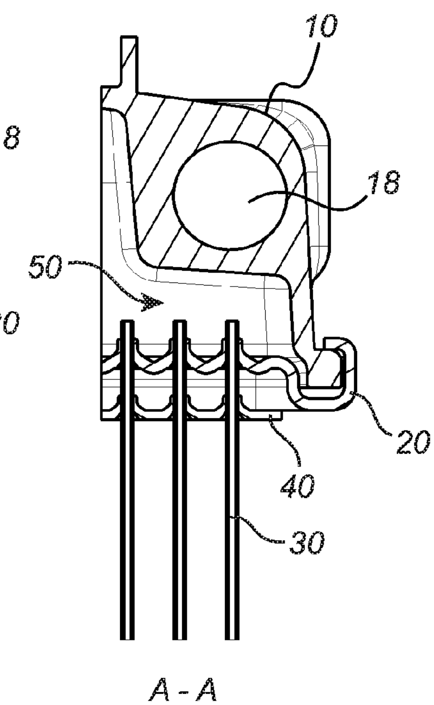

Fig. 5b

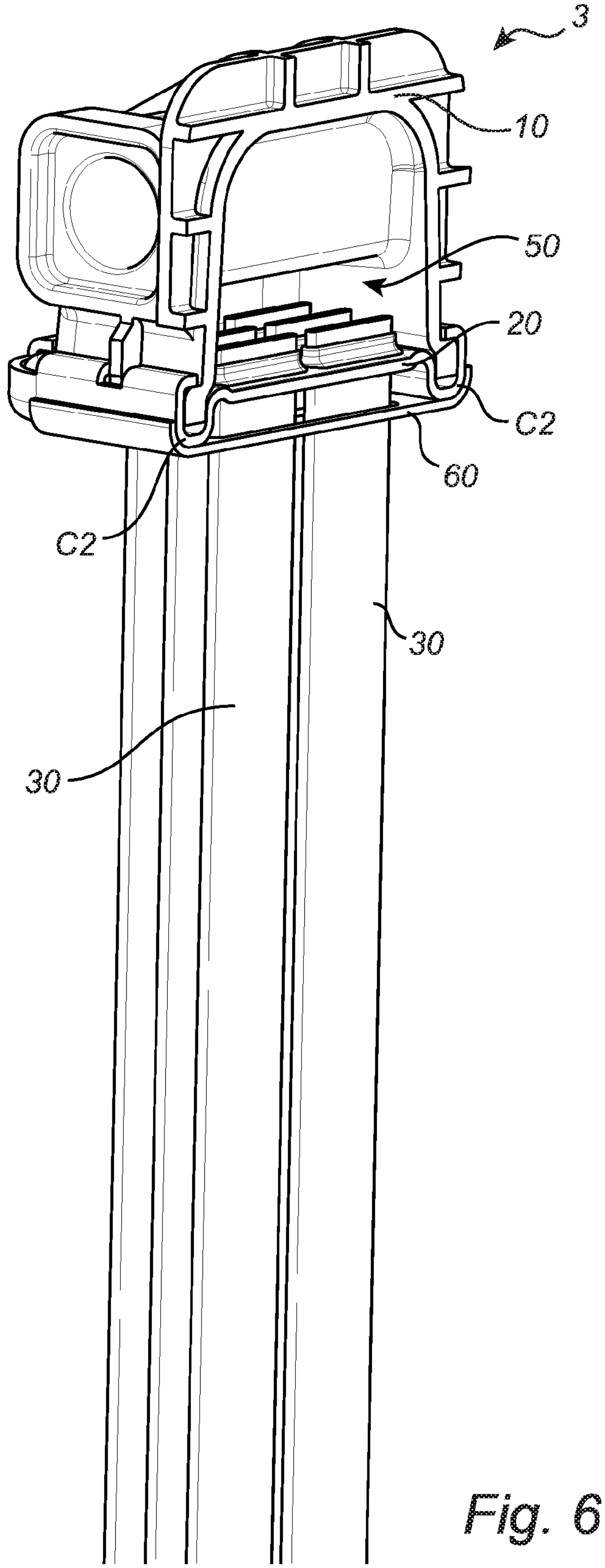

Fig. 6

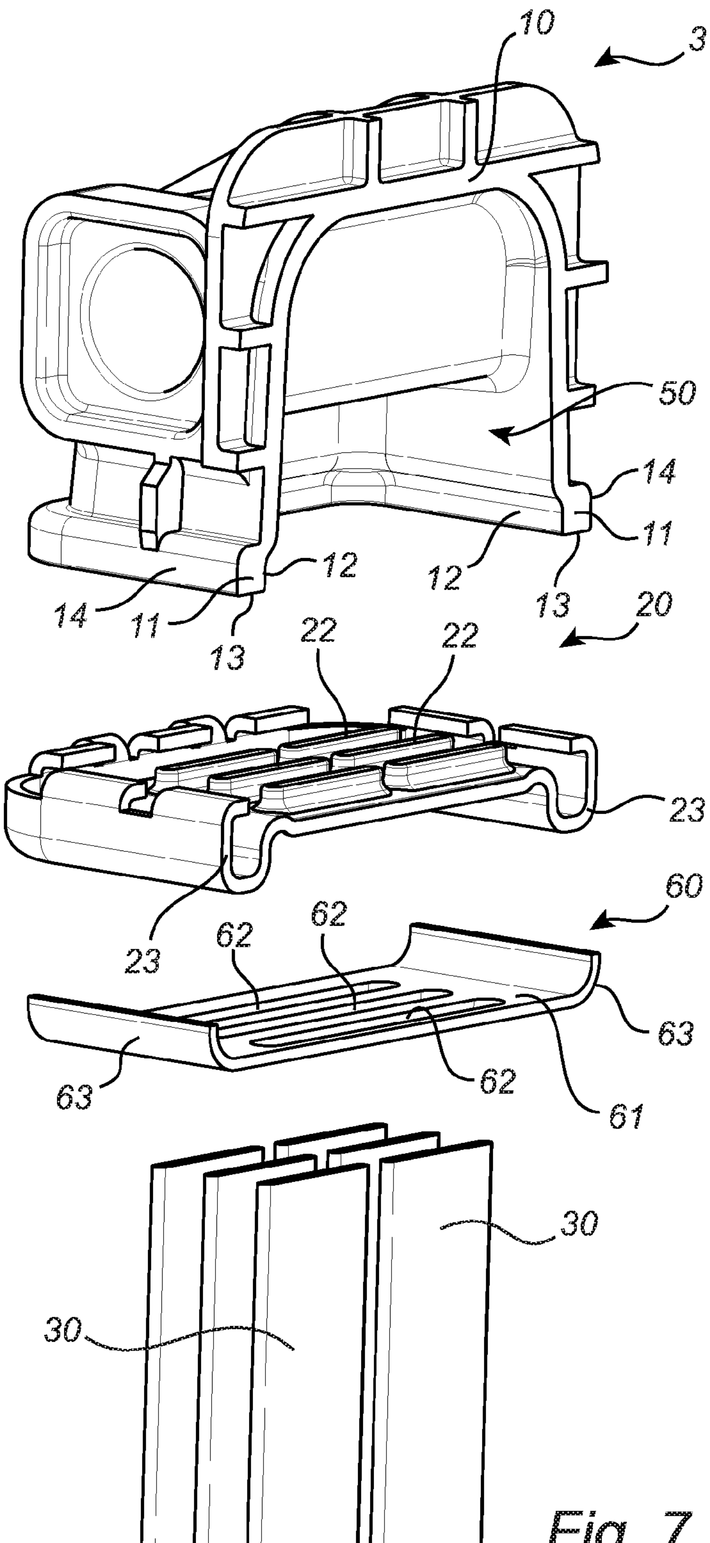

Fig. 7

HEAT EXCHANGER WITH REINFORCED HEADER PLATE

TECHNICAL FIELD

[0001] The present invention relates to a heat exchanger and in particular to a heat exchanger of the type comprising a coolant housing, a header plate and a plurality of tubes for transporting coolant from and to the coolant housing. The invention concerns a reinforcement of the heat exchanger in order to withstand high pressures in the coolant housing.

TECHNICAL BACKGROUND

[0002] Heat exchangers are used in various applications, such as air conditioners, air compressors, gas turbines, refrigerators, and automotive applications. Heat exchangers for automotive use may be a radiator or a charge air cooler.

