Jan. 23, 1968 R. MICHEL 3,364,901

# HEATING TUBE SYSTEM FOR BOILER FIRING CHAMBER

Filed March 16, 1965 3 Sheets-Sheet 1

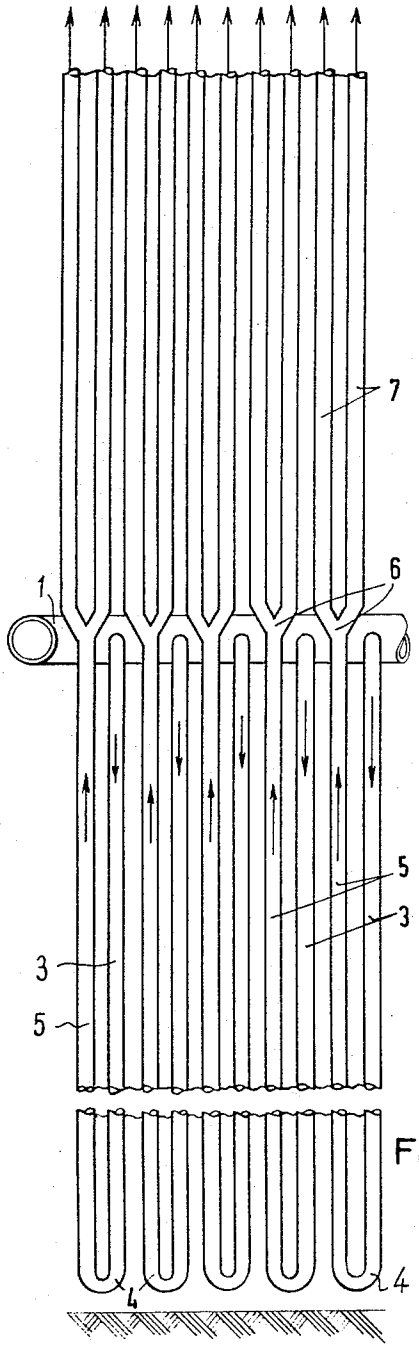


Fig.1

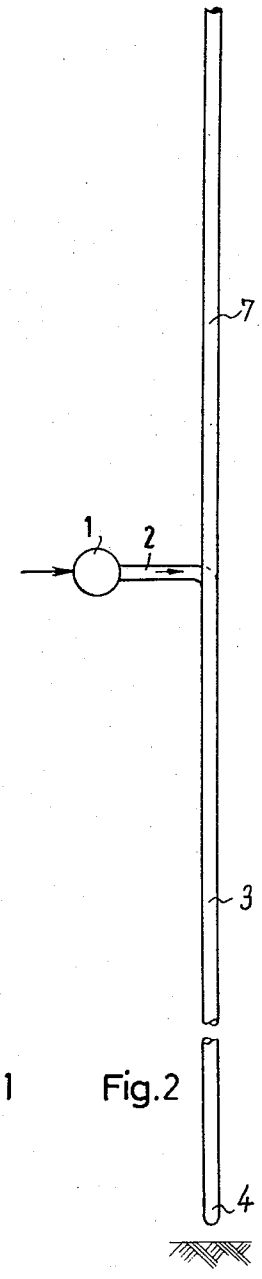


Fig.2

Jan. 23, 1968 R. MICHEL 3,364,901

# HEATING TUBE SYSTEM FOR BOILER FIRING CHAMBER

Filed March 16, 1965 3 Sheets-Sheet 2

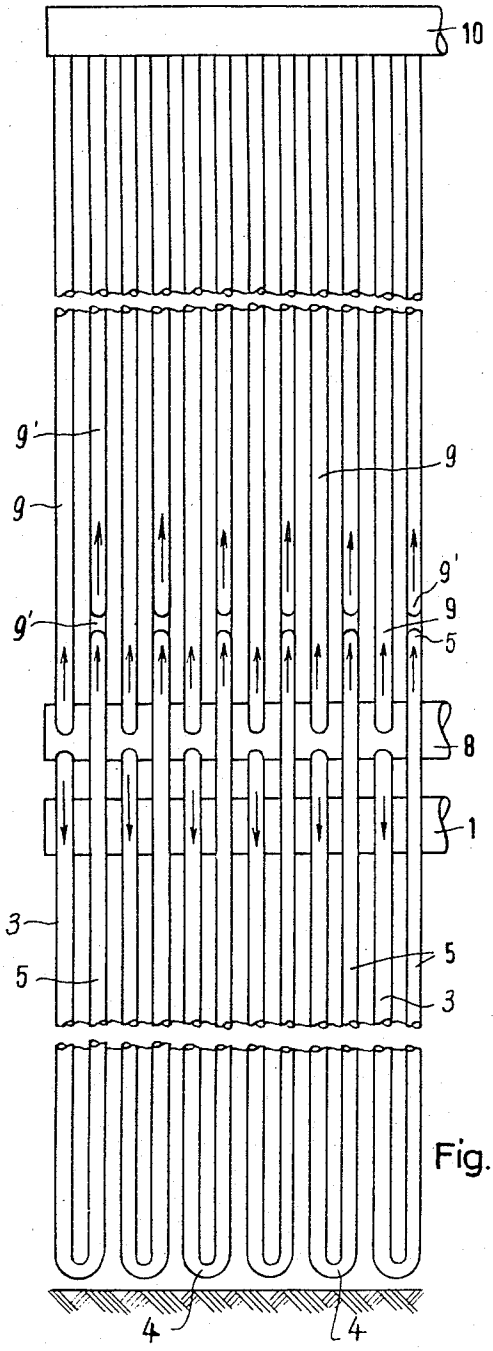


Fig. 3

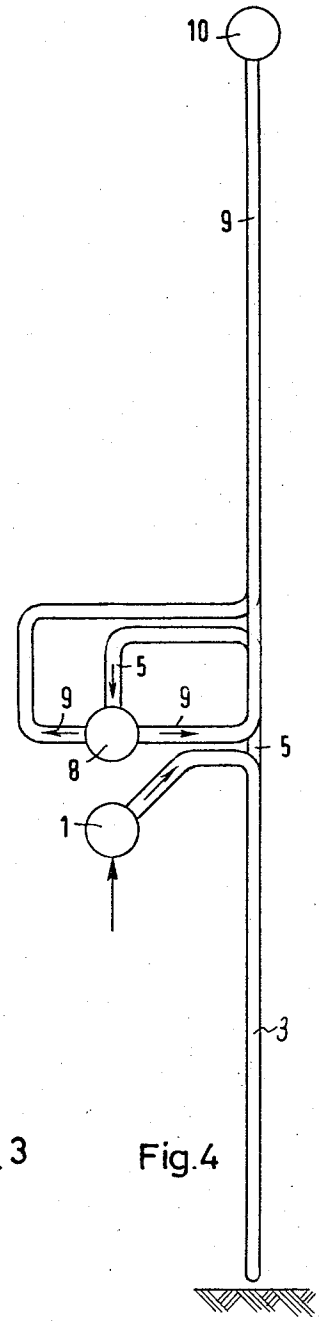


Fig. 4

Jan. 23, 1968 R. MICHEL 3,364,901

HEATING TUBE SYSTEM FOR BOILER FIRING CHAMBER

Filed March 16, 1965 3 Sheets-Sheet 3

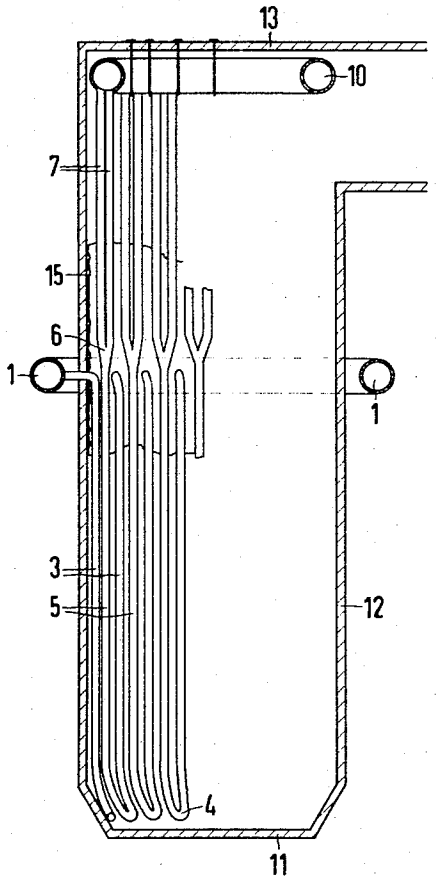


Fig. 5

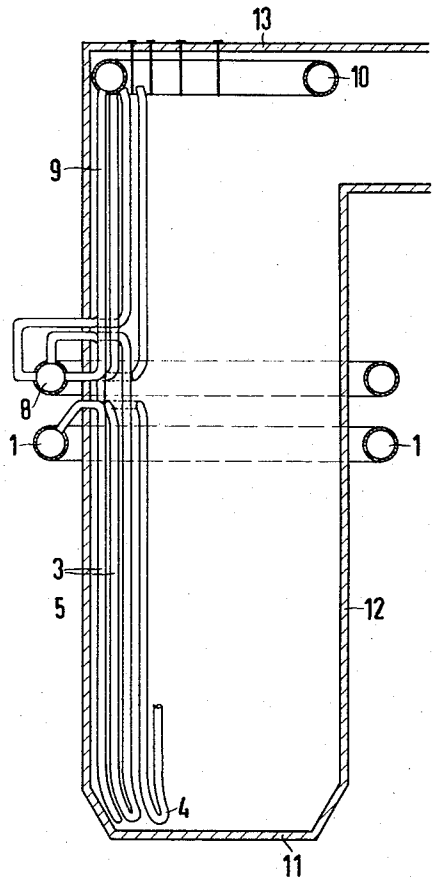


Fig. 6

United States Patent Office 3,364,901 Patented Jan. 23, 1968



3,364,901

# HEATING TUBE SYSTEM FOR BOILER FIRING CHAMBER

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19 Claims. (Cl. 122—6)

My invention relates to forced-flow boilers of the "once-through" type. More particularly, it relates to improved forced-flow boilers of such once-through type which are capable of practicable operation at both subcritical and supercritical operating pressures.

The forced-flow once-through type boiler generally known as the modified once-through or subcritical once-through boiler generally discharges its wet steam and water to an external separator. In this operation, some of the water may be removed by blowdown in order to control the amount of solids and salts in solution and thereby maintain the desired concentration. The