Jan. 17, 1967 R. MICHEL 3,298,360

PRESSURE-FIRED ONCE-THROUGH BOILER

Filed Jan. 5, 1966 4 Sheets-Sheet 1

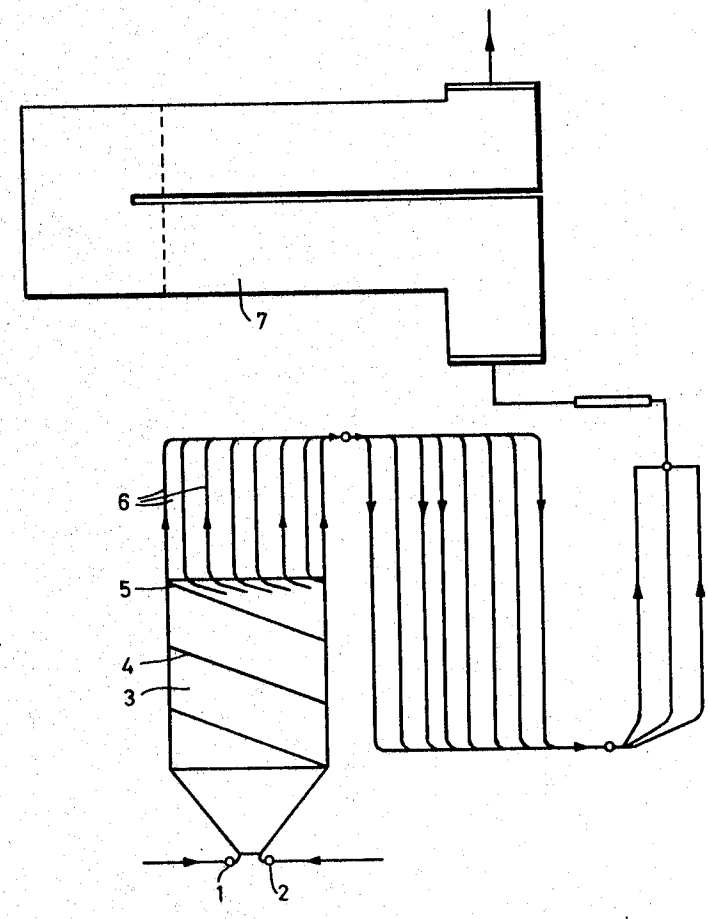


FIG. 1

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PRESSURE-FIRED ONCE-THROUGH BOILER
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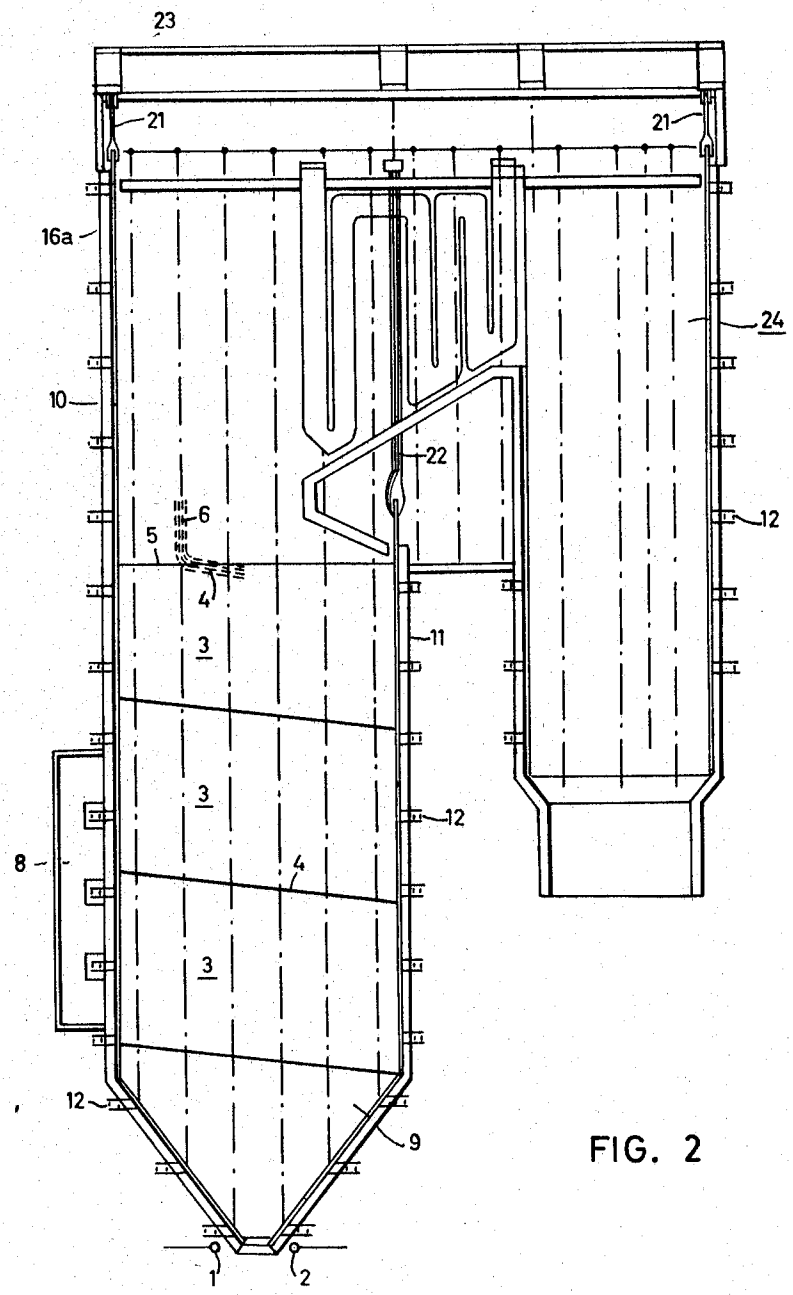