[0003] Automotive and other heat exchangers may be constructed with a pair of coolant housings which are linked by a core leading a coolant between the coolant housings. The core is typically formed by a plurality of tubes which are located adjacent each other. The tubes may be joined to a header plate which in turn is attached to the coolant housing. The different parts are typically brazed or welded together.

[0004] The above exemplified heat exchanger construction can be used for cooling internal combustion engines wherein an engine coolant is circulated through the engine block and thereafter through the heat exchanger where it transfers heat to the through-passing air. The heat exchanger is typically located at an air intake in the front of the vehicle in order to maximize the air flow through the heat exchanger.

[0005] The heat exchanger construction may also be provided for cooling air within an engine system between for example a turbocharger and an engine intake.

[0006] The coolant pressure may be controlled. By increasing the coolant pressure, vaporization of the coolant can be avoided and the cooling system may thus increase its cooling efficiency. However, an increased coolant pressure puts higher pressure on the mechanical parts of the system, for example on the heat exchanger. In particular, joints between the tubes, the header plate and the coolant housing are exposed to recurrent stress as the coolant pressure repeatedly increases and decreases. In the long run this may cause fatigue and breakdown of the cooling system. One typical area sensitive to fatigue is the joints interconnecting the header plate with the coolant housing since the fluctuating coolant pressure causes the relatively weak coolant housing to repeatedly change dimensions, which changes must be accommodated by the header plate.

[0007] One solution to this problem is to reinforce the header plate to make it more rigid. JP9126681 provides an example of a reinforcing clip which is provided on the header plate in a position between the tubes. The free ends of the clips are bent to follow the shape of the header body and clamp against the same. The reinforcing clip is retained by engaging units provided on the header plate. The parts may be brazed to each other. The solution requires modification of the header plate. Further it requires a complex assembly process since multiple reinforcing clips must be oriented and mounted in spaces having a limited access

[0008] Thus, there still exists a need for improvement with regards to reinforcement of the components in these types of heat exchangers.

SUMMARY OF THE INVENTION

[0009] It is an object of the invention to provide an improved heat exchanger design, in particular with respect to reinforcement of the header plate.

[0010] It is a further object of the invention to provide a heat exchanger which facilitates the production process and which can contribute to cost-efficiency.

[0011] The above and other objects are achieved by a heat exchanger according to claim **1**.

[0012] When pressurized coolant flows through the closed cavity, the walls of the coolant housing tend to bend outward due to the pressure. In particular, the side walls tend to bulge. The inventors have identified portions in the joint between the coolant housing and the header plate which are particularly exposed to fatigue due to such bulging. In order to strengthen the construction, a reinforcing plate is provided. The reinforcing plate is joined to the header plate along the end portion thereof which encompasses the corner between the free edge portion and the outer side surface portion of the border of the coolant housing. Thereby the above mentioned weak portions are strengthened and reinforced so as to increase their resistance to fatigue. The reinforcing plate limits the displacement of the coolant housing in view of the header plate when the heat exchanger is pressurized.

[0013] Regardless of the design of the reinforcing plate, the header plate may be designed and manufactured in a standardized manner without care taken to the reinforcement needed for a particular application. Further, the assembly of the reinforcing plate may be made with only minor effects to the assembly line.

[0014] The reinforcing plate may be made of the same material as the rest of the components of the heat exchanger, i.e. typically an aluminum alloy. This means that a brazed homogenous joint may be formed along all contact surfaces between the reinforcing plate and the header plate in the very same brazing process that is normally used when joining all components of a heat exchanger. Thus, no extra joining step is required whereby the reinforcing plate easily may be integrated in the assembly line.

[0015] Further features and advantages are achieved by embodiments disclosed in the dependent claims.

[0016] In one embodiment, the reinforcing plate is joined to one or more tubes embraced by the apertures of the reinforcing plate. This strengthens the overall torsional rigidity of the heat exchanger and further decreases the risk of fatigue related breakdowns.

[0017] In another embodiment, the reinforcing plate may be arranged to provide a gap between the reinforcing plate and each of one or more tubes which are embraced by the apertures of the reinforcing plate. This feature may be preferred in order to provide an easy assembling of the components. Also, by a gap tolerances are made of less importance facilitating both production of the reinforcing plate and assembling thereof.

[0018] Regardless of if the reinforcing plate is joined to the tubes or provides a gap between the reinforcing plate and the tubes, the apertures of the reinforcing plate may embrace only one tube or embrace a plurality of tubes.

