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(54) PANEL FOR REGENERATIVE HEAT-EXCHANGERS

PANEEL FÜR REGENERATIVEN WÄRMETAUSCHER

PANNEAU POUR ECHANGEURS DE CHALEUR A RECUPERATION

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Description

The present invention relates to a heat exchange panel or element adapted for use in a regenerative or recuperative type heat exchanger and such as may be used in packages of many such panels or elements within a regenerative or recuperative gas to gas, vapour bearing gas to gas or gas or vapour bearing gas to air heat exchanger of the well known Ljungstrom or similar type.

Within Ljungstrom and such heat exchangers a body of sheet elements or panels is alternately exposed to passage through the interstitial spaces between the individual elements of a hotter flow of gas or gas and vapour and a cooler flow of gas,gas and vapour or air. It is the purpose of the elements or panels to accept and store heat energy as rapidly as possible from the hotter flow and when after a time interval a cooler flow is directed through the same interstitial spaces to give out the stored heat energy to the cooler flow thus raising the temperature of that flow. The elements or panels may be rotated or translated in such a way that they proceed alternately through the hotter and cooler flows. Alternatively the elements or panels may be stationary and the hotter and cooler flows respectively directed by means of dampers to pass alternately through the elements or panels.

This invention has application for such regenerative and recuperative gas to gas or gas to air heat exchangers particularly, but not exclusively, where one or both of the gas flows, or the gas flow, contains vapours at or near their condensing temperatures or dew point and which vapours are corrosive to certain metals and other materials and which may be in a particular instance oxides of sulphur and of nitrogen as produced during the combustion of fossil and other fuels.

GB-A-2099973 discloses a thermal regenerator for exchanging heat between two fluid streams. A fluid permeable mass of heat transfer material is formed by a multiplicity of parallel, non-planar, layers of thermally absorbing fluid porous or permeable material. Each layer comprises components of different thermal conductivity. A first component of each layer of higher thermal conductivity and corrosion resistant comprises expanded sheet, perforated sheet or an open mesh of woven, knitted or felted fibres, strands or wires. A second component of lower thermal conductivity envelopes the first component so that the latter component is encapsulated within the second component of the layer. The two components are intimately interlocked together against separation and the composite layer so formed is a rigid, permeable, integral mass resistant to fatigue failure or other damage from pulsating fluid flow and able to operate at higher temperatures than could the material of the second, encapsulating component alone. The encapsulating component is a moisture absorbent plastics material, e.g. nylon, which may in turn be coated on all sides of the first layer (including the openings when the layer comprises expanded sheet metal) with a further moisture absorbent material such as lithium chloride. A labyrinth of flow passages is provided by the layers through the fluid permeable mass for fluid flow through the mass. The hygroscopic absorbent properties of the second components of the layers are relied upon to improve the total heat transfer capacity of the layers. In the preferred arrangement the layers are positioned generally in planes transverse to the direction of the fluid flow through the regenerator.

According to a first aspect the present invention consists in a heat exchange panel or element adapted for use in a regenerative or recuperative heat exchanger comprising a heat storage and transfer member which includes a composite wall member made from portions of different thermal conductivity, one said portion of higher thermal conductivity and forming a reinforcing grid within the wall member comprising a metal mesh of strips or strands and a second portion of lower thermal conductivity constituting an encapsulating layer enveloping and extending through the mesh so that the mesh is contained within the encapsulating layer, the portions are intimately interlocked together against separation, the composite wall member is enabled to operate at higher temperatures than could the material of the encapsulating layer alone and at least some of the mesh continues longitudinally and directly throughout the major part of the length and breadth of the wall member, characterised in that the composite wall member is imperforate, the encapsulating layer filling the mesh so that the composite wall member is a completely solid imperforate mass resistant to passage of fluid therethrough, at least outside the mesh on both sides of the wall member the encapsulating layer is of a material which is inert and resistant to corrosive effects of condensing vapours or acid gaseous oxides or vapours which may condense on the layer, and the thickness of the encapsulating layer outside the mesh is substantially less than the transverse extent of the mesh across the total thickness of the wall member and said transverse extent of the mesh is substantially to outer surfaces of the wall member whereby the mesh conducts heat from the outer surfaces to promote the heat absorption of the wall member.

Thus the composite wall member of the heat exchange panel or element in accordance with the invention differs from the layers in the fluid permeable mass of the thermal regenerator disclosed in GB-A-2099973 in that it is not fluid permeable, and the heat absorption of the wall member is promoted by the thinness of the encapsulating layer outside the mesh and not by being of a moisture absorbent material as taught in GB-A-2099973. The characterising features of the composite wall member enable the heat exchange panel or element to be used for regenerative hating in an industrial environment in which sever corrosion and fouling can give rise to serious operating problems and inefficiencies, and in which the operating temperature is close to

the upper working temperature of the material of the encapsulating layer.

At least immediately next to the mesh the encapsulating layer may be composed of a material, such as a plastics, which may or may not be filled with particulated mineral or other substance to provide as high a heat capacity as possible for any given volume or mass of the filled material.

