The present invention relates to header type tubular heat exchangers, for example, to feed water heaters, wherein a liquid medium (feed water) flowing through a bundle of tubes is brought into indirect heat exchange with a medium such as steam, which may be condensed by the heat exchange and which at least enters in the vapour phase the casing of the heat exchanger, wherein said bundle of tubes is enclosed.

Feed water heaters were hitherto of a design requiring large waterboxes which were difficult to keep watertight, or of a design which dispensed with large waterboxes but were not suitable when a large heat exchange surface was required. Moreover, in this latter design maintenance was very difficult since the tubes could not be repaired: when a tube leaked, it had to be plugged.

In a header type tubular heat exchanger according to the present invention a liquid medium flowing through bundles of tubes enclosed in a casing is brought in heat exchange with a second medium which at least enters the said casing in the vapour phase and is condensed there by heat exchange, wherein the inlet and the outlet pipes of the first medium are arranged at one end of said casing and the said bundles of tubes are so arranged that the said first medium performs at least two U-turns when flowing through said bundles of tubes.

According to one embodiment of the present invention said bundles of tubes having, for example, three U-turns are attached by headers to two short vertical feed water inlet and outlet-pipes arranged side by side in the cover of a vertical cylindrical casing, into which casing the said pipe bundles extend. By detaching the cover from the said casing and the said feed water inlet- and outlet-pipes from their connections, the entire bundles of U-bend pipes can be withdrawn from the casing and any defective tube can be repaired, after having been made accessible in this way.

Preferably the ascending branch of the tube bundles connected to a header of the feed water pipes is enveloped in a mantle separating the same from the rest of the interior of the casing. This mantle is closed on the bottom and open on top. Live steam is introduced into this mantle near its bottom, and leaves the same desuperheated on top. After turning about within the said cover, the saturated steam flows downward in the casing being condensed by heat exchange with the U-bend pipes. The condensate flows off at the bottom of the casing.

Preferably a supporting structure composed of longitudinal tubular frame members and transverse frame members is suspended on the short inlet- and outlet-feed water pipes. Horizontal baffles are clamped to the said transverse frame members both inside and outside the said mantle; these baffles force the steam to flow zig-zag firstly in a generally upward direction in the desuperheating section inside the said mantle, and then in a generally downward direction through the rest of the casing. Thereby the path, along which heat exchange between the two media takes place, is extended in length.

According to another embodiment of the present invention the feed water enters at the top of the cover of the casing and is passed through a few comparatively wide fall pipes to the bottom of the casing where it enters a plurality of small headers from which it flows into a nest of small bore tubes leading with some vertical U-bends to small headers at the top of the casing and from there through an outlet in the cover of the casing.

The bottom of the casing is filled with condensed water of the level of which is controlled preferably by a U-leg, and the feed water enters first into heat exchange with this condensate before coming into heat exchange with the condensing steam in the main portion of the casing. The last upward portion of the small bore tubes may be enclosed by a jacket within the casing into which live steam is introduced from outside, this part forming the de-superheating section.

In order that the invention may be clearly understood and readily carried into effect an embodiment thereof will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 is a longitudinal section of a feed water heater according to the invention.

FIG. 2 is a cross section on the line II—II of FIG. 1.

FIG. 3 is a cross section on the line III—III of FIG. 1, on a larger scale.

FIG. 4 is a diagrammatic perspective view of part of a supporting structure.

FIG. 5 is a diagrammatic longitudinal section of a second embodiment.

FIG. 6 is a corresponding section of a third embodiment and

FIG. 7 is a section on the line VII—VII of FIG. 6. Referring firstly to FIGS. 1—4 the casing 1 is supported on brackets 2, and has a lateral inlet 3 for superheated steam at its lower portion and an outlet 4 for the condensate at its bottom. A cover 5 is connected by flanges 6 to the casing 1 and carries side by side (FIG. 2) a feed water inlet pipe 7 and outlet pipe 8, which are welded into it. A number of separate parallel straight inlet headers 10 are connected, each through a small bent tube 9, to the inlet pipe 7; similarly a number of separate parallel straight outlet headers 12 are connected, each through a tube 12, to the outlet pipe 8. Between each header 10 and the corresponding header 11 there is connected a row of heat-exchange tubes 12, which start from both headers in the horizontal direction, then turn immediately vertically downward, have a 180° bend near the bottom of the casing 1 and in the middle just under the inlet and outlet pipes 7 and 8 form another 180° bend.

