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[54] **HEAT EXCHANGER OF THE TUBE AND PLATE TYPE**
9 Claims, 3 Drawing Figs.

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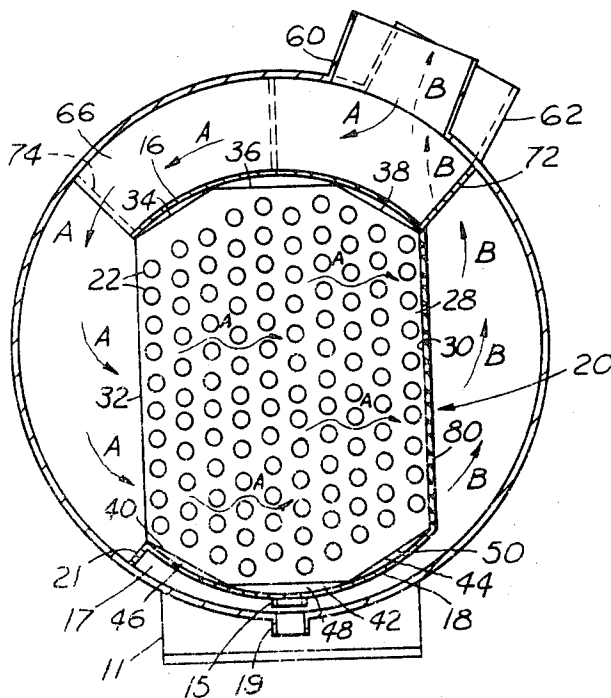
[50] Field of Search.....165/159-163.
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ABSTRACT: A heat exchanger having an outer shell with an elongated upper support place and an elongated lower support plate mounted in the shell. A tube bundle slidable between the plates is rigidly fixed at one end to the shell and freely supported at the other end of the shell. A fluid inlet and outlet are located on one side of the shell and communicate with inlet and outlet chambers separated by a barrier wall extending circumferentially of the tube bundle between the upper support plate and the shell and further defined by longitudinally extending barrier walls between the upper support plate and the shell. A perforated plate is positioned on one side of the tube bundle for distributing fluid lengthwise of the tube bundle. The lower support plate and the shell define a moisture collecting chamber.



