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(54) A HEAT EXCHANGER

(57) A heat exchanger 1 adapted to exchange heat between a first fluid operating at high pressure and a second fluid, comprising a first conduit for guiding the flow of the first fluid and a second conduit for guiding the flow of the second fluid, wherein in a selected section the second conduit encompasses at least part of the first fluid in a fluid-tight manner, wherein the second conduit comprises, within the selected section, a safety device 30 adapted to enable flow of fluids between inner A and outer B sides of the second conduit at the selected section when a set pressure difference between them is exceeded.

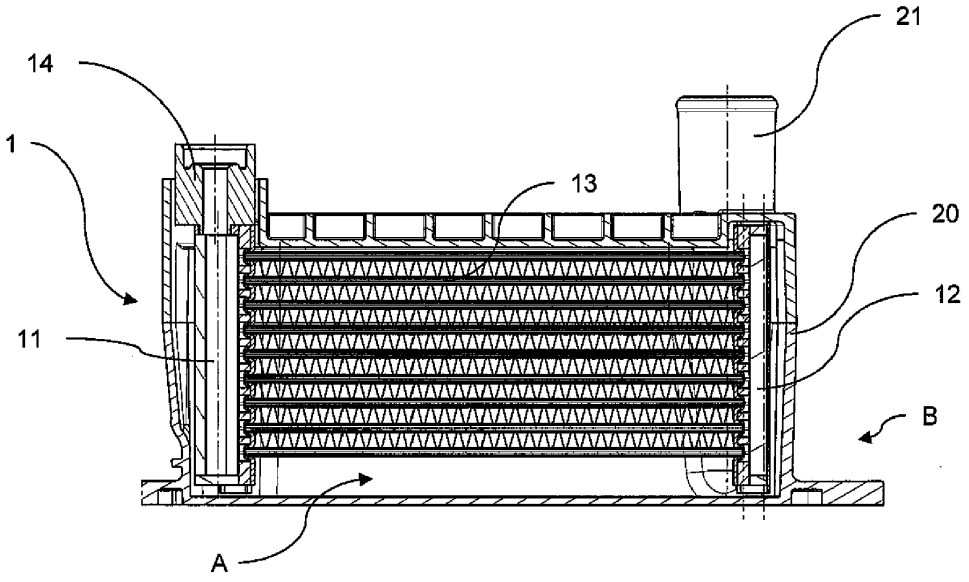

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The invention relates to heat exchangers. In particular, the invention relates to heat exchangers adapted for a fluid operating at high pressures.

BACKGROUND OF THE INVENTION

[0002] There are known heat exchangers designed for exchanging heat between two fluids, where one of the fluids operates at high pressures. An example of such fluid is CO_2, known also as R744. These heat exchangers can comprise a conduit for the first fluid and a conduit for the second fluid. Both conduits are then arranged in a manner allowing the heat to be exchanged between said fluids. One of the possible solutions is to locate the first conduit at least partly within the second conduit, so that the second fluid can flow around the elements of the first conduit, thereby enabling heat exchange.

[0003] There are however risks involved with operating high pressure heat exchangers. As the operating pressure of the first fluid is high, for example at the level of 150 bars, any leaks in the first conduit can result in severe consequences. This can be a case especially when the first conduit is encompassed in a fluid-tight manner within the second conduit, the second conduit being adapted only for pressures of the second fluid, which are significantly lower. If the leak occurs in this encompassed area, the pressure builds up quickly and destroys the structure of the second conduit in an unpredictable manner. For example, if the second conduit is a plastic housing, some parts of this housing can separate and gain great velocity, thereby damaging other elements situated in the vicinity of the heat exchanger. Further, a damage could be done to a person servicing or operating a vehicle, in which the heat exchanger can be placed. Another situation is also possible. Upon leak in the first conduit, encompassed by the second conduit, the second conduit can also leak without bursting or ejecting fragments of its structure. However, the placement of this leak is hard to predict. The fluid then leaves through a new opening at random location, possibly also at high speed and temperature, and can damage other components of the vehicle.

[0004] Therefore, the aim of the invention is to remedy this situation and enhance safety when operating a high pressure heat exchanger. This aim is to be achieved in a cost-efficient, adaptable and reliable manner.

SUMMARY OF THE INVENTION

[0005] The object of the invention is a heat exchanger adapted to exchange heat between a first fluid operating at high pressure and a second fluid, comprising a first conduit for guiding the flow of the first fluid and a second conduit for guiding the flow of the second fluid, wherein in a selected section the second conduit encompasses at least part of the first fluid in a fluid-tight manner, wherein the second conduit comprises, within the selected section, a safety device 30 adapted to enable flow of fluids between inner A and outer B sides of the second conduit at the selected section when a set pressure difference between them is exceeded.

