Oct. 20, 1942. R. A. BOWMAN ET AL 2,299,455

HEAT EXCHANGER

Filed Sept. 26, 1940

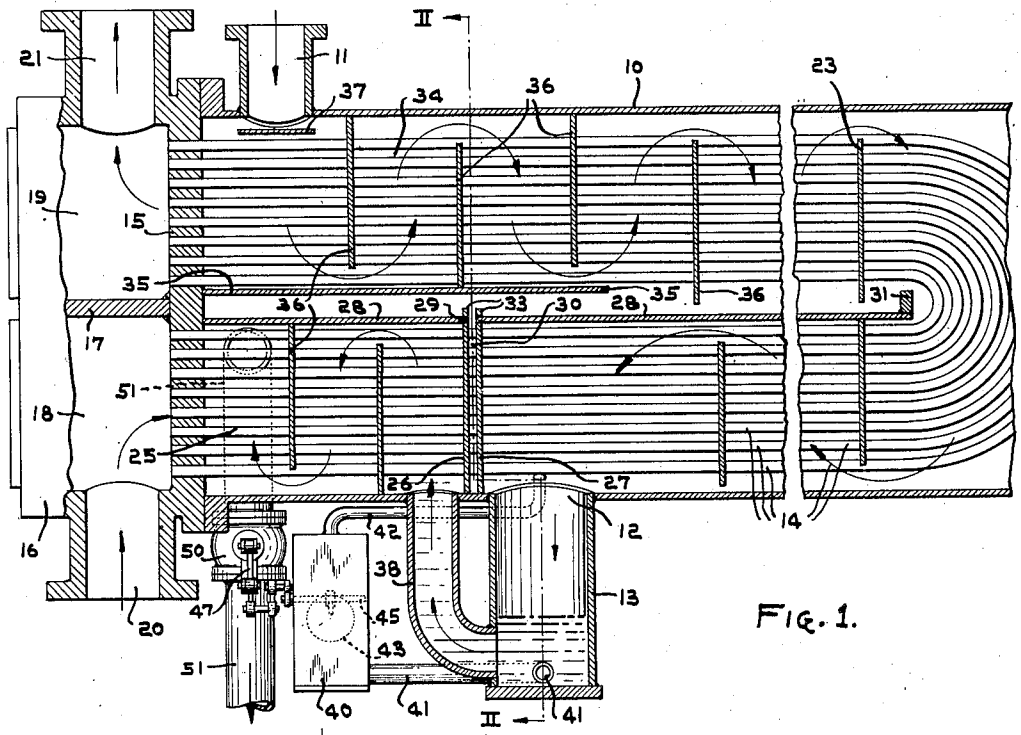


FIG. 1.

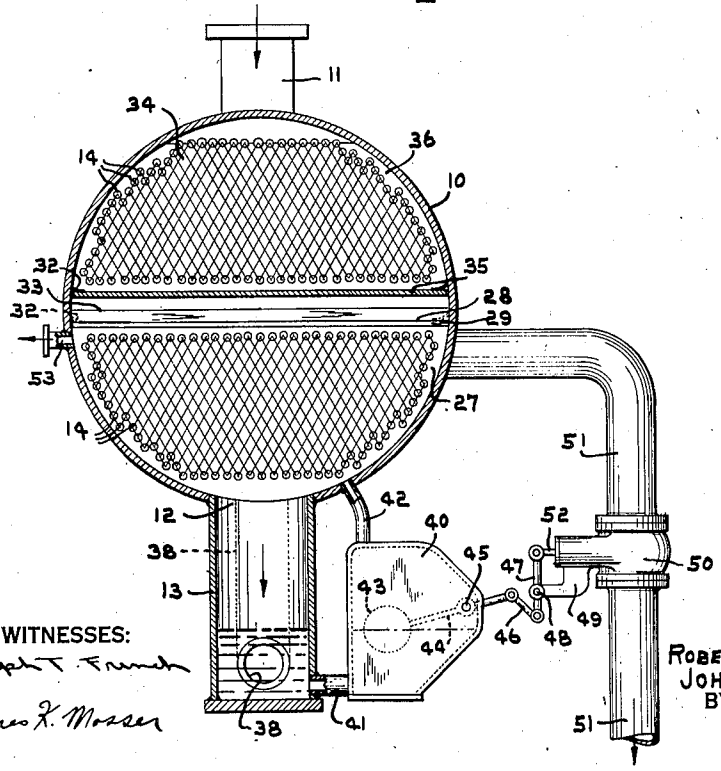


FIG. 2.

