Jan. 12, 1937. H. J. KERR 2,067,670

FLUID HEATER

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Fig. 1

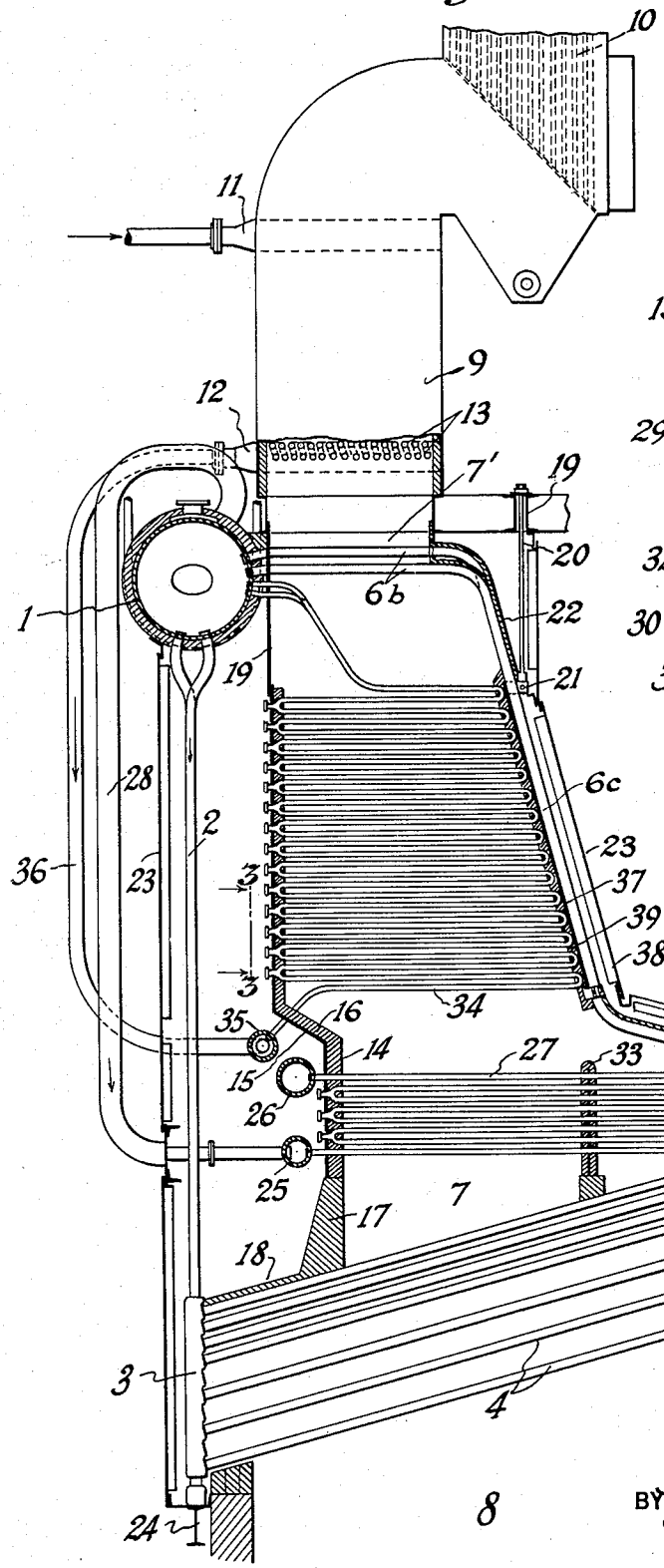


Fig. 2

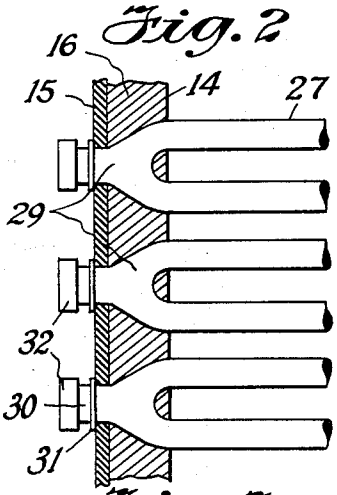
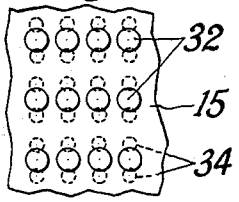


Fig. 3



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INVENTOR
Howard J. Kerr
BY Benj. R. Newcomb
ATTORNEY

