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(54) MODULAR HEAT PIPE HEAT EXCHANGER

MODULARER HEIZROHRWÄRMETAUSCHER

ECHANGEUR THERMIQUE MODULAIRE À CALODUCS

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to a heat pipe heat exchanger for transferring heat from a hot gas to a cold gas, in particular in heat recovery installations for preheating combustion air and/or combustion gas. A heat pipe heat exchanger according to the preamble of claim 1 is known from US 1 725 906.

BACKGROUND OF THE INVENTION

[0002] Heat recovery systems are used in various industries in order to recover heat from one medium and transfer it to another medium. The use of excess heat of one gas to preheat another gas reduces energy consumption and is therefore also more environment friendly.

[0003] One such heat recovery system is e.g. disclosed in US 4,434,004, which relates to a method and an apparatus for the recovery and recycling of heat from hot exhaust gases, specifically from exhaust gases in metallurgical processes and from warm gases. Warm or hot exhaust gases transfer their retained heat to the lower portions of vertically positioned heat pipes. Cold air or gas is then directed past the upper portion of the heat pipes, thereby transferring the heat of the heat pipes to the cold air or gas. The apparatus comprises a lower chamber through which the hot gas is fed and an upper chamber through which the cold gas is fed. Heat pipes are vertically arranged in the two chambers and extend from one chamber into the other. As the hot gas passes through the lower chamber, heat from this hot gas is absorbed by the lower portion of the heat pipes thereby cooling down the hot gas. In the heat pipes, the heat is transferred from its lower portion to its upper portion. The cold gas passing through the upper chamber is heated up by passing through the hotter upper portion of the heat pipes.

[0004] Heat pipe heat exchangers are often used for their very rapid heat transfer. They do however, like other types of heat exchangers, face the problem of fouling and contamination of dirt, dust and particles in the fluids. Such dirt may indeed be deposited on the heat transfer surface of the heat pipe and thereby reduce the heat transfer efficiency between the heat pipe and the fluid to be heated or cooled. Furthermore, as more and more dirt is deposited, the heat pipe heat exchanger becomes clogged and the pressure drop through the heat exchanger is then increased.

[0005] It is thus periodically necessary to perform a maintenance shutdown of the heat recovery system to clean up the contamination and open up the flow passages through the heat exchanger. In view of the large number of heat pipes arranged in such a heat exchanger, the cleaning of the heat pipes is generally a very time consuming process. Furthermore, the difficult access to the various areas in the heat exchanger does not facilitate the clean up process. Prolonged shutdown periods necessarily result in production losses and high operational costs.

OBJECT OF THE INVENTION

[0006] The object of the present invention is to provide a heat pipe heat exchanger, which avoids the above disadvantages.

SUMMARY OF THE INVENTION

[0007] This object is achieved by a heat pipe heat exchanger as claimed in claim 1.

[0008] A heat pipe heat exchanger for transferring heat from a hot gas to a cold gas comprises a housing with a first chamber for feeding a hot gas therethrough; a second chamber for feeding a cold gas therethrough; and a plurality of heat pipes extending between the first chamber and the second chamber for transferring heat from the hot gas to the cold gas. According to an important aspect of the invention, partition panels are arranged in the first and second chambers for dividing the chambers into heat pipe compartments, the partition panels being arranged in a plane essentially parallel to the flow of gas through the chambers, heat pipe cartridges being removably arranged in the heat pipe compartments in the housing. Each heat pipe cartridge comprises a frame with a support panel for supporting a plurality of heat pipes. The support panel is arranged such that, when the heat pipe cartridge is arranged in the housing, the support panel cooperates with a separation wall between the first chamber and the second chamber to form a gas-tight partition between the first and second chambers; Furthermore, the heat pipes traversing the support panel and being secured thereto in a gas-tight manner.

[0009] One or more partition panels divide the cross-section of gas flow into two or more smaller cross-sections. This division of the chambers, along their width, into smaller compartments enhances the acoustic characteristics of the heat exchanger by reducing the flow-induced vibrations that may lead to a structural collapse of the heat exchanger. In the heat exchangers of the present invention, vibration of the heat pipes is greatly reduced, thereby avoiding such a structural collapse.

[0010] According to the present invention, the heat pipes are bundled together in heat pipe cartridges for facilitating the heat exchanger maintenance. The heat exchanger is divided into a number of heat pipe compartments, each of which is designed and configured so as to receive one heat pipe cartridge therein.

[0011] Such a heat pipe cartridge is installed in the heat exchanger such that its support panel is level with the separation wall. The support panel is connected to the separation wall so as to form a separation between the first and second chambers.

[0012] During a maintenance shutdown, the heat pipes can be inspected. If one or more of the heat pipe cartridges require maintenance, e.g. because of a broken heat pipe or heavily contaminated heat transfer surfaces, the heat pipe cartridges concerned can be lifted out of the heat exchanger. A replacement heat pipe cartridge may then be installed into the heat exchanger and the heat transfer system can be put back into operation. The damaged heat pipe cartridge can be cleaned or mended outside of the heat exchanger, thus without prolonging the stoppage period of the heat recovery system. Indeed, the most time consuming part of the maintenance can now be performed outside the heat exchanger, while the latter is in operation. By providing a modular heat pipe heat exchanger with exchangeable heat pipe cartridges, the stoppage period of the heat recovery system can be greatly reduced.

