FURNACE WALL FOR FORCED ONCE-THROUGH BOILER

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1 Claim. (Cl. 122—235)

This invention relates generally to boilers of the supercritical once-through type and has particular relation to a furnace wall organization for such a boiler.

In once-through boilers the fluid medium, which is generally boiler water and steam, passes through the heat exchange surface in a continuous path from entrance into the boiler to exit from the boiler and for this reason there are long continuous tube circuits in such a boiler through which the medium is forced by means of the feed pump. In boilers of this type operating at supercritical pressure the temperature along these long tube runs continuously changes thereby creating a problem with regard to differential thermal expansion when portions of the tube circuits are placed in adjacent relation. The present invention is concerned with the lining of the furnace wall of such a once-through supercritical boiler with tubes which form a portion of the heat absorbing surface of the boiler.

In accordance with the invention there is provided a group of adjacent tubes connected between common inlet and outlet headers so that the tubes are in parallel flow relation with the tubes being formed into vertical loops so that they extend up and down the furnace walls throughout at least the lower portion of the furnace and around a substantial portion of the furnace interior, as for example, half of the furnace interior. The vertical runs of these adjacent tubes form, in effect, vertically disposed panels with adjacent panels being interconnected by U-bends and with there being a sufficient number of such U-bends relative to the dimension of the furnace wall so that a symmetrical pattern in the panel arrangement is provided. The vertical tube runs in each of the panels are supported from their upper ends by means of a horizontal structural support element with each of the tube elements being free to expand downwardly. Since, with a supercritical boiler the tube elements in adjacent panels will have different metal temperatures they will of course expand different amounts so that means must be provided to permit this differential movement of the interconnected vertical tube runs in adjacent panels. This is accomplished in the present invention by providing a sufficient laterally extending length of tube at the lower end of the interconnected tubes to accommodate this movement. The lower end of the panels on the side walls are bent outwardly so that they extend laterally outward from the bottom of the furnace to provide this lateral tube length and the interconnecting tube portions at the lower end of the panels on the end walls are crossed in a manner to provide the required lateral tube run. The symmetrical arrangement of the panels on the furnace walls tends to repeatedly locate the various tube elements in the panels in a similar relation in the furnace, i.e., with a symmetrical panel arrangement a particular tube element located in one corner of the furnace will also appear at the next corner, and since there is unequal heat absorption in various areas of the furnace, as for example, the center portion of the walls may have greater heat absorption than the corners, there would be unequal or an unbalanced fluid and metal temperature in the tubes across the width of each panel because some of the elements would continuously traverse zones of high heat absorption while others would repeatedly be in zones of low heat absorption. In order to overcome this result to a substantial extent, the interconnection of the tubes of a centrally disposed pair of panels is such as to change the relative location of the interconnected tubes in these panels thereby destroying the effect of the symmetrical panel arrangement with regard to producing an unbalanced temperature across the width of each panel.

It is an object of this invention to provide an improved furnace wall construction for supercritical once-through boilers wherein the wall is lined with heat exchange tube elements.

Other and further objects of the invention will become apparent to those skilled in the art as the description proceeds.

With the aforementioned objects in view, the invention comprises an arrangement, construction and combination of the elements of the inventive organization in such a manner as to attain the results desired as hereinafter more particularly set forth in the following detailed description of an illustrative embodiment, said embodiment being shown by the accompanying drawings wherein:

Fig. 1 is a vertical section through the lower portion of a furnace of a supercritical once-through boiler embodying the present invention, with the section being taken on line 1—1 of Fig. 2 looking at one of the end walls of the furnace;

Fig. 2 is a transverse section of the furnace taken along line 2—2 of Fig. 1;

Fig. 3 is a view in the nature of a fragmentary perspective of the tube circuit disposed along the inner surface of the lower end of the furnace shown in Figs. 1 and 2;

Fig. 4 is a development of this tube circuit which covers half of the circumference of the lower end of the furnace.

Referring now to the drawing, wherein like reference characters are used throughout to designate like elements, the illustrative and preferred embodiment of the invention shown therein comprises a furnace 20 of a supercritical once-through boiler and which, as shown, has a lower portion lined with heat exchange tubes that form a portion of the heat exchange circuit of the boiler with it being understood that these tubes may line a greater portion of the furnace wall which is indicated, and, if desired, may line the entire furnace. Furnace 20 is of a bottom type and accordingly has the lower portion of its side walls 22 and 24 sloping inwardly and terminating in spaced relation to form a discharge opening 26. These side walls extend between the end walls 28 and 30 so that the furnace, as indicated in Fig. 2, is generally square in transverse section.

As embodied, the tube arrangement above the section line 1—1 of Fig. 2 is identical with the tube arrangement lining the furnace half below this section line so that only one of these arrangements need be described with one of these arrangements being shown in perspective in Fig. 3 and in development of Fig. 4. The tubes lining each of these halves of the furnace comprise a group of continuous, adjacent parallel tubes connected to a common inlet header 32 and a common outlet header 34 so that the tubes of each group are in parallel flow relation. As indicated in Fig. 1 there are 24 tubes interconnected to these headers (with only half the tubes being shown in Figs. 2 and 4 and one quarter in Fig. 3 for the sake of clarity) and they are wound or formed into vertical loops so that they extend up and down the furnace wall throughout the lower end of the furnace and wind half of the furnace interior commencing at the center of side or front wall 22 and terminating at the center of side or rear wall 24.

