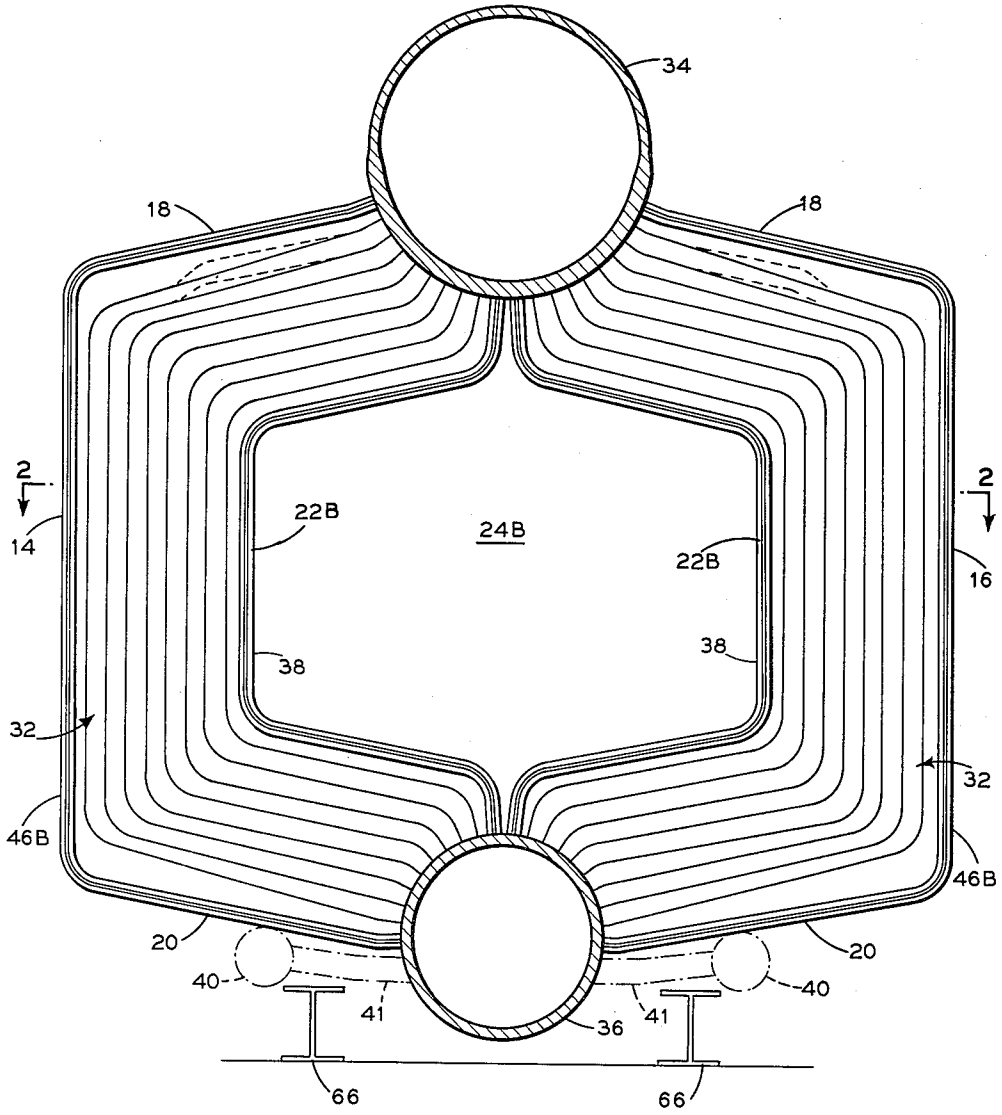
Feb. 27, 1962 C. C. HAMILTON ETAL 3,022,774

