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(54) Panel-type heat exchanger.

(57) A heat exchanger is disclosed comprising a plurality of panels each whereof being formed by two plate-like elements (1a, 1b) interconnected by longitudinal fins (2) effective to define a plurality of vertical conduits (3) for hot corrosive fumes to flow therethrough.

The panels are packed together and mutually spaced apart, closure elements being provided at the pack top and bottom ends effective to define channels (8) for air to flow horizontally therethrough.

EP 0 038 454 A2

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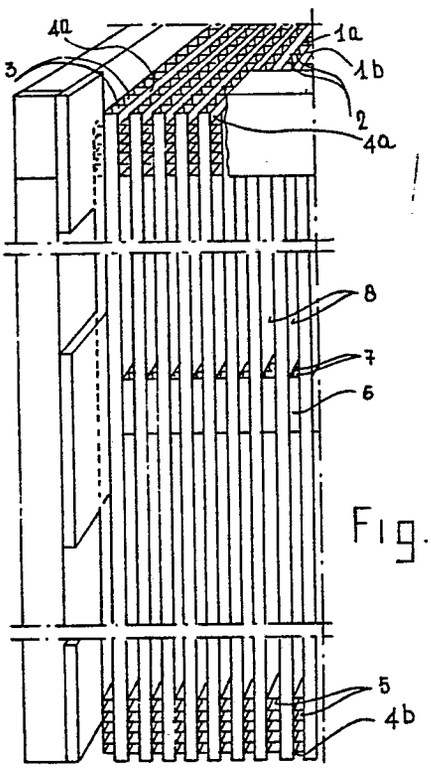

Fig. 2

This invention relates to a panel-type heat exchanger having vertical conduits and horizontal channels.

It is a known fact that special attention is devoted nowadays to the recovery of all possible forms of energy, to meet requirements both of an economical and foreign currency nature.

In particular, it has always been of interest to recover the amounts of heat wasted to the atmosphere by exhaust gases or fumes released from industrial processes, such as to cycle it back into the emitting industrial plant.

Naturally, the recovery of amounts of heat which would otherwise go wasted is implemented by means of heat exchangers which operate on the physical principle of thermal exchange between fluids which are circulated through adjacent but separate conduits.

Currently available exchangers are mostly constructed of metal materials, such as iron, stainless steel, aluminum, etc.

Such exchangers, where used to treat fumes which contain corrosive substances, require the application of a protective coating to their inner walls, owing to the corrosive action that the fume condensation can indeed exert on the metal material.

A further technical drawback results from the difference between the expansion coefficients of the two materials placed in mutual contact, namely that of the protective coating and that of the metal

material.

This expansion differential leads to the formation of cracks in the coating which uncover portions of the metal surface, which thus remain exposed to the corrosive action of the fume condensation.

This is indeed a basic problem with currently available exchangers of metal construction, on account of which problem particularly high costs must be born for the maintenance and restoring of the entire exchange system.

This invention sets out to provide a heat exchanger which affords reduced manufacture and maintenance costs, and can be modularly assembled to ensure a high degree of flexibility in application under varying conditions.

Within the above general aim, it is possible to arrange that the heat exchanger of this invention can be formed from a commercially readily available material, of the general type of polycarbonate, and which is currently utilized for temporary panel erecting or for covering greenhouses.

According to one aspect of the present invention, there is provided a panel-type heat exchanger having vertical conduits and horizontal channels, characterized in that it comprises a plurality of panels including two plate-like elements each, said plate-like elements being interconnected by a plurality of longitudinal fins adapted to define within said panels a plurality of vertical conduits

for hot corrosive fumes to flow therethrough, said panels being packed together and mutually spaced apart, closure elements being provided at the top and bottom ends effective to define channels for air to flow horizontally therethrough.

