Oct. 1, 1968 J. GUTKOWSKI 3,403,724

HEAT EXCHANGERS

Filed July 25, 1966

FIG. 1

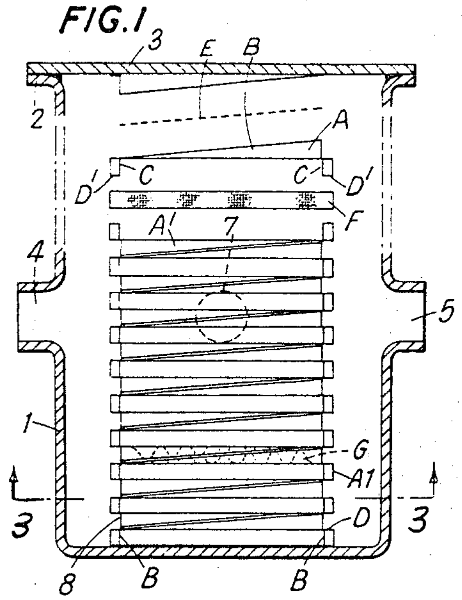


FIG. 2

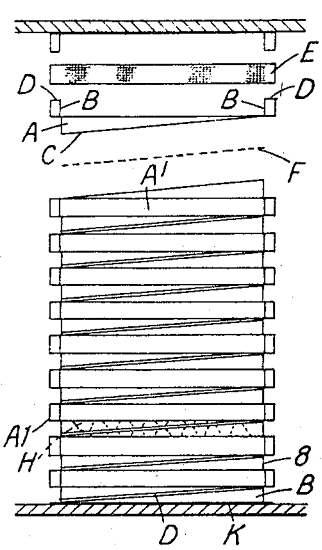


FIG. 4

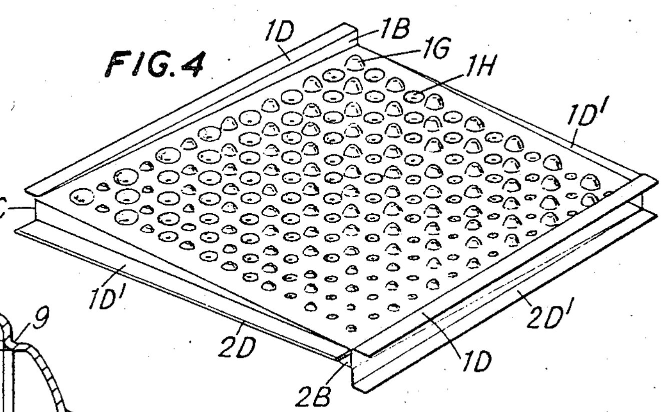
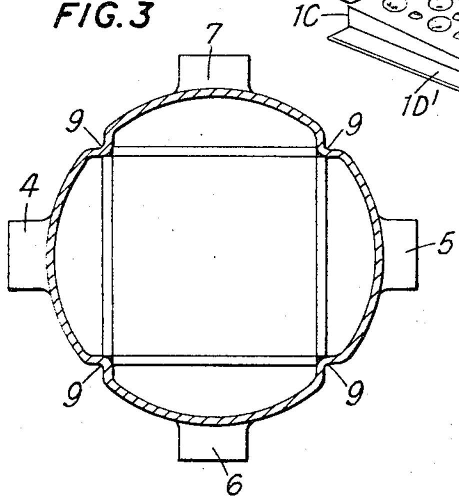


FIG. 3



INVENTOR
JANUSZ GUTKOWSKI

By Shoemaker and Mattare

ATTORNEYS.

