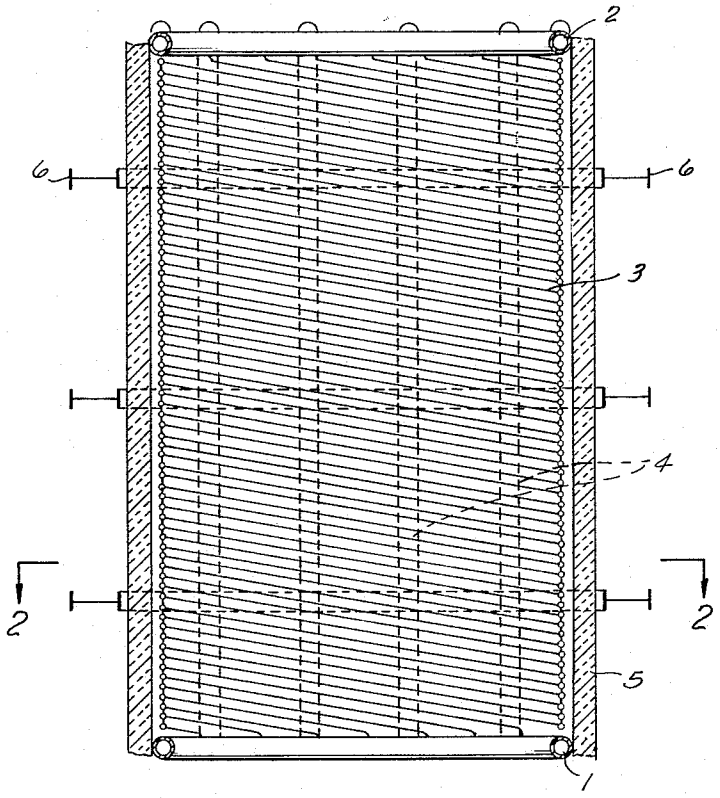
Jan. 3, 1967 O. ENGLER 3,295,504

TUBE SUPPORT FOR STEAM BOILERS HAVING AN UPRIGHT WALL FORMED BY HELICALLY ARRANGED TUBES

Filed June 8, 1965 3 Sheets-Sheet 1

FIG. 1



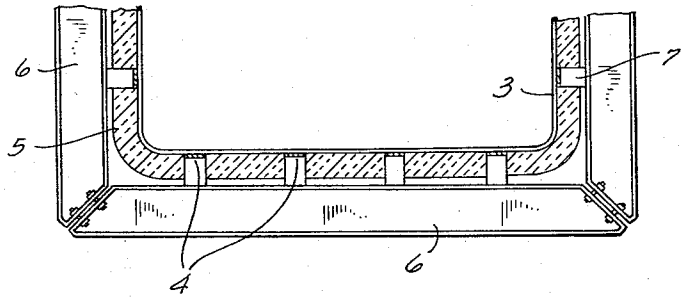


FIG. 2

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TUBE SUPPORT FOR STEAM BOILERS HAVING AN UPRIGHT WALL FORMED BY HELICALLY ARRANGED TUBES

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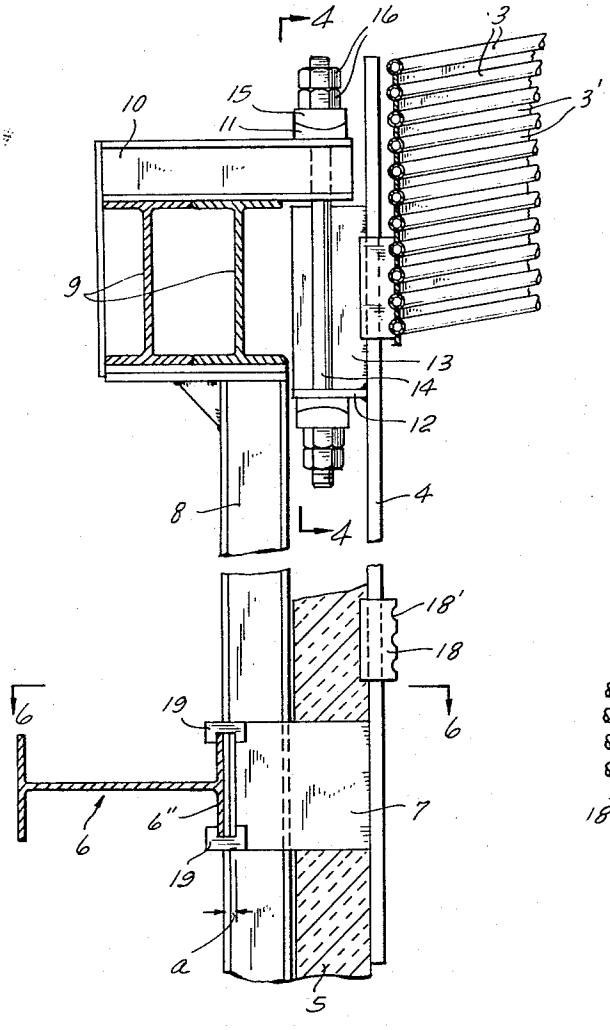