balance of the water accompanies the steam into the convection section of the boiler for evaporation to complete dryness and then passes on to the superheater. In this type of boiler, no circulating pump other than the feedwater pump may be required but, for proper operation, a sensitive and responsive control system is required therefor. This type boiler may also be suitable for supercritical pressure operation.

Supercritical boilers are those that are capable of operation beyond the 3206.2 p.s.i.a. point, i.e., the point at which steam and water coexist at the same density. When a steam-water mixture at this high pressure is heated above its 705.4° F. saturation temperature, dry superheated steam is produced.

In a forced-flow once-through type boiler wherein it is desired to effect both subcritical and supercritical operation, the firing chamber therein is of necessity of greater height to enable operation at supercritical pressures. In such chamber, the walls thereof either may be faced with a parallel array of vertically disposed tubes suspended from the ceiling of the firing chamber or the walls may actually comprise such arrays. The arrays suitably have associated therewith support members for rigidly maintaining the arrays in their proper disposition, wall seals, heat insulators and other necessary support and ancillary structures. In these boilers, it is necessary, for subcritical operation, to insure that all of the tubes are traversed by the working medium in parallel single paths from the bottom to the tops of the tubes.

However, for supercritical operation, where the working medium, i.e., the steam-water mixture, may be required to make a second passage through heating equipment, and considering the great height required in combustion chambers for boilers to be operated at supercritical pressures, it is not feasible for reasons of efficiency and practicality to pass a steam water mixture both from the top to the bottom of the tubes and to distribute the working medium for a second passage. To overcome such problem, boilers have been designed for operation at critical pressures wherein the heating apparatus has included two interarranged sections for enabling two passages of working medium, the two sections having provided therebetween an unheated tube wherein the working medium descends after the completion of its first passage to commence its second passage. However, this latter construction presents a disadvantage in that it can only be used for supercritical operating pressures and consequently can be started only and is operative only, at supercriticality, even under partial load conditions.



Accordingly, it is an important object of this invention to provide a working medium heating tube arrangement in the firing chamber of a boiler which enables employment of the boiler for both subcritical and supercritical operation.

It is another object to provide an arrangement in accordance with the preceding object which is of stable construction.

