July 24, 1956 W. M. BYERLEY 2,756,028

HEAT EXCHANGE APPARATUS

Filed Sept. 24, 1953

FIG. 1.

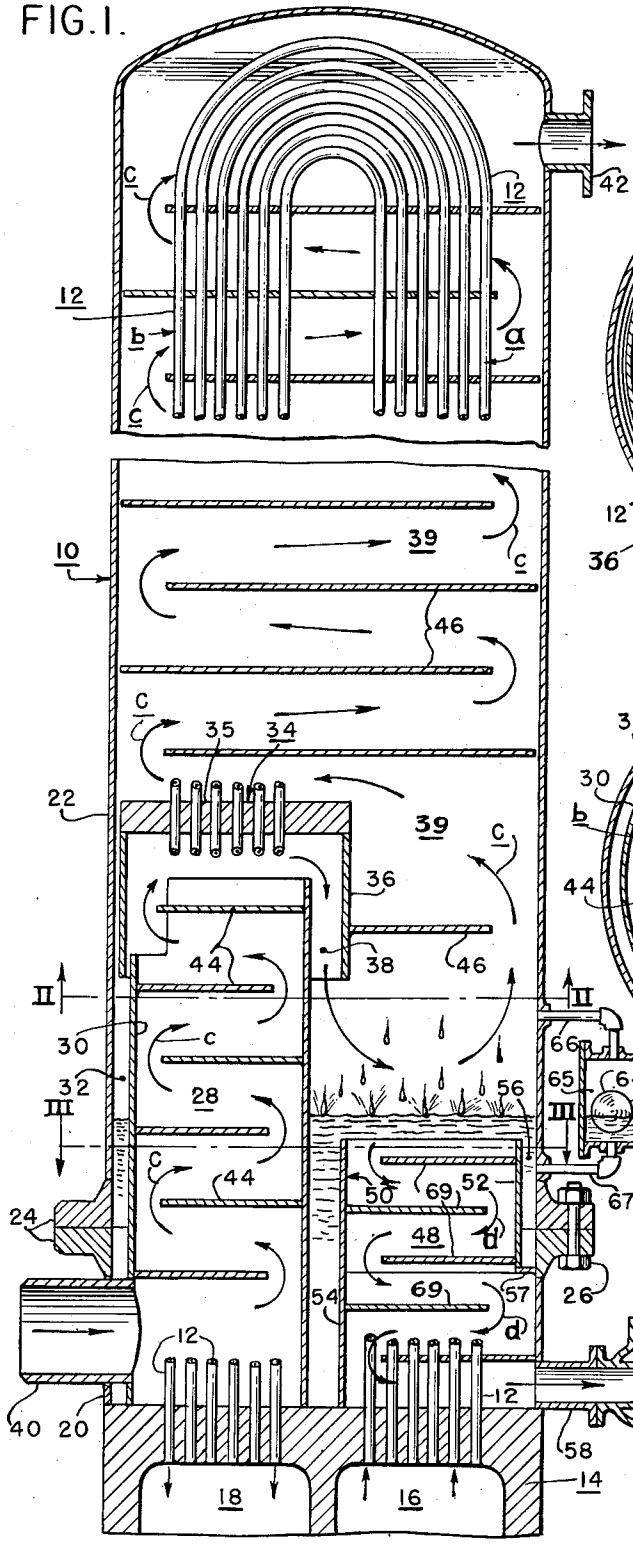
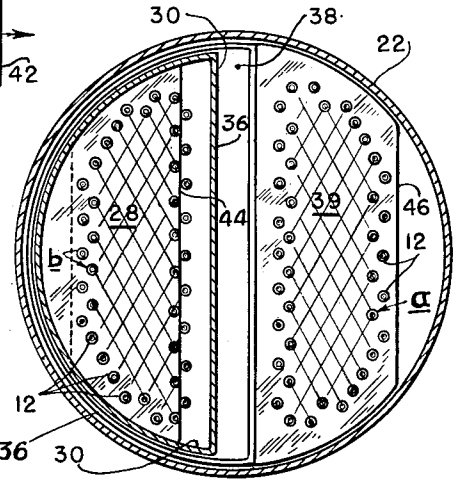


FIG. 2.