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Fig. 4

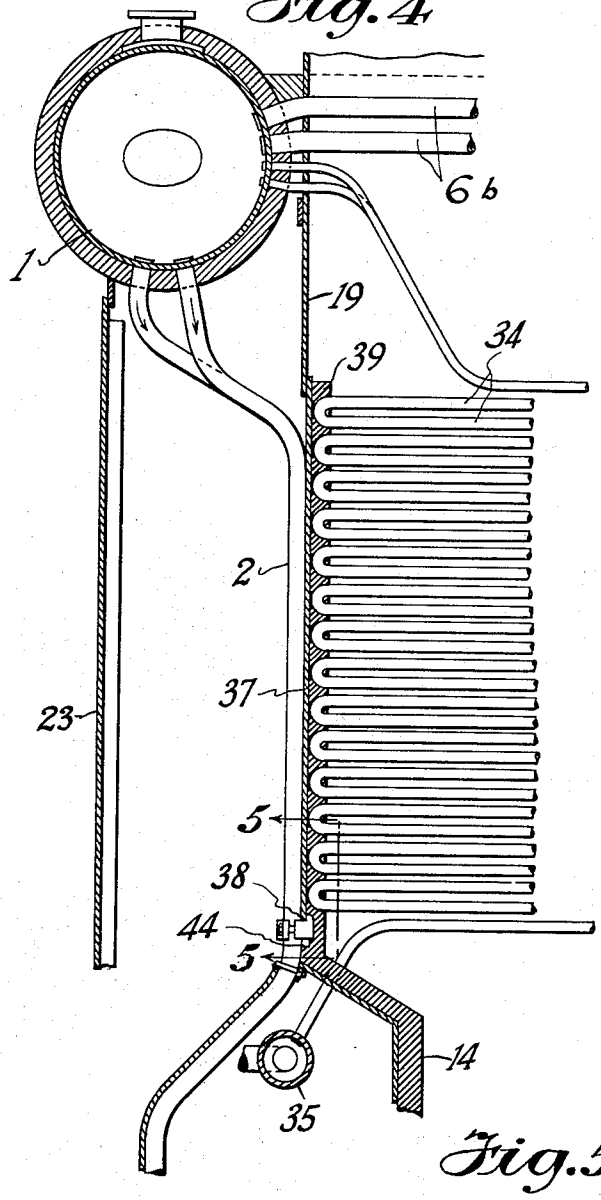


Fig. 6

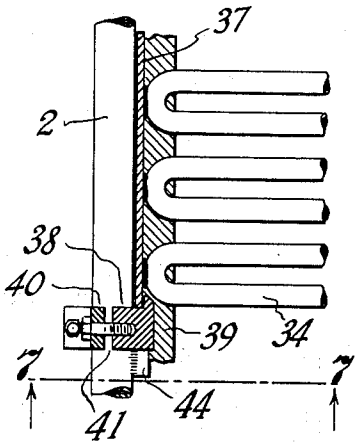


Fig. 7

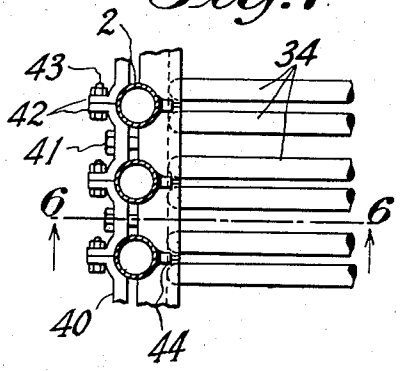
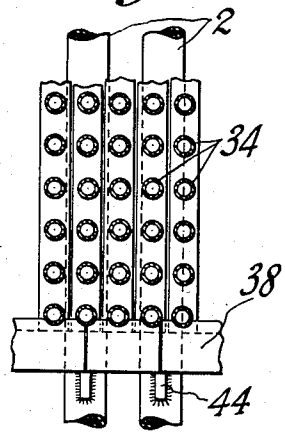


