United States Patent

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[72] Inventor **Ramsey Sheikh**
Westboro, Mass.

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[73] Assignee **Riley Stoker Corporation**
Worcester, Mass.
a corporation of Massachusetts

[54] **STEAM GENERATING UNIT**
17 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **122/235,** 122/510
[51] **Int. Cl.** **F22b 21/02**
[50] **Field of Search** 122/6A, 235, 235A, 333, 336, 478, 494, 510, 331

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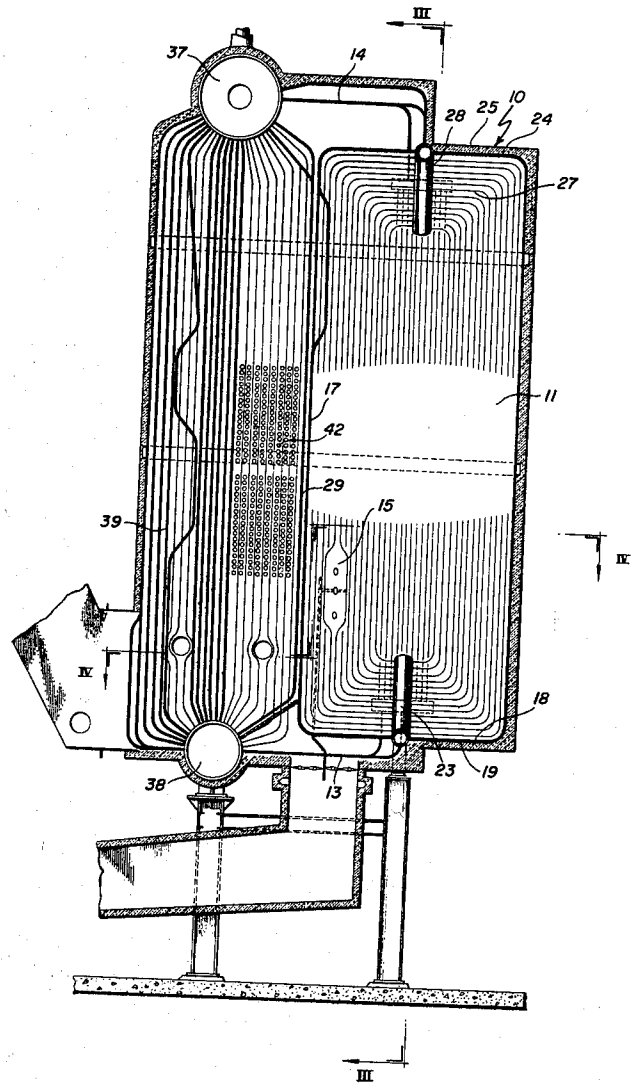
Primary Examiner—Kenneth W. Sprague
Attorney—Ward, McElhannon, Brooks & Fitzpatrick

ABSTRACT: This invention relates to a steam generating unit and, more particularly, to apparatus for generating steam in which the heat from the products of combustion is used very efficiently in a compact, prefabricated construction arrangement.