In accordance with the invention, the foregoing objects are attained by providing a heating tube apparatus for the firing chamber of a boiler which enables the boiler to operate at both subcritical and supercritical pressures without any danger of instability and inoperativeness. To this end, the inventive concept resides in the employment of a working medium inlet distributing means which is horizontally disposed and which is connected near their upper ends to a first group of vertically disposed parallel arranged tube elements that start at a point above the midline, preferably at about the two-thirds height point of the firing chamber and extend to near the floor of the firing chamber. At the bottom of these first group tube elements they are respectively connected to a second group of tube elements, which extend upwardly in parallel with the first group tube elements to about the upper ends of the first group elements at which point each of the second group tube elements bifurcate into at least two tube elements. Thereby there is provided a third group of two tube elements which have a length substantially equal to the height of the firing chamber above the line of the upper ends of the first and second group tube elements. The upper ends of the third group tube elements suitably terminate in working medium outlet collecting means. The respective tube elements may be integrally continuous with each other so that, actually, they may be single U-shaped tubes having shorter legs corresponding to the first group tube elements and longer legs, the lower portions of the longer legs corresponding to the second group tube elements, each of the lower portions bifurcating into the third group tube elements. The working medium introduced into the upper ends of the first group tube elements traverses them in a downward path and then traverses the second and third group tube elements in an upward path to the outlet collecting means. With this arrangement, the doubled number of third group tube elements resulting from the bifurcations can provide at least a double cross-section of heating tubing to enable the handling of the increasing volume of working medium as it moves in its upward path. Alternatively, rather than have the second group tube elements each bifurcate into two tubes they can instead expand into larger cross-section tubes.

To provide the greater number of tubes to provide greater cross-section and thereby the handling of increased volume of the working medium at the upper portion of its upward path, there may be utilized an intermediate working medium collecting means disposed slightly above the working medium inlet distributing means which operates to collect the working medium as it completes a first and longer portion of its upward path and then functions to distribute working medium to a larger, i.e., at least a double number of tubes which terminate at the outlet collecting means, the working medium completing its upward path to the outlet collecting means through the latter larger number of tubes.

Within the contemplation of the invention, there may be provided a plurality of heating tube arrays as hereinabove set forth, each of the arrays having individual distributing means and collecting means associated therewith. Alternatively, there may be provided single horizontally disposed inlet distributing and outlet collecting means disposed about the periphery of the firing chamber to feed and collect working medium from all of the tubes comprising the arrays.

To effect a saving of masonry costs, the tubes may suitably be welded together to be gas tight and the arrays then utilized as the walls of the combustion chamber. Alternatively, the tubes may be provided with a sheet metal skin thereon. When an intermediate collecting means is employed, tubes may be welded at the region adjacent the intermediate collecting means and above and below this region, a gas-tight sheet metal skin may be affixed to the tubes.

Generally speaking and in accordance with the invention, there is provided a heating tube system for the firing chamber of a boiler comprising an array of vertically disposed tube elements, a first lower disposed group of a chosen number of such elements having a length less than the height of the array, a second lower disposed group of the chosen number of tube elements substantially having such length and respectively disposed adjacent to the elements of the first group, each of the elements of the first group being respectively connected at their lower ends to the lower ends of their adjacent second group tube elements to form the base of the array. A third upper disposed group of tube elements is provided in a number greater than the aforesaid chosen number, such as twice such chosen number, each of the latter elements respectively having a length substantially equal to the aforesaid height less the length of the first and second group tube elements, and being connected at their lower ends to the upper ends of the second group tube elements and adapted to be connected at their upper ends to working medium outlet collecting means. There is further provided working medium inlet distributing means disposed near the upper ends of the first group tube elements for providing working medium to these first group tube elements, the working medium traversing the first group tube elements in a downward path, and traversing the second and third group tube elements in an upward path to the outlet collecting means. The greater than chosen number of third group tube elements enables an increased volume of working medium passing therethrough.

In one embodiment constructed according to the invention, there is provided a heating tube system for the firing chamber of a boiler comprising a substantially planar array of registered vertically disposed working medium heating tubes adapted to be suspended from the roof of the firing chamber, each of the tubes being of U-shaped configuration, the bases of the tubes lying substantially in a horizontal line at the base of the array. Each of the tubes comprises a first and longer open-ended leg adapted to be coupled to a working medium outlet collector and a second and shorter closed-end leg, the ends of the second legs being substantially in registration in a horizontal line. A horizontally disposed working medium entry distributor is positioned near the line of the aforesaid closed ends. The embodiment includes respective connections from the distributor to the second legs to provide working medium thereto, the working medium traversing the second legs in a downward path and the first legs in an upward path to the outlet collector.

In accordance with another illustrative embodiment of the invention, there is provided a heating tube system for the firing chamber of a boiler comprising a planar array of a first group of lower vertically disposed U-shaped tubes, each of the U-shaped tubes comprising first and second legs, a working medium outlet collector, a second group of upper vertically disposed tubes equal in number to the sum of the numbers of said first and second legs, each of said second groups being substantially longitudinally aligned with one of the first and second legs respectively, the respective lower ends of the second group tubes being spaced from the upper ends of the aforesaid legs, the upper ends of the second group tubes terminating in the outlet collecting means. There are further provided horizontally disposed inlet distributing means positioned near the upper ends of the legs and connected to the upper ends of the first legs for supplying working medium



thereto and horizontally disposed intermediate collecting means disposed near the upper ends of the legs and the lower ends of the second group tubes and connected to these ends for collecting working medium from the second legs and supplying it to the second group tubes, the working medium traversing the first legs in a downward path, and traversing the second legs and the second group tubes in an upward path to the outlet collecting means.

