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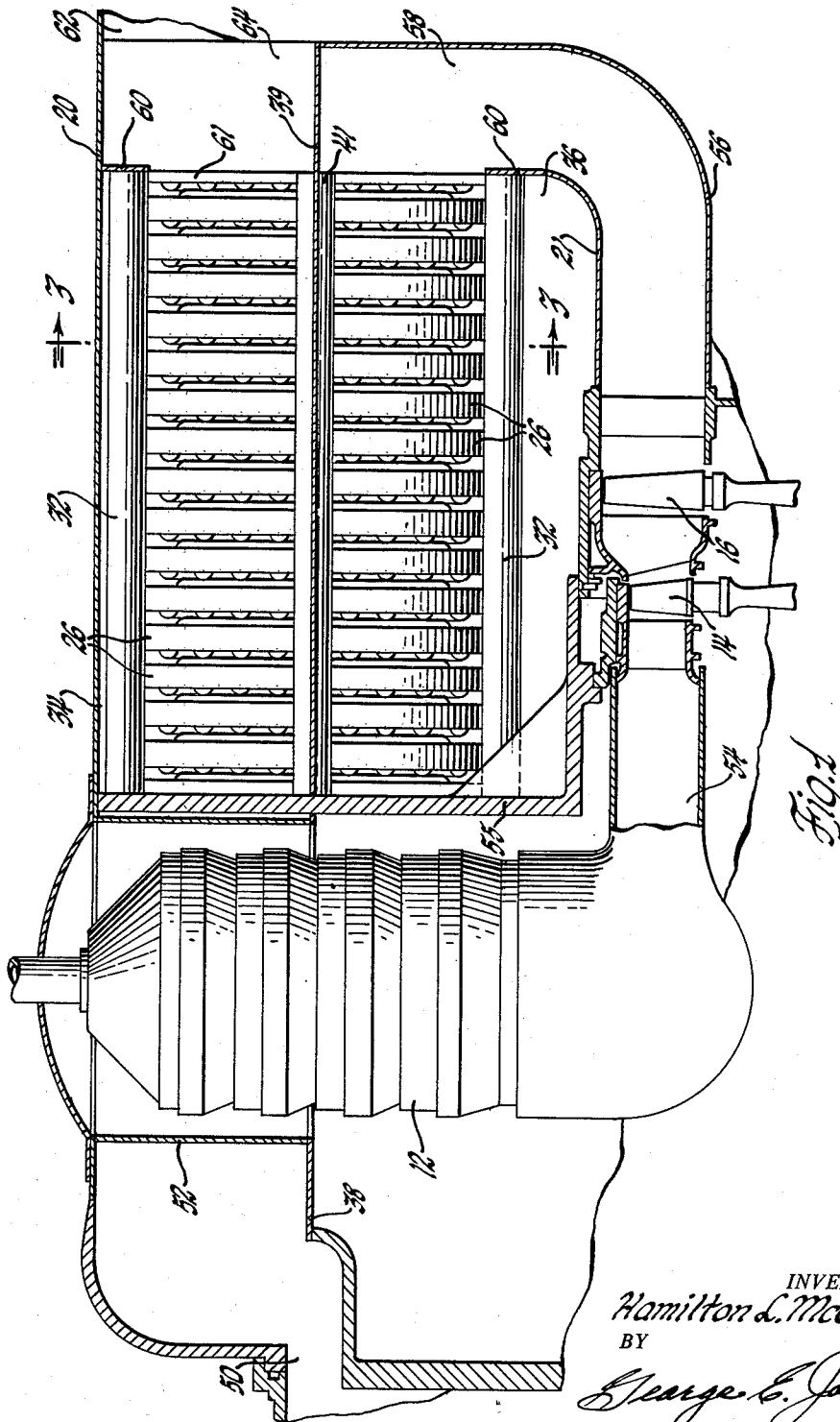
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3,098,522