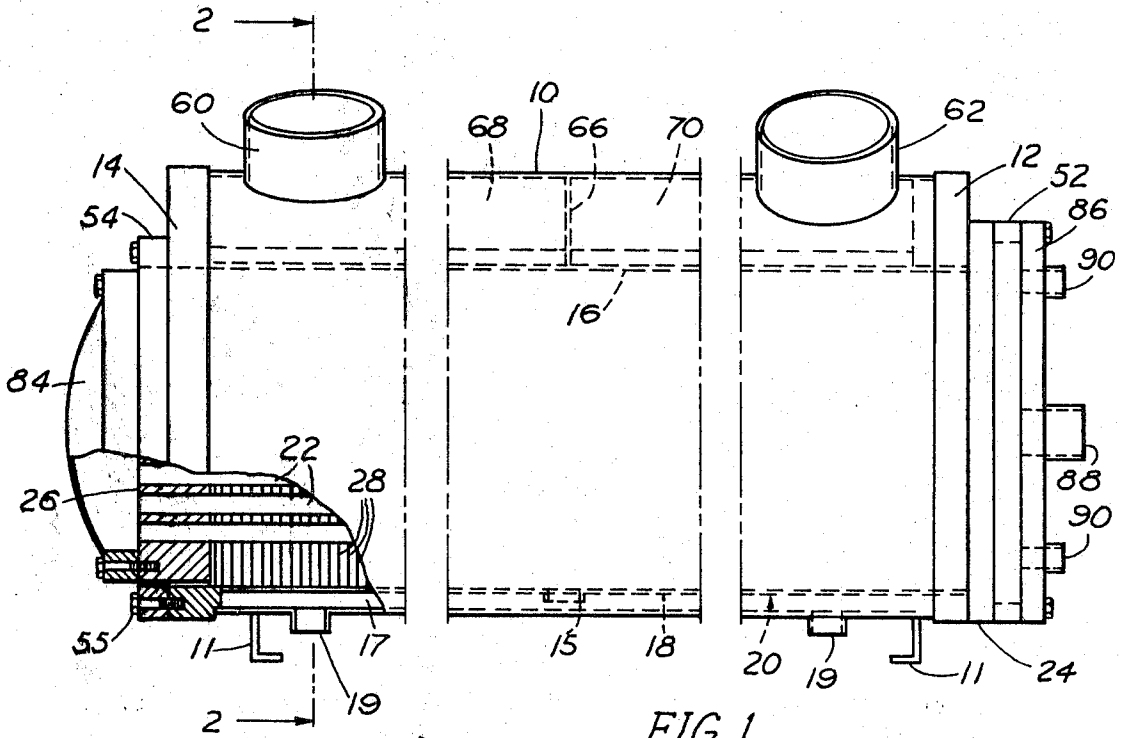


FIG. 1

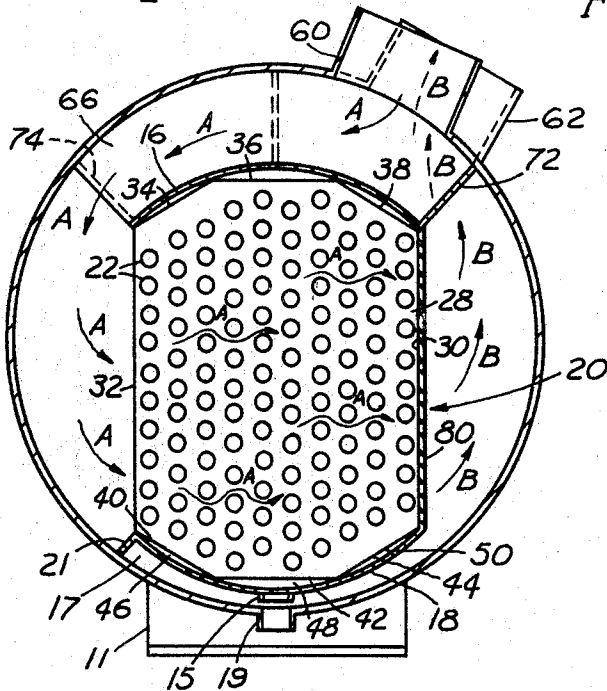


FIG. 2

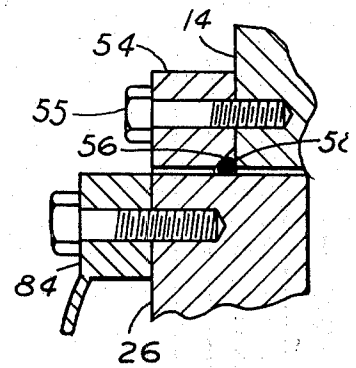


FIG. 3

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HEAT EXCHANGER OF THE TUBE AND PLATE TYPE

BACKGROUND OF THE INVENTION

This invention relates to heat exchangers and, more particularly, to heat exchangers of the tube and plate type.

It is known how to design heat exchangers to obtain a given heat transfer for a given fluid flow rate and volume. It is also known how to control pressure drop and how to obtain a moisture-free effluent if the fluid is gas. When the engineer is given considerable latitude in external configuration, these criteria usually present little problems. However, the structure in which the heat exchanger is to be employed sometimes imposes limitations such that conventional heat exchanger designs cannot be used. For example, where the inlet and the outlet must be on the same side of the heat exchanger, with variable spacing therebetween, and the entire fluid quantity must flow only once across the cooling surface evenly distributed for the entire area and provision made for moisture collection, special problems arise.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a new and improved heat exchanger of the tube and plate type having the fluid inlet and outlet on the same side and capable of providing efficient heat transfer with a low pressure drop.