[0019] In one embodiment, the opening defined by the border of the coolant housing is oblong. In this case, the reinforcing plate is arranged to extend between two opposing locations on a long side of the border of the coolant housing. It has been found that reinforcement of the header plate along the long side of the border of the coolant housing provides a strong overall reinforcement of the heat exchanger and also provides an improved torsional rigidity. This is particularly the case when the reinforcing plate is located along a central area of the long side.

[0020] In one embodiment, the tubes are arranged in a plurality of parallel rows. Each row comprises a plurality of tubes. The rows may extend in the direction of the long side of the border. In such embodiment, the reinforcing plate may be arranged to embrace at least two adjacent tubes in each row. By this configuration, the reinforcing plate may extend along as many tubes along the long side as desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The invention will be described in detail with reference to the schematic drawings.

[0022] FIG. **1** is a three-dimensional view of a typical heat exchanger in line with the present invention.

[0023] FIG. **2** is a view of a coolant housing and a part of the core of a heat exchanger according to a first embodiment.

[0024] FIG. **3** is an exploded view of the arrangement in FIG. **2**.

[0025] FIG. **4***a* is a side view towards the open section of the arrangement in FIG. **2**.

[0026] FIG. **4***b* is a cross-sectional view of a section taken along line A-A in FIG. **4***a*.

[0027] FIG. **5***a* is side view towards a short side of the arrangement in FIG. **2**.

[0028] FIG. **5***b* is a cross-sectional view of a section taken along line B-B in FIG. **5***a*.

[0029] FIG. **6** is a view of a coolant housing and a part of the core of a heat exchanger according to a second embodiment.

[0030] FIG. **7** is an exploded view of the arrangement n FIG. **6**.

DETAILED DESCRIPTION

[0031] A heat exchanger **1** for heat exchange between a coolant and air is illustrated in FIG. **1**. For illustrative purposes the heat exchanger is implemented with the reinforcing plate of the invention. The heat exchanger **1** may be a radiator or a charge air cooler for use in engine cooling systems. A coolant is circulated in a closed system formed by two opposing coolant housings **10** and a plurality of tubes **30** extending between the housings. The disclosed embodiment is provided with a plurality of vertically arranged tubes **30**. It is however to be understood that the tubes with remained function may be horizontally arranged. The tubes are arranged side by side in at least one row. A number of parallel rows, each row comprising a plurality of tubes, may be provided.

[0032] A header plate **20** is attached to each coolant housing **10** to form a closed cavity. The tubes **30** connect to the closed cavity through apertures in the header plate.

[0033] During operation air is allowed to pass by the tubes **30**. The tubes **30** are designed to provide a large area relative its volume in order to optimize the heat exchange. To further improve the heat exchanging area, waffled thin metal sheets **70**, may be arranged between the individual tubes **30**. Turbulator elements may also be provided.

[0034] The tubes **30** and the header plates **20** are preferably made of metal such as aluminum. It is however to be understood that also other types of materials may be used. In case of aluminium, the aluminum is preferably of the type provided with a surface treatment facilitating brazing.

[0035] The coolant housings are typically made of plastics, composite or metal.

[0036] The typical process of manufacturing a brazed heat exchanger of the above type may be briefly explained as follows: A plurality of tubes are stacked with or without intermediate distance forming waffled thin metal material. The stacked plurality of tubes is kept together by arranging two opposing header plates on top of the free ends of the plurality of tubes. The tubes are arranged to extend with their free ends through apertures in the opposing header plates. The resulting stacked arrangement is thoroughly degreased and provided with a fluxing agent in order of dissolving inevitable natural surface oxides of the aluminum. The stacked arrangement is subsequently fed through an oven where all connecting surfaces in the stacked arrangement are brazed together to form a rigid unit with homogenous, brazed joints along all contact surfaces. Finally a coolant housing is arranged on top of each header plate and joined thereto. The coolant housings are typically clamped in place by flanges on the header plate, which flanges clamp the peripheral border of the coolant housing. A gasket is arranged between the coolant housing and the header plate before joining the same. The resulting clamped joint will be made fluid tight by the reactive forces of the thus compressed gasket. Thereby a closed, fluid tight system is provided allowing a closed circulation of a fluid from the first coolant housing, via the plurality of tubes towards the second coolant housing.