The above mentioned and more specific objects and features of my invention will be apparent from, and will be mentioned in, the following description of a heating tube system for the firing chamber of a boiler according to the invention, shown by way of example in the accompanying drawing in which FIG. 1 is a schematic depiction in elevation of an illustrative embodiment of the invention, FIG. 2 is an elevational view at a right angle to that of FIG. 1, FIG. 3 is a schematic depiction in elevation of another illustrative embodiment of the invention, FIG. 4 is an elevational view at a right angle to that of FIG. 3, and FIGS. 5 and 6 are diagrammatic views of the tube system embodiments respectively of FIGS. 1 and 3 as mounted in the firing chamber.

Referring now to FIGS. 1 and 2 wherein there is shown an illustrative embodiment constructed in accordance with the principles of the invention, the heating tube system comprises a plurality of vertically disposed registered U-shaped tubes, each of these tubes comprising an open-ended first and longer leg **5** and a closed-end shorter leg **3** in parallel spaced disposition with leg **5**, all of the tubes forming a substantially planar array which is substantially coextensive in length with the height of the firing chamber. The bent tube section bases **4** of the U-shaped tubes lie in a substantially horizontal line near and spaced from the floor of the firing chamber.

As is seen in FIGS. 1 and 2, the longer first legs of the U-shaped tubes actually comprise a lower single tube moiety and an upper two tube moiety **7** integrally continuous with the lower moiety, the two-tube moiety **7** extending from the lower moiety at the bifurcations **6** of the lower moiety. The shorter leg **3** of each U-shaped tube is substantially coextensive in length with the lower moiety of the longer leg **5**, the closed ends of legs **3** and the bifurcations **6** of the lower moieties of tube **5** being disposed in a horizontal line, such ends being alternately interleaved between adjacent bifurcations **6**.

An entry distributor **1** for providing working medium to the tubes is substantially disposed to be parallel to the tube array and adjacent to the horizontal line formed by bifurcations **6** and the ends of shorter legs **3**. Extending horizontally from distributor **1** are a plurality of horizontally disposed tubes **2** which may be equal in number to the number of U-shaped tubes and which terminate in shorter legs **3** near the ends thereof. The upper ends of the two tubes comprising the upper moiety **7** of a longer leg **1** are adapted to be connected to an outlet collector **10** (FIG. 5).

Arrangements of tubes as shown in FIG. 1 may suitably be located near the walls **12** of a firing chamber (FIG. 5). They may also actually be utilized to form a wall of the chamber to minimize masonry costs. In this latter situation, the tubes may be welded together to form a gas-tight wall **15** or a sheet metal skin may be provided directly thereon at the wall side of the tubes as shown fragmentarily in FIG. 5. It is appreciated that such arrangement enables boiler operation with supercritical pressure firing.

Although not shown in FIGS. 1 and 2, it is to be realized that the tube array is suitably provided with bracing members, wall seals, heat insulation and other materials normally required in boiler firing systems.

In the operation of the arrangement of FIGS. 1 and 2, working medium entering from entry distributor **1** traverses legs **3** in a downward path and legs **5** in an upward path to the outlet collector. The two tube upper moieties **7** of legs **5** extending from bifurcations **6** provides a larger

cross section of heating tube volume traversed by the working medium in its path to the outlet collector to enable the efficacious handling of increased steam volume. It has been found that bifurcations 6 and the upper closed ends of legs 3 suitably should be located at a point more than halfway up from the floor of the firing chamber, a location at the two-thirds height of the chamber (FIG. 5) being advantageous. It is, of course, to be realized that rather than have a bifurcation into tube sublegs occur at locations 6 in longer legs 5, the upper moieties of legs 5 instead can be tubes of greater cross section than those of the lower moieties to permit the handling of increased working medium, i.e., steam volume.

