(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 242 063 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 87302447.5

(22) Date of filing: 20.03.87

(51) Int. Cl.[4]: F28G 13/00 , F28D 9/00 , F28F 9/00

(30) Priority: 15.04.86 GB 8609148

(43) Date of publication of application: 21.10.87 Bulletin 87/43

(84) Designated Contracting States: BE DE FR GB IT NL

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(54) Heat exchanger.

(57) The invention is concerned with a heat-exchanger which is readily dismantled for cleaning with the minimum of down-time. The heat-exchanger comprises a set of parallel spaced apart heat-conducting plates mounted in a frame member surrounding and engaging the peripheries of the plates. The plates are so mounted to the frame member for example, in grooves or in rubber mountings, that they are readily detached and removed for cleaning and/or replacement when a portion of the frame member is removed or opens upon a hinge. Two separate fluids are introduced into and exhausted from alternating sets of channels formed between the plates through inlet and outlet passages in the frame member whereby heat-exchange takes place through the plates. The fluids may travel at right angles to each other, co-currently or in counter-current.

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HEAT-EXCHANGERS

This invention is concerned with heat-exchangers. Heat-exchangers of conventional type comprise two sets of fluid channels separated by heat conducting walls, such as metal walls, whereby a hot fluid passing through one set of channels transfers some of its heat through the walls to a cooler fluid passing through the other set of channels. The fluid may be a liquid, a vapour or a gas. By such means, in industrial and other processes which use large amounts of energy, economy in the use of energy can be achieved by passing hot exhaust liquids, vapours and/or gases through a heat-exchanger when heat is extracted and returned to the process, for example, by way of ingoing fresh fluids.

However, one problem which occurs is that exhaust fluids often carry additional waste material which deposit upon the heat-conducting walls of the heat-exchanger and reduce the width of the fluid channels as well as interfering with the heat-conducting efficiency of the separating walls between the channels. Eventually, such a contaminated heat-exchanger has to be scoured through with cleansing fluids or be discarded. Both procedures are expensive and time consuming.

The present invention is concerned with a heat-exchanger in which the heat-conducting walls are readily available for replacement and/or cleansing of deposits.

According to the present invention, a heat-exchanger comprises a set of parallel, spaced-apart heat-conducting plates defining between them a set of fluid flow channels, a frame member surrounding and engaging the entire peripheries of each of the plates, first inlet passages through the frame member opening into alternate flow channels through which a fluid may be introduced into the alternate flow channels, first outlet passages through the frame member opening into the alternate flow channels through which the fluid may be discharged from the alternate flow channels, second inlet passages through the frame member opening into intermediate flow channels between and immediately adjacent to the alternate flow channels through which a second fluid may be introduced into the intermediate flow channels and second outlet passages through the frame member opening into the intermediate flow channels through which the second fluid may be discharged characterised in that each plate is readily detachable from its engagement with the frame member and a portion of the frame member is readily removable from the frame member whereby the plates can be readily withdrawn and replaced.

In a preferred form of the invention, the frame member is rectangular in shape and correspondingly rectangular plates are kept parallel and separated from each other by their peripheries being held within grooves formed in the inner surface of the frame member. One side of the rectangular frame member is removable or preferably hinged so that the plates are exposed and can be readily withdrawn from the grooves by hand for cleaning or replacement.

The plates are preferably of metal such as aluminium.

In one form of the invention the first inlet passages and the first outlet passages lie on opposite sides of the frame member and the second inlet passages and second outlet passages lie on further opposite sides of the frame member such that the fluid flowing in the alternate flow channels travels at right angles to the second fluid flowing in the intermediate flow channel.

In another form of the invention one set of the inlet passages are confined to a portion of the frame member near one end of the heat-exchanger and the corresponding set of outlet passages are confined to a portion of the opposite side of the frame member near the other end of the heat-exchanger such that fluid passing through the flow channel corresponding with the sets of inlet and outlet passages travels partly at right angles to the partly parallel with the fluid passing through the other flow channels.

The invention will now be more specifically described by reference to the accompanying drawings, in which :

Figure 1 is a diagrammatic illustration (partly exploded) of a heat-exchanger in accordance with the invention, and

Figure 2 is a diagrammatic illustration of a further embodiment of the heat-exchanger.

In Figure 1, the heat-exchanger body 1 is box-like in shape, consisting of a rectangular frame member 2, which in turn consists of a vertical frame 3, a top frame 4, a bottom frame 5, and a door member 6 hinged to frames 3 and 4, and two end members 7,8. Frames 3,4 and 5 have grooves 9, formed on the inside to receive the peripheral edges of plain metal plates 10, (for example, of aluminium) of a series 11 of such plates 10, and hold within the body 1 the series 11 of plates 10, in parallel spaced relationship, so forming channels 12, between the plates 10, through which fluids can flow as explained below.

