July 2, 1968 R. R. NOE 3,390,721

MULTIPLE HEADER FEEDWATER HEATER

Filed April 22, 1966 2 Sheets-Sheet 1

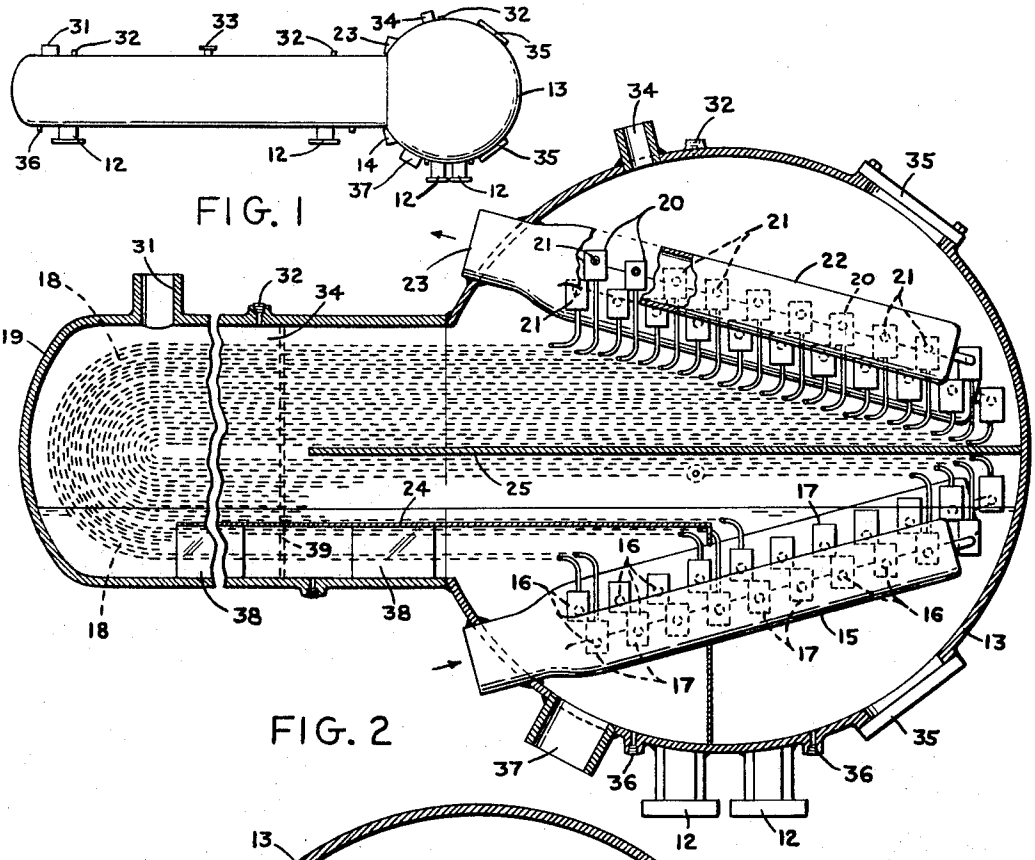


FIG. 1

FIG. 2

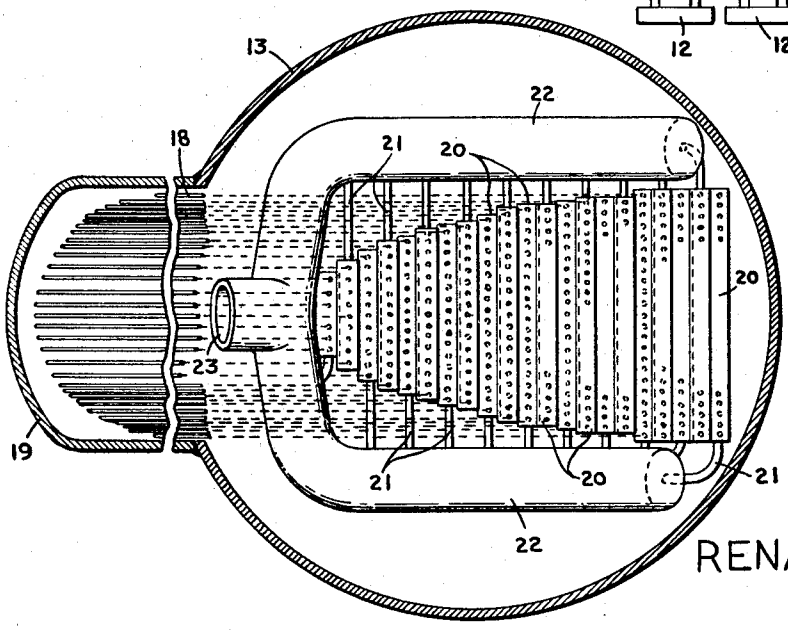


FIG. 3

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MULTIPLE HEADER FEEDWATER HEATER