Further features will be more readily understood from the following detailed description of a preferred, though not limitative, embodiment of a panel-type heat exchanger according to the invention, as illustrated by way of example only in the accompanying drawings, where:

Figure 1 is a perspective view of the basic components of the heat exchanger according to the invention;

Figure 2 is a fragmentary perspective view, to an enlarged scale, of the panels which make up the heat exchanger of Figure 1; and

Figures 3 and 4 are diagramatic perspective views of modularly assembled exchangers using a number of individual exchangers.

With reference to the drawing figures, a heat exchanger according to the invention has its exchange surfaces formed by side-by-side panels made of a material of the type of polycarbonate, each panel comprising two plate-like elements 1a,1b interconnected by a plurality of longitudinally extending fins 2 adapted for defining within the panel a plurality of vertical conduits 3 wherethrough fumes are caused to

flow.

Said panels are cut to rectangular shapes and overlaid to form a pack with parallel internal conduits 3, with the interposition between each panel and the two contiguous ones, of suitable spacers comprising panel sheet off-cuts. Said off-cuts are cemented to the end edges, top 4a and bottom 4b, of the panels, and have their conduits 5 extending orthogonally to the conduits 3 for the fumes. The panel-to-panel spacing is also achieved by means of panel material off-cuts or slices 6 which are positioned at different height levels and cemented between the two plate-like surfaces of the panels; said intermediate off-cuts have channels 7 extending in the same direction as the conduits 3 and the gap between side-by-side panels allows the definition of channels 8 extending orthogonally to the conduits 3 and intended to act as passageways for air. The exchanger according to the invention is arranged in a suitable peripheral frame to form a single or unitary block. Said frame comprises a three-dimensional system made up of iterative load bearing elements, namely uprights 9, cross-pieces 10, and stringers 11, which are either welded or riveted together with the intermediary of end gussets.

The side gaps of the frame are closed by rows of shields 12 which are in the shape of a flattened pyramid and made of a metal material, such as to provide a tight sealed enclosure.

On the enclosure front, the bottom row of shields

is replaced with an inlet mouth 13 for the introduction of cooling air, of conventional design, advantageously in the shape of a truncated pyramid having a flattened rectangular base, whilst on the back, the row of shields is replaced with a mouth 14 serving as an outlet for exhausting the hot air.

The enclosure is then completed with the provision of two lids 15,16, in the form of hoods, which are positioned on the pack top and bottom sides.

The lids are in the shape of a truncated pyramid with square base, and formed from a metal material, to respectively direct the fumes entering the exchanger at 15 and leaving it at 16.

Attention is drawn on the fact that, with the above construction, the fume conduits and air channels 8 are mutually separated, and that very large thermal exchange surface areas are achieved.

This invention is susceptible to many variations; it is in fact contemplated that several exchangers may be coupled together to meet a variety of applicational requirements. The coupling may be implemented serially, or in parallel, in series-parallel, with optimum modular features.

With particular reference to Figure 3, there is shown a serial coupling (fume series, air series) of two unit exchangers 17,18, wherefrom the top and bottom hoods of the individual exchangers have been removed to allow the parallelepipedal packs to be assembled together in stacked relationship by means of a peripheral form of mutual fastening.

For this coupling, provision is made to include a connective element 19 between the outlet mouth for the air of a first exchanger 17 and the inlet mouth of the exchanger 18.

With specific reference to Figure 4, there is illustrated a parallel fumes-air coupling of two unit exchangers 20,21 arranged one beside the other.

The exchanger assembly resulting from the above coupling may have individual pairs of top and bottom lids, or two hoods 22,23 only may be used for the fume inlet and outlet, which would then be of a larger size and located over and under the two side-by-side parallelepipedal packs.

Similarly to the above, two air inlet and outlet mouths 25,24 only may be used.

Other possible features can be beneficial to particular applications.

As an example, the individual exchangers may be coupled in accordance with a fume-serial and air-parallel scheme by arranging two exchangers in overlying relationship, with external "Y" fittings between the air outlets of the two exchangers. In this case, one would achieve a lower fume temperature and increased amount of heated air, but at a lower temperature than with fume-serial and air-serial setups.