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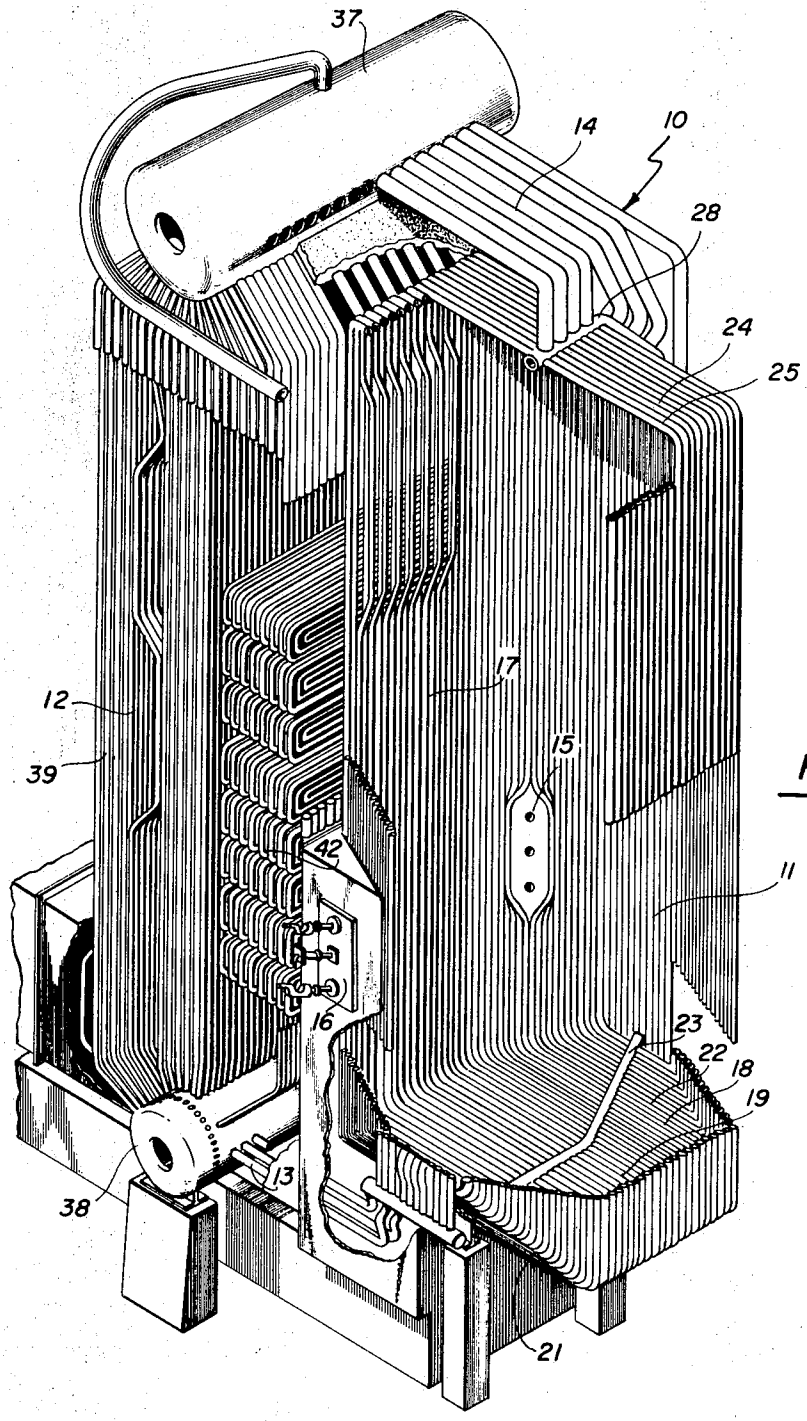


