

Aug. 12, 1941.

C. H. GAY

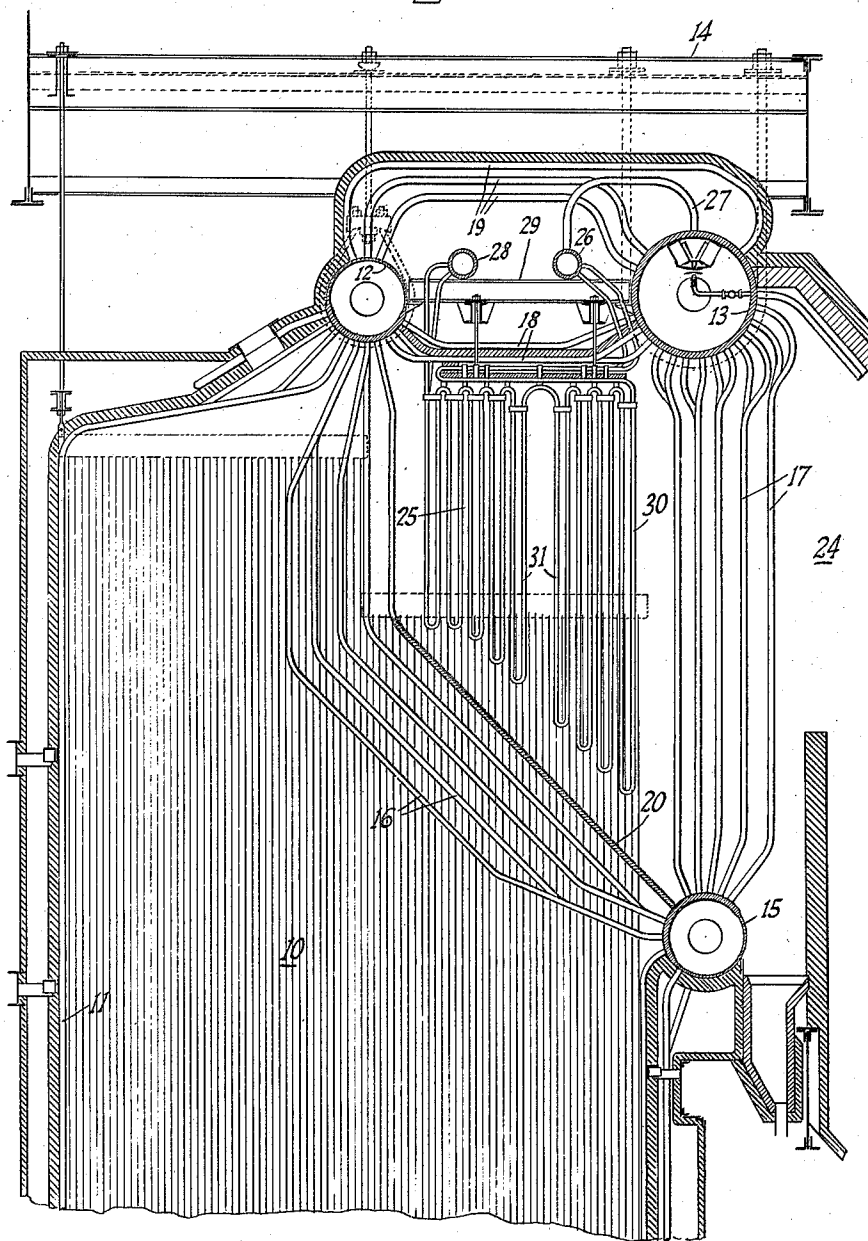
2,252,071

STEAM GENERATOR

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4 Sheets-Sheet 1