Alternatively, it would be possible to provide a coupling of individual unit exchangers in accordance with a fume-parallel and air-serial scheme; that is, by coupling two exchangers with an external connection

between the air outlet mouth of the first exchanger and the inlet one of the second.

In the latter case, one would achieve a higher temperature of the heated air and less marked lowering of the fume temperature.

The unit exchanger of this invention operates as follows. Hot corrosive gases are led along the path indicated by the vertical arrows; in other words, they can only flow in through the hood 15 from above the conduits 3 and leave downwards through the hood 16, whilst the cooling air can only leak into the channels 8 through the mouth 16 and leave in a heated condition through the mouth 14.

Thus the invention achieves its objects.

The invention as described and illustrated is susceptible to many modifications and variations without departing from the purview of the instant inventive concept.

Furthermore, all of the details may be replaced with other, technically equivalent ones.

In practicing the invention, the materials employed, as well as the shapes and dimensions, may be any suitable ones for individual applicational requirements without departing from the true scope of the invention as outlined in the appended claims.

C L A I M S

1. A panel-type heat exchanger having vertical conduits and horizontal channels, characterized in that it comprises a plurality of panels including two plate-like elements (1a, 1b) each, said plate-like elements being interconnected by a plurality of longitudinal fins (2) adapted to define within said panels a plurality of vertical conduits (3) for hot corrosive fumes to flow therethrough, said panels being packed together and mutually spaced apart, closure elements being provided at the top and bottom ends effective to define channels (8) for air to flow horizontally therethrough.

2. A heat exchanger according to Claim 1, characterized in that said panels (1a, 1b) are extruded polycarbonate based material panels having adhesive material interposed therebetween to hold together the panels in an assembly.

3. A heat exchanger according to Claim 2, characterized in that said closure elements are formed from thin off-cuts of the panel material and with conduits (5) extending in an orthogonal direction to the conduits (3) in said panels.

4. A heat exchanger according to Claim 2, characterized in that between the side-by-side panels (1a, 1b) there are arranged and secured, as by cementing, narrow strips or slices (6) of panel material having the function of intermediate spacers and having conduits (7) extending parallel to the conduits (3) in said panels.

5. A heat exchanger according to Claim 1, characterized in that the panel pack is contained within an enclosure of parallelepipedal shape provided, at the top and bottom ends thereof, with lids (15, 16, 22, 23) in the form of hoods respectively for the introduction of fumes to be cooled and discharge of the thus cooled fumes and provided, at the front and back thereof, with mouths (25, 24) respectively for the introduction of cooling air and discharge of thus heated air.