In a firing chamber wherein a plurality of planar tube arrangements as shown in FIG. 1 are utilized, there may be respectively associated with each arrangement, an inlet distributor and outlet collector suitably of cylindrical configuration, and having a length as required by the width of the array, such as about two to three meters, depending upon the sizes of the tube arrays. Alternatively, there may be provided in the firing chamber a single inlet distributor and a single outlet collector. In this alternative arrangement, the inlet distributor and outlet collector are disposed around the periphery of the combustion chamber and connected to all of the tubes in the separate tube arrays whereby working medium may be fed to and collected from all of the tubes by the single inlet distributor and outlet collector respectively.

The embodiment constructed in accordance with the principles of the invention as shown in FIGS. 3 and 4 employs a lower planar array of a set of U-shaped tubes each of the latter tubes comprising a shorter leg 3 and a slightly longer leg 5 and an upper coplanar array of tubes which terminate at a working medium outlet collector 10. The upper array comprises a set of slightly longer tubes whose closed ends are respectively substantially equispaced from the upper ends of shorter legs 3 of the lower U-shaped tubes and a set of shorter tubes whose ends are respectively substantially equispaced from the upper ends of longer legs 5 of the U-shaped tubes. A working medium inlet distributor 1 is horizontally disposed in a plane parallel to, spaced from, near the ends of legs 3, and working medium is fed therefrom to legs 3 to traverse legs 3 in a downward path to the bent tube section bases of the lower U-shaped tubes located near the floor of the firing chamber. An intermediate outlet collector 8 is suitably disposed in a plane parallel to the plane of the tube array, spaced therefrom and advantageously located slightly above inlet distributor 1 to bridge the space between legs 3 and the longer tubes of the upper tube array. The working medium traverses longer legs 5 in an upward path and thence enters intermediate outlet collector 8. From intermediate outlet collector 8, the working medium enters the longer tubes of the upper tube array through respective tubes 9 and the shorter tubes of the upper tube array through respective tubes 9'. The working medium thence traverses the tubes of the upper array in an upward path to outlet collector 10.

Effectively, the tube arrangement of FIGS. 3 and 4, by the use of intermediate collector 8 and the tubes of the upper array again enables a doubling of cross sectional tube area to be traversed by the working medium for a terminating portion of its upward path to outlet collector 10.

It has been found that the lengths of the lower array of U-shaped tubes and the tubes comprising the upper array are chosen such that the inlet distributor 1 and intermediate collector 8 are located above the midline of the height of the firing chamber, the two-thirds point of such height, as shown in FIG. 6 being advantageous. To enable the use of the array to be used as the wall of the firing chamber, the tubes in the region of inlet distributor 1 and outlet collector 8 may be tightly welded together to one another to form a rigid structure at this region. The sections above and below the welded region may be strongly joined by a gas-tight sheet metal skin to facilitate operation therewith with supercritical pressure. The tube arrangements are adapted to be suspended from the roof of the firing chamber and are suitably equipped with support members, bracing, heat insulation and other necessary appurtenances 13.

Similar to the embodiment of FIGS. 1 and 2, each of the tube arrays shown in FIGS. 3 and 4 and used in a firing chamber may either be respectively equipped with an entry distributor 1, an intermediate outlet collector 8 and an outlet collector 10 or there may be respectively provided a single peripherally disposed inlet distributor, intermediate outlet collector, and outlet collector. In the latter situation, as described hereinabove in connection with the embodiment of FIGS. 1 and 2, the single distributor and collectors would have connections to all of the tubes comprising a plurality of tube arrays.

It will be obvious to those skilled in the art, upon studying this disclosure, that heating tube systems for boiler firing chambers according to my invention permit of a great variety of modifications and hence can be given embodiments other than that particularly illustrated and described herein without departing from the essential features of my invention and within the scope of the claims annexed hereto.

I claim:

1. A heating tube system for the firing chamber of a boiler comprising an array of vertically disposed tube elements, a first lower disposed group of a chosen number of said elements having a length less than the height of said array, a second lower disposed group of said chosen number of elements substantially having said length respectively disposed adjacent to the elements of said first group, each of the elements of said first group being respectively connected at their lower ends directly to the lower ends of said adjacent elements of said second group to form the base of said array, a third upper disposed group of tube elements of a number greater than said chosen number, each of said third group of tube elements respectively having a length substantially equal to said height minus said first and second group element tube length, said third group tube elements being respectively connected at their lower ends to the upper ends of said second group tube elements, working medium outlet collecting means, said third group tube elements being adapted to be connected at their upper ends to said working medium outlet collecting means, working medium inlet distributing means disposed near the upper ends of said first group tube elements and connected thereto for providing working medium to said first group tube elements, said working medium traversing said first group tube elements in a downward path, and traversing said second and third group tube elements in an upward path to said outlet collecting means, said greater than chosen number of third group tube elements enabling an increased volume of working medium to pass therethrough.