FIG. 3

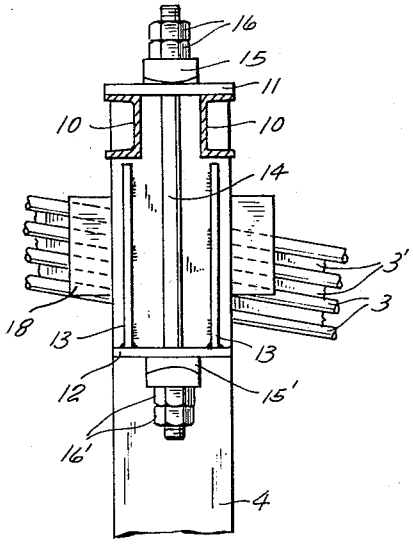


FIG. 4

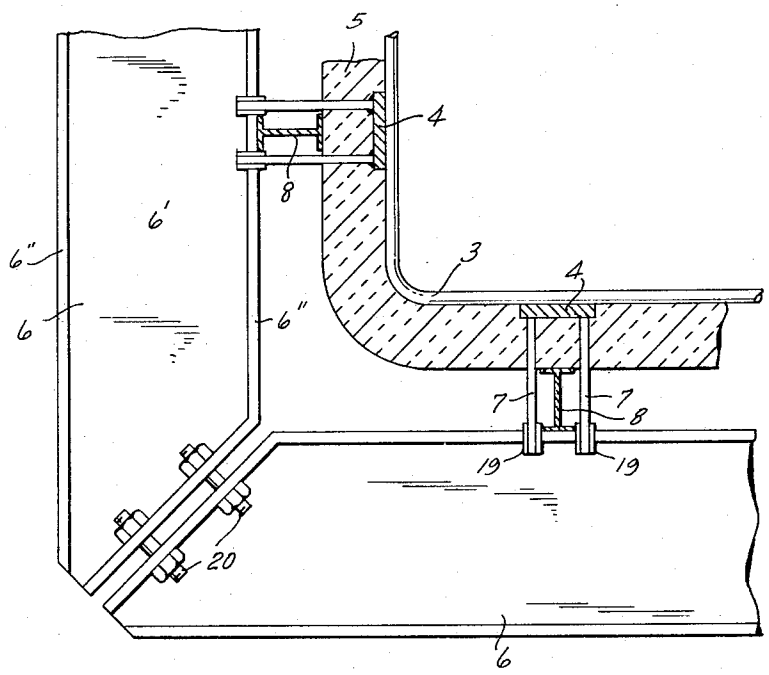
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TUBE SUPPORT FOR STEAM BOILERS HAVING AN UPRIGHT WALL FORMED BY HELICALLY ARRANGED TUBES

Filed June 8, 1965 3 Sheets-Sheet 3

FIG. 6



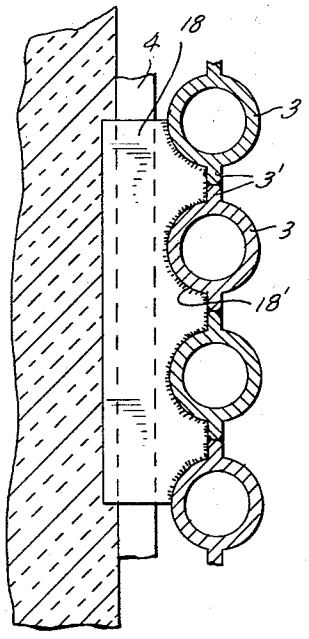


FIG. 5

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3,295,504

TUBE SUPPORT FOR STEAM BOILERS HAVING AN UPRIGHT WALL FORMED BY HELICALLY ARRANGED TUBES

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8 Claims. (Cl. 122—510)