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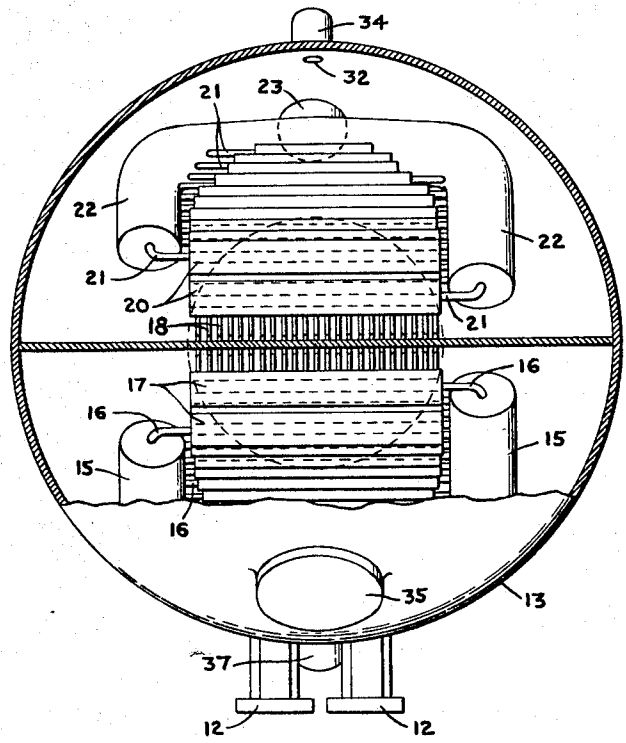


FIG. 4

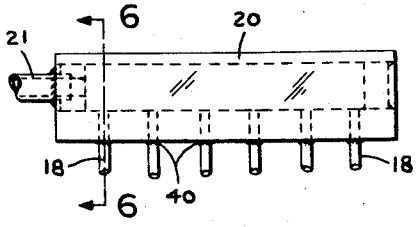


FIG. 5

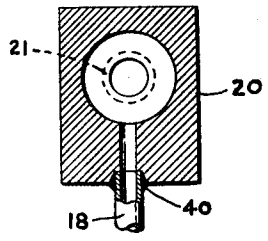


FIG. 6

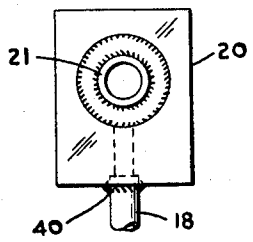


FIG. 7

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MULTIPLE HEADER FEEDWATER HEATER

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6 Claims. (Cl. 165—111)

ABSTRACT OF THE DISCLOSURE

A multiple header feedwater heater having inclined, bifurcated, distribution and collection headers for the passage of feedwater through the heater. Each distribution and collection header is connected in fluid flow communication to a plurality of horizontal sub-headers. Each distribution sub-header is connected to a corresponding collection sub-header by a plurality of U-shaped tubes.

This invention relates generally to heat exchange apparatus, and particularly to a feedwater heater of the multiple header type.

It is an object of the invention to provide a feedwater heater of the multi-pass type which can withstand temperature variations without deterioration.

Another object of the invention is to provide a feedwater heater which is not subject to high pressure drops on the tube side.

Another object of the invention is to provide a feedwater heater of the multi-pass type which does not require high pressure closures or a thick tube sheet.

A still further object of the invention is to provide a high pressure feedwater heater of a multiple header type, which is relatively inexpensive and durable.

A still further object of the invention is to provide a high pressure feedwater heater of the multiple header type, which does not require a de-superheater shroud.

Among the further objects of the invention is to provide a feedwater heater of the multiple header type, whose components are not severely stressed with changes in the thermal and pressure conditions.