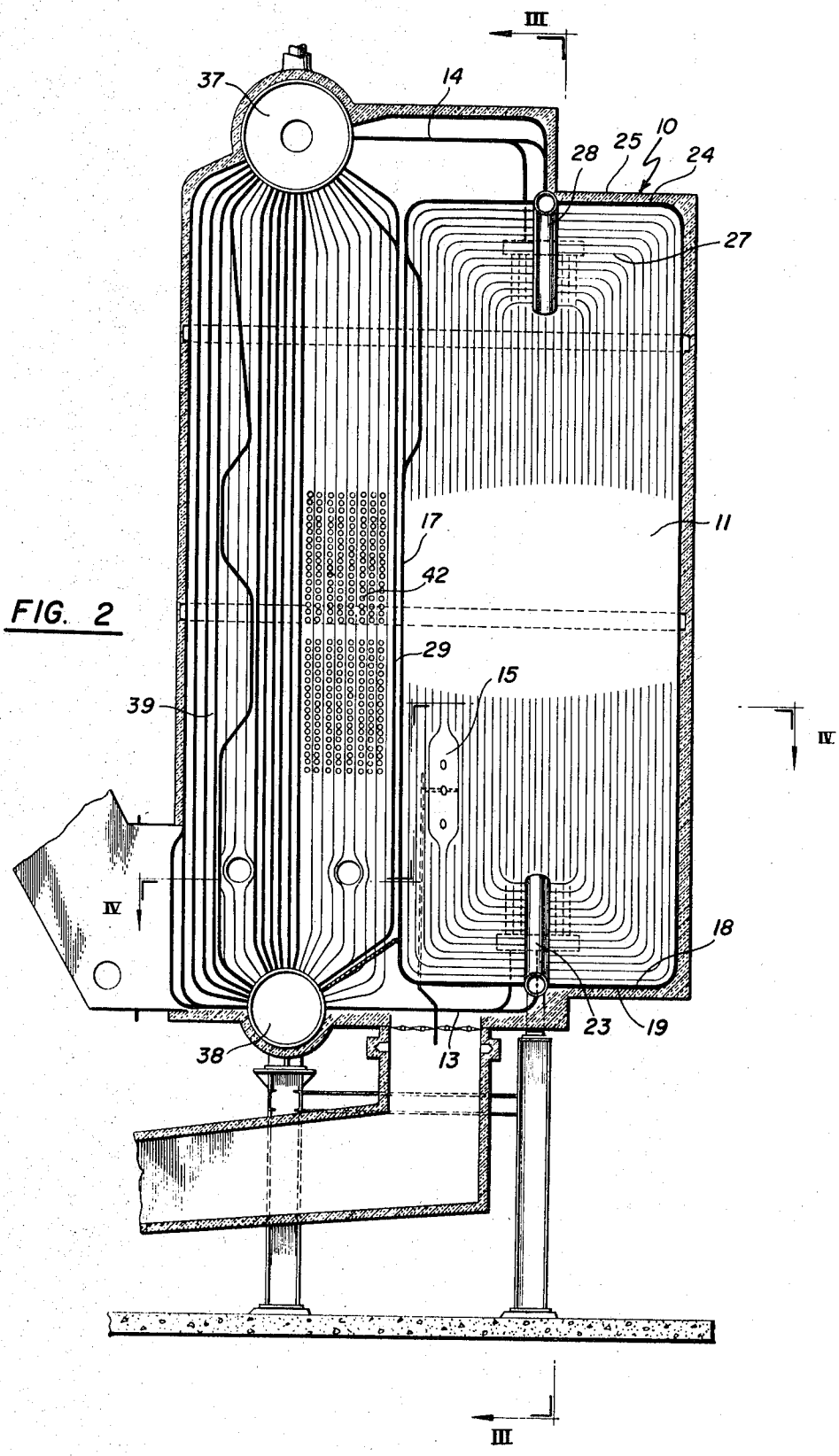
FIG. 1

INVENTOR.
RAMSEY U. SHEIKH

BY

Marvin S. Blodgett

FIG. 2



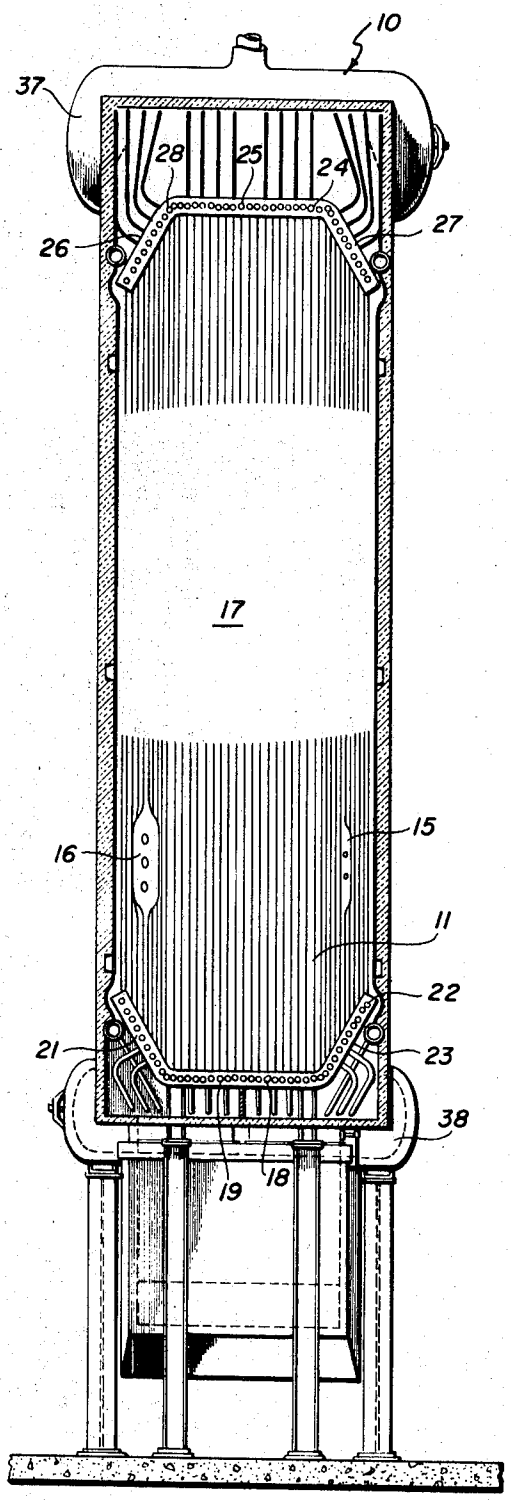


FIG. 3

FIG. 5

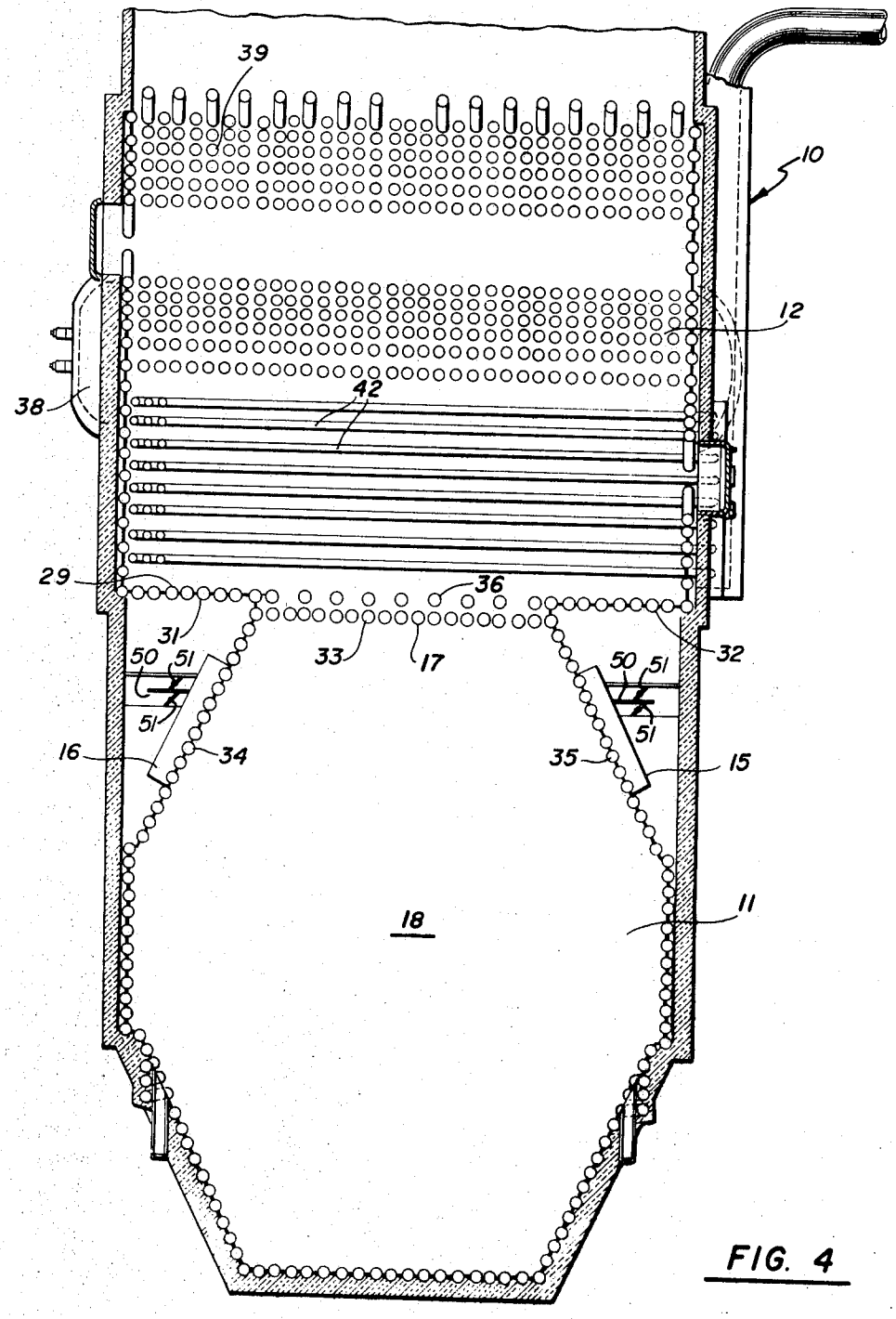


FIG. 4

STEAM GENERATING UNIT

BACKGROUND OF THE INVENTION

It has become fashionable in the boiler industry for the past several years to state with considerable pride that boilermakers have been continually pessimistic in predicting the maximum practical size of package boilers. For instance, the largest package boiler fifteen years ago was for an evaporation of approximately 40,000 lbs/hr. Today, just a few years later, the maximum size is over 200,000 lbs/hr., or five times as large. It may be assumed that this expansion will continue and that in ten years or so the boiler industry will be shipping boilers of 400,000 lbs/hr. or larger in the form of premanufactured package boilers. The expression "package boiler," when it relates to the larger sizes, no longer describes a boiler which is lifted from a railcar, set on its foundation, and piped to steam, fuel and feedwater connections. Instead, the completed installation in many cases consists of several boiler assemblies, ducts, heat recovery equipment, fans, drives, etc. By and large, the common denominator for these units is the fact that the field labor costs have been kept to a minimum. Usually, the net result is that delivered and erected first cost of a package boiler is substantially below that of a field-erected unit of the same evaporation. This is the fundamental reason why there is a wide market for this type of boiler. A comprehensive analysis of relative costs of package versus field-erected boilers was recently made and it was concluded that cost comparisons are difficult to make because of the fact that they are not truly comparable types of boilers. In addition, the variation in the cost of package boilers themselves can be as much as 50 percent depending on whether the unit is conservatively rated or whether it is a marginal unit pushed to extremes of design. As the size of package boilers increases this percentage spread becomes a significant dollar factor in the overall cost of an installation and should be examined very carefully. In addition to the above matters, a new factor has entered the situation which may affect the economics of package boilers