United States Patent Office

3,403,724

Patented Oct. 1, 1968

3,403,724

HEAT EXCHANGERS

Janusz Gutkowski, 7 Rufus Close, Lewes, Sussex, England

Filed July 25, 1966, Ser. No. 567,492
Claims priority, application Great Britain, July 28, 1965, 32,189/65
12 Claims. (Cl. 165—119)

ABSTRACT OF THE DISCLOSURE

A heat exchanger particularly suited for use in conjunction with gas turbine engines to filter as well as cool the oil used in the engine. The heat exchanger comprises a stock of impermeable plates each of which separates one of a plurality of paths for the oil from one of a plurality of paths for the cooling medium, the plates being provided with inclined flanges designed to support sheets of filter material diagonally between adjacent plates.

This invention relates to heat exchangers and it is an object of the invention to provide a heat exchanger which is particularly suited for use in conjunction with gas turbine engines.

Among the many accessories required for a gas turbine engine are an oil filter, a fuel filter and an oil-to-fuel heat exchanger. Normally, each of these accessories is carried in a separate housing with separate seals, connections and mountings.

It is an object of the invention to provide a heat exchanger which will also function as a filter for at least one of the two fluids to be passed through the exchanger in heat-exchanging relationship.

It is a further object of the invention to provide a heat exchanger for a gas turbine engine which combines the functions of an oil-to-fuel heat exchanger, an oil filter and a fuel filter.

From one aspect, the invention consists in a heat exchanger comprising a stack of impermeable plates serving to separate a plurality of first spaces from a plurality of second spaces, means defining a path for a first fluid through said first spaces, means defining a path for a second fluid through said second spaces, and filter media in said first spaces secured to said plates in such a way that they intervene in said first path.

From another aspect, the invention also consists in a heat exchanger made up from a plurality of elements, each comprising a pair of spaced impermeable quadrilateral plates, means joining co-operating flanges on two opposite parallel sides of said plates to form two fluid-tight seams, and a quadrilateral filter member having two of its edges secured respectively between said two pairs of flanges, a third of its edges sealed to one of said plates, and its fourth edge sealed to the other plate.

From yet another aspect the invention consists in a heat exchanger made up from a plurality of thin rectangular plates of impermeable heat-conductive material, each plate having raised portions of continuously increasing height on two parallel sides and dropped portions of continuously increasing depth on the other two parallel sides, flanges on said raised and dropped portions, and rows of protuberances from each surface of said plate the heights and depths of said protuberances corresponding to the heights and depth of said raised and dropped portions.

One method of performing the invention will now be

described with reference to the accompanying diagrammatic drawings in which:

FIGURE 1 is a front elevation of a combined filter and heat exchanger in accordance with the invention;

FIGURE 2 is a side view of the core of the heat exchanger illustrated in FIGURE 1;

FIGURE 3 is a cross-sectional view of the heat exchanger illustrated in FIGURE 1 on the 3—3 looking in the direction of the arrows; and

FIGURE 4 is a perspective view of one element of the heat exchanger core shown in FIGURES 1 and 2.

The heat exchanger illustrated includes a container **1** having an upper flange **2** to which is welded a cover **3**. The container **1** is provided with inlet and outlet ports **4** and **5** for one fluid and inlet and outlet ports **6** and **7** for the other fluid. Housed within the container **1** is a heat-exchanging and filtering core **8** comprising a stack of filter members and separate plates. The four corners of the core are sealed in fluid-tight fashion to ribs **9** on the container and the core is also sealed in fluid-tight fashion to be base of the container and to the cover **3**. For this purpose the end plates of the stack differ from the remaining plates, as will be explained hereinafter.

To clarify the construction of the core, the upper parts of FIGURES 1 and 2 have been drawn as exploded views illustrating the individual filter members such as E and F and the individual separator plates, such as A and A'. Each of the plates A and A' is generally square and is provided with two raised portions B on two opposite parallel sides and two dropped portions C on the other two parallel sides. As can be seen from FIGURE 1 of the drawings, the height of the two raised portions B increases continuously to the right of the drawing and, as can be seen from FIGURE 2 of the drawing, the depth of the dropped portions C increases continuously to the left of the drawing. The extremity of each of the raised and dropped portions is turned over at right angles to produce a flange. The flanges of the raised portions B can be seen at D and the flanges of the dropped portions can be seen at D'.