Fig. 5



INVENTOR
Howard J. Kerr
BY Benj. R. Newcomb
ATTORNEY

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Fig. 8

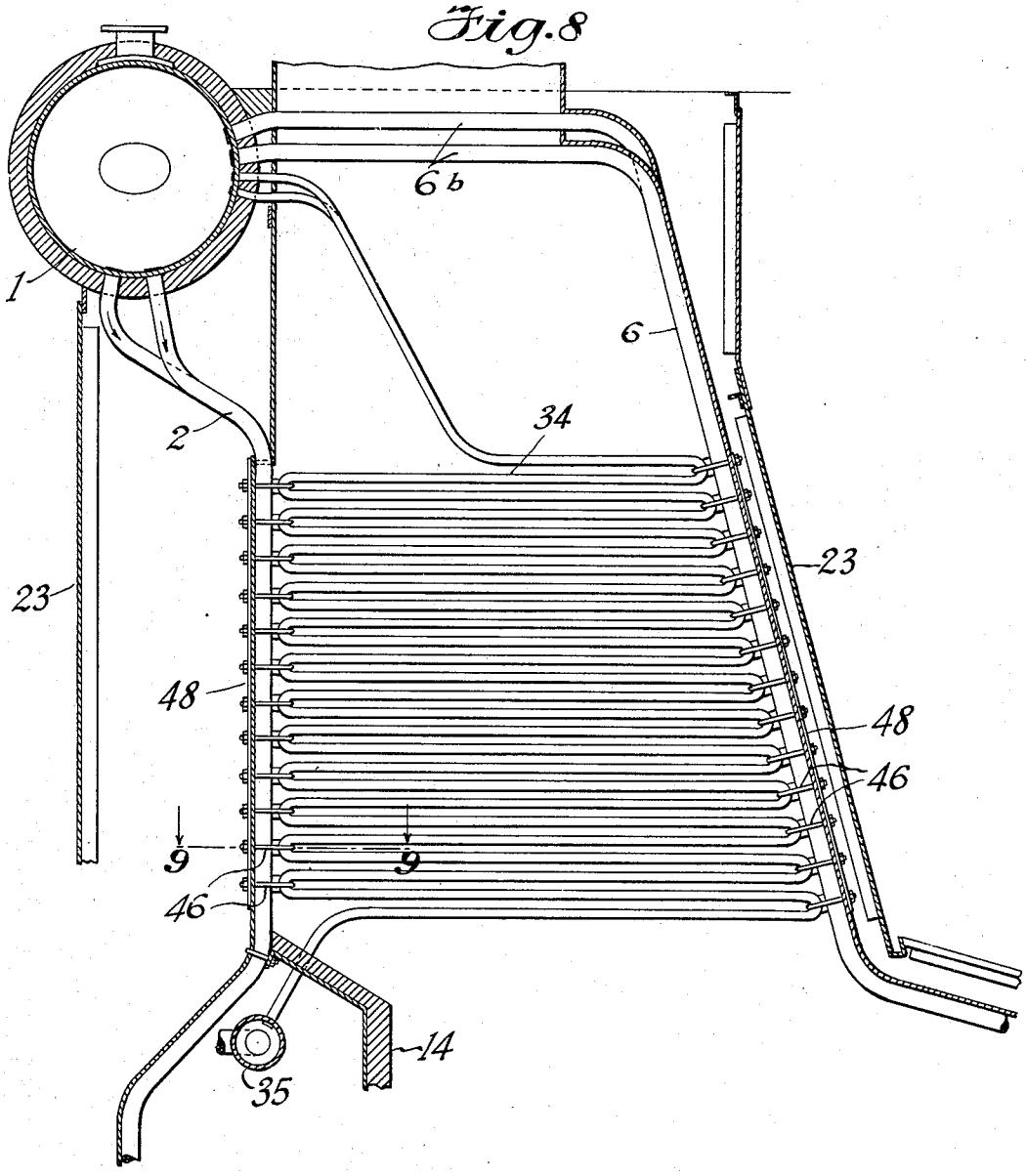


Fig. 9

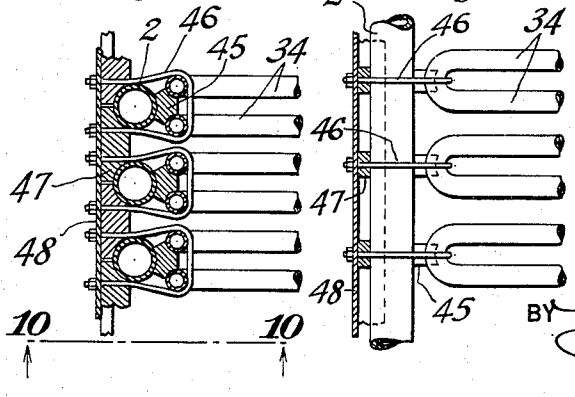


Fig. 10

INVENTOR
Howard J. Kerr
BY
ATTORNEY

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UNITED STATES PATENT OFFICE

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FLUID HEATER

Howard J. Kerr, Westfield, N. J., assignor to The Babcock & Wilcox Company, Bayonne, N. J., a corporation of New Jersey

Application February 20, 1932, Serial No. 594,175

22 Claims. (Cl. 122—303)

My present invention relates in general to the construction and operation of water tube boilers, and more particularly to water tube boilers in which the generation of steam is effected in a bank of natural circulation tubes connected to a steam and water drum located at a substantial distance above the uppermost point of steam generation in the tube bank, whereby the circulation of the fluid in the tube bank is substantially increased by the high hydraulic head to which it is continuously subjected. The invention is especially useful in high drum water tube boilers comprising two steam generating stages, a forced circulation stage through which all of the feed water to the unit is circulated and heated to a substantial temperature, and a natural circulation stage through which the portion of the water unevaporated in the forced circulation stage is circulated and evaporated.

The general object of my present invention is the provision of a water tube steam boiler having an improved arrangement and construction of the fluid heating surface thereof. Another object is the provision of a high drum water tube boiler with an improved arrangement of and supporting means for the auxiliary fluid heating surface included therein.

