

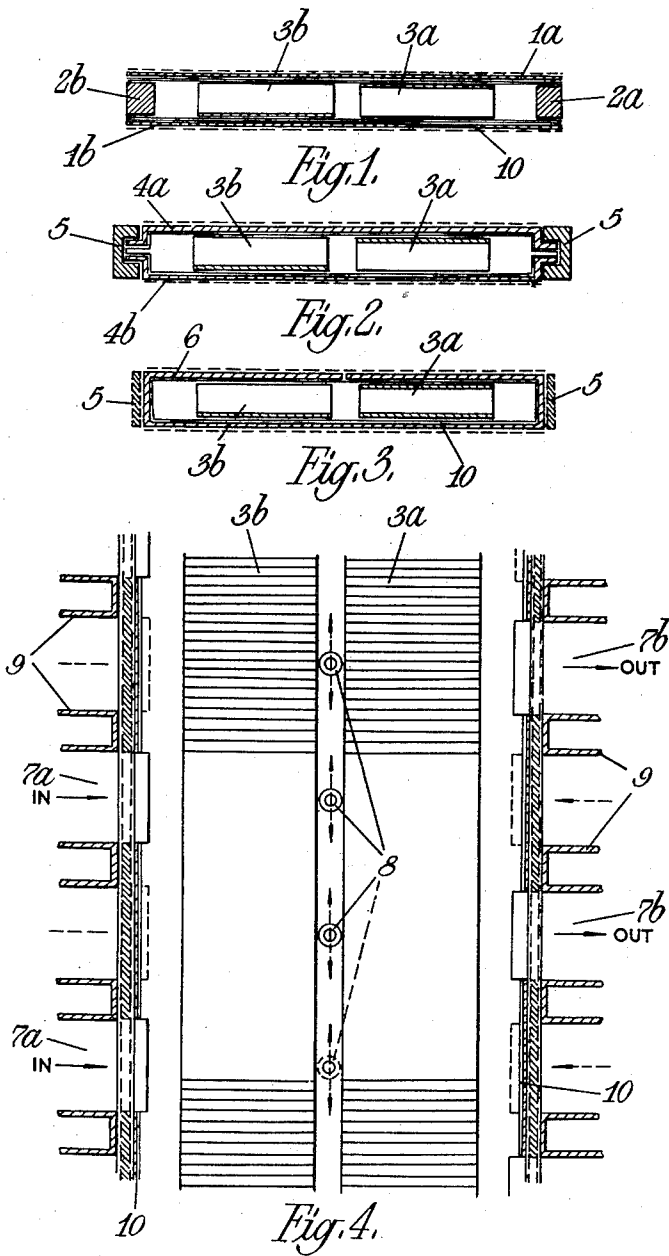
Dec. 20, 1960

W. HRYNISZAK
HEAT EXCHANGERS

2,965,359

Filed April 16, 1957

4 Sheets-Sheet 1



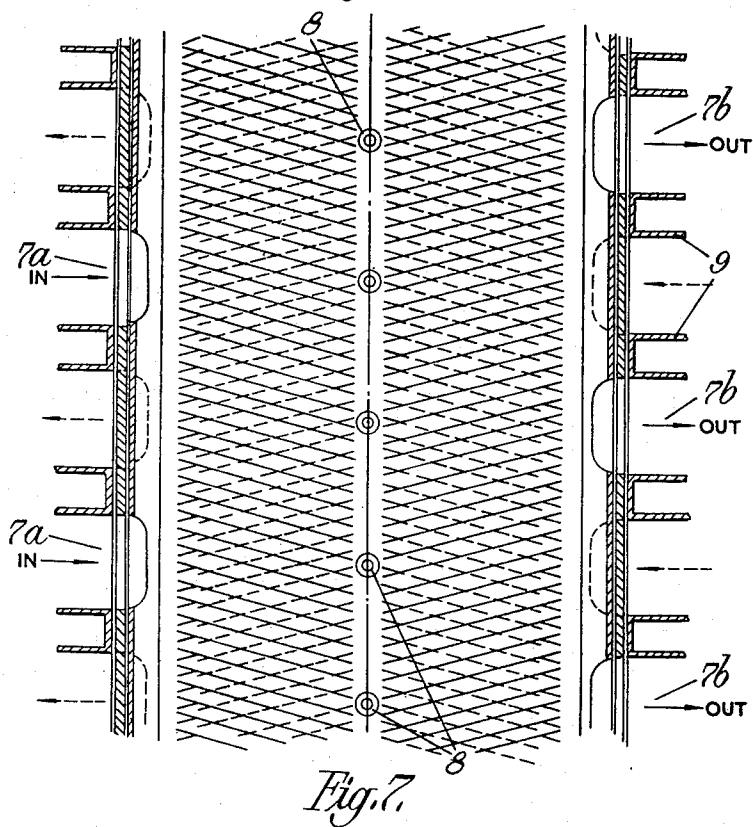
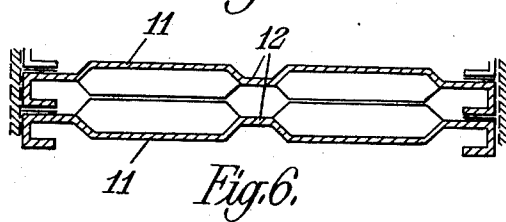