In assembling the core, the flanges D' are lined up with the corresponding flanges of the next lower plate in the stack with the edges of a filter member F between them. The flanges and the filter member are sealed together in fluid-tight fashion by crimping, welding, soldering or bonding or they may be held in position by an additional elongated clip. Similarly, the flanges D are lined up with the corresponding flanges of the next higher plate in the stack with the edges of the filter member E between them and are sealed together in the same way as the flanges D'. An assembly of two separator plates A and A' constituting one element of the core is shown in FIGURE 4 and, to clarify the construction of this assembly, parts of the upper plate A are indicated by the suffix **1** and parts of the lower plate A' by the suffix **2**.

In the assembly illustrated at two plates A and A' differ from each other in respect of the relationship between the directions of slope of the flanges. This arrangement is necessary to ensure that the filter members in each path all slope in the same direction. If, however, this feature is not required, the core may be made up from identical plates and in this case the filter members will slope alternately in the two opposite directions.

As can be seen from FIGURE 1, there are a plurality of parallel paths between the inlet **4** and the outlet **5**, each path passing through the space between two of the plates A and A'. A filter member E extends across each of these paths and fluid passing from the inlet 4 to the outlet 5 must pass through one of the filter members E. Similarly, there are a plurality of paths between the inlet 6 and the outlet 7 and each of these paths again extends between two of the plates A and A', one of the filter members F being interposed in each of the paths. The filter members E serve to filter the first fluid and the filter members F serve to filter the second fluid and the plates A provide for the support of the filter members and an exchange of heat between the first and second fluids.

Each of the plates A and A' is provided with a number of protuberances from both its upper and its lower surface. The heights of these protuberances are such that when the plates are assembled the tips of the protuberances hold the respective filter member in a flat inclined position as shown in the drawing. To this end, the protuberances from each surface are arranged in a plurality of parallel rows and the rows of protuberances from the upper surface are perpendicular to the rows of protuberances from the lower surface. The heights of all the protuberances in each row are the same but the heights of the rows increase progressively across each plate. Thus, considering the plate A1 shown in FIGURES 1 and 2, it can be seen that the protuberances G from the upper surface increase in height from the left of FIGURE 1 towards the right and that the protuberances H from the lower surface of the plate increase in height from the right of FIGURE 2 towards the left.

As already pointed out, the end plates of the stack differ from the remaining plates to enable them to be readily sealed to the container and the cover. Thus the top plate J includes the two dropped portions C and the flanges D', but does not include raised portions B or flanges D. Similarly, the lowermost plate K includes the two raised portions B and the flanges D, but does not include dropped portions C or flanges D'. In addition, the upward protrusions G are preferably omitted from the top plate J and the downward protrusions are omitted from the bottom plate K.

The plates A and A' are fabricated from thin sheet material of relatively high thermal conductivity. They may consist, for example, of beryllium copper or stainless steel. The filter members E and F may consist of any suitable filter material, and this will, of course, be selected in accordance with the fluid flowing through the path concerned and with the fineness of the particles it is desired to filter out. In one particular example, the filter members both consist of wire cloth. It is to be understood that the edges of the filter members which are not clamped between the flanges of the plates are sealed to the outsides of the flanges of the upper and lower pairs of plates, respectively. In the case of wire cloth filter elements, this sealing may be performed, for example, by brazing.

If desired, the filter-heat exchanger in accordance with the invention may be constructed as a unit having a permanently installed head including the two inlets and two outlets and a core which can be removed for cleaning, together with its container.

The embodiment of the invention has been illustrated with protuberances generally in the form of right circular cones, but it is to be understood that the protuberances may have any other desired shape, although they preferably have sides sloping either to a point, a dome, or a ridge. The base of each protuberance may be, for example, circular, elliptical or rectangular.

It will be apparent that many other variations may be made in the embodiments described herein without departing from the scope of the invention as defined in the following claims.