STEAM GENERATOR

Filed May 7, 1959 6 Sheets-Sheet 1

FIG. 1



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STEAM GENERATOR

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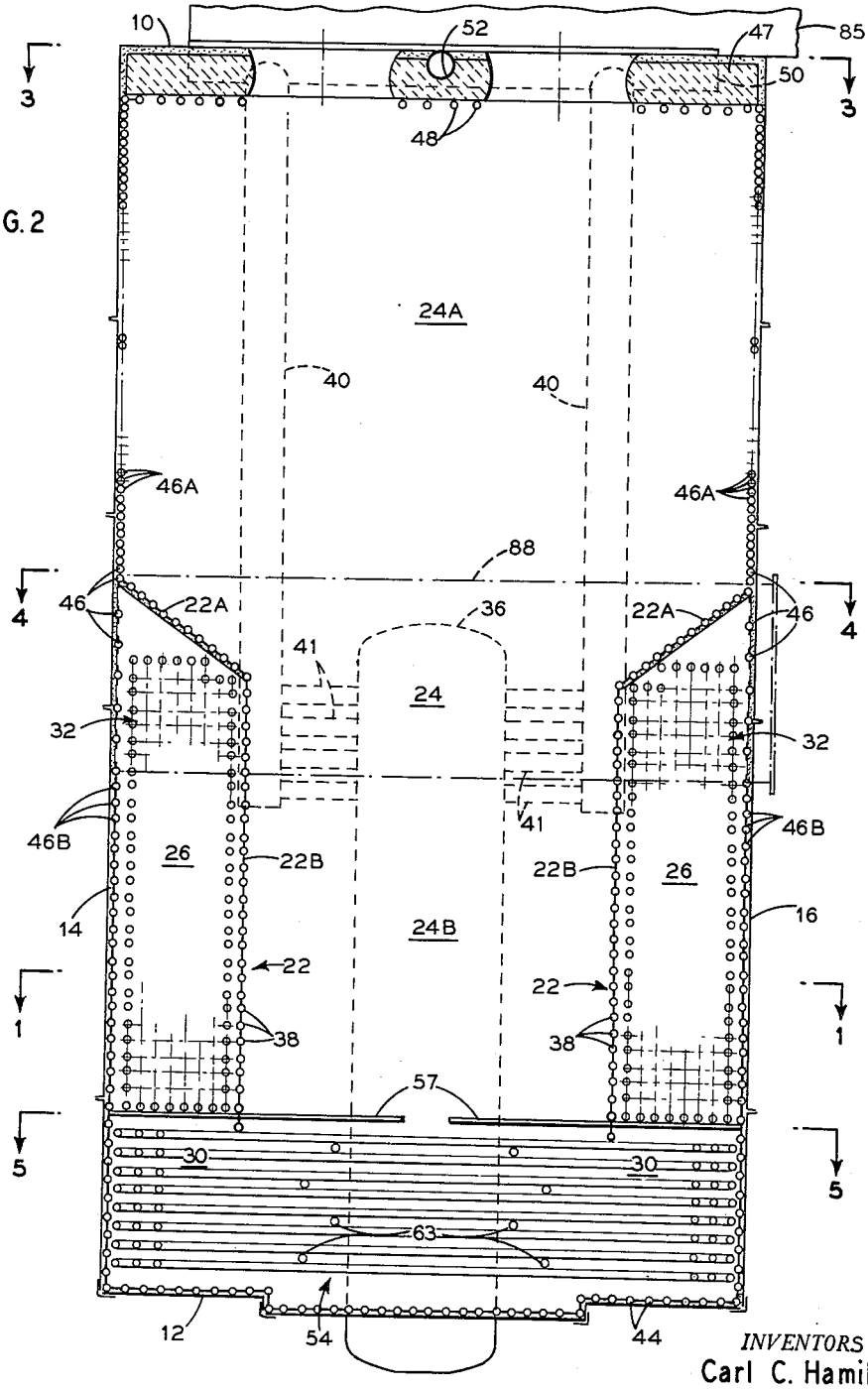
FIG. 2



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STEAM GENERATOR

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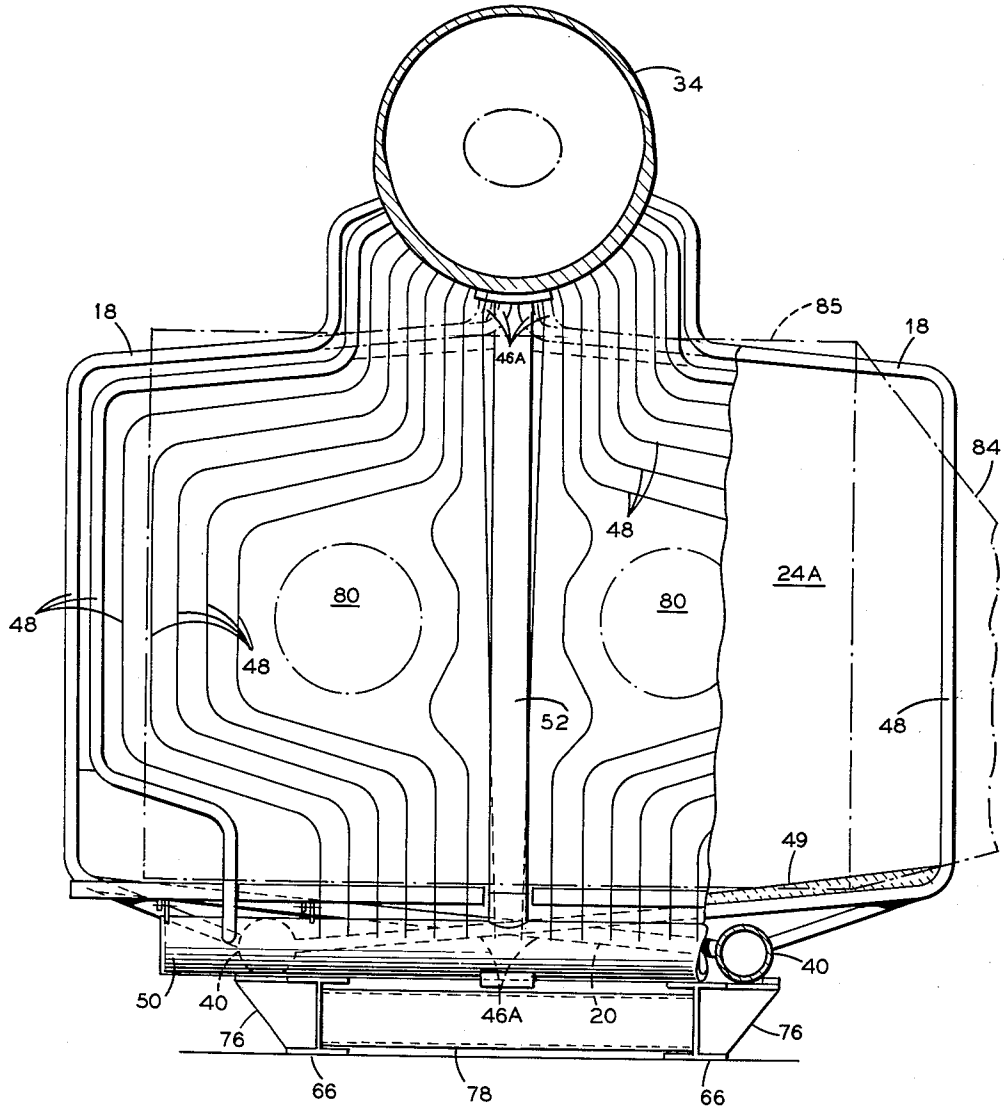
FIG. 3