Another object of the present invention is to provide the foregoing in a heat exchanger having means for supporting a tube bundle within an outer shell for relative movement therebetween.

A further object of this invention is to provide the foregoing in a heat exchanger having means precluding short circuiting of gas flow between the inlet and outlet and for insuring proper circulation of gas flow.

Still another object of the present invention is to provide a heat exchanger having means for distributing gas flow equally along the entire tube bundle.

The heat exchanger of the present invention comprises a cylindrical shell having a pair of opposed plates mounted therein and a tube bundle slidable between said plates and mounted within said shell for relative movement therewith. The tube bundle comprises a plurality of spaced elongated tubes received in openings of a plurality of transversely extending fin sheets. A fluid inlet tube and a fluid outlet tube are provided adjacent the top of the shell and oriented in such a manner as to correspond to external fluid couplings. A barrier wall is mounted between the shell and the upper support plate for separating the inlet tube from the outlet tube and for directing fluid flow in an arcuate path into one side of the tube bundle. A perforated plate is provided on the other side of the tube bundle for distributing the fluid lengthwise of the tube bundle. A chamber is located at the bottom of the exchanger for collecting liquid condensed from the fluid as it is cooled to produce a moisture-free effluent.

The foregoing and other objects, advantages and characterizing features of the present invention will become clearly apparent from the ensuing detailed description of an illustrative embodiment thereof, taken together with the accompanying drawing wherein like reference numerals denote like parts throughout the various views.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevational view of a heat exchanger of the present invention with portions broken away and shown partially in section and partly in elevation to more clearly illustrate the internal structure thereof;

FIG. 2 is a vertical cross-sectional view, on an enlarged scale, taken about on line 2-2 of FIG. 1; and

FIG. 3 is a fragmentary, sectional view, on an enlarged scale, illustrating the floating connection between the shell and tube bundle of the heat exchanger.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, there is shown an illustrative embodiment of heat exchanger constructed in accordance with the present invention comprising an outer cylindrical shell 10 supported on bracket feet 11 and having end plates 12 and 14 at opposite ends thereof. An upper support plate 16 and a lower support plate 18 extend substantially the length of shell 10 and are arcuately shaped in cross section so that a circumferentially projected line following the curvatures of plates 16 and 18 define a circle smaller in diameter than cylindrical shell 10. The ends of upper and lower support plates 16 and 18 are rigidly secured to end plates 12 and 14 to form a unitary construction where therewith. Lower support plate 18 is provided with one or more drains 15 leading to a moisture collecting chamber 17 comprising the space between the bottom of shell 10 and lower support plate 18. Shell 10 also is provided with drains 19 for the discharge of liquid from chamber 17. An elongated barrier wall 21 is positioned along the length of lower support plate 18 between such plate and shell 10 to prevent flow of gas into moisture chamber 17.

The terms upper, lower, upwardly, downwardly, top, bottom, leftwardly, rightwardly and the like as used herein are applied only for convenience of description with reference to FIGS. 1 and 2 and should not be taken as limiting the scope of this invention.

Heat transfer means, generally designated 20 and hereinafter referred to as a tube bundle, comprise a plurality of parallel, elongated tubes 22 supported at their opposite ends by header end plates 24 and 26 in fluid-tight relationship. A plurality of longitudinally spaced fin sheets 28 disposed between header end plates 24 and 26 extend transversely of tubes 22 and are provided with openings for receiving said tubes in fluid-tight relationship. Fin sheets 28 are secured to tubes 22 in known manner. The entire tube bundle 20 is slidable endwise within shell 10 between plates 16 and 18.

