Feb. 10, 1959 J. L. MORGAN 2,873,098

HEAT EXCHANGE APPARATUS

Filed Oct. 3, 1955

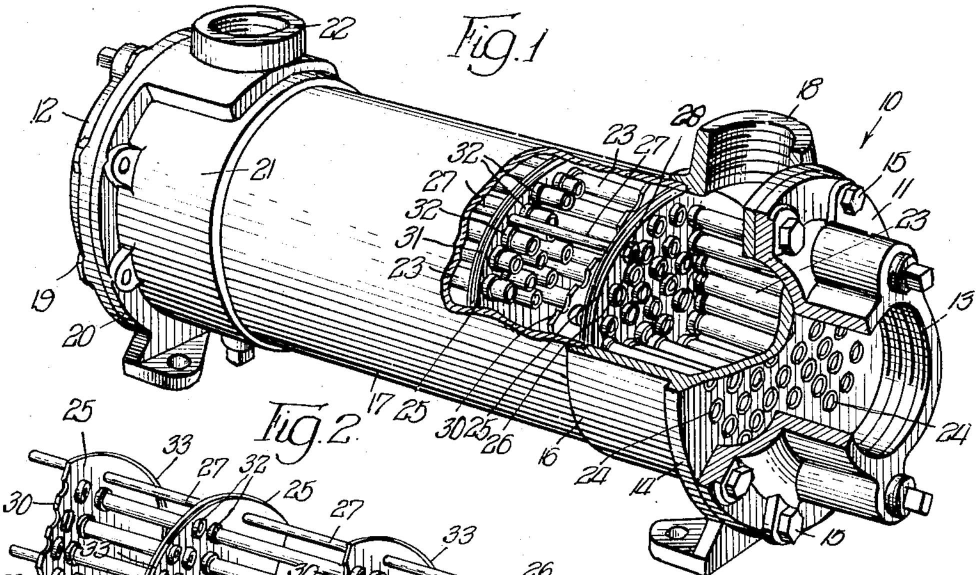

Fig. 1

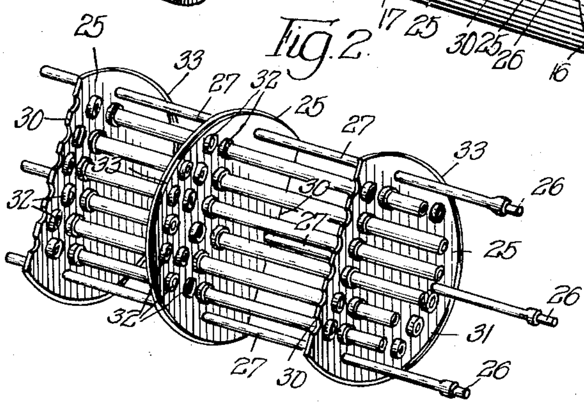

Fig. 2

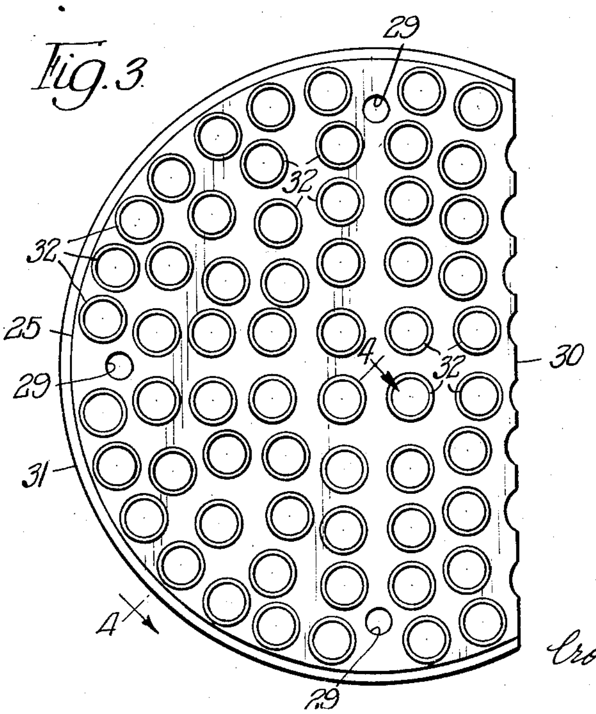

Fig. 3

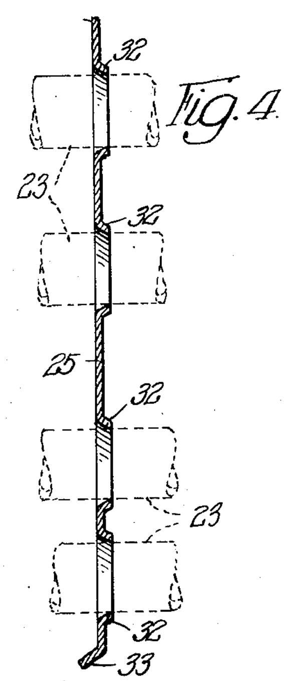

Fig. 4

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United States Patent Office

2,873,098
Patented Feb. 10, 1959

2,873,098

HEAT EXCHANGE APPARATUS

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Application October 3, 1955, Serial No. 538,090

3 Claims. (Cl. 257—236)

The present invention relates generally to improved heat exchange apparatus and more specifically is directed to the provision of an improved baffle plate for use in heat exchangers of conventional design.

Known forms of tubular heat exchange apparatus make use of a plurality of spaced baffle plates having a number of apertures extending therethrough which support tubes running longitudinally of the body portion of the heat exchange unit. The baffle plates are of substantially circular design having a segment removed along one side thereof to promote the tortuous passage of fluid through the body portion of the heat exchanger in contact with the outer surfaces of the tubes maintained therein. The apertures in the baffle plates are of a greater diameter than the outer diameter of the tubes to allow ready insertion of the tubes therethrough. The sharp edges of the baffle plates are apt to, and often do, cut into the tubes as a result of vibration set up upon the operation of the unit. In properly positioning the baffle plates in spaced relation within the body portion of the heat exchanger, it is necessary to utilize rods which support sleeve spacers intermediate each baffle plate to eliminate longitudinal movement of the plates along the tubes.