STACKED PLATE HEAT EXCHANGERS

Filed Aug. 7, 1959

4 Sheets-Sheet 1



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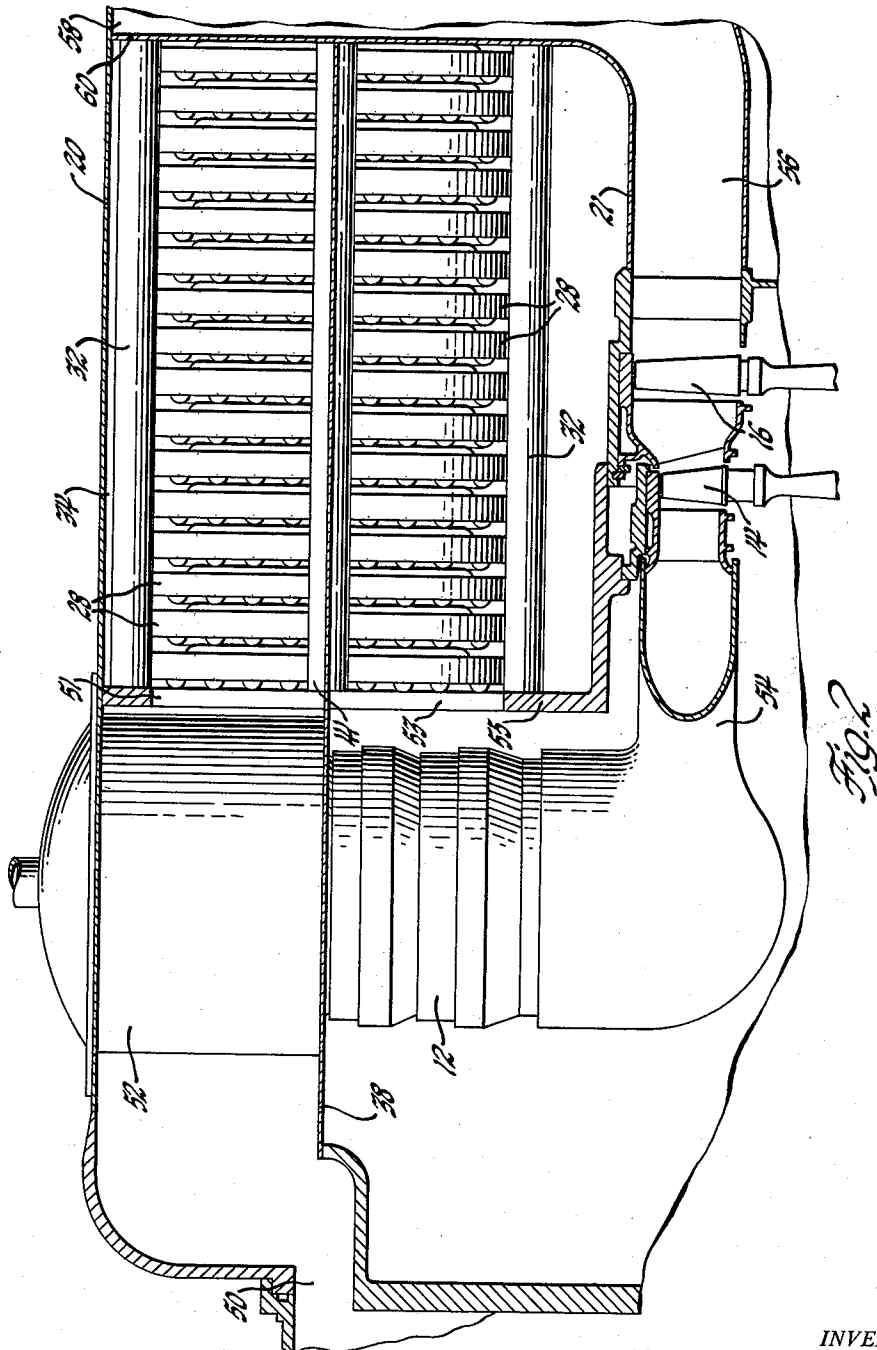