The door member 6, has rubber strips 13, mounted in such a position as to make contact, on closing, with the exposed edges of the plates 10, so as to ensure that each plate 10 is firmly engaged within the body 1 so that each channel 12 is sealed from each other channel 12.

In the frame 4, inlet passages 14, pass through the frame 4 into each alternate channel 12 (designated as 12A) and outlet passages 15, pass from each channel 12A through the frame 5. Similarly inlet passages 16, pass through the frame 3 into channels 12 (designated as 12B) which are between the immediately adjacent to the channels 12A, and outlet passages 17, are formed in the door member 6, which open into channels 12B when the door is closed.

In operation, when the door member 6′ is closed, hot fluid, for example hot exhaust air from an industrial plant, enters channels 12A through the inlet passages 14, from a common manifold (not shown) and passes out from the channels 12A through outlet passages 15, to a common exhaust manifold (not shown). A second fluid passes into the channels 12B through the inlet passages 16, and out of the outlet passages 17, in a direction at right angles to the direction of the fluid in the channels 12A. The second fluid (for example, fresh air being drawn into an industrial plant) is at a lower temperature than the fluid flowing in the channels 12A and it is heated by heat transferred from the fluid in the channels 12A through the plates 10, into the channels 12B. The deposit of any unwanted material on the plates 10 from the hot fluid is discouraged by the smooth surface of the plates and the "washing down" action of the fluid passing vertically downwards through the channels 12A.

However, despite the self-cleaning effect of the fluid passing downwardly in the channels 12A, in the course of time, deposits do tend to collect upon the surfaces of the plates 10 facing into the channels 12A and so constrict the width of the channels 12A and reduce the heat conductivity of the plates 10. When this happens, the heat-exchanger 1 is rapidly brought back to high efficient working by opening the door member 6, sliding out the plates 10, from the grooves 9, and replacing them with either new or with cleaned plates 10. On closing the door member 6, the heat-exchanger 1 is ready to be brought back into operation. Due to the novel construction of the heat-exchanger 1, the time taken to replenish the plates 10 by hand is at a minimum.

In the heat exchanger illustrated in Figure 1, the fluid passing through channels 12A travels at right angles to the second fluid passing through channels 12B ("cross-flow"). A more efficient heat-exchange through the plates 10 occurs if the fluid in the channels 12A travels in the same direction as the second fluid in channels 12B ("co-current flow") and still more efficiency is achieved if the fluid in channels 12A travels in the opposite direction to the second fluid in channels 12B ("counter-current flow"). In these circumstances however, passages for introducing or exhausting the fluid and second fluid from the respective channels, 12A and 12B, occur in common frames (for example frames 4,5) so that complicated sets of manifolds (not shown) are required to connect with the alternating sets of passages.

In Figure 2 there is illustrated an alternative construction for achieving a substantially counter-current flow of the fluid and second fluid. The heat-exchanger 18 of Figure 2, is of similar construction to the heat-exchanger 1 of Figure 1, except that in the frame 3 the inlet passages 16 are confined to a bottom portion of frame 3 while the outlet passages 17 are confined to a top portion of door member 6. By these means, access to the channels 12A and 12B is made through the inlet passages 14, 16 and outlet through outlet passages 15, 17, by way of simple manifolds 19, 20, 21, and 22. The direction of the fluid through the channels 12A is vertically downwards while the second fluid which passes through the channels 12B is partly horizontal but substantially vertically upwards (as shown by the line 23) thus providing the optimum conditions for an efficient heat-exchange through the plates 10.

The fluid and second fluid may be a liquid, a vapour or a gas. The heat-exchanger in accordance with the invention is particularly useful in taking heat from exhaust gases leaving a stenter used for the orientation of plastic films and transfering the heat to fresh gases entering the stenter which are to be used for heat treatment of the films. Waste materials carried by the exhaust gases which condense on the plates 10 can readily be removed, from time to time, by sliding out the plates 10 and either cleaning immediately or replacing by clean plates 10.

When it is essential that the plant process is not brought to a halt, two heat exchangers is parallel may be installed so that one can be operating while the other is being cleaned.

Although the plates 10 are preferably mounted within grooves formed in the frame member 2, other mountings, such as rubber or plastic tracks may be used providing that the plates 10 are readily removable and replaceable.