FIG. 2

PRESSURE-FIRED ONCE-THROUGH BOILER

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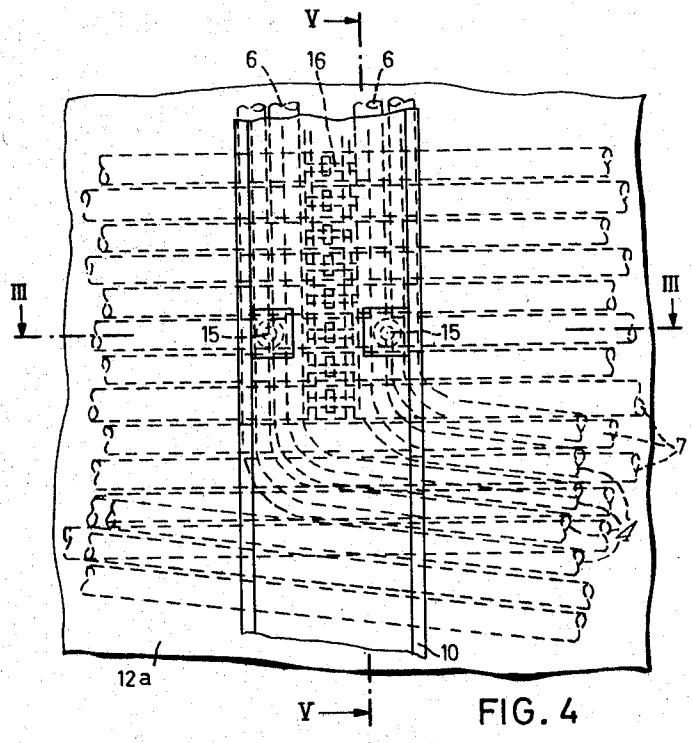


FIG. 4

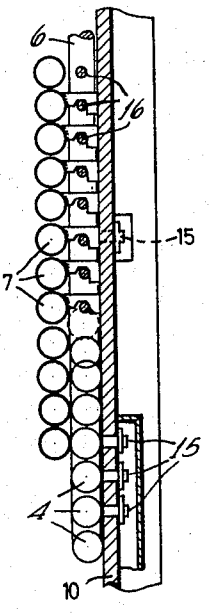


FIG. 5

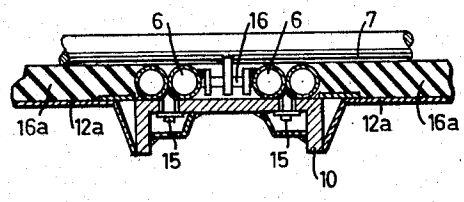


FIG. 3

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PRESSURE-FIRED ONCE-THROUGH BOILER