[0013] The support panel of the heat pipe cartridge is preferably connected to the separation wall by means of a removable weld so as to form a gas-tight seal between the first and second chambers. A circumferential removable weld is performed after installation of the heat pipe cartridge on the heat exchanger. Before removal of the heat pipe cartridge from the heat exchanger, this circumferential weld can be broken. It should be noted that the connection between support panel and separation wall may be achieved by other suitable means, such as e.g. bolts. A seal element may be arranged between support panel and separation wall so as to form a gas-tight seal between the first and second chambers.

[0014] The heat exchanger preferably comprises a first opening in an outer wall of the second chamber and a second opening in the separation wall between the first and second chambers; the first and second openings being arranged and dimensioned so as to feed a heat pipe cartridge therethrough. The first and second openings allow for the heat pipe cartridge to be easily and quickly fed into or removed from the heat exchanger.

[0015] The heat pipes are advantageously secured to the support panel by means of a screw and counter-nut mechanism with metal gaskets provided on both sides of the support panel thereby providing a gas-tight connection that may nevertheless be loosened for the replacement of the heat pipes for maintenance and replacement purposes.

[0016] These and other preferred embodiments are recited in the appended dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1: is a perspective view of a heat recovery system with two heat pipe heat exchangers according to the present invention;

FIG. 2: is a perspective view of a heat recovery system of Fig.1 without its transition hoods;

FIG. 3: is a perspective view of a heat pipe cartridge for the heat recovery system of Fig.1; and

FIG. 4: is a perspective view of the frame of the heat pipe cartridge of Fig.3.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0018] Fig.1 shows a preferred embodiment of a heat pipe recovery system 10 with two heat pipe heat exchangers 12, 12' according to the present invention. One heat exchanger 12, 12' may be used for preheating combustion gas, while the other one 12, 12' may be used for preheating combustion air.

[0019] Each heat exchanger 12, 12' comprises a first chamber 14 with a first port 16 and a second port 18 and a second chamber 20 with a third port 22 and a fourth port 24. The second chamber 20 is, in the embodiment shown in the figures, vertically arranged above the first chamber 14. A plurality of heat pipes 26 - generally a few thousand - is vertically arranged in the first and second chambers 14, 20. These heat pipes 26 generally extend over the whole height of the second chamber 20, pass through a separation wall (not visible in Fig.1) from the second chamber 20 to the first chamber 14 and extend over the whole height of the first chamber 14. The air or gas flow through the heat exchanger may be from the first and third ports 16, 22 to the second and fourth ports 18, 24 respectively. Preferably, however, the heat exchanger is operated in a counter-flow mode, wherein air or gas flow through the heat exchanger from the first and fourth ports 16, 24 to the second and third ports 18, 22 respectively.

[0020] According to the present invention, the heat pipes 26 are bundled together in heat pipe cartridges for facilitating

the heat exchanger maintenance. The heat exchanger 12 shown in Fig.1 is divided, in the gas flow direction, into three heat pipe modules 28, 28', 28", each of which are again divided, perpendicular to the gas flow direction, into two heat pipe compartments 30, 30'. Each heat pipe compartment 30, 30' is designed and configured so as to receive one heat pipe cartridge therein.

[0021] The heat pipe modules 28, 28', 28" and heat pipe compartments 30, 30' are more apparent on Fig.2, which represents the heat recovery system 10 of Fig.1 wherein the transition hoods for connection with ducts of have been removed. Fig.2 also shows the separation wall 32 between the first and second chambers 14, 20.

[0022] It can also be seen that partition panels 34 are arranged between the heat pipe compartments 30, 30'. These partition panels 34 are in a direction parallel to the flow of gas through the heat exchanger 12, 12' and divide the cross-section of gas flow into two smaller cross-sections. This division of the chambers 14, 20, along their width, into smaller compartments enhances the acoustic characteristics of the heat exchanger by reducing the flow-induced vibration. In the heat exchangers 12, 12' of the present invention, vibration of the heat pipes is greatly reduced, thereby reducing noise pollution by the heat exchangers. The partition panels 34 are preferably removably arranged so that they may be removed during a maintenance shutdown for facilitating access to the heat pipes 26. More than one partition panel 34 may be provided so as to divide the cross-section of gas flow into more than two smaller cross-sections.

[0023] As stated above, the heat pipes 26 are, according to the present invention, bundled, together in heat pipe cartridges 36, one of which is shown in more detail on Fig.3. The heat pipe cartridge 36 is now more closely described by referring to Figs 3 and 4, the latter representing the heat pipe cartridge 36 of Fig.3 with all of the heat pipes removed.

[0024] The heat pipe cartridge 36 comprises a plurality of heat pipes 26 - a few hundred thereof - mounted in a frame 38. Such a frame 38 comprises a support panel 40 with an upper surface 42 facing, when installed, the second chamber 20 and a lower surface 44 facing, when installed, the first chamber 14. The support panel 40 comprises a number of apertures for passing the individual heat pipes 26 therethrough. Connection means, which are more closely described below, are provided for securing each heat pipe 26 to the support panel 40. The frame 38 further comprises a number of auxiliary panels 46 with apertures for passing the individual heat pipes 26 therethrough. The auxiliary panels 46 are arranged parallel to and at a predetermined distance from the support panel 40 and each other. The apertures of the auxiliary panels 46 have a diameter large enough to pass the heat pipes 26 with their associated fins therethough without creating a secure connection between the auxiliary panels 46 and the heat pipes 26. Indeed, the purpose of the auxiliary panels 46 is mainly to keep neighbouring heat pipes 26 at a predetermined distance from each other. The auxiliary panels 46 serve as distance guide and keep the heat pipes in line during operation.