Preferably the thickness of the material of the encapsulating layer outside the mesh is of the order of 0.1-0.3mm.

The average density of such a metal mesh and plastics composite wall member is considerably less than that of the equivalent metal or glass enamelled metal elements presently in use in the aforementioned Ljungstrom and such heat exchangers whereas the specific heat capacity of the wall member is for any given volume as good as for metal or glass enamelled metal elements.

At least to provide the corrosion resistance outside the mesh the material of the encapsulating layer may be chosen from preferred plastics such as to reduce the adherence and building up of dust or scales on the surfaces of the composite wall member. As taught in UK Patent Number 1 372 680, the surfaces of the wall member could be made to be non-fouling in respect of organic and other agents or growths.

The encapsulating layer may be made of another suitable material of lower thermal conductivity than the metal mesh, if desired, for example glass.

The metal mesh which forms the heat conducting material within the proposed panel or element, in operating as a reinforcing grid within the composite wall member, imparts structural stability to the panel or element. That stability would not be present if a panel or element of purely plastics material were to be used, and it enables greater rigidity and stability to be imparted to any preferred ridging, folding or other profile forming of the panel or element for it to present undulating surfaces for enhanced heat transfer at those surfaces.

The mesh may comprise interwoven or overlaid discrete metal strips or strands of wire or filament, for example of steel, aluminium, copper or brass, or it may comprise a sheet of metal, for example of one of the metals just mentioned, which has been pierced and expanded such that the sheet whilst retaining its unity effectively presents a network of strip or strand portions. In the latter form a preferred material is that known as EXPAMET which is metal sheet which has been pierced, expanded and subsequently flattened. The percentage open area of such a sheet between the strip or strand portions may vary, typically between 5 and 25% of the total area of the mesh.

The thickness of the metal of the mesh may vary with the size of the panel or element but typically will be 0.3-1.0mm thick, resulting in a typical total, or laminate, thickness, of the wall member between 0.5 and 1.5mm.

According to a second aspect of the present invention a regenerative or recuperative type heat exchanger is provided which includes a heat exchange panel or element in accordance with the first aspect of the invention herein set forth, the panel or element being positioned in a plane parallel to the direction of fluid flow through the heat exchanger when in use.

Further, according to a third aspect of the present invention there is provided a regenerative or recuperative heat exchanger of the Ljungstrom or similar type containing a body of heat exchange panels or elements each in accordance with the heat exchange panel or element as set forth in the first aspect of the invention herein, the panels or elements being positioned in planes parallel to the direction of fluid flow through the heat exchanger.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings wherein:

Figure 1 shows schematically a side elevation of a regenerative heat exchanger with heat exchange elements according to the present invention, part sectioned through section A-A of Figure 2;

Figure 2 shows a plan view through section B-B of Figure 1;

Figure 3 shows a perspective view of part of a heat exchange element;

Figure 4 shows a side view of an alternative form of heat exchange element, and

Figure 5 shows a perspective view of part of yet another form of heat exchange element in accordance with the invention.

Referring to the drawings, a regenerative heat exchanger 1 comprises a drum 2 carried by a rotating shaft 3 and including peripheral pockets 4 housing removable heat exchange panels or elements 5. The heat exchange panels or elements 5 are arranged in packs in the pockets 4 with the panels or elements of each pack in contiguous relationship but with passages defined between them for the flow of gas, gas and vapour or air for heat exchange with the panels or elements. The panels or elements are corrugated, ridged or otherwise suitably profiled for the passages to be defined and for there to be turbulent flow of the gas, gas and vapour or air between the panels or elements. The heat exchanger 1 has a heat input side 1A and a heat output side 1B, and suitable ductings 6, 7 are provided for gas, gas and vapour or air flows (shown arrowed) through the drum 2 at these sides for heat exchange with the panels or elements 5. The panels or elements 5 are positioned in the pockets 4 in planes parallel to the direction of flow of the gas, gas and vapour or air through the drum. The drum 1 is rotated very slowly, e.g. less than 1 r.p.m., by the

shaft 3.

Each heat exchange panel or element 5 includes, as shown in Figures 3 and 4, an imperforate composite wall member 9 made from portions of different thermal conductivity, one portion of higher thermal conductivity comprising a metal mesh 10 of interwoven wire strands while a further wall portion 11 of lower thermal conductivity constitutes an encapsulating layer which completely covers, extends through and fills the mesh. The two portions of the wall are thus soundly mechanically bonded together and so intimately interlocked that delamination of the portions is prevented. Outside the mesh the covering of the encapsulating layer over the strands of the mesh is reduced to a very thin skin, preferably 0.1-0.3mm thick, which is substantially thinner than the thickness of the mesh and its strands, the skins outside the mesh being fused together by the material of the encapsulating layer through the openings between the strands of the mesh. The mesh 10, therefore, has a transverse extent across the depth of the wall member 9 substantially to the opposite outer surfaces or the wall member so that the mesh is able to conduct heat from the outer surfaces of the wall member into the body of the wall member to promote the heat absorption capacity of the wall member. The wall member 9 is incorporated, applied and fashioned into the panel or element to be suitable for application to the heat exchanger 1. Particularly for this purpose some of the mesh 10 continues longitudinally and directly throughout the major part of the length and breadth of the panel or element 5 such that differential temperature between any two diverse locations in the element 5 is minimised by the lateral transfer of heat energy through strands of the mesh. The panel or element 5 includes a peripheral bead 5A around the wall member 9. The bead 5A may be omitted, if desired.