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

Of the drawings, Fig. 1 is a sectional elevation, partly broken away, of a high drum water tube boiler constructed in accordance with my invention; Fig. 2 is an enlarged fragmentary view illustrating the arrangement of the superheater and economizer tubes shown in Fig. 1; Fig. 3 is an enlarged end view taken on the line 3—3 of Fig. 1; Fig. 4 is a sectional elevation, partly broken away, of a modified construction; Fig. 5 is an enlarged section on the line 5—5 of Fig. 4; Fig. 6 is an enlarged section on the line 6—6 of Fig. 7, and illustrating the economizer support shown in Fig. 4; Fig. 7 is a section on the line 7—7 of Fig. 6; Fig. 8 is a sectional elevation, partly broken away, of a second modification; Fig. 9 is a section on the line 9—9 of Fig. 8; and Fig. 10 is a section on the line 10—10 of Fig. 9.

In the drawings, and particularly in Figs. 1 to 3, I have illustrated my invention as embodied in a high drum two-stage water tube boiler, which comprises a steam and water drum 1 having its water space connected by vertical downtake circulators 2 to vertical downtake headers 3 of a bank of superposed horizontally inclined water tubes 4 having their upper ends expanded into vertical uptake headers 5. The uptake headers 5 are connected by a series of uptake circulators 6 to the steam and water drum 1 in a manner hereinafter described. The tube bank 4 is positioned in the lower portion of a vertical heating gas pass 7 in communication with a furnace chamber 8 of any suitable form.

The heating gas pass illustrated is of tapering cross-sectional area in the direction of gas flow, and has a gas exit 7' at its uppermost end into a flue 9 in which an air preheater 10, of any suitable form, is positioned to receive the gases after their passage over the tubes of an economizer arranged in the flue adjacent the gas outlet from the boiler. The economizer is formed by horizontal inlet and outlet headers 11 and 12, respectively, connected by a series of return bend tubes 13 arranged in parallel therebetween.

In the boiler illustrated, the gas pass 7 is partly defined by a substantially vertical wall 14 formed by metallic plates 15 arranged edge to edge and lined at their inner sides with a layer of refractory heat insulating material 16. The wall 14 is supported by a supporting wall 17 carried by the upper row or rows of steam generating tubes 4. The lowermost portion of that side of the gas pass is defined by the downtake headers 3, and the space between the headers and the wall 17 is closed by an inclined baffle 18 extending along the upper row of tubes 4. It will be noted that in this embodiment the downtake circulators 2 are outside of and horizontally spaced from the wall 14. The space between the upper end of the wall 14 and gas exit 7' is closed by vertical plates 19.

The opposite side wall of the gas pass is defined by the uptake headers 5 and uptake circulators 6. As shown, each uptake circulator 6 has an inwardly inclined lower section 6a, horizontal upper portion 6b extending across the gas exit 7', and an intermediate inwardly inclined vertical section 6c. The uptake circulators are supported from a top supporting structural member 19 through rods 20 connected to lugs 21 welded on the circulators. This wall of the heating gas pass is partly closed by plates 22 conforming to the curvature of the circulators 6. A boiler casing 23 encloses all of the boiler parts heretofore

described and with those parts is supported from below on I-beams 24.

To adequately screen the heat absorbing elements hereinafter described from exposure to the radiant heat of the furnace, and to prevent the passage of molten slag particles when pulverized coal is burned in the furnace chamber, the upper rows of the steam generating tubes 4 are arranged in spacing and number to provide a radiant heat screen, while the lower rows of tubes are more widely spaced to provide an effective slag screen.

The transversely arranged steam and water drum 1, circulators 2 and 6, and the tube bank 4, combine to form the natural circulation steam generating stage of the boiler. In view of the high rate of heat transfer present in the tube bank 4, due to the exposure of the tubes to the radiant heat of the furnace and to the heating gases while at their highest temperature in the gas pass, it is highly desirable to provide a rapid circulation of the water to be evaporated through the tube bank to prevent the tubes from overheating. For this purpose, the steam and water drum 1 is located a substantial vertical distance above the tube bank and the circulators are made long, providing in operation a considerable static head on the fluid in the bank.

It has heretofore been proposed in designing high drum water tube boilers to locate the auxiliary fluid heating surface of the boiler in portions of the boiler other than the first vertical pass in which the natural circulation tube bank was located. Such constructions would have many practical disadvantages in operation. For example, the surface area exposed to external radiation would be undesirably large and the amount of expensive insulating material required commercially prohibitive. Furthermore, the horizontal portions 6b of the uptake circulators containing steam and water passing to the steam and water drum would be liable to overheating on exposure to high temperature gases, due to the steam and water separating action occurring therein. By utilizing the portion of the gas pass of a high drum boiler bounded by the natural circulation tube bank, steam and water drum, and the uptake and downtake circulators, for the location of part or all of the remaining boiler heating surface, it is possible to increase the thermal efficiency of the unit, while the radiation losses, cost of construction and floor space occupied by the unit are substantially decreased. The temperature of the heating gases would also be reduced sufficiently to permit the horizontal portions of the uptake circulators to be safely exposed thereto. The absence of flow directing baffles and changes in direction of the heating gas flow will provide an effective flow of the heating gases with a low draft loss and fan power consumption.