in a very significant way. It is now almost universal practice to design field-erected boilers from the smallest industrial to the largest central-station size around the welded wall-type of construction. This relatively new factor has a significant bearing on the shop versus field costs of all boilers. It is interesting to note that, generally speaking, package boilers with this type of construction are conspicuous by their absence from the market. This is because this type of construction has been very difficult to incorporate into this type of boiler. The attempt to extend the known package boiler designs into the larger sizes results in the difficulty that package boilers in general are designed with certain compromises with sound design practice. As these boilers become larger, however, the availability of the boiler becomes much more important, since it represents a larger capital investment and more processes are dependent upon its generation of steam. These and other difficulties experienced with the prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a steam generating unit of the package type in which the heat efficiency is high.

Another object of this invention is the provision of a steam generating unit in which the major elements are capable of construction in a manufacturing plant and shipped to the field for final assembly.

A further object of the present invention is the provision of a steam generating unit of the package type having high availability.

It is another object of the instant invention to provide a package steam generating unit having high steam generating capacity without attendant gas flow problems.

A still further object of the invention is the provision of a steam generating unit in which the fuel burning and gas flow arrangement is such to promote excellent mixing of gases and absence of temperature stratification.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

SUMMARY OF THE INVENTION

In general, the present invention consists of a steam generating unit having a vertically-elongated furnace section of welded wall construction, having a boiler section of vertically-elongated form mounted parallel to and adjacent the furnace section, having feeder tubes connecting the two sections at their lower ends, and having steam release tubes joining the two sections at their upper ends.