FIG. 2

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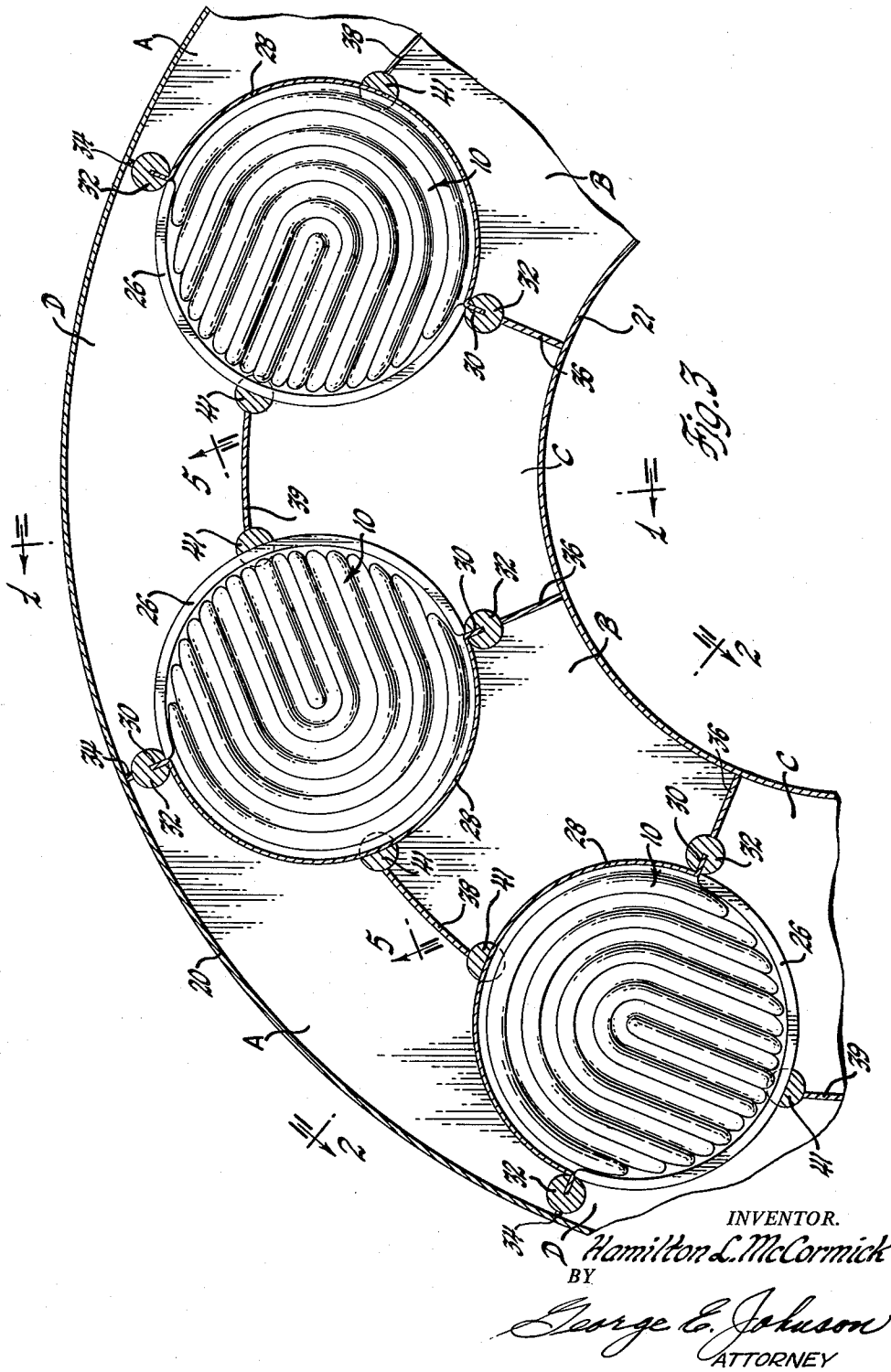