In the high drum water tube boiler illustrated, the portion of the gas pass between the natural circulation tube bank and the horizontal portions of the uptake circulators is utilized effectively by the arrangement in successive upper portions thereof of a superheater and an economizer, although other types of heating surface, such as a steam reheater or air preheater, could be used in lieu of or in conjunction with the foregoing apparatus.

As shown, the superheater is formed by horizontal inlet and outlet headers 25 and 26 respectively, connected by a series of parallel return bend steam tubes 27 extending horizontally into the heating gas pass. The headers 25 and 26 are preferably located at the outer side of the gas pass wall 14, the header 25 being connected to the steam space of the steam and water drum 1 by steam pipes 28, and the return bends of the superheater tubes at that side of the pass being formed in Y formations 29 having shank portions 30 extending through the wall 14. The outer end of each tube shank has a collar 31 welded thereon in contact with the outer side of the wall plate 15, and a removable cap 32 to facilitate cleaning of the tubes. The inner portions of the superheater tubes are supported by a vertical plate member 33 carried by the upper row of tubes 4. The superheater so constructed is adequately protected from radiant heat and slagging by the tube bank 4 and in operation absorbs a limited amount of heat from the hot gases leaving that bank. In the boiler illustrated the heating gases leaving the superheater would normally be at a temperature substantially above the saturated steam temperature and could be used for the generation or reheating of steam in any heat transfer elements that may be exposed thereto.

Substantially all of the remaining portion of the heating gas pass is preferably occupied by an economizer. The economizer shown in Fig. 1 is formed by a series of closely spaced return bend tubes 34 arranged in parallel and similar in form to the superheater tubes 27 previously described. The economizer shown has an upflow circulation, the lower ends of the tubes being connected to an inlet header 35, which in turn is connected to the outlet header 12 of the flue economizer by downcomers 36. An alternate arrangement would provide a feed connection direct to header 35. The upper most legs of the tubes 34 are bent inwardly and then horizontally into the adjacent side of the steam and water drum. The return bend portions of the tubes 34 at the downtake circulator side of the gas pass are of Y formation and supported in the wall 14 in the same manner as the corresponding portions of the superheater tubes. The return bends of the economizer tubes at the uptake side of the gas pass are supported by the sections 6c of the uptake circulators by spot welding the bend portions of each tube to a narrow vertical plate 37 clamped to one of the uptake circulators by a cross member 38 secured to the circulators and covering the weld and bend portions with a layer of heat insulating material 39. While the economizer shown is of the upflow type, it is feasible and within the scope of my invention that the fluid flow therein be downwardly, or partly downward and partly upward.

In the operation of the two-stage high drum water tube boiler illustrated, heating gases are generated in the furnace and pass upwardly successively over the natural circulation stage, superheater, forced flow stage, horizontal portions of the uptake circulators, water economizer and air preheater, the gases progressively decreasing in temperature and in volume during their passage, and the effective flow area for the heating gases being proportioned to maintain high mass flow. The feed water to the unit is delivered by a suitable boiler feed pump (not shown) to the inlet header 11 of the flue economizer, and after being heated during its downward passage through the economizer tubes is delivered to the inlet header of the forced flow stage. During its upward flow therethrough, a portion of the water is evaporated, and the steam and water mixture discharged into

the steam and water drum. It will be noted that in the forced flow stage of the boiler, all of the flow from the inlet header **35** to the steam and water drum is through parallel flow paths, in which the use of junction headers between the tube legs is avoided. The use of parallel flow paths in and after the steam generating zone is especially desirable. This arrangement affords a low fluid head loss and a positive and uniform distribution of the fluid flow. The avoidance of junction headers renders this construction especially adapted for the generation of steam at high pressures.

The portion of the water unevaporated in the forced circulation stage and delivered to the steam and water drum **1** passes downwardly through the circulators **2** into the relatively shallow natural circulation tube bank. Due to the high rate of heat absorption present in this portion of the boiler heating surface, the balance of the water will be rapidly evaporated. The high static head to which the fluid in the tubes **4** is subjected, causes the fluid to circulate rapidly through the tube bank and upwardly through the circulators **6** into the steam and water drum. The steam generated in the forced and natural circulation stages passes from the steam and water drum into the superheater tubes **27** where it is superheated to the desired degree before passing to the point of utilization.