[0025] The support panel 40 and the auxiliary panels 46 are, as shown in fig.4, connected together by means of four connection rods 48. The support panel 40, the auxiliary panels 46 and four connection rods 48 are securely connected together, e.g. by welding, to form the frame 38 of the heat pipe cartridge 36.

[0026] The heat pipes 26 are securely connected to the support panel 40 and, in order to avoid the transfer of gas from one chamber 14, 20 into the other, the connection of the heat pipes should be gas tight. A number of connection means are known, such as e.g. welding of the heat pipe directly to the support panel; pressing and tightening with seal rings; or screwing into the support panel. Preferably, however, a screw and counter-nut mechanism is used wherein tightness is achieved on both sides of the support panel by the screw head on the one side and the counter-nut on the other. Metal gaskets are preferably provided on both sides of the support panel 40 between the screw head and the upper surface 42 of the support panel 40 and between the counter-nut and the lower surface 44 of the support panel 40.

[0027] The screw and counter-nut mechanism has the advantage that individual heat pipes 26 can be removed from the support panel 40 and replaced. Damaged heat pipes can thus be replaced easily. Furthermore, a gas-tight seal is formed between the upper and lower surfaces 42, 44 of the support panel 40 so that gas from the first chamber 14 does not mix with gas from the second chamber 20. This is of particular importance if one of the gasses is a combustion gas.

[0028] In order to install and remove the heat pipe cartridges 36, the heat exchanger is provided with a first opening 50 in an outer wall 52 of the second chamber 20. A second opening 54 is arranged in the separation wall 32 between the first and second chambers 14, 20.

[0029] During installation, a heat pipe cartridge 36 is vertically lowered into the heat exchanger 12, 12' through the first opening 50 and the second opening 54. The support panel 40 is lowered to the level of the separation wall 32 to close the second opening 54. Preferably, the support panel 40 rests with its edge on the separation wall 32 before it is welded thereto on the whole of its circumference, thereby creating a gas-tight connection between the support panel 40 and the separation wall 32. Once installed in the heat exchanger 12, 12', the lower portion of the heat pipes 26 is arranged in the first chamber 14 and acts as evaporator when hot gas is fed through the first chamber 14, while the upper portion of the heat pipes 26 is arranged in the second chamber 20 and acts as condenser when cold gas is fed through the second chamber 20.

[0030] During a routine maintenance shutdown, the heat pipes 26 can be inspected via manholes and inspection windows 56 arranged in the sidewalls of the heat exchanger 12, 12'. If one or more of the heat pipe cartridges 36 requir maintenance, e.g. because of a broken heat pipe or heavily contaminated heat transfer surfaces, the heat pipe cartridges 36 concerned can be removed by breaking the weld between the support panel 40 and the separation wall 32 and by

lifting the damaged heat pipe cartridge 36 out of the heat exchanger 12, 12'. A replacement heat pipe cartridge 36 is then installed into the heat exchanger and the heat transfer system can be put back into operation. The damaged heat pipe cartridge 36 can be cleaned or mended outside of the heat exchanger, thus without prolonging the stoppage period of the heat recovery system. Indeed, the most time consuming part of the maintenance can now be performed outside the heat exchanger, while the latter is in operation. By providing a modular heat pipe heat exchanger with exchangeable heat pipe cartridges, the stoppage period of the heat recovery system can be greatly reduced.

[0031] It should be noted that the present description relates to a heat exchanger associated to a hot stove installation. Such a heat exchanger generally has the two chambers 14, 20 arranged vertically one above the other. It is however also in the scope of the invention to place the two chambers 14, 20 almost horizontally one next to the other. The heat pipes should however present a slight inclination (e.g. at least 5°) with respect to the horizontal. Such arrangements may be used for other applications such as e.g. power plants.

LIST OF REFERENCE SIGNS

[0032]

10	heat recovery system	34	partition panel
12	heat pipe heat exchanger	36	heat pipe cartridge
14	first chamber	38	frame
16	first port	40	support panel
18	second port	42	upper surface
20	second chamber	44	lower surface
22	third port	46	auxiliary panel
24	fourth port	48	connection rod
26	heat pipe	50	first opening
28	heat pipe module	52	outer wall
30	heat pipe compartment	54	second opening
32	separation wall	56	inspection window

Claims

1. Heat pipe heat exchanger for transferring heat from a hot gas to a cold gas, said heat pipe heat exchanger (12, 12') comprising a housing with a first chamber (14) for feeding a hot gas therethrough;
a second chamber (20) for feeding a cold gas therethrough;
a plurality of heat pipes (26) extending between the first chamber (14) and the second chamber (20) for transferring heat from said hot gas to said cold gas; and heat pipe cartridges, wherein each heat pipe cartridge (36) comprises a frame (38) with a support panel (40) for supporting a plurality of heat pipes (26); said support panel (40) being arranged such that, when said heat pipe cartridge (36) is arranged in said heat pipe compartments (30, 30'), said support panel (40) cooperates with a separation wall (32) between said first chamber (14) and said second chamber (20) to form a gas-tight partition between said first and second chambers (14, 20); said heat pipes (26) traversing said support panel (40) and being secured thereto in a gas-tight manner
characterized by
partition panels (34) arranged in said first and second chambers (14, 20) for dividing said chambers (14, 20) into heat pipe compartments (30, 30') said partition panels (34) being arranged in a plane essentially parallel to the flow of gas through said chambers (14, 20), the direction of flow of said gas through one heat pipe compartment (30, 30') being parallel to the direction of flow of said gas through a neighbouring heat pipe compartment (30, 30') and by the heat pipe cartridges (36) removably arranged in said heat pipe compartments (30, 30') in said housing.

