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JACOB LEE TURNER AND JAMES G. RUSSELL, OF MILTON, MASSACHUSETTS

HEAT EXCHANGER

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This invention relates to improvements in heat exchangers.

It is among the objects of this invention to provide apparatus which is remarkably simple in construction, economical to manufacture and operate, and highly efficient in performance. Apparatus made in accordance with the invention may be used to transfer thermal units from one fluid to another and it is an object to so arrange the paths of flow of these fluids that the one being acted upon, as it were, is presented to the influence of the other fluid in a thin, hollow stream with the acting fluid flowing both inside and outside of this stream in close proximity thereto. It is also an object to support the elements conducting the fluids in such manner that no undue strain is placed upon the apparatus as the temperature of these elements changes in accordance with the thermal transfer.

When the heat exchanger is to be used as a cooler or evaporator, and a liquid refrigerant is employed as the heat absorbent, it is a feature to provide in combination with the heat exchanger proper an accumulation chamber into which the gasified refrigerant may discharge and from which the liquid refrigerant may be fed by gravity to the base of the evaporator. It is also a feature to provide a novel baffle for arresting any liquid particles entrained in the gasified refrigerant entering the accumulation chamber and preventing their further travel with the gas. Other objects and features of construction will be noted as the detailed description develops.

The best mode in which we have contemplated applying the principles of our invention is disclosed in the accompanying drawings, in the form of a casing which contains the fluid that is to give up or receive heat from another fluid. Near the top of this casing is a header which supports a second header, close by the bottom of the casing, by means of a series of pairs of nested tubes. The outer tube of each pair forms a flow connection between the two headers for passage of the fluid to be acted upon while the inner tube of each pair extends beyond the

ends of the outer tubes through both headers and constitutes a passage for flow of the acting fluid. Since the latter is also in contact with the outside of the outer tube of each pair, the exchange of heat to or from the fluid acted upon is exceedingly high in proportion to the size of the heat exchanger.

It is intended that the patent shall cover by suitable expression in the appended claims whatever feature of patentable novelty exists in the invention disclosed.

In the accompanying drawings:

Figure 1 is an elevation, in medial section, (as on line 1—1 of Fig. 2) of a heat exchanger constructed in accordance with the principles of this invention;

Figure 2 is a plan of a section taken as on line 2—2 of Figure 1;

Figure 3 is another elevation, showing the adaptation of the exchanger as an evaporator in combination with an accumulation chamber and a device for controlling the supply of liquid refrigerant; and

Figure 4 is a plan in section on line 4—4 of Fig. 3.

Referring more particularly to the drawings the heat exchanger comprises a two-part casing 10 which is here shown in the form of a cylinder having a tightly sealed bottom 12 and top 13. At the upper edge of the lower part 10a is attached a collar 14 which serves in conjunction with a similar collar 16, attached to the upper part 10b, to clamp a header 20 securely between them. This header is annular in shape and surrounds an opening 22 through it at its center. Its outer wall has both an upstanding rim 20a and a depending rim 20b which engage co-operating grooves in the collars 14, 16 so that upon the bolts 21 being tightened the top part 10b, header 20 and bottom part 10a are secured firmly together, there being gaskets 23 to prevent any leakage.

A second header 24 similar in shape to the top header is provided near the bottom of the casing, but is not directly attached thereto. On the contrary, it is a feature to support this header in the casing by means of a series of pipes, 26, 28 connecting it to the top header. These pipes or tubes are arranged in pairs

with the pipes of each pair having their longitudinal axis concentric. The outer pipe 26 of each pair extends between the bottom plate 20c of the top header 20 and the top plate 24a of the bottom header 24 thus connecting the interiors of the two headers. The inner pipe 28 of each pair extends through the outer pipe and is joined to the top plate 20d of the top header and the bottom plate 24b of the bottom header. Accordingly, these inner pipes serve as passageways through both the headers and the outer pipes.

