June 18, 1968 W. A. HALE 3,388,692

MODULAR BOILER

Filed Sept. 29, 1966 3 Sheets-Sheet 1

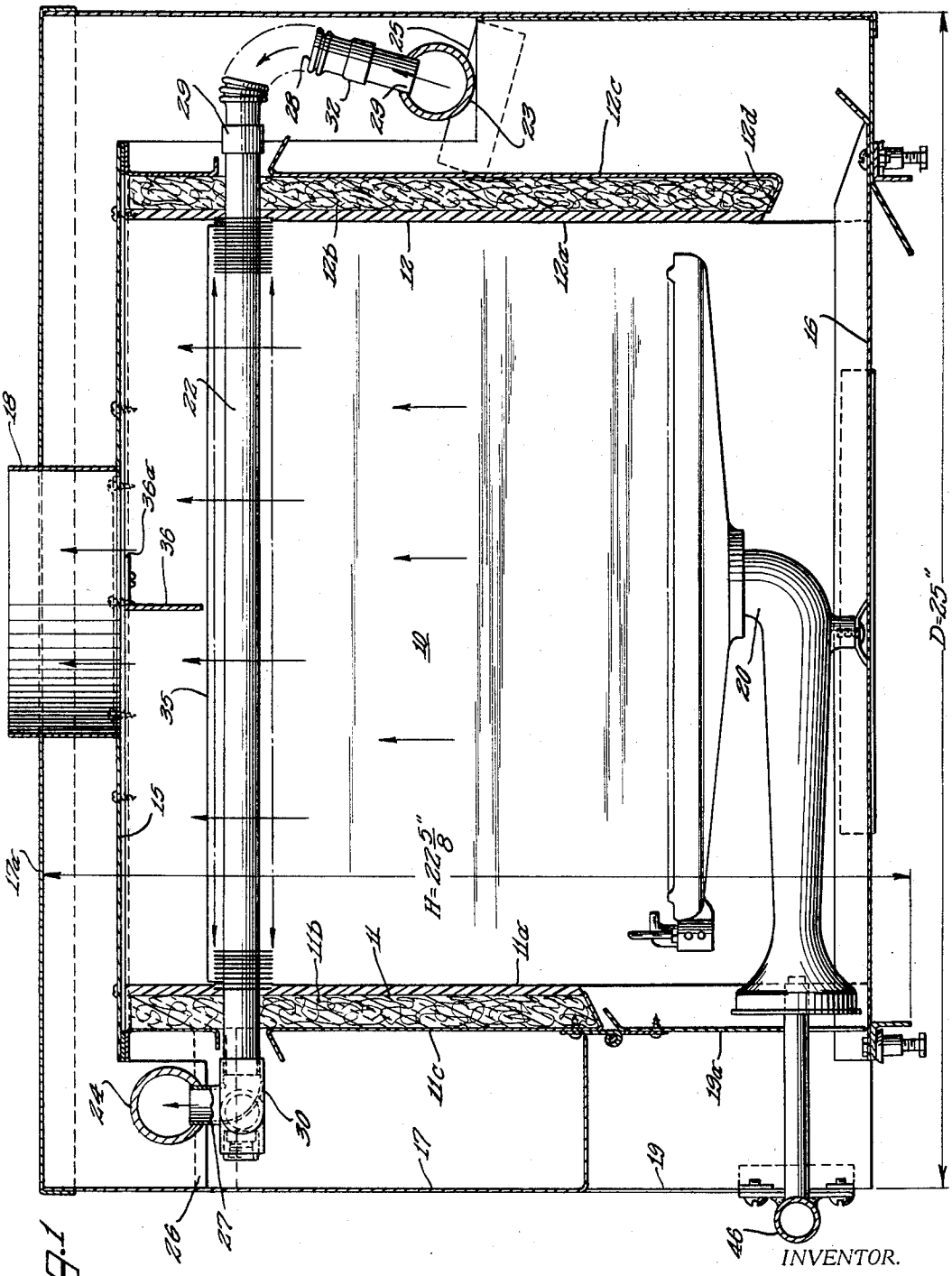


FIG. 1

INVENTOR.