Fig. 1



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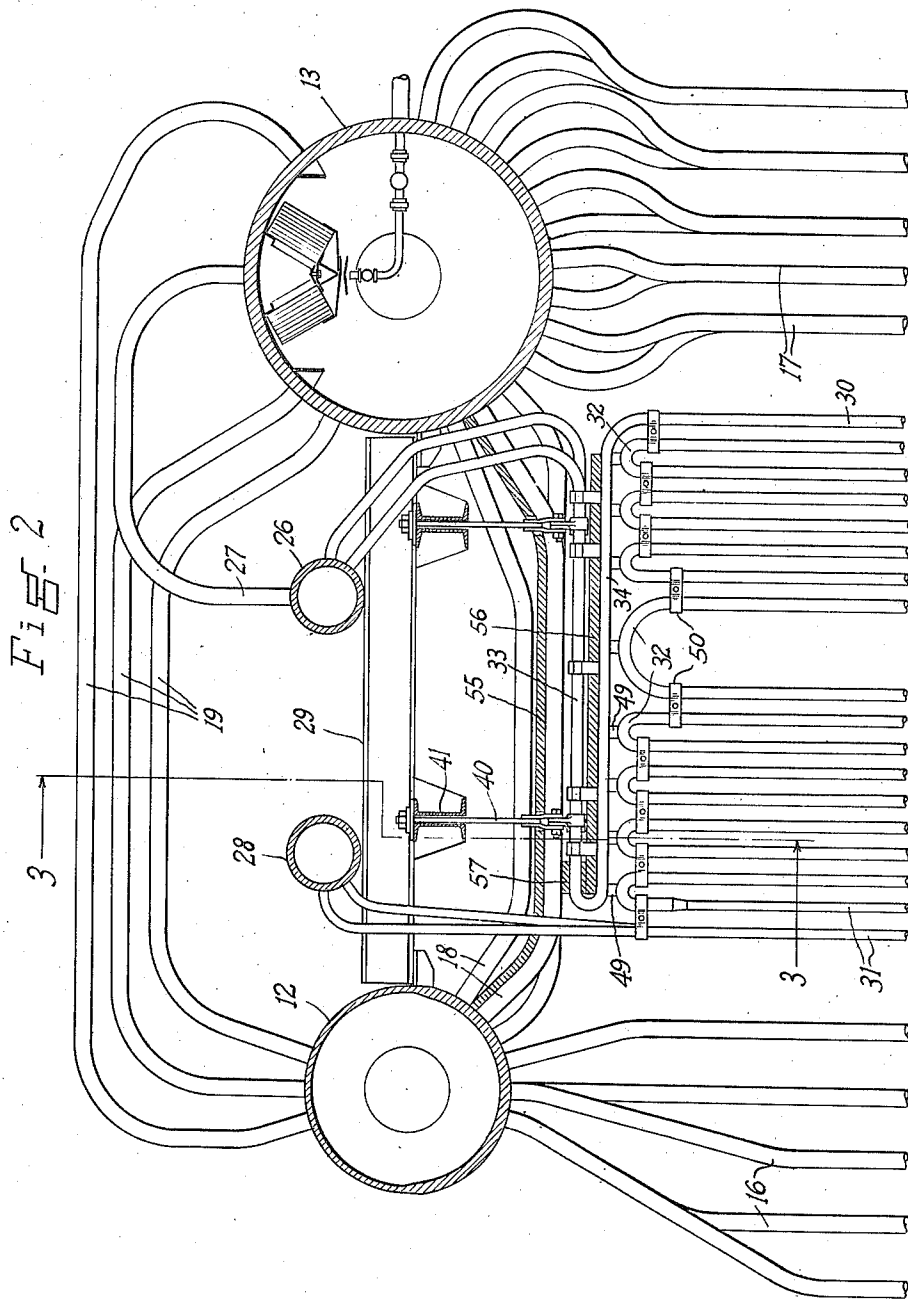
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STEAM GENERATOR