The present invention relates to an arrangement for supporting the tubes of a steam boiler having an upright substantially cylindrical wall formed by helically arranged tubes. In forced circulation boilers or in once-through type boilers, the upright substantially cylindrical wall of the boiler is formed by a plurality of tubes which extend in contact with each other in substantially helical form substantially parallel to each other from the lower to the upper end of the cylindrical wall and which are welded to each other so as to form a continuous wall. This substantially cylindrical wall of the boiler encloses a combustion chamber or another chamber through which hot combustion gases pass so that liquid fed from an annular inlet means at the lower end of the boiler is transformed into steam as the liquid passes through the tubes forming the wall to pass in an outlet collector at the upper end of the boiler.

The helically arranged tubes are preferably fin tubes arranged in helical form substantially parallel to each other with the edges of the fins of adjacent tubes abutting against and welded to each other. The helical arranged tubes in such boiler constructions extend inclined only at a very small angle with respect to the horizontal and are therefore subjected to considerable bending stresses resulting not only from the actual weight of the tubes, and the fluid passing therethrough, but also from the weight of additional elements, such as burners and other armatures, fixedly connected to the tubes. Such bending stresses acting on the tubes would require a considerable increase of the wall thickness of the tubes which would not only make the construction rather expensive, but which in turn would increase also the weight of the tubes and the bending stresses resulting from this increased weight.

It is an object of the present invention to provide a proper support for helically arranged tubes forming an upright substantially cylindrical wall in boiler types of the aforementioned kind so that the wall thickness of the tubes need not to be increased due to excessive bending stresses acting thereon.

It is an additional object of the present invention to provide for a tube support for helically arranged tubes forming an upright substantially cylindrical wall of steam boilers of the aforementioned type in which the tubes are relieved from bending stresses so that the tubes may not only support their own weight, but also the weight of additional elements fixed thereto without the necessity of increasing the wall thickness of the tubes.

It is a further object of the present invention to provide for such a tube support which is arranged in such a manner to provide for a proper support of the tubes even during heat expansion and contraction of the latter.

It is finally an object of the present invention to provide for a tube support of the aforementioned kind which is constructed of relatively few and simple parts so that the support arrangement can be manufactured at reasonable cost and will stand up properly under extended use.

With these objects in view, the present invention comprises in a steam boiler having an upright substantially cylindrical wall formed by a plurality of tubes extending in contact with each other in substantially helical form

substantially parallel to each other from the lower to the upper end of the cylindrical wall and being welded to each other, support means, and a plurality of substantially vertical tie means fixed at the upper ends thereof to said support means and extending spaced from each other along the aforementioned wall of the boiler substantially from the upper to the lower end thereof and being fixedly connected to the tubes forming the wall so that the weight of the tubes and any weight carried thereby is suspended by the tie means on the support means, whereby bending stresses in the tubes are reduced so that the latter can be made with a wall thickness constructed only to withstand the pressure of the fluid medium passing through the tubes.

The tie means are preferably arranged along the outer surface of the wall and preferably the tie means are welded at spaced portions thereof to the tubes. Preferably the tie means have vertically spaced portions facing the outer surface of the wall and having at the aforementioned portions a contour matching that of the tube portions forming the outer wall surface and being welded thereto. The boiler wall formed by the helically arranged tubes is preferably surrounded by a heat insulation which preferably also extends about the tie means so that the latter are held substantially at the same temperature as the boiler wall and are subjected to the same heat expansion and contraction as the tubes forming the boiler wall.

The arrangement according to the present invention preferably includes also annular reinforcing means at the exterior of the heat insulation and surrounding the latter and the cylindrical wall operatively connected to the tubes forming the wall. These annular reinforcing means will reinforce the substantially cylindrical wall of the boiler formed by the helically arranged tubes against bulging due to increased pressure in the space enclosed by the cylindrical wall.