[0037] A first embodiment of a part of an oblong arrangement **2** forming the fluid side of the heat exchanger **1** is illustrated in FIG. **2**. The illustrated part forms an end of the oblong arrangement **2**. The part is illustrated as a cut-off to facilitate understanding of the design. The cross section is representative of any part of the arrangement **2** along either one of the coolant housings **10** in FIG. **1**.

[0038] The arrangement **2** comprises the coolant housing **10**, the header plate **20** and the plurality of tubes **30**. It is appreciated that these components may take many forms within the scope of the appended claims.

[0039] The coolant housing **10** and the header plate **20** form a closed cavity **50** by that the header plate **20** covers an opening of the coolant housing **10**. The tubes **30** are in communication with the closed cavity **50** by that their free open ends are arranged to extend into the closed cavity **50** through the header plate **20**.

[0040] The invention is defined by a reinforcing plate **40**. The reinforcing plate **40** is arranged along and at least partly in contact with an outside surface of the header plate **20**. By outside surface is meant a surface facing away from the closed cavity **50**.

[0041] The structural details of the different components in this embodiment and their attachment to each other will now be disclosed with reference to FIGS. **3** and **4***a*-**4***b*.

[0042] Starting with the coolant housing **10**, the coolant housing **10** comprises a top wall **16** and side walls **17** extending from the top wall **16**. The top wall **16** and the side walls **17** define a bowl-shaped inner cavity of the coolant housing **10**. The end of the side walls **17** forms a peripheral border which defines an opening in the coolant housing **10**. The border **11** is in this embodiment a peripheral rim which extends in an outward direction from the closed cavity **50** along the perimeter of the coolant housing **10**. It goes without saying that the border **11** may have a number of different designs within the scope of the invention.

[0043] The coolant housing **10** is further provided with a coolant inlet or outlet **18**. The inlet/outlet **18** is arranged to be connected to a non-disclosed coolant circulating system.

[0044] The opening of the coolant housing **10** is covered by the header plate **20** for separating the closed cavity **50** of the coolant housing **10**. The header plate **20** is also provided for connecting the tubes **30** such that the tubes **30** are in communication with the closed cavity **50**. To this end, the header plate **20** is provided with apertures **22**. Each aperture **22** receives a free open end of a tube **30**.

[0045] It is important that the attachment between the header plate **20** and the coolant housing **10** is tight in order to prevent leakage. To this end, the header plate **20** is arranged to crimp the border **11** of the coolant housing **10**. The crimping is achieved by that an end portion **23**, extending from a main portion **21**, of the header plate **20** encompasses an inner side surface portion **12**, a free edge portion **13**, an outer side surface portion **14** and an outer upper surface portion **15** of the border **11** at opposing locations on the border **11**. More precisely, the header plate **20** crimps the border **11** along the two opposing long sides and along the two opposing short sides. Thus, in this embodiment, the header plate **20** is arranged to crimp around the border on at least two opposing locations.

[0046] By inner side surface portion **12** of the coolant housing **10** within the scope of the invention is meant a surface portion of the border **11** constituting an elongation of the inner envelope surface of the coolant housing **10**. The inner envelope surface of the coolant housing **10** faces the closed cavity **50**.

[0047] By outer side surface portionl4 of the coolant housing **10** within the scope of the invention is meant a surface portion of the border constituting an elongation of the outer envelope side surface of the coolant housing **10**. The outer envelope surface of the coolant housing **10** faces away from the closed cavity **50**.

[0048] By free edge portion **13** of the coolant housing **10** within the scope of the invention is meant a surface portion of the border located between the inner and outer envelope surfaces of the coolant housing **10**.

[0049] By outer upper surface portion **15** of the border within the scope of the invention is meant a surface portion of the border facing away from the header plate **20**.

[0050] By encompassing is meant that the end portion **23** of the header plate **20** follows the surface portions of the coolant housing **10**, however it is not necessary that the end portion **23** of the header plate **20** abuts the surface along the whole surface portion of the coolant housing **10**. Thus, the contact between the end portion **23** of the header plate **20** and the outer side surface portion **14** of the coolant housing **10** may be continuous or discontinuous along the circumference of the coolant housing **10** as long as a fluid tight sealing is achieved. An intermediate flexible sealing may be arranged where necessary.

