Aug. 15, 1950 R. H. TULL 2,519,084

SHELL AND TUBE HEAT EXCHANGER HAVING ZIG-ZAG TUBES

Filed March 13, 1945

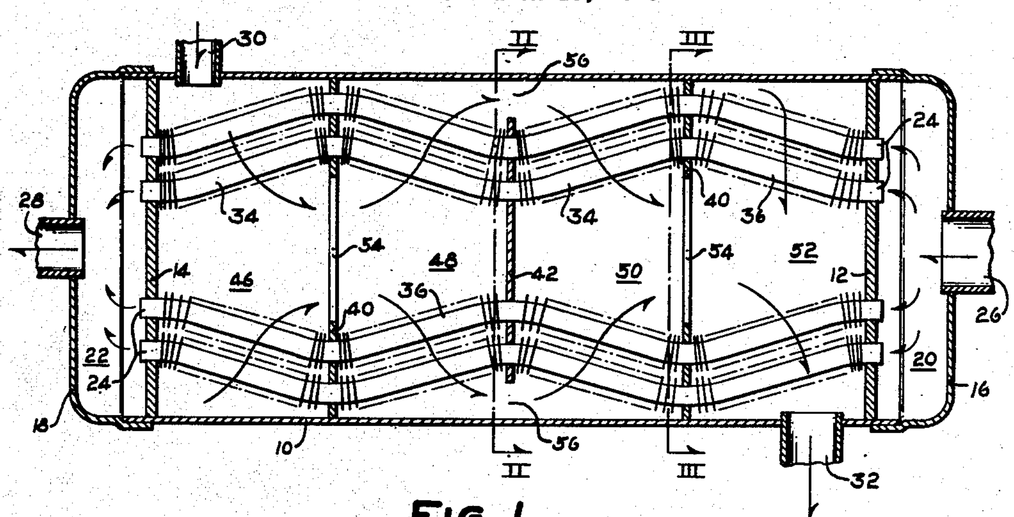

FIG. 1.

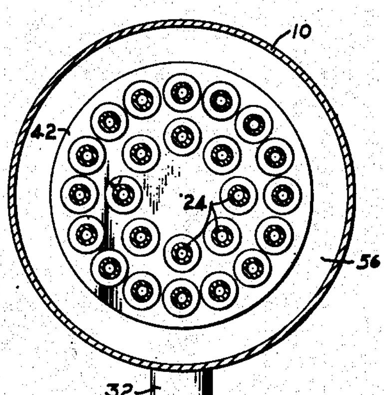

FIG. 2.

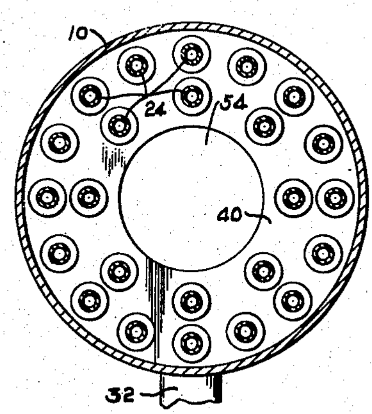

FIG. 3.

WITNESSES:

INVENTOR
ROBERT H. TULL

BY

ATTORNEY

Patented Aug. 15, 1950 2,519,084

UNITED STATES PATENT OFFICE

2,519,084

SHELL AND TUBE HEAT EXCHANGER HAVING ZIG-ZAG TUBES

Robert H. Tull, Springfield, Mass., assignor, by mesne assignments, to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application March 13, 1945, Serial No. 582,507

4 Claims. (Cl. 257—236)

1

My invention relates to a heat exchanger of the shell and tube type in which one fluid medium flows through tubes enclosed in a shell and another fluid medium flows through the shell in contact with the surfaces of the tubes.

One object of the invention is to provide an improved heat exchanger of the type set forth.

A further object of the invention is to devise a heat exchanger of the type set forth which will give a high rate of heat transfer from one medium to another without unduly prolonging the path of travel of the media or retarding the rate of flow thereof.