The mesh may be made of strands of copper, aluminium, nickel, bronze or other strand material of high thermal conductivity.

The encapsulating layer 11 immediately enveloping the mesh strands is composed of a plastics material 12 filled with particulated mineral or other substance to provide as high a heat capacity as possible for any given volume or mass of the filled plastics material. The plastics material 12 may be un-filled. The encapsulating layer also includes thin outer layers 13 on both sides of the wall member 9 composed of a plastics or other material which inseparably bonds with the plastics material 12, is inert and unaffected by corrosive effects of any condensing vapours or acid gaseous oxides or vapours which may condense upon it. The outer layers 13 may be omitted so that the encapsulating layer is composed entirely of the plastics material 12, filled or un-filled, which not only extends through the mesh but provides the thin skins over the strands of the mesh outside the mesh.

The material of the encapsulating layer 11 may be a thermoplastic or thermosetting plastics having suitable flexibility to permit thermal stressing during use of the panel. It must be able to withstand the highest operational temperatures of the panel. With the mesh contained within it the plastics material is able to operate satisfactorily at temperatures in excess of those at which the material might be expected to function on its own. A urethane or other elastomer is, for example, suitable. Depending upon the type of plastics material used for the encapsulating layer, the material may be applied molten to the mesh, sprayed in the form of a powder on to the mesh or the mesh may be dipped into a bed of the powder fluidised by compressed air to be covered by that material.

Glass may be used to form the encapsulating layer 11 instead of plastics material.

Instead of the mesh 10 being of interwoven wire strands it may comprise an arrangement of cross-laid strands 10' as shown in Figure 4. The mesh may be made of interwoven or cross-laid sheet metal strips.

Another form of the composite wall member 9 is shown in Figure 5 of the accompanying drawings. In this case there is the encapsulating layer 11 as before but the mesh 10 is formed from pierced and expanded metal sheet which though a unitary piece of material presents a network of strip or strand portions 10" across the length and breadth of the wall member. Preferably this mesh is formed from pierced, expanded and flattened metal sheet, for example steel or aluminium EXPAMET. Again the mesh is completely covered and filled as in the previously described form of the composite wall member, by the encapsulating layer 11 which also extends through the openings of the mesh to fuse together through the mesh the portions of the encapsulating layer at opposite sides of the mesh sheet and interlock the mesh and encapsulating layer inseparably together. The encapsulating layer 11 may include thin outer layers, as in the other embodiments described and illustrated.

Claims

1. A heat exchange panel or element (5)adapted for use in a regenerative or recuperative type heat exchanger (1) comprising a heat storage and transfer member which includes a composite wall member (9) made from portions of different thermal conductivity, one said portion of higher thermal conductivity and forming a reinforcing grid within the wall member comprising a metal mesh (10) of strips or strands and a second said portion of lower thermal conductivity constituting an encapsulating layer (11) enveloping and extending through the mesh so that the mesh is contained within the encapsulating layer, the portions are intimately interlocked together against separation, the composite wall member is enabled to operate at higher temperatures than could the material of the encapsulating layer alone,

and at least some of the mesh continues longitudinally and directly throughout the major part of the length and breadth of the wall member, characterised in that the composite wall member (9) is imperforate, the encapsulating layer (11) filling the mesh so that the composite wall member is a completely solid imperforate mass resistant to passage of fluid therethrough, and at least outside the mesh (10) on both sides of the wall member the encapsulating layer is of a material (13) which is inert and resistant to corrosive effects of condensing vapours or acid gaseous oxides or vapours which may condense on the layer, and the thickness of the encapsulating layer (11) outside the mesh (10) is substantially less than the transverse extent of the mesh across the total thickness of the wall member and said transverse extent of the mesh is substantially to outer surfaces of the wall member whereby the mesh conducts heat from the outer surfaces to promote the heat absorption of the wall member.

2. A heat exchange panel or element according to Claim 1 characterised in that at least immediately next to the mesh the encapsulating layer (11) is composed of plastics material (12).

3. A heat exchange panel or element according to Claim 1 characterised in that the encapsulating layer (11) is made of glass.

4. A heat exchange panel or element according to any preceding claim characterised in that the encapsulating layer (11) at least immediately next to the mesh is of a material filled with particulated mineral or other substance which promotes the heat capacity of the material.

5. A heat exchange panel or element according to any preceding claim characterised in that the inert and corrosion resistant material of the encapsulating layer (11) is a plastics which reduces the adherence and building up of dust or scales on the wall member.