More specifically, the furnace section is polygonal in cross section and burners are located on two of the sides which are adjacent to and angularly arranged relative to a rear wall. The furnace section is provided with a bottom consisting of a flat central portion joined to upwardly-inclined portions on the sides. The header extends transversely across the bottom with horizontal and inclined portions lying in the central and inclined portions, respectively. In addition, the furnace section is provided with a roof consisting of a horizontal central portion joined to a downwardly-inclined portion on each side and a header extends transversely across the roof with horizontal and inclined portions lying in the central and inclined portions of the roof.

BRIEF DESCRIPTION OF THE DRAWINGS

The character of the invention, however, may be best understood by reference to one of its structural forms, as illustrated by the accompanying drawings, in which:

FIG. 1 is a perspective view of a steam generating unit embodying the principles of the present invention,

FIG. 2 is a longitudinal sectional view of the unit,

FIG. 3 is a sectional view of the unit taken on the line III–III of FIG. 2,

FIG. 4 is a horizontal sectional view of the unit taken on the line IV–IV of FIG. 2, and

FIG. 5 is a sectional view of a portion of a wall.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, wherein are best shown the general features of the invention, the steam generating unit, indicated generally by the reference numeral **10**, is shown as consisting of a furnace section **11** and a boiler section **12**. The furnace section **11** is formed of welded wall construction of the type shown in section in FIG. 5 and is of vertically-elongated form. The boiler section **12** is also of vertically-elongated form and is mounted parallel to and adjacent to the furnace section. Feeder tubes **13** connect the two sections at their lower ends and steam release tubes **14** join the two sections at their upper ends. Each section has a cross-sectional dimension which permits transportation on a railroad flat car with adequate overhead and side clearance. The cross-sectional shape of the furnace section **11** is octagonal and burners **15** and **16** are located on two of the sides which are adjacent to and angularly-arranged relative to the rear wall **17**.