William A. Hale

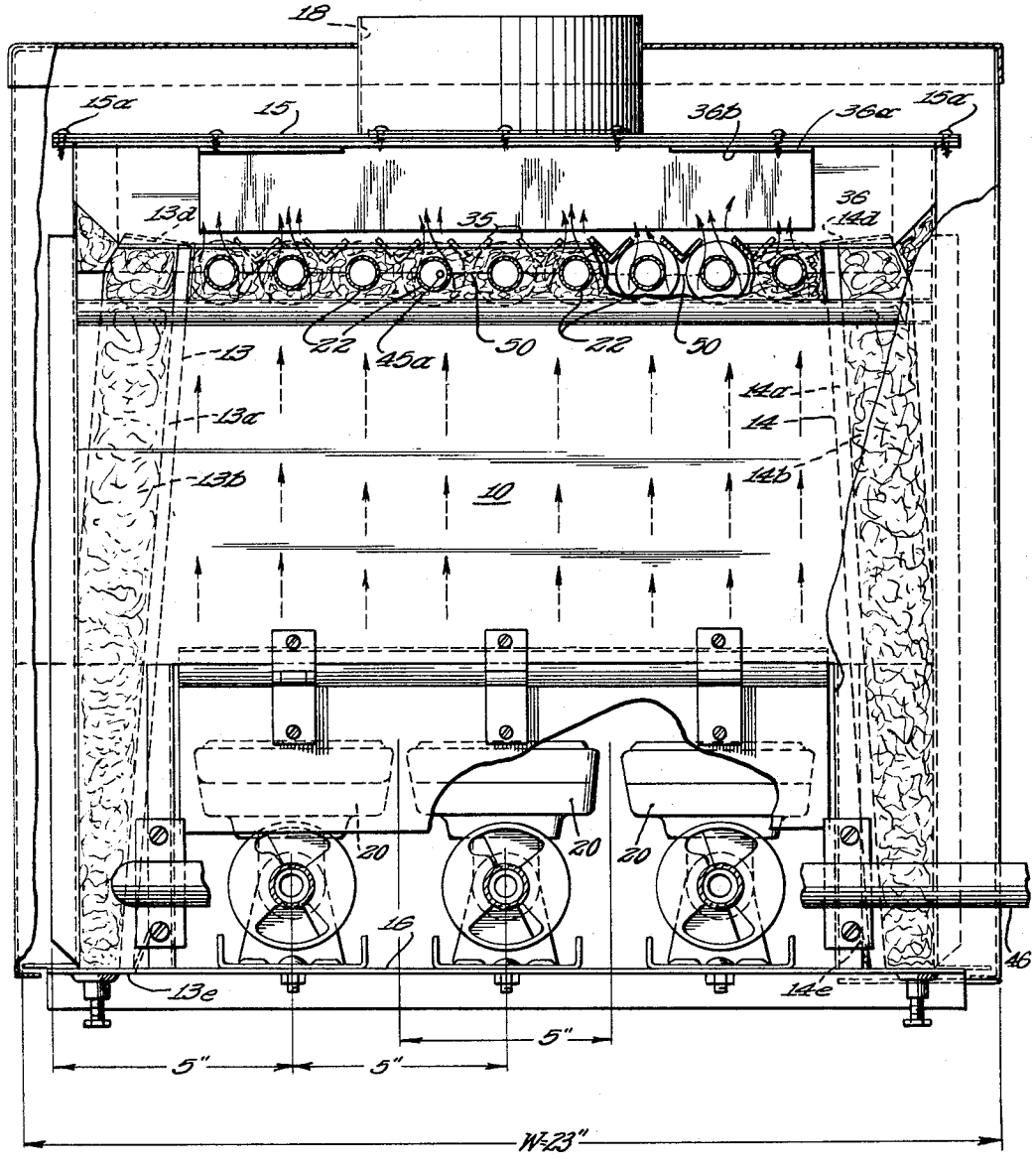
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Fig. 2