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STEAM GENERATOR

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FIG. 4

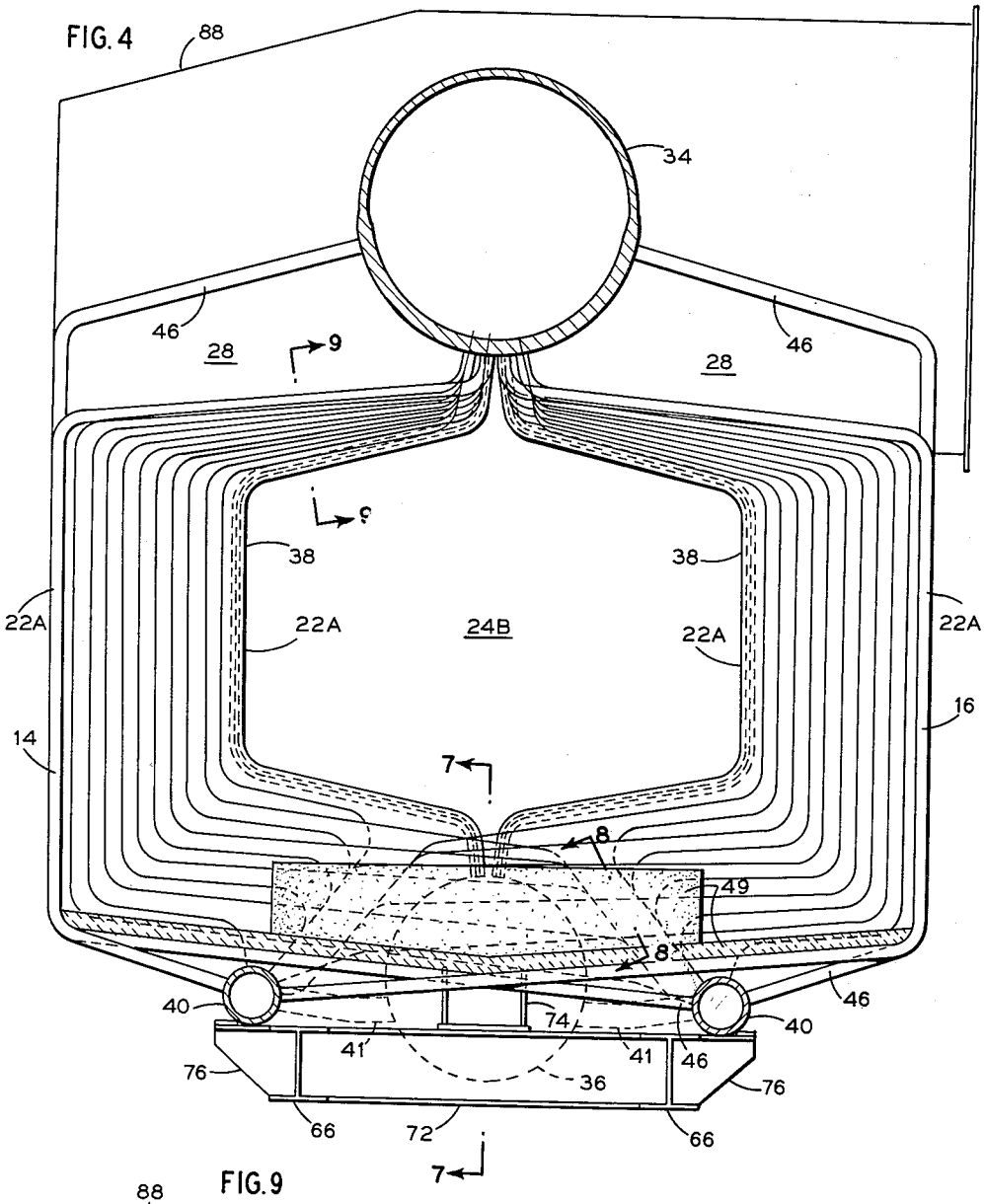
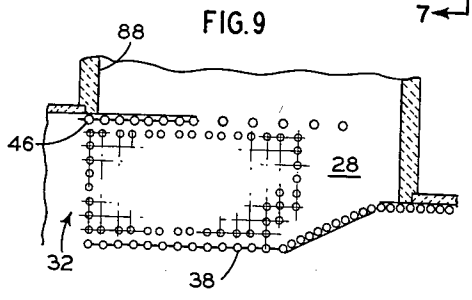