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4 Sheets-Sheet 2



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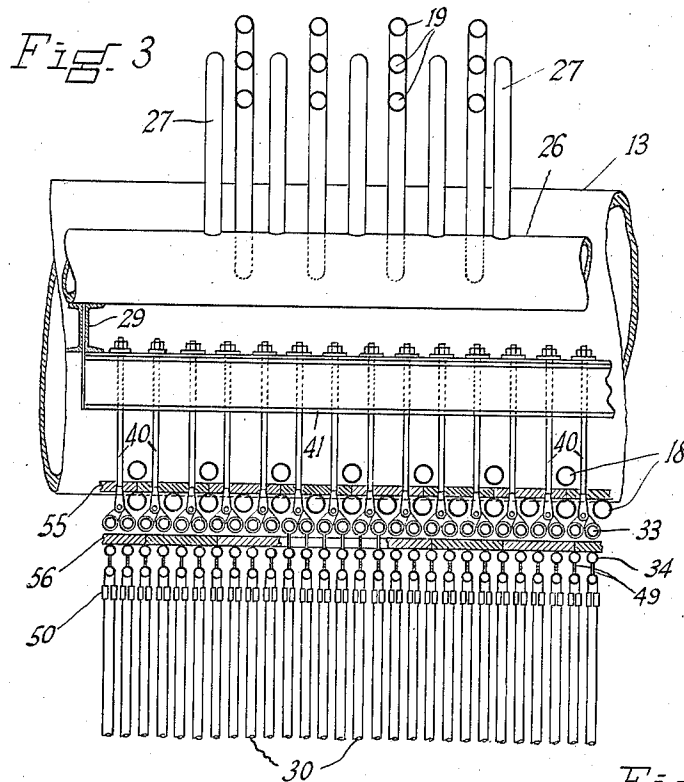
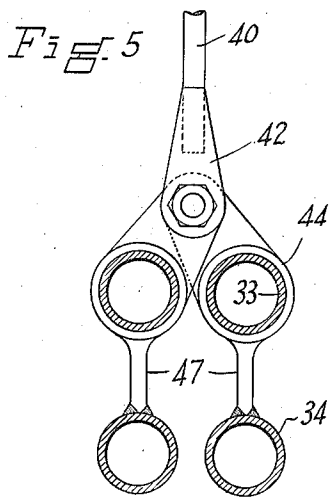
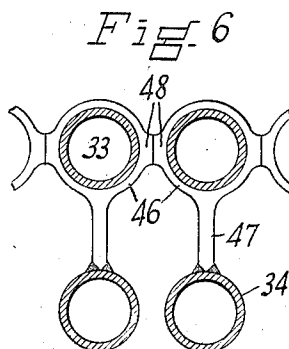
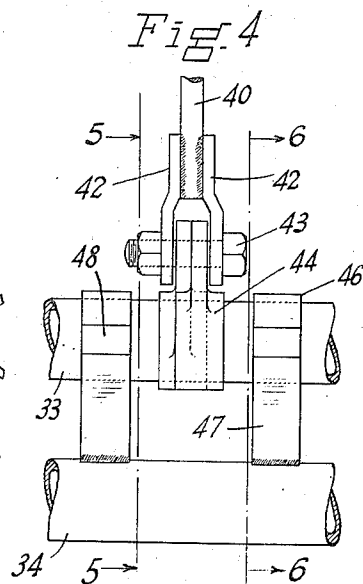
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STEAM GENERATOR

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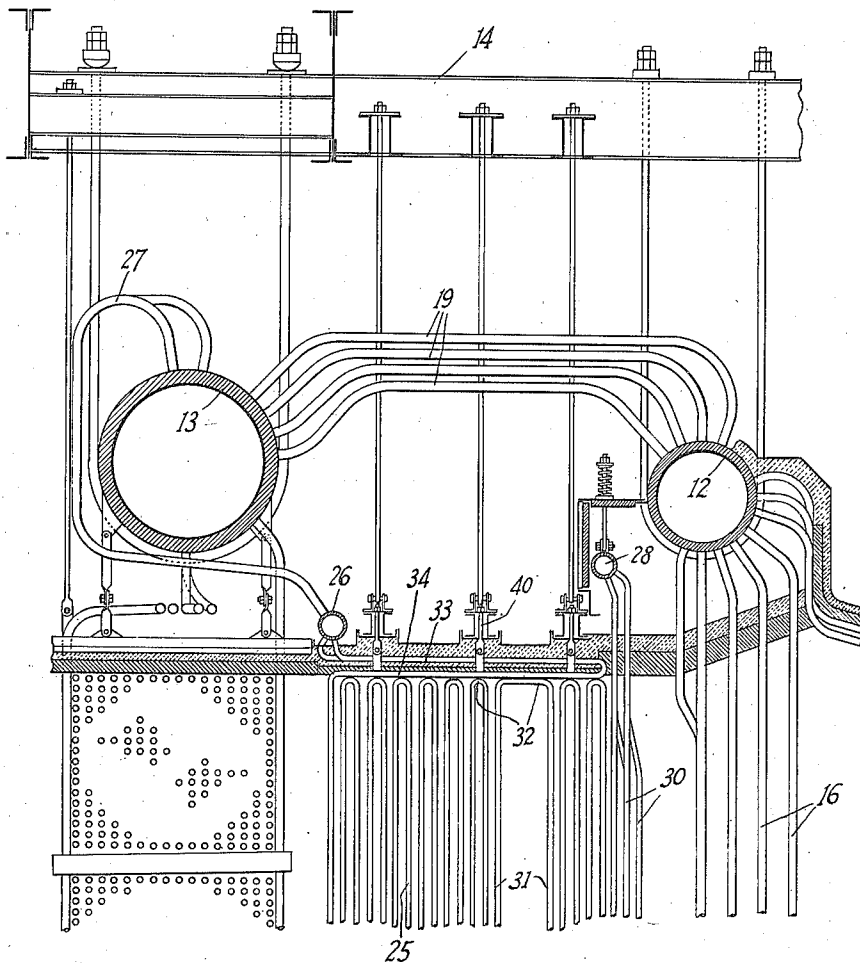
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STEAM GENERATOR