2. A heating tube system for a boiler firing chamber comprising a plurality of arrays of vertically disposed tube elements, each of said arrays comprising a first lower disposed group of a chosen number of said elements having a length less than the height of said array, a second lower disposed group of said chosen number of elements substantially having said length respectively disposed adjacent to the elements of said first group, each of the tube elements of said first group being respectively connected at their lower ends directly to the lower ends of said adjacent elements of said second group to form the base of said array, a third upper disposed group of tube elements of a number greater than said chosen number, each of said third group of tube elements respectively having a length substantially equal to said height minus said first and second group elements tube length, said third group tube elements being respectively connected at their lower ends to the upper ends of said second group tube elements, working medium outlet collecting means,

said third group tube elements being adapted to be connected at their upper ends to said working medium outlet collecting means; horizontally disposed working medium distributing means connected to said first group tube elements for providing working medium to said last named tube elements, said working medium traversing said first group tube elements in a downward path and traversing said second and third group tube elements in an upward path to said outlet collecting means, said greater than chosen number of third group tube elements enabling an increased volume of working medium to pass therethrough.

3. A heating tube system as defined in claim 2 wherein said arrays are substantially coextensive in length with the height of the firing chamber and are adapted to be suspended from the roof of the firing chamber and to function as the walls of the chamber.

4. A heating tube system as defined in claim 2 wherein said working medium inlet distributing means and outlet collecting means comprise respective working medium inlet distributors and outlet collectors associated with each of said arrays, each of said inlet distributors being horizontally disposed in a plane parallel to and spaced from its associated array and connected to said first tube group tube elements therein near the upper ends thereof, the upper ends of said third group tube elements of each array being adapted to be connected to its associated outlet collector.

5. A heating tube system as defined in claim 2 wherein said working medium distributing means and outlet collecting means respectively comprise a horizontally disposed peripherally encircling inlet distributor connected to said first group tube elements and to horizontally disposed peripherally encircling outlet collector, the upper ends of said third group tube elements being adapted to be connected to said outlet collector.

6. A heating tube system as defined in claim 2 wherein the upper ends of said first and second group tube elements are located at a point above half the height of the firing chamber.

7. A heating tube system as defined in claim 6 wherein the upper ends of said first and second group tube elements are located at a point about two-thirds the height of the firing chamber.

8. A heating tube system as defined in claim 2 wherein the tubes in an array are adapted to be formed into a gas tight wall through their being welded together.

9. A heating tube system as defined in claim 2 wherein the tubes in an array are adapted to be formed into a gas tight wall by the placing of a gas-tight sheet metal skin thereon.

10. A heating tube system for a boiler firing chamber comprising an outlet collector, a substantially planar array of registered parallel vertically disposed working medium heating tubes terminating in said outlet collector, means for securing said outlet collector to the roof of the firing chamber so as to suspend the heating tube system therefrom, each of said tubes being of like U-shape configuration, the bases of said tubes lying substantially in a horizontal line at the base of said array near the bottom of said firing chamber, each of said tubes comprising a first open-ended leg substantially coextensive in length with the height of said firing chamber, each of said first legs comprising a first upper wider cross section portion and a second lower narrower cross section portion, and a second closed-ended leg parallel to, spaced from and shorter than said first leg, and having a cross section substantially equal to said narrower cross section, the ends of said second legs being substantially in registration in a horizontal line, a horizontally disposed working medium entry distributor disposed near said line of closed ends, and respective connections from said distributor to said second legs to provide working medium thereto, said working medium traversing said second legs in a downward path and said first legs in an upward path to said outlet collector.

11. A heating tube system for a boiler firing chamber comprising an outlet collector, a substantially planar array of registered parallel vertically disposed working medium heating tubes connected to said outlet collector and adapted to be suspended from the roof of said firing chamber, each of said tubes being of like U-shape configuration, the bases of said tubes lying substantially in a horizontal line at the base of said array near the bottom of said firing chamber, each of said tubes comprising a first open-ended leg substantially coextensive in length with the height of said firing chamber, each of said first tube legs comprising a first and longer moiety extending upwardly from said base and a second and shorter moiety comprising bifurcation of said first moiety at its upper end and a plurality of spaced parallel sublegs extending from said bifurcation, and a closed-end second tube leg substantially coextensive in length with said first moiety, the ends of said second tubes being located near the bifurcations of said first moieties and lying in a substantially horizontal line, a horizontally disposed working medium entry distributor near said line of closed ends, parallel with and spaced from said array, and respective tube connections from said distributor to said second legs to provide working medium thereto, said working medium traversing said second legs in a downward path and said first legs in an upward path to said outlet collector.