Preferably a plurality of annular reinforcing means are arranged spaced from each other in vertical direction about the exterior of the heat insulation and a plurality of connecting means are provided which extend through the heat insulation and which respectively connect the tie means to the annular reinforcing means with slight play in direction transverse to the longitudinal direction of the tie means.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, 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 drawings, in which:

FIG. 1 is a schematic longitudinal section through a boiler with a support arrangement according to the present invention;

FIG. 2 is a partial cross section taken along lines 2—2 of FIG. 1 and viewed in direction of the arrows;

FIG. 3 is a partial cross sectional view similar to that shown in FIG. 1 and drawn to an enlarged scale;

FIG. 4 is a cross sectional view taken along the lines 4—4 of FIG. 3 and viewed in the direction of the arrows;

FIG. 5 is a cross sectional view of a detail of the support arrangement shown in FIG. 3 and drawn to a further enlarged scale; and

FIG. 6 is a cross sectional view taken along the lines 6—6 of FIG. 3 and viewed in the direction of the arrows.

Referring now to the drawings, and more specifically to FIGS. 1 and 2 of the same, it will be seen that the boiler in which the support arrangement of the present

invention is used mainly comprises an upright substantially cylindrical wall formed by a plurality of tubes **3** extending in contact with each other in substantially helical form substantially parallel to each other from the lower to the upper end of the cylindrical wall. The tubes **3** are preferably fin tubes, as shown at an enlarged scale in FIG. 5, having each a pair of oppositely arranged fins **3'** and the fins of adjacent tubes **3** abut along longitudinal edges thereof against each other and being welded to each other along the longitudinal edges of the fins, as shown in FIG. 5. It is mentioned that the term cylindrical wall as used in the specification and the claims includes a wall of circular cross section, as well as a wall of substantially square, rectangular, or polygonal cross section. The tubes **3** communicate at the lower end thereof with an annular inlet means **1** and at their upper ends with an annular outlet means **2**. Hot combustion gases are passed through the space defined by the cylindrical wall formed by the tubes **3** so that water fed into the annular inlet means **1** will, during passage thereof through the tubes **3**, be transformed into steam which is collected at the annular outlet means **2** and fed from there to a point of use. The spirally arranged fin tubes **3** forming the boiler wall are supported at spaced portions thereof by a plurality of substantially vertical tie means **4** extending spaced from each other along the outer surface of the cylindrical wall of the boiler substantially from the upper to the lower end thereof end thereof and being fixedly connected in a manner as will be described in further detail later on to the tubes **3** forming the boiler wall so that the weight of the tubes and any weight carried thereby is suspended by the tie means on a support, not shown in FIG. 1 but shown in FIG. 3 and described later on in detail, whereby the bending stresses in the tubes are reduced so that the wall thickness of the latter need not to be increased on account of the bending stresses occurring in the tubes due to the weight of armatures and other elements connected thereto.

Heat insulating means **5** are provided around the outer surface of the cylindrical wall formed by the tubes **3** and the heat insulating means **5** surround also the longitudinally extending tie means **4** so that the latter are at substantially the same temperature as the outer surface of the cylindrical wall to expand and contract during temperature variations of the latter substantially in the same manner as the cylindrical wall. A plurality of annular reinforcing **6** surround, vertically spaced from each other the heat insulating means **5** and each of the annular reinforcing means **6** is preferably formed from a plurality of I-beam sections connected at the ends thereof to each other by screws or the like as schematically indicated in FIG. 2. The annular reinforcing means **6** are respectively connected to the tie means **4** and through the latter to the tubes **3** by connceting means **7** extending through the heat insulating means **5** as schematically indicated in FIGS. 1 and 2.

It is mentioned that FIGS. 1 and 2 are strictly schematical and a more complete description and illustration of a once-through type boiler in which the support arrangement for supporting the spirally arranged tubes according to the present invention may be used can be found in the copending application filed April 22, 1956 under the Serial No. 450,126. It is, however, also mentioned that the support arrangement according to the present invention may not only be used on once-through boilers as disclosed in the aforementioned application, but on any type of boilers which include an upright substantially cylindrical wall formed by a plurality of tubes extending in contact with each other in substantially helical form substantially parallel to each other from the lower to the upper end of the cylindrical wall and being welded to each other.

