Oct. 8, 1940. T. K. E. KALLSTENIUS 2,217,316

PLATE STACK HEAT EXCHANGER

Filed Nov. 26, 1938 2 Sheets-Sheet 1

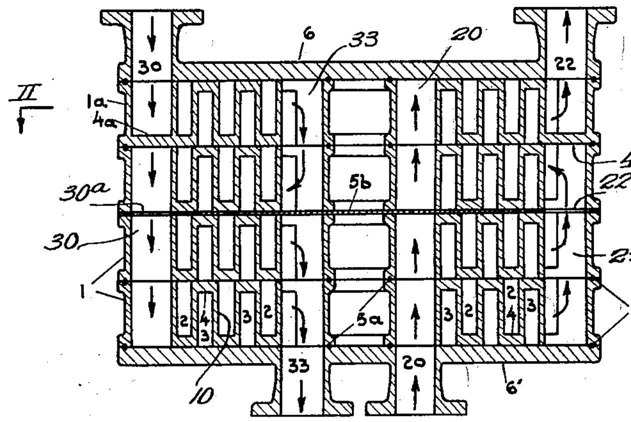


FIG. 1.

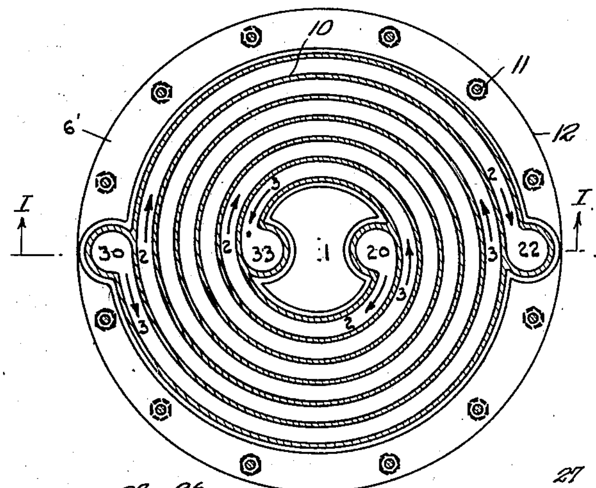


FIG. 2.

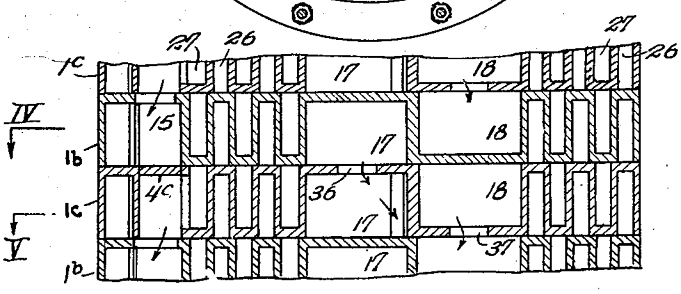


FIG. 3.

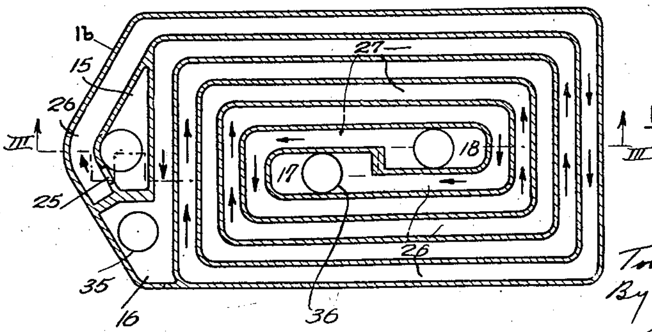


FIG. 4.

Inventor:

Torsten K. E. Kallstenius

By Daniel C. Marble

his Attorney

Oct. 8, 1940. T. K. E. KALLSTENIUS 2,217,316

PLATE STACK HEAT EXCHANGER

Filed Nov. 26, 1938 2 Sheets-Sheet 2

FIG. 2a.

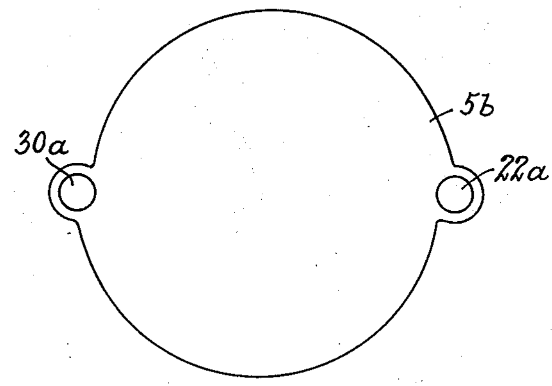
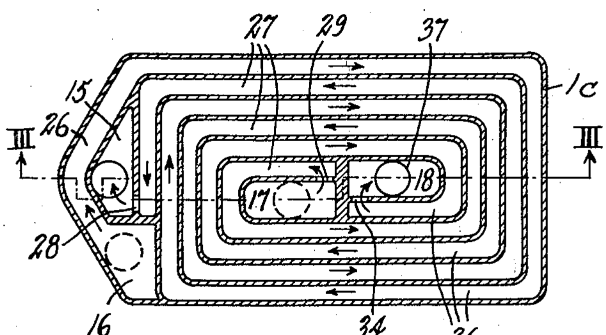


FIG. 5.



INVENTOR.
Torsten Karl Edmund Kallstenius
BY
Janis C. Marble
his ATTORNEY.

Patented Oct. 8, 1940 2,217,316

UNITED STATES PATENT OFFICE

2,217,316

PLATE STACK HEAT EXCHANGER

Torsten Karl Edmund Kallstenius, Stocksund, Sweden, assignor, by mesne assignments, to American Heat Reclaiming Corporation, New York, N. Y., a corporation of New York

Application November 26, 1938, Serial No. 242,457
In Sweden November 30, 1937

4 Claims. (Cl. 257—245)

My invention relates to fluid heat exchangers and more particularly to exchangers of the spiral flow type.

In accordance with my invention I provide a heat exchanger of this kind made up of a plurality of similar sections secured together so that the fluids may flow through the different sections either in series or in parallel. One of the advantages of my improved heat exchanger is that its capacity may be varied by adding or subtracting sections. Inasmuch as the sections may be arranged for parallel flow, an addition of sections increases the volume of fluid which may be handled by the heat exchanger, as well as increasing the heat transfer area.

One of the objects of my invention is to provide, in a heat exchanger of this type, spiral channels having a substantially rectangular cross-section. Such cross-section not only makes possible a maximum heat transfer area, but also gives a substantially constant velocity of flow of the fluids, thereby reducing the tendency for any solids to be precipitated.

Another object of my invention is to utilize the crests of the channels in one section for closing the opened edges of the channels in an adjacent section. In accordance with one embodiment of my invention different fluids are caused to flow in corresponding channels in adjacent sections, whereby heat is transferred through these closures at the edges of the grooves, as well as through the spiral walls between the different grooves in each section.

Further objects and advantages of my invention will be apparent from the following description considered in connection with the accompanying drawings, which form a part of this specification and of which:

Fig. 1 is a cross-sectional view of one embodiment of my invention and is taken on the line I—I of Fig. 2;

Fig. 2 is a cross-sectional view taken on the line II—II of Fig. 1;

Fig. 2*a* is a top view of an element forming part of the heat exchanger illustrated in Fig. 1;

Fig. 3 is a cross-sectional view of another embodiment of my invention, and is taken on the lines III—III of Figs. 4 and 5;

Fig. 4 is a cross-sectional view taken on the line IV—IV of Fig. 3; and

Fig. 5 is a cross-sectional view taken on the line V—V of Fig. 3.

Referring more particularly to Figs. 1, 2 and 2*a*, reference characters **1** and **1*a*** designate generally the plate sections of which the heat exchanger is made up. Each section **1** includes spiral walls **10** which are alternately connected together at their top and bottom edges by radial walls **4**. The walls **4** and **10** thus define a pair of spiral channels **2** and **3**, the walls **4** constituting crests of the grooves forming these channels. As will be seen, the channels in each plate are open at one edge, but these open edges are closed by the walls **4** in adjacent plates, with the exception of the channels formed in the end sections, which are closed by headers **6** and **6'**.

Each plate section is also formed to provide inlet manifolds **20** and **30** and outlet manifolds **22** and **33**. The spiral channel **2** of each section is connected at one end to an inlet manifold **20** and at the opposite end to outlet manifold **22**, while the spiral channel **3** is connected at one end to inlet manifold **30** and at the other end to outlet manifold **33**.

Section **1*a*** is the same as sections **1**, except that it is provided with a radial wall **4*a*** which closes one end of inlet manifold **30** and outlet manifold **22**. Header **6** is provided with an inlet manifold **30** and an outlet manifold **22**, while **6'** is formed with an inlet manifold **20** and an outlet manifold **33**.

Any suitable packing means, such as is designated by **5*a*** may be provided for preventing leakage between the adjacent sections. As shown, a gasket **5*b*** is provided between two of the sections **1**. The configuration of this gasket is clearly shown in Fig. 2*a*, from which it will be seen that it is provided with openings **22*a*** and **30*a***, which are in alignment with manifolds **22** and **30**, respectively. The remainder of the gasket is solid and therefore it prevents communication between manifolds **20** in the sections on either side of the gasket, and between manifolds **33** in such sections. The sections are secured together between the headers by means of tie-bolts **11** which extend through flanges **12** formed on the headers.

The operation of the above described heat exchanger is as follows:

Fluid entering manifold **30** in header **6** flows into header **30** in section **1*a*** and thence through spiral channel **3** to manifold **33** in this section. Inasmuch as this manifold is in direct communication with manifold **33** in plate section **1** immediately therebelow, the fluid flows into this manifold and through spiral channel **3** to manifold **30**. Gasket **5*b*** prevents the flow of fluid from the manifold **33** directly above the gasket to the similar manifold formed in the section immediately below the gasket. However, the opening **30a** in the gasket permits flow of fluid from the manifold **30** in the section immediately above the gasket to the similar manifold in the section below the gasket. Inasmuch as this manifold is in direct communication with manifold **30** in the lowermost section, the fluid flows in parallel through the channels **3** in the two lower sections and into the manifolds **33** in each of these sections. From here it is discharged through the manifold **33** in the lower header **6'**.

The other fluid is admitted through the manifold **20** in header **6'** and flows into the manifolds **20** in the two lower sections, inasmuch as all of these manifolds are in direct communication. The fluid flows in parallel through the spiral channels **2** in the two lower sections, and into the manifolds **22**. From here the fluid flows through the opening **22a** in the gasket **5b** and thence through the spiral channel **2** in the section immediately above the gasket. From this channel the fluid is discharged into the manifold **20**, which is in direct communication with the corresponding manifold in section **1a**, from where the fluid flows through channel **2** to the manifold **22** in section **1a**, and thence out through the manifold **22** in header **6**.

Thus it will be seen that the flow of both fluids is in series through the two uppermost sections, and in parallel through the two lowermost sections. It will be noted that the fluid which is admitted through manifold **30** in header **6** always flows through a spiral channel **3** in each of the sections, while the fluid admitted through manifold **20** in header **6'** always flows through the spiral channel **2**. Thus, inasmuch as the same fluid is flowing in corresponding channels in the different sections, little or no heat transfer takes place through the walls **4** forming the crests.

In the embodiment illustrated in Figs. 3 through 5, the arrangement is such that dissimilar fluids flow through the corresponding channels in adjacent plate sections, and therefore the walls forming the crests, as well as the spiral walls serve to transfer heat. In this embodiment the heat exchanger is made up of a plurality of plate sections **1b** and **1c** arranged alternately. In Fig. 4 there is shown a cross-section taken through a plate **1b** while Fig. 5 shows a cross-section taken through a plate **1c**. Each plate is arranged to provide manifolds **15**, **16**, **17** and **18**. As appears in Fig. 4 manifold **15** of section **1b** is connected through an opening **25** with a channel **26**. The opposite end of this channel communicates with manifold **17**. Manifold **16** is connected to a channel **27**, the opposite end of which is connected to manifold **18**. In plate section **1c**, on the other hand, as appears from Fig. 5, manifold **15** is connected through an opening **28** with channel **27**, while the other end of this channel is connected through an opening **29** with manifold **17**. The other channel **26** communicates at one end with manifold **16**, while at the opposite end it is connected through an opening **34** with manifold **18**.

In plate **1b** manifold **15** is opened at both ends, while in plate **1c** this manifold is closed at the upper end by means of a radial wall **4c**. Manifold **16** in plate **1c** is formed with an opening **35** in its lower wall, as is shown in Fig. 4, but in plate section **1c** there is no corresponding opening, as appears from Fig. 5. Manifold **17** in section **1b** is closed at the top by a solid wall, while manifold **17** in section **1c** has an opening **36** in its upper wall. Manifold **18** in section **1b** has a solid bottom wall, while the manifold in section **1c** has an opening **37** formed in its bottom wall.

The flow of fluids through the above described heat exchanger is as follows:

Fluid admitted through the open upper end of manifold **15** in plate section **1b** flows therefrom through opening **25** into channel **26**. The fluid flows from the opposite end of this channel into manifold **17** and thence through the opening **36** into the corresponding manifold **17** in plate section **1c**. From this manifold the fluid flows through opening **29** into channel **27** and from this channel through the opening **28** to manifold **15**. Thus, the fluid has passed through channel **26** in section **1b**, but in channel **27** in the section **1c**. Fluid which is admitted into manifold **18** in section **1b** flows therefrom through passage **27** in this section to manifold **16**. From this manifold it flows through opening **35** into the corresponding manifold in section **1c** and thence into channel **26** in this section and through opening **34** into manifold **18**. Consequently, this fluid has passed through channel **27** in section **1b**, but through channel **26** in section **1c**. Consequently, different fluids flow through corresponding channels in adjacent plates and therefore an exchange of heat takes place through the walls forming the crests of the channels and which separate corresponding channels in the adjacent plates. In this manner, the entire metal wall area of the sections forming the heat exchanger is utilized for heat transfer.

While I have shown and described two more or less specific embodiments of my invention, it is to be understood that this has been done for the purpose of illustration only, and the scope of my invention is not to be limited thereby but is to be determined from the appended claims.

I claim:

1. A heat exchange apparatus comprising plates with convolute flow channels of a substantially rectangular cross-section formed by grooves in opposite faces of each plate so as to present facial crests between grooves on both sides, said plates being assembled face to face in abutting position so that the channels of any one intermediate plate have the open sides thereof closed by the abutting crests of adjacent plates and means for connecting the ends of successive channels of adjacent plates.

2. A heat exchange apparatus comprising plates with convolute flow channels of a substantially rectangular cross-section formed by grooves in opposite faces of each plate so as to present facial crests between grooves on both sides, said plates being assembled face to face in abutting position so that the channels of any one intermediate plate have the open sides thereof closed by the abutting crests of adjacent plates, and means for connecting the respective channels of adjacent plates so that the channels which are connected together are radially out of alignment.

3. A heat exchanger apparatus comprising plates with convolute flow channels of a substantially rectangular corss-section formed by grooves in opposite faces of each plate so as to present facial crests between grooves on both sides, said plates being assembled face to face in abutting position so that the channels of any one intermediate plate have the open sides thereof closed by the abutting crests of adjacent plates, and means for connecting the ends of successive channels of adjacent plates comprising inner and outer open ended chambers formed in each plate,

each channel being connected at one end to an outer chamber and at the other end to an inner chamber, corresponding chambers in the different plates being in alignment and in communication with each other to form manifolds, whereby corresponding channels in the different plates are connected for parallel flow therethrough.

4. A heat exchange apparatus comprising plates with convolute flow channels of a substantially rectangular cross-section formed by grooves in opposite faces of each plate so as to present facial crests between grooves on both sides, said plates being assembled face to face in abutting position so that the channels of any one intermediate plate have the open sides thereof closed by the abutting crests of adjacent plates, and means for connecting the channels of adjacent plates comprising a pair of inner chambers and a pair of outer chambers, each channel being connected at one end to an inner chamber and at the other end to an outer chamber, the chambers in any plate being directly in communication with corresponding chambers in one adjacent plate and separated from corresponding chambers in the other adjacent plate, and communicating chambers being connected to non-corresponding channels in adjacent plates, whereby the connected channels in adjacent plates are radially out of alignment.

TORSTEN KARL EDMUND KALLSTENIUS.