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Fig. 7



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UNITED STATES PATENT OFFICE

2,252,071

STEAM GENERATOR

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13 Claims. (Cl. 122—478)

The present invention relates in general to vapor generating units incorporating vapor superheating surface, and more particularly to the construction and arrangement of a steam superheater and its supporting provisions in a water tube steam boiler.

In modern high capacity steam generating units designed to deliver superheated steam at pressures above 850 lbs. per sq. in. and temperatures above 900° F., the convection steam superheating surface is usually separated from the furnace by a single bank of relatively widely spaced tubes which serves as a slag screen and also to reduce the heating gas temperature to a value at which the desired superheat can be effected without exposing the superheater tubes to unsafe gas temperatures. The heating gases entering the first generating tube bank will be normally above 2000° F. and while the gas temperature is lowered by the heat absorption of this tube bank, the gases on contacting with the superheater tubes will be at a temperature approaching the maximum temperature which the superheater tubes are designed to withstand. The high steam generating capacity and high superheat temperature for which such units are designed require a large amount of convection heated steam superheating surface in a high temperature heating zone. The problem of supporting such superheating surface has been found to present substantial difficulties. This problem is especially difficult where the superheating surface is formed by vertically looped tubes pendantly supported. In such superheaters the tubes tend to expand and contract under varying temperature conditions and it is important that the designed tube spacing be maintained under such conditions to secure the designed superheating effect.

The main object of my invention is the provision of an improved construction and arrangement of a vapor superheater in a vapor generating unit of the character described. A further and more specific object is the provision of an improved construction and arrangement of the supporting means for a pendant type steam superheater in a steam boiler of the Stirling type.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying draw-

ings and descriptive matter in which I have illustrated and described preferred embodiments of my invention.

Of the drawings:

Fig. 1 is a sectional elevation of the upper portion of a steam generating unit embodying the invention;

Fig. 2 is an enlarged view of a portion of Fig. 1;

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 2;

Fig. 4 is an enlarged view of a portion of Fig. 2;

Figs. 5 and 6 are sectional views taken on the lines 5—5 and 6—6 of Fig. 4 respectively; and

Fig. 7 is a view similar to Fig. 2 illustrating a modification.

In Figs. 1 to 6 of the drawings the invention is illustrated as incorporated in a steam generating unit having a steam boiler of the Stirling type. The steam generating unit comprises a furnace 10 of substantially rectangular horizontal cross-section and substantial height and adapted to be fired by coal, oil or gas in any suitable manner. The walls of the furnace are lined with vertical water tubes 11 connected into the boiler circulation system in a well known manner. The steam boiler comprises front and rear upper steam and water drums 12 and 13 respectively, spaced apart in the upper part of the setting and hung from the external steelwork 14, and a lower water drum 15 connected to the upper drums 12 and 13 by front and rear banks of water tubes 16 and 17 respectively. The drums 12 and 13 are interconnected below their normal water lines by rows of water circulator tubes 18. The drums are also connected by steam circulators 19 for conducting steam from the front drum to the rear drum. The rear drum is shown with suitable steam washing and separating devices located therein.