The tube spacing across the natural circulation bank is partly limited commercially by the thickness of the header walls. This wall thickness must be increased for constructions intended for high pressures and consequently the possible amount of heating surface of this type exposed to the heating gases in high pressure boilers is limited. In the economizer construction shown however, the tubes may be closely spaced in the gas pass and any increase in the draft loss thereby caused is more than off-set by the increased heat absorption attained. A greater thermal efficiency is possible with the described arrangement than if the forced flow stage was replaced by a tube bank of the type used in the natural circulation stage.

The boiler construction illustrated in Figs. 4 to 7 differs from that in Figs. 1 to 3 by the elimination of the Y formation of the economizer return bends at the downtake side of the gas pass and by the bending of the downtake circulator tubes **2** inwardly from the adjacent wall **23** of the boiler casing to define a portion of the gas pass. In this construction the metal plates **37**, cross members **38**, spot weld connection and heat insulating material **39** are used at both sides of the gas pass for supporting the economizer tubes. The cross members **38** are clamped to the circulators by clamping members **40** and bolts **41**, as shown in Figs. 6 and 7. Each clamping member **40** preferably extends between the outer sides of a pair of circulators, and is provided with end flanges **42** for connection to the end flanges of adjacent clamping members by bolts **43**. The cross members **36** are additionally supported on the circulator tubes by lugs **44** welded on the tubes at the lower sides of the cross members.

In the construction illustrated in Figs. 8 to 10, the economizer tubes are supported on the uptake and downtake circulators by a different arrangement which consists of a triangular spacer block **45** positioned between each circulator tube and an adjacent pair of parallel economizer tube return bends, and arranging U-shaped bolts **46** about the combined tube structure with their ends extending through blocks **47** spacing the circulators from the wall plate **48**, to which the bolts are secured. It will be understood that the uptake circulators in the modified constructions may be supported in a manner similar to that described in connection with the embodiment illustrated in Fig. 1. The downtake circulators **2** in the constructions shown in Figs. 4 to 10 might well be straight as in Fig. 1 and the economizer tubes extended and connected thereto in that location. In such a construction, the baffles **18** and **19** would not be required.

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. A water tube boiler comprising in combination a furnace chamber, a vertical heating gas pass communicating with said chamber, a natural circulation bank of steam generating tubular elements extending across said gas pass, a steam and water drum positioned a substantial distance above said tube bank and providing a considerable static head on the fluid in said tube bank, spaced rows of downtake and uptake circulators extending along opposite sides of said gas pass for a considerable height and connecting said tube bank with said steam and water drum, a plurality of fluid heating elements exposed to the heating gases in the portion of said gas pass bounded by said uptake and downtake circulators, tube bank and steam and water drum, and means for supporting said fluid heating elements from one of said rows of circulators.

2. A high drum water tube boiler comprising in combination a furnace chamber, a stack, a single vertical heating gas pass extending between said chamber and stack, a natural circulation bank of steam generating tubular elements extending across said gas pass, a steam and water drum positioned a substantial distance above said tube bank and providing a considerable static head on the fluid in said tube bank, spaced downtake and uptake circulators defining opposite sides of said gas pass and connecting said tube bank with said steam and water drum, a superheater and an economizer both arranged in the portion of said gas pass bounded by said uptake and downtake circulators, tube bank and steam and water drum, and means for supporting said economizer above said superheater and from said circulators.

3. A water tube boiler comprising in combination a furnace chamber, a vertical heating gas pass communicating with said chamber, a natural circulation stage including a bank of steam generating tubular elements in said gas pass, a steam and water drum positioned above said tube bank, downtake circulators connecting one end of said tube bank with said steam and water drum, and uptake circulators connected to the other end of said tube bank and having substantially horizontal portions extending across said gas pass and connected to said steam and water drum, said downtake and uptake circulators defining opposite sides of said gas pass, a plurality of fluid heating tubular elements horizontally arranged in said gas pass above said tube bank and

in the space bounded by said uptake and downtake circulators, tube bank and steam and water drum, and means for supporting said fluid heating elements from said uptake and downtake circulators.

4. A water tube boiler comprising in combination a furnace chamber, a vertical heating gas pass communicating with said chamber, a natural circulation stage including a bank of horizontally inclined water tubes in said gas pass, a steam and water drum positioned above said tube bank, downtake circulators connecting one end of said tube bank with said steam and water drum, and uptake circulators connected to the other end of said tube bank and having substantially horizontal portions extending across said gas pass and connected to said steam and water drum, and a forced flow stage including a plurality of multiple loop return bend water tubes arranged in parallel in said gas pass above said tube bank and in the space bounded by said uptake and downtake circulators, tube bank and steam and water drum, and having their upper ends connected to said steam and water drum, and means for supplying feed water to the lower ends of said return bend water tubes.