Among the still further objects of the invention is to provide a feedwater heater of the multiple header type, which is not frequently subject to costly shutdown due to failure, and is easily repaired by reason of the ready accessibility of the component parts.

Yet another object of the invention is to provide a feedwater heater of the multiple header type which does not require very thick tube sheets, but is very compact and reliable.

Yet a still further object of the invention is to provide a high pressure feedwater heater of the multiple header type equipped with superior thermo-dynamic and design characterisitics.

Yet another object of the invention is to provide a feedwater heater which uses multiple individual headers, each serving one row of tubes, rather than a single tube sheet serving all tubes.

A still further object of the invention is to provide a feedwater heater which has multiple headers on the inlet side and corresponding multiple headers on the outlet side, each of which is fed or feeds a single distribution header.

Yet another object of the invention is to provide a feedwater heater in which heat transfer occurs over the entire flow path of the feedwater, from entry to exit.

Yet still a further object of the invention is to provide a feedwater heater which can be constructed with assembly of the tube bundle preceding the installation of the baffles and tube supports.

A still further object of the invention is to provide a feedwater heater with improved tube welds.

Yet another object of the invention is to provide a feedwater heater with increased ligament for tube welds.

Feedwater heaters have been in use, and have incorporated tube sheets and high pressure closures, but their reliability has not been of the highest order. They have required a very heavy construction and they eventually succumb to thermal and pressure stresses.

Newer designs of equipment demand steam at higher temperature and pressure, thereby making greater and greater demands upon feedwater heaters, subjecting them to greater and greater stresses. In the absence of improved designs, vast increases in heaviness of construction would have been required, in order to resist the greater thermal and pressure stresses. The present invention obviates the necessity for such heavier constructions.

It has been found that an inclined distribution header and a correspondingly inclined collection header could be arranged, each of which would feed or collect water from a plurality of horizontal, staggered, tube row headers. These tube row headers could be connected to each other by intimately disposed U-shaped tubes extending in a bunch throughout the length of the casing.

The use of multiple headers arranged in staggered pitched relation provides extremely compact disposition of the tubes, ease in welding the tubes to the multiple headers, minimizing thermal and pressure stresses. The installations of baffles and tube supports of the grid type after the tube bundle is assembled and the use of a submerged long subcooling zone without the need of a subcooling shroud is also a feature of the design. The barform of multiple header provides a strong construction that withstands pressures of 5,000 p.s.i.g. or even more, with strong joints, and provides a flat surface for easy drilling, aligning and welding. The tube row headers being positioned on an incline, and being fed alternately from the bifurcated, inclined distribution header, makes possible extremely close pitch. The use of the staggered feeding pipe manifolds not only for distribution, but for collection, enables a very compact assembly. The use of multiple tube row headers enables increased spacing between tube connections with accompanying improvement in selection and quality of tube welds. Thin tubes are welded to correspondingly thin members, and there is no requirement that a thin tube be welded to a relatively thick tube sheet. Elimination of the tube sheet and high pressure closure in the design enables heating of the feedwater from its point of entry to its point of exit from the feedwater heater. In the present construction, sub-assemblies may be completed by welding their individual components together, and then they may be incorporated in the final assembly. All welds are at all times accessible for repairs, and the sub-assemblies may be individually tested for freedom from defects, without the necessity for testing the entire assembly. After final assembly, any defects discovered may be easily repaired or the defective tubes or welds replaced. The feedwater heater devised in accordance with the present invention is reliable, durable and relatively easy to construct, maintain or repair.

By way of illustration of the invention, there is shown in the drawings:

FIGURE 1 is an elevational view of the heater;

FIGURE 2 is a fragmentary side view of the heater, partly broken away to show distribution headers in their respective inclined positions;

FIGURE 3 is a fragmentary top view of the heater with the upper shell removed, showing the collection header;

FIGURE 4 is an end view of the heater shell partly broken away;

FIGURE 5 is a side view of a multiple header;

FIGURE 6 is a cross-sectional view taken on the lines 6—6 of FIGURE 5; and

FIGURE 7 is an end view of the multiple header.