This tube arrangement or formation in effect provides a
number of adjacent panels identified as 36 through 50. The vertical tube runs in each of these panels are connected by one of the horizontally disposed structural channel members 52 which extend about the furnace at the upper region of the panels with the tubes in effect hanging from these support channels and being free to expand downwardly therefrom and with members 53 supported from rods 52 which in turn hang from the framework 55 (Fig. 3).

Panels 36 and 38 line one half of the inner surface of front or side wall 23 with the tubes in these panels extending downwardly along this side wall to the opening 26 in the bottom of the furnace where these tubes, as clearly seen in Fig. 3, are bent laterally outwardly and interconnected by interwoven U-bends. This particular arrangement forms a laterally extending tube portion, which for the innermost pair of interconnected tubes of these two panels is indicated as 54 and is of sufficient length to accommodate the differential expansion of the interconnected tube runs of the panels with the laterally extending tube portions of the other interconnected tubes of these panels of course being greater than that indicated at 54 and accordingly more than sufficient to accommodate the differential expansion encountered.

Panels 40 and 42 which line one half of the end wall 28 have their tubes interconnected at the lower end in a manner which will accommodate relative vertical movement of the interconnected tube portions and also will change the relative location of the interconnected tube portions in each panel. The tubes 1 through 6 (Fig. 4) in panel 40 are accordingly connected to the tubes 1 through 6 in panel 42 in reverse relation while the tubes 7 through 12 in panel 40 are connected with the tubes 7 through 12 in panel 42 in reverse relation with the latter group of tubes in panel 40 being crossed over the former group of tubes in this panel. This arrangement provides for a sufficient lateral run or horizontal extend of the U-bend interconnecting the tubes in these two panels to accommodate the differential expansion of the interconnected tube portions and it also changes the location of the respective interconnected tube portions in each panel with respect to the edges of each panel.

Panels 44 and 46, tubes 1 through 8 in panel 44 are connected with tubes 5 through 12 in panel 46 with the U-bends interconnecting these tubes being intermeshed as shown while tubes 9 and 10 in panel 44 are connected in relation to tubes 11 and 12 of this panel with tubes 3 and 1 of panel 46 and tubes 11 and 12 interconnecting tubes 4 and 3 of panel 46 so that the U-bends by means of which the tube elements are interconnected will have a sufficient horizontal run to accommodate the necessary differential expansion of the interconnected tube elements.

Panels 48 and 50 are similar to panels 36 and 38 with panels 48 and 50 lining the inner surface of one half of the side or rear wall 24 and with the laterally extending tube portions formed on the lower end of those panels accommodating differential vertical movement of the interconnected tube elements of the panels.

The lower end of the tube elements of each of the panels are positioned exteriorly of the furnace in order that a pressure tight furnace wall may be had even though relatively complicated tube bending is required necessitating the crossing of the tubes in the end walls to accommodate differential expansion of the interconnected vertical tube runs of the panels and also in order to simplify the fabrication and construction problems.

With the furnace wall construction in accordance with the invention the effects of a symmetric panel arrangement in the furnace with regard to producing an unbalanced fluid temperature in the tubes across each panel is effectively destroyed and the interconnected vertically extending tube portions in adjacent panels may move relative to one another as is required in a supercritical once-through unit where the temperature along each of the tubes continuously varies with these results being obtained in a relatively simple and economic manner involving a minimum of fabrication problems.

While I have illustrated and described a preferred embodiment of my invention it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. I therefore do not wish to be limited by the above description of the details set forth but desire to avail myself of such changes as fall within the purview of my invention.

What I claim is:

In a once-through boiler the combination of a vertical furnace of rectangular transverse section having its front and rear walls sloped inwardly and terminating in spaced relation hereby forming a hopper bottom with an opening at the bottom thereof, the lower portion of the furnace having the inner surface of the walls lined with tubes which comprise one group of side by side parallel tubes connected at their opposite ends to common inlet and outlet headers and extending from the furnace wall from the furnace bottom and a location intermediate the top and bottom of the furnace and covering half the circumference of the furnace from adjacent the center of the front wall across an end wall to adjacent the center of the back wall, each vertical run of the entire group of adjacent tubes forming in effect a panel with the lower ends of the panels being exteriorly of the furnace bottom, means connected with the tubes of each panel at the upper region thereof and effective to support the tubes from this region for expansion downwardly, the number of tubes in the group and the width of the furnace walls being such that there is a symmetrical arrangement of panels on the walls with their being only complete panels on each wall and being at least two panels on the front and back walls and at least four panels on the end wall, the groups of tubes being disposed so that the tubes of adjacent pairs of panels are interconnected at their upper and lower ends by return bends with the return bends at the upper end being completely interconnected so as to lie flat and parallel with the wall, the return bends at the lower end of each of the adjacent pair of panels on the end wall being crossed in a manner to interconnect the tubes in these adjacent panels in reverse order from the center of each panel outward, and the return bends at the lower end of other panels on the end wall being crossed only with respect to a limited number of the tubes of each pair of panels that are nearest each other in a manner so that the laterally extending portion of each return bend is of sufficient length to accommodate substantial differential expansion of the tubes in the panels, the tubes of the interconnected panels on the front and rear walls extend downwardly along the wall to the opening in the furnace bottom and then laterally horizontally outward a sufficient distance to accommodate a substantial differential expansion of the tubes of these panels and with the return bends interconnecting these tubes being interconnected, the other half of the furnace circumference being lined with another and similarly disposed group of tubes.

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