6. A heat exchange panel or element according to any preceding claim characterised in that the mesh (10) comprises interwoven or overlaid discrete metal strips.

7. A heat exchange panel or element according to any of Claims 1 to 5 characterised in that the mesh (10) comprises interwoven or overlaid discrete metal strands of wire or filament (10').

8. A heat exchange panel or element according to any of Claims 1 to 5 characterised in that the mesh comprises pierced and expanded sheet metal material which presents in effect a network of strip or strand portions (10").

9. A heat exchange panel or element according to Claim 8 characterised in that the sheet of metal material is of a kind which has been flattened after it has been pierced and expanded.

10. A heat exchange panel or element according to Claim 9 characterised in that the open area of the mesh (10) between the strip or strand portions (10') is 5-25% of the total area of the mesh.

11. A heat exchange panel or element according to any preceding claim characterised in that it is profiled to present undulating surfaces for enhanced heat transfer at those surfaces.

12. A heat exchange panel or element according to any preceding claim characterised in that the thickness of the metal of the mesh (10) is 0.3-1.0mm thick.

13. A heat exchange panel or element according to any preceding claim characterised in that the thickness of the material of the encapsulating layer (11) outside the mesh (10) is of the order of 0.1-0.3mm.

14. A heat exchange panel or element according to any preceding claim characterised in that the total thickness of the wall member (9) is of 0.5-1.5mm.

15. A heat exchange panel or element according to any preceding claim characterised in that a peripheral bead (5A) is provided around the wall member(9).

16. A regenerative or recuperative type heat exchanger characterised in that it includes a heat exchange panel or element (5) as claimed in any preceding claim, the panel or element being positioned in a plane parallel to the direction of fluid flow through the heat exchanger when in use.

17. A regenerative or recuperative heat exchanger of the Ljungstrom or similar type characterised in that it contains a body of heat exchange panels or elements (5) each in accordance with the heat exchange panel or element as claimed in any of Claims 1 to 15, the panels or elements being positioned in planes parallel to the direction of fluid flow through the heat exchanger when in use.

18. A regenerative or recuperative heat exchanger according to Claim 17 characterised in that the heat exchange panels or elements (5) are removably housed in pockets (4) of a rotatable drum (2).

19. A regenerative or recuperative heat exchanger according to Claim 17 or Claim 18 characterised in that the heat exchange panels or elements (5) are

arranged in packs in contiguous relationship and having passages defined between them for flow of gas, gas and vapour or air for heat exchange with the panels or elements.

20. A regenerative or recuperative heat exchanger according to Claim 19 characterised in that the heat exchange panels or elements (5) are profiled for the passages to be defined and for there to be turbulent flow between the panels or elements.

Patentansprüche

1. Eine Wärmeaustauschplatte oder -element (5), die oder das in einem Wärmeaustauscher (1) von dem regenerativen oder dem rekuperativen Typ verwendbar ist, mit einem Wärmespeicher- und Übertragungselement, welches ein zusammengesetztes Wandelement (9) aufweist, das aus Bereichen unterschiedlicher Wärmeleitfähigkeit gebildet ist, wobei ein Bereich, der von einer höheren Wärmeleitfähigkeit ist und innerhalb des Wandelements ein Verstärkungsgitter bildet, ein Metallnetz (10) aus Streifen oder Litzen aufweist, wobei ein zweiter Bereich von niedrigerer Wärmeleitfähigkeit eine Einkapselungsschicht (11) bildet, welche das Netz einhüllt und sich durch das Netz erstreckt, so daß das Netz innerhalb der Einkapselungsschicht enthalten ist, wobei die Bereiche eng miteinander gegenüber Trennung verriegelt sind, wobei das zusammengesetzte Wandelement dazu befähigt ist, bei höheren Temperaturen zu funktionieren als es das Material der Einkapselungsschicht allein könnte, und wobei zumindest ein Teil des Netzes sich in der Längsrichtung und unmittelbar durch den Hauptteil von Länge und Breite des Wandelements fortsetzt, **dadurch gekennzeichnet,** daß das zusammengesetzte Wandelement (9) unperforiert ist, wobei die Einkapselungsschicht (11) das Netz füllt, so daß das zusammengesetzte Wandelement eine vollständig feste, unperforierte Masse ist, die gegenüber einer Passage von Fluid durch sie hindurch widerstandsfähig ist, daß zumindest außerhalb des Netzes (10) auf beiden Seiten des Wandelements die Einkapselungsschicht aus einem Material (13) ist, welches inert und gegenüber korrosiven Effekten von kondensierenden Dämpfen oder sauren gasförmigen Oxiden oder Dämpfen widerstandsfähig ist, welche sich an der Schicht kondensieren können, daß die Dicke der Einkapselungsschicht (11) außerhalb des Netzes (10) wesentlich geringer ist als die Quererstreckung des Netzes über die Gesamtdicke des Wandelements und daß diese Quererstreckung des Netzes im wesentlichen bis zu den Außenseiten des Wandelements ist, so daß das Netz Wärme von den Außenseiten leitet, um die Wärmeabsorption des Wandelements zu unterstützen.