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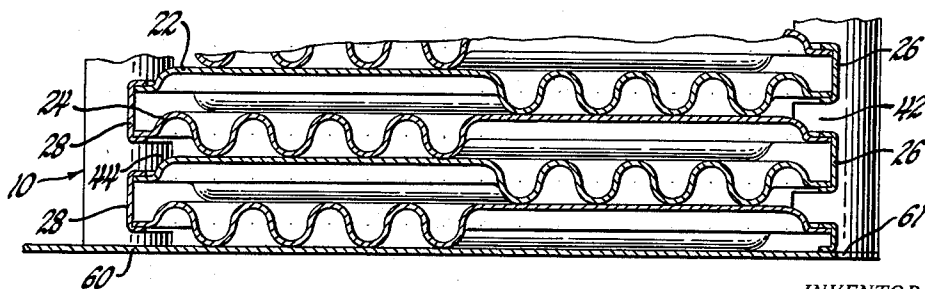
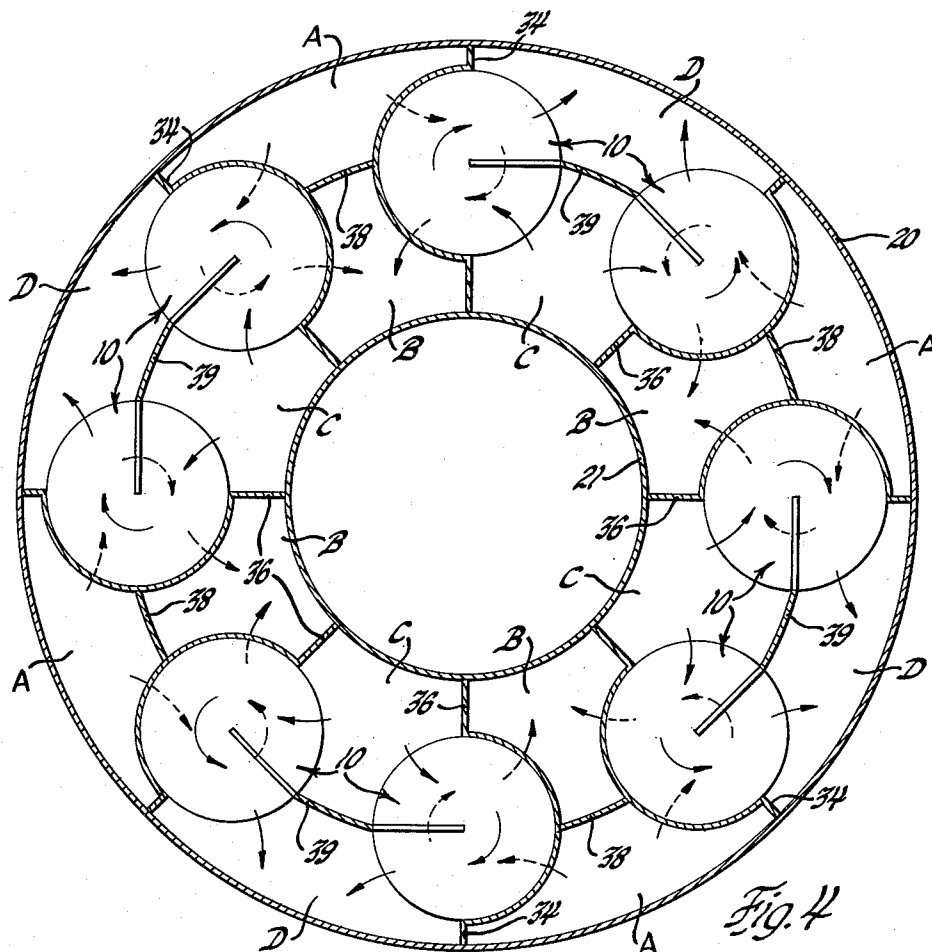