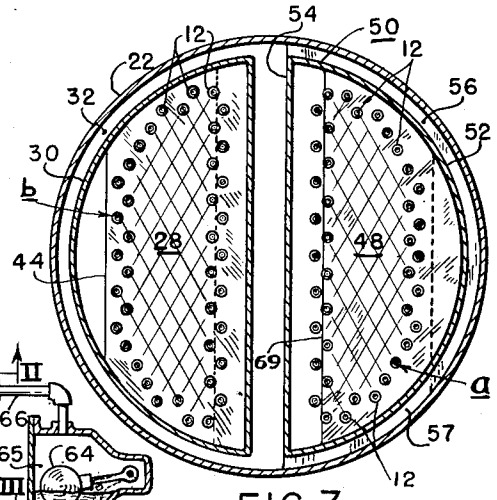


FIG. 3.

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HEAT EXCHANGE APPARATUS

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4 Claims. (Cl. 257—32)

This invention relates to heat exchangers, such as feedwater heaters, provided with vertically disposed water tubes forming a plurality of passes, more particularly to feedwater heaters of the above type having a desuperheating section in the last pass.

In heat exchangers of the above type, it is desirable to provide a shell which is removable for periodic tube inspection. Also, it is essential that condensate be prevented from forming or collecting within the desuperheating section, since condensate collected within the desuperheating section defeats the purpose of that section. In such a heat exchanger, it is also desirable to have a drain cooling section spaced horizontally from the desuperheating section. Since the flange connections for the shell are disposed in the lower region of the heat exchanger and encompass the drain cooling section and the considerably hotter desuperheating section, maintaining the flanges at a uniform temperature, which is essential to prevent buckling of the flanges, becomes a problem.

It is an object of the invention to provide a feedwater heater of the above type having a vertically removable shell in which leakage of fluid to atmosphere through the shell connection is substantially eliminated.

It is a further object of the invention to provide a feedwater heater of the above type in which the flange connection means for the shell is maintained at a substantially common temperature throughout its periphery.

A more specific object is provide, in a feedwater heater of the above type having a desuperheating section and a drain cooling section disposed at the bottom, an arrangement whereby the shell flange connection means is in good heat transfer relation with fluid of substantially uniform temperature.

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

Fig. 1 is a central vertical section showing a heat exchanger embodying the invention, portions having been omitted for clarity of illustration;

Fig. 2 is a cross section taken on line II—II of Fig. 1, looking upwardly; and

Fig. 3 is a cross section taken on line III—III of Fig. 1, looking downwardly.

Referring to the drawing in detail, there is shown a heat exchanger, generally designated **10**, having a plurality of vertically disposed U-shape or hairpin tubes **12** attached at their lower ends to a header member **14**. The header member **14** is provided with an inlet chamber **16** and an outlet chamber **18** communicating with the open ends of the tubes **12**. Thus, feed water for a boiler or the like (not shown) admitted to the inlet chamber **16** flows upwardly through the tubes **12** to provide a first water pass *a* and thence downwardly to provide a second water pass *b*, from whence it discharges into the chamber **18** in a heated state, as will subsequently be described. The tubes **12** are disposed within a shell comprising a lower shell portion **20** attached at its lower periphery to the header **14** and an upper shell portion **22** of inverted cup-shape. The lower and the upper shell portions **20** and **22**, respectively, are provided with mating flange members **24** arranged to be clamped together by means of bolts **26** to seal the heating fluid provided therein, for example, superheated steam, from the atmosphere.

A desuperheating section **28** is provided in the lower portion of the second pass *b* by vertically extending tubular baffle structure **30**, of generally semicircular cross section, enveloping the tubes **12** and defining a semi-annular space **32** with the upper and lower shell portions **22** and **20**, respectively. The lower edge portion of the baffle structure **30** is attached to the upper surface of the header **14** in any desirable manner to provide a leakproof joint therewith.

A cap member **34** having an upper horizontally disposed plate **35** and a downwardly extending peripheral flange portion **36** is supported by the tubes **12** in a fluidtight manner and is so positioned relative to the baffle structure **30** that the depending portion **36** encompasses the upper portion of the latter and together therewith defines a downwardly directed steam passage **38** communicating with a main cooling space or condensing section **39**.