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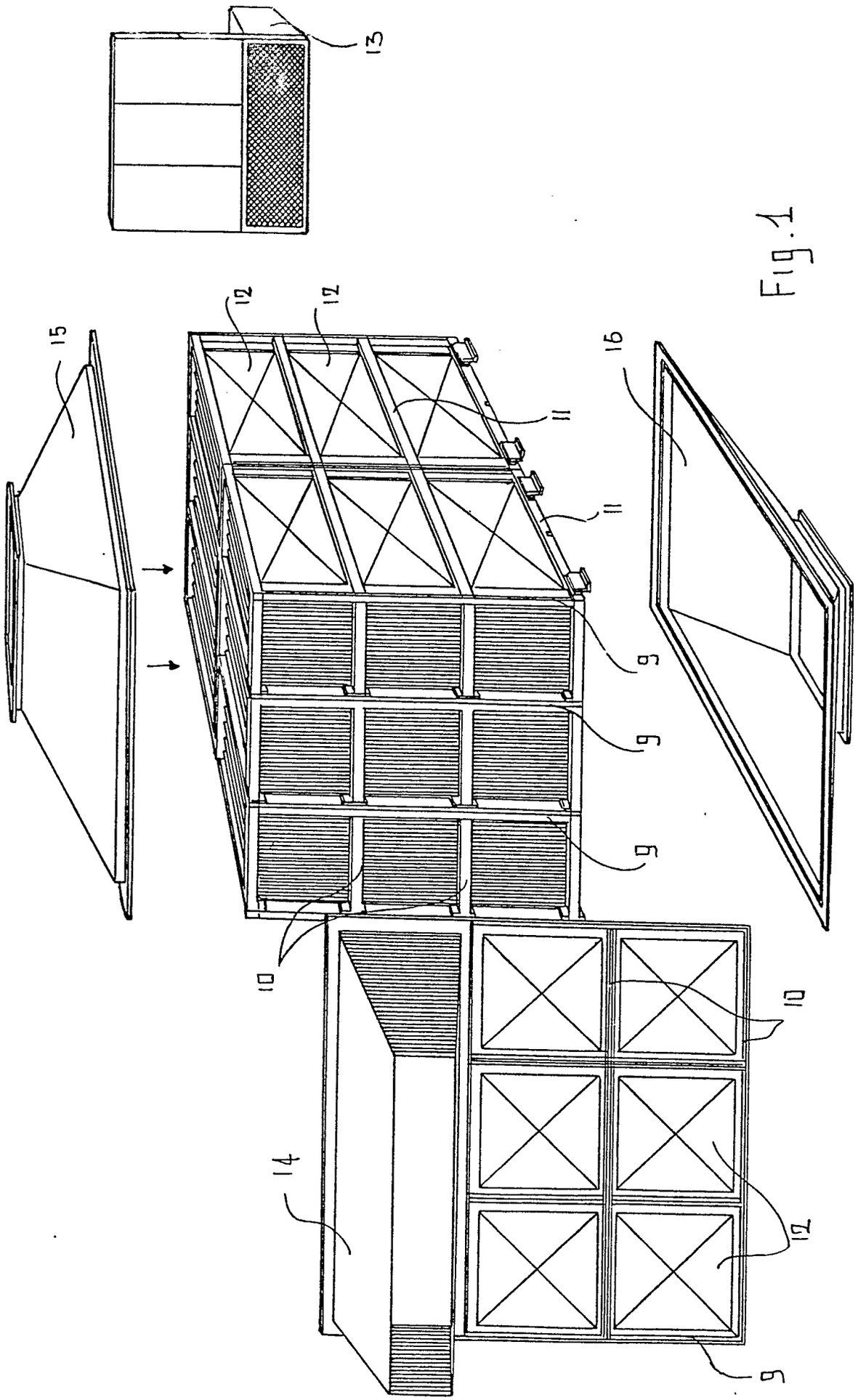