2. The heat pipe heat exchanger according to claim 1, wherein said support panel (40) of said heat pipe cartridge 36 is connected to said separation wall (32) by means of a removable weld so as to form a gas-tight seal between said first and second chambers (14, 20).

3. The heat pipe heat exchanger according to claim 1, wherein said support panel (40) of said heat pipe cartridge 36 is connected to said separation wall (32) by means of bolts, a seal element being arranged between said support panel (40) and said separation wall (32) so as to form a gas-tight seal between said first and second chambers (14, 20).

4. The heat pipe heat exchanger according to any of claims 1 to 3, wherein said frame (38) further comprises one or more auxiliary panels (46), each auxiliary panel (46) comprising a plurality of apertures for receiving heat pipes (26) therethrough, said apertures being arranged so as to provide guides for said heat pipes (26) and keep said heat pipes (26) essentially parallel to each other.

5. The heat pipe heat exchanger according to claim 4, wherein said heat pipes (26) are provided with fins and said apertures of said auxiliary panels (46) have a diameter large enough to pass said fins therethrough.

6. The heat pipe heat exchanger according to any of claims 4 to 5, wherein said frame comprises one or more connection rods (48) for connecting said support panel (40) and said auxiliary panels (46) thereto.

7. The heat pipe heat exchanger according to any of claims 1 to 6, wherein said heat exchanger (12, 12') comprises a first opening (50) in an outer wall (52) of said second chamber (20) and a second opening (54) in said separation wall between said first and second chambers (14, 20); said first and second openings being arranged and dimensioned so as to feed a heat pipe cartridge therethrough.

8. The heat pipe heat exchanger according to any of claims 1 to 7, wherein said support panel (40) is welded to said separation wall (32) when said heat pipe cartridges (36) is installed in said heat exchanger (12, 12').

9. The heat pipe heat exchanger according to any of claims 1 to 8, wherein manholes and inspection windows (56) are arranged in the sidewalls of said heat exchanger (12, 12').

10. The heat pipe heat exchanger according to any of claims 1 to 9, wherein the heat pipes (26) are secured to said support panel (40) by means of a screw and counter-nut mechanism.

11. The heat pipe heat exchanger according to claim 10, wherein a metal gasket is provided between a screw head of the screw and an upper surface (42) of said support panel (40); and/or between a counter-nut and a lower surface (44) of said support panel (40).

Patentansprüche

1. Wärmerohr-Wärmetauscher zur Übertragung von Wärme von einem heißen Gas zu einem kalten Gas, wobei der Wärmerohr-Wärmetauscher (12, 12') ein Gehäuse umfasst mit
einer ersten Kammer (14), um ein heißes Gas dadurch zu leiten;
einer zweiten Kammer (20), um ein kaltes Gas dadurch zu leiten; mehreren Wärmerohren (26), die sich zwischen der ersten Kammer (14) und der zweiten Kammer (20) erstrecken, um Wärme von dem heißen Gas zu dem kalten Gas zu übertragen; und
Wärmerohrpatronen, wobei jede Wärmerohrpatrone (36) einen Rahmen (38) mit einer Tragplatte (40) zum Tragen mehrerer Wärmerohre (26) umfasst; wobei die Tragplatte (40) derart angeordnet ist, dass, wenn die Wärmerohrpatrone (36) in Wärmerohrräumen (30, 30') angeordnet ist, die Tragplatte (40) mit einer Trennwand (32) zwischen der ersten Kammer (14) und der zweiten Kammer (20) zusammenwirkt, um eine gasdichte Trennung zwischen der ersten und zweiten Kammer (14, 20) zu bilden; wobei die Wärmerohre (26) die Tragplatte (40) durchqueren und gasdicht daran angebracht sind,
gekennzeichnet durch
Trennplatten (34), die in der ersten und zweiten Kammer (14, 20) angeordnet sind, um die Kammern (14, 20) in Wärmerohrräume (30, 30') zu unterteilen, wobei die Trennplatten (34) in einer Ebene angeordnet sind, die im Wesentlichen parallel zu dem Gasstrom **durch** die Kammern (14, 20) ist, wobei die Stromrichtung des Gases **durch** einen Wärmerohrraum (30, 30') parallel zu der Stromrichtung des Gases **durch** einen benachbarten Wärmerohrraum (30, 30') ist, und **durch** die Wärmerohrpatronen (36), die abnehmbar in den Wärmerohrräumen (30, 30') in dem Gehäuse angeordnet sind.

2. Wärmerohr-Wärmetauscher nach Anspruch 1, wobei die Tragplatte (40) der Wärmerohrpatrone (36) derart mittels einer entfernbaren Schweißstelle mit der Trennwand (32) verbunden ist, dass eine gasdichte Abdichtung zwischen der ersten und zweiten Kammer (14, 20) gebildet ist.

3. Wärmerohr-Wärmetauscher nach Anspruch 1, wobei die Tragplatte (40) der Wärmerohrpatrone (36) mittels Bolzen mit der Trennwand (32) verbunden ist, wobei ein Dichtelement derart zwischen der Tragplatte (40) und der Trennwand

(32) angeordnet ist, dass eine gasdichte Abdichtung zwischen der ersten und zweiten Kammer (14, 20) gebildet ist.

4. Wärmerohr-Wärmetauscher nach irgendeinem der Ansprüche 1 bis 3, wobei der Rahmen (38) ferner eine oder mehrere Zusatzplatten (46) umfasst, wobei jede Zusatzplatte (46) mehrere Öffnungen zur Aufnahme von Wärmerohren (26) dadurch umfasst, wobei die Öffnungen derart angeordnet sind, dass sie Führungen für die Wärmerohre (26) bereitstellen und die Wärmerohre (26) im Wesentlichen parallel zueinander halten.

5. Wärmerohr-Wärmetauscher nach Anspruch 4, wobei die Wärmerohre (26) mit Rippen versehen sind und die Öffnungen der Zusatzplatten (46) einen Durchmesser aufweisen, der groß genug ist, um die Rippen dadurch zu führen.

6. Wärmerohr-Wärmetauscher nach irgendeinem der Ansprüche 4 bis 5, wobei der Rahmen eine oder mehrere Verbindungsstangen (48) umfasst, um die Tragplatte (40) und die Zusatzplatten (46) damit zu verbinden.

7. Wärmerohr-Wärmetauscher nach irgendeinem der Ansprüche 1 bis 6, wobei der Wärmetauscher (12, 12') eine erste Öffnung (50) in einer Außenwand (52) der zweiten Kammer (20) und eine zweite Öffnung (54) in der Trennwand zwischen der ersten und zweiten Kammer (14, 20) umfasst; wobei die erste und die zweite Öffnung derart angeordnet und bemessen sind, dass sie eine Wärmerohrpatrone dadurch führen.

8. Wärmerohr-Wärmetauscher nach irgendeinem der Ansprüche 1 bis 7, wobei die Tragplatte (40) an die Trennwand (32) angeschweißt ist, wenn die Wärmerohrpatronen (36) in dem Wärmetauscher (12, 12') eingebaut sind.

9. Wärmerohr-Wärmetauscher nach irgendeinem der Ansprüche 1 bis 8, wobei Mannlöcher und Sichtfenster (56) in den Seitenwänden des Wärmetauschers (12, 12') angeordnet sind.

10. Wärmerohr-Wärmetauscher nach irgendeinem der Ansprüche 1 bis 9, wobei die Wärmerohre (26) mittels eines Schraube- und Gegenmuttermechanismus an der Tragplatte (40) angebracht sind.

11. Wärmerohr-Wärmetauscher nach Anspruch 10, wobei eine Metalldichtung vorgesehen ist zwischen einem Schraubenkopf der Schraube und einer oberen Oberfläche (42) der Tragplatte (40); und/oder zwischen einer Gegenmutter und einer unteren Oberfläche (44) der Tragplatte (40).

Revendications

1. Échangeur de chaleur à caloducs pour transférer une chaleur d'un gaz chaud à un gaz froid, ledit échangeur de chaleur à caloducs (12, 12') comprenant un logement avec
une première chambre (14) pour alimenter un gaz chaud à travers celle-ci ;
une deuxième chambre (20) pour alimenter un gaz froid à travers celle-ci ;
une pluralité de caloducs (26) s'étendant entre la première chambre (14) et la deuxième chambre (20) pour transférer une chaleur dudit gaz chaud audit gaz froid ;
et des cartouches de caloducs, dans lequel chaque cartouche (36) de caloducs comprend un cadre (38) avec un panneau support (40) pour supporter une pluralité de caloducs (26) ; ledit panneau support (40) étant agencé de telle manière que, lorsque ladite cartouche (36) de caloducs est agencée dans des compartiments (30, 30') de caloducs, ledit panneau support (40) coopère avec une paroi de séparation (32) entre ladite première chambre (14) et ladite deuxième chambre (20) pour former une cloison étanche aux gaz entre lesdites première et deuxième chambres (14, 20) ; lesdits caloducs (26) traversant ledit panneau support (40) et étant fixés sur celui-ci d'une manière étanche aux gaz,
caractérisé par
des panneaux de cloisonnement (34) agencés dans lesdites première et deuxième chambres (14, 20) pour diviser lesdites chambres (14, 20) en compartiments (30, 30') de caloducs, lesdits panneaux de cloisonnement (34) étant agencés dans un plan essentiellement parallèle à l'écoulement de gaz à travers lesdites chambres (14, 20), le sens d'écoulement dudit gaz à travers un compartiment (30, 30') de caloducs étant parallèle au sens d'écoulement dudit gaz à travers un compartiment (30, 30') de caloducs voisin et par
les cartouches (36) de caloducs agencées de façon amovible dans lesdits compartiments (30, 30') de caloducs dans ledit logement.

2. Échangeur de chaleur à caloducs selon la revendication 1, dans lequel ledit panneau support (40) de ladite cartouche (36) de caloducs est connecté à ladite paroi de séparation (32) au moyen d'une soudure amovible de façon à former

un joint étanche aux gaz entre lesdites première et deuxième chambres (14, 20).

3. Échangeur de chaleur à caloducs selon la revendication 1, dans lequel ledit panneau support (40) de ladite cartouche (36) de caloducs est connecté à ladite paroi de séparation (32) au moyen de boulons, un élément d'étanchéité étant agencé entre ledit panneau support (40) et ladite paroi de séparation (32) de façon à former un joint étanche aux gaz entre lesdites première et deuxième chambres (14, 20).

4. Échangeur de chaleur à caloducs selon l'une quelconque des revendications 1 à 3, dans lequel ledit cadre (38) comprend en outre un ou plusieurs panneau(x) auxiliaire(s) (46), chaque panneau auxiliaire (46) comprenant une pluralité d'ouvertures pour recevoir des caloducs (26) à travers celles-ci, lesdites ouvertures étant agencées de façon à prévoir des guides pour lesdits caloducs (26) et à maintenir lesdits caloducs (26) essentiellement parallèles les uns aux autres.

5. Échangeur de chaleur à caloducs selon la revendication 4, dans lequel lesdits caloducs (26) sont prévus avec des ailettes et lesdites ouvertures desdits panneaux auxiliaires (46) ont un diamètre suffisamment grand pour laisser passer lesdites ailettes à travers celles-ci.

6. Échangeur de chaleur à caloducs selon l'une quelconque des revendications 4 ou 5, dans lequel ledit cadre comprend une ou plusieurs tige(s) de connexion (48) pour connecter ledit panneau support (40) et lesdits panneaux auxiliaires (46) à celles-ci.

7. Échangeur de chaleur à caloducs selon l'une quelconque des revendications 1 à 6, dans lequel ledit échangeur de chaleur (12, 12') comprend une première ouverture (50) dans une paroi extérieure (52) de ladite deuxième chambre (20) et une deuxième ouverture (54) dans ladite paroi de séparation entre lesdites première et deuxième chambres (14, 20) ; lesdites première et deuxième ouvertures étant agencées et dimensionnées de façon à alimenter une cartouche de caloducs à travers celles-ci.

8. Échangeur de chaleur à caloducs selon l'une quelconque des revendications 1 à 7, dans lequel ledit panneau support (40) est soudé sur ladite paroi de séparation (32) lorsque ladite cartouche (36) de caloducs est installée dans ledit échangeur de chaleur (12, 12').

9. Échangeur de chaleur à caloducs selon l'une quelconque des revendications 1 à 8, dans lequel des trous d'homme et des fenêtres d'inspection (56) sont agencés dans les parois latérales dudit échangeur de chaleur (12, 12').

10. Échangeur de chaleur à caloducs selon l'une quelconque des revendications 1 à 9, dans lequel les caloducs (26) sont fixés sur ledit panneau support (40) au moyen d'un mécanisme à vis et contre-écrou.

11. Échangeur de chaleur à caloducs selon la revendication 10, dans lequel une rondelle de métal est prévue entre une tête de vis de la vis et une surface supérieure (42) dudit panneau support (40) ; et/ou entre un contre-écrou et une surface inférieure (44) dudit panneau support (40).