2. Eine Wärmeaustauschplatte oder -element gemäß Anspruch 1, **dadurch gekennzeichnet,** daß zumindest in unmittelbarer Nähe zu dem Netz die Einkapselungsschicht (11) aus Kunststoffmaterial (12) gebildet ist.

3. Eine Wärmeaustauchplatte oder -element gemäß Anspruch 1, **dadurch gekennzeichnet,** daß die Einkapselungsschicht (11) aus Glas gebildet ist.

4. Eine Wärmeaustauschplatte oder -element gemäß einem der vorhergehenden Ansprücbe, dadurch gekennzeichnet, daß die Einkapselungsschicht (11) zumindest in unmittelbarer Nähe zu dem Netz aus einem Material ist, das mit einem teilchenförmigen Mineral oder einer anderen Substanz gefüllt ist, welches oder welche die Wärmekapazität des Materials fördert.

5. Eine Wärmeaustauschplatte oder -element nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das inerte und gegenüber Korrosion widerstandsfähige Material der Einkapselungs-Schicht (11) ein Kunststoff ist, welcher die Anhaftung und den Aufbau von Staub oder Schuppen an dem Wandelement verringert.

6. Eine Wärmeaustauschplatte oder -element gemäß einem der vorhergebenden Ansprüche, **dadurch gekennzeichnet,** daß das Netz (10) durchflochtene oder daraufgelegte einzelne Metallstreifen aufweist.

7. Eine Wärmeaustauschplatte oder -element gemäß einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet,** daß das Netz (10) durchflochtene oder daraufgelegte einzelne Metallitzen aus Draht oder Filament (10') aufweist.

8. Eine Wärmeaustauschplatte oder -element gemäß einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet,** daß das Netz ein durchlöchertes und expandiertes Blechmetallmaterial aufweist, welches im Effekt ein Netzwerk aus Streifen- oder Litzenbereichen (10") präsentiert.

9. Eine Wärmeaustauschplatte oder -element gemäß Anspruch 8, **dadurch gekennzeichnet,** daß das Blech aus dem metallischen Material von einer Art ist, welche geebnet worden ist, nachdem sie durchlöchert und expandiert worden ist.

10. Eine Wärmeaustauschplatte oder -element gemäß Anspruch 9, **dadurch gekennzeichnet,** daß der offene Bereich des Netzes (10) zwischen den Streifen- oder Litzenbereichen (10') 5 bis 25 % des Ge-

samtbereichs des Netzes ist.

11. Eine Wärmeaustauschplatte oder -element gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** daß sie oder es profiliert ist, um wellige Oberflächen für eine erhöhte Wärmeübertragung an diesen Oberflächen zu ergeben.

12. Eine Wärmeaustauschplatte oder -element gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** daß die Dicke des Metalls des Netzes (10) 0,3 - 1,0 mm dick ist.

13. Eine Wärmeaustauschplatte oder -element gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** daß die Dicke des Materials der Einkapselungsschicht (11) außerhalb des Netzes (10) in der Größenordnung von 0,1 - 0,3 mm ist.

14. Eine Wärmeaustauschplatte oder -element gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** daß die Gesamtdicke des Wandelements (9) im Bereich zwischen 0,5 - 1,5 mm ist.

15. Eine Wärmeaustauschplatte oder -element gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** daß eine Umfangsbördelung (5A) um das Wandelement (9) herum vorgesehen ist.

16. Ein Wärmeaustauscher von dem regenerativen oder rekuperativen Typ, **dadurch gekennzeichnet,** daß er eine Wärmeaustauschplatte oder -element (5) aufweist, wie in einem der vorhergehenden Ansprüche beansprucht, wobei die Platte oder das Element in einer Ebene positioniert ist, die parallel zu der Richtung des Fluidstromes durch den Wärmeaustauscher verläuft, wenn er in Gebrauch ist.

17. Ein regenerativer oder rekuperativer Wärmeaustauscher von dem Ljungstrom oder einem ähnlichen Typ, **dadurch gekennzeichnet,** daß er einen Körper aus Wärmeaustauschplatten oder -elementen (5) enthält, von denen jede oder jedes in Übereinstimmung mit der Wärmeaustauschplatte oder dem Wärmeaustauschelement ist, wie in einem der Ansprüche 1 bis 15 beansprucht, wobei die Platten oder Elemente in Ebenen positioniert sind, die parallel zu der Richtung des Fluidstromes durch den Wärmeaustauscher verlaufen, wenn er in Gebrauch ist.

18. Ein regenerativer oder rekuperativer Wärmeaustauscher gemäß Anspruch 17, **dadurch gekennzeichnet,** daß die Wärmeaustauschplatten oder -elemente (5) in Taschen (4) einer drehbaren Trommel (2) entfernbar untergebracht sind.