Fig. 5

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STACKED PLATE HEAT EXCHANGERS

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This invention relates to heat exchangers and more particularly to heat exchangers for transferring heat from one gaseous fluid to another.

In the design and use of a regenerative gas turbine engine, it has been found advantageous to provide a "gas-to-gas" heat exchanger that would be light in weight, compact, and also efficient in transferring heat between the two gases. Such a heat exchanger would not be limited to any particular application but the problems confronted in the field of gas turbine engines have necessitated improvements which have evolved constituting the present invention.

One object of the present invention is to provide an improved heat exchanger which is compact, light in weight and efficient in performing its function of transferring heat from one fluid to another.

A feature of the present invention is a heat exchanger comprising a stack of plates each of which is corrugated to present open-ended U-shaped grooves for the conveying of fluids such as gases and in which heat may be transferred between those fluids as they are caused to flow along opposite sides of each plate.

These and other important features of the invention will now be described in detail in the specification and then pointed out more particularly in the appended claims.

In the drawings:

FIGURE 1 is a sectional view looking in the direction of the arrows 1—1 in FIGURE 3 showing a path of fluid to be cooled, which in this case constitutes burner discharge gases, with relation to a heat exchanger structure in which the present invention is embodied;

FIGURE 2 is a sectional view looking in the direction of the arrows 2—2 in FIGURE 3 showing the path of gases including air to be heated by burner discharge gases;

FIGURE 3 is a sectional view looking in the direction of the arrows 3—3 in FIGURE 1 and showing three heat exchangers as part of a circular series or cylindrical arrangement of exchangers and suitable manifolding;

FIGURE 4 is a diagrammatic section view of a circular series of heat exchangers such as shown in FIGURES 1, 2 and 3, the arrangement including manifolding suitable for an installation such as a gas turbine engine; and

FIGURE 5 is an enlarged sectional view through a heat exchanger looking in the direction of the arrows 5—5 in FIGURE 3.

A convenient arrangement for providing a turbine engine with heated air or gases for combustion is a series of heat exchangers within a cylindrical housing encircling the engine for the purpose of extracting heat from the engine exhaust gases. FIGURE 4 shows one arrangement of eight heat exchangers 10. Four burner cans such as the burner can 12 may be radially arranged to operate in conjunction with the exchangers, i.e. one burner can 12 operating with two exchangers 10. Details regarding the burners or the engine are not disclosed herein as they form no part of the present invention. In disclosing a suitable manifolding for conveying the heat supplying and receiving gases to and from the individual heat exchangers, the drawings do, however, show rotor blades 14 and 16 of two turbine stages and suitable baffles or wall structures of sheet metal supplying two separate paths for the gases. In the arrangement of FIGURE 4, the eight heat exchangers 10 are arranged in circular series within an outer housing 20 of cylindrical contour.

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Coaxial with this outer housing is an inner housing 21 which is adapted to encircle the turbine engine components including the blades 14 and 16.

Each heat exchanger 10 comprises a stack of circular plates 22 and 24. Each plate 22 or 24 is corrugated in such a way as to present substantially U-shaped grooves or ridges with the grooves being open ended in the assembly of each stack as hereinafter appears more fully. Each set of adjacent plates 22 and 24 is connected by a half ring 26 or 28 to form a seal between them for an arcuate distance of 180° at alternate sides of the exchanger. The ends of these half rings fit into slots 30 formed in diagonally opposed bars 32 extending lengthwise of each heat exchanger. The outer bars 32 are each joined to the outer housing 20 by means of a baffle plate 34. The inner bar 32 of each heat exchanger is joined to the inner wall 21 by a baffle plate 36. Adjacent heat exchangers 10 are connected together by means of alternate baffle plates 38 and 39.

As seen in FIGURES 1, 2 and 3, the inner and outer housings 21 and 20 cooperate with a baffle plate 38 to form two chambers A and B on one side of each heat exchanger 10 and with a baffle plate 39 to form two chambers C and D on the other side of each heat exchanger. Looking at the entire heat exchanger arrangement from a section viewpoint, FIGURE 4 clearly shows the over-all arrangement.

With regard to the heat exchanger structure, it can be seen from FIGURE 5 that the ridges formed in each imperforate plate 22 or 24 contact the ridges of each of the adjacent but reversed plates. It will also be noted that the half rings 26 and 28 form seals between adjacent plates independent of the grooves and that the grooves of each plate have open ends connecting with the manifolding of the entire arrangement. Hot gas entering through an opening 42 between half rings 26 from a chamber C will flow straight in between a set of the corresponding plates 22 and 24 then follow the grooves through a 180° turn and return by means of straight grooves to the manifolding—the chamber D at the other side of a baffle plate 39. It will also be seen that relatively cool gases entering through an opening 44 (FIGURE 5) from a chamber A will pass between half rings 28 and through the open ends of grooves formed by the corrugations in the corresponding plates, turn 180° and then enter a chamber B of the manifolding at the other side of a baffle plate 38. The two gases, therefore, will flow in separate paths leading along opposite sides of each plate, this arrangement facilitating heat transfer between the two.