The furnace section **11** is provided with a bottom **18** which consists of a flat central portion **19** joined to upwardly-inclined portions **21** and **22** on the sides. The header **23** extends across the bottom **18** with horizontal and inclined portions lying in the central portion **19** and the inclined portions **21** and **22**, respectively.

The feeder tubes **13** extend rearwardly from the header **23** and are welded to corresponding feeder tubes extending forwardly from the boiler section **12**. The furnace section **11** is provided with a roof **24** consisting of a horizontal central portion **25** joined to downwardly-inclined portions **26** and **27** on the sides. A header **28** extends transversely across the roof **24** with horizontal and inclined portions lying in the central portion **25** and the inclined portions **26** and **27**, respectively.

The steam release tubes **14** extend rearwardly from the header **28** and are welded to corresponding steam release tubes extending forwardly from the boiler section. The rear wall **17** of the furnace section **11** and a front wall **29** of the boiler section **12** are located in juxtaposition. The front wall **29** of the boiler section has two side panels **31** and **32** (see FIG. **4**) which lie in a transverse plane and define a gap between them. The rear wall of the furnace section **11** has a central panel **33** which lies in the said gap and also has the two forwardly-inclined panels **34** and **35** which lie at a substantial horizontal angle to the said side panels of the front wall of the boiler section.

Each side panel **31** and **32** of the front wall **29** of the boiler section **12** and its corresponding forwardly-inclined panel **34** and **35**, respectively, of the rear wall of the furnace section form a space of triangular horizontal cross-sectional shape in which lie burner boxes associated with the burners **15** and **16**. As a practical matter, a plurality of vertically-spaced burners are mounted in each burner box and extend through the said forwardly-inclined panels **34** and **35**, as is evident in FIG. **4**. Each burner box is provided with a baffle **50** and dampers **51** to permit delivery of air selectively to an individual burner.

The aforementioned gap in the front wall of the boiler section is provided with widely-spaced tubes **36** which extend from the upper drum **37** to the lower drum **38** and these tubes are not joined in their intermediate portions. The central panel **33** of the rear wall **17** of the furnace portion **11** has some of its tubes bent out of the plane of the panel in the upper portion to form a gas exit opening. The tube spacing and location in longitudinal vertical planes is the same as the spacing and location of the tubes in the widely-spaced tubes **36** in the aforementioned gap.

The boiler section **12** is provided with an upper drum **37** and a lower drum **38** which are joined in the usual manner by a mass of downcomer tubes **39**. The drums are joined by a front, rear, and two sidewalls formed of closely-spaced tubes which, in turn, are joined by welded strips. A baffle **41** extends downwardly from the upper drum **37** to divide the space formed by the said walls into a forward pass in which a superheater **42** is located and a rearward pass in which the said mass of downcomer tubes **39** is located.

The furnace section **11** and the boiler section **12** are independently manufactured at a location remote from the construction site. As has been stated above, the boiler section is provided with forwardly-directed feeder tubes at the lower end and steam release tubes at the upper end, while the furnace section is provided with rearwardly-directed feeder tubes at the lower end and steam release tubes at the upper end. The sections are independently transported to the construction site where they are mounted in parallel juxtaposition and the feeder and steam release tubes are welded together.

The advantages of the above construction will be apparent from a close study. For one thing, a safe margin of water circulation in the boiler has been assured by providing a high-head boiler which permits the handling of high heat absorption rates that are inherent in shop-assembled boilers. Since both sections are constructed entirely of welded walls, they have sufficient structural rigidity to permit shipping them in a horizontal position; the packages are placed on the railroad car with the long axis parallel to the length of the car. Installation at the site consists simply of swinging the assemblies into a vertical position and setting them on four piers or other suitable load pedestals. The only pressure part welding consists of joining a limited number of feeder and release tubes, as has been described above. With this design, the diameter of the drum is no longer a factor because of shipping limitations. This makes it possible to use 54 and 60 inch diameter drums thereby permitting the installation of adequate steam separating equipment. These drum sizes are identical to the drums presently used in field-erected boilers. Consequently, steam purity levels can be comfortably maintained in spite of severe load fluctuations and, certainly, with better purity than has been experienced with conventional package boilers.

It has long been known that a rectangular furnace cross section is not the ideal shape for uniform radiant heat absorption along the periphery. In the ideal case, a point source of radiation in the center of a circle will radiate uniformly to the circumference. FIG. **4** shows the close approximation to the ideal that has been achieved with the present steam generating unit. The fuel and air are injected through the burners in a diagonally-opposed fashion with the trajectories meeting approximately in the center of the octagonal furnace. The resultant high intensity core of combustion is a single oblong flame mass that radiates to all walls in a uniform manner. The high velocity jets from both sides impinge on each other and the momentum is converted into secondary atomization of liquid fuels and a high degree of turbulence. In the preferred embodiment, four burners would be associated with each of the inclined panels to give a total of eight burners and experience has shown that the turndown which is possible is far greater than with most existing boilers. Although opposed firing is maintained to retain uniformity in heat absorption and gas flow for continuous operation, under light load conditions and for the cleaning of burner guns and the like, individual burners can be removed from operation without detrimental effects. The present design provides for access for inspection, repair of cleaning of the entire generating bank, superheater, and furnace. It is clear, then, that the present design has provided a shop-assembled boiler that has all the characteristics of proven field-erected designs without excluding the economic advantages of shop assembly.

It is obvious that minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desired to confine the invention to the exact form herein shown and described, but it is desired to include all such as properly come within the scope claimed.

I claim:

1. A steam generating unit, comprising:

a. a furnace section of welded wall construction of vertically-elongated form;

b. a boiler section of vertically-elongated form mounted parallel and adjacent to the furnace section;

c. feeder tubes connecting the two sections at their lower ends;

d. steam release tubes joining the two sections at their upper ends;

e. each of said sections having cross-sectional dimensions permitting it to be accommodated with its length horizontal on a railroad flatcar with adequate overhead and side clearance;

f. each of said sections further being of such complete and integral construction as to permit self support with its length horizontal and as to require for completion of its pressure parts only the connection of feeder and steam release tubes to the other section; and wherein the furnace section is provided with a bottom consisting of a flat central portion joined to an upwardly-inclined portion on each side and wherein a header extends transversely across the said bottom with horizontal and inclined portions lying in the central and inclined portions, respectively.

2. A steam generating unit as recited in claim **1**, wherein the said feeder tubes extend rearwardly from the header and are welded to corresponding feeder tubes extending forwardly from the boiler section.

3. A steam generating unit, comprising: a. a furnace section of welded wall construction of vertically-elongated form;

b. a boiler section of vertically-elongated form mounted parallel and adjacent to the furnace section;

c. feeder tubes connecting the two sections at their lower ends;

d. steam release tubes joining the two sections at their upper ends;

e. each of said sections having cross-sectional dimensions permitting it to be accommodated with its length horizon-

tal on a railroad flatcar with adequate overhead and side clearance; and

f. each of said sections further being of such complete and integral construction as to permit self support with its length horizontal and as to require for completion of its pressure parts only the connection of feeder and steam release tubes to the other section; and wherein the furnace section is provided with a roof consisting of a horizontal central portion joined to a downwardly-inclined portion on each side and wherein a header extends transversely across the said roof with horizontal and inclined portions lying in the central and inclined portions of the roof.

4. A steam generating unit as recited in claim 6, wherein the said steam release tubes extend rearwardly from the header and are welded to corresponding steam release tubes extending forwardly from the boiler section.

5. A steam generating unit, comprising a furnace section of welded wall construction of vertically-elongated form, a boiler section of vertically-elongated form mounted parallel and adjacent to the furnace section, feeder tubes connecting the two sections at their lower ends, steam release tubes joining the two sections at their upper ends, said furnace section having a cross-sectional shape forming a polygon of more than four sides arranged to approximate a circle, and burners located on at least two of said sides and positioned to produce high velocity fuel and air jets which meet and impinge on each other approximately in the center of said cross section to produce a high intensity core of combustion in a single oblong flame mass that radiates to all of said furnace walls in a uniform manner.