A steam inlet pipe **40** is provided in the lower shell portion **20** and extends therethrough into communication with the desuperheating section **28**. A vent connection **42** is provided in the upper shell portion **22**. Thus, superheated steam entering through the inlet connection **40** circulates upwardly through the desuperheating section **28** losing a portion of its superheat to the tubes contained therein and thence passes through the passage **38** at the upper end of the desuperheating section **28** into the condensing section **39**, and condensing on its way upward. Any air and non-condensable gases are passed through the vent connection **42**. A number of horizontal baffle plates **44** and **46** may be provided in the desuperheating section and the condensing section, respectively, to form a tortuous path for the steam, indicated by the arrows *c*, as it circulates through the heat exchanger. Although the manner in which the baffles **46** are supported on the tubes **12** has not been shown in detail, it will be understood that they may be supported thereon in any desired manner. The baffles **46** and the cap member **34** for the desuperheating section have been shown as spaced slightly from the vertical wall of the upper shell member **22** to permit removal of the shell by lifting upwardly thereon after the bolts **26** have been removed from the flanges. This spacing is on the order of 1/16" in actual practice but has been exaggerated for clarity of illustration.

By properly designing the desuperheating section **28**, none of the superheated steam will condense therein, but condensation will occur after discharge therefrom into the condensing section **39**. As condensate forms in the condensing section and drops downwardly, that portion of the condensate which falls above the desuperheating section **28** is diverted by the cap member **34** so that no moisture enters the desuperheating section **28** but is permitted to accumulate exteriorly of the desuperheating section **28**.

A drain cooling section **48** is provided in the lower portion of the first pass *a* in side-by-side relation with the desuperheating section **28** and includes a baffle structure **50** having an upper tubular portion **52** of generally semi-circular cross section enveloping the lower portion of the tubes **12** in the first pass *a* and a vertical partition **54** extending downwardly beyond the edge of the portion **52** and resting on the upper surface of the header **14**. The partition **54** is attached to the header **14** in a fluidtight manner. The semi-circular portion **52** is spaced

from the upper and lower shell portions 22 and 20, respectively, and forms therewith a semi-annular space 56. The space 56 is closed at the lower end of the portion 52 by a semi-annular plate 57 attached to the lower edge of the portion 52 and extending radially outwardly therefrom. Thus, it will be seen that condensate forming in the main cooling chamber may fall into the confines of the drain cooling section 48 and also around the baffle structure 50 defining the same.

A drain connection 58 connected to the drain cooler through the lower portion of the shell serves to drain condensate formed within the heat exchanger.

A liquid level control mechanism, generally designated 60, of any desired type having a valve 62 movable to open position by upward movement of a float mechanism 64 and movable to closed position by downward movement of the float mechanism 64, is attached to the discharge outlet 58 to control flow of condensate therefrom. As well understood in the art, the float mechanism 64 is contained within a chamber 65 having a pipe connection 66 with the atmosphere within the upper portion of the shell and having a pipe connection 67 with the upper portion of the shell at a level below that of the controlled height of the condensate. The liquid level control mechanism 60 is adjusted to maintain the level of the condensate within the heat exchanger at a height above the upper edge of the baffle structure 50 forming the drain cooling section 48, but below the outlet passage 38 of the desuperheating section.

The drain cooling section 48 may be provided with a plurality of horizontal baffle plates 69 to provide a tortuous path for the condensate, as it circulates therethrough on its way to the drain outlet 58, as indicated by the arrows *d*.

Operation

The heat exchanger heretofore described operates in substantially the following manner. Superheated steam is admitted to the desuperheating section 28 through the steam inlet 40 and circulates upwardly therethrough in a tortuous path around the baffles 44 and the tubes 12 in the direction of the arrows *c*. At the upper end of the desuperheating section, the steam is deflected downwardly by the cap member through the passage 38 into the condensing section 39. The superheated steam, in circulating through the desuperheating section, loses a considerable amount of heat to the second water pass *b*. However, it retains a sufficient amount of superheat to prevent condensate forming therein.

Upon entering the condensing section, the steam circulates upwardly from side to side around the baffles 46 and the tubes 12 losing its remaining heat on its way upwardly to the vent 42. The steam will condense and fall downwardly to the lower portion of the condensing section, flooding the region around the desuperheating section 28 and filling the semi-annular space 32, the semi-annular space 56 and the drain cooling section 48 to the level previously described.