Fig.1

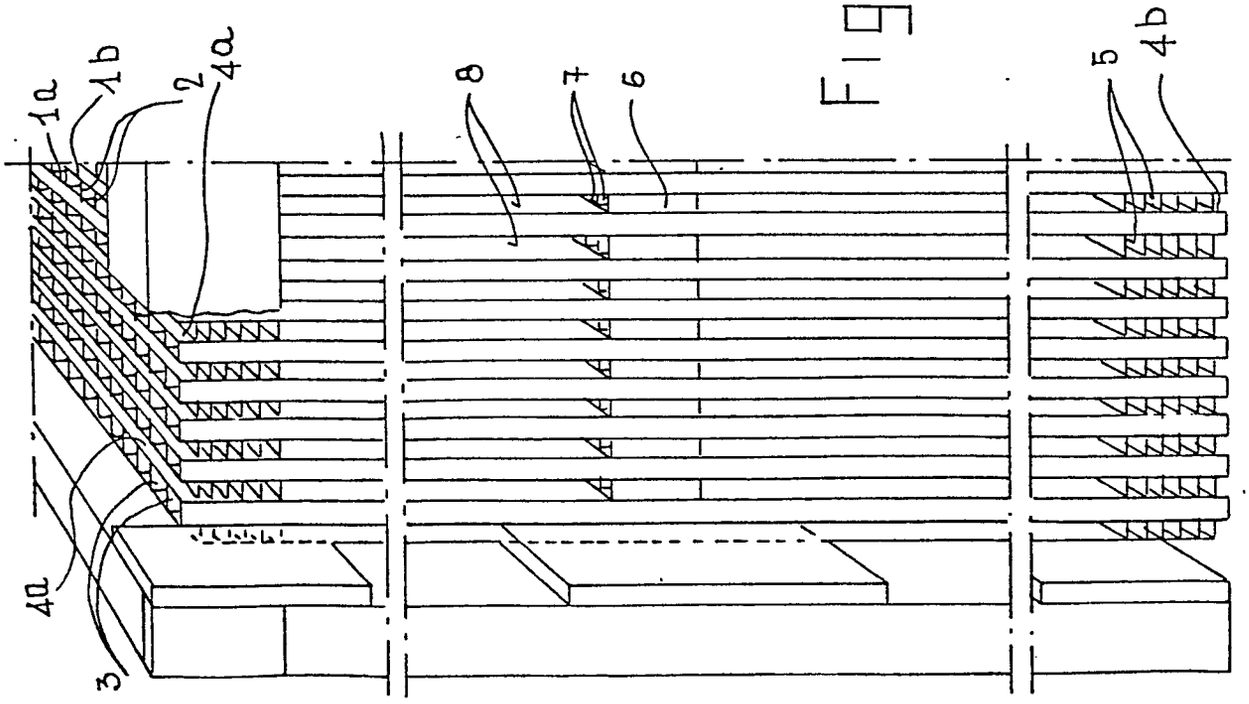

FIG. 2

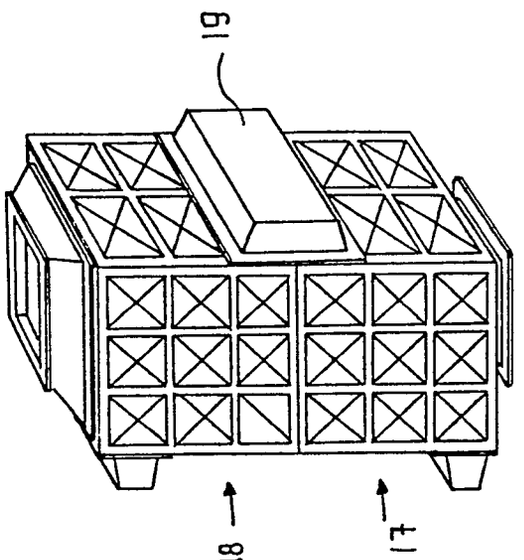

FIG. 3

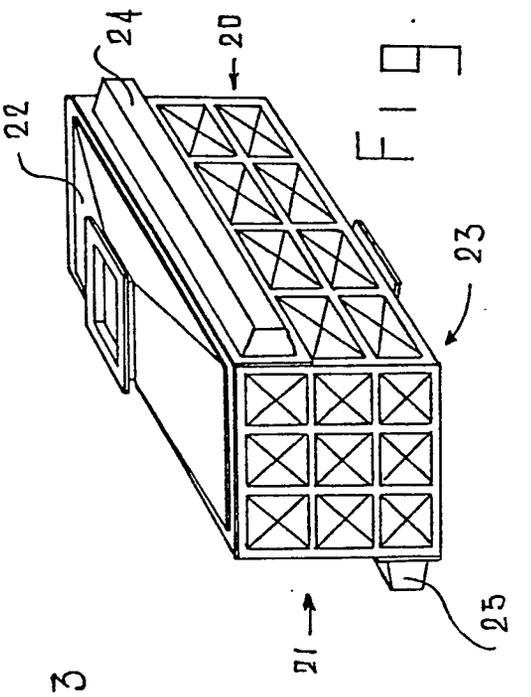

FIG. 4