6. A steam generating unit comprising a furnace section of welded wall construction of vertically-elongated form, a boiler section of vertically-elongated form mounted parallel and adjacent to the furnace section, feeder tubes connecting the two sections at their lower ends, steam release tubes joining the two sections at their upper ends, said furnace section having a rear wall and said boiler section having a front wall located in juxtaposition to the rear wall of the furnace section, said boiler section having a front wall including two side panels lying in a transverse plane and defining a gap between them, the rear wall of the furnace section having a central panel which lies in said gap and two forwardly inclined panels which lie at a substantial horizontal angle to the said side panels of the front wall of the boiler section.

7. A steam generating unit as recited in claim 6, wherein each side panel of the front wall of the boiler section and its corresponding forwardly-inclined panel of the rear wall of the furnace section form a space of triangular horizontal cross-sectional shape, wherein a burner box is located in the space, and wherein a plurality of vertically-spaced burners are mounted in the burner box and extend through the said forwardly-inclined panel.

8. A steam generating unit as recited in claim 7, wherein the burner box is provided with a baffle and dampers to permit delivery of air selectively to an individual burner.

9. A steam generating unit as recited in claim 6, wherein the said gap in the front wall of the boiler section is provided with widely-spaced tubes which extend from the upper drum to the lower drum and which are not joined in their intermediate portions.

10. A steam generating unit as recited in claim 9, wherein the central panel of the rear wall of the furnace portion has some of its tubes bent out of the plane of the panel in the upper portion to form a gas exit opening, and wherein the tube spacing and location in longitudinal vertical planes is the same as the spacing and location of the tubes in the widely-spaced tubes in the said gap.

11. A steam generating unit as recited in claim 5, wherein the boiler section has an upper and a lower drum joined by a mass of downcomer tubes, wherein the drums are joined by a front, rear, and two side walls formed of closely-spaced tubes joined by welded strips, and wherein a baffle extends downwardly from the upper drum to divide the space formed by the said walls into a forward pass in which a superheater is located and a rearward pass in which the said mass of downcomer tubes is located.

12. A steam generating unit as recited in claim 6, wherein the furnace section and the boiler section are independently manufactured at a location remote from a construction site, wherein the boiler section is provided with forwardly-directed feeder tubes at the lower end and steam release tubes at the upper end, wherein the furnace section is provided with rearwardly-directed feeder tubes at the lower end and steam release tubes at the upper end, wherein the sections are independently transported to a construction site where they are mounted in parallel juxtaposition and the feeder and steam release tubes are welded together.

13. A steam generating unit, comprising:

a. a furnace section of welded wall construction of vertically-elongated form, said welded wall construction comprising vertical tubes interspersed with flanges welded thereto along their lengths the cross-sectional shape of the furnace section being polygonal and including a rear wall,

b. a boiler section of vertically-elongate form mounted parallel and adjacent to the furnace section, and

c. burners located on two sidewalls of said furnace section which are adjacent to and angularly arranged relative to said rear wall, the furnace section being provided with a bottom consisting of a flat central portion joined to an upwardly-inclined portion on each side, said upwardly-inclined portions being formed of constructions of the tubes and flanges of said sidewalls.

14. A steam generating unit as recited in claim 13, wherein a header extends transversely across the said bottom with horizontal and inclined portions lying in the central and inclined portions, respectively.

15. A steam generating unit as recited in claim 14, wherein the furnace section is provided with a roof consisting of a horizontal central portion joined to a downwardly-inclined portion on each side and wherein a header extends transversely across the said roof with horizontal and inclined portions lying in the central and inclined portions of the roof.

16. A furnace structure comprising tube panel walls having parallel tubes interspersed with flanges, said walls being arranged to surround an interior region, the ends of the tubes forming the panel walls being bent inwardly of said enclosure toward a common line at each end of the enclosure, a header at each end of said enclosure and lying along said common line, said majority of the tubes being connected to said headers thereby to provide a structurally sound enclosure with minimal header connection requirements, the tubes in first selected regions of said panel walls being configured to form first openings for the admission of burners into said interior region and the tubes in second selected regions of said panel walls being configured to form second openings for the exit of exhaust gases from said interior region.

17. A furnace structure according to claim 16 wherein the bent ends of some of the tubes are arranged to form inclined walls at the ends of the enclosure.