As indicated in Figs. 1 and 2, the front tube bank 16 contains three rows of tubes, alternate tubes in the two front rows being bent out of alignment with the remaining tubes to form a slag screen. The lower inclined portions of the third tube row have studs projecting into their intertube spaces and covered with refractory to form a baffle 20 extending upwardly from the lower drum 15. A steam superheater 25 of the pendant type occupies substantially all of the space between the banks of tubes 16 and 17. With the described arrangement high temperature heating gases are generated in the furnace 10, passing upwardly therethrough into contact with the front tube bank 16, thence around the

upper end of the baffle 20, and rearwardly across the superheater and rear tube bank 17 to a heating gas outlet 24. The gas outlet 24 may be connected to a suitable economizer and/or an air heater, and thence to a stack connection.

The steam superheater 25 comprises a horizontally arranged inlet header 26 connected along its length to the top of the drum 13 by a series of tubes 27. A superheater outlet header 28 is arranged adjacent the inlet header 26 and both of the headers supported upon transversely spaced beams 29 extending between and supported by the drums 12 and 13. The headers 26 and 28 are connected by a series of substantially parallel steam superheating tubes 30, each formed in a flat multiple-looped coil, with the coils in lateral spaced alignment and providing parallel steam flow paths between the inlet and outlet headers. Each of the tubes 30 includes a series of vertical tube legs 31 interconnected in series at their upper and lower ends by looped portions 32. The tube legs 31 are proportioned in length in accordance with the available space above the baffle 20, so that the rearmost tube legs are of the greatest length. Each of the tube coils is divided into spaced front and rear sections to facilitate the inspection and cleaning of the superheater tubes. The upper looped portions 32 are positioned adjacent the water circulator tubes 18. In the space therebetween is arranged upper and lower horizontally extending serially connected tube legs 33 and 34 respectively. Each tube leg 33 is extended upwardly and connected to the inlet header 26, while the corresponding tube leg 34 is connected to the corresponding rearmost vertical tube leg 31. The foremost tube leg 31 is extended upwardly and connected to the outlet header 28. With this arrangement steam from the drum 13 passes through the tubes 27 to the header 26, thence serially through the horizontal tube legs 33 and 34, and thence serially through the vertical tube legs 31 to the header 28, so that the flow of steam through the superheater will be generally counter to the flow of heating gases across the superheater tubes, whereby maximum superheat temperatures are obtained.

The superheater tube coils are supported from the beams 29 by hanger rods 40 detachably connected to cross-beams 41 supported from the beams 29. As shown in Figs. 3 to 5, each rod 40 has a pair of eye plates 42 welded to its lower end and through which a bolt 43 extends to provide a pivot axis for a pair of toggle collars 44 loosely mounted on a pair of adjacent tube legs 33. As shown, only two hanger supports are required for each pair of adjacent superheater tube coils. Each pair of tube legs 33 and 34 is interconnected to form a supporting beam for the remaining portion of the superheater tube coil by collar members 46 loosely mounted on the tube leg 33, and each having a projecting lower plate portion 47 welded to the tube leg 34. Each of the collar members 46 is provided with lateral bosses 48 having flattened ends engaging corresponding bosses on adjacent tube legs 33 to maintain the side-by-side tube coils in spaced relation. The supporting beam defined by the tube legs 33 and 34 and connecting members 46 carries the remaining portion of the superheater tube coil through plates 49 welded to the lower portion of the tube leg 34 and the top of each of the adjacent upper looped portions 32 of the vertical tube legs 31. The tube legs 31 of each coil are held in spaced relation by split clamps 50 connecting adjacent tube legs. The tube legs 33 are

movable axially relative to the collars 44 and 45, so that relative movement of the tube legs 33 and 34 is possible in operation under differential temperature conditions.

The superheater headers and hanger connections are protected from the heating gas flow across the superheater by refractory mounted on the water circulators 18 and forming a roof section 55 extending between the drums 12 and 13. Protection is also afforded the collar members 44 and 45 by a row of tile 56 mounted on the tube legs 34 and closing the spaces therebetween to form a roof section subjacent the roof section 55, the space between the front end of the tile 56 and the roof section 55 being closed by special tile members 57 carried by the tube legs 33. With this construction the superheater supporting provisions will contribute substantially to the support and maintenance of the roof section between the upper drums.