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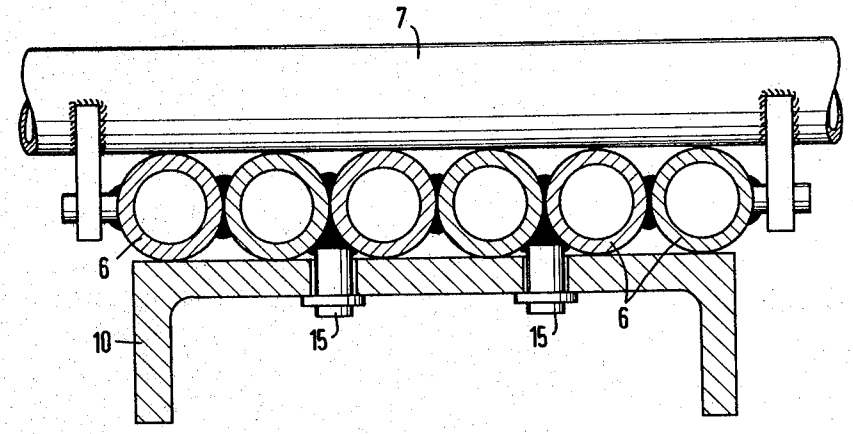


Fig. 6

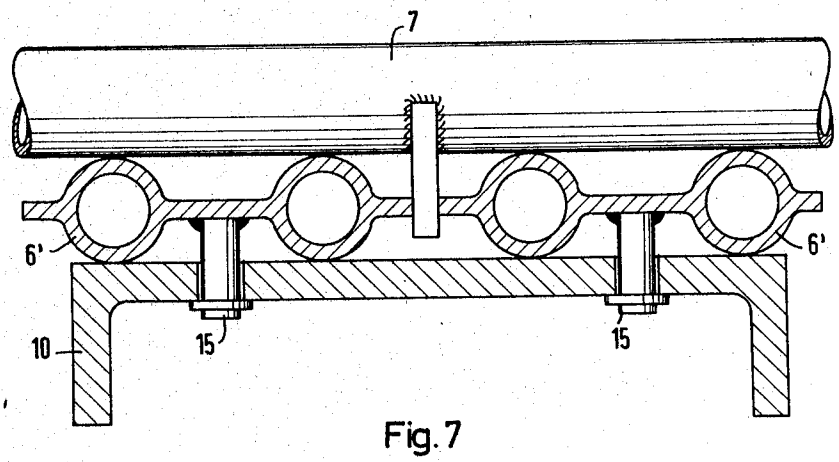


Fig. 7

United States Patent Office 3,298,360 Patented Jan. 17, 1967

3,298,360

PRESSURE-FIRED ONCE-THROUGH BOILER

Rupprecht Michel, Erlangen, Germany, assignor to Siemens-Schuckertwerke Aktiengesellschaft, Berlin, Germany, a corporation of Germany

Filed Jan. 5, 1966, Ser. No. 528,680
Claims priority, application Germany, Nov. 2, 1961, S 76,506
9 Claims. (Cl. 122—510)

This application is a continuation-in-part of my copending application Serial No. 234,484, filed October 31, 1962, assigned to the assignee of the present invention.

My invention relates to a forced-flow steam generator of the once-through type with pressurized firing whose system of boiler tubes follows a generally ascending course and is suspended from above. A steam generator of this type is also described and illustrated in my Patent No. 3,108,576, issued October 29, 1963, assigned to the assignee of the present invention.

Such a once-through generator, having its boiler system suspended on a frame of structural steel, requires taking into account the occurrence of thermal tension due to different temperatures obtaining at respectively different localities; and it is an object of my invention to satisfy these requirements to a better, more reliable yet economical degree than heretofore attained, by securing a relatively free mobility of the suspended boiler-tube system toward all sides.

To this end, and in accordance with a feature of my invention, the pressure-fired once-through boiler is provided with an evaporator system of ascending tubes which extend in winding turns about the firing chamber and border against the flat surfaces of structural steel columns, preferably channel structures, that extend vertically along the boiler system. The evaporator tube system, thus suspended from the vertical columns pass about the firing chamber at a continuously constant inclination in the upward direction. This affords giving all of the evaporator tubes the same length, and to have them all assume substantially the same temperature at the same height. The tubes are preferably welded together in groups, for example in groups of four or six individual tubes. The groups may be spaced two to three meters from each other. The groups are hung or welded to the vertical columns, such as the channel structures, which are substantially in face-to-face engagement with the enclosure of the firing chamber. Also suspended from the columns of the supporting structure, together with the boiler-tube system, are the sheet-metal envelope and the heat insulation of the boiler, as well as a number of horizontal external girders that hold the components together, and also the burner box.