WITNESSES:

Ralph T. Frueh

James K. Mosser

INVENTORS
ROBERT A. BOWMAN AND
JOHN P. RATHBUN.
BY

R. B. Rummler

ATTORNEY

Patented Oct. 20, 1942 2,299,455

UNITED STATES PATENT OFFICE

2,299,455

HEAT EXCHANGER

Robert A. Bowman, Folcroft, and John P. Rathbun, Prospect Park, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 26, 1940, Serial No. 358,390

7 Claims. (Cl. 257—32)

This invention relates to heat exchangers, more particularly to heat exchangers wherein provision is made for sub-cooling the condensate, and it has for an object the provision of improved apparatus of this character.

The trend in high pressure heater practice is to use a sub-cooling section in order to increase the heat recovery from the bled steam and thus reduce the quantity of steam required. The sub-cooler should be confined to the first tube pass, but the amount of surface required is normally very much less than the surface in this pass. While a longitudinal baffle may me provided to segregate as much of the first pass surface as is required for sub-cooling duty, this is not satisfactory as only part of the feed water is thus utilized for sub-cooling and the rise in temperature of the feed water in the sub-cooler is thus increased, with a resultant penalty on the mean temperature difference between the cooling water and the condensate in this section. This, of course, increases the amount of surface required in both the sub-cooling and condensing sections.

It is submitted that the most economical arrangement is to partition off by a longitudinal baffle all of the first tube pass and utilize the required part of this pass nearest to the inlet tube plate. It is, of course, necessary to flood this sub-cooler, and since the rest of the first pass tubes which are in the condensing section must not be flooded, means must be provided for accomplishing this double purpose.

It is proposed to drain the condensate from the condensing section into a small hotwell provided with a suitable float control which will actuate a valve in the condensate discharge line from the sub-cooling section. This will result in the outlet pressure from the sub-cooling section being reduced a sufficient amount to account for the static head between the condensate level in the hotwell and the condensate water level in the sub-cooling section. Normally, this pressure differential would cause steam leakage from the condensing section into the sub-cooling section through the transverse separating baffle, which would obviously defeat the purpose of the sub-cooler.

To overcome this last-mentioned difficulty, it is proposed to collect condensate on the longitudinal baffle separating the first pass tube from the remaining tubes of the heat exchanger and drain it through a port in the baffle to the space between two transverse baffles positioned relatively close together. These transversely-extending baffles will constitute means for segregating the inlet portion of the first pass from the remainder of the pass, the segregated portion constituting the sub-cooler section.

The draining of condensate from the longitudinal baffle to the space between the pair of transversely-extending baffles will result in distribution of this condensate around all of the tubes in the first pass, thus water-sealing the clearance holes for the tubes in the transverse baffles, as well as any clearance space between these baffles and the shell.

Therefore, it is an object of the present invention tc provide heat exchange apparatus having a sub-cooling section constituted by only the colder portion of the first tube pass.

Another object of the invention is the provision of heat exchange apparatus having a sub-cooling section comprised by the inlet or cold portion of the first tube pass, together with means for water-sealing the sub-cooler from the remainder of the apparatus.

Another object of the invention is the provision of heat exchange apparatus having a sub-cooler together with means for maintaining the latter flooded with condensate.

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

Fig. 1 is a longitudinal sectional view through a heat exchanger embodying the principles of the invention; and,

Fig. 2 is a transverse sectional view taken along the line II—II of Fig. 1, looking in the direction of the arrows.

In the drawing there is shown heat exchange apparatus comprised by a shell 10 having a steam inlet 11 and a condensate outlet 12, the latter communicating with a hotwell 13. A plurality of U-tubes 14 extend longitudinally of the shell and have their terminal portions supported at one end thereof by a stationary tube plate 15, the latter comprising a portion of the waterbox structure 16. The waterbox 16 is provided with a transverse partition 17 dividing the interior thereof into an inlet compartment 18 and an outlet compartment 19 provided with an inlet connection 20 and an outlet connection 21, respectively. Suitable means, such as intermediate tube supports 23, may be provided for further supporting the tubes 14 at suitable intervals throughout their length.