It will be appreciated that the heat-exchanger described above may be used for extracting heat from exhaust gases leaving a stenter used for the orientation of plastic film and transferring the extracted heat to fresh gases entering the stenter which are to be used for heat treatment of the film which is to be orientated.

Claims

1. A heat-exchanger comprising a set of parallel spaced-apart heat-conducting plates defining between them a set of fluid flow channels, a frame member surrounding and engaging the entire peripheries of each of the plates, first inlet passages through the frame member opening into alternate flow channels through which a fluid may be introduced into the alternate flow channels, first outlet passages through the frame member opening into the alternate flow channels through which the fluid may be discharged from the alternate flow channels, second inlet passages through the frame member opening into intermediate flow channels between and immediately adjacent to the alternate flow channels through which a second fluid may be introduced into the intermediate flow channels and second outlet passages through the frame member opening into the intermediate flow channels through which the second fluid may be discharged characterised in that each plate is readily detachable from its engagement with the frame member and a portion of the frame member is readily removable from the frame member whereby the plates can be readily withdrawn and replaced.

2. A heat-exchanger as claimed in claim 1 in which the frame member and plates are rectangular.

3. A heat-exchanger as claimed in claim 1 or claim 2 in which the plates are held within grooves formed in the inner surface of the frame member.

4. A heat-exchanger as claimed in claim 1, claim 2 or claim 3 in which one side of the frame member is hinged to permit removal of the plates.

5. A heat-exchanger as claimed in any one of the preceding claims 1 to 4 in which the plates have plain smooth surfaces.

6. A heat-exchanger as claimed in any one of the preceding claims 1 to 5 in which the first inlet passages and the first outlet passages lie on opposite sides of the frame member and the second inlet passages and second outlet passages lie on further opposite sides of the frame member such that the fluid flowing in the alternate flow channels travels at right angle to the second fluid flowing in the intermediate flow channel.

7. A heat-exchanger as claimed in claim 6 in which one set of the inlet passages are confined to a portion of the frame member near one end of the heat-exchanger and the corresponding set of outlet passages are confined to a portion of the opposite side of the frame member near the other end of the heat-exchanger such that fluid passing through the flow channels corresponding with the sets of inlet and outlet passages travels partly at right angles to and partly parallel with the fluid passing through the other flow channels.

8. The use of apparatus as claimed in any one of the preceding claims for extracting heat from exhaust gases leaving a stenter used for the orientation of plastic films and transferring the heat to fresh gases entering the stenter which are to be used for heat treatment of the films.