The main difficulty confronting efficient operation of a heat exchange unit of conventional design is the occurrence of a high percentage of leakage through the baffle plates either in the areas of the tube apertures or about the outer peripheries thereof. The presence of this type of leakage reduces the amount of fluid which is flowed through the body portion of the heat exchanger in serpentine fashion. The amount of fluid flowing through the body portion in straight-line flow is greatly increased and as a result, the heat exchange efficiency of the unit is reduced. This particular problem is exceedingly serious as it is generally considered that the attainment of 60 percent proper flow in existing heat exchangers approaches maximum efficiency. In some of the larger units proper flow has been measured as low as 12 percent of the total throughflow and from this it can be readily seen that the presence of leakage about the baffle plates materially reduces the efficiency of the heat exchanger. This problem along with the detrimental action of the sharp edges of the baffle plate tube apertures resulting in damage to the tubes in response to vibrating forces are the principal problems existing in the field of heat exchange unit design.

It is an object of the present invention to increase the heat exchange efficiency of known types of heat exchange units by the provision of a new and improved baffle plate for use therein.

Another object is to provide a new and improved baffle plate for use in known types of heat exchange units which is capable of securely receiving the tubes therethrough and protect the tubes from damage resulting from the presence of vibration.

Still another object is the provision of a new and improved baffle plate for use in heat exchange units which is provided with flanged tube apertures and a partially flanged outer periphery capable of substantially reducing leakage, protecting tubes passed therethrough from damage due to vibration and eliminating the necessity of using tie rods and spacers to maintain proper positioning of a plurality of baffle plates within the body portion of the heat exchange unit.