Referring now to the drawings in detail, there is provided a casing **11** which has a plurality of bottom supports **12**. The casing is tubular, with a bulbous enlargement **13** at one end. This enlargement has a tubular feedwater inlet **14** communicating with a bifurcated, inclined distribution header **15** extending upwardly toward the end of the enlargement **13** and toward the central longitudinal axis of the casing. The distribution header **15** communicates with alternate opposite feed-lines **16** extending in a horizontal direction. Each of the feeding lines **16** feed into numerous bottom multiple headers **17**, which are generally elongated boxes having a somewhat rectangular or square vertical cross-section area. Each multiple header **17** feeds a plurality of tubes **18**. These tubes extend upwardly and then bend at an angle of 90°, extending out of the enlargement **13** toward the opposite end of the tubular portion of the casing **11**. The tubes **18** are disposed in general parallelism with each other and with the casing. At the end thereof, they change direction by reason of a U-shaped bend, still each in general parallelism with the other, and in general parallelism with the convex end **19** of the casing **11**. Having accomplished a 180° change in direction, the tubes **18** extend back into the bulbous enlargement **13** of the casing **11**. There, they once more make a 90° bend in order to extend upwardly to connect to a plurality of top multiple headers **20**, substantially identically disposed with and in conformity to the bottom multiple headers **17**. These top multiple headers **20** are connected by short feeding lines **21**, with a collection header **22**, which is bifurcated and substantially identical with the distribution header **15**, disposed at an acute angle to the horizontal in general correspondence with the distribution header **15**. By this arrangement, as is the case with the distribution header **15**, the collection header can be fed from a plurality of top multiple headers **20**, feeding alternately to each other to the collection header **20**, and, also, disposed in staggered relation to each other, so that the greatest possible number of tubes **18** can be incorporated into a relatively small compact bunch. The collection header **22** is inclined downwardly toward the end of the enlargement **13** and toward the central longitudinal axis of the casing **11**. The collection header communicates with a feed-water outlet **23** in the casing **11**. The tubes **18** extending from the distribution header **15** are separated into two sections by a horizontal division plate **24**, which is approximately positioned so as to divide the lower half of the casing **11** into two approximately equal parts. The horizontal division plate does not extend all the way to the end **19** of the casing **11**, but merely to the point where the tubes **18** are U-shaped. The horizontal division plate **24**, at the point where it is in general alignment with the center of the bulbous enlargement **13**, bends in a downward direction, and extends to the bottom of the bulbous enlargement **13**. The feedwater heater is intended to operate with a liquid level just above the horizontal division plate **24**, as shown in FIG. 2.

The tubes **18**, which extend back into the bulbous enlargement **13** after they have accomplished the U-shaped bend, are all separated from those tubes **18** which extend outwardly from the multiple headers **17** below the central longitudinal axis of the casing **11**, by a horizontal division plate **25**, which divides the casing **11** and the bulbous enlargement **13** horizontally into two generally equal upper and lower sections that communicate with each other only at the end **19** beyond the plate **25**, which does not reach to the end **19**. The plate **25** terminates a short distance beyond the bulbous enlargement **13** and is intended primarily to maintain the lower half of the bulbous enlargement **13** as a separate zone from the upper half of the bulbous enlargement **13**.

It is to be noted in FIGURE 2 that the placement of the bottom multiple headers **17** and the top multiple headers **20** can be easily arranged at close pitch in a plane inclined upwardly, thereby permitting the attachment of horizontal row above row of tubes **18**, which are incorporated into a very compact bundle. The tubes **18** are thereby susceptible to be arranged symmetrically in numerous horizontal rows in a compact mass, thereby permitting the casing to be of relatively small circumference. This is especially possible positioning the distribution header **15** and the collection header **22** in an inclined manner, and connecting the multiple headers **17**, **20**, alternately to the opposite sides of the bifurcated distribution header **15** and collection header **22**, as well as arranging those multiple headers **17**, **20** in alternate staggered relation above and below each other, as is shown in FIG. 2.

As shown in FIGURES 5, 6 and 7, the cross-sectional area of the multiple headers **17**, **20** is generally rectangular and the headers are longitudinally elongated bars or boxes. They may be thus strong enough to withstand pressures of 5,000 p.s.i.g. or more. They can provide adequate metal for ligament and re-enforcement, and they provide a flat surface for ease in drilling, aligning and welding. Ease of fabrication and low cost is the result. The feeder lines **16** and **21** emanating from alternate opposite sides of the distribution header **15** and the collection header **22**, and the bifurcated construction of those headers **15**, **22**, allows more space for the multiple headers **17**, **20**.

