This invention relates to a fluid fired vapor generator and integral superheater unit of a type having means for controlling the degree of superheat of its steam delivery.

The invention relates to a unit of the above indicated type having a gas heated superheater with a plurality of serially connected vapor passes, in combination with an attemperator arranged in parallelism relative to controlled steam flow through one of the intermediate steam passes.

More specifically the invention involves a combination similar to that indicated above wherein the extent of heat absorbing surface of the intermediate vapor pass is of a value less than that of either a preceding or a subsequent serially connected vapor pass. This particular intermediate vapor pass is of smaller free flow area for vapor, and may have a number of tubular heating elements smaller than those in the other steam passes.

The invention is particularly advantageous in connection with the use of marine boilers of the type having a multiple pass superheater in a turbine driven relationship to banks of vapor generating tubes. The use of the invention in such a boiler and vapor generator simplifies the vapor temperature control problem and minimizes the weight and space requirements of piping and control devices externally of the setting.

For a better understanding of the invention reference should be made to the accompanying drawings in which a preferred embodiment of the invention is illustrated.

In the drawings:

Fig. 1 is essentially a vertical section through a combined steam generating and superheating installation involving the invention.

Fig. 2 is a detailed vertical section showing the arrangement of superheater headers and connected superheater tubes on the section line 2—2 of Fig. 1; and

Fig. 3 is a view illustrating the arrangement of the superheater header components and the connected superheater tubes to provide a plurality of steam passes, with a part of the steam from the inlet header of an intermediate steam pass passing through an attemperator and then returning to the outlet of said intermediate pass, this flow of steam being controlled to provide an optimum value of the steam temperature at the outlet of the superheater.

Referring first to the disclosure in Fig. 3 of the drawings, there is illustrated a steam and water drum 18 from which steam flows through a tubular connection 12 to a header section or component 14.

The steam flow from the superheater inlet formed by the header component 14 takes place through a group of uniformly spaced U-tubes such as 20 and 22 and similar to those shown in Fig. 2, arranged for parallel flow. These elements together with the header component 24 constitute means for conducting the steam back and forth across the gas pass in the first steam pass which may be regarded as indicated by the arrow 26. It is to be understood that the two tubes 20 and 22 shown in Fig. 3 are representative of a bank of closely spaced tubes connecting the header components 14 and 24. Such an arrangement of tubes may be regarded as further indicated by the disclosure of Fig. 1. These tubes extend across a gas pass in which the steam is superheated by furnace gases contacting the U-tubes. The structure and arrangement of these tubes are similar to the U-tubes shown in Fig. 2.

From the header component 24 the steam flows lengthwise thereof.

From the header component 24, steam flows through similar U-tubes such as 34 and 36 to the header component 38, the U-tubes such as 34 and 36 being arranged in a manner similar to those forming the first steam pass. This flow of steam in the second steam pass is indicated by the arrow 40.

In the third steam pass the steam flows from the upper portion of inlet header component 33 at the right of the diaphragm 44 in the direction of the arrow 48 to a header component 48. The steam flow continues from the header component 44 to the header component 50 at the left of the header diaphragm 44. The steam flow in this fourth steam pass is indicated by the arrow 54, and it is to be noted that the width of the steam pass indicated by this arrow is less than the width of the other steam passes. In other words, the U-tubes such as 56 and 58 connecting the header components 50 and 48 of the fourth pass constitute a smaller bank of tubes. By way of specific example, there are 46 U-tubes in the first steam pass, 47 in the second, 44 in the third, 15 in the fourth and 41 in the fifth. The purpose of this arrangement is to afford such steam flow resistance that a controlled proportion of the superheated steam entering the header component 46 will flow from the nozzle 61 through the tubular connector 62 to and through the tubular elements (diagrammatically indicated at 64) of the attemperator when the thermostatically operated valve 68 is opened. From these elements the attmperated steam flows through the tubular connector 66 which includes a valve 65 preferably thermostatically operated from the steam temperature at the superheater steam outlet 70. Such an arrangement would, as is well known in the art, involve a thermally responsive element disposed in the steam from the steam outlet 70, and so varying the operation of the valve 68 that an optimum temperature at the steam outlet is maintained. In the present instance where the steam generating unit is to have a maximum capacity of 75,000 lbs. of steam per hour delivered from the superheater at a pressure of 625 p. s. i. and a temperature of 850 F, super—
heating surface is provided to attain a steam delivery temperature of 850 F. When the unit is operating at a fractional load of approximately 39,000 lbs. of steam per hour.