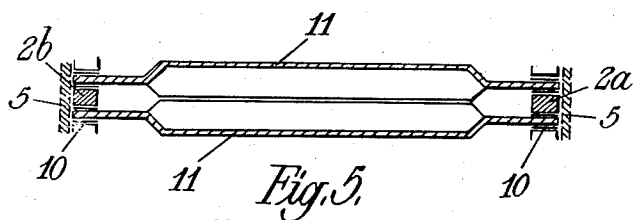
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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

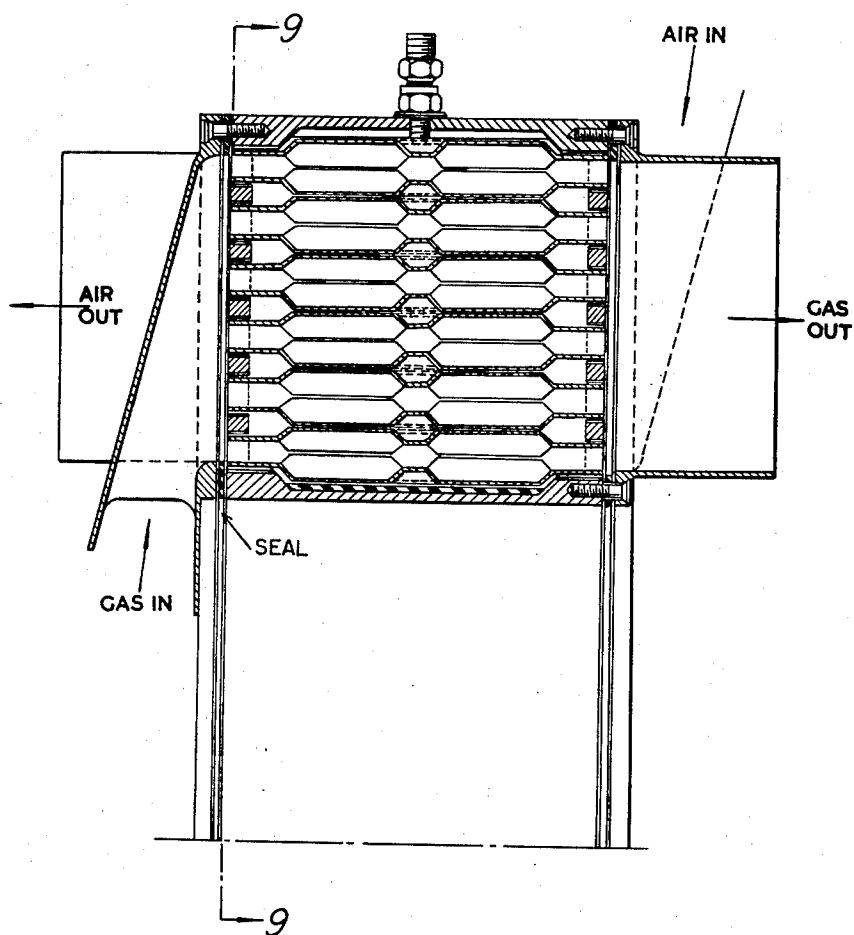


Fig. 8.