It will thus be seen that the semi-annular spaces 32 and 56 form a continuous tubular wall of water extending from below the flanges 24 upwardly above the flanges and shielding them from the differences in tempertures between the desuperheating section 28 and the drain cooling section 48. Since the water is at a substantially uniform temperature, the flange members 24 are uniformly heated throughout their peripheries, so that uneven expansion therein does not occur and buckling strains which would affect the seal formed thereby are substantially eliminated.

It will also be noted that with the above arrangement a desuperheating section and a drain cooling section may be advantageously incorporated in a plural water pass heat exchanger in which the water tubes are mounted vertically and the upper shell 22 is removable for inspection of the tubes.

While the invention has been shown 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 is claimed is:

1. In a heat exchanger, a vertical shell and a header structure defining a cooling space, tubes mounted vertically therein and providing for flow of water therethrough in a plurality of passes, baffle structure enveloping lower portions of the tubes of the last pass and defining a steam desuperheating section, means for admitting steam to said cooling space including an inlet connection to said desuperheating section, means extending across the upper end of said desuperheating section for diverting condensation away from the latter, said shell comprising an upper portion and a lower portion connected to each other by flange means, means including an outlet connection for discharging condensate through said shell, and means for maintaining the level of the condensate at a height above said flange means, said baffle structure being connected at its lower end in fluid-tight relation with said header and disposed in spaced relation with said shell in the region adjacent said flange means, whereby condensate accumulating in said cooling space is prevented from entering said desuperheating section but is free to flood the lower portion of said shell exteriorly of said baffle structure.

2. The structure recited in claim 1 in which said condensation diverting means includes a cap member having a portion extending across the tubes enveloped by said baffle and connected in fluid-tight relation therewith, and a dependent peripheral portion enveloping the upper portion of said baffle and together therewith forming a passage for discharge of steam from said desuperheating section.

3. In a heat exchanger, a vertical shell structure and a header structure defining a cooling space, tubes mounted vertically therein and providing for flow of water therethrough in first and second passes, baffle structure enveloping lower portions of said tubes in said second pass for defining a steam desuperheating section, means for admitting steam to said cooling space including an inlet connection to said desuperheating section, means for venting said cooling space including an outlet connection, said baffle structure including a vertical tubular wall portion in spaced relation with said shell and an upper wall portion extending to said tubular wall portion, said baffle structure having a passage disposed below said upper wall portion, said shell structure comprising an upper shell and a lower shell connected to each other at a level below the upper wall portion of said baffle structure, means for discharging condensate from said cooling space including a discharge connection in said shell, and means for maintaining the level of such condensation at a height intermediate the connection between the upper and the lower shells and the upper edge of the vertical wall portion of said baffle, whereby the upper and the lower shells are maintained at a common temperature adjacent their connection by the accumulated condensate.

4. A heat exchanger comprising a vertical shell structure and a header structure defining a cooling space, tubes mounted vertically therein and providing for flow of water therethrough in first and second passes, baffle structure enveloping lower portions of said tubes in said second pass and defining a steam desuperheating section, baffle structure enveloping lower portions of said tubes in said first pass and defining a drain cooling section, means for admitting steam to said cooling space including an inlet connection to said desuperheating section, means extending across the upper end of said desuperheating section for diverting condensation away from the latter, said shell structure comprising an upper shell and a lower shell connected to each other by flange means disposed below said condensation diverting means, means

including an outlet connection for discharging non-condensable gases through said upper shell, said baffle structure of the steam desuperheating section being connected at the lower end in fluid-tight relation with said header and disposed in spaced relation with said shell in the region adjacent said flange means, whereby condensate accumulating in said cooling space is prevented from entering said desuperheating section but is free to enter the drain cooling section and to flood the lower portion of said shell exteriorly of said desuperheating section, said baffle structure of the drain cooling section extending upwardly to a lesser height than the baffle structure of the desuperheating section, and means for

maintaining the level of such condensate at a height above the baffle of said drain cooling section but below the upper edge of the baffle of the desuperheating section, whereby said flange means is maintained at a substantially common temperature by the accumulated condensate.

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