FIGS. 3–6 illustrate the support arrangement for supporting the substantially helically arranged tubes **3** in further detail. As can be seen from FIGS. 3 and 6 a plurality of vertical I-beams **8** are arranged spaced from each other along the outer surface of the heat insulating means **5**. The lower ends of these I-beams are properly supported in any well known manner, not shown in the drawings, on an appropriate foundation, whereas a plurality of horizontally arranged I-beams **9** are fixedly connected, for instance by welding to the upper ends of the vertical I-beams **8**, in the manner as shown in FIG. 3. The I-beams **9** are preferably arranged to surround the wall formed by the fin tubes **3** in the region of the upper end of the boiler. A pair of short beams **10** of U-shaped cross section are connected spaced from each other, for instance by welding to the upper flanges of the I-beams **9** in the region above each beam **8** projecting with the inner ends thereof inwardly beyond the I-beams **9** in the manner as best shown in FIGS. 3 and 4. A short plate **11** connected to the upper flanges of the U-beams **10**, for instance by welding, bridges the gap between the webs of the spaced beams **10**, as best shown in FIG. 4, and the plate **11** is formed with an opening therethrough through which a bolt **14** provided with screw threads at the opposite ends thereof extends. A transverse plate **12** is welded along the inner edge thereof to each tie means or bar **4** and the plate **12** is also formed with an opening therethrough through which the lower end of the bolt **14** extends. A pair of side plates **13** extend substantially parallel to the bolt **14** on opposite sides thereof, and the side plates **13** are welded along the inner longitudinal edges thereof to the bar **4** and along the lower edges thereof to the plate **12** to reinforce the latter against bending stresses. A pair of nuts **16** threadingly connected to the upper threaded end of each bolt **14** abut preferably by means of a washer **15**, sandwiched between the lower one of the nuts **16** and the transverse plate **11**, against the latter so that the bolts **14** are supported on the respective plates **11** which in turn are supported on the overhanging ends of the U-beams **10**. The plate **12** fixed to the tie bar **4** is supported preferably by means of a pair of washers **15'** on a pair of nuts **16'** threadingly engaging the lower end of the respective bolt **14**. In this way, each tie bar **4** is supported at its upper end on support means comprising the U-shaped beams **10**, the I-beams **9** and the vertical I-beams **8**. The washer **15** has preferably a spherical bottom face and the washers **15'** engage each other along preferably spherical faces permitting thereby each bar **4** and each bolt **14** to tilt slightly with respect to the support means to compensate for any inaccuracies of the support arrangement.

Each of the tie means is preferably at vertically spaced portions thereof fixedly connected, preferably by welding, to portions of the outer surface of the wall formed by the helically arranged tubes **3**. For this purpose a plurality of engaging means comprising plates **18** are fixed, preferably by welding, to longitudinally spaced portions of the bars **4** and each of the plates has at the surface **18'** thereof facing and engaging the outer surface of the wall formed by the fin tubes **3** a contour matching that of the fin tube portions forming the outer wall surface and the plate **18** is welded along its contoured surface **18'** to the corresponding surface portions of the fin tubes **3** as best shown in FIG. 5. The fin tubes **3** are thus supported at spaced portions thereof by the tie means **4**, **18** which in turn are supported at the upper ends thereof on the support means **8**, **9**, **10** in the manner as described before. Each of the tie means may be adjusted slightly in vertical direction by turning the nuts **16** and **16'** in the one or the other direction on the threaded ends of the screw bolts **14** so that in this way the weight of the tubes **3** and any weight carried thereby may be evenly distributed onto the plurality of tie means. Since the heat insulating means **5** surround not only the wall formed by the tubes **3**, but also the tie means **4**, **18**, the tie means will be held at substantially the same temperature as will prevail at the outer surface of the cylindrical wall of the boiler so that

the tie means will be subjected to the same heat expansion and contraction as the boiler wall.