5. A water tube boiler comprising in combination a furnace chamber, a stack, a single vertical heating gas pass of progressively decreasing flow area extending between said chamber and stack, a natural circulation steam generating stage including a bank of horizontally inclined water tubes in said gas pass, a steam and water drum positioned a substantial distance above said tube bank and at one side of said gas pass, downtake circulators connecting one end of said tube bank with said steam and water drum, and uptake circulators connected to the other end of said tube bank and having substantially horizontal portions extending across said gas pass adjacent the level of said steam and water drum, and a forced flow steam generating stage including a plurality of upflow return bend water tubes arranged in parallel in said gas pass above said tube bank and in the space defined by said uptake and downtake circulators, tube bank and steam and water drum, and having their upper outlet ends connected to said steam and water drum, and means for supplying all of the feed water for said boiler to the lower inlet ends of said return bend water tubes.

6. A water tube boiler comprising a plurality of steam generating tubular elements, a steam and water drum positioned above said elements, downtake and uptake circulators connecting said elements with said steam and water drum, a plurality of tubular fluid heating elements arranged in the portion of said gas pass between said uptake and downtake circulators, and a supporting connection between each of said fluid heating elements and one of said circulators.

7. A water tube boiler comprising a plurality of steam generating tubular elements, a steam and water drum positioned above said elements, downtake and uptake circulators connecting said elements with said steam and water drum, a return bend tubular fluid heating element arranged in the portion of said gas pass between said uptake and downtake circulators, and a supporting connection between the return bend portion of said fluid heating element and one of said circulators.

8. A water tube boiler comprising parts defining a heating gas pass, circulator tubes at opposite sides of said gas pass and arranged in substantially the same vertical plane, a fluid conduit element formed in a series of return bends in the plane of said circulator tubes, and means connecting return bend portions at opposite sides of said element to adjacent circulator tubes.

9. A water tube boiler comprising in combination a furnace chamber, a vertical heating gas pass communicating with said chamber, a natural circulation bank of steam generating tubular elements extending across said gas pass, a steam and water drum positioned a substantial distance above said tube bank and providing a considerable static head on the fluid in said tube bank, spaced downtake and uptake circulators connecting said tube bank with said steam and water drum, a plurality of tubular fluid heating elements arranged in the portion of said gas pass bounded by said uptake and downtake circulators, tube bank and steam and water drum, and a supporting connection between said fluid heating elements and circulators.

10. A water tube boiler comprising in combination a furnace chamber, a vertical heating gas pass communicating with said chamber, a bank of steam generating tubular elements extending across said gas pass, a steam and water drum positioned above said tube bank, spaced downtake and uptake circulators connecting said tube bank with said steam and water drum, a return bend tubular fluid heating element arranged in a portion of said gas pass defined by said uptake and downtake circulators, and a supporting connection between return bend portions of said fluid heating element and adjacent uptake and downtake circulators.

11. A water tube boiler comprising in combination a furnace chamber, a vertical heating gas pass communicating with said chamber, a bank of steam generating tubular elements extending across said gas pass, a steam and water drum positioned above said tube bank, spaced downtake and uptake circulators connecting said tube bank with said steam and water drum, a plurality of return bend tubular fluid heating elements arranged in said gas pass between said uptake and downtake circulators, and a supporting connection between return bend portions of each of said fluid heating elements and one of said circulators comprising metallic plates carried by said circulators at the inner side thereof, a layer of heat insulating material at the inner side of said plates, and the return bend portions of said fluid heating elements being embedded in said insulating material and welded to said plate.

12. A water tube boiler comprising in combination a furnace chamber, a vertical heating gas pass communicating with said chamber, a bank of steam generating tubular elements extending across said gas pass, a steam and water drum positioned above said tube bank, spaced downtake and uptake circulators connecting said tube bank with said steam and water drum, a plurality of return bend tubular fluid heating elements arranged in parallel in said gas pass between said uptake and downtake circulators, and a supporting connection between return bend portions of each of said fluid heating elements and one of said circulators comprising a metallic plate at the outer side of said circulators, a layer of heat insulating material on the inner side of said plate and contacting with said circulators, a spacer block of refractory material between each of said circulators and the return bend portions of a pair of adjacent fluid heating elements, and supporting means surrounding and holding said

fluid heating elements and circulators in a predetermined relation relative to said plate.

13. A water tube boiler comprising in combination a furnace chamber, a vertical heating gas pass communicating with said chamber, a natural circulation stage including uptake and downtake headers, a bank of horizontally inclined water tubes in said gas pass and having their ends connected to said headers, a steam and water drum positioned a substantial distance above said tube bank, and circulators connecting said downtake headers with said steam and water drum, circulators connected to said uptake headers and having horizontal portions extending across said gas pass and connected to said steam and water drum, and a forced flow steam generating stage including a plurality of closely spaced return bend water tubes arranged in parallel in said gas pass in the space bounded by said uptake and downtake circulators, tube bank and steam and water drum, and having their outlet ends connected to said steam and water drum, and a supporting connection between the return bend portions of each of said water tubes and corresponding uptake and downtake circulators.

