United States Patent

Michel

[15] **3,670,703**

[45] **June 20, 1972**

[54] FORCED-FLOW BOILER

[72] Inventor: **Rupprecht Michel**, Erlangen, Germany

[73] Assignee: **Kraftwerk Union Aktiengesellschaft**, Muhlheim (Ruhr), Germany

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[21] Appl. No.: **57,711**

[30] **Foreign Application Priority Data**

July 26, 1970 Germany ..... P 19 38 043.9

[52] **U.S. Cl.** ..... **122/406 R**, 122/318

[51] **Int. Cl.** **F22b 29/02**

[58] **Field of Search** 122/33, 235, 305–320, 122/406, 6; 165/142

[56] **References Cited**

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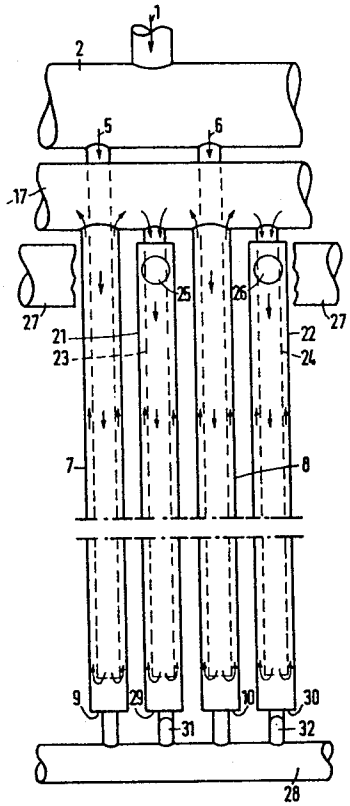
Primary Examiner—Kenneth W. Sprague

Attorney—Curt M. Avery, Arthur E. Wilfond, Herbert L. Lerner and Daniel J. Tick

[57] **ABSTRACT**

Forced-flow boiler includes combustion chamber walls formed of vertical welded tube-crosspiece tube systems comprising riser tubes having respective downcomer tubes located therewithin.