The described construction provides a simple and highly effective support for the superheater, with only a relatively few external supporting attachments. The number of external supports required depends partly upon the number of tube legs arranged horizontally and utilized in the supporting beam for the remaining portion of the superheating coil. The expensive hung arch construction usually required for the roof section between the upper drums can thus be eliminated. The individual symmetrical suspension support of each of the looped portions 32 substantially eliminates distortion of the superheater coils during operation. The construction also provides a convenient arrangement for positioning the superheater headers at any desired location between the upper drums without requiring the use of excessively long external superheater tube extensions or the support of the tube coils from the superheater headers.

The modified construction illustrated in Fig. 7 differs from that shown in Figs. 1 to 6 by a change in location of the inlet and outlet headers 26 and 28, the omission of the beams 29 and water circulators 18 between the drums, and the support of the superheater tube coils and associated roof section directly from the external steelwork 14. This construction not only provides an effective support for the superheater coils but also is effective in maintaining a cool and permanent roof in a very hot zone.

While in accordance with the provisions of the statutes I have illustrated and described herein the best forms of my invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

I claim:

1. In a steam boiler, a steam superheater comprising a steam superheating tube having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions and upper and lower horizontally arranged serially connected tube legs extending across the upper ends of said vertical tube legs, means for supporting said upper tube leg from an external support at longitudinally spaced points, means connecting said upper and lower tube legs to form a horizontal beam structure, and means for connecting the upper looped portions of said vertical tube legs to said lower tube leg.

2. In a steam boiler, a steam superheater comprising a plurality of steam superheating tubes arranged side-by-side and forming parallel steam flow paths, each of said tubes having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions and upper and lower horizontally arranged serially connected tube legs extending across the upper ends of said vertical tube legs, means for supporting said upper tube leg from an external support at longitudinally spaced points, means connecting said upper and lower tube legs to form a horizontal beam structure, and means for separately connecting each of said upper looped portions of said vertical tube legs to said lower tube leg.

3. In a steam boiler, a steam superheater comprising inlet and outlet headers, a plurality of steam superheating tubes arranged side-by-side and forming parallel steam flow paths between said headers, each of said tubes having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions and upper and lower horizontally arranged serially connected tube legs extending across the upper ends of said vertical tube legs, means for supporting said upper tube leg from an external support at longitudinally spaced points, means connecting said upper and lower tube legs to form a horizontal beam structure permitting relative longitudinal movement of said tube legs, and means for permanently connecting the upper looped portions of said vertical tube legs to said lower tube leg.

4. In a steam boiler, a steam superheater comprising inlet and outlet headers, a plurality of steam superheating tubes arranged side-by-side and forming parallel steam flow paths between said headers, each of said tubes having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions and upper and lower horizontally arranged serially connected tube legs extending across the upper ends of said vertical tube legs, means for supporting said upper tube leg from an external support at longitudinally spaced points, means connecting said upper and lower tube legs to form a horizontal beam structure permitting relative longitudinal movement of said tube legs, said last mentioned means having provisions for spacing adjacent tubes, means for permanently connecting the upper looped portions of said vertical tube legs to said lower tube leg, and means for holding said vertical tube legs in spaced relation.

5. In a steam boiler, front and rear horizontally arranged steam and water drums, a vertically extending tube bank having its upper ends connected to said front drum, a roof section extending between said drums, a steam superheater comprising inlet and outlet headers, a plurality of multiple-looped steam superheating tubes vertically arranged side-by-side at the rear of said tube bank and forming parallel steam flow paths between said headers, supporting steelwork above said roof, and common means for supporting said roof section and pendently supporting said superheater from said steelwork.

6. In a steam boiler, front and rear horizontally arranged steam and water drums, a tube bank having its upper ends connected to said front drum, a steam superheater comprising inlet and outlet headers, a plurality of steam superheating tubes arranged side-by-side at the rear

of said tube bank and forming parallel steam flow paths between said headers, each of said tubes having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions and upper and lower horizontally arranged serially connected tube legs extending across the upper ends of said vertical tube legs, supporting steelwork above said superheater, means for supporting said upper tube leg from said supporting steelwork at longitudinally spaced points, means connecting said upper and lower tube legs to form a horizontal beam structure, and means for connecting the upper looped portions of said vertical tube legs to said lower tube leg.

7. In a steam boiler, a pair of horizontally arranged steam and water drums, a plurality of tube banks having their upper ends connected to said drums, a roof extending between said drums, a steam superheater comprising inlet and outlet headers, a plurality of steam superheating tubes arranged side-by-side between said tube banks and forming parallel steam flow paths between said headers, each of said tubes having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions and upper and lower horizontally arranged serially connected tube legs extending across the upper ends of said vertical tube legs, a supporting beam extending between and carried by said drums above said roof, means for supporting said upper tube leg from said supporting beam at longitudinally spaced points, means connecting said upper and lower tube legs to form a horizontal beam structure supporting said roof and permitting relative longitudinal movement of said tube legs, and means for separately connecting each of said upper looped portions to said lower tube leg.

8. In a steam boiler, a pair of horizontally arranged steam and water drums, a plurality of spaced tube banks having their upper ends connected to said drums, a steam superheater comprising a plurality of steam superheating tubes arranged side-by-side in the space between said tube banks, each of said tubes having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions and a horizontally arranged serially connected tube leg extending across the upper ends of said vertical tube legs, means for supporting each of said superheater tubes independently of its ends comprising an external support above said superheater, means for supporting said horizontal tube leg at points spaced longitudinally thereof from said external support, and means for connecting upper looped portions of said vertical tube legs to said horizontal tube leg.

9. In a steam boiler, a pair of horizontally arranged steam and water drums, a plurality of spaced tube banks having their upper ends connected to said drums, a roof extending between said drums, a steam superheater comprising inlet and outlet headers above said roof, a plurality of steam superheating tubes arranged side-by-side in the space between said tube banks and forming parallel steam flow paths between said headers, each of said tubes having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions and a horizontally arranged serially connected tube leg extending across the upper ends of said vertical tube legs, a supporting beam carried by said drums above said roof and supporting said headers, means for supporting each of said super-

heater tubes independently of its connections to said headers comprising hanger means for supporting said horizontal tube leg at points spaced longitudinally thereof from said supporting beam, and means for connecting upper looped portions of said vertical tube legs to said horizontal tube leg.

10. In a fluid heater, a pair of horizontally extending parallel fluid heating tubes, and means for supporting said tubes in transversely spaced relation comprising a support above said tubes, a hanger rod carried by said support, a pair of collar members loosely mounted on said tubes and having a common pivot connection to the lower end of said hanger rod, and additional collar members similarly mounted on said tubes and having contacting bosses arranged to maintain said tubes in transversely spaced relation.

11. In a fluid heater, a pair of parallel U-shaped fluid heating tubes having upper and lower horizontally extending leg portions, means for supporting said tubes, a collar member loosely mounted on each of said upper leg portions and having a boss thereon arranged in abutting contact with a boss on the collar member of the other tube to maintain said tubes in transversely spaced relation, each of said collar members having a projecting plate portion welded to the corresponding lower leg portion.

12. In a steam boiler, a steam superheater comprising inlet and outlet headers, a plurality of steam superheating tubes arranged side-by-side and having their opposite ends connected to said headers, each of said tubes having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions

and a horizontally arranged tube leg extending across the upper ends of and serially connected to said vertical tube legs, a supporting structure above said superheater, means for supporting each of said superheater tubes independently of its connections to said headers comprising hanger means carried by said supporting structure and connected to said horizontally arranged tube leg at longitudinally spaced points, and means for supporting the upper looped portions of said vertical tube legs from said horizontally arranged tube leg.

13. In a steam boiler, a steam superheater comprising inlet and outlet headers, a pair of steam superheating tubes arranged side-by-side and having their opposite ends connected to said headers, each of said tubes having a series of vertically arranged tube legs serially connected at their upper and lower ends by looped portions and a horizontally arranged tube leg extending across the upper ends of and serially connected to said vertical tube legs, an external support above said superheater, means for supporting said superheater tubes independently of their connections to said headers comprising hanger rods carried by said external support, means forming a pivot connection between each of said horizontally arranged tube legs and the lower end of said hanger rods at longitudinally spaced points and permitting movement of said tubes about an axis parallel to the axes of said horizontally arranged tube legs, and means for connecting the upper looped portions of said vertical tube legs to the corresponding horizontally arranged tube leg.

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