As herein shown the top header is divided into two compartments by partitions 34 which cause the fluid entering by connection 30 to pass downward through the three pipes 26 nearest thereto into the bottom header. From the latter the fluid passes upward through the other three pipes 26 into the other compartment of the top header from whence it goes on through the outlet 32. Such an arrangement affords a rather short course of flow for the fluid to be acted upon, but this may be greatly increased by the provision of additional partitions in the upper headers and others in the lower headers, so that, if desired, the fluid may successively transverse all the outer pipes connecting the two headers.

The action of the exchanger is as follows. When used as a heater, the acting fluid, hot liquid, steam or other high temperature fluid, is supplied to the casing through either the pipe 40 connected near the bottom or through the pipe 42 connected to the top. This highly heated medium flows thence through the casing, part of it bathing the outside of the headers and the connecting pipes 26 and part of it flowing through the inner pipes 28. Simultaneously with this flow of the heat-giving fluid, there is fed to the upper header the fluid to be heated. This enters the header and by virtue of the partitions therein is forced to pass to the lower header through the thin annular space formed between the pipes of each pair. After reaching the lower header this heated fluid is then forced through similar annular passages formed by other pairs of pipes back to the top header from whence it discharges. Since the fluid to be heated is in the form of a thin annular hollow stream as it passes from one header to the other, and since both the inside or hollow of this stream and the outside are in close proximity to the heat-giving fluid, the increase in temperature of the fluid being heated is exceedingly rapid, and since substantially all the heat of the heating fluid is available to the heated fluid (it being contemplated that the outer surface of the exchanger will be properly insulated to guard against any appreciable heat loss) it is evident that the effectiveness of the apparatus is very high.

While it is preferable to circulate the acting

fluid through the casing and inner tubes and the fluid acted upon through the headers and outer tubes, it is of course perfectly feasible to reverse this arrangement. For example, flue gases might be introduced through pipe 30 and pass thence through the headers and tubes 26 to the outlet 32, while water to be heated is circulated through the casing.

When, however, the exchanger is employed as an evaporator with an evaporative refrigerant such as anhydrous ammonia, it is desirable to form the upper part of the casing so that it may serve as an accumulation chamber, as seen in Figure 3. The top plate 13 becomes the bottom of this chamber 10b' and the outlet 42 extends upward therein to about the level 1—1 at which the liquid refrigerant is to be maintained. In proximity to the upper end of this outlet 42 is a baffle 44 in the form of a plate extending across the chamber, slightly wider in width than the outlet opening, with depending sides 44a converging to the outlet pipe 42. From the top of the header a connection 46 leads to the usual compressor and another connection 48 leads to a float chamber 50 in which is a float 52 pivotally mounted with shaft 54. A crank 56 on the latter is connected by a link 58 to another crank 60 which in its turning controls the valve 62 that is in the supply line 64 connected to the accumulation chamber. From near the bottom of the latter is a connection 66 to the float chamber and another connection 68 leading to the bottom of the casing.

Anhydrous ammonia or other suitable refrigerant is fed to the accumulation chamber at a rate determined by the level of liquid therein, this level of course being the same as that in chamber 50 affecting the float. Any flash gas occasioned by this supply feed is taken care of in the accumulation chamber and has no effect on the evaporator proper. The liquid refrigerant feeds by gravity through connection 68 to the bottom of casing 10 from whence it passes upward around the lower header 24 and through its central opening and thence through the opening 22 in the top header. Part of it of course flows through the inner pipes 28. It takes up heat from the fluid which is simultaneously being fed through the headers and the thin annular spaces between pipes 26 and 28. Naturally this heated (as it were) refrigerant would rise through outlet 42 and thus effect a thermo-circulation of the refrigerant, but with anhydrous ammonia, the refrigerant is also transformed to a gas in the form of bubbles which rush up outlet 42 into the accumulation chamber. Any particles of liquid entrained in this gas, or caused by the spattering as the bubbles reach the surface of the refrigerant, are trapped by the baffle 44 and prevented from passing on into connection 46. The transformation

of the refrigerant into gas and its withdrawal as such by the compressor, tend to lower the liquid level in the accumulator and float chambers as the flow through connection 68 continues. This brings about an opening of the valve 62 to admit additional liquid from the supply until the desired level is restored. In practice it is found that the level is very closely maintained, the float and valve assuming that position where the supply substantially equals the withdrawal of the refrigerant by the compressor.