At full load the steam temperature leaving the superheater will be appreciably in excess of 850 F., unless means are provided to absorb some of the heat. A submerged surface attemperator of a multiple loop type, indicated by 64, is provided in the water space of the steam and water drum. While embraced within the water space of the drum the inner passages of the tubular elements are not directly connected with the drum space but are connected by inlet conduit 62 and valved outlet conduit 66 to the inlet header space and the outlet header space, respectively, of the fourth steam pass elements.

When valve 68 is opened a portion of the superheated steam leaving the third pass flows through 64, 66, and 56, while the remaining portion flows through elements 56–58 of the fourth pass. As the flow resistance through the elements 56–58 is quite high in the load range above the control point of 39,000 lbs. per hour, opening the valve 68 permits a flow of steam through the attemperator and that steam gives up some of its heat to the water of the steam and water drum. With this arrangement a simple thermostatically controlled valve 68 and short and simple piping can be used between the superheater headers and the attemperator.

Maximum flow through the attemperator will be permitted at maximum load, while at the control point load of approximately 39,000 lbs. per hour, valve 68 will be closed.

Steam from the steam connector or conduit 66 passes through the nozzle 67 into the outlet header component 50 of the fourth steam pass which is also the inlet header component of the last steam pass. This header component is connected to the outlet header component 74 of the intermediate pass which as also the double header component of the last steam pass. The header component is connected to the outlet header component 74 (separated from 68 by the diaphragm 82) by a bank of U-tubes 81–82 as previously described. The flow of steam in the last steam pass of the superheater is indicated by the arrow 80.

It is to be noted from an inspection of Figs. 2 and 3 that the inlet ends for the U-tubes of the intermediate steam pass are connected to the outlet header component 50 of that pass at the side of that header component directly opposite the side to which the nozzle 67 is connected. U-tubes representative of the U-tubes of this intermediate control pass are indicated at 56 and 58 in the drawings. This arrangement of nozzle and U-tubes relative to the header component 50 and the tubular connector 66 leading from the attemperator to the control pass promotes effective mixing of the attemperated steam and the unattemperated steam, such mixing taking place before the steam has passed very far axially of the header component 50. This arrangement is also effective in avoiding unbalance of the flow through the U-tube elements of the last steam pass connecting the upper end of the header component 50 to the outlet header component 74.

Fig. 1 of the drawings shows the superheater disposed at an interdeck position relative to banks of steam generating tubes 51 and 52 which connect the downtake headers 84 with the uptake headers 86. As is well known in the art, these headers are separate tubular elements arranged in contiguous positions at the sides of the gas pass to substantially form the opposite walls thereof. The downtake headers 84 are connected to the water space of the drum 10 by a series of connectors 85, and these downtake headers are connected at their lower ends to a lower transverse header of mud-drum 90. The uptake headers 86 are individually connected by large diameter circulators 92 with the drum 10.

Beneath the banks of steam generating tubes and the superheater is furnace 94, the side walls of which include other steam generating tubes such as 95–98 connected into the circulation system of the installation by a connection at their lower ends to the header 100 and at their upper ends by connection to the uptake header 102. The latter has connected thereto risers such as 104 and 106 leading to the steam space of the drum 10, the upright portions of these risers being disposed between the exterior casing 108 and the refractory furnace wall 110 and the wall defined by the headers 86. The down-take furnace header 100 is connected to the water space of the drum 10 by a plurality of downtake tubes such as 112 and 114, the lower ports of which are disposed between the refractory furnace wall 110 and the exterior casing wall 118 through the latter of which one or more burners such as 120 are disposed, for firing the furnace. The floor of the furnace is indicated at 122.

The installation shown is a single pass installation in which the gases pass from the furnace 94 flow upwardly across the steam generating tubes of the bands 51–52, across the tubes forming the former steam passes of the superheater, and across the transverse tubular elements of an airheater 124.

The superheater headers, as indicated in Fig. 2 of the drawings, are disposed between the inner side wall 126 and the outer casing wall 128, with the U-tubes connecting those headers extending to points of adjacency relative to the opposite side wall 130.

The illustrative steam generating and superheating installation is of a type which has long been successful in marine use, and, with the particular improvement herein involved in this invention, it provides for the generation of steam and the superheating of the generated steam in such a manner that the final temperature of the steam will be maintained at an optimum value without the use of expensive equipment such as three way control valves, and without the use of steam flow controlling orifices.

Invention provides an arrangement of a combination of steam generating, a steam superheating and superheated steam attemperation apparatus which involves a minimum in weight and space requirement of piping external of the setting for use in regulating the final delivered temperature of the superheated steam through a wide range of boiler rating.

By using U-type elements, the inlet and outlet headers for the elements of the control pass are both located on the same side of the boiler, and this permits the attemperator piping to be on one side of the setting.

While the invention has been described with reference to the particular embodiment shown in the drawings, it is to be appreciated that it is not limited to all of the details thereof. The invention consists in and comprises the arrangement herebefore commensurate with the scope of the subjoined claims.

What is claimed is:

1. In a vapor superheater, an arrangement of
tubular elements forming at least three vapor passes across a heating zone, said passes being connected for series flow of the vapor across said zone, an atemperator connected in parallel relative to the tubular elements in an intermediate pass of vapor flow, and means for varying the division of vapor flow between said intermediate pass and the atemperator to maintain an optimum vapor temperature at the outlet of the superheater.

2. In a vapor superheater, an arrangement of U-shaped tubular elements forming at least three vapor passes across a heating zone, said passes being connected for series flow of the vapor across said zone, an atemperator connected in parallel relative to the tubular elements in an intermediate pass of vapor flow, and means for varying the division of vapor flow between said intermediate pass and the atemperator to maintain an optimum vapor temperature at the outlet of the superheater, the atemperator being characterized by a pressure drop less than that of its related intermediate pass.

3. In a steam generating and superheating installation, walls forming a gas pass, spaced steam generating tubes extending across the gas pass and connected into a circulating system, said system including a steam and water drum connected to the steam generating tubes, a convection superheater including an arrangement of header connected U-tubes extending back and forth across the gas pass and conducting steam across the gas pass in a plurality of three or more serially connected steam passes, an atemperator, one of said passes intermediate the first and last being arranged and connected in parallel with the atemperator and having a free steam flow area less than that of the atemperator, and a steam flow controller regulating the division of steam between the atemperator and the tubes of said intermediate pass to maintain the temperature of the steam at the outlet of the superheater at an optimum value.

4. In a steam generating and superheating installation, walls forming a gas pass, spaced steam generating tubes extending across the gas pass and connected into a circulating system, said system including a steam and water drum connected to the steam generating tubes, a convection superheater including an arrangement of header connected U-tubes extending across the gas pass and conducting steam back and forth across the gas pass in a plurality of three or more serially connected steam passes, an atemperator disposed within the water space of the drum, one of said passes intermediate the first and last being arranged and connected in parallel with the atemperator, and a steam flow controller regulating the division of steam between the atemperator and the tubes of said intermediate pass to maintain the temperature of the steam at the outlet of the superheater at an optimum value.

5. In a steam generating and superheating installation, walls forming a gas pass, spaced steam generating tubes extending across the gas pass and connected into a circulating system, said system including a steam and water drum connected to the steam generating tubes, a convection superheater including an arrangement of header connected U-tubes extending across the gas pass and conducting steam back and forth across the gas pass in a plurality of three or more serially connected steam passes, an atemperator, one of said passes intermediate the first and last being arranged and connected in parallel with the atemperator and having a steam free flow area less than that of the atemperator, and a steam flow controller regulating the division of steam between the atemperator and the tubes of said intermediate pass to maintain the temperature of the steam at the outlet of the superheater at an optimum value.

6. In a vapor superheater, an arrangement of U-shaped tubular elements forming at least three vapor passes across a heating zone, said passes being connected for series flow of the vapor across said zone, an atemperator connected in parallel relative to the tubular elements in an intermediate pass of vapor flow, and means including a thermostatically operated valve for varying the division of vapor flow between said intermediate pass and the atemperator to maintain an optimum vapor temperature at the outlet of the superheater.

7. In a fluid heater, an arrangement of tubular elements forming at least three fluid passes across a heating zone, said passes being connected for series flow of the fluid across said zone, an atemperator arranged in parallel relative to the tubular elements in an intermediate pass of vapor flow, and means for varying the division of fluid flow between said intermediate pass and the atemperator to maintain an optimum fluid temperature at the outlet of the heater.

8. In a steam generating and superheating installation, walls forming a gas pass, spaced steam generating tubes extending across the gas pass and connected into a circulating system, said system including a steam and water drum connected to the steam generating tubes, a convection superheater including an arrangement of header connected U-tubes extending across the gas pass and conducting steam back and forth across the gas pass in a plurality of serially connected steam passes, one of said passes intermediate the first and last having a number of U-tubes therein smaller than the number of U-tubes in the other passes and arranged and connected in parallel with the atemperator, an inlet header component for the intermediate steam pass, an outlet header component for the intermediate steam pass having the intermediate steam pass U-tubes joined to the latter header component at one side thereof, a tubular connector leading from the intermediate steam pass to the atemperator, a conduit nozzle joined to the latter header component on its side opposite the U-tube connections, a tubular connector leading from the atemperator to said nozzle, and a steam flow controller regulating the steam flow to the atemperator to maintain the temperature of the steam at the outlet of the superheater at an optimum value.

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