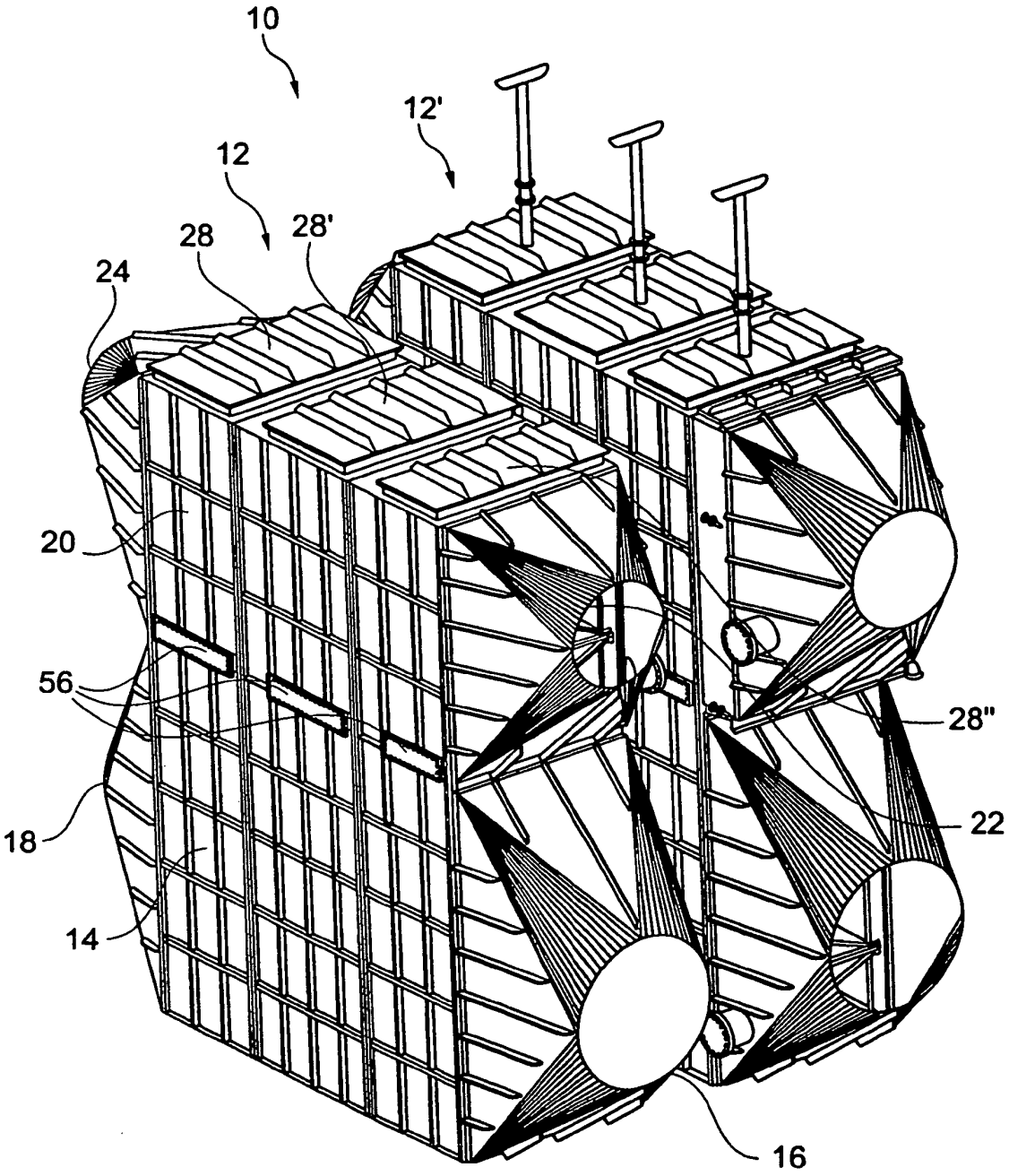

Fig. 1

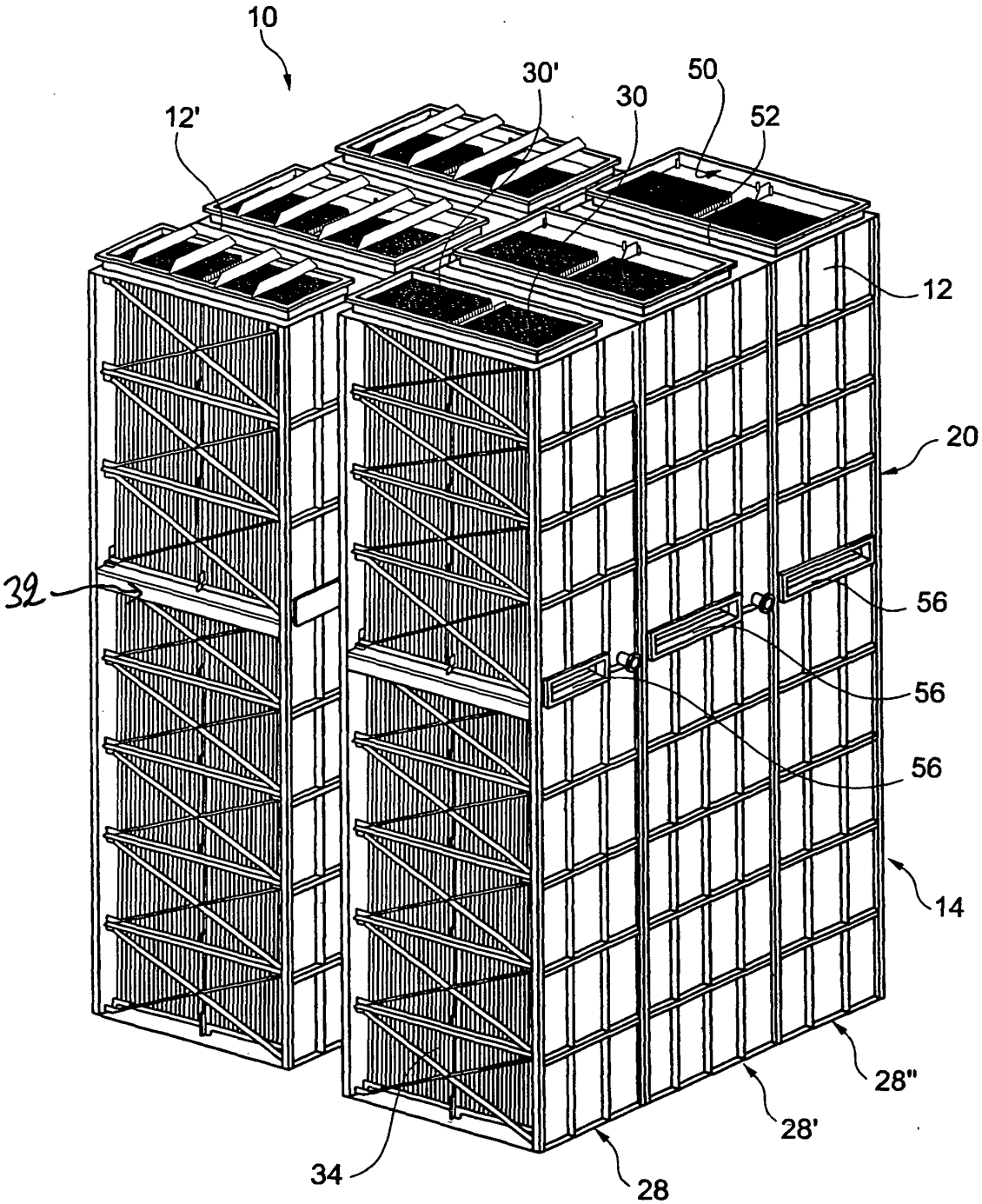

Fig. 2

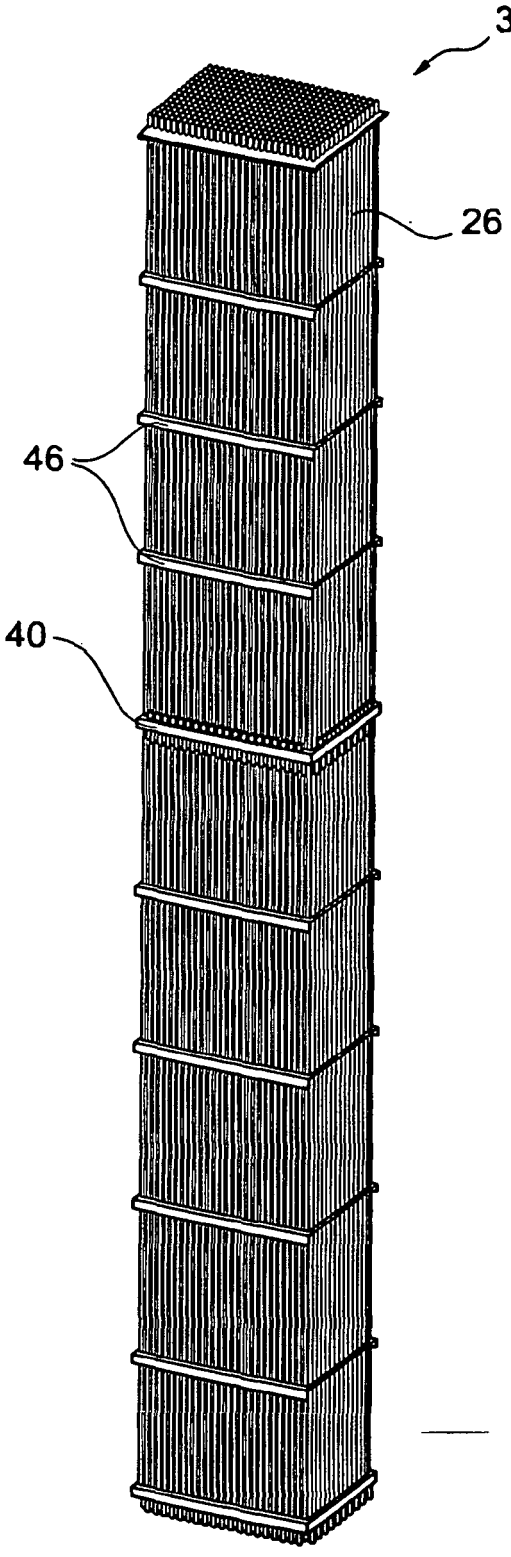

Fig. 3

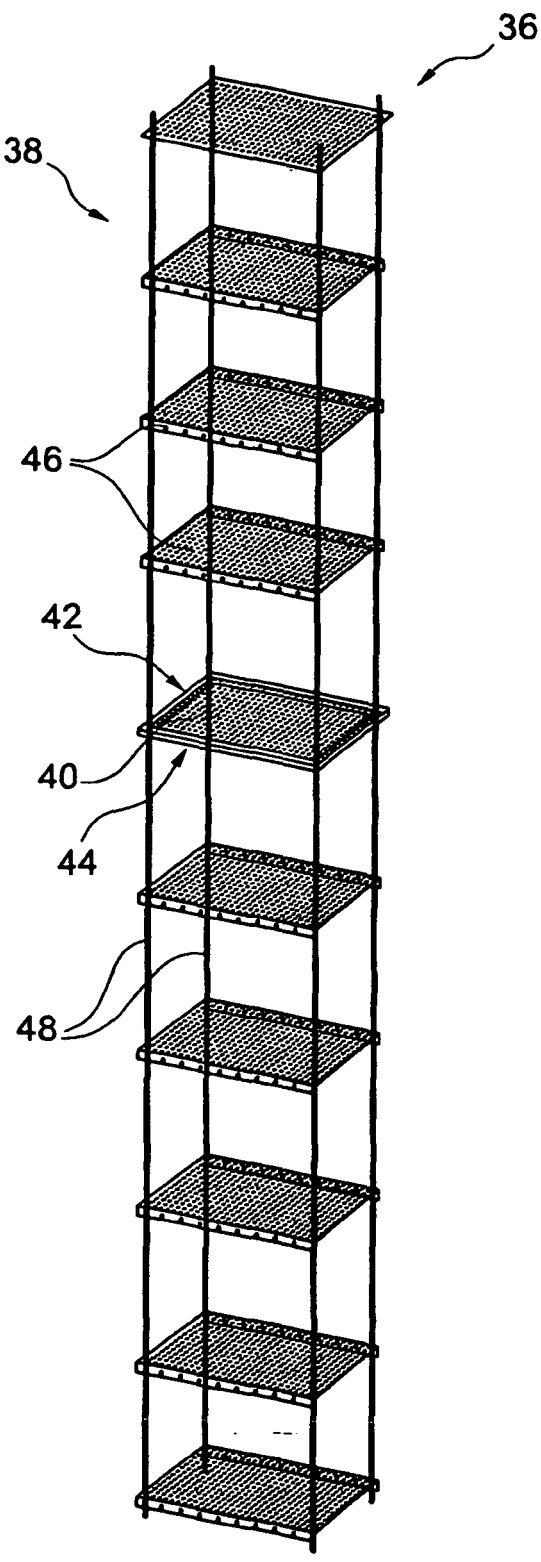

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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