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4 Sheets-Sheet 4

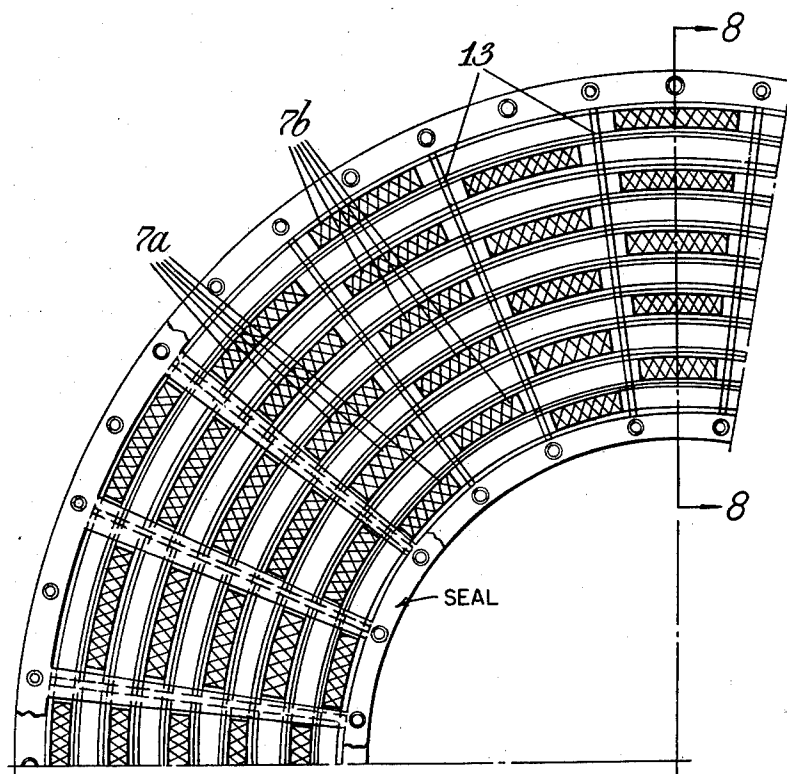


Fig. 9.

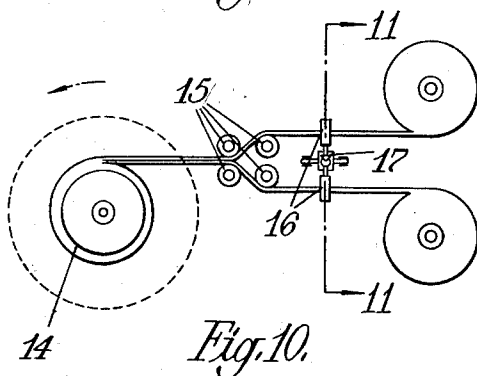


Fig. 10.

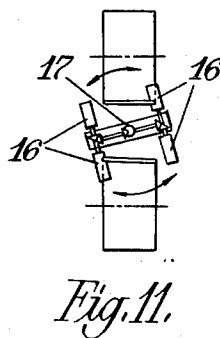


Fig. 11.

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HEAT EXCHANGERS

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8 Claims. (Cl. 257—245)

This invention relates to heat exchangers of the plate type that is to say of the type which comprise a number of spaced sheets the spaces between the sheets forming flow channels for heat exchanging fluids which flow channels may be further subdivided by corrugations.

The object of the present invention is to provide a heat exchanger of the above type which is easy to manufacture and assemble and suitable for large scale production.

The invention consists in a plate type heat exchanger comprising a plurality of pairs of spaced sheets having side walls at the peripheral edges thereof forming flow channels of rectangular form, the spaces between the sheets being interrupted by corrugated inserts or by corrugating the sheets themselves, the length of said corrugations being such that spaces are formed between their ends and the side walls, and inlet and outlet openings being formed in said side walls said openings in one wall being in staggered relationship to the openings in the other wall the arrangement being that hot fluid channels alternate with cold fluid channels.

The invention further consists in a heat exchanger in accordance with claims 2 to 11 below.