FIG. 9



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STEAM GENERATOR

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FIG. 10

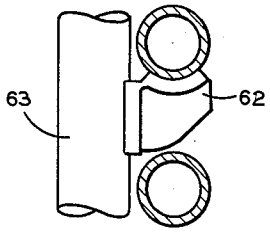
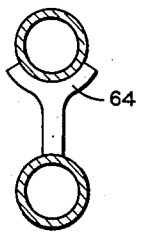


FIG. 5

FIG. 11



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STEAM GENERATOR

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FIG. 7

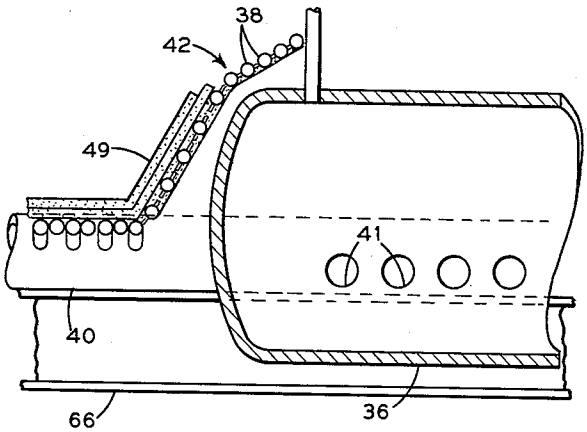


FIG. 8

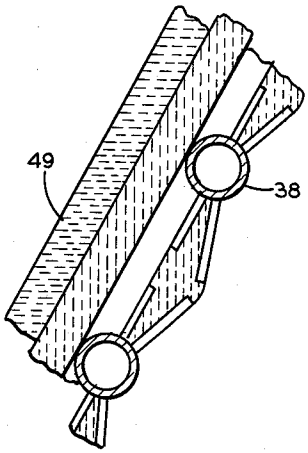
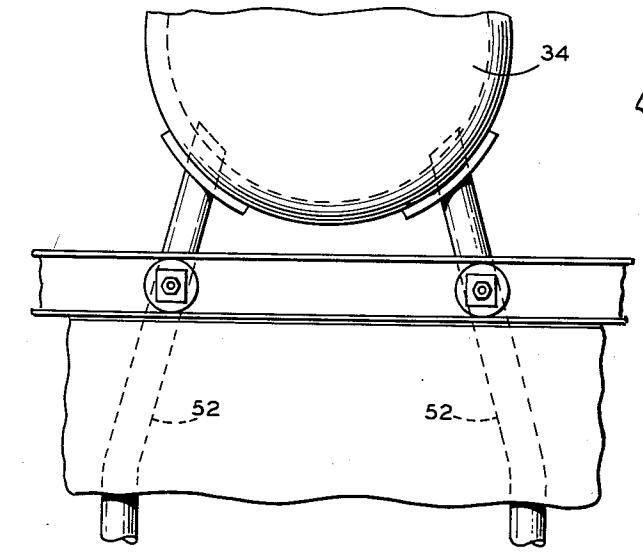
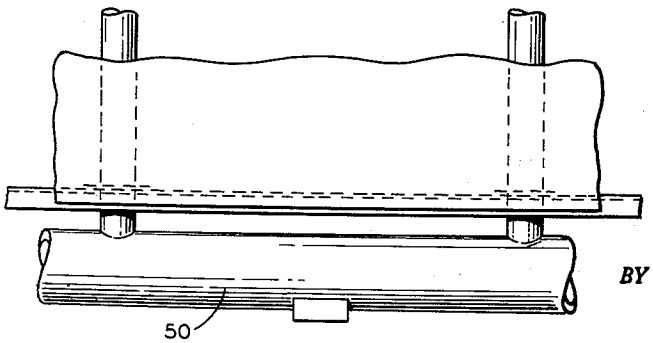


FIG. 6





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United States Patent Office 3,022,774 Patented Feb. 27, 1962

3,022,774
STEAM GENERATOR

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Filed May 7, 1959, Ser. No. 811,718
12 Claims. (Cl. 122—478)

This invention relates in general to the construction and operation of steam generators and more particularly to improvements in the construction and operation of water tube boilers of the shop assembled type.

The general object of the present invention is the provision of a shop-assembled steam generator possessing the virtues of compactness, portability, simplicity, reliability and ability to provide sustained efficient operation at high ratings with a minimum of physical size for the output achieved and a low draft loss. A further and more specific object of the invention is the provision of a steam generating unit of the type described which is characterized by an arrangement of fuel burning provisions and a furnace construction permitting the burning of a fluid fuel at high rates of heat release per cubic foot of furnace volume; its readiness upon delivery to be skidded or lifted onto the foundation, hooked up and placed in operation, thereby saving in cost of building and erection; an arrangement of fluid heating surface in the furnace increasing the effectiveness of the furnace without increasing its volume or outside space requirements and reducing refractory required in the furnace to a minimum; and its ability to deliver a uniform steam temperature over a wide load range and to respond to wide and frequent load swings.

In accordance with the invention the steam generating unit comprises walls including fluid heating tubes forming a setting divided by partitions into a furnace and a pair of convection heating gas passes, with each of the heating gas passes extending along a portion of the width and length of the setting and with the furnace extending the length of the setting and having one portion extending the width of the setting and another portion disposed intermediate and opening to the gas inlet end of each of the convection heating gas passes. Each of the heating gas passes is occupied by a bank of fluid heating tubes having their upper ends connected to a steam and water drum extending the length of the setting and their lower ends connected to a water drum extending the length of the heating gas passes. The fuel burning means and furnace are constructed and relatively arranged so as to effect a flow of heating gases longitudinally through the furnace and reversely and in parallel through the convection heating gas passes. Some of the fluid heating tubes of the unit are constructed and arranged to form a baffle for shielding the lower drum from the high temperature heating gases; others of the fluid heating tubes are arranged to form the floor and roof of the furnace; and still others of the fluid heating tubes are arranged upright and collectively act to support the weight of a steam superheater disposed in the gas discharge end of the furnace and in the gas inlets of the convection heating gas passes. Another feature of the invention is the provision of a downcomer tube or tubes arranged to supply fluid to some of the fluid heating tubes and to support a substantial portion of the weight of the steam and water drum.

The various features of novelty which characterize our 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 we have illustrated and described a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a vertical section of a steam generator constructed in accordance with the invention taken on the line 1— 1 of FIG. 2;

FIG. 2 is a sectional plan view taken along the line 2—2 of FIG. 1;

FIG. 3 is a vertical section taken along the line 3—3 of FIG. 2 and partly broken away to show the interior of the furnace;

FIG. 4 is a vertical section taken along the line 4—4 of FIG. 2;

FIG. 5 is a vertical section taken along the line 5—5 of FIG. 2;

FIG. 6 is a vertical section of a modification of the upper drum support arrangement shown in FIG. 3;

FIG. 7 is a sectional view taken along the line 7—7 of FIG. 4;

FIG. 8 is an enlarged sectional view taken along the line 8—8 of FIG. 4;

FIG. 9 is a sectional view taken along the line 9—9 of FIG. 4;

FIG. 10 is an enlarged view of one of the superheater support lugs; and

FIG. 11 is an enlarged view of one of the spacer lugs between superheater tubes.

In the drawings the invention has been illustrated as embodied in a shop-assembled bottom-supported natural circulation steam generating unit designated principally for oil, gas, or combination firing and for furnace operation under internal gaseous pressures above atmospheric pressure; and available in standard sizes for loads ranging up to 100,000 pounds of steam per hour at pressures from 250 to 775 p.s.i. and at temperatures ranging from the saturation temperature corresponding to the pressure to 750° F. with the use of a superheater. The maximum cross-section of the unit is fixed by shipping clearances, with the necessary furnace and boiler heating surface usua'ly being gained by increasing the length of the unit while holding the cross-section constant. Preassembly of the components of the unit in the factory assures a better quality finished unit, minimizes the time and effort required at the project site to place the unit in service, and assures optimum performance. The unit requires no prepared foundation other than a floor of sufficient strength, and no skilled labor for making the few connections required to place it in service.

The steam generating unit comprises a setting of rectangular cross-section having upright front and rear walls 10 and 12, respectively, upright opposing side walls 14 and 16, an upper enclosing wall or roof 18 and a lower enclosing wall or floor 20. The space within the setting is divided by a pair of upright partition walls 22 into a furnace 24 and a pair of convection heating gas passes 26 symmetrically arranged at opposite sides of the setting and each having a gas outlet 28 at one end thereof and a gas inlet 30 at its opposite end opening to the rear end of the furnace 24. Each of the heating gas passes 26 extends along only a portion of the length and width of the setting. The furnace 24 extends along the length of the setting, with one portion 24A of the furnace disposed forwardly of the heating gas passes 26 and extending the width of the setting and the remaining portion 24B disposed intermediate and extending along the length of the heating gas passes 26. The furnace portion 24B has a vertical cross-sectional area substantially smaller than that of the furnace portion 24A and opens at its rear end to the gas inlet 30 of each of the heating gas passes 26.

Each of the heating gas passes 26 is occupied by a bank of upwardly extending tubes 32 of relatively small diam-

eter disposed across the flow of gases and having their upper ends connected to a horizontally arranged upper steam and water drum 34 and their lower ends, except for the last row of tubes relative to heating gas flow, connected to a horizontally arranged lower water drum 36. The last row of tubes relative to heating gas flow of the tube banks 32 have their lower ends connected to horizontally arranged lower side wall headers 40. The portions of the drums 34 and 36 in the heating gas passes 26 are protected from excessive heat by having the tubes 32 enter the drums over their entire exposed portions. The cross-flow of gases over the tubes 32 provides the most advantageous use of this convection heat absorbing surface and contributes to high steam generating capacity within the space available. Each tube 32 extends downwardly and outwardly from the drum 34, then vertically downward, and then downwardly and inwardly to the drum 36 or to one of the headers 40, in the case of the last row of tubes of each tube bank. The tubes 32 are arranged on alternate wide and narrow back spacing to simplify tube replacement; to provide an optimum quantity of heat absorption surface in the space available, thereby insuring high efficiency operation; and to minimize draft loss. The tubes 32 are preferably of 2 inches outside diameter. The relatively small diameter of these tubes, together with the cross-flow of gases thereover, provide optimum rates of heat transfer from the hot gases to the fluid in the tubes. The rapid flow of heat through the tubes to the small column of fluid in each tube makes the unit a notably fast steamer, capable of coming on the line quickly and readily handling sudden load changes. The upper steam and water drum 34 is disposed superjacent and extends the length of the combustion chamber 24 and has its longitudinal axis in the same vertical plane as the longitudinal centerline of the setting and the furnace. The lower water drum 36 extends the length of the portion 24B of the furnace and has its longitudinal axis in the same vertical plane as that of the upper drum 34.

The partition walls 22 extend upwardly from the lower drum 36 to the upper drum 34 and include portions 22A projecting inwardly and rearwardly from the side walls 14 and 16, respectively, and portions 22B extending longitudinally of the setting from the inner ends of the portions 22A to a location spaced from the rear wall 12 to provide the openings to the gas inlets 30 of the heating gas passes 26. Each partition wall is formed by closely spaced tubes 38 of relatively small outside diameter, preferably 2 inches, to promote high rates of heat transfer and having their intertube spaces closed by metallic studs welded to the tubes along the lengths thereof so that the wall is substantially imperforate to gas flow. The large amount of water cooled surface in the partition walls 22 increases the effectiveness of the water cooled furnace without increasing its volume or its outside space requirements. The tubes 38 of the partition walls 22 are similar in form to the tubes 32 and have their upper portions bent inwardly and upwardly at a slight angle to the horizontal for connection to the drum 34 and to define with the metallic studs therebetween the roof of the furnace portion 24B. The tubes 38 of the partition wall portions 22B have their lower portions bent inwardly and downwardly at a slight angle to the horizontal for connection to the drum 36 and to form with the metallic studs therebetween the major portion of the floor of the furnace portion 24B. The drums 34 and 36 are protected from excessive furnace heat by having the tubes 38 connected thereto enter the drums immediately adjacent to and on opposite sides of the vertical axes thereof. The tubes 38 of the partition wall portions 22A have their lower portions bent inwardly and downwardly for connection to the lower side wall headers 40. The headers 40 are disposed on opposite sides of the longitudinal centerline of and subjacent to the furnace 24, extend longitudinally of the setting from the front wall 10 to a point a short distance beyond the juncture of the partition wall portions 22A and 22B, and are connected for fluid supply from the drum 36 by tubes 41. As shown in FIGS. 4, 7 and 8, the lower portions of the tubes 38 of the partition wall portions 22A have their intertube spaces studded and covered with refractory to form a rearwardly inclined baffle wall 42 for shielding the front end of the lower drum 36 from the high temperature combustion gases, with alternate tubes 38 of each partition wall portion 22A terminating in the lower side wall header 40 on the opposite side of the furnace 24 and the remainder terminating in the lower side wall header 40 on the corresponding side of the furnace 24. The baffle wall 42 extends across the furnace 24, is positioned adjacent to and upstream gas-wise of the front end of the drum 36, constitutes the front end of the floor of the furnace portion 24B, and extends to the rear end of the floor of the furnace portion 24A.

The rear wall 12, side walls 14, 16, roof 18, and floor 20 of the setting are formed by insulation covered gas-tight metallic casing lined by fluid cooled tubes secured thereto and of relatively small outside diameter, preferably 2 inches, to promote high rates of heat transfer. The rear wall 12 includes a row of closely spaced tubes 44 having their intertube spaces closed by metallic studs and their opposite ends connected to the drums 34 and 36. Each side wall includes a row of tubes 46, some 46A of which are disposed in the furnace portion 24A in tangent relationship, while the remainder 46B are located in the corresponding heating gas pass 26. The tubes 46A of the side walls have their upper portions bent inwardly and upwardly in converging relation for connection to the drum 34 and to form a portion of the roof 18 of the setting, as well as the roof of the furnace portion 24A. The drum 34 is protected from radiation from the high temperature gases in the furnace by having the tubes 46A enter the drum immediately adjacent to and on opposite sides of the vertical axis thereof. The tubes 46A of the side walls have their lower portions bent inwardly and downwardly to form a portion of the floor of the setting, as well as the floor of the furnace portion 24A, with alternate tubes of the tubes 46A of each side wall terminating in the lower side wall header 40 on the opposite side of the furnace and the remainder terminating in the lower side wall header 40 on the corresponding side of the furnace. The floor of the furnace portion 24A and the lower portion of the inclined baffle 42 are covered with two courses of firebrick 49. The tubes 46B of each side wall at the low temperature end of the corresponding heating gas pass 26 are relatively widely spaced and studded to support refractory closing the intertube spaces, while the remaining tubes 46B are closely spaced and have their intertube spaced closely by metallic studs welded thereto. The tubes 46B of the side walls have their upper portions bent inwardly and upwardly for connection to the drum 34 and to form the remainder of the roof of the setting, as well as the roof or upper end of the heating gas passes 26; and have their lower portions bent inwardly and downwardly for connection to the drum 36 and to form the remainder of the floor of the setting, as well as the floor or lower end of the heating gas passes 26. The front wall 10 comprises firebrick 47 covered by metallic casing and lined by a row of widely spaced tubes 48 having their upper ends connected to the drum 34, and their lower ends, excepting the corner tubes, connected to a transverse horizontally arranged header 50 at the outer side of the wall and subjacent the furnace portion 24A. The corner tubes 48 next adjacent the side wall tubes 46A have their lower ends connected to the headers 40. The amount of exposed refractory in the front wall 10 is sufficient to maintain furnace temperature and insure stable ignition and operation under low-load conditions. The header 50 is connected to the drum 34 by an upright downcomer tube 52 encased in the wall 10 at the outer side of the tube row 48. The front end of each of the headers 40 opens into and is connected to the

header 50, but in a fluid circulation sense each header 40 is separated from the header 50 at the junction therewith by a diaphragm 43.