The outlet tubes of the evaporator system are preferably mounted to extend vertically upward in the upper portion of the firing chamber. This affords additionally using these vertical evaporator outlet tubes for holding the tubes of the radiation-heated superheater located in the upper portion of the firing chamber. The superheater is preferably given the shape of a horizontal meander band. Its tubes, according to a further feature of the invention, are suspended from, and horizontally displaceable relative to, the outlet tubes of the evaporator located in front of the vertical channel structures or other supporting columns.

The pressurized firing of the boiler requires providing it with a pressure-tight wall. The wall is preferably formed of metal sheets welded between the vertical and horizontal supporting steel members, the latter being also given a channel section preferably. An insulating layer for protecting the sheet metal from excessive heating can

be fastened in the upper portion of the firing chamber between the radiation-heated heating surface of the superheater and the pressure-tight sheet-metal envelope. The insulating material can be fastened by means of stretchable (ductile) metal. Preferably the thickness of the insulation is approximately equal to the diameter of the boiler tubes. The tube systems of the superheater, located in the insulated range within the top portion of the firing chamber, are subjected to a greater amount of thermal expansion than the evaporator system because the temperature in the superheater is approximately 80° C. higher. However, as mentioned, the superheater tubes are so suspended from the evaporator tubes as to be capable of performing corresponding horizontal displacements under the effect of greater thermal elongation.

The walls of the second boiler portion can be lined by radiation heating surfaces of the pre-superheater in an essentially vertical arrangement and can be pressure-tightened in the same manner as described above with reference to the first portion of the boiler.

According to another feature of the invention, the vertical columns or channel structures of the boiler plant are protected from being excessively heated by arranging the above-mentioned vertical groups of welded-together tubes in front of these structures so that the welded groups of tubes form a heat shield traversed by the working medium.

The above-mentioned and more specific features of my invention will be described in the following with reference to an embodiment of a steam boiler according to the invention illustrated by way of example on the accompanying drawings in which:

FIG. 1 is a schematic flow diagram of the once-through boiler.

FIG. 2 illustrates by a sectional schematic view the individual tube systems and their locations within the boiler.

FIG. 3 is a cross section taken in the region of the boiler where the evaporator tubes change from a gradually ascending path to respective vertical end portions, the section being taken along the line III—III in FIG. 4.

FIG. 4 is a front view of the boiler region according to FIG. 3.

FIG. 5 is a vertical section along the line V—V in FIG. 4.

FIG. 6 is a cross section of a modified detail corresponding as regards location to the section shown in FIG. 3; and

FIG. 7 shows still another modification of a detail, in the manner of FIGS. 3 and 6.

The illustrated boiler is of the forced-flow once-through type and corresponds in principle and as to some design aspects to the boilers according to my above-mentioned Patent 3,108,576 (Serial No. 795,150) and my Patent No. 3,026,857, the latter being also assigned to the assignee of the present invention.

Referring to the diagram of FIG. 1, showing the tube layout of the evaporator and superheater systems essential to the invention, the feed water, after leaving the economizer (not shown) passes through distributors **1**, **2** at the bottom of the boiler into the evaporator tube system **4** which is wound about the firing chamber **3** with a constant upward gradient. This tube system is suspended, according to the invention, on flat or profiled steel structures, preferably channel irons, that extend vertically upward along the entire boiler assembly. In the illustrated embodiment, these vertical columns consist of channel structures **10**, **11** (FIGS. 2 to 5). In the region denoted in FIG. 1 by **5**, the continuous ascending portion of the evaporator system terminates and the evaporator tubes turn upwardly so that the outlet portions **6** of these tubes (FIGS. 1, 3, 4) are vertical. The region **5** is located at about two-thirds of the entire height of the firing chamber

3. The outlet tubes **6** of the evaporator system are mounted in groups directly behind the supporting columns or channel structures **10** for cooling purposes (FIG. 3).

The superheater **7** (FIG. 1) of the boiler forms horizontal meander bands located in the upper portion of the firing chamber and is suspended from the evaporator outlet tubes **6** that extend upwardly through that portion of the boiler.