It is also to be noted that the tube **18** and the multiple headers **17**, **20** may be easily welded together by reason of their dimensional compatibility. There is no requirement for welding thin tubes **18** to heavy tube sheets, as is usually required in conventional feedwater heaters. Relatively wide spacing of tubes **18** on headers **17**, **20** permit joining the tubes to the headers with welding techniques, such as socket welds **40** shown in FIGURE 6, which would be impractical for joining tubes to tube sheets in conventional feedwater heaters. Tubes, headers and heating pipes may be preassembled prior to final assembly. Individual sub-assemblies can be separately tested with hydrostatic test on the tube side, to full test pressure, before final assembly of the heater. All welds are easily accessible, and may be readily repaired if defects are discovered before final assembly, during the test. All welds can be accomplished in accordance with A.S.M.E. standards and will inevitably be more reliable than tube sheet welds of conventional design feed-water heaters.

A single assembly, comprising one bottom multiple header **17**, and one top multiple header **20**, interconnected by a group of side tubes **18**, may be preassembled and tested for pressure and thermal stability, before being connected to the collection header **22** and the distribution header **15**. Combination inlet and outlet preassemblies are thereby assured as to satisfactory performance. In actual use, they are not subjected to the stresses which contribute to the failure of a tube sheet supplying all tubes. In addition, preassembly fabrication facilitates using baffles **38** and tube supports **39** of a grid type construction, which can be installed during or after assembly of the tube bundle, further simplifying construction of the feedwater heater. The remaining features of the casing **11** are conventional. There is provided a drip inlet **31**, startup vents **32**, safety valves **33**, steam inlet **34**, manholes **35**, drains **36**, and condensation outlet **37**.

The foregoing description is merely intended to illustrate an embodiment of the invention. The component parts have been shown and described. They each may have substitutes which may perform a substantially similar function; such substitutes may be known as proper substitutes for the said components and may have actually been known or invented before the present invention; these substitutes are contemplated as being within the scope of the appended claims, although they are not specifically catalogued herein.

What is claimed:

1. A feedwater heater comprising:
(a) a casing;
(b) a steam inlet at the top of the casing;
(c) a condensation outlet at the bottom of the casing;
(d) a feedwater inlet at the bottom of the casing;
(e) a feedwater outlet at the top of the casing;
(f) the inlet communicating with a bifurcated distribution header;
(g) the outlet communicating with a bifurcated collection header;
(h) multiple headers communicating with the distribution header, disposed transversely to and intermediate the bifurcations thereof and in staggered relation to each other;
(i) multiple headers communicating with the collection header, disposed transversely to and intermediate the bifurcations thereof and in staggered relation to each other;
(j) a bunch of elongated tubes extending through the casing in general parallelism with each other;
(k) each tube connected at one end to a multiple header of the distribution header, and at the other end to a multiple header of the collection header;
(l) the distribution header and the collection header inclined with respect to the bunch of elongated tubes;
(m) means to direct steam from the steam inlet through the casing over the tubes.

2. A feedwater heater comprising:
(a) the device according to claim 1; and
(b) the multiple headers communicating with the collection header and also those connected to the distribution header being connected by feeder lines alternately to opposite legs of the bifurcated collection header, and the bifurcated distribution header.

3. A feedwater heater comprising:
(a) the device according to claim 1; and

(b) both the tubes and the multiple headers formed of material having substantially the same wall thickness.

4. A feedwater heater comprising:
(a) the device according to claim 1; and
(b) a bulbous enlargement at one end of the casing to accommodate the collection, distribution and multiple headers.

5. A feedwater heater comprising:
(a) the device according to claim 1;
(b) the distribution header's inclination being upwardly at one end of the casing;
(c) the collection header's inclination being downwardly toward the same end of the casing;
(d) the distribution header and collection header being disposed in general symmetry with each other above and below the longitudinal axis of the casing.

6. A feedwater heater comprising:
(a) the device according to claim 1; and
(b) the means to direct the steam being in part, a horizontal division plate extending from one end of the casing toward the other, generally at the longitudinally axis of the casing, and in part separating the tubes from the distribution header from the tubes to the collection header.

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