Each sheet 28 has parallel lateral side edges 30 and 32 extending vertically between plates 16 and 18 and defining side walls extending longitudinally of the tube bundle 20. Such fin sheets customarily are fabricated in rectangular form. The provision of curved upper and lower edges conforming to plates 16 and 18 would be quite expensive. It is a particular feature of my invention that sheets 28 are constructed to closely fit plates 17 and 18 in a manner facilitating relative sliding therebetween. To this end, the top end of each sheet 28 has three chordal edges 34, 36 and 38 and the bottom end thereof also has three chordal edges 40, 42 and 44 which define passages 46, 48 and 50 between such edges and the lower support plate 18 for connecting the spaces between adjacent sheets 28. Fin sheets 28 having such a top and bottom configuration are relatively easy and inexpensive to fabricate, permit utilization of substantially all of the available space between plates 16 and 18, and provide spaced bearing points therewith facilitating sliding therebetween.

A spacer plate 52 separates tube sheet or end plate 24 and cover 86, and these elements are secured to end plate 12 of shell 10.

In order to compensate for relative expansion and contraction between shell 10 and tube bundle 20, means are provided on the left end of the assembly for permitting relative movement between shell 10 and bundle 20. Such means include a retainer ring 54 disposed about header end plate which projects beyond the end of shell plate 14 (FIG. 3). Ring 54 has a beveled annular seat 56 accommodating an O-ring seal 58 which is urged against end plate 14 of shell 10 and end plate 26 of tube bundle 10 in fluid-tight relation thereto, thereby preventing the escape of gas. Retainer ring 54 is secured to end plate 14 by suitable screws 55.

A gas inlet tube 60 is provided on the upper left hand portion of shell 10 and a gas outlet tube 62 is provided on the upper right hand portion of shell 10 as seen in FIG. 1. With reference to FIG. 2, it will be seen that the axes of inlet 60 and outlet 62 are slightly askew from each other and do not lie in a

common plane cut longitudinally along the axis of shell 10. However, they are positioned on the same side of the heat exchanger, which poses special problems.

Means are provided on the upper portion of tube bundle 20 for insuring gas flow throughout the entire tube bundle and preventing a short circuit path from inlet 60 directly to outlet 62. Such means comprises an arcuately shaped barrier wall 66 extending circumferentially about the upper surface of upper support plate 16 and extending vertically between plate 16 and shell 10 to form an inlet chamber 68 and an outlet chamber 70. A barrier wall 72 connected to one end of wall 66 extends in a direction normal thereto longitudinally of shell 10 along one edge of plate 16 and terminates at end plate 14 to prevent gas flow in a clockwise direction from chamber 68 as viewed in FIG. 2. A barrier wall 74 connected to the other end of wall 66 extend in a direction normal thereto along the opposite edge of plate 16, terminating at the end plate 12 to prevent gas flow in an anticlockwise direction into chamber 70, as viewed in FIG. 2.

Means are provided for distributing the gas lengthwise of tube bundle 20, such means being in the form of a perforated plate 80 preferably positioned on the outlet side of tube bundle 20, being the right side wall, as shown in FIG. 2. Plate 80 extends longitudinally of tube bundle 20 and vertically between support plates 16 and 18. It should be appreciated, however, that perforated plate 80 can instead be positioned on the inlet side of tube bundle 20, if desired, within the purview of the present invention.

End covers 84 and 86 are fastened at opposite ends of the heat exchanger by suitable connecting means to provide a closed unitary construction and serve as mufflers to distribute the coolant through tubes 22 of tube bundle 20.

In operation, coolant is admitted into transversely paired couplings 88 and directed into tubes 22 located adjacent the sides of tube bundle 20. The coolant flows longitudinally of tube bundle 20 into end cover or muffler 84 where it is directed into the centrally located tubes 22 and returned through tube bundle 20 into end cover or muffler 86 and exhausted through couplings 90.

The coolant is cycled through tube bundle 20 for cooling a high temperature gas admitted into chamber 68 of the exchanger by means of inlet tube 60.

The gas cannot flow directly to outlet 62 because of barrier wall 66, and flows circumferentially about upper plate 16 in an anticlockwise direction as indicated by arrows A in FIG. 2 because of the obstruction present by longitudinal wall 72. Thus the gas flows downwardly along one side of tube bundle 20 and thereacross between fin sheets 28 as indicated by arrows A. Gas is precluded from entering into moisture collecting chamber 17 by wall 21. Perforated plate 80 imposes a resistance to flow sufficient to cause the gas to be distributed over the entire length of tube bundle 10 on the inlet side thereof. Finally, the gas flows outwardly through the right side of tube bundle 20 (FIG. 2) upwardly as indicated by arrows B into outlet chamber 70 and is discharged through outlet tube 62.

Unlike most conventional heat exchangers, the entire volume of gas is not directed through a sinuous path about a series of baffles. Instead, the gas is distributed along the length of the tube bundle and flows therethrough only once. Each unit volume of gas flows between only one pair of fin sheets 28, so that only a minimum pressure drop is realized during the course of gas flow.

Moisture in the gas flowing between fin sheets 28 condenses, forming liquid droplets on sheets 28 and on tubes 22 which collect and feed downwardly by gravity onto lower support plate 18. The liquid passes through passages 46, 48 and

50 and drain 15 into moisture collecting chamber 17 and can be discharged from shell 10 through bottom drains 19. Accordingly, moisture is removed from the gas as it is being cooled to provide a cooled, dry effluent.

From the foregoing, it is apparent that the objects of the present invention have been fully accomplished. As a result of the present invention, a new and improved heat exchanger, having characteristics dictated by external design criteria, is provided for effecting the transfer of heat in an efficient manner. Also, novel features are incorporated in the heat exchanger to produce moisture-free effluent with a relatively low pressure drop. A preferred embodiment of the principles of this invention having been described and illustrated, it is to be realized that modifications thereof can be made without departing from the broad spirit and scope of this invention as defined in the appended claims.

I claim:

1. A heat exchanger comprising a shell having a fluid inlet and a fluid outlet on the same side thereof, a pair of opposed plates mounted in said shell on opposite sides thereof and extending longitudinally thereof, at least one of said plates being spaced from the shell wall and said plates being spaced from each other along a first transverse axis, said inlet and outlet being generally on the same side of said shell as said one of said plates, a tube bundle disposed within said shell between said spaced plates and extending longitudinally of said shell, means supporting said bundle within said shell for movement relative thereto, said bundle being spaced from said shell wall on opposite sides thereof along a second transverse axis generally normal to said first axis, and means separating said inlet from said outlet and directing flow of fluid from said inlet to said outlet in a path extending transversely through said bundle generally in the direction of said second axis, wherein said separating and directing means comprises a transverse wall disposed between said inlet and said outlet and extending between said one of said plates and said shell, and wherein said separating and directing means also includes longitudinal walls extending from said transverse wall in opposite directions along opposite sides of said one plate.

2. A heat exchanger as set forth in claim 1 together with means for distributing said fluid lengthwise of said tube bundle.

3. A heat exchanger as set forth in claim 2, wherein said distributing means comprises a perforated plate disposed along one side of said bundle.

4. A heat exchanger as set forth in claim 1 wherein said tube bundle has a plurality of spaced elongated tubes and a plurality of fin sheets spaced apart longitudinally of said tubes and extending transversely thereof.

5. A heat exchanger as set forth in claim 4, wherein said plates are arcuate in transverse section, and wherein said fin sheets are of generally rectangular configuration with the corners thereof removed substantially along chords of the arcs of said plates.

6. A heat exchanger as set forth in claim 1, wherein the other of said plates also is spaced from the shell wall along said first axis, and a moisture collecting chamber is located between said other of said plates and said shell.

7. A heat exchanger as set forth in claim 6 together with a barrier wall across said moisture collecting chamber on the inlet side of said tube bundle.

8. A heat exchanger as set forth in claim 1 wherein said bundle is detachably secured to one end of said shell and is mounted for sliding movement adjacent the other end of said shell.

9. A heat exchanger as set forth in claim 7, wherein said shell is cylindrical in shape.