By utilizing the lower headers 40 and 50 instead of an extension of the lower drum to receive the side and front wall tubes of the furnace portion 24A the maximum possible furnace volume and burner clearances are provided and the problem of adequate protection of the lower drum from the high temperature combustion gases in the furnace portion 24A is eliminated. Moreover, the tangent and extended surface tubes in the furnace zone not only increase the amount of radiant heat absorbing surface in the space available and the ratio of heat absorbing surface to furnace volume but eliminates the need for refractory materials in the walls so arranged.

As shown in FIGS. 2 and 5, the rear or gas discharge end of the furnace and the gas inlets 30 of the heating gas passes are occupied by a drainable type superheater 54. The superheater tube portions located in the heating gas passes 26 absorb heat chiefly by convection and the tube portions located in the gas discharge end of the furnace absorb heat mostly by direct radiation from the furnace. The combination of the falling steam temperature characteristic of the radiant portion of the superheater with increasing steam flow, together with the rising steam temperature characteristic of the convection portion of the superheater with increasing steam flow, provides a substantially constant steam temperature over a relatively wide range of loads. The superheater 54 comprises three groups of horizontally disposed nested multi-looped tubes extending substantially the width of the setting and arranged in laterally spaced vertically extending panels, with corresponding panels serially connected to define parallel flow paths for fluid flow between horizontally arranged upper inlet and lower outlet headers 56 and 58, respectively. The header 56 is connected to the drum 34 by tubes 60. The space at the gas inlet end of the superheater between the top of the panels and the drum 34 is mostly closed by metallic baffles 55 connected to the drum 34, while the space at the gas inlet end of the superheater between the bottom of the panels and the drum 36 is mostly closed by metallic baffles 57 connected to the drum 36. Adjustment of the superheat is attained by altering the height of the baffles 55, 57 to change the gas mass velocity over the superheater tubes. The portions of the drums 34 and 36 in the superheater zone are protected from excessive heat by refractory 59. As shown in FIGS. 10 and 11, the superheater tubes are supported by lugs 62 welded to upright fluid cooled support tubes 63 at vertically spaced positions therealong, while the vertical spacing between tubes is maintained by Y-shaped lugs 64. The support tubes 63 have their opposite ends connected to the drums 34 and 36, are symmetrically arranged on opposite sides of the longitudinal centerline of the setting, and are positioned between the tubular panels. Each of the lugs 62 has a recessed portion adapted to receive a tube. Each of the lugs 64 has its lower end secured to the corresponding tube and its upper end formed with a seat fitted to the next vertically adjacent tube. The lugs 62 and 64 cooperate to restrain lateral and vertical movements of the tubes, while permitting longitudinal movement thereof. Lateral movement of the tubes is also restrained by lugs 65 welded to the side wall tubes 46B at vertically spaced positions therealong and disposed between the outermost loops of the tubular panels.

The steam generating unit is bottom-supported by structural steel members including I-beams 66 adapted to be carried by the concrete foundation. The beams 66 extend the length of the setting and are symmetrically arranged on opposite sides of the longitudinal centerline thereof. The weight of the drums 34 and 36 and of the tubes extending therebetween is mostly supported by longitudinally spaced I-beams 68 extending between the beams 66 and below the drum 36 and expansibly secured to castings 70 welded to the drum; and by an I-beam 72 extending between the beams 66 and fixedly secured to a casting 74 welded to the front end of the drum 36. The lower side wall headers 40 and the superheater outlet header 58 are carried by longitudinally spaced castings 76 projecting from the beams 66. The front wall header 50 is carried by the beams 66 and cooperates with the beams 66 and the upright downcomber tube 52 to provide additional support for the upper drum 34. The tube 52 lies in the same vertical plane as the vertical axis of the drum 34 and is of sufficient diameter and thickness to resist bending moment stresses in carrying the drum and to withstand the compression forces transmitted to it. Thus the tube 52 functions as a supply tube in the fluid circulation system and as, in effect, part of the support provisions for the upper drum 34. As an alternative, the tube 52 may be replaced by two vertically extending tubes of smaller diameter and thickness symmetrically arranged on opposite sides of the vertical axis of the drum 24, as shown in FIG. 6. The beams 66 are braced at their front end by a channel member 78 extending therebetween, as shown in FIG. 3.

The fluid cooled furnace 24 is especially intended for the burning of a fluid fuel at extremely high rates of heat release. The furnace is fired by a pair of horizontally extending burners symmetrically disposed at the same elevation on opposite sides of the vertical centerline of the front wall 10 and arranged to direct fuel and air under pressure in mixing relationship into the furnace through corresponding burner ports 80 formed in the front wall 10. The burners and furnace are proportioned and arranged to prevent flame impingement on the boundary walls of the furnace, to permit the several flame and gas streams to pass through the furnace without substantial interference with one another and with the same length of travel and time for combustion, to yield a turbulence that will cause uniform temperature and gas composition across the discharge end of the furnace, and to provide a flow path of sufficient length to insure complete combustion. When the support tube arrangement of FIG. 6 is used, the furnace is fired by a horizontally extending burner centrally disposed in the front wall 10. Air is supplied to the burners by a forced draft fan, not shown, which passes air under pressure through a duct 84 to a windbox 85 enclosing the burners and secured to the front wall 10. By operating with the combustion gases under pressure in the furnace there is no need for an induced draft fan, furnace infiltration is eliminated, and efficiency is increased.