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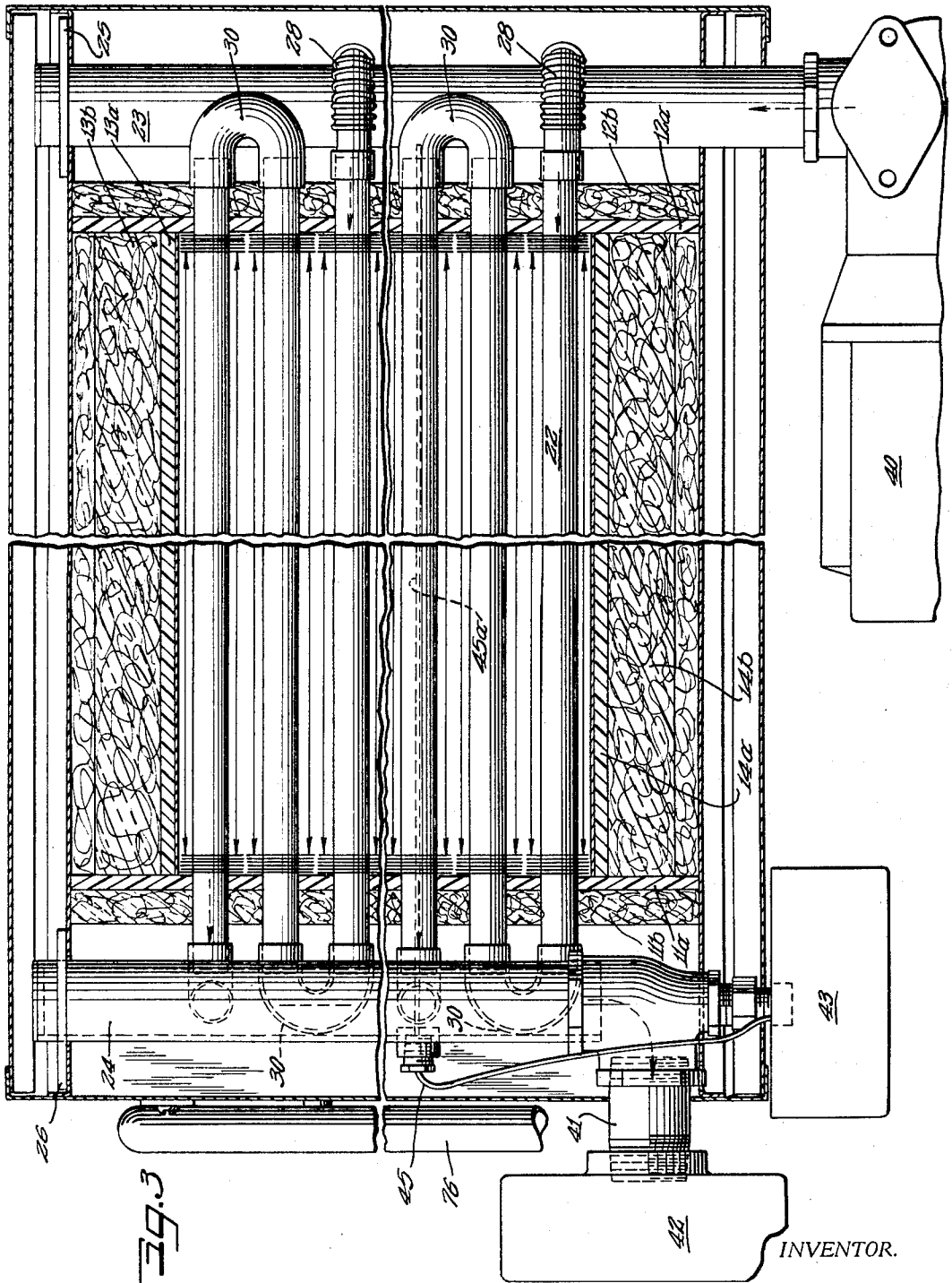


Fig. 3

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MODULAR BOILER

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13 Claims. (Cl. 122—367)

ABSTRACT OF THE DISCLOSURE

A hot-water boiler construction is provided in which the water tubes and burner element are proportioned to permit a modular construction of varying sizes of boiler units. Water tube passes forming individual heat exchanger units are employed to correspond to single burner units and the combustion chamber walls are constructed in accordance with multiples of a single combustion width to thereby simplify design and construction of multiple burner boiler systems. The water tubes of the boiler are provided with connections external of the combustion chamber and separability of the boiler is provided along lines passing through the water tubes so that servicing of the heat exchanger units is greatly simplified. Safety features including utilization of a thermostatic element within the heat exchanger unit and within the combustion chamber is also provided.

As those skilled in the art of boiler construction are aware, increasing labor costs have created serious problems in the manufacture of home heating units. This will be appreciated when it is realized that a wide variation exists in the heat output required for efficiently heating homes, or the like, constructed in a wide range of sizes. In the past it has been contemplated by those working in the boiler field, that substantially individual boilers be provided to most efficiently handle each individual home size. This has required expensive engineering time in the development of a wide range of boiler sizes, expensive inventories of component parts not ordinarily interchangeable from one boiler to the next, increased expense in the manual handling of the components and the assembly thereof, and complications in the manufacture and sale of the complete line of heating units. In accordance with the principles of the present invention, the deficiencies of the prior art have been eliminated and an extremely efficient, compact, and simple boiler is provided.