10 Claims, 6 Drawing Figures



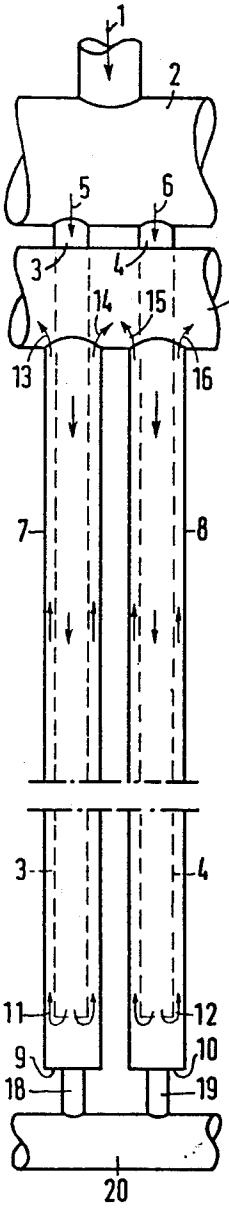


Fig. 1

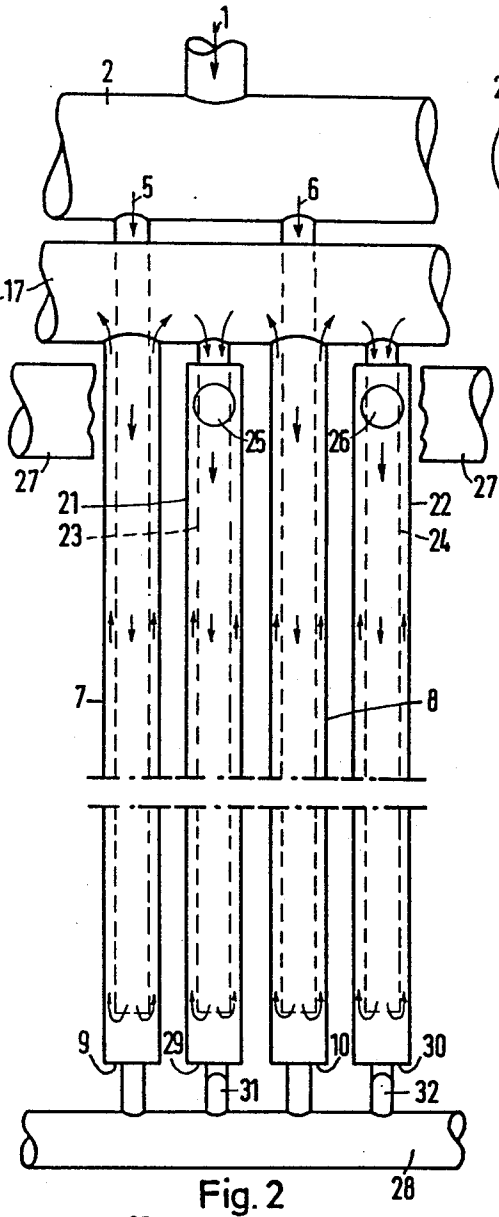


Fig. 2

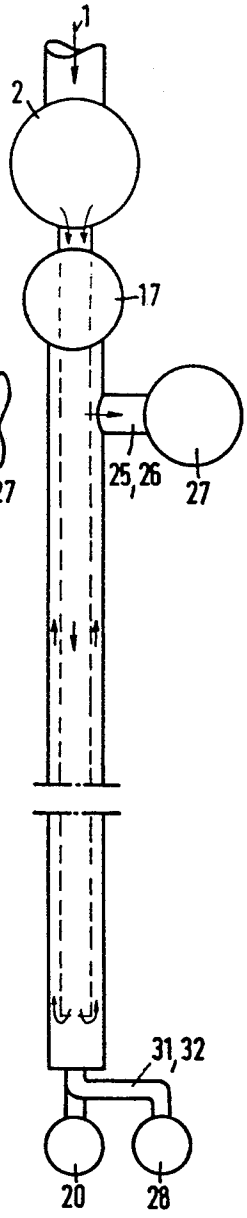


Fig. 3

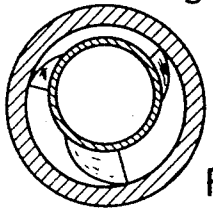


Fig. 5

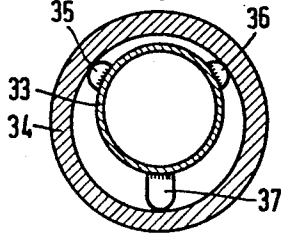


Fig. 4

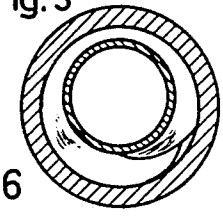


Fig. 6

FORCED-FLOW BOILER

My invention relates to once-through or forced-flow boilers and more particularly to such once-through boilers having at least part of the combustion chamber walls thereof formed by vertically welded tube-crosspiece tube systems.

In a known boiler of this type of construction, which is operated at subcritical pressure, the tubes are provided in the interior thereof with ribs or other roughening structures in order to prevent film deposition phenomena. During operation at supercritical pressure, this boiler employing a riser tube-downcomer tube system with a single downcomer tube must also be operated always supercritically at start-up because with this system steam-water mixtures cannot readily be uniformly distributed to a very great number of downcomer tubes.

It is accordingly an object of my invention to provide forced-flow boiler which is constructed so as to avoid this disadvantage of the heretofore known tube-crosspiece tube systems so that it is also possible to start up and also to continuously operate at full load at subcritical pressure.

With the foregoing and other objects in view I provide, in accordance with my invention, forced-flow boiler comprising combustion chamber walls formed of vertical welded tube-crosspiece tube systems including riser tubes having respective downcomer tubes located therewithin. The heated riser tubes are of a relatively greater diameter so that a greater flow-through rate can be obtained with a smaller number of riser tubes for the combustion chamber walls. A thermally elastic construction necessarily results therefrom having a relatively smaller number of parallel strings or lines, so that such a boiler can be started up more rapidly without any fear of undesirable stresses in the horizontal tie rods or tension members.