The invention also consists in plate type heat exchangers substantially as described below with reference to the diagrammatic drawings in which:

Figures 1-4 show various forms of flow channel in which corrugated inserts form secondary heat exchange surfaces;

Figures 5 to 7 show various forms of flow channel in which the corrugated parts form a primary heat exchange surface;

Figures 8 and 9 show a sectional view of heat exchanger in accordance with one form of the invention;

Figures 10 and 11 illustrate details of a manufacturing process for making a heat exchanger in accordance with the present invention.

Referring to Figure 1 a flow channel comprises two flat sheets 1a, 1b separated by walls 2a, 2b. In the space formed between the walls 2a, 2b and flat sheets 1a, 1b are two corrugated inserts 3a, 3b both identical in shape and size and spaced apart from each other. The corrugations run at right angles to the walls 2a, 2b and, to enable heat exchanging fluid to enter the flow channel, inlets and outlets are cut in the said walls as will be described more fully later with reference to Figure 4. It is preferred that the inlets and outlets be in staggered relationship to one another to ensure an even distribution of fluid through the spaces formed by the corrugations.

Figure 2 shows a form of flow channel comprising two sheets 4a, 4b having their edges bent so as to abut one another thus forming a space for corrugated inserts 3a, 3b as before. Walls 2a, 2b are thus no longer required. Inlet and outlet openings are cut in the bent edges as before, after brazing the parts together. In this form the thickness of metal in the path of hot fluid

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is only that of the sheets 4a, 4b which should be as thin as possible as heat transfer takes place between those sheets in adjacent flow channels as will be more fully described later. To prevent burning through of the bent portions the channels can be supported in heat resistant material 5 as shown.

In Figure 3 a sheet 6 is bent so as to form a space of rectangular cross section and in it are placed corrugated inserts 3a, 3b. As in the case of the form shown in Figure 2 the parts of the sheet fulfilling the function of walls 2a, 2b in Figure 1 need protection from hot fluid by a heat resistant material 5.

A plan view of the flow channel of Figure 3 is shown in Figure 4. The staggered relationship of inlets 7a and outlets 7b for the flow channel are shown and ducts 8 are provided in the space between corrugated inserts 3a, 3b for the introduction of a cleaning fluid if desired. The cleaning fluid may flow in either direction through the channel passing through the inlet and outlet openings during a time when the supply of heat exchanging fluid to the channel is cut off. Seals between the various openings are shown at 9, these seals abutting against the side walls of the heat exchanger in which the inlets and outlets 7a and 7b are formed.

The parts of each flow channel can be made by rolling from strip and may be assembled automatically with strips of brazing material 10 between the various parts, the assembly then being heated to melt the brazing material. After brazing the completed flow channel has the inlet and outlet openings cut and then the requisite lengths cut off for each heat exchanger.

Alternatively the assembled flow channel may be wound around a spool in manner to be described later for instance in connection with Figures 8 and 9.

In all the flow channels shown in Figures 1-3 the corrugated inserts act as secondary heat exchange surfaces that is to say they increase the heat transfer area in the flow channel but each side of the corrugation is subjected to the same heat exchanging fluid.

In Figure 5 sheets 11, which are spaced from each other by walls 2a, 2b are themselves corrugated to avoid the use of separate corrugated inserts. The corrugations are bounded on either side by flat marginal portions which are held between the walls 2a, 2b. As the corrugations of adjacent sheets rest one on the other the corrugations are disposed so that the corrugations of one sheet are at an angle to those of the sheets in contact therewith. As before the parts forming a flow channel can be brazed together using strips of brazing foil 10. The walls 2 can be protected by insulating material 5.

In Figure 6 which may be regarded as illustrating the use of single plates with their edges turned over the walls 2a, 2b of Figure 5 are replaced by bending the edges of the sheets 11. In the form shown the corrugations of the sheets 11 are interrupted between the flat marginal portions by a flat part 12 in which ducts 8 (see Figure 7) may be provided to permit the introduction of cleaning fluid to flow in the channels, if required, when the supply of heat exchanging fluid has been cut off.

The corrugations of each sheet 11 in the case of Figure 5 are disposed so that the corrugations of adjacent sheets are at an angle to one another. The corrugations may all run in the same direction in one sheet or they may be disposed at an angle to each other on either side of flat portion 12 as shown more clearly in the plan view of Figure 6 shown in Figure 7.