Other objects not specifically set forth will become apparent from the following detailed description made in conjunction with the accompanying drawing, wherein:

Fig. 1 is a perspective view in partial section of a conventional form of heat exchange unit utilizing the improved baffle plates of the present invention;

Fig. 2 is a fragmentary perspective view of the baffle plates illustrating the manner in which tubes are mounted thereby;

Fig. 3 is an elevation of an improved baffle plate; and

Fig. 4 is a sectional view of the baffle plate of Fig. 3 taken along line 4—4 therein.

Referring in particular to Fig. 1, a heat exchange unit **10** is shown therein as comprising bonnets **11** and **12** on either ends thereof, each having fluid conduit means **13** (one of which is shown) associated therewith. The bonnet **11** is attached to a header plate **14** by bolts **15**. The header plate **14** includes an integral body section **16** which telescopically receives one end of an elongated body portion **17**. The body section **16** is further provided with a fluid conduit means **18** which allows for the passage of fluid into or out of the body portion **17**. The remaining bonnet **12** is similarly attached by bolts **19** to a header plate **20** which has an integral body section **21** telescopically receiving the other end of the main body portion **17**. The body section **21** is also provided with a fluid conduit means similar to that designated by the numeral **18**.

Internally of the body portion **17** are a plurality of longitudinally extending, laterally spaced tubes **23** which have their ends expanded and rolled in the form of flanges **24** about the outer edges of apertures within the header plates **14** and **20**. Supporting the tubes **23** and controlling the flow of fluid directed through the conduit means **18** and **22** are spaced baffle plates **25** which, as shown in Figs. 2 and 3, may be held in spaced relation by a rod **26** carrying a plurality of sleeve spacers **27**. The baffle plates **25** are drawn into intimate contact with the ends of the spacers **27** on each of the rods **26** by reason of a nut **28**. This particular arrangement is of conventional design. The baffle plates **25** are provided with apertures **29** to receive the rods **26** therethrough. When these rods are used, the receiving apertures **29** are preferably of a smaller inner diameter than the outer diameter of the sleeve spacers **27** to allow the latter to abut against the plates **25** and be drawn in close contact therewith by the nuts **28** to prevent leakage through the apertures **29**.

The improved baffle plate **25** of the present invention is shown in detail in Figs. 3 and 4. These plates are each formed with a flat edge **30** which are alternately spaced, as shown in Figs. 1 and 2, to allow fluid to flow through the body portion **17** in contact with the tubes **23** in a serpentine fashion. The remaining outline of the baffle plates **25** is semi-circular as indicated by the edge **31** and this edge is in sealing engagement with the inner surface of the body portion **17** in a manner to be described.

The main features of the baffle plates **25** include the manner in which the tube apertures are formed. These apertures are defined by radially extending flanges **32** which are circumferentially continuous and which are conically shaped in outline. As illustrated in Fig. 4, the smallest inner diameter of the tube flanges **32** exists near its outermost extremity and this diameter is intended to be sufficiently less than the outside diameter of the tube **23** passed therethrough to bring about sealing engagement between the inner surface of the flange 32 and the outer periphery of the tube 23. In this manner leakage through the tube apertures in the baffle plates 25 is eliminated and the efficiency of the heat exchange unit is greatly increased.

To further aid in cutting down the leakage of fluid through the baffle plates 25 a radially directed flange 33 is provided about the outer periphery of the semi-circular portion 31. This flange, as shown in Fig. 4, extends at an angle approximating 45° with respect to the vertical and horizontal planes. The flange 33 is adapted for sealing engagement with the inner surface of the body portion 17 to prevent leakage of fluid in straight flow lines through the baffle about its periphery defined by the semi-circular portion 31. As can be readily seen, the flanges 32 which extend substantially axially with respect to the tubes 23 in conjunction with the radially extending flange 33 are capable of substantially increasing the efficiency of a heat exchange unit by materially reducing the amount of leakage occurring therein.

The provision of the flanges 32 and 33 in addition to the aforementioned advantages are of material importance in other respects. By the use of closely spaced tube apertures in the baffle plates 25 it is possible to fabricate the baffle plates from lightweight resilient metallic material while relying on the flanges 32 to impart to the material the requisite rigidity necessary to properly maintain the tubes 23 in their operative positions. In order to insure the maintenance of proper rigidity it has been found preferable to space the apertures from one another at approximately 0.5 of an inch measuring this distance from centers to centers of adjacent apertures. While it is not always possible to accurately space all of the apertures in this manner, it has been found that by spacing the majority of the apertures used in the baffle plates at this distance with respect to adjacent apertures, adequate rigidity may be imparted to a plate of steel or brass having a thickness within the range of approximately .010 to .030 inch. Under these circumstances it can be readily seen that plates of this nature in the absence of the flanges 32 generally exhibit resilient properties.

By following the aforementioned procedure in fabricating the baffle plates 25 the inherent resiliency of the metallic material may be put to important use in materially aiding in reducing leakage. The flanges 32, by reason of their conical shape, resiliently receive the tubes 23 inserted through the plate. As a result the inherent flexibility of the metal of the flanges 32 acts to force the inner surface of the flanges into close sealing engagement with the outer surface of the tubes. To further insure proper sealing contact between the flanges 32 and the tubes 23, the opposed surfaces may be soldered or braised in any suitable manner. For example, spaced rings or threads of solder may be provided about the outer periphery of the tubes 23 prior to their insertion through the baffle plates 25. The rings of solder may then be aligned with the inner surface of the flanges 32 and suitable heat applied thereto in bonding the opposed surfaces. The assembled tubes and baffle plates may then be readily inserted in the body portion of the heat exchange unit.

An additional important result arising from the use of resilient engagement between the flanges 32 and the tubes 23 is the elimination of the use of rods 26 and spacers 27. The close sealing fit between the tubes and their baffle plates eliminates the necessity of using the spacers 27 to insure proper spacing of the baffle plates within the body portion 17. This feature, of course, decreases the total cost of a heat exchange unit while at the same time the presence of the baffles 25 materially increases the efficiency of the unit.

The flange 33, as stated above, is of particular importance in aiding in the reduction of leakage between the inner surface of the body portion 17 and the outer periphery of the baffle plate 25 in contact therewith. As the baffle plates 25 may be made from resilient metallic material, the flange 33 is inherently resilient and is capable of flexing into tight sealing engagement with the internal surface of the body portion 17. In installing the assembled baffle plates and tubes, it is necessary merely to force the baffle plates into the interior of the body portion 17 while relying on the inherent resiliency of the material of the plates to cause the flange 33 to maintain itself in tight sealing engagement with the wall of the body portion. As a result, the combined resilient sealing action of the flanges 32 and 33 presents a fluid-tight seal and the flow of fluid is controlled to an extent that a high percentage of fluid flows tortuously through the body portion 17 in contact with the outer surfaces of the tubes 23 without any appreciable loss of efficiency due to straight-through flow.

The presence of the radially extending flanges 32 presents a substantially smooth internal surface of substantial length to the outer periphery of the tubes 23. As a result, any vibration present in the operation of the heat exchange unit is incapable of causing the tubes 23 to be damaged by contact with sharp aperture edges. Still further, the closely maintained contact between the inner surface of the flanges 32 and their respective tubes 23 is sufficient to eliminate relative movement therebetween in response to vibrating forces.

From the foregoing it can be readily seen that by making use of the new and improved baffle plates of the present invention in heat exchange units of known design, a saving in cost of construction may be realized due to the elimination of rods and spacers as well as the use of lightweight material from which the baffle plates may be constructed. Still further, the baffle plates may be readily mounted on the tubes and the assembled unit installed within a body portion of a heat exchanger in such a manner as to insure increased efficiency of operation by reducing leakage of fluid past the baffle plates. Still further, the life of the tubes utilized is increased by the elimination of damage thereto caused by sharp tube aperture edges.

Obviously many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. A heat exchange unit having an outer elongated shell provided with header plates having first fluid conduit means associated therewith, a plurality of tubes within said shell and extending longitudinally thereof with their ends sealed within apertures in said header plates, said tubes being in communication with said first conduit means, a plurality of spaced baffle plates of lightweight resilient metallic material mounted on said tubes within said shell, each of said baffle plates including a plurality of apertures extending therethrough each being defined by a circumferentially continuous flange extending axially with respect to said tubes, said flanges being closely spaced to impart rigidity to the main portion of their associated baffle plates, each of said flanges internally receiving a tube and having its inner peripheral surface in resiliently flexed sealing engagement with the outer peripheral surface of its associated tube, each of said baffle plates being in sealing engagement with the inner surface of said shell along a substantial portion of its outer periphery by reason of an outer radial flange integral therewith which is inclined axially relative to the longitudinal axis of said shell, said outer flange being in flexed resilient sealing engagement with said shell, and second fluid conduit means associated with said shell for communication thereinto for fluid contact with said baffle plates and the outer surfaces of said tubes.

2. A heat exchange unit having an outer elongated shell

provided with header plates having first fluid conduit means associated therewith, a plurality of tubes within said shell and extending longitudinally thereof with their ends sealed within apertures in said header plates, said tubes being in communication with said first conduit means, a plurality of spaced baffle plates of lightweight and very thin resilient metallic material mounted on said tubes within said shell, each of said baffle plates including a plurality of apertures extending therethrough each being defined by a circumferentially continuous flange extending axially with respect to said tubes, said flanges being closely spaced to impart rigidity to the main portion of their associated baffle plates, each of said flanges being inwardly directed outwardly of its associated baffle plate, the smallest inner diameter thereof being less than the outer diameter of a tube received therethrough thereby placing said flanges in flexed resilient sealing engagement with the outer periphery of said tubes, each of said baffle plates being in sealing engagement with the inner surface of said shell along a substantial portion of its outer periphery by reason of an outer radial flange integral therewith which is inclined axially relative to the longitudinal axis of said shell, said outer flange being in flexed resilient sealing engagement with said shell, and second fluid conduit means associated with said shell for communication thereinto for fluid contact with said baffle plates and the outer surfaces of said tubes.

3. A heat exchange unit having an outer elongated shell provided with header plates having first fluid conduit means associated therewith, a plurality of tubes within said shell and extending longitudinally thereof with their ends sealed within apertures in said header plates, said tubes being in communication with said first conduit means, a plurality of spaced baffle plates of lightweight resilient metallic material mounted on said tubes within said shell, each baffle plate having a thickness on the order of 0.01 to 0.03 of an inch, each of said baffle plates including a plurality of apertures extending therethrough each being defined by a circumferentially continuous flange extending axially with respect to said tubes, the majority of said apertures being spaced from one another with respect to their centers at approximately 0.5 inch to impart rigidity to said baffle plates, each of said flanges being inwardly directed outwardly of its associated baffle plate, the smallest inner diameter thereof being less than the outer diameter of a tube received therethrough thereby placing said flanges in flexed resilient sealing engagement with the outer periphery of said tubes, each of said baffle plates being in sealing engagement with the inner surface of said shell along a substantial portion of its outer periphery by reason of an outer radial flange integral therewith which is inclined axially relative to the longitudinal axis of said shell, said outer flange being in flexed resilient sealing engagement with said shell, and second fluid conduit means associated with said shell for communication thereinto for fluid contact with said baffle plates and the outer surfaces of said tubes.

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