In the arrangement as shown in FIGURES 1 and 2, gases to be heated and including air are adapted to enter through port 50 and surround a cylindrical wall 52 which encircles one end of a burner can 12. The baffling is such that these gases enter ports 51 (FIGURE 2) in a radial wall 55 and are admitted to the chambers A between the baffles 38 and the outer housing 20. These gases leave each of these chambers by way of the ports 44 of two adjacent heat exchangers 10. After reversing the direction of flow of those gases in each heat exchanger, those gases are discharged into the corresponding chambers B and are then caused to flow through an opening 53 (FIGURE 2) in the radial wall 55 to the zone around each burner can 12. These gases are consumed in the burner and are discharged by means of ducts such as the duct 54 to the blades 14 and 16 and are then led by ducts such as the duct 56 to a zone 58. The latter is separated from the heat exchangers by a radial wall 60. Inside the baffle 39 the radial wall 60 is apertured (see FIGURE 1) to permit these hot gases to enter a chamber C. The gases then enter the openings 42 between plates and impart their heat to the gases which have entered at 50. They then pass to the chambers D. These gases are

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then discharged from the chambers D by way of openings 61 in the wall 60 to an annular zone 64 outside the baffles 39. Duct work 62 receives the gases for ultimate discharge or exhaust.

The partitions 38 and 39 are suitably joined to bars 41 in such a way that gases cannot pass directly from a chamber A to a chamber B or from a chamber C to a chamber D but are constrained to flow through the U-shaped grooves of the heat exchangers 10. This is conveniently done by notching the bars 41 tightly to receive the half rings 26 and 28. A more comprehensive description of the baffles, radial walls and other details making up the manifolding is not included herein as those details may take any of numerous forms in order properly to serve the heat exchangers 10. The latter are shown as being cylindrical but they could be elliptical in section or have straight "runs" for substantial groove lengths if such designs are preferred in given installations. Not only is this latitude in section possible but furnace brazing of the plates into a unitary structure for each heat exchanger is contemplated. Also, a stock thickness in the order of .010 to 0.25 inch is acceptable for regenerative gas turbine use. The number of corrugations, the over-all dimensions and number of plates may be varied depending upon heat transfer requirements. The radial walls 55 and 60 are not corrugated as they form end plates for the series of exchangers.

From the above, it can be seen that each heat exchanger 10 constitutes a compact, lightweight and efficient heat exchanger arrangement of corrugated plates 22, 24 and that each stack of plates is such as to permit ease and low cost of manufacture.

I claim:

1. A heat exchanger comprising a stack of sheet metal plates, each of said plates being corrugated to form two sets of U-shaped ridges, said two sets defining open ended grooves on opposite sides of the given plate, the open ends of the grooves of said two sets being oppositely directed, the ridges of each of said plates being in contact with the ridges of an adjacent plate, manifolding surrounding said heat exchanger, baffles in said manifolding cooperating with the latter in defining four separate chambers outside said stack and extending the length of the latter, two of said chambers being in communication with opposite open

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ends of said grooves as defined by alternate plates and adapted to conduct one fluid, the other two of said four chambers being in communication with opposite open ends of those grooves defined by the plates separated by said alternate plates and adapted to conduct a second fluid, said manifolding defining four ports, each of said four ports communicating with one of said four separate chambers, and the arrangement being such that each of said fluids will flow through one of said ports, into one of said chambers, through said stack between adjacent plates, into another of said chambers and out from another of said ports.

2. An annular arrangement of heat exchangers each being in the form of a stack of plates as set forth in claim 1, said exchangers being retained by said baffles between two telescopically arranged housings cooperating with the baffles in forming portions of said manifolding, the chambers of said exchangers for handling said one fluid forming spaces separating said exchangers into pairs, the chambers of said exchangers for handling said second fluid each forming a space separating the exchangers of one pair of exchangers, some of the ports of said exchangers being located at one end of said annular arrangement for conducting said one fluid, and the remainder of said ports of said exchangers being located at the other end of said annular arrangement for conducting said second fluid.

3. An arrangement of heat exchangers as set forth in claim 2, said housings and heat exchangers each being cylindrical with their axes parallel, the plates of the heat exchangers each extending in a plane transverse to said axes, and the said baffles extending in planes parallel with said axes.

References Cited in the file of this patent

UNITED STATES PATENTS

574,157	Ljungstrom	Dec. 29, 1896
1,720,536	Young	July 9, 1929
2,131,265	Bichowsky	Sept. 27, 1938
2,136,153	Rosenblad	Nov. 8, 1938
2,348,020	Norris	May 2, 1944
2,677,531	Hock et al.	May 4, 1954
2,870,608	Comyns-Carr	Jan. 27, 1959
2,946,192	Hambling	July 26, 1960