A still further object of the invention is to devise a heat exchanger for carrying out the foregoing objects which will be compact, light and inexpensive to produce.

A particular object is to provide a heat exchanger having a shell of minimum bulk, whereby the required space, weight and cost of the shell are reduced.

These and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a view in longitudinal section of a heat exchanger embodying my invention, some of the tubes being omitted;

Fig. 2 is a section on line II—II of Fig. 1; and

Fig. 3 is a section on line III—III of Fig. 1.

In the drawings there is shown a shell 10 provided with tube sheets 12 and 14 which, together with the respective adjacent end walls 16 and 18 of the shell form headers 20 and 22 segregated from the remainder of the interior of the shell. Finned tubes 24 are carried by the tube sheets 12 and 14 and communicate at their respective ends with the headers 20 and 22. An inlet 26 leads to one of the headers 20 and an outlet 28 leads from the other header 22. Thus, a fluid medium admitted through the inlet 26 will flow into the header 20, through the tubes 24, into the header 22 and out through the outlet 28. The interior of the shell 10 between the headers 20 and 22 is provided with an inlet 30 located near the discharge header 22 and an outlet 32 located adjacent the inlet header 20. A fluid medium admitted through the inlet 30 and discharged through the outlet 32 will be in counterflow relation with the medium flowing through the tubes 24.

In order to carry out the invention, the tubes 24 are alternately bent towards the wall and the longitudinal axis of the shell, so as to form, starting from the left-hand end of the tubes in Fig. 1, diverging portions 34 and converging portions 36. The interior of the shell, between the tube sheets 12 and 14, is provided with baffles 40 and 42. The baffles 40 and 42 cooperate with each other and with the tube sheets 12 and 14 to provide compartments 46, 48, 50 and 52. The baffles 40 extend inwardly from the wall of the shell and are provided with central openings 54, while the baffles 42 have their peripheries spaced from the wall of the shell so as to form openings 56. As will be seen from Fig. 1, the tube portions 34, at the point of maximum divergence, pass through, and are preferably supported by the baffles 40. The tube portions 36, at the point of maximum convergence, pass through the baffles 42, of which only one is shown in the illustrated embodiment. The baffles 42 may be secured to the wall of the shell, by a spider or the like, not shown, so as to act as a support for the tube portions passing therethrough, or the baffles 42 may be carried by said tube portions.

By this arrangement, a fluid medium, entering the space 46, flowing through the shell, and emerging through the outlet 32, will always flow at an angle to the longitudinal axes of the tubes and substantially parallel to the planes of the fins on the tubes.

Operation

A medium, such as warm liquid refrigerant, is admitted through the inlet tube 26, flows through the tubes 24 and is discharged through the outlet 28. Another medium, such as relatively cool vaporized refrigerant, is admitted through the inlet 30 into the space 46 and into contact with the diverging tube portions 34 in this space. The gas passes between the fins of the tubes and between and around the tubes themselves, and flows through the central opening 54 into the next space 48 where the gas comes into contact with the converging portions 36 of the tubes. From the space 48 the gas flows through the openings 56 into the space 50 and from the space 50 through the opening 54 into the space 52 and out through the outlet 32. The path of flow of the gas through the tubes 24 and from the inlet 30 to the outlet 32 is indicated by the arrows in Fig. 1.

It will thus be seen that by this arrangement of the tubes and baffles a gas flowing through the interior of the shell must cross and recross the converging and diverging tube portions at an angle to the axis of the tube portions and substantially parallel to the planes of the fins. By this means the gas will have intimate and prolonged contact with the surface of the tubes and the fins without material reduction in the velocity of the flow of the gas.

It will also be seen that by this arrangement of the tubes and the baffles, the desired prolonged and intimate contact of the medium flowing through the shell with the medium flowing through the tubes is obtained without correspondingly increasing the length or diameter of the shell.

It will be particularly noted that by bending the tubes inwardly at the baffle 42 to provide the passage space 56 for flow of fluid, the shell need be only big enough to enclose the baffles 40, thereby reducing the required space, weight and cost of the shell.

The structure described is adapted for use wherever it is desired to bring two fluid media having a temperature differential into heat exchange relation.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

What I claim is:

1. A heat exchanger comprising an elongated shell, an intake header at one end of said shell, a discharge header at the other end of said shell, a plurality of tubes extending longitudinally through said shell and communicating at their opposite ends with said headers, said tubes providing a flow path for a fluid medium and being bent, successively, toward the wall of said shell and toward the center of said shell, to provide alternately diverging and converging portions, there being an inlet disposed near one end of said shell and leading to the interior of the shell between said headers and an outlet disposed near the other end of said shell and leading from said interior of said shell, whereby the interior of said shell between said headers provides a flow path for another fluid medium, a baffle extending inwardly from the wall of said shell and through which said diverging tubes pass near their point of maximum divergence, there being a central opening in said baffle, and a baffle having its periphery spaced from the wall of said shell and through which said converging tubes pass near their point of maximum convergence, said baffles being so arranged within the shell that a fluid medium flowing through said interior of said shell is compelled to flow through the central opening of said first mentioned baffle and between the periphery of said second mentioned baffle and the wall of said shell, whereby said fluid flows at an angle to the axes of said tubes throughout its travel from said inlet to said outlet.

2. A heat exchanger comprising an elongated shell, an intake header at one end and a discharge header at the other end of the shell, the shell being of uniform cross section between the headers, a nest of tubes extending longitudinally through the shell and communicating at their opposite ends with the headers, the tubes providing a flow path for one fluid and being of zigzag form, there being an inlet disposed near one end of the shell and leading to the interior of the shell between the headers and an outlet disposed near the other end of the shell and leading from the interior of the shell, whereby the interior of the shell between the headers provides a flow path for a second fluid, and baffles located at the inflection or bend zones between the headers and having openings through which the tubes extend, there being space on the concave side of the tubes and the baffle at each inflection zone between the headers for flow of fluid passing from the inlet to the outlet whereby such fluid is constrained to flow to and fro across tubes of the nest.

3. A heat exchanger comprising an elongated shell, an intake header at one end and a discharge header at the other end of the shell, a nest of tubes extending longitudinally through the shell and communicating at their opposite ends with the headers, the tubes providing a flow path for one fluid and being of zigzag form, there being an inlet disposed near one end of the shell and leading to the interior of the shell between the headers and an outlet disposed near the other end of the shell and leading from the interior of the shell, whereby the interior of the shell between the headers provides a flow path for a second fluid, and baffles located at the inflection or bend zones between the headers and having openings through which the tubes extend, there being space on the concave side of the tubes and the baffle at each inflection zone between the headers for flow of fluid passing from the inlet to the outlet whereby such fluid is constrained to flow to and fro across tubes of the nest.

4. A heat exchanger comprising an elongated shell, an intake header at one end and a discharge header at the other end of the shell, a nest of tubes extending longitudinally through the shell and communicating at their opposite ends with the headers, the tubes providing a flow path for one fluid and being of zigzag form with contiguous convergent and divergent sections, there being an inlet disposed near one end of the shell and leading to the interior of the shell between the headers and an outlet disposed near the other end of the shell and leading from the interior of the shell, whereby the interior of the shell between the headers provides a flow path for a second fluid, and transversely extending baffles spaced axially of said tubes dividing the interior space of the shell into a plurality of passes, said baffles being mounted at the points of maximum convergence and maximum divergence of the tubes with the perimeter of a baffle located at a point of maximum convergence spaced from the interior wall of the shell to provide a passage for flow of said second fluid between contiguous passes while a baffle at the point of maximum divergence has its perimeter in contact with the wall of the shell and is formed with a central opening for said flow.

ROBERT H. TULL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
898,932	Schnug	Sept. 15, 1908

FOREIGN PATENTS

Number	Country	Date
22,097	Great Britain	Sept. 28, 1912
402,628	Great Britain	Dec. 7, 1933
413,406	Great Britain	July 19, 1934