In FIG. 2 the burner box and primary combustion chamber is denoted by **8**. The lower portion of the main firing chamber forms an ash funnel **9**. The pressure-tight envelope of the firing chamber required for pressurized firing is obtained by forming the inner wall of the firing chamber, including the funnel **9**, of sheet metal and welding the sheets together between the vertical supporting columns **10**, **11** as well as between the horizontal girders with which the boiler tubes are joined. That is, the vertical columns **10**, **11** as well as any additional structural supporting components are held together by means of horizontal girders **12** (FIG. 2) which are joined with the vertical channel structures **10**, **11** by means of linkages or pin-and-slot connections, thus permitting an expansion of the pressure-tight boiler assembly within the fire-chamber envelope under the effect of the high temperatures occurring during operation of the boiler. Instead of using masonry, the necessary heat insulation is preferably provided by heat insulating plates or bats **16***a* (FIGS. 2, 3). The insulation is externally protected by another envelope of sheet metal **12***a* (FIG. 3). As regards these and related design details, reference may be had, if desired, to my above-mentioned Patent 3,108,576.

Referring particularly to FIGS. 3, 4 and 5, the suspension of the meander-arrangement of the superheater in region **5** (FIGS. 1, 2) will be further described presently. In the region where the sloping or inclined evaporator tubes **4**, extending at a continuous upward inclination about the firing chamber, turn upwardly to become the outlet tubes **6** of the evaporator, a number of holder pins **15** are welded to the outlet tubes **6** and pass through bores in the vertical channel structures **10**, thus joining the outlet tubes of the evaporator with the channel structure, as is best apparent from FIG. 3. Also welded to the outlet tubes **6** of the evaporator are holders **16** for fastening the meander tubes of the radiation-heated superheater **7**. The holders **16** are glidably engaged by lugs welded to the superheater tubes **7** so as to permit horizontal displacements of the superheater tubes **7** under the effect of thermal expansion. Heat insulation **16***a* protects the outer sheet-metal envelope **12***a* from excessively high temperatures.

The upwardly-extending outlet tubes **6** of the evaporator system are preferably also employed to aid in suspending the boiler system. For this purpose, the enclosed boiler system is shown suspended in FIG. 2 by means of additional links **21**, **22**. The links **21** connect evaporator outlet tubes **6** with a bridge structure **23** mounted on top of the vertical channel structures, whereas other links, as exemplified at **22**, join the sheet-metal envelope with the same bridge structure **23**.

Each link **22** is formed by two adjacent vertical superheater tubes which jointly form a hairpin configuration whose bight, located at the lower end of these tubes, forms an eye engaged by the top end of one of the respective vertical column structures **11**. The superheater tubes **22** issue from a collector above and are led in bundles, vertically, through the transverse stress zone in conventional manner. In the illustrated boiler according to the invention, such superheater tubes, traverse and cooled by the working medium being superheated, also serve for the suspension of the supporting channels **10**, **11** located therebelow, and thus for supporting the evaporator tube system **3**, the burner box and such other associated parts of the boiler as are supported by the suspended channel members **10**, **11**.

Normally, therefore, no supporting masonry need be provided for the tubes of a boiler according to the invention. As mentioned, the insulation **16***a* is not a supporting structural member, but serves to protect the outer sheet-metal skin against excessive heating, and also laterally shields the vertical iron structures **10**, **11**.

Shielding of the vertical supporting structures **10**, **11** is made especially effective if several boiler tubes are welded together. While in the embodiment shown in FIG. 3, the vertical tubes **6** extending along the vertical U-beam structures **10** are welded together in groups of two, it is more favorable to weld the tubes together in groups of six as shown in FIG. 6, or in groups of four as shown in FIG. 7, so that a wide band or shield results, which reliably prevents excessive heating of the vertical beams **10**. The tubes may be of the finned type, such as the tubes **6'** in FIG. 7.

As shown in FIG. 2, the steadily and slowly rising tubes **4** bend and rise verically upward in zone **5**. While all parallel tubes **4** extend at approximately the same distance from each other, their upper, vertical portions **6** form the above-mentioned groups or bands, starting with the bending at point **5**, which, for example, include four or six tubes each, and form the above-described welded bands at the respective localities of the vertical columns **10**, **11**. The tubes located in the space between two vertical supports are suspended freely without mutual contact.

The second portion of the boiler, denoted as a whole by **24** in FIG. 2 is preferably given a design and mounting corresponding to that described above with reference to the first portion of the boiler. That is, the additional heating surfaces and the extension of the firing or combustion chamber container in the second boiler portion **24** are combined to a unit that comprises the tube systems of these heating surfaces as well as the appertaining sheet-metal envelope and the horizontal supporting girders **12**, and this unit is suspended from the vertical channel structures in the same manner as described above.