[0051] In the disclosed embodiment, the end portion **23** of the header plate **20** abuts two opposing surface portions of the border **11**, being the inner side surface portion **12**, the outer side surface portion **14** and the outer upper surface portion **15**, so as to achieve the crimping effect. It is appreciated that the crimping effect may be achieved by different configurations of the header plate **20** and its end portion **23**. For example, the header plate **20** may encompass only the free edge portion **13** and the outer side surface portion **14** at each opposing location to press the opposing locations of the border **11** toward each other. In other words, the header plate **20** may have a clip-like form and function. Other configurations are also obvious to the skilled person.

[0052] The header plate **20** comprises end flaps **24** which encompass the outer upper surface portion **15** of the border **11**. This feature strengthens the crimping and thus further increases the tightening of the joint between the header plate **20** and the coolant housing **10**. By a non-disclosed gasket being arranged between the header plate **20** and the border **11** such gasket will be compressed by the crimping and the reaction force resulting from the compressed gasket will ensure a fluid tight joint and prevent any significant movements.

[0053] During operation, when pressurized coolant flows through the closed cavity **50**, the coolant housing **10** tends to bend outward due to the pressure. In particular, the side walls **17** tend to bulge. The bending is typically cyclic, meaning that over time there is a risk of fatigue. The inventors have identified two weak portions on the header plate **20** which are particularly exposed to fatigue stress at high coolant pressures. The first portion is the corner C1 between the main portion **21** and the first part of the end portion **23** which encompasses the inner side surface portion **12** of the coolant housing **10** and thereby the inner envelope surface portion of the coolant housing **10**. The second portion is the corner C2 in the end portion **23** which encompasses the corner between the free edge portion **13** of the coolant housing **10** and the outer side surface portion **14** of the coolant housing **10**, i.e. the inner envelope surface portion of the coolant housing **10**. Moreover, it has been realized that the part of the end portion **23** which runs along the outer side surface portion **14** of the coolant housing **10**, i.e. the outer envelope surface portion tends to bend outward due to the border **11** being pressed in an outward direction. Even if the end portion **23** does not break, it will be exposed to wear over time with the consequence that the crimping loosens thus un-tightening the joint between the coolant housing **10** and the header plate **20**. There is also a risk that the cyclic stress causes fatigue in the brazed joints between the header plate **20** and the tubes **30**.

[0054] In order to strengthen the design, the invention provides a reinforcing plate **40**. The reinforcing plate **40** comprises a main portion **41** forming a bottom and at least two opposing end portions **43**.

[0055] The reinforcing plate **40** is formed by stamped sheet metal and is preferably made of the same material as the header plate **20** and the tubes **30** to facilitate joining there between.

[0056] The reinforcing plate **40** is arranged on an outside surface of the header plate **20**, and extends between two opposing crimped locations on the border **11** of the coolant hosing **10**.

[0057] The reinforcing plate **40** is in contact with and joined to the header plate **20** at least at two positions: one at each crimped location on the border **11**. More precisely, the reinforcing plate **40** is arranged in contact with and joined to each of the end portions **23** of the header plate **12**. The joint is arranged along at least the part of the end portion **23** which encompasses the corner C2 between the free edge portion **13** of the coolant housing **10** and the outer side surface portion **14** of the border **11**.

[0058] By that the reinforcing plate **40** is joined to this particular part of the header plate **20**, the above mentioned weak corners C**1** and C**2** are strengthened and reinforced so as to increase their resistance to fatigue due to high cyclic pressures in the coolant housing **10**. The reinforcing plate **40** limits the displacement of the header plate **20** and of the coolant housing **10** when the latter is pressurized. The limited displacement reduces stresses on the coolant housing **10**, the header plate **20** and the tubes **30** and also on all joints between these components.

[0059] The end portions **43** of the reinforcing plate **40** are curved so as to follow the curvature of the end portions **23** of the header plate **20**. The reinforcing plate **40** may be joined to the header plate **20** along other portions as well. In the disclosed embodiment, there is by way of example a joint between the header plate **20** and the reinforcing plate **40** along the main portion **41** of the reinforcing plate **40** and the header plate **20**.

[0060] The height H of the opposing end portions **43** of the reinforcing plate **40** may vary. As a minimum the reinforcing plate **40** should extend around the corner C**2** of the header plate **20** and at least along a portion of the end portion **23** of the header plate **20**. It must however not necessarily have the same height and extension as the end portion **23** of the header plate **20**.

[0061] The reinforcing plate **40** comprises apertures **42**. In the disclosed embodiment, each aperture **42** embraces a single tube **30**. By the term embrace is within the scope of the invention meant that the tube **30** is located in the aperture **42**, however the tube **30** need not abut the reinforcing plate **40** as will be illustrated further on. In this embodiment, however, the reinforcing plate **40** is arranged in contact with and joined to each of the tubes **30**. This feature strengthens the torsional rigidity of the heat exchanger as such and may further add to the reinforcement of the relevant corners C**1** and C**2**.

[0062] In the disclosed embodiment, the apertures **42** have peripheral rims **42***a* which give an extra support and contact surface to the tubes **30**. The header plate **20** comprises similar peripheral rims **22***a*.

[0063] The joint in the contact surfaces between the header plate **20** and the reinforcing plate **40** are preferably brazed, homogenous joints, which joints are formed in the very same process step as is previously disclosed for being used when brazing the stacked components making up the heat exchanger in FIG. **1**.

[0064] A two-dimensional view toward a short side end of the arrangement **2** in FIG. **2** is illustrated in FIG. **5***a*. A section taken along the line B-B is illustrated in FIG. **5***b*.

[0065] The reinforcing plate **40** extends between two opposing locations, being crimped by the header plate **20**, on the long side of the border **11** of the coolant housing **10**. This positioning of the reinforcing plate **40** may be advantageous when the opening of the coolant housing **10** has an oblong extension with a length considerably exceeding the thickness of the heat exchanger. It has been found that reinforcement of the header plate **20** along the long side of the border **11** of the coolant housing **10**, in particular along a central area of the long side, provides a strong reinforcement of the heat exchanger. By central area is meant that the reinforcing plate **40** embraces tubes **30** which are not located at the end of the long side, i.e. adjacent the short side of the order **11**.

[0066] The reinforcing plate **40** could in other embodiments (not disclosed) also extend between two opposing locations on the short sides of the border **11** of the coolant housing **10**.

[0067] A second embodiment of a part of the arrangement **3** forming the fluid side of the heat exchanger **1** is illustrated in FIGS. **6** and **7**. The components which are similar to the ones illustrated in the first embodiment are provided with the same reference numerals.

[0068] The arrangement **3** comprises a reinforcing plate **60** which has a slightly different configuration than the first embodiment of the reinforcing plate **40**. The reinforcing plate **60** comprises a main portion **61** forming a bottom and two opposing end portions **63** which extend from the main portion **61**.

[0069] The reinforcing plate **60** is joined to the header plate in similar manner as in the first embodiment. In other words, the reinforcing plate **60** is joined to each of the end portions **23** of the header plate **20**. The joint is arranged along at least the part of the end portion **23** which encompasses the corner C**2** between the free edge portion **13** and the outer side surface portion **14** of the border **11**. Similar to the first embodiment, the end portions **63** are curved so as to follow the curvature of the end portions **23** of the header plate **20**.

[0070] The reinforcing plate **60** is provided with apertures **62**. Contrary to the first embodiment, each aperture **62** encompasses a pair of adjacent tubes **30**. In this embodiment, the tubes **30** are located in a plurality of rows being two rows in the illustrated case. The rows are located in parallel. Each row comprises a plurality of tubes **30**. The illustrated part of the arrangement **3** shows three tubes **3** in each row. Each row extends in the direction of the long side of the border **11** which provides an oblong opening of the coolant housing **10**.

[0071] The reinforcing plate **60** embraces adjacent tubes **30** in adjacent rows. Moreover, the single reinforcing plate **60** is provided with a plurality of apertures **62** which together embrace a plurality of tubes **30** along the rows.

[0072] The reinforcing plate **60** differs from the reinforcing plate **40** of the first embodiment also in that it is not joined to the tubes **30**. On the contrary, the reinforcing plate **60** is arranged to provide a gap between the reinforcing plate **60** and each of the tubes **30** embraced by the apertures **62**. This feature may be preferred in order to facilitate assembling of the components. Further, the tolerances of the apertures **62** of the reinforcing plate **60** may be given a reduced importance.

[0073] The two above disclosed embodiments exemplifies the great variety of designs of the reinforcing plate **40** and **60** that is feasible within the scope of the invention. Regardless of the design of the reinforcing plate **40**, **60**, the header plate **20** may be designed and manufactured in a standardized manner without care taken to the type of reinforcing plate **40**, **60** to be used.

[0074] The reinforcing plate may be chosen and added during the assembly of the heat exchanger with only minor effect on the assembly line.

[0075] It is to be understood that a plurality of reinforcing plates **40**, **60** may be arranged side by side along the header plate **20**. The reinforcing plates **40**, **60** may be arranged side by side in contact with each other or be arranged with an intermediate distance.

[0076] By making the reinforcing plates **40**, **60** in the very same material as the rest of the heat exchanger with the exception of the coolant housing which typically is made of plastics, the reinforcing plate **40**, **60** requires no separate joining step but will be brazed to adjacent components being in contact therewith during the conventional brazing step. Further, by being of the same material as the header plates **20** and the tubes **30**, the reinforcing plates **40**, **60** will move thermally together with the rest of the heat exchanger causing no additional stress to the brazed joints.

[0077] It is appreciated that the embodiments of the invention as disclosed above may be altered in different ways within the scope of the appended claims. For example, the number of apertures **42** and **62** and the geometry thereof may vary depending on the type of tubes and their geometry. Another example is that the border may take any suitable form. It is appreciated that the reinforcing plate according to the invention can be used in any type of heat exchanger where the coolant housings are attached to the header plate by crimping, brazing, welding or the like.

1. Heat exchanger comprising:

a coolant housing having a border which defines an opening;

a header plate arranged to cover the opening;

wherein the header plate crimps the border of the coolant housing by encompassing a free edge portion, an outer side surface portion and an outer upper surface portion on at least two opposing locations on the border;

whereby a closed cavity for coolant is defined by the coolant housing and the header plate; and

wherein the header plate is provided with apertures, each aperture receiving a tube for guiding coolant from or to the closed cavity;

the heat exchanger further comprising:

a reinforcing plate extending between two opposing locations on the border of the coolant housing, and extending on the outside of the header plate in view of the closed cavity, the reinforcing plate being made of the same material as the header plate and the tubes;

wherein the reinforcing plate is joined, at each of said opposing locations, to an outer surface portion of the header plate encompassing a corner between the free edge portion and the outer side surface portion of the border;

wherein the reinforcing plate is provided with at least one aperture embracing one or more of the tubes which are received by the header plate; and

wherein the reinforcing plate is arranged to provide a gap between the reinforcing plate and each of one or more tubes embraced by the apertures of the reinforcing plate.

2. The heat exchanger according to claim **1**, wherein the reinforcing plate is joined to one or more tubes embraced by the apertures of the reinforcing plate.

3. (canceled)

4. The heat exchanger according to claim **1**, wherein each of the at least one apertures of the reinforcing plate embraces only one tube received by the header plate.

5. The heat exchanger according to claim **1**, wherein each of the at least one apertures of the reinforcing plate embraces a plurality of tubes received by the header plate.

6. The heat exchanger according to claim **1**,

wherein the opening defined by the border is oblong; and

wherein the reinforcing plate is arranged to extend between two opposing locations on a long side of the border.

7. The heat exchanger according to claim **6**,

wherein the tubes are arranged in a plurality of parallel rows, each row comprising a plurality of tubes;

wherein the rows extend in the direction of the long side of the border; and

wherein the reinforcing plate embraces at least two adjacent tubes in each row.

8. The heat exchanger according to claim **6**, wherein the reinforcing plate is arranged at a central area of the header plate with respect to the long side of the border.

9. The heat exchanger according to claim **1**,

wherein the tubes have an oblong cross-section and are arranged with the same orientation, and

wherein the reinforcing plate extends along the long sides of the tubes.

10. The heat exchanger according to claim **1**, wherein the reinforcing plate is joined to the header plate by brazing.

11. The heat exchanger according to claim **1**, wherein the header plate encompasses also an inner side surface portion at each of said two opposing locations on the border.

12. The heat exchanger according to claim **1**, wherein the coolant housing comprises a top wall and side walls which extend from the top wall, the top wall and side walls defining a bowl-shaped inner space of the coolant housing.

13. The heat exchanger according to claim **7**, wherein the reinforcing plate is arranged at a central area of the header plate with respect to the long side of the border.

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