The support arrangement according to the present invention preferably includes also a plurality of annular reinforcing means arranged spaced from each other in vertical direction substantially in horizontal planes and each formed by a plurality of I-beams **6** having a web portion **6'** arranged in the respective horizontal plane and a pair of flange portions **6''**. The inner of the flanges **6''** may be fixedly connected for instance by welding to the outer flanges of the vertically arranged I-beams **8**. The adjacent ends of the I-beam **6** are preferably connected to each other by screw bolts and nuts **20** as shown in FIG. 6. Each of the annular reinforcing means **6** is connected by connecting means to the tie means **4** and each of the connecting means preferably comprises a pair of plates **7** fixed along longitudinal inner edges thereof to the respective bar **4** of the tie means, for instance by welding, and the plates **7** extend through the heat insulating means **5** and are respectively arranged to opposite sides of the vertical I-beams **8**. Each of the plates **7** has at opposite ends of its outer edge a pair of claw portions **19** engaging opposite edge portions of the inner flange **6''** of the respective I-beam **6**. The claw portions **19** have each a mouth opening of a width greater than the width of the respective flange **6''** so that each plate **7** may shift relative to the respective I-beam **6** through the distance *a* (FIG. 3). The tie means **4** and the tube **3** connected thereto may therefore yield slightly in outward direction due for instance to heat expansion relative to the I-beams **6**, however, the latter will reinforce the wall of boiler formed by the tubes **3** against excessive bulging in outward direction due to forces which may occur due to over-pressure in the space defined by the cylindrical wall of the boiler.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of tube support for steam boilers differing from the types described above.

While the invention has been illustrated and described as embodied in a tube support for a steam boiler having a upright wall formed by helically arranged tubes, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

What is claimed is:

1. In a steam boiler having an upright substantially cylindrical wall formed by a plurality of tubes extending in contact with each other in substantially helical form substantially parallel to each other from the lower to the upper end of said cylindrical wall and being welded to each other, in combination, support means; and a plurality of substantially vertical elongated tie means fixed at the upper ends thereof to said support means and extending spaced from each other along the outer surface of said wall substantially from the upper to the lower end thereof at spaced portions thereof, said tie means having portions facing the outer surface of said wall and having at said portions a contour matching that of the tube portions forming the outer wall surface and being welded at said portions to the tubes forming the wall so that the weight of the tubes and any weight carried thereby is suspended by said tie means on said support means, whereby bending stresses in said tubes are reduced.

2. In a steam boiler having an upright substantially cylindrical wall formed by a plurality of fin tubes extending in substantially helical form substantially parallel to each other from the lower to the upper end of said cylindrical wall with the free edges of adjacent fin tubes abutting against and welded to each other, in combination, support means; and a plurality of substantially vertical elongated tie means fixed at the upper ends thereof to said support means and extending spaced from each other along the outer surface of said wall substantially from the upper to the lower end thereof, each of said tie means comprising an elongated vertical metal bar and a plurality of engaging means fixed to vertically spaced portions of each bar and each having at a portion thereof facing the outer surface of said wall a contour matching that of the fin tube portions forming the outer wall surface of said portions of said engaging means being welded to the fin tube portions opposite thereto so that the weight of the tubes and any weight carried thereby is suspended by said tie means on said support means, whereby bending stresses in said tubes are reduced.

3. In a steam boiler having an upright substantially cylindrical wall formed by a plurality of fin tubes extending in substantially helical form substantially parallel to each other from the lower to the upper end of said cylindrical wall with the free edges of adjacent fin tubes abutting against and welded to each other, in combination, support means; a plurality of substantially vertical elongated tie means fixed at the upper ends thereof to said support means and extending spaced from each other along the outer surface of said wall substantially from the upper to the lower end thereof, each of said tie means comprising an elongated vertical metal bar and a plurality of engaging means fixed to vertically spaced portions of each bar and each having at a portion thereof facing the outer surface of said wall a contour matching that of the fin tube portions forming the outer wall surface and said portions of said engaging means being welded to the fin tube portions opposite thereto so that the weight of the tubes and any weight carried thereby is suspended by said tie means on said support means, whereby bending stresses in said tubes are reduced; heat insulating means surrounding the outer surface of said wall and said tie means; annular reinforcing means at the exterior of said heat insulating means and surrounding the latter and said cylindrical wall; and a plurality of connecting means extending through said heat insulating means and respectively connecting each bar of said tie means to said annular reinforcing means with play in direction transverse to the respective bar.