The possibilities of adapting the heat exchanger to any desired duty is evident. Few or many pairs of tubes can be provided as conditions warrant, and the length or depth of the casing and tubes can be altered as well to increase or decrease the effective transfer space provided between the inner and outer tubes. The simplicity of the elements is also easily appreciated. Standard pipes and fittings only need be used for the casing and general connections and the headers are easily formed by casting. The suspension of the lower header by the connecting pipes enables this header to move without strain on the casing in the event of any elongation or contraction which may result from changing temperatures. This is particularly advantageous when the same exchanger is to be used part of the year as a heater and at other periods as a cooler. The pronounced compactness is also a characteristic feature of the exchanger, and makes it possible to install the apparatus in places and spaces where exchangers hereto available have not been adaptable.

We claim:

1. A heat exchanger having a two-part casing adapted to receive and discharge a fluid; an annular header secured between the parts of said casing, having connections for receiving and discharging another fluid; and a second annular header supported within said casing by a series of pairs of tubes; the tubes of each pair being arranged one inside the other, with the outer tube secured to the adjacent walls of the headers and forming a passageway between the headers, and with the inner tube attached to the remote walls of the headers and forming a passageway for the casing fluid.

2. A heat exchanger having a casing adapted to receive and discharge a cooling fluid; a pair of headers associated therewith adapted to receive and discharge a fluid to be cooled; a series of pairs of tubes extending between said headers, the tubes of each pair being arranged one inside the other with the outer tube forming a passageway between the headers for the cooled fluid and with the inner tube extending through said headers and forming a passageway for the cooling fluid; a partition across said casing above the headers to form an accumulation cham-

ber thereabove; a tube extending upward in said chamber from said partition; a connection between the accumulation chamber and the bottom of said casing for transfer of the cooling fluid; and means associated with the accumulation chamber for maintaining a supply of cooling fluid therein.

3. A heat exchanger having a casing adapted to receive a refrigerant as a liquid and discharge it as a gas; means associated therewith for circulating a fluid to be cooled comprising a pair of headers connected by a series of pairs of tubes, the tubes of each pair being arranged one inside the other with the outer tube forming a flow passage between the headers and with the inner tube extending through the headers for passage of the refrigerant; a partition across said casing providing a space above said headers and tubes into which the refrigerant passes from the tubes as a gas; an accumulation chamber above said partition; a tube extending from said partition into said accumulation chamber; a baffle at the outlet of the last said tube for arresting any liquid particles entrained in the gaseous refrigerant entering the accumulation chamber; means for maintaining a supply of liquid refrigerant in the accumulation chamber; and a connection between said chamber and the bottom of the casing for transfer of said liquid refrigerant thereto whereby it may pass upward through said inner tubes and thereby absorb heat from the fluid to be cooled.

4. A heat exchanger comprising a casing adapted for circulation of a fluid and having opposed parts, a header between said parts having a groove and tongue connection therewith, means for clamping said parts and headers together; a second header inside said casing, supported from the first mentioned header by a series of tubes arranged in pairs with one tube of each pair inside the other tube thereof; the inner tubes of said pairs extending through said headers and the outer tubes opening into the said headers thereby to form a tortuous passage for flow of fluid separate from the path of flow of the casing fluid.

Signed at Milton, Massachusetts, this 24th day of November, 1930.

JACOB LEE TURNER.
JAMES G. RUSSELL.