Inlets 7a and outlets 7b cut in walls 2 and the insulating material 5 in the case of Figure 5 and in the insulating material 5 and end portions of sheet 11 in the case of Figure 6 are staggered as shown. Seals 9 separate the various openings.

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In the form of Figures 5 and 6 the corrugated portions are part of sheet 11 and hence form the dividing walls between flow channels; they thus form primary heat exchange surfaces as they are in contact with hot fluid on one side and a cold fluid on the other.

Flow channels of the forms described in Figures 1-3 or 5-6 can be assembled one on top of the other in the form of a column or stack, channels for hot fluid alternating with channels for cold fluid or, as shown in Figures 8 and 9, wound in the form of a continuous strip around a spool. In this way a plurality of inlets and outlets are formed on an annulus and the heat exchanger is in a convenient form for use with gas turbine plant where annular ducts are necessary.

Figure 8 is a section on the line 8-8 of Figure 9 and Figure 9 is a section on the line 9-9 of Figure 8.

Radial grooves 13 are formed in the end walls of the heat exchanger as shown in Figure 9 and these grooves accommodate seals separating the inlets and outlets.

In the form illustrated in Figures 8 and 9 which may be regarded as showing the use of pairs of flat tubes wound around a spool the openings for each flow channel have to be cut in a certain way. This is carried out by assembling two flow channels completely and brazing them together, the two channels being in the form of long strips. One end of each strip is then fixed to a spool 14 as shown in Figure 10 and the spool caused to rotate. The feeding of the two flow channels strips is controlled by rollers 15. Four cutters 16 are assembled on a tool 17 which can be oscillated around an axis parallel to the strips so that the openings are cut simultaneously either on the right side of the uppermost strips and on the left side of the lower strip or vice versa depending on the position of the cutters. The speed of the spool is increased as the diameter of the heat exchanger assembly on the spool increases so that the openings are radially in line.

Figure 11 shows sections on the line 11-11 of Figure 10 looking in the direction of the arrows and shows the four cutters 16 in one cutting position.

In the complete heat exchanger shown in Figure 9 the inlets 7a are in radial alignment with each other and so are the outlets 7b, sectors containing inlets 7a alternating with sectors containing outlets 7b.

I claim:

1. A plate type heat exchanger comprising a plurality of pairs of spaced sheets having side walls at the peripheral edges thereof forming flow channels of rectangular form, corrugated sheet material interrupting the spaces

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between the said spaced sheets, the length of the corrugations thereof being such that spaces are formed between their ends and the side walls, and inlet and outlet openings being formed in said side walls said openings in one wall being in staggered relation to the openings in the other wall, the arrangement being that hot fluid channels alternate with cold fluid channels.

2. A heat exchanger in accordance with claim 1 in which each pair of sheets are formed from continuous strips of metal and two such pairs, arranged one above the other, are wound around a spool the heat exchanging fluids flowing through the spaces between each pair of sheets in a direction substantially parallel to the axis of the spool.

3. A heat exchanger in accordance with claim 2, in which the inlets and outlets for hot fluid are respectively in radial alignment with each other but displaced circumferentially respectively from respectively radially aligned outlets and inlets for cold fluid.

4. A heat exchanger in accordance with claim 3, in which the end faces of the heat exchanger have radially extending grooves between the radially aligned rows of inlets and outlets in which grooves seals are situated to restrict leakage between the hot fluid path and the cold fluid path.

5. A heat exchanger in accordance with claim 4, in which on each side of the heat exchanger the hot fluid is conducted to and from the heat exchanger by a series of ducts interleaved with ducts conducting cold fluid to and from the heat exchanger.

6. A heat exchanger in accordance with claim 5, in which the side walls are formed by turning over the edges of each sheet.

7. A heat exchanger in accordance with claim 6, in which the corrugations are formed in the sheets themselves and the corrugations of one sheet are disposed in angular relation to the corrugations of adjacent sheets.

8. A heat exchanger in accordance with claim 7, in which the corrugations are interrupted intermediate their ends by a flat portion which flat portion has holes therein to which a cleaning fluid can be communicated.

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