According to my invention, two or more of such systems can be enclosed within one another and can be traversed by working medium sequentially. It is also thereby possible to effect a uniform distribution of the steam-water mixture at the next following traversal because no significant transverse flows prevail in the upper distribution accumulators or manifolds. The downcomer tubes located in the interior of the heated riser tubes can have a relatively small wall thickness of, for example, only 2 mm, because they only have to endure an extremely slight pressure difference which is hardly greater than 5–10 atmospheres absolute pressure. It has been found to be particularly desirable in such systems if all of the distribution accumulators or manifolds are located in the vicinity of the cover of the boiler.

In accordance with other features of my invention, to provide spacing of the inner tube with respect to the inner surface of the outer tube, welded dogs or cams are disposed, for example, at distances of one to two meters from one another on the outside of the downcomer tube and distributed at three locations on the periphery thereof. If desired, these dogs can be of different lengths or can be omitted along a line of the casing of the tube so that the downcomer tube is disposed eccentrically to the riser tube in which it is located or, in an extreme case, is located at one side thereof in abutment with the inner surface of the riser tube wall. In the latter case, the downcomer tube is located at the unheated side at the inner surface of the riser tube wall.

The cams or dogs serving as spacers are provided in accordance with the invention with a specific shape which produces a vortex in the flow or which diverts the flow into quite specific paths. Thus, by disposing flat cams or dogs at an inclination to the axis of the tube, diversions of the flow are produced so that the rising working medium flow winds itself helically upward. Also provided in accordance with the invention is a continuous flat iron plate that is welded on to the tube and which induces a rotational flow about the inner downcomer tube. In all of these cases turbulence of the flow can be effected and thereby film deposition phenomena avoided in a simpler manner than by employing the heretofore conventional and considerably more expensive inner rib formations on the tube.

The inlet and outlet accumulators or manifolds in accordance with the invention are located above one another and are multiply subdivided along the periphery of the combustion chamber wall. Moreover, in the supply lines to the inlet and outlet accumulators, throttle valves are provided for adjusting the flow rate of the working medium to the heating of the respective tube section. Caps are welded to the underside of the tubes in order to divert the flow at the bottom. In case the system is constructed so as to be drainable of the water content thereof, these caps can be provided with drainage joints or unions. It is thereby possible, for example, to connect to one another the reversing ends of the individual tubes belonging to a common tube section through a pressure equalizing line with a drainage valve.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in forced-flow boiler, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing, in which:

FIG. 1 is a fragmentary diagrammatic view of a tube-crosspiece tube system for a forced flow boiler according to the invention;

FIG. 2 is a view similar to that of FIG. 1 of two combined systems as shown in FIG. 1;

FIG. 3 is a right side view of FIG. 2; and

FIGS. 4, 5 and 6 are sectional views, respectively, of modified forms of an individual riser tube containing a downcomer tube.

Referring now to the drawings and first particularly to FIG. 1 thereof, there is shown an embodiment of the forced-flow boiler of my invention wherein working medium flows in direction of the arrow 1 into a distributor or manifold 2 which is located in the vicinity of the cover of the boiler. The working medium then flows downwardly in direction of the arrows 5 and 6 through a number of downcomer tubes, of which the downcomers 3 and 4 are shown in FIG. 1. The downcomer tubes 3 and 4 are located inside riser tubes 7 and 8, respectively, which are provided with cross-pieces not illustrated in FIG. 1, to which they are welded in a conventional manner so that a gas-tight combustion chamber or funace wall is produced in this manner.

As is further shown in FIG. 1, the downcomer tubes 3 and 4 terminate in the lower region of the heated riser tubes 7 and 8 above the caps 9 and 10 thereof so that the flow is reversed in direction of the arrows 11 and 12 and, in the radially outer region, as indicated by the arrows 13, 14, 15 and 16, high-risingly terminates in the outlet collector 17. The wall thickness of the downcomer tubes along the lengths thereof, which are located within the riser tubes and the outlet accumulators, can be extremely thin because they are subjected to only very slight differential pressure. In the embodiment shown in FIG. 1, the lower caps 9 and 10 are furthermore provided with connecting tube portions 8 and 19 leading to a common accumulator line or manifold 20. The lines 20 of the system (only one of which being shown in FIG. 1) are connected to suitable drainage valves. Moreover, with these accumulator lines 20 small differences in heating and flow-through rate in the individual parallel tubes can be equalized, because such a line 20 can also act as a pressure equalizing line.