The feed water enters through the inlet pipe 7, flows downward through the pipes 12 on the left hand side of the figures, and, after three U-bends, rises on the right hand side of the figures and leaves the outlet pipe 8. The rising tubes 12 on the right hand side of the figures are encased in a mantle 13 closed at the bottom, into which the superheated steam enters from the steam inlet 3 and wherein this steam is first de-superheated in heat exchange with the feed water flowing through the tubes 12. The wet steam turns to the left of the figures inside the cover 5, and flows downward through the casing 1 as far as the latter is not occupied by the mantle 13, and is condensed by heat exchange with the descending, ascending and again descending part of the tubes 12, the condensate flowing off at 4 as sintered.
Brackets 17 are welded laterally to the feed water tubes, and on which cross beams 18 are attached supporting the headers 10 and 11 and hence the bundles of tubes 12. Each row of tubes 12 is presented in a plane direction perpendicular to the plane of projection of FIG. 1 carries baffle strips 40 fitting closely to one another side by side and offset from one another at different levels 20, 20 etc. The baffle strips 40 are arranged parallel to the headers 10, 11: each baffle strip 40 has a number of perforations 41 through which pass the tubes 12 constituting one row. In the casing 1 a supporting frame is suspended from the inlet and outlet tubes 7, 8 through a support structure 42. The frame consists of longitudinal tubular members 14, a vertical plate 15 (forming the inner wall of said mantle 13), horizontal bar members 16 and plate segments 26 and angle profile ring segments 19, all welded together. These ring segments are completed by detachable ring segments 19' bolted to the said frame. The baffle strips are clamped down on the ring segments 19', 19' by means of rings segments 21 and fit closely to one another and between the said bar members 16 and/or segments 26 so as to block the path of the steam over the full extent, leaving passages 22, 23, 24, 25, . . . which are offset as from one level of baffles 29 to another, 20, so as to force the steam to follow a zig-zag path as indicated by arrows in FIGS. 1 and 4, first in a general upward direction through the superheating stage inside the mantle 13 and then in a general downward direction in the rest of the casing 1, the condensate being drawn off at 4.

For clarity the tubes 12 and holes 41 are omitted from FIG. 3, and only a few tubes 12 and holes 41 are shown in FIG. 4. Also the removable part 30' of the angle profile ring member is omitted from the lower part of FIG. 4. FIG. 3 is a section looking down at the first level 20 of baffles, with the second level 20' underneath indicated on the left.

For inspection and repair of the tubes 12, the flange connection 6 between the casing 1 and the cover 5 and the connections of the feed water inlet and outlet pipes 7 and 8 to have been detached. The said pipes 7, 8, headers 10, 11, pipes 12 and supporting frame with baffles 20, 20', can be withdrawn longitudinally from the casing 1. By removing the detachable sections 39' of the angle profile ring member the tubes 12 become fully accessible. Any defective bundle of tubes 12 can be removed after cutting off the connecting connector tubes 9.

Referring now to FIGS. 3, 5, in FIG. 5, a cylindrical casing 1 is connected by flanges 6 to a cover 5 into which the feed water inlet 7 and outlet 8 are welded. The inlet 7 is connected by four comparatively larger bore pipes 7' and smaller branch pipes 9' to small headers 10 arranged side by side near the bottom of the casing 1. At each small header 10 a nest of tubes 12 is connected leading firstly upward, then at 12' horizontally from right to left, then again upward to the upper end of casing 1, then with two U-bends downward and upward again to small headers 11 lying side by side and connected by short branch pipes 9" to the feed water outlet 8.

Baffle strips 20, 20' are fitted across each nest of tubes 12 so as to force the steam to pursue a zig-zag path. Each strip corresponds in width to one small header 10 and 11, respectively, as in the embodiment according to FIGS. 1–4.

The bottom of the casing 1 has an outlet 4 connected by a U-leg 39 to a drain outlet box 31 connected to the condensate drain 32. A short compensating pipe 31' vents steam led from the condensate in the box 31 back into the casing 1. The drain outlet box 31 and drain 32 are just above the level of the horizontal portion 12' of the nests of tubes, so that the condensate level adjusts itself in the casing in such a manner that the said horizontal portion 12' is covered.

Steam is introduced into the casing 1 through the steam inlet 3, firstly into a de-superheating section enclosed by a mantle 13 surrounding the upper ends of the tube nests joining the headers 11. The steam escapes at the upper and lower ends of the mantle 13 into the casing 1 and is condensed there in heat exchange with the tube nests 12.

The feed water from the inlet 7 enters accordingly first into heat exchange with the condensate at the bottom of the casing 1, cooled said condensate, then with the condensing steam and lastly with the live steam in the de-superheating section before leaving through the outlet 8.

Each nest of tubes 12 can be removed in the following manner.

(1) The complete tube nests are laid bare by removing the cover.

(2) The sealing plates of the de-superheating section are removed.

(3) The connections between the nest of tubes 12 to be removed and the water inlet and outlet branches 7 and 8 are cut out at the small branch pipes 9".

(4) The section containing the defective tube is pulled away, the tube repaired and the section replaced.

In the embodiment according to FIG. 6 the U-bends of the tubes 12 are obviated and straight tubes only are used. The feed water inlet 7 is again connected by full pipes 7' and branch pipes 9" to secondary full width headers 10 lying side by side at the bottom of the casing 1. Short straight tubes 12 lead to headers 11 extending across the whole width of the casing 1, and connected by short branch pipes 9' to short headers 10', extending over about one third of the width of casing 1. From there long straight tubes 12 lead to first headers 11 extending over about two thirds the width of the casing 1, and connected similarly dimensioned second two-third width headers 10'' at the level of the one-third width headers 10' by downward tubes. The second two-third width headers 10'' are in turn connected by upward tubes to the primary headers 11' lying at the level of the first two-third width headers 11' and connected by branch pipes 9'' to the feed water outlet 8.

The headers 10' and 10'' and the headers 11' and 11'' may in fact be in one piece, respectively, and only internally partitioned. The condensed water level in the casing 1 is approximately adjusted by suitably positioning the box 31 and drain pipe 32 at a height between the headers 10' and 10'', 11' and 11'' respectively.

The operation of the embodiment according to FIGS. 6, 7 corresponds to that of the embodiment according to FIG. 5. The U-bends of the latter being replaced by the headers 11' and 11''.

The removal of defective nests of tubes 12, 12' in this embodiment is carried out in the same manner as described for the first embodiment described in this specification.

While the present invention is intended primarily for feed water heaters, it is applicable with suitable modifications, if desired, to other heat exchangers.

What we claim as our invention and desire to secure by Letters Patent is:

A header-type tubular heat-exchanger comprising a vessel containing a first fluid, an inlet duct and an outlet duct for a second fluid, said ducts passing through the wall of said vessel, a plurality of groups of heat-exchange tubes within said vessel, each of said tubes having an inlet and an outlet end, a plurality of separate parallel inlet headers and a plurality of separate outlet headers parallel to the inlet headers within said vessel, each said group of tubes having one said inlet header attached to the inlet end of the tubes in the group and one said outlet header attached to the outlet end thereof, each group of tubes being disposed parallel to the other groups with corresponding portions of each group of tubes being parallel to corresponding portions of the other groups, a plurality of inlet tubes connected between said inlet duct and said inlet headers, a plurality of outlet tubes connected between said outlet headers and said outlet duct, and a plurality of baffles for said first fluid within said vessel, each baffle comprising a number of contiguous perforated strips parallel to said
headers, and each said strip having only one of said group of heat-exchanger tubes passing through the perforations therein, so that when said groups of tubes are removed from said vessel, each said group of tubes together with the associated inlet and outlet headers and the associated baffle strips may, on disconnection of the associated inlet and outlet tubes, be removed laterally as an individual group.

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