14. A steam generator comprising a natural circulation bank of horizontally inclined steam generating tubes extending across a vertical heating gas pass, a steam and water drum above and extending transversely of said tube bank, rows of uptake and downtake fluid conduits connecting the uptake and downtake ends of said tube bank respectively to said drum, a bank of return bend tubular fluid heating elements of substantial length extending across said gas pass above said tube bank and in the space defined by said rows of uptake and downtake fluid conduits, tube bank, and drum, said fluid heating elements having return bend portions adjacent one of said rows of fluid conduits, and means forming a supporting connection between said return bend portions and said last mentioned fluid conduits.

15. A steam generator comprising spaced rows of vertical uptake and downtake headers at opposite sides of a vertical heating gas pass, a natural circulation bank of horizontally inclined steam generating tubes extending across said gas pass and connecting said rows of headers, a steam and water drum above and extending transversely of said tube bank, rows of uptake and downtake circulators connecting said rows of uptake and downtake headers respectively to said drum, a bank of return bend tubular fluid heating elements of substantial length extending across said gas pass above said tube bank and in the space defined by said rows of uptake and downtake circulators, tube bank, and drum, said fluid heating elements having return bend portions adjacent one of said rows of circulators, and means forming a supporting connection between said return bend portions and said last mentioned circulators.

16. A steam generator comprising spaced rows of vertical uptake and downtake headers at opposite sides of a vertical heating gas pass, a natural circulation bank of horizontally inclined steam generating tubes extending across said gas pass and connecting said rows of headers, a steam and water drum above and extending transversely of said tube bank, rows of uptake and downtake circulators connecting said rows of uptake and downtake headers respectively to said drum, a bank of return bend tubular fluid heating elements of substantial length extending across said gas pass above said tube bank and in the space defined by said rows of uptake and downtake circulators, tube bank, and drum, said fluid heating elements having return bend portions adjacent said row of uptake circulators, means for supporting said return bend portions from said uptake circulators, and suspension means external to said drum for supporting said uptake circulators.

17. A water tube boiler comprising in combination a furnace chamber, a vertical heating gas pass communicating with said chamber, a natural circulation stage including a bank of steam generating tubular elements in said gas pass, a steam and water drum positioned a substantial distance above said tube bank, and spaced downtake and uptake circulators connecting said tube bank and steam and water drum, and a forced flow stage including a plurality of steam generating tubular elements arranged in said gas pass above said tube bank in the space between said uptake and downtake circulators, means for supplying feed water to said forced flow stage, said forced flow stage steam generating elements being arranged to discharge into said steam and water drum, and means for supporting said forced flow stage steam generating elements from said uptake circulators.

18. Fluid heating apparatus comprising a heating gas pass, vertically extending supporting tubes extending along opposite sides of said gas pass, an auxiliary fluid heater comprising fluid heating tubes each having a series of superposed tube legs extending across said gas pass and serially connected at opposite sides of said gas pass by return bend portions arranged in vertical planes, and means for supporting said auxiliary fluid heater tubes at opposite sides of said gas pass from adjacent supporting tubes independently of subjacent support.

19. Fluid heating apparatus comprising a heating gas pass, vertically extending supporting tubes extending along opposite sides of said gas pass, an auxiliary fluid heater comprising fluid heating tubes each having a series of superposed tube legs extending across said gas pass and serially connected at opposite sides of said gas pass by return bend portions arranged in vertical planes, means forming a supporting connection between adjacent tube legs of each fluid heater tube, and means for supporting said auxiliary fluid heater tubes at opposite sides of said gas pass from adjacent supporting tubes independently of subjacent support.

20. A steam boiler comprising a bank of steam generating tubes, a steam and water drum above said tube bank, groups of tubes spaced longitudinally of said tube bank and connecting said tube bank and drum, an auxiliary fluid heater arranged above said tube bank, and means for supporting said fluid heater at spaced points by said spaced groups of tubes and independently of support from said tube bank.

21. A steam boiler comprising a bank of steam generating tubes, a steam and water drum above said tube bank, spaced groups of circulator tubes arranged to connect the opposite ends of said tube bank to said drum, an auxiliary fluid heater arranged in the space defined by said groups of circulator tubes, tube bank, and drum, and means for supporting said fluid heater in its entirety by said spaced groups of circulator tubes independently of said tube bank.

22. A steam boiler comprising a bank of steam generating tubes, a steam and water drum above said tube bank, spaced groups of circulator tubes arranged to connect the opposite ends of said tube

bank to said drum, an auxiliary fluid heater arranged in the space defined by said groups of circulator tubes, tube bank, and drum and comprising fluid heating tubes each having a series of superposed tube legs serially connected adjacent said groups of circulator tubes by return bend portions arranged in vertical planes, and means engaging return bend portions of said fluid heating tubes for supporting said fluid heating tubes from said circulator tubes independently of said tube bank.

HOWARD J. KERR.