The embodiment shown in FIGS. 2 and 3 relates to a series connection of two tube systems such as that of FIG. 1, it being obvious, of course, that, in the same sense, a series connection of additional tube systems of this general type can be effected. The outlet accumulator or manifold 18 of the first tube system thus simultaneously serves as the inlet distributor 2 for the

next following tube system. In the same manner as for the first system, the heated riser tubes **21** and **22** contain in the interior thereof downcomer tubes **23** and **24**, respectively. The working medium leaves the riser tubes **21** and **22** through a separate tube member or tube portions **25**, **26** bent from the tubes **21** and **22**, and is conducted to an outlet accumulator or manifold **27**. For the second system, a separate accumulator line **28** is provided for the draining purpose, tube connections **31** and **32** to an accumulator line **28** being provided from the lower closure caps **29** and **30** of the riser tubes **21** and **22**, respectively.

In FIG. **4**, there is provided a cross-sectional view of an embodiment of the invention wherein a downcomer tube **23** is disposed eccentrically within a riser tube **34**. Cams or dogs **35**, **36** and **37** are provided as spacers at predetermined distances above one another and about the periphery of the downcomer tube **33**. It is also possible to omit one of the dogs or cams, as shown in FIG. **5**, so that the inner downcomer tube **33** abuts the inner surface of the wall of the riser tube **34** at one side thereof, the contact location being at a side of the riser tube **34** which is not subjected to heating. In such a case, it may be sufficient to employ only two or even only one cam or dog at the periphery of the downcomer tube **33**.

As shown in FIG. **5**, the cams or dogs can be in the form of inclined blades in order in this manner to effect a transverse movement of the working medium in addition to the longitudinal movement thereof. Especially in those cases wherein the inner tube is traversed by the flow on all sides thereof, a torsional flow can be excited in this manner, which facilitates heat transfer to the working medium. Instead of employing cams or dogs or the like, as shown in FIG. **6**, helical bands **40** are welded to one of the tubes so as to induce a rotary flow of the medium. By all of these constructions it is possible to produce turbulence, rotational flows or the like in a much simpler manner than has been obtained heretofore by the conventional and much more costly inner ribs that have been provided on steam tubes.

I claim:

1. Forced-flow boiler having a combustion chamber comprising a plurality of vertical tube-crosspiece-tube systems mutually joined by welding to form a wall of the combustion chamber, each of said systems including a riser tube and a downcomer tube located within said riser tube eccentrically thereto.

2. Forced-flow boiler according to claim **1** including means connecting said tube systems serially with one another.

3. Forced-flow boiler according to claim **1**, including spacer members secured by welding to the outer surface of said downcomer tubes at at least two locations on the peripheral surface thereof.

4. Forced-flow boiler according to claim **3** wherein said spacer members are in the form of dogs.

5. Forced-flow boiler according to claim **3** wherein said spacer members are spaced from one to two meters from one another.

6. Forced-flow boiler according to claim **3** wherein said spacer members are so disposed and are of such dimension as to support said inner downcomer tube in eccentric position to said outer riser tube.

7. Forced-flow boiler according to claim **1**, including at most two spacer members secured by welding to the outer surface of said downcomer tubes so that said downcomer tubes, respectively, engage a relatively cool side of said riser tubes, respectively.

8. Forced-flow boiler according to claim **1** including at least one spacer member in the form of a flat iron plate helically disposed about the peripheral surface of said downcomer tube and secured by welding thereto.

9. Forced-flow boiler according to claim **1**, including inlet distributor means and outlet accumulator means disposed above one another along the periphery of said combustion chamber wall and being multiply subdivided, working medium supply lines connected to said distributor means and said accumulator means, and throttle valve means for adjusting working medium flow-through rate to heating of a respective section of the tubes being disposed in said supply lines.

10. Forced-flow boiler according to claim **1**, including tube portions located at the lower end of said tube systems, and a common pressure equalizing line having a drainage valve therein being connected to said tube portions.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,670,703 Dated June 20, 1972

Inventor(s) RUPPRECHT MICHEL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading to the printed specification, Line 8

"July 26, 1970 Germany .....P 19 38 043.9"

should read

--July 26, 1969 Germany .....P 19 38 043.9--

Signed and sealed this 5th day of March 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents