

Aug. 25, 1936.

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2,052,299

STEAM BOILER

Original Filed April 30, 1924

5 Sheets-Sheet 1

Fig. 1.

Fig. 1 a.

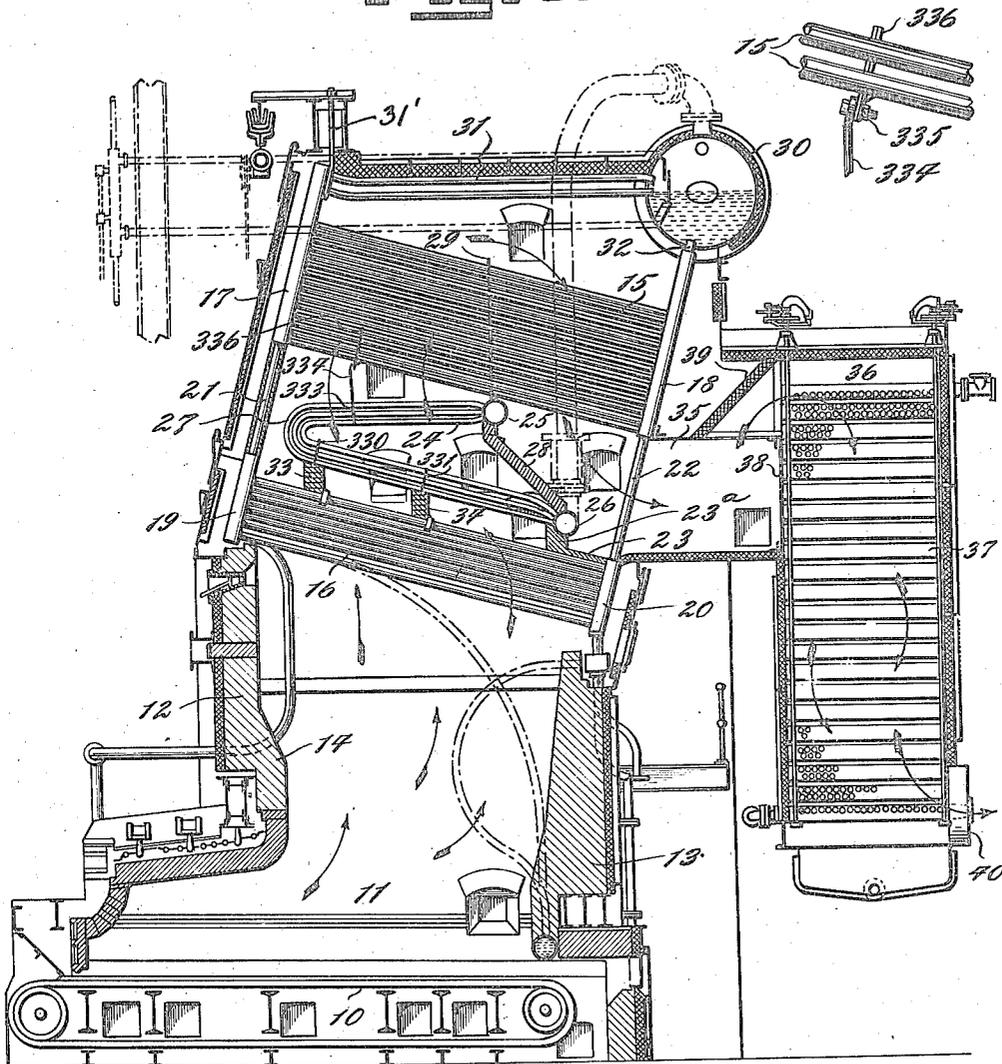


Fig. 1 b.

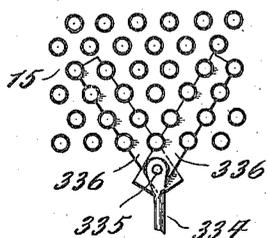
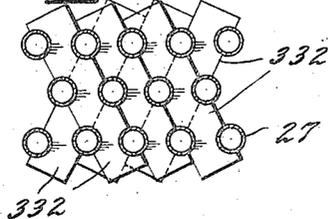


Fig. 1 c.



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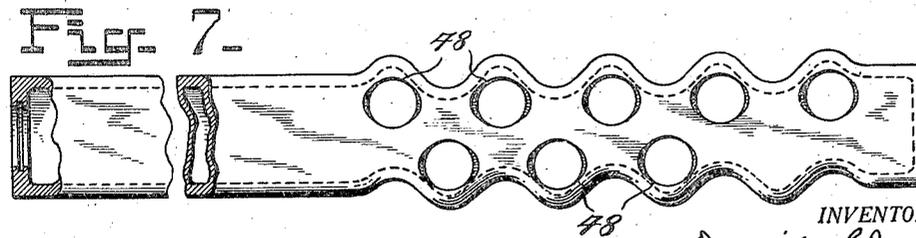
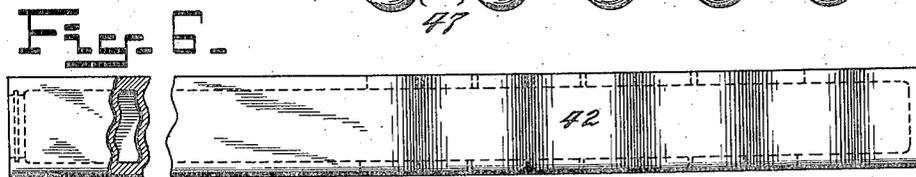
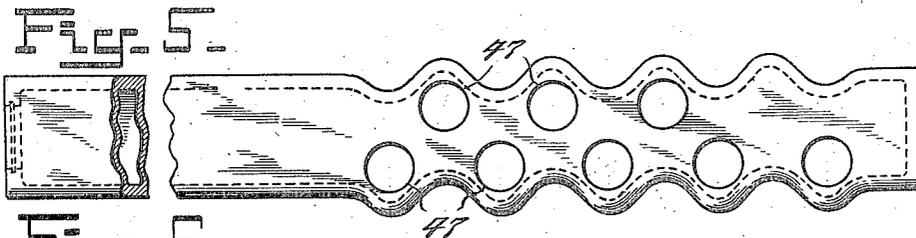
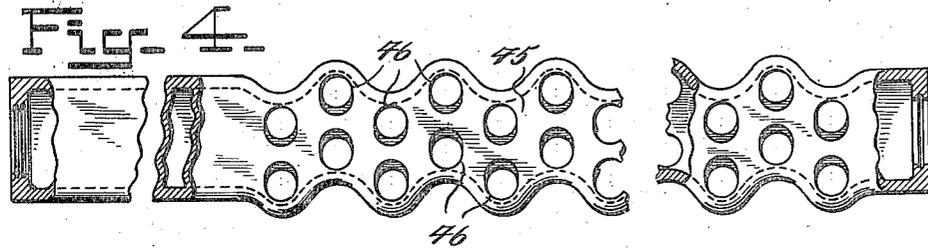
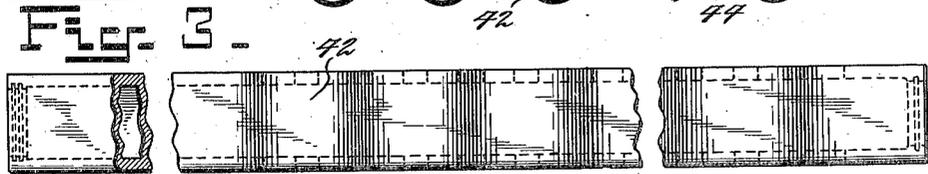
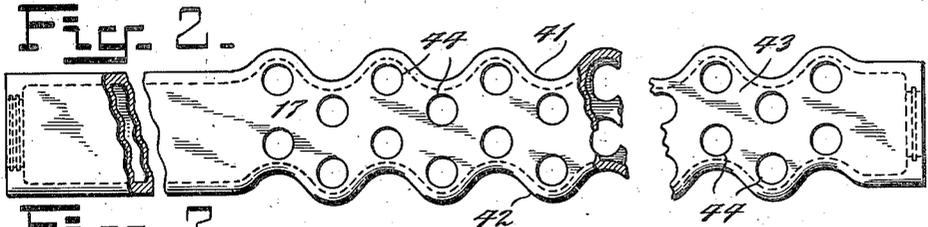
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STEAM BOILER

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Fig. 8.

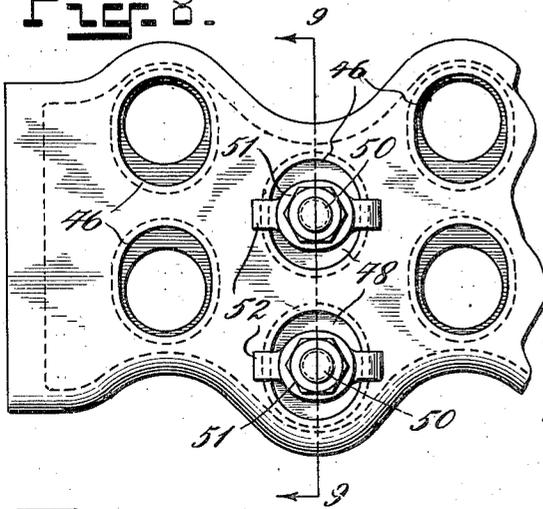


Fig. 9.

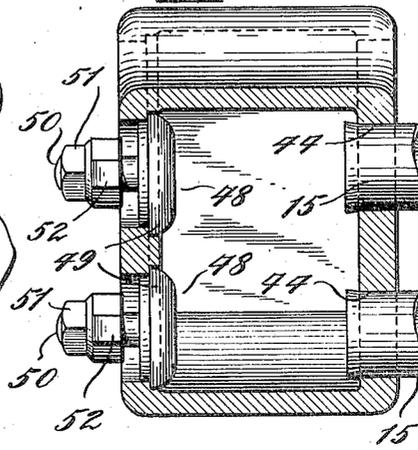


Fig. 10.

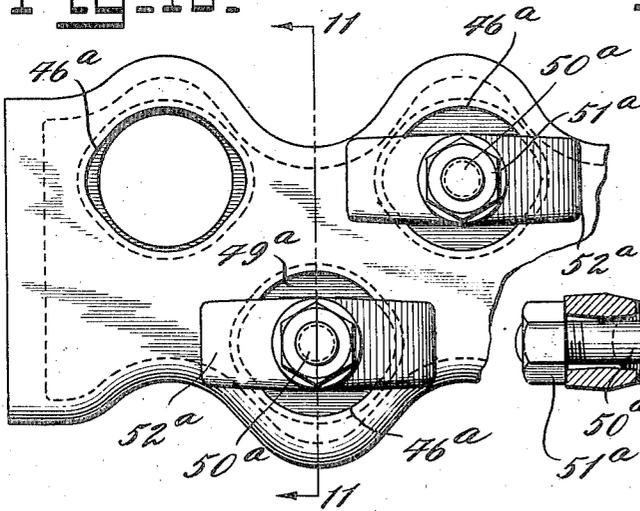


Fig. 11.

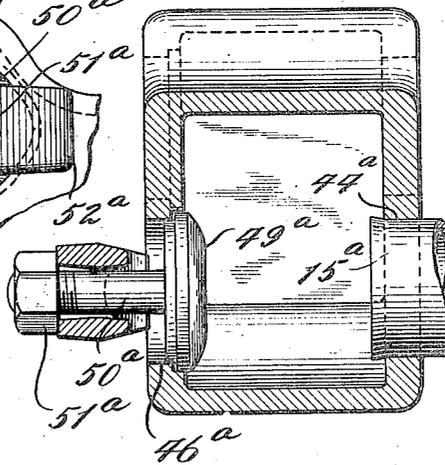
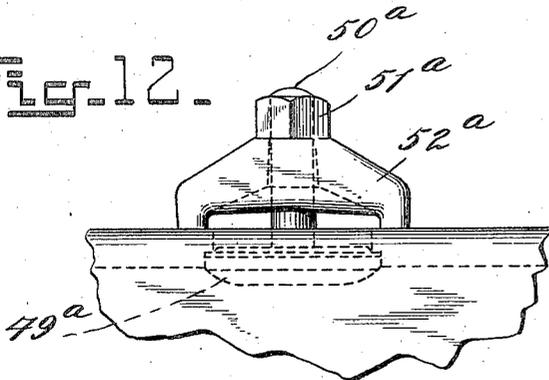


Fig. 12.



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Fig. 13.

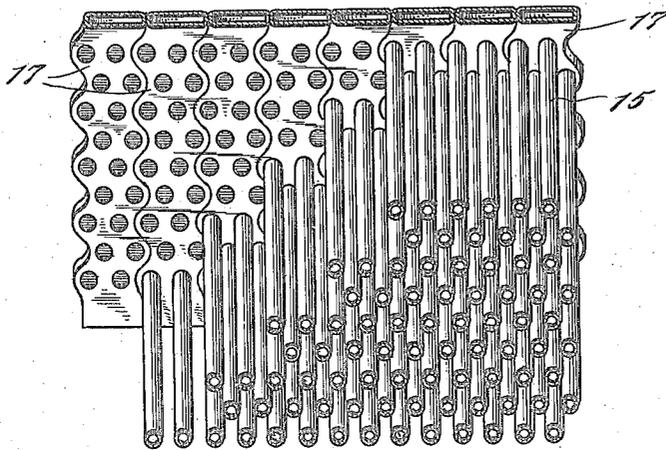
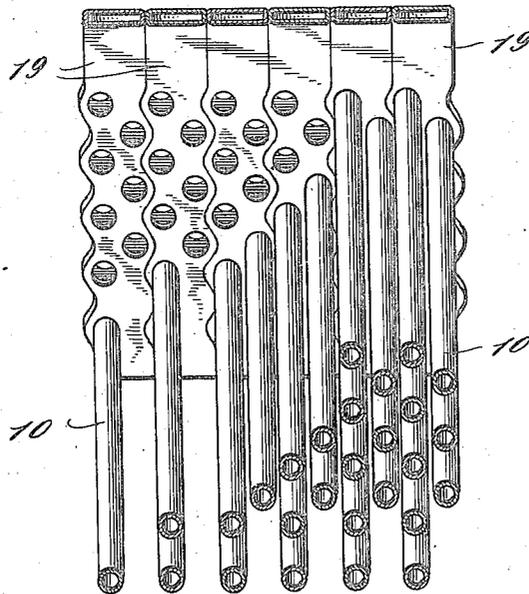


Fig. 14.



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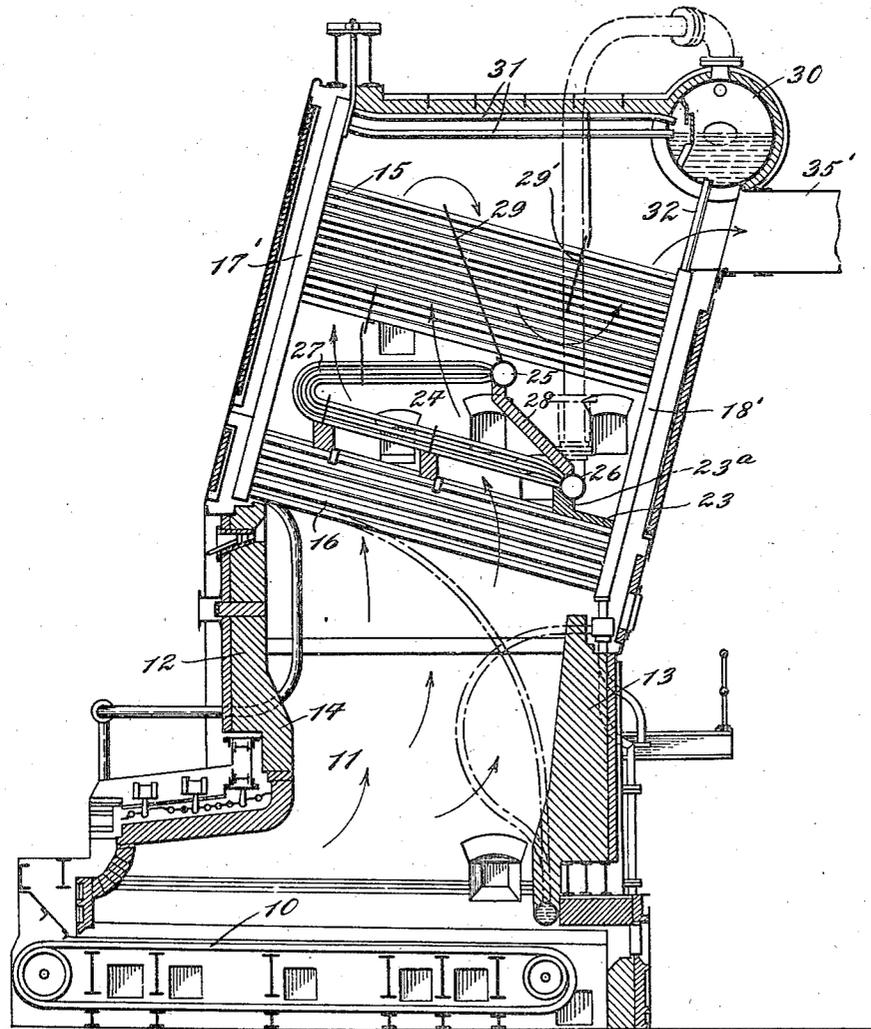
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Fig. 15.



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UNITED STATES PATENT OFFICE

2,052,299

STEAM BOILER

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Application April 30, 1924, Serial No. 709,955
Renewed July 11, 1933

16 Claims. (Cl. 122-303)

My invention more particularly relates to a steam boiler of the water tube type, and having the tubes and associated parts arranged in a compact and efficient manner. This invention is especially adapted for high pressure steam boilers of this type.

My invention will best be understood by reference to the accompanying drawings, in which Fig. 1 is a sectional side elevation illustrating a steam boiler embodying my invention; Figs. 1^a, 1^b, and 1^c are detail views illustrating certain of the parts of Fig. 1; Fig. 2 is a front view of a header for the upper bank of tubes; Fig. 3 is a side view of the header shown in Fig. 2; Fig. 4 is a rear view thereof; Fig. 5 is a front view of one of the headers for the lower bank of tubes; Figs. 6 and 7 are side and rear views, respectively, of the header shown in Fig. 5; Fig. 8 is a fragmentary rear view of a portion of one of the headers illustrated in Fig. 4 and showing hand-hole covers in position in two of the openings; Fig. 9 is a sectional view taken along the plane of the line 9-9 of Fig. 8; Fig. 10 is a fragmentary view similar to Fig. 8 and illustrating a portion of one of the headers for the lower bank of tubes; Fig. 11 is a sectional view taken along the plane of the line 11-11 of Fig. 10; Fig. 12 is a fragmentary side view of one of the headers with the handhole cover in position; Fig. 13 is a fragmentary view illustrating a portion of a plurality of nested headers for the upper bank of tubes, with the tubes connected to a portion thereof; Fig. 14 is a view similar to Fig. 13, illustrating headers and tubes of the lower bank; and Fig. 15 is a view corresponding generally to Fig. 1, but showing a different form of boiler with which the invention may be practiced.

Like reference characters indicate like parts in the different views.

Referring now to the drawings and first to the general arrangement of the parts illustrated in Fig. 1, a chain grate stoker 10 is located in the lower portion of the furnace chamber 11 which is enclosed at the front and rear by the front and rear walls 12 and 13, respectively, the inner face of the front wall preferably being inclined upwardly and outwardly at one portion as at 14, and the rear wall preferably being inclined upwardly and outwardly throughout the major portion thereof, as illustrated, to form a furnace chamber of an upwardly increasing flow area. Above the furnace chamber is located a water tube boiler comprising upper and lower spaced banks 15 and 16, respectively, of horizontally inclined water tubes, the ends of the tubes of the

upper bank being connected to uptake and down-take headers 17 and 18, respectively, while the lower bank of tubes 16 are connected to headers 19 and 20, respectively, the headers 17 and 19 preferably being connected by nipples 21, while the headers 18 and 20 are connected by nipples 22. The headers 17, 19 and 18, 20 form upper and lower header sections of uptake and down-take headers, respectively, and while I have illustrated the same as physically distinct and connected by nipples, it will, of course, be understood that the same may be integral. Such an arrangement is illustrated in Fig. 15, which will be more fully described later. The tubes of the lower bank 16 are preferably exposed for substantially their entire length to the radiant heat of the furnace, a baffle 23 preferably being placed on the lower bank of tubes and extending forwardly from the upper ends of the headers 20, in order to direct the gases forwardly.

In the space between the upper and lower banks of tubes 15 and 16 is located a superheater, which I have indicated generally at 24, and comprising headers 25 and 26, extending at right angles to the water tubes of the boiler, the headers being connected by tubes 27 that are bent to a V-form, and with the straight portions of the tubes forming one part of the V, and which enter the uppermost superheater box 25, substantially horizontal, the tube portions forming the other side of the V and which enter the lowermost box 26 being substantially parallel to the lower bank of tubes. The lower superheater box 26 is preferably sealed, or substantially sealed, against an upward extension 23^a of the baffle 23, a suitable baffle 28 being placed between the superheater boxes 25 and 26. A baffle 29 extends from the upper box 25 across the upper bank of tubes 15, and preferably in a vertical direction, so as to create an upward pass across the upper tubes of a progressively diminishing flow area. The uptake headers 17 are preferably connected to the steam and water drum 30 by circulating tubes 31, which are connected to the upper ends of the headers 17, while the headers 18 may conveniently be connected to the steam and water drum by nipples 32. Hangers 31', one of which is shown in Fig. 1 and which are connected to a fixed support of the framework, engage the circulating tubes 31 adjacent the uptake headers 17 and thus form a suspension means for the circulating tubes, headers, and tube banks of the boiler. Preferably, a plurality of walls or baffles 33 and 34 extend upwardly from the top of the lower bank of tubes

16 to the portions of the superheater tubes 27, which are parallel thereto, and serve to direct the gases which pass upwardly across the lower bank of tubes among the tubes of the superheater. The superheater is preferably spaced from one end of the boiler as illustrated, and affords a free space between the upper and lower banks of tubes through which the gases are directed after passing over the tubes of the second bank in their flow to the outlet flue. The space between the two banks of tubes, therefore, is entirely utilized, the portion at the left, as viewed in Fig. 1, being occupied by the superheater, while the portion at the right is utilized as a flue for the flow of gases after passing over the tubes of the upper bank.

Preferably, spacing members indicated generally at 330 and 331 extend upwardly from the walls or baffles 33 and 34 across the lower branches of the superheater tubes, each such spacing member preferably comprising two walls or layers, each composed of strips 332 extending diagonally between the tubes and installed by inserting them in the lanes between the tubes, and then turning them into place, the strips comprising the two walls or layers being located in lanes extending at an angle to each other, so that the strips are arranged at angles to each other. The superheater tubes are preferably staggered, as indicated. The upper branches of the superheater tubes are preferably spaced by strips 333, which may be similar to the strips 330 and 331. These strips are preferably supported from the upper bank of boiler tubes by supporting members or tie pieces 334, preferably treated on their outer surfaces, as by calorizing, to render them heat resisting. These pieces 334 are attached at their upper ends, as at 335, to pieces 336 (see Fig. 1^b) extending between the tubes of the upper bank 15, the strips extending upwardly to a point sufficient to afford the necessary support for the upper branches of the superheater tubes.

The gases from the furnace chamber pass upwardly in a single pass across the tubes of the lower bank 16, and then over the tubes of the superheater 24, and then pass upwardly through the first pass across the tubes of the upper bank 15 and over the baffle 29, and then downwardly in a second pass across the tubes of the upper bank. After leaving the second pass, the gases preferably pass between the nipples 22 joining the upper and lower header sections 18 and 20 to a flue 35, from which, after passing upwardly over a baffle 38, they pass downwardly through a flue 36, and over an economizer 37 located therein, the economizer illustrated being the high pressure stage of a two-stage economizer, the low pressure stage of which is not illustrated. Preferably, the flue 36 and the economizer 37 extend to a point above the flue 35, and in order to direct the gases from the flue 35 to the upper end of the economizer, a baffle 38 extends upwardly from the lower portion and the outer end of the flue 35, the flue 35 preferably comprising an inclined wall section 39, which, with the baffle 38, serves to direct the gases to the upper end of the economizer in a manner generally indicated by the direction of the arrow. The gases then flow downwardly over the tubes of the economizer 37 to an outlet flue 40.

I have illustrated in Figs. 2 to 8 the preferable arrangement of the headers and the parts associated therewith for the upper and lower banks of tubes. Referring to Figs. 2, 3 and 4, the illustrative header 17 has two opposite walls 41 and

42 which are sinuous in form, while one of the other walls 43 of the header is provided with tube openings 44 arranged in rows transversely of the header as illustrated, and preferably with two openings to each row, there being one row only for each sinuosity of the header and the rows preferably being placed opposite to the bend or sinuosity. The wall 45 of the header opposite to the wall 43 is provided with handholes 46, preferably corresponding in number to the tube openings, and located opposite thereto in the usual manner. With two tube holes per row per header, as illustrated, there are twice as many boiler tubes 15 connected to each header as there are horizontal rows of tubes.

Referring now to Figs. 5, 6 and 7, the headers are of the same general form as those illustrated in Figs. 2, 3 and 4 and need not further be described. These headers, however, are provided with a single tube opening 47 opposite each sinuosity, with handholes 48 opposite thereto in the opposite wall, so that there is the same number of tubes connected to the lower section of each header as there are horizontal rows of tubes in the lower bank. Furthermore, the tube openings, and the tubes connected thereto are of larger diameter than the corresponding tube openings and tubes of the upper bank, as will be evident from an inspection of Figs. 13 and 14, and are further spaced apart than are the tube openings and tubes of the upper section, the parts being so arranged that when the headers of the lower section are nested together, as illustrated in Fig. 14, the flow area for the gases between any two tubes per unit length of the tubes is greater than for the upper bank of boiler tubes and the combined areas of the spaces between the tubes of a row are preferably more than one-half of the total sectional area of the pass.

The arrangement of the tube openings and the tubes in both Figs. 13 and 14, brings the tubes of the successive rows into staggered relation, and produce diagonal lanes in both directions between the tubes, as well as horizontal lanes, which are convenient for cleaning purposes.

In Figs. 8 and 9, I have illustrated the handholes 46 for the upper headers 17 and the handhole covers 48 in position therein in two of the openings. The handhole cover comprises the usual cover plate 49 to which is secured a bolt 50, the cover plate being secured in position by a nut 51 which engages a bridge piece 52. The construction of the parts illustrated in Figs. 10, 11 and 12 is the same, except as to size, as those illustrated in Figs. 8 and 9, and the same reference characters are applied thereto, except that the character *a* is appended thereto, and need not further be described.

In operation, the hot gases rise from the combustion chamber and flow through the first pass of the boiler and are cooled. These cooled gases, in the arrangement shown, flow downward in the second pass of the boiler, and because the economizer is located in the vertical flue with the gas inlet at the top and the gas outlet at the bottom, it will be seen that the gases continue to flow downward until they reach the outlet of the economizer, from which point they may flow over a low pressure stage of the economizer. The cooled gases have a lesser tendency to rise than the hot gases in the furnace and in the first pass of the boiler, so that obviously less effort will be required on the part of the fan, which is preferably located beyond the economizer, to draw the gases through the boiler and over the econo-

mizer, than would be the case if the gases made a greater number of turns in passing over the boiler and advantage was not taken of the difference in density in the ascending and descending columns of the gases. This fact, furthermore, is increased by the fact that as the gases pass downward through the second pass, there is no tendency for the hotter gases to flow at a greater velocity than the cooler gases, thereby causing a laming action, such as would occur in an upward pass.

By using larger tubes in the lower bank with wider spaces between them than between the smaller tubes of the main upper bank, a freer flow of the hot gases over the tubes is secured, and the slagging difficulties minimized. Furthermore, by spacing the tubes of the lower bank wider apart than the tubes of the upper bank, the hot gases flow more freely over the tubes than would be the case if they were spaced more closely. This wide spacing reduces heat absorption by contact of hot gases with the tubes to a lesser value than would be the case with close spacing, which condition is appropriate to tubes subjected to radiant heat and located in the path of the hottest gases. The upper tube bank arrangement promotes heat absorption from the gases that have passed over the lower tube bank and superheater, being thereby cooled by increasing the mass flow, a result of the baffle and the inclination of the baffle contracting the passes in the direction of flow. Heat absorption is also promoted in the upper bank by the use of smaller tubes and closer spacing, which adds heating surface per foot of length, subdivides the gas stream more effectively and more frequently mixes the gases that are cooled by contact with those not so cooled by reason of passing between the tubes of a given layer.

While I have illustrated sectional headers as the water chambers connecting the ends of the tubes, it will be understood that many features of my invention may be used in boilers in which water legs are used instead of sectional headers.

In Fig. 15 is shown the invention as applied to a boiler in which the spaced banks of tubes 15 and 16 are connected to continuous uptake and downtake headers 17' and 18', respectively. The arrangement is substantially the same as shown and described in connection with Fig. 1, and similar reference characters have been applied to similar parts. In this form of boiler, however, the gases, after passing through the first pass between the uptake headers and the baffle 29, are deflected downwardly through a pass formed between the baffle 29 and a second baffle 29', and then upwardly between the baffle 29' and the downtake headers 18'. They then pass between the nipples 32 into a flue 35' which may lead to an economizer or other device. In other respects, the operation is substantially the same as previously described in connection with Fig. 1.

I claim:

1. In a steam boiler, two spaced banks of inclined water tubes, uptake and downtake headers to which the ends of said tubes are connected, each header comprising an upper section for the upper bank and a lower section for the lower bank, each section being continuous throughout and the upper section being sinuous in form, the headers and tubes being constructed and arranged to form diagonal lanes in both directions between the tubes of both banks, and with twice as many tubes connected to the upper section of each header as there are horizontal rows of tubes in the upper bank, and with the same number of

tubes connected to the lower section of each header as there are rows of tubes in the lower bank.

2. In a steam boiler, two spaced banks of inclined water tubes, uptake and downtake headers to which the ends of said tubes are connected, each header comprising an upper section for the upper bank and a lower section for the lower bank, each section being continuous throughout and the upper section being sinuous in form, the headers and tubes being constructed and arranged to form diagonal lanes in both directions between the tubes of both banks, and with twice as many tubes connected to the upper section of each header as there are horizontal rows of tubes in the upper bank, and with the same number of tubes connected to the lower section of each header as there are rows of tubes in the lower bank, the tubes of the lower bank being of larger diameter than those of the upper bank.

3. In a steam boiler, two spaced banks of inclined water tubes, uptake and downtake headers to which the ends of said tubes are connected, each header comprising an upper section for the upper bank and a lower section for the lower bank, each section being continuous throughout and the upper section being sinuous in form, the headers and tubes being constructed and arranged to form diagonal lanes in both directions between the tubes of both banks, and with twice as many tubes connected to the upper section of each header as there are horizontal rows of tubes in the upper bank, and with the same number of tubes connected to the lower section of each header as there are rows of tubes in the lower bank, the tubes of the lower bank being of larger diameter and further spaced apart than those of the upper bank.

4. In a steam boiler, two spaced banks of inclined water tubes, uptake and downtake headers to which the ends of said tubes are connected, each header comprising an upper section for the upper bank and a lower section for the lower bank, each section being continuous throughout and the upper section being sinuous in form, the headers and tubes being constructed and arranged to form diagonal lanes in both directions between the tubes of both banks, and with twice as many tubes connected to the upper section of each header as there are horizontal rows of tubes in the upper bank, and with the same number of tubes connected to the lower section of each header as there are rows of tubes in the lower bank, and a furnace located beneath the lower bank of tubes, the lower bank of tubes being exposed for substantially their entire length to the radiant heat of the furnace.

5. In a steam boiler, two spaced banks of inclined water tubes, uptake and downtake headers to which the ends of said tubes are connected, each header comprising an upper section for the upper bank and a lower section for the lower bank, each section being continuous throughout and the upper section being sinuous in form, the headers and tubes being constructed and arranged to form diagonal lanes in both directions between the tubes of both banks, and with twice as many tubes connected to the upper section of each header as there are horizontal rows of tubes in the upper bank, and with the same number of tubes connected to the lower section of each header as there are rows of tubes in the lower bank, and a superheater located between the two said banks of tubes.

6. In a steam boiler, two spaced banks of in-

clined water tubes, uptake and downtake water chambers to which the ends of said tubes are connected, a superheater located between the two said banks of tubes with bent tubes having straight portions, one portion of said tubes being substantially parallel to the lower bank of tubes and spaced therefrom, and a plurality of walls extending upwardly from the lower bank of tubes across the branches of the superheater tubes which are parallel to the lower bank.

7. In a steam boiler, two spaced banks of inclined water tubes, the tubes of the lower bank being exposed to the radiant heat of the furnace for substantially their entire length, uptake and downtake water chambers to which the ends of said tubes are connected, a superheater located between the two said banks of tubes with bent tubes having straight portions, one portion of said tubes being substantially parallel to the lower bank of tubes and spaced therefrom, and a plurality of walls extending upwardly from the lower bank of tubes across the branches of the superheater which are parallel to the lower bank.

8. A boiler having above the combustion chamber a bank of approximately horizontal tubes below which and approximately parallel thereto is a second bank, the tubes in horizontal alignment in the second bank being spaced apart farther than those in horizontal alignment in the first bank and the vertical distance from the lowest tubes of the first bank to the adjacent tubes of the second bank being greater than that between the two adjacent horizontal lines of tubes in the first bank and at least as great as the minimum distance between adjacent horizontal lines of tubes in the second bank, and vertical headers alongside of and in contact with each other and carrying both banks of tubes.

9. In combination, a combustion chamber, a boiler comprising banks of horizontally inclined tubes disposed above the chamber and spaced apart in the direction of the flow of gases from the chamber, the tubes in each bank being arranged in horizontal rows and approximately uniformly spaced apart in said rows, each of said rows in the lower bank having a smaller number of tubes therein than a row in the upper bank and the vertical distance between the lowest row in the upper bank and the uppermost row in the lower bank being greater than the distance between the two lowermost rows in the upper bank, and uptake and downtake headers connected to the opposite ends of the tubes in each bank, the headers and tubes being constructed and arranged to form diagonal lanes in both directions between the tubes of both banks.

10. In combination, a combustion chamber, a boiler comprising banks of horizontally inclined tubes disposed above the chamber and spaced apart in the direction of the flow of gases from the chamber, the tubes in each bank being arranged in horizontal rows and approximately uniformly spaced apart in said rows, each of said rows in the lower bank having a smaller number of tubes therein than a row in the upper bank and the vertical distance between the lowest row in the upper bank and the uppermost row in the lower bank being greater than the distance between the two lowermost rows in the upper bank, and uptake and downtake headers connected to the opposite ends of the tubes in each bank, the headers and tubes being constructed and arranged to form diagonal lanes in both directions between the tubes of the upper bank.

11. A boiler having above the combustion chamber a bank of approximately horizontal tubes below which and approximately parallel thereto is a second bank, the tubes in the lower bank being of larger diameter than those in the upper bank and both the horizontal and vertical spacing between tubes in the lower bank being greater than the horizontal and vertical spacing of tubes in the upper bank, and vertical headers alongside and adjacent each other and carrying both banks of tubes, the headers and tubes being constructed and arranged to form intersecting lanes of substantially uniform width between the tubes of both banks.

12. A boiler having above the combustion chamber a bank of approximately horizontal tubes below which and approximately parallel thereto is a second bank, the tubes in the lower bank being of larger diameter than those in the upper bank and the horizontal spacing between said tubes in the lower bank being greater than the horizontal spacing between the tubes in the upper bank, and vertical headers alongside and adjacent each other and carrying both banks of tubes, the headers and tubes being constructed and arranged to form intersecting lanes of substantially uniform width between the tubes of both banks.

13. A boiler having above the combustion chamber a bank of approximately horizontal tubes below which and approximately parallel thereto is a second bank in a plurality of horizontal lines of staggered tubes, the tubes in said second bank being of larger diameter than those in the first bank, the tubes in horizontal alignment in the second bank being spaced apart farther than those in horizontal alignment in the first bank, and the vertical distance between the tubes in adjacent horizontal lines of the second bank being greater than that between the horizontal lines of tubes in the first bank, the tubes of both banks being so arranged as to form intersecting lanes of substantially uniform width therebetween.

14. A boiler having above the combustion chamber a bank of approximately horizontal tubes below which and approximately parallel thereto is a second bank in a plurality of horizontal lines of staggered tubes, the diameter of the tubes in the second bank being at least as great as the diameter of the tubes in the first bank, the tubes in horizontal alignment in the second bank being spaced apart farther than those in horizontal alignment in the first bank, and the vertical distance between the tubes in adjacent horizontal lines of the second bank being greater than that between the horizontal lines of tubes in the first bank, the tubes of both banks being so arranged as to form intersecting lanes of substantially uniform width therebetween.

15. A boiler having above the combustion chamber a bank of approximately horizontal tubes below which and approximately parallel thereto is a second bank in a plurality of horizontal lines of staggered tubes, the diameter of the tubes in the second bank being at least as great as the diameter of the tubes in the first bank, the tubes in horizontal alignment in the second bank being spaced apart farther than those in horizontal alignment in the first bank, and the vertical distance between the tubes in adjacent horizontal lines of the second bank being greater than that between the horizontal lines of tubes in the first bank, the tubes of both

banks being so arranged as to form diagonal lanes therebetween in both directions.

5 16. A boiler having above the combustion chamber a first bank of tubes and below which is a second bank comprising tubes extending longitudinally of the tubes of the first bank, the tubes in both banks being disposed in rows in planes extending transversely of the direction of flow of gases through the banks, the center to

center spacing of tubes in the rows being greater for the second bank than for the first bank, the distance between the planes of adjacent rows being greater for the second bank than for the first bank, and the tubes of both banks being so arranged as to form intersecting diagonal lanes therebetween. 5

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