[0006] Preferably, the safety device 30 comprises a fuse element of locally reduced mechanical resistance to pressure.

[0007] Preferably, the second conduit is formed by a housing 20.

[0008] Preferably, the fuse element is a wall portion 31 with an area outlined by sections 32 of a reduced thickness.

[0009] Preferably, the sections 32 of reduced thickness define a flap with at least one hinge 33 constituted by a section of non-reduced thickness.

[0010] Preferably, at least one section 32 of the reduced thickness forms a groove 34 on the inner side A of the second conduit.

[0011] Preferably, at least one section 32 of the reduced thickness forms a groove 34 on the outer B side of the second conduit.

[0012] Preferably, at least the sections of the reduced thickness form grooves 34 on the inner A and outer B sides of the second conduit.

BRIEF DESCRITPTION OF DRAWINGS

[0013] Examples of the invention will be apparent from and described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows a cross-section of a heat exchanger;

Fig. 2 shows a perspective view of the heat exchanger according to the invention;

Figs. 3a-3d show examples of shapes of a safety device;

Figs. 4a-4b show examples of operation of the safety device;

Figs. 5a-5j show various embodiments of the safety device.

DETAILED DESCRIPTION OF EMBODIMENTS

[0014] The invention concerns a heat exchanger adapted to exchange heat between two fluids. The first fluid is a refrigerant operating at high pressure, for example R744 (CO_2), and the second fluid is a coolant. The heat exchanger comprises a first conduit for guiding the first fluid and a second conduit for guiding the second fluid. The second conduit at least partly encompasses the first conduit, so that the heat exchange can be enabled.

[0015] In the example shown in Fig. 1, the first conduit comprises two manifolds 11, 12 connected by tubes 13. Manifold 11 has connecting inlet and outlet pipes 14, 15, through which the first fluid enters and exits the heat exchanger 1 after traversing the tubes 13. Further, the heat exchanger 1 comprises the second conduit, which is constituted by a housing 20. This housing 20 encompasses the manifolds 11, 12 and the tubes 13. The housing 20 also comprises inlet and outlet pipes 21, 22, through which the second fluid enters and exits the heat exchanger 1. The housing 20 serves as guiding means for the second fluid and is arranged so that the second fluid flows between the tubes 13 and manifolds 11, 12, thereby enabling heat exchange with the first fluid.

[0016] The first conduit is adapted to guide the first fluid at high pressure. On the other hand, the second conduit, in this instance a housing 20, is adapted for operating pressure which is much lower. Although during normal operation of the heat exchanger this does not pose a problem, the situation changes upon any leaks or damage in the first conduit. As the housing 20 encompasses the first conduit, upon a leak the first fluid enters the second conduit and thus elevates the level of operating pressure. The second conduit is thus likely to be damaged in a manner hard to predict, and thus poses a danger to safety of users, operators and other components located nearby. To alleviate this problem, a safety device is provided in the heat exchanger 1.

[0017] Fig. 2 presents a heat exchanger 1 with a safety device according to the invention. The safety device is adapted to enable flow of fluids between the inner A and outer B sides of the second conduit (sides being indicated in Fig. 1). In particular, it is adapted to enable such flow within a selected section where the first conduit is encompassed by the second conduit in a fluid-tight manner. This flow occurs however only if a set pressure difference between the inner A and outer B side of the second conduit is exceeded. In other words, if there is a leak in the first conduit, which is located within the second conduit, the first fluid will enter the second conduit. The pressure in the second conduit will increase, so that the pressure difference between the inner A side of the second conduit and the outer B side of the second conduit will consequently also increase. The safety device is adapted to enable flow of fluids between the inner A and outer B sides of the second conduit, within the selected section, if this pressure difference exceeds a set level. In case of R744 operating at pressure of 150 bars, and the location the second conduit within a vehicle, this difference can be set at level of 150 bars. It can be also set at a lower value. At a lower level, the outflow will take place with lower fluid pressure (and consequently with lower force), thereby lowering a risk of high energy impact of the fluid (or safety device elements) onto other components or the like.

[0018] In Fig. 2, the second conduit is formed by a housing 20. In such case, the safety device 30 can comprise a fuse element of locally deliberately reduced mechanical resistance to pressure. It can be for example a portion of reduced thickness. As the thickness of the wall is associated with resistance to pressure, in case of excessive pressure this portion will burst, i.e. create an opening of a pre-defined shape, and enable flow of the fluid. To limit the possibility of creating projectiles out of housing material, this portion is preferably relatively of small dimensions and simple shapes, such as a disk or the like. Housing 20 can be made of plastic or of metal.

[0019] In some cases the above-described form of the fuse element may not be sufficient or satisfactory.

[0020] As a further improvement, the fuse element can be carried out in form of a wall portion 31 of non-reduced thickness, the area of which is outlined by sections 32 of reduced thickness. In other words, the sections 32 of reduced thickness outline the general shape of the wall portion 31. In such case, the wall will break along lined sections in a predictable manner. The general shape of wall portions 31 can be round, rectangular, trapezoidal, triangular etc.

[0021] As can be seen in Figs. 3a-3d, the wall portion 31 may be generally outlined by sections 32 of reduced thickness, whereas these sections 32 may be intersected by portions of non-reduced thickness. These portions form hinges 33, rupturing of which will be either hindered or prevented in the above-described scenario, depending on thickness selection and desired outcome. In other words, the sections of reduced thickness define a flap with at least one hinge constituted by a section of non-reduced thickness. Consequently, the wall portion 31 can be prevented from separation in case of bursting. This will reduce the possible damage. There can be a single hinge 33, or more of them. Preferably, there are two hinges 33 located at a selected side of the shape of the wall portion 31.

[0022] Figs. 4a-4b show examples of operation of the flap. In particular, Fig. 4a shows a flap with a hinge before and after opening, wherein the hinge is of non-reduced thickness. On the other hand, Fig. 4b shows a situation in which the flap opened and hinges on a portion of reduced thickness - this may be an intentional design resulting from a selected shape and localization of the safety device. Further, the sections of reduced thickness can in fact have varying thickness, for example selected sections have a first thickness and other sections have a second thickness, which is different from the first thickness, and which still differs from sections of non-reduced thickness. In other words, different level of thickness reduction can be present within the safety device. This may improve hinging action or provide rupturing in a precisely defined manner.

[0023] Fig. 5a-5j present different embodiments of the invention. In particular, the wall portion of locally reduced thickness forms a groove or plurality of grooves of selected cross-section shapes and placement. The grooves can run in a single row, or there can be multiple rows of the same or similar grooves located next to each other. Fig. 5a shows pairs of trapezoidal grooves located

on both sides of the wall. Fig. 5b shows pairs of rectangular grooves located on both sides of the wall. Fig. 5c shows pairs of triangular grooves located on both sides of the wall.

[0024] Fig. 5d and Fig. 5e show configuration in which there are grooves on both sides of the wall, wherein said grooves are displaced with respect to each other along the wall. Said grooves are have a depth greater than half of the wall thickness and are located next to each other. Fig. 5d shows rectangular grooves and Fig. 5e shows trapezoidal grooves.

[0025] Fig. 5f and Fig. 5g show yet another example of groove configuration, in which a single groove is located on each side of the wall, wherein said groove is relatively wide. Fig. 5f shows a circular groove and Fig. 5g shows an oblong groove.

[0026] Fig. 5h shows an example of a single groove with trapezoidal cross-section. Fig. 5i shows an example of a single groove with triangular cross-section. Fig. 5j shows an example of a single groove with oblong cross-section.

[0027] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of drawings, the disclosure, and the appended claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to the advantage.

Claims

1. A heat exchanger 1 adapted to exchange heat between a first fluid operating at high pressure and a second fluid, comprising a first conduit for guiding the flow of the first fluid and a second conduit for guiding the flow of the second fluid, wherein in a selected section the second conduit encompasses at least part of the first fluid in a fluid-tight manner, **characterized in that** the second conduit comprises, within the selected section, a safety device 30 adapted to enable flow of fluids between inner A and outer B sides of the second conduit at the selected section when a set pressure difference between them is exceeded.

2. A heat exchanger according to any preceding claim, wherein the safety device 30 comprises a fuse element of locally reduced mechanical resistance to pressure.

3. A heat exchanger according to any preceding claim, wherein the second conduit is formed by a housing 20.

4. A heat exchanger according to any preceding claim, wherein the fuse element is a wall portion 31 with an area outlined by sections 32 of a reduced thickness.

5. A heat exchanger according to claim 4, wherein the sections 32 of reduced thickness define a flap with at least one hinge 33 constituted by a section of non-reduced thickness.

6. A heat exchanger according to claim 4 or 5, wherein at least one section 32 of the reduced thickness forms a groove 34 on the inner side A of the second conduit.

7. A heat exchanger according to claim 4 or 5, wherein at least one section 32 of the reduced thickness forms a groove 34 on the outer B side of the second conduit.

8. A heat exchanger according to claim 4 or 5, wherein at least the sections of the reduced thickness form grooves 34 on the inner A and outer B sides of the second conduit.

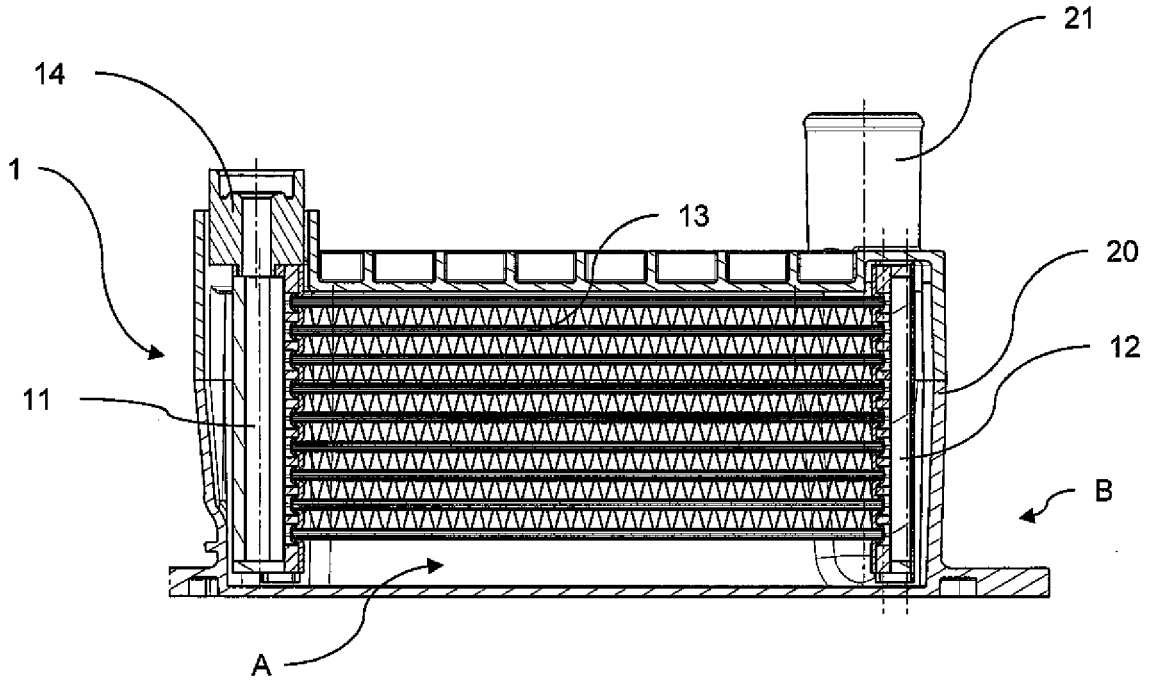

Fig. 1

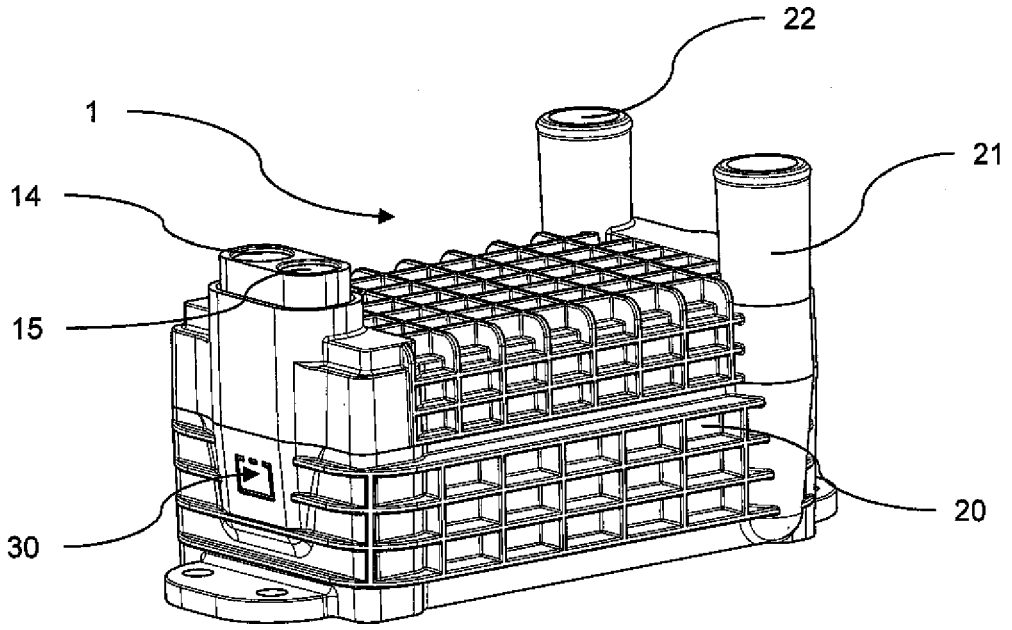

Fig. 2

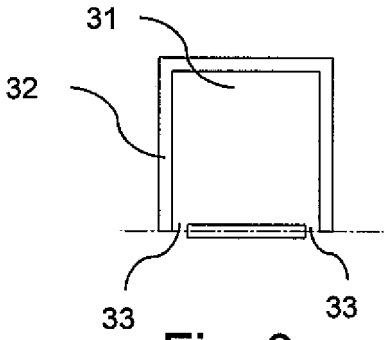

Fig. 3a

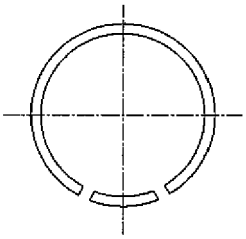

Fig. 3b

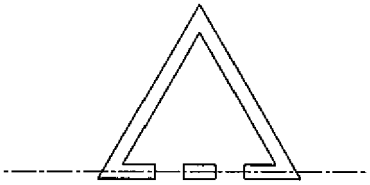

Fig. 3c

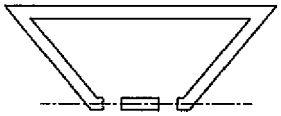

Fig. 3d

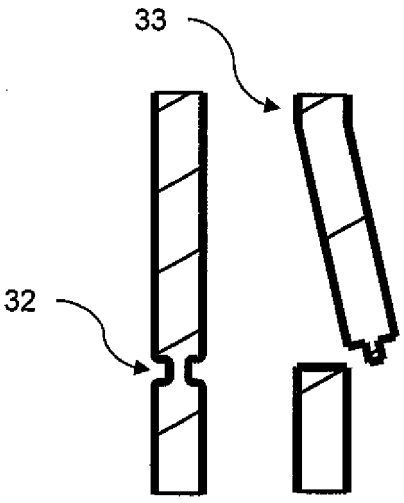

Fig. 4a

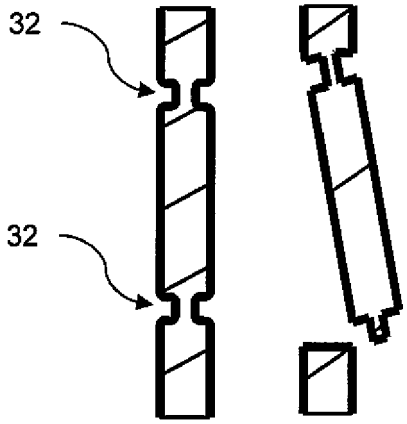

Fig. 4b

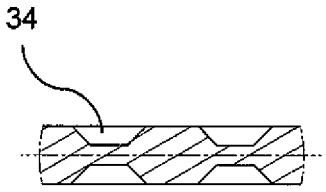

Fig. 5a

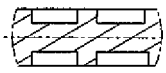

Fig. 5b

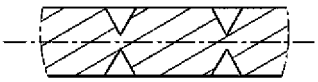

Fig. 5c

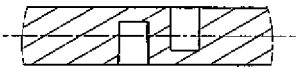

Fig. 5d

Fig. 5e

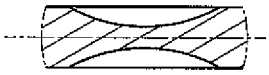

Fig. 5f

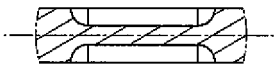

Fig. 5g

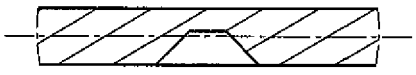

Fig. 5h

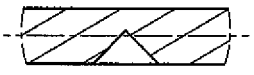

Fig. 5i

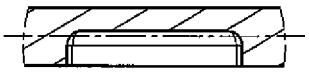

Fig. 5j

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EUROPEAN SEARCH REPORT

Application Number
EP 18 46 1524

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	* columns 2-3; figures 1-6 *	4-8	F28D7/16
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TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F
B65D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 August 2018	Merkt, Andreas

CATEGORY OF CITED DOCUMENTS

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