In accordance with the principles of the present invention, a boiler is constructed having a gradually upwardly narrowing combustion chamber venting vertically to atmosphere. The side walls are relatively thin and are constructed of a composite insulating material. The boiler is constructed on a modular plan permitting a wide variation in boiler size with an absolute minimum number of different parts. By providing two burner sizes and employing various numbers of the individual burner units in a given boiler, ten boiler capacities may readily be achieved providing a graded output from approximately 50,000 B.t.u.'s per hour to 430,000 B.t.u.'s per hour. In each case, additional rating may very simply be achieved by selecting a boiler having an additional one or more burner units and correspondingly longer input and output headers. Fundamental dimensions of the component parts of the boiler system remain constant throughout the selection of boiler size range. As a result, once a boiler output has been

determined by a heating engineer, that output may readily be accomplished merely by adding one or more identical burner units with its related fire wall and finned water tube sections. Although it is not intended that under ordinary circumstances a boiler will be modified in the field, the complete flexibility of the boiler construction of the present invention permits almost exact matching between a building heating requirement and the boiler capable of most efficiently heating the space.

In addition to providing a novel modular construction system for boilers, I have provided a simplified system of construction, which renders servicing in the field extremely simple, which eliminates all soldered joints from within the fire box of the boiler, and which provides completely controlled expansion of the various heated components so that all servicing and inspection of possible points of leakage may be undertaken without dismantling the boiler and failure from fatigue ordinarily occurring in boilers as a result of continual expansion and contraction of heating components is eliminated.

It is, accordingly, an object of the present invention to provide an efficient boiler constructed on a modular basis to thereby provide a wide range of boiler capacity with a minimum number of different components.

Another object of the present invention is to provide a novel boiler incorporating a tapering fire box with horizontal water tubes.

Another object of the present invention is to provide a copper-tube hot water boiler incorporating thermal expansion means external of the fire box but inside of the boiler jacket and having all solder joints external of the fire box.

Still another object of the present invention is to provide a novel boiler separably joined along a generally horizontal plane such that separation of the components permits removal of, or inspection of, the boiler tubes in their entirety.

Still other objects of the invention will at once become apparent to those skilled in the art from a consideration of the attached drawings and specification wherein a preferred embodiment of the invention is shown by way of illustration, and wherein:

FIGURE 1 is a side-elevational view, partly broken away to show internal construction, of a hot water boiler constructed in accordance with the principles of the present invention;

FIGURE 2 is an end-elevational view, as viewed from the left, of FIGURE 1; and

FIGURE 3 is a plan view of the boiler of the present invention as shown in FIGURES 1 and 2.

As shown on the drawings:

A consideration of the figures of the attached drawings shows that the boiler of the present invention is a compact, extremely simple device. In this respect, it is in contrast to most prior art boiler configurations. In the form illustrated, the boiler comprises a fire box **10**, front and rear walls **11** and **12**, side walls **13**, **14** and top and bottom panels **15** and **16**, respectively. The fire box thus formed is enclosed, mainly for aesthetic effects, by an outer sheet metal honsing **17** which covers the entire boiler, providing only for an exhaust gas flue **18** and air inlet openings **19**.

As shown on the drawings, a plurality of burners **20** are provided in the fire box **10**. Immediately over each

individual burner **20**, a hot water boiler tube heat exchanger, preferably constructed of finned copper, is positioned in the manner illustrated particularly in FIGURE 3. The boiler tube heat exchanger associated with each individual burner is preferably a three-pass tube generally in an S configuration. In the arrangement shown, this is occasioned by the fact that the burner units **20** have a dimensional width approximately equal to three passes of finned tubing thereby providing an equal increment of tubing and burner. In practice, I have successfully employed cast iron burner elements of a rectangular configuration having a width of 4⅜" in combination with three-pass tubes of ⅞" outside diameter copper tubing. On this basis, I have provided an incremental length of five inches as will be more fully described below.