12. A heating tube system for a boiler firing chamber comprising an outlet collector, a substantially planar array of registered parallel vertically disposed working medium heating tubes connected to said outlet collector and adapted to be suspended from the roof of said firing chamber, each of said tubes being of like U-shape configuration, the base of said tubes lying substantially in a horizontal line at the base of said array adjacent the bottom of said firing chamber, each of said tubes comprising a first open-ended leg substantially coextensive in length with the height of said firing chamber, each of said first tube legs comprising a first and longer moiety extending upwardly from said base to a point at least above the midline of the height of said firing chamber and a second and shorter moiety comprising a bifurcation of said first moiety at its upper end and a pair of spaced parallel sublegs extending from said bifurcation, and a closed-end second leg substantially coextensive in length with said first moiety, the ends of said second tubes being located in a substantially horizontal line with the ends of said first moieties and respectively alternately intermediate said last named ends, a horizontally disposed working medium entry distributor disposed near, spaced from, and in a plane parallel to the plane of said last named line, and respective tube connections from said distributor to said second legs to provide working medium to said second legs, said working medium traversing said second legs in a downward path and said first legs in an upward path to said outlet collector.

13. A heating tube system as defined in claim 12 wherein said first moieties and second legs extend to a point about two-thirds the height of the firing chamber.

14. A heating tube system as defined in claim 12 wherein said tubes are adapted to be welded together to form a gas-tight wall and said last named wall is adapted to function as a wall of the firing chamber.

15. A heating tube system as defined in claim 13 wherein said tubes are adapted to have a gas-tight sheet metal skin laid thereon and wherein said array having said sheet metal skin thereon is adapted to function as a wall of the firing chamber.

16. A heating tube system for a boiler firing chamber comprising a planar array of a first group of lower vertically disposed U-shaped tubes, each of said U-shaped tubes comprising first and second legs, a working medium outlet collector, a second group of upper disposed tubes equal in number to the sum of said first and second legs,

each of said second groups being substantially longitudinally aligned with one of said first and second legs respectively, the respective lower ends of said second group tubes being spaced from the upper ends of said legs, the upper ends of said second group tubes terminating in said outlet collector, horizontally disposed inlet distributing means positioned near the upper ends of said legs and connected to the upper ends of said first legs for supplying working medium to said first legs, horizontally disposed intermediate collecting means disposed near the upper ends of said legs and the lower ends of said second group tubes and connected to said ends for collecting working medium from said second legs and supplying it to said second group tubes, said working medium traversing said first legs in a downward path, and traversing said second legs, and said second group tubes in an upward path to said outlet collector and means for securing said outlet collector to the roof of the firing chamber so as to suspend the heating tube system therefrom.

17. A heating tube system as defined in claim 16 wherein the upper ends of said U-shaped tubes are located at a point about two-thirds the height of the firing chamber.

18. A heating tube system for the firing chamber of a boiler comprising a planar array of a first group of lower vertically disposed U-shaped tubes, each of said U-shaped tubes comprising first and second legs, the upper ends of said U-shaped tubes being located at a point about two-thirds the height of the firing chamber, a working medium outlet collector, a second group of upper disposed tubes equal in number to the sum of said first and second legs, each of said second groups being substantially longitudinally aligned with one of said first and second legs respectively, the respective lower ends of said second group tubes being spaced from the upper ends of said legs, the upper ends of said second group tubes terminating in said outlet collector, horizontally disposed inlet distributing means positioned near the upper ends of said legs and connected to the upper ends of said first legs for supplying working medium to said first legs, horizontally disposed intermediate collecting means disposed near the upper ends of said legs and the lower ends of said second group tubes and connected to said ends for collecting working medium from said second legs and supplying it to said second group tubes, said working medium traversing said first legs in a downward path, and traversing said second legs, and said second group tubes in an upward path to said outlet collector, the tube sections in the region opposite said intermediate collecting means being adapted to be welded together and the areas of said array above and below said sections being adapted to have a gas-tight sheet metal skin laid thereon to thereby provide a gas-tight array which is adapted to function as a wall of the firing chamber.

19. A heating tube system as defined in claim 16 wherein said first legs are slightly longer than said second legs and wherein said second group tubes aligned with and spaced from said second legs are correspondingly longer than said second group tubes aligned with and spaced from said first legs.

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