A section 25 comprised by the inlet or cold portion of the first tube pass is segregated from the

remaining portion of that pass by a pair of slightly-spaced, transversely-extending, vertical partitions 26 and 27. A horizontal baffle 28 extends longitudinally of the shell and separates the first pass tubes from the tubes of the remaining passes. This horizontal baffle 28 is provided with a transversely-extending slot or opening 29 overlying and aligned with the space 30 between the transversely-extending baffles 26 and 27. The horizontal baffle is provided at its innermost free end with a transversely-extending dam member 31 and is sealed at its longitudinal edges by suitable means, such as the Lamiflex seal 32 (Fig. 2).

It will be apparent that condensate deposited on the baffle 28 will accumulate thereon due to the dam member 31 and will drain therefrom into the space 30 between the transversely-extending baffles 26 and 27.

It may be desirable to provide the longitudinal baffle 28 with weir members 33 adjacent the opening 29 in order to maintain sufficient condensate upon the baffle 28 to keep the Lamiflex seals 32 covered, thereby water-sealing the joints between the baffle 28 and the shell.

Where the apparatus includes a desuperheating section, such as shown at 34, there may be provided an additional horizontal baffle 35 in vertically-spaced relation with respect to the baffle 28 in order to prevent fine particles of condensate lying on the baffle 28 being picked up and deposited on the tubes of the desuperheating section by the steam flowing through the latter.

Preferably, suitable baffles 36 extending transversely of the tubes 14, are provided throughout the apparatus to obtain maximum contact of the steam with the condensing and cooling surface. Similarly, a baffle 37 may be provided in the path of steam entering at the inlet 11 to prevent erosion of tubes by impingement of high velocity steam.

The hotwell 13 is located at the condensing side of the transverse baffles 26 and 27, but is in communication with the sub-cooler 25 through a conduit 38. In order that the sub-cooler 25 may be maintained completely flooded at all times, there is provided an automatic float valve control comprised by a float housing 40 in communication with the bottom of the hotwell through the conduit 41 and vented to the interior of the condensing portion of the apparatus through the conduit 42. A float 43, disposed within the housing 40, is carried at one end of the lever 44, the latter being pivoted at 45 to the housing 40 with its free end projecting outwardly of the latter. This free end is pivotally connected through the link 46 with a lever 47 pivotally mounted at 48 on the arm 49 of the valve housing 50, the latter constituting a section of the condensate discharge conduit 51. The lever 47 is operatively connected through the valve rod 52 with a control valve (not shown) mounted in the valve housing 50.

It will be apparent from consideration of Fig. 2 that upon increase in the amount of condensate in the hotwell 13, the float 43 in the housing 40 will be raised, thereby moving the valve rod 52 to the left to open the valve in the housing 50 and permit discharge of condensate from the sub-cooling section 25, with which the condensate discharge conduit 51 communicates. The condensate discharged through the conduit 51 will be replaced by condensate from the hotwell 13 until the level in the latter has fallen enough to cause the float 43 to drop sufficiently to close the valve in the housing 50, thereby shutting off the discharge flow of condensate from the sub-cooler.

The last section of the condensing portion of the apparatus, considered in the direction of steam flow, may be provided with the usual offtake for air and non-condensable gases, as at 53 (Fig. 2).

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, and it is desired, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What is claimed is:

1. Heat exchange apparatus comprising a horizontal shell having a steam inlet and a condensate outlet; a plurality of tubes extending longitudinally of said shell; waterbox structure associated with said tubes and providing for circulation of water therethrough in a plurality of passes with the first pass tubes disposed in the lower part of the shell; means segregating the space within the shell surrounding the coldest portion of the first pass from the remainder of the space within the heat exchanger with the segregated portion constituting a sub-cooler, said means comprising first and second spaced, parallel, vertical baffles extending transversely of the first pass tubes at a material distance from the inlet ends thereof and approximately engaging at their edges with the sides and bottom of the shell, and a horizontal baffle extending from the top of said first vertical baffle to the inlet end of the exchanger in overlying relation to the tubes of the sub-cooler and having sealing engagement at its longitudinal edges with the sides of the shell; means for maintaining said horizontal baffle covered with condensate during operation of the apparatus; and means for directing the overflow of condensate from said horizontal baffle to the space between the first and second vertical baffles to maintain said space filled.