The vertical columns **10** extend along the front and both side walls of the boiler, up to the top. However, in the rear of the boiler, where the vertical carrying columns are indicated in FIG. 2 at **11**, and where the transverse stress in the zone leading to the second boiler is located, the vertical carrying columns extend only up to the height at which the tubes **22** are bunched together and lead vertically through the transverse stress area. Here the carrying columns **11** are suspended from the superheater tubes **22**.

In all other respects the boiler may correspond to the known pressure-fired forced-flow boilers of the once-through type such as exemplified by the above-mentioned patents.

To those skilled in the art, it will be obvious, upon a study of this disclosure, that my invention permits of various modifications and can be given embodiments other than 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 once-through pressure-fired steam boiler comprising walls defining a firing chamber and including a sheet-metal enclosure, an evaporator system located on said walls within said chamber and comprising upwardly sloping evaporator tube portions and vertically arranged outlet tube portions located above and said vertical tube portion being interconnected to said sloping tube portions, said sloping tube portions extending about said firing chamber, horizontal girders located externally of said chamber walls and forming a unit together therewith, a carrier structure comprising structural steel columns extending vertically along said unit and having flanges directed outwardly relative to said chamber, first suspension means suspending said evaporator tube system from said columns and including means connected to said vertical tube portions, a radiation superheater tube system located on the wall of said chamber adjacent to said vertical tube

portions, and second suspension means suspending said superheater tube system from said vertically arranged outlet tube portions, said carrier structure including third suspension means linked to the upper ends of said columns for suspending said columns and thus said evaporator system and said superheater tube system therewith from above.

2. In a once-through boiler according to claim 1, said vertical columns consisting of channel members having respective web portions adjacent to said vertical outlet tube portions.

3. In a once-through boiler according to claim 2, said firing chamber having an upper portion and a lower portion, said sloping tube portions of said evaporator system being located in said lower chamber portion, and said vertically arranged outlet tube portions being located adjacent said channel members and in the upper chamber portion, said superheater tube system comprising tubes of meander-shaped arrangement communicating with said evaporator system.

4. In a once-through boiler according to claim 3, said first suspension means comprising pin means fixedly joined to respective outlet tube portions and extending through the web portion of one of said respective channel members.

5. In a once-through boiler according to claim 3, said superheater tube system comprising a plurality of horizontal tubes located adjacent to said vertically arranged outlet tube portions, said second suspension means comprising a first element fixedly attached to one of said respective horizontal tubes of said superheater tube system, a second element joined to said outlet tube portions, and means defining a slidable connection between said first and second elements for horizontal relative displacement between them.

6. In a once-through boiler according to claim 2, said carrier structure including an overhead bridge structure and said third suspension means comprising linking means supporting said channel members from said bridge structure.

7. In a once-through boiler according to claim 4, said firing chamber defining a first boiler portion and a flue path extending past said superheater tube system, a second boiler portion adjacent said first boiler portion and communicating with said flue path, said second boiler portion comprising heating-surface walls having groups of tubes suspended thereon, a pressure-tight sheet-metal enclosure and external horizontal supporting girders around said heating surface walls, and vertically extending members for supporting said second boiler portion linked to said bridge structure.

8. In a once-through boiler according to claim 1, said vertically arranged outlet tube portions of said evaporator system comprising mutually spaced groups of vertical tubes, the groups being horizontally spaced from each other, each group including a plurality of tubes welded together and jointly forming a heat-protective wall structure in front of one of said respective vertical columns.

9. In a once-through boiler according to claim 1, said vertical columns consisting of channel members having respective web portions, said vertically arranged outlet tube portions of said evaporator system comprising groups of mutually adjacent and structurally joined tubes, said groups being located in front of said respective webs and forming a heat-protective wall structure relative thereto.

References Cited by the Examiner

UNITED STATES PATENTS

2,878,791	3/1959	Lieberherr	122—478
3,055,348	9/1962	Brash	122—510
3,078,830	2/1963	Evans	122—6
3,081,748	3/1963	Koch	122—406

FOREIGN PATENTS

1,194,599	11/1959	France.
398,413	9/1933	Great Britain.
870,735	6/1961	Great Britain.
877,116	9/1961	Great Britain.

KENNETH W. SPRAGUE, *Primary Examiner.*