19. Ein regenerativer oder rekuperativer Wärmeaustaucher gemäß Anspruch 17 oder gemäß Anspruch 18, **dadurch gekennzeichnet,** daß die Wärmeaustauschplatten oder -elemente (5) in Paketen bzw. Stapeln in einer aneinandergrenzenden Beziehung angeordnet sind und Passagen aufweisen, die zwischen ihnen für einen Strom von Gas, Gas und Dampf oder Luft für einen Wärmeaustausch mit den Platten oder Elementen definiert sind.

20. Ein regenerativer oder rekuperativer Wärmeaustauscher gemäß Anspruch 19, **dadurch gekennzeichnet,** daß die Wärmeaustauschplatten oder -elemente (5) profiliert sind, um die Passagen zu definieren und um einen turbulenten Strom zwischen den Platten oder Elementen zu erzeugen.

Revendications

1. Panneau ou élément d'échange thermique (5) adapté pour être utilisé dans un échangeur de chaleur (1) du type à régénération ou du type à récupération, comprenant un élément de stockage et de transfert de chaleur, lequel comprend un élément de paroi composite (9) constitué de portions ayant des conductibilités thermiques différentes, une telle portion, de conductibilité thermique plus grande, formant une grille de renforcement à l'intérieur de l'élément de paroi comprenant un treillis métallique (10) de bandes ou de torons, et une deuxième telle portion, de conductibilité thermique plus faible, constituant une couche d'enrobage (11), enveloppant le treillis et s'étendant à travers lui de sorte que le treillis soit contenu à l'intérieur de la couche d'enrobage, que les portions s'interpénètrent intimement et ne puissent ainsi se séparer, que l'élément de paroi composite puisse fonctionner à des températures plus élevées que celles auxquelles pourrait fonctionner le matériau de la couche d'enrobage seul, et qu'au moins une partie du treillis continue longitudinalement et directement sur la plus grande partie de la longueur et de la largeur de l'élément de paroi, caractérisé en ce que l'élément de paroi composite (9) n'est pas perforé, que la couche d'enrobage (11) remplit le treillis de telle sorte que l'élément de paroi composite est une masse complètement pleine et non perforée s'opposant au passage de fluide à travers elle, et qu'au moins à l'extérieur du treillis (10) et sur les deux côtés de l'élément de paroi, la couche d'enrobage est en un matériau (13) qui est inerte et qui résiste aux effets corrosifs de vapeurs se condensant ou d'oxydes gazeux acides ou de vapeurs pouvant se condenser sur la couche, et que l'épaisseur de la couche d'enrobage (11) à l'extérieur du treillis (10) est notablement inférieure à l'étendue transversale du treillis en travers de l'épaisseur totale de l'élément de paroi et que le

treillis s'étend transversalement jusqu'aux surfaces extérieures de l'élément de paroi d'où il résulte que le treillis conduit la chaleur en provenance des surfaces extérieures pour renforcer l'absorption de chaleur de l'élément de paroi.

2. Panneau ou élément d'échange thermique selon la revendication 1, caractérisé en ce que, au moins au voisinage immédiat du treillis, la couche d'enrobage (11) est en une matière plastique (12).

3. Panneau ou élément d'échange thermique selon la revendication 1, caractérisé en ce que la couche d'enrobage (11) est faite de verre.

4. Panneau ou élément d'échange thermique selon l'une des revendications précédentes, caractérisé en ce que, au moins au voisinage immédiat du treillis, la couche d'enrobage (11) est en un matériau rempli de particules minérales ou de tout autre substance particulaire qui améliore la capacité thermique du matériau.

5. Panneau ou élément d'échange thermique selon l'une des revendications précédentes, caractérisé en ce que le matériau inerte et résistant à la corrosion de la couche d'enrobage (11) est une matière plastique qui réduit l'adhérence et l'accumulation de poussières ou de dépôts sur l'élément de paroi.

6. Panneau ou élément d'échange thermique selon l'une des revendications précédentes, caractérisé en ce que le treillis (10) comprend des bandes métalliques individuelles entrelacées ou se recouvrant.

7. Panneau ou élément d'échange thermique selon l'une des revendications 1 à 5, caractérisé en ce que le treillis (10) comprend des torons métalliques individuels de fil ou de filament (10') entrelacés ou se recouvrant.

8. Panneau ou élément d'échange thermique selon l'une des revendications 1 à 5, caractérisé en ce que le treillis comprend un matériau à base d'une tôle métallique percée et expansée, qui présente en fait un réseau de portions de bandes ou de torons (10").

9. Panneau ou élément d'échange thermique selon la revendication 8, caractérisé en ce le matériau à base de tôle métallique est d'un type qui a été aplati après qu'il a été percé et expansé.

10. Panneau ou élément d'échange thermique selon la revendication 9, caractérisé en ce que la surface ouverte du treillis (10) entre les portions de bandes ou de torons (10') représente 5 à 25 % de la surface totale du treillis.

11. Panneau ou élément d'échange thermique selon l'une des revendications précédentes, caractérisé en ce qu'il est profilé pour présenter des surfaces ondulées pour augmenter le transfert thermique sur ces surfaces.

12. Panneau ou élément d'échange thermique selon l'une des revendications précédentes, caractérisé en ce que l'épaisseur du métal du treillis (10) est comprise entre 0,3 et 1 mm.

13. Panneau ou élément d'échange thermique selon l'une des revendications précédentes, caractérisé en ce que l'épaisseur du matériau de la couche d'enrobage (11) à l'extérieur du treillis (10) est de l'ordre de 0,1 à 0,3 mm.

14. Panneau ou élément d'échange thermique selon l'une des revendications précédentes, caractérisé en ce que l'épaisseur totale de l'élément de paroi (9) est de 0,5 à 1,5 mm.

15. Panneau ou élément d'échange thermique selon l'une des revendications précédentes, caractérisé en ce qu'un profilé périphérique (5A) est prévu autour de l'élément de paroi (9).

16. Echangeur de chaleur du type à régénération ou du type à récupération, caractérisé en ce qu'il contient un panneau ou élément d'échange thermique (5) selon l'une des revendications précédentes, le panneau ou élément étant positionné dans un plan parallèle à la direction de l'écoulement du fluide à travers l'échangeur de chaleur lorsqu'il est en service.

17. Echangeur de chaleur à régénération ou à récupération du type Ljungstrom ou d'un type similaire, caractérisé en ce qu'il contient un corps de panneaux ou éléments d'échange thermique (5), chacun en conformité avec le panneau ou élément d'échange thermique selon l'une des revendications 1 à 15, les panneaux ou éléments étant positionnés dans des plans parallèles à la direction de l'écoulement du fluide à travers l'échangeur de chaleur lorsqu'il est en service.

18. Echangeur de chaleur à régénération ou à récupération selon la revendication 17, caractérisé en ce que les panneaux ou éléments d'échange thermique (5) sont logés de façon amovible dans des alvéoles (4) d'un tambour rotatif (2).

19. Echangeur de chaleur à régénération ou à récupération selon la revendication 17 ou la revendication 18, caractérisé en ce que les panneaux ou éléments d'échange thermique (5) sont disposés en

paquets, contigus les uns aux autres, des passages étant définis entre eux pour l'écoulement d'un gaz, d'un gaz ou d'une vapeur ou l'air pour un échange de chaleur avec les panneaux ou éléments.

20. Echangeur de chaleur à régénération ou à récupération selon la revendicaiton 19, caractérisé en ce que les panneaux ou éléments d'échange thermique (5) sont profilés pour les passages à définir et pour qu'il y ait un écoulement turbulent entre les panneaux ou éléments.

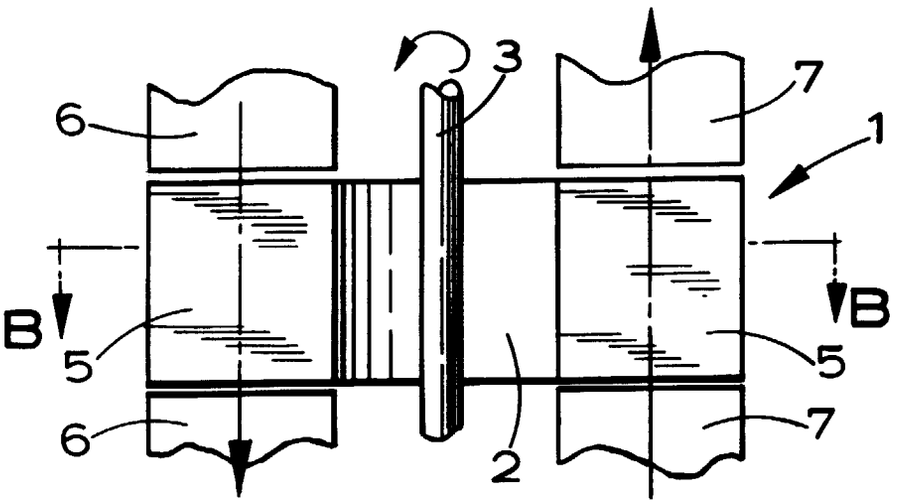

FIG.1.

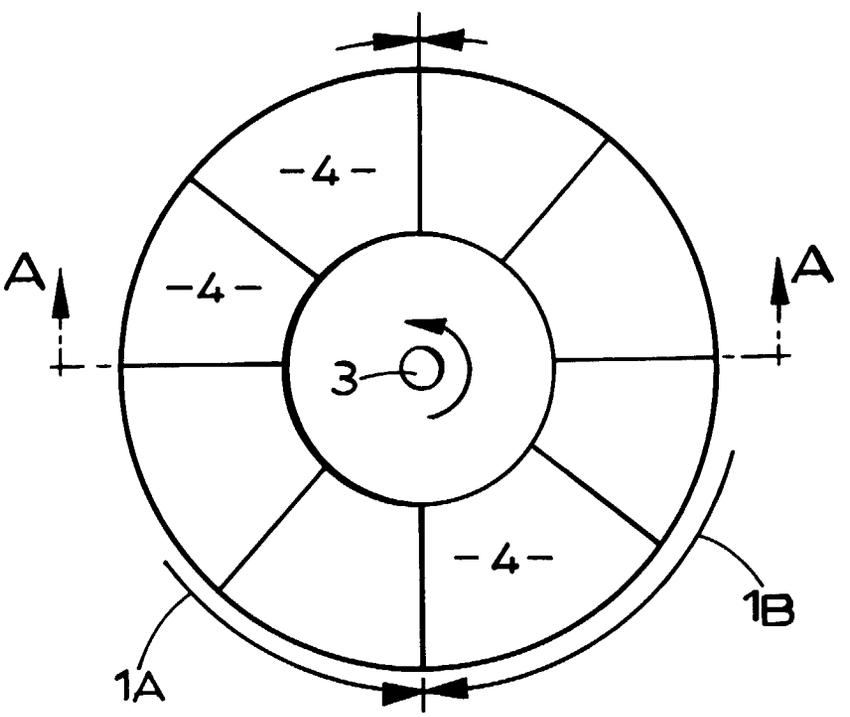

FIG.2.

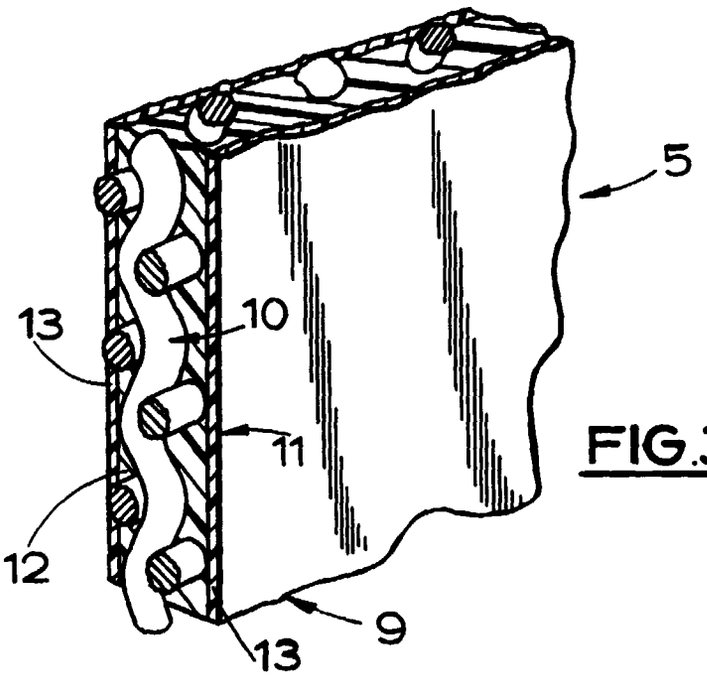

FIG.3.

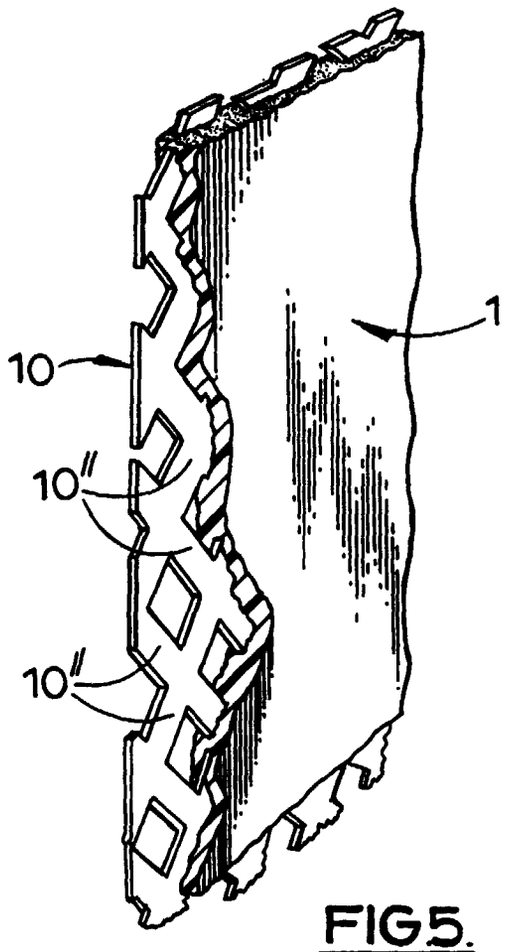

FIG5.

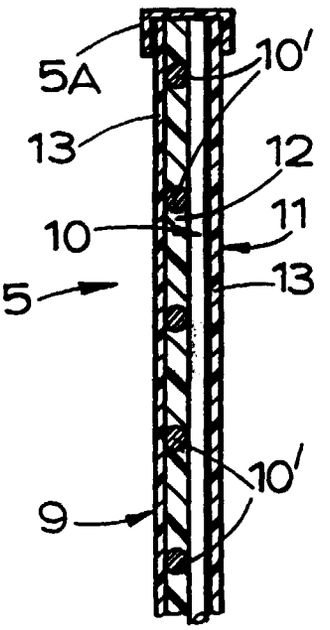

FIG.4.