4. In a steam boiler having an upright substantially cylindrical wall formed by a plurality of fin tubes extending in substantially helical form substantially parallel to each other from the lower to the upper end of said cylindrical wall with the free edges of adjacent fin tubes abutting against and welded to each other, in combination, support means; a plurality of substantially vertical elongated tie means fixed at the upper ends thereof to said support means and extending spaced from each other along the outer surface of said wall substantially from the upper to the lower end thereof, each of said tie means comprising an elongated vertical metal bar and a plurality of engaging means fixed to vertically spaced portions of each bar and each having at a portion thereof facing the outer surface of said wall a contour matching that of the fin tube portions forming the outer wall surface and said portions of said engaging means being welded to the fin tube portions opposite thereto so that the weight of the tubes and any weight carried thereby is suspended by said tie means on said support means, whereby bending stresses in said tubes are reduced; heat insulating means surrounding the outer surface of said wall and said tie means; a plurality of annular reinforcing means arranged spaced from each other in vertical direction substantially in horizontal planes and each formed by I-beams having a web portion in the respective plane and a pair of flange portions; and a plurality of plates for each of said bars of said tie means and each fixedly connected along one edge thereof to the respective bar and having at the other edge thereof a pair of claw portions respectively engaging opposite edge portions of one of said flanges with play in transverse direction so that the plates may slide through the distance of said play relative to the respective I-beam in transverse direction of the latter.

5. In a steam boiler having an upright substantially cylindrical wall formed by a plurality of tubes extending in parallel in contact with each other in substantially helical form from the lower to the upper end of said cylindrical wall and being welded to each other, in combination, upright support means located outwardly spaced from said upright substantially cylindrical wall; a plurality of substantially vertical elongated tie means fixed at the upper ends thereof to said support means, said tie means being spaced from said support means by an annular space and being fixedly connected to the tubes forming said wall; a vertical heat insulation wall substantially located in said annular space between said support means and tie means; and connecting means passing through said vertical heat insulation wall and connecting said tie means at portions spaced from said upper ends thereof to said upright supporting means with play in horizontal direction.

6. In a steam boiler having an upright substantially cylindrical wall formed by a plurality of tubes extending in parallel in contact with each other in substantially helical form from the lower to the upper end of said cylindrical wall and being welded to each other, in combination, upright support means located outwardly spaced from said upright substantially cylindrical wall; a plurality of substantially vertical elongated tie means fixed at the upper ends thereof to said support means, said tie means being spaced from said support means by an annular space and depending in close proximity of said wall, substantially from the upper to the lower end thereof and being welded to the tubes forming said wall; a vertical heat insulation wall substantially located in said annular space between said support means and tie means; and connecting means passing through said vertical heat insulation wall and connecting said tie means at portions spaced from said upper ends thereof to said upright supporting means with play in horizontal direction.

7. In a steam boiler having an upright substantially cylindrical wall formed by a plurality of tubes extending in parallel in contact with each other in substantially helical form from the lower to the upper end of said cylindrical wall and being welded to each other, in combination, upright support means located outwardly spaced from said upright substantially cylindrical wall; a plurality of substantially vertical elongated tie means fixed

at the upper ends thereof to said support means said tie means being spaced from said support means by an annular space and depending spaced from each other along the outer surface of said wall, substantially from the upper to the lower end thereof and being fixedly connected to the tubes forming said wall; a vertical heat insulation wall substantially located in said annular space between said support means and tie means; and connecting means passing through said vertical heat insulation wall and connecting said tie means at portions spaced from said upper ends thereof to said upright supporting means with play in horizontal direction.

8. In a steam boiler having an upright substantially cylindrical wall formed by a plurality of tubes extending in parallel in contact with each other in substantially helical form from the lower to the upper end of said cylindrical wall and being welded to each other, in combination, upright support means located outwardly spaced from said upright substantially cylindrical wall; a plurality of substantially vertical elongated tie means having in the region of the upper ends thereof portions projecting transversely therefrom, said tie means depending from said support means and being fixedly connected to the tubes which form a boiler wall containing hot gases; screw means adjustably connecting said portions of said tie means to said support means so as to permit uniform distribution of the weight of said wall and said tie means to said support means; and connecting means passing through said vertical heat insulation wall and connecting said tie means at portions spaced from said upper ends thereof to said upright supporting means with play in horizontal direction.

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