In the form illustrated, each heat exchanger **22** is connected to an inlet, or water return, header **23**, and an outlet, or water supply header **24**. The headers **23** and **24** are rigidly secured to the boiler housing by any conventional means such as for example fixed brackets **25** and **26**. The individual tubes **22** are rigidly secured to the outlet header **24** by silver soldering or brazing, as indicated at **27**, but are flexibly secured to the inlet header **23** by means of a bellows or accordion-type connector **28**. The flexible connector, preferably constructed of brass or copper, is soft soldered to the individual tube **22** as at **29** and **32** and is silver soldered or brazed to the header **23** as at **29**. In the embodiment illustrated, in which three passes of tubing are employed in each increment or module, adjacent passes are joined by U connectors **30** which are soft soldered to the ends of the tube as particularly shown in FIGURE 3. As a result of the above specified construction, soft soldering is employed substantially throughout the boiler construction. More particularly, all joints of whatever nature are located outside of the fire box area. As a result, none of the joints are themselves in any way subjected to the direct application of heat. It will, of course be recognized that in view of the fact that the present boiler is a water tube boiler, it is intended that the temperature of the tubes never exceed the melting point of soft solder and the use of soft solder is desirable for field repairs. For example, the slip joint at **32** preferably comprises a soft solder joint which thereby permits removal of a tube section without the need for high temperature grazing equipment in the field. The use of such soft solder connections is unnecessary to the successful operation of the boiler but it is preferred that the boiler unit be only soldered with high temperature hard solder alloys where tube connections enter the headers as at **29**. This will assure substantial physical strength to the joints where needed at the same time permitting their disassembly without the utilization of a high temperature acetylene torch or the like.

Combustion gases are burned in the fire box area **10** and, upon combustion, pass in the direction of the upwardly directed arrows as shown particularly in FIGURE 2. The gases pass around the finned tubes **22** in a path made tortuous by the provision of inverted V channel members **35**. The channels **35** are simply laid longitudinally between adjacent passes of the tubing **22** and are retained in place by gravity. In order to assure that the baffles **35** are not inadvertently moved during shipment of an assembled furnace, a single bracket **36** is provided. Preferably, the bracket is constructed of angle iron having a flange **36***a* which is cut away as at **36***b* over the area of the flue **18**. The baffle **36** extends across the center of the flue **18** but in view of the absence of any horizontal flange in the area of the flue, does not materially modify the air flow. The bracket **36** projects downwardly to a point slightly spaced from the upper edges of the angle iron baffles **35** and prevents the baffles from being upwardly dislodged from their positions between adjacent tube passes. It will be appreciated that the baffle pattern illustrated is an extremely simple and inexpensive one, while at the same time being an extremely efficient system. It will be understood that the triangular baffle employed could be reversed by placing the V's upsidedown from the position shown in FIGURE 2 over the centerline of the tubes. In such circumstances the legs of the angles would be extended to meet at a point intermediate between adjacent tube passes and longitudinally extending spaced apertures would be placed at the point of the V, thereby providing the same flow path as that illustrated.

Insulation is, as illustrated, of a composite form. I have found extremely satisfactory, a composite insulation marketed under the trademark "Fiberfrax" by Carborundum Company. The material comprises a very high temperature resistant insulation layer, on the order of 5/16" thick backed by a layer of approximately 1½" of lower temperature insulation. In the drawings, the high temperature resistant material is shown at **11***a*, **12***a*, **13***a* and **14***a* of the respective walls **11**, **12**, **13** and **14**, while the low temperature material integrally backed thereto is correspondingly indicated at **11***b*, **12***b*, **13***b* and **14***b*. The high temperature material is sufficiently self-supporting to satisfactorily provide the interior wall surfaces and, accordingly, means are provided merely for supporting the edges of the individual wall. In FIGURE 2, these means are shown as comprising stainless steel angle members **13***d*, **13***e* and **14***d*, **14***e*. These angles position the walls **13** and **14** in a narrowing configuration. Similarly, the walls **11** and **12** are supported in position by angle members **11***d* and **12***d*, respectively.

It will be seen from the above considerations, that a simple, extremely inexpensive and compact boiler construction has been provided. Water at a relatively low temperature is returned from the home heating system to the return header **23** by way of a circulating pump **40**, is pumped through the header **23** and thence into the fire box or combustion chamber **10** by way of finned copper tubes **22** and into the outlet or supply header **24**. The water leaves the header **24** via supply line **41** and its accompanying automatic controls **42**. A thermostat **43** is provided for controlling energization of the circulating pump **40** in a conventional manner.