2. Heat exchange apparatus comprising a horizontal shell having a steam inlet and a condensate outlet; a hotwell for receiving condensate from said condensate outlet; a plurality of tubes extending longitudinally of said shell; a stationary tube plate closing the inlet end of said shell and supporting the terminal portions of the tubes at said inlet end; means closing the other end of the shell; waterbox structure associated with said tubes and providing for circulation of water therethrough in a plurality of passes with the first pass tubes disposed in the lower part of the shell; means segregating the coldest portion of the first pass from the remainder of the exchanger with the segregated portion constitutnig a sub-cooler, said means comprising a pair of closely-spaced, parallel, vertical baffles extending transversely of the first pass between the inlet end thereof and the condensate outlet and spaced a material distance from the former and approximately engaging at their edges with the sides and bottom of the shell, and a horizontal baffle extending from the stationary tube plate to the nearer of said pair of baffles and having sealing engagement at its longitudinal edges with the sides of the shell; means for maintaining a liquid seal at the edges of said horizontal baffle and said pair of vertical baffles during operation of the apparatus; and means providing for pas-

sage of condensate from the hotwell to the sub-cooler.

3. A structure as specified in claim 2, including means operable in response to change in level of condensate in the hotwell for controlling discharge of condensate from the sub-cooler.

4. Heat exchange apparatus comprising a horizontal shell having a steam inlet and a condensate outlet; a plurality of tubes extending longitudinally of said shell; waterbox structure associated with said tubes and providing for circulation of water therethrough in a plurality of passes with the first pass tubes disposed in the lower part of the shell; means segregating the space within the shell surrounding the coldest portion of the first pass tubes from the remainder of the space within the heat exchanger with the segregated portion constituting a sub-cooler, said means comprising first and second spaced, parallel, vertical baffles extending transversely of the first pass tubes at a material distance from the inlet ends theerof, and horizontal baffle structure extending from the tops of said vertical baffles towards both ends of the exchanger in overlying relation to the tubes of the first pass; means for maintaining said horizontal baffle structure covered with condensate during normal operation of the apparatus; and means for directing the overflow of condensate from said horizontal baffle structure to the space between the first and second vertical baffles to maintain said space filled.

5. Heat exchange apparatus comprising a horizontal shell having a steam inlet and a condensate outlet; a plurality of tubes extending longitudinally of said shell; waterbox structure associated with said tubes and providing for circulation of water therethrough in a plurality of passes with the first pass tubes disposed in the lower part of the shell and constituting a sub-cooler; a horizontal baffle separating said first pass tubes from the remaining tubes and defining an opening for flow of condensate from the space above said baffle to the sub-cooler; and means for maintaining the horizontal baffle covered with condensate whereby said baffle is water sealed with respect to the shell.

6. Heat exchange apparatus comprising a horizontal shell having a steam inlet and a condensate outlet; a plurality of tubes extending longitudinally of said shell; waterbox structure associated with said tubes and providing for circulation of water therethrough in a plurality of passes with the first pass tubes disposed in the lower part of the shell and constituting a sub-cooler; a horizontal baffle separating said first pass tubes from the remaining tubes and defining an opening for flow of condensate from the space above said baffle to the sub-cooler; and dam means about said opening for maintaining the horizontal baffle covered with condensate whereby said baffle is water-sealed with respect to the shell.

7. Heat exchange apparatus comprising a horizontal shell having a steam inlet and a condensate outlet; a plurality of tubes extending longitudinally of said shell; waterbox structure associated with said tubes and providing for circulation of water therethrough in a plurality of passes with the first pass tubes disposed in the lower part of the shell and constituting a sub-cooler; a horizontal baffle separating said first pass tubes from the remaining tubes and defining an opening for flow of condensate from the space above said baffle to the sub-cooler for counter-flow through the latter; and dam means about said opening for maintaining the horizontal baffle covered with condensate whereby said baffle is water-sealed with respect to the shell.

ROBERT A. BOWMAN.
JOHN P. RATHBUN.