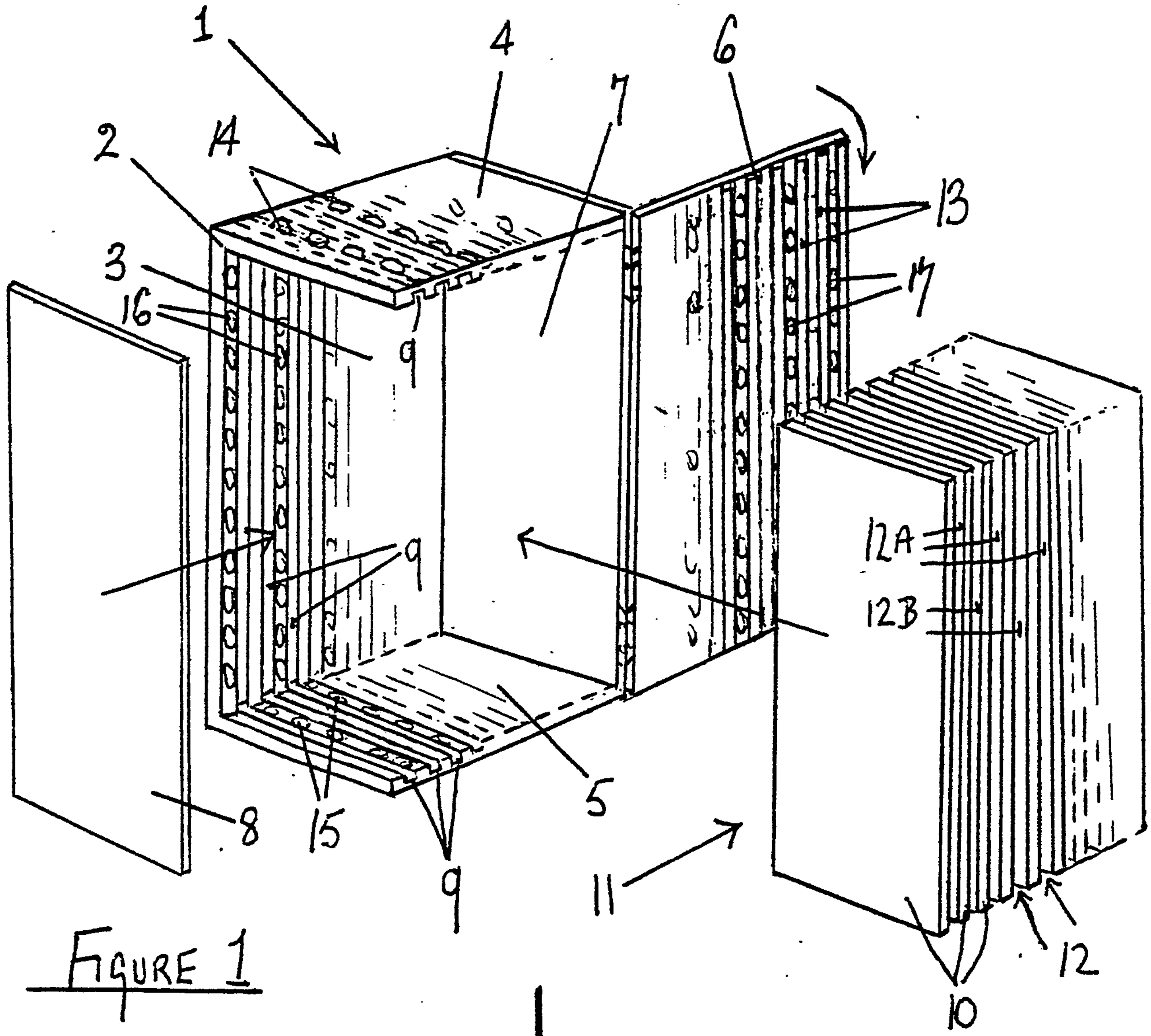

FIGURE 1

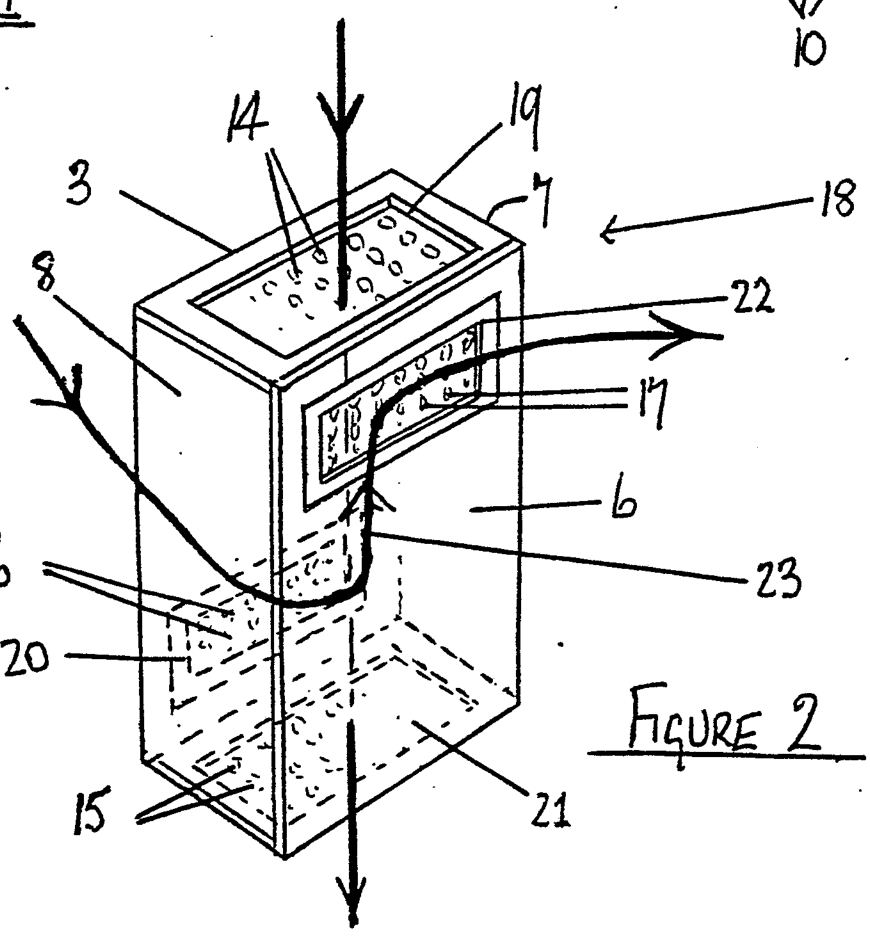

FIGURE 2