What I claim as my invention and desire to secure by Letters Patent of the United States is:

1. In a heat exchanger a thin rectangular plate of impermeable heat-conductive material having raised portions of continuously increasing height on two parallel sides and dropped portions of continuously increasing depth on the other two parallel sides, flanges on said raised and dropped portions, and rows of protuberances from each surface of said plate the heights and depths of said protuberances corresponding to the heights and depths of said raised and dropped portions.

2. A heat exchanger comprising a container provided with inlet and outlet ports for a first fluid and inlet and outlet ports for a second fluid, and a stack of spaced substantially parallel impermeable plates each serving to separate one of a plurality of first spaces providing communication between said inlet and outlet ports for the first fluid from one of a plurality of second spaces providing communication between said inlet and outlet ports for the second fluid, wherein two opposite edges of each of said plates are provided with flanges located on one side of said plate and lying in a first plane inclined to the surface of said plate, wherein the other two opposite edges of each of said plates are provided with flanges located on the other side of said plate and lying in a second plane inclined to the surface of said plate, wherein the two flanges on one side of each plate are secured to co-operating flanges of an adjacent plate by respective fluid-tight seams to form one of said first spaces, wherein the two flanges on the other side of each plate are secured to co-operating flanges of an adjacent plate by respective fluid-tight seams to form one of said second spaces, and wherein filter members are provided in said first spaces, each filter member having two of its edges secured respectively between two of said co-operating flanges and its other two edges sealed respectively to two of said adjacent plates.

3. A heat exchanger as claimed in claim 2, wherein each of said filter members lies substantially in a respective one of said first planes.

4. A heat exchanger as claimed in claim 2, including further filter members in said second spaces.

5. A heat exchanger as claimed in claim 4 wherein each of said further filter members is located substantially in a respective one of said second planes.

6. A heat exchanger as claimed in claim 5, wherein the opposed surfaces of adjacent plates are provided with evenly spaced co-operating protuberances arranged in a regular pattern.

7. A heat exchanger as claimed in claim 6, wherein the protuberances are arranged in rows, wherein in each row the height of all the protuberances is the same, and wherein the heights of the rows increase progressively from one edge of the plate to the opposite edge.

8. A heat exchanger as claimed in claim 7, wherein the protuberances from one surface of each plate terminate substantially in the respective one of said first planes while the protuberances from the other surfaces of each plate terminate substantially in the respective one of said second planes.

9. A heat exchanger as claimed in claim 8 wherein the protuberances are arranged in parallel rows and wherein the protuberances from one surface of each plate co-operate with the corresponding protuberances from the opposed surface of the adjacent plate to grip the respective filter medium between them.

10. A heat exchanger element comprising a pair of spaced impermeable quadrilateral plates, means joining co-operating flanges on two opposite sides of said plates to form two fluid-tight seams, and a quadrilateral filter member having two of its edges secured respectively between said two pairs of flanges, a third of its edges sealed to one of said plates, and its fourth edge sealed to the other plate, wherein said co-operating flanges lie in a plane inclined to both plates, wherein the opposed surfaces of the two plates are provided with inwardly facing contiguous protuberances terminating substantially in said inclined plane, and wherein each of said plates is provided with two further flanges on its other two opposite sides, the flanges of one plate lying in a second plane in-

clined to the surface of said one plate and the flanges of the other plate lying in a third plane inclined to said second plane and to the surface of said other plate.

11. A heat exchanger as claimed in claim **10**, wherein the inwardly facing protuberances co-operate to hold the filter element so that it extends diagonally across the space between said plates from its third edge to its fourth edge.

12. A heat exchanger element as claimed in claim **10**, wherein said one plate is provided with further protuberances terminating substantially in said second plane, and wherein said other plate is provided with further protuberances terminating substantially in said third plane.

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ROBERT A. O'LEAR, *Primary Examiner.*

A. W. DAVIS, *Assistant Examiner.*