The compactness and efficiency of the system will be more fully appreciated when the over-all dimensions of the commercial embodiments are stated. In practice, the boiler series of the present invention provides a height dimension $H=22\frac{5}{8}''$ or substantially less than two feet. Similarly, the depth dimension $D=25''$ and a standard width dimension employing three-burner tube increments of $W=23''$. With this arrangement, a boiler, essentially less than two cubic feet in dimension provides 160,000 B.t.u.'s per hour output from a rated gas input of 210,000 B.t.u.'s per hour, operating on heating gas. As above noted, the incremental width of a burner and tubing unit or module comprises five inches in the form illustrated. Accordingly, design of a unit with one less burner and its corresponding three-pass water tube will provide a B.t.u. output rating of 112,000 B.t.u.'s per hour and, similarly, the subtraction of a second burner unit and tube complement will provide a rating of 56 B.t.u.'s per hour.

By employing a burner head of the same width dimension, but five inches additional length, as an example 17" rather than 12", and by simultaneously increasing the walls **13** and **14** in length to provide a five-inch additional fire box length, and hence a thirty-inch outside dimension D, a one-burner unit will provide 72,000 B.t.u.'s per hour output, a two-burner unit will provide 144,000 B.t.u.'s per hour, and a four-burner unit will provide approximately 216,000 B.t.u.'s per hour. Accordingly, with very simple, and modular changes, the boiler may readily be designed to accommodate output values from approximately 50,000 B.t.u.'s per hour to 200,000 B.t.u.'s per hour, all with a maximum width and height of less than two feet and a length of thirty inches or less.

In view of the extremely compact size of boilers constructed in accordance with the present invention, I have provided a fail-safe high temperature control of superior

efficiency. Capillary temperature responsive tube 45 is provided. This tube is conventional in construction and may be purchased as, for example only, a Wilcolator High-Limit type LM5 unit that will effect actuation of a switch at 335° F. to deenergize or close off the conventional main solenoid actuated valve (not shown) in the fuel line 46 for the burner units 20. In the present invention the heat sensing element is introduced into the water tube at a point outside the boiler and extends inside the tube as shown at 45*a* across the combustion chamber. Hence, if the water is lost from the system, the burner will shut down almost instantly, and well below a damaging temperature. Directly sensing the water temperature inside the chamber 10 provides absolute control of the boiler system and provides against hot spots along the capillary tube or deterioration thereof by direct contact with the combustion gases as happens in previously known systems.

Servicing of the boiler of the present invention is extremely simple. This is occasioned by its compactness and by the fact that it is readily dismantled without, in most cases, heating any of the critical joints. The boiler walls 11 and 12, comprising respectively, the inner high temperature liner 11*a*, 12*a*, intermediate temperature insulation 11*b*, 12*b* and the outer reinforcing metal fire box walls 11*c*, 12*c*, are horizontally separated along the line 50. As can be seen clearly from a consideration of FIGURE 2, the separation line 50 passes through the center of the water tubes 22. During manufacture the sheet metal fire box walls 11*c*, 12*c*, are provided with holes slightly larger than the diameter of the tubes 22 and the walls subsequently slit by a saw with a width on the order of 1/16" along the line 50. By piercing the insulation 11*a*, 11*b*, 12*a*, 12*b*, with apertures substantially the diameter of the tubing, downward movement of the upper portions of the wall 11, 12 in assembly of the device, to a point at which the saw slit is closed, will provide a crushing of the insulation material to provide a snug seal about the tubes as they pass through the sheet metal 11*c*, 12*c*. Disassembly for servicing is a simple matter and may readily be accomplished merely by removing the topmost cover plate 17*a* unscrewing the boiler top wall 15 from the side walls 13, 14 by unscrewing screws 15*a*, and lifting the top wall 15 upwardly. This completely exposes the tubes 22 with the overlying loose baffles 35. If it is essential that one or more of the tubes 22 be replaced, the tube may readily be removed by heating the soft solder joint 32 and a similar joint at 27. While it is apparent that work may be done on the burners 20 from above, by removal of the tubes as above described, ordinarily maintenance of the burners is accomplished through the openings 19 in the outer wall 17 of the boiler access to the burners is readily accomplished by means of a hinged access plate 19*a*. It will accordingly be seen that the boiler of the present invention is, by reason of its extreme compactness and simple construction, readily serviced in the field. In view of the minimum number of parts, occasioned by the modularity of the boiler both as to boiler tube and burner configurations, an absolute minimum of parts is required to stock service facilities.

Boilers constructed in accordance with the invention have readily passed certification standards and have proved not only inexpensive but extremely efficient. Through the utilization of a few components, a wide variation in heating capacity is provided without requiring a large inventory of different types of parts. It will, of course, be apparent to those skilled in the art that the dimensions specifically described hereinabove are means as illustrative of a highly successful unit and are not in any sense limitations. Variations in size of the components may be undertaken without in any way departing from the scope of the novel concepts of the present invention. Similarly, other structural changes may be made, and will be apparent to those skilled in the art from a consideration of the above description of my invention. Accordingly, it is my intention that the scope of the present invention be limited solely by that of the hereinafter appended claims.

I claim as my invention:

1. In combination in a boiler, a combustion chamber formed of four side walls of a high temperature thermal insulation, a floor and a top wall, at least one fuel burner unit adjacent said floor, a generally horizontal water tube heat exchanger extending through two of said side walls and the insulation thereof above each said burner unit, flue means downstream of said heat exchanger, inlet and exhaust headers connecting opposite ends of said heat exchanger outside said walls, means rigidly mounting said headers, each of said heat exchangers having a flexible connection at one end thereof with one of said headers outside of said walls to provide for expansion of said tube exchanger units relative to said headers, each tube exchanger unit having a total horizontal width substantially the same as the width of the fuel burner unit directly therebelow, whereby said burners and tubes are in the same dimensional multiple and said boiler may be incrementally increased in size by adding an increment of length to said two side walls, an additional water tube heat exchanger and an additional burner.

2. The boiler construction set forth in claim 1 wherein each exchanger unit comprises a plurality of passes one of which is secured to the inlet header and the other to the outlet header.

3. The boiler combination set forth in claim 1 wherein said tube heat exchangers have transverse fins within said combustion chamber and a triangular baffle above and between adjacent passes of tubing requiring upward gas flow to leave the combustion chamber by passing around said tubes and upwardly substantially directly over the respective centerlines thereof.

4. The boiler construction set forth in claim 1 wherein each pass of each of said tubes extends completely through the said two side walls and wherein all interconnecting tube joints are constructed outside said walls.

5. The boiler construction set forth in claim 1 wherein at least said two side walls are generally horizontally separable along a line passing through said tubes whereby said tubes may be serviced by removal of said top wall and the upper portions of said two side walls.

6. The boiler construction set forth in claim 1 wherein the other two of said side walls are inclined toward each other as they progress upwardly to provide a gradually restricting combustion chamber in the upward direction.

7. The boiler construction set forth in claim 6 wherein each exchanger unit comprises a plurality of passes one of which is secured to the inlet header and the other to the outlet header.

8. The boiler construction set forth in claim 6 wherein said tubes have transverse fins within said combustion chamber and a triangular baffle above and between adjacent passes of tubing requiring upward gas flow to leave the combustion chamber by passing around said tubes and upwardly substantially directly over the respective centerlines thereof.

9. The boiler construction set forth in claim 6 wherein each pass of each of said tubes extends completely through the said two side walls and wherein all interconnecting tube joints are constructed outside said walls.

10. The boiler construction set forth in claim 6 wherein at least said two side walls are generally horizontally separable along a line passing through said tubes whereby said tubes may be serviced by removal of said top wall and the upper portions of said two side walls.

11. The boiler construction set forth in claim 1 wherein temperature responsive means is carried in at least one of said tubes in the combustion chamber and closes said burner off at a predetermined excessively high temperature.

12. A temperature responsive boiler comprising a combustion chamber, a burner in said chamber, a plurality of

water tube passes in said chamber and a heat responsive element inside at least one of said passes and within said chamber for deenergizing said burner upon an increase in temperature within said pass to a temperature greater than the boiling temperature of water and substantially below the temperature of destruction of said passes.

13. The boiler construction set forth in claim 1 wherein each heat exchanger unit is secured to one of said headers via a flexible metal bend whereby expansion occasioned in said heat exchanger tube unit by operation of the boiler is accommodated.

References Cited

UNITED STATES PATENTS

1,117,050	11/1914	Honigmann	122—367 XR
2,756,727	7/1956	Caplan	122—359
3,062,197	11/1962	Fleischer	122—510
3,160,145	12/1964	Miller	122—367
3,118,430	1/1964	Russell et al.	122—367 XR
3,242,910	3/1966	Hale	122—367 XR

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