The heating gases resulting from the combustion of the fuel and air introduced into the furnace flow horizontally and rearwardly through the furnace and over the radiant heat absorbing tube portions of the superheater 54, then divide into parallel streams which flow reversely and horizontally through the heating gas passes 26 and successively over the convection heat absorbing tube portions of the superheater 54 and the tube banks 32 disposed therein. The parallel streams then pass through the gas outlets 28, which extend between the drum 24 and the corresponding side walls, to a common flue 88 for flow to another heat trap, if desired, or to the stack.

With the boiler construction described, feed water enters the drum 34 and flows downwardly in parallel through the upright support tube 52, the last few tubes 46B in the low gas temperature end of the heating gas passes 26, and the tubes of the last few rows, with respect to gas flow, of the tube banks 32. The tube 52 supplies fluid to the tubes 48 of the front wall 10, while the downcomer tubes of the tube banks 32 and the tube row 46B are connected for parallel supply of fluid to the remaining tubes of the tube banks 32, to the riser tubes of all the boundary walls, except the front wall, of the setting, and to the tubes 38 of the partition walls 22. Steam and water mixtures generated in the riser tubes of the tube banks 32, the boundary wall tubes of the set-

ting and the partition wall tubes 38 discharge to the drum 34. Saturated steam is supplied from the drum 34 to the superheater inlet header 56 by way of the tubes 60, the steam then passing through the tubes of the superheater and the outlet header 58 to the point of use.

While in accordance with the provisions of the statutes we have illustrated and described herein the best form and mode of operation of the invention now known to to us, 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 our claims, and that certain features of our invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. A steam generator comprising walls forming a setting, a partition means dividing said setting into a heating gas pass and a furnace chamber laterally adjoining and opening to one end of said heating gas pass, an upper steam and water drum, a lower water drum, a bank of steam generating tubes in said heating gas pass extending between and connected to said drums, means for supplying heating gases to said furnace and effecting a flow of heating gases longitudinally through said furnace and reversely through said heating gas pass, a superheater disposed across the gas discharge and inlet ends of the furnace and heating gas pass respectively and comprising a plurality of horizontally spaced tubes panels arranged in vertical planes and extending across substantially the full width of the setting, a superheater support tube connected at its opposite ends to said drums and positioned between and extending across said panels of said superheater, and means for supporting said panels from said support tube said last named means including lugs secured to said support tube and each having a recess adapted to carry a superheater tube, with the lugs cooperating to restrain lateral and vertical movements of the superheater tube while permitting completely free longitudinal movement thereof.

2. A steam generator comprising walls forming a setting, partition means dividing said setting into a heating gas pass and a furnace chamber laterally adjoining and opening to one end of said heating gas pass, an upper steam and water drum, a lower water drum, an upright convection heated bank of steam generating tubes in said heating gas pass extending between and connected to said drums, means for supplying heating gases to said furnace and effecting a flow of heating gases longitudinally through said furnace and reversely through said heating gas pass, a superheater disposed across the gas discharge and inlet ends of the furnace and heating gas pass respectively and comprising a plurality of horizontally spaced tube panels arranged in vertical planes and extending across substantially the full width of the setting, each panel including a plurality of nested return bend tubes, a plurality of superheater support tubes connected at their opposite ends to said drums and positioned between and extending across adjacent panels of said superheater, and means for supporting said panels at vertically spaced positions along said support tubes, said last named means including lugs secured to said support tubes and each having a recess adapted to carry a superheater tube, with the lugs cooperating to restrain lateral and vertical movements of the superheater tubes while permitting completely free longtiudinal movement thereof.

3. A steam generator comprising walls forming a setting, upright partition walls dividing said setting into a pair of heating gas passes and a furnace chamber laterally adjoining and opening to one end of each of said heating gas passes, an upper horizontally arranged steam and water drum, a lower horizontally arranged water drum, an upright convection heated bank of steam generating tubes in each of said heating gas passes extending between and connected to said drum, means for supplying heating gases to said furnace and effecting a flow of heating gases longitudinally through said furnace and reversely and in parallel through said heating gas passes, a superheater disposed across the gas discharge and inlet ends of the furnace and heating gas passes respectively and comprising a plurality of horizontally spaced tube panels arranged in vertical planes and extending across substantially the full width of the setting, each panel including a plurality of nested horizontally extending return bend tubes, a plurality of upright superheater support tubes connected at their opposite ends to said drums and positioned between and extending across adjacent panels of said superheater, and means for supporting said panels at vertically spaced positions along said support tubes, said last named means including lugs secured to said support tubes and each having a recess adapted to carry a superheater tube, with the lugs cooperating to restrain lateral and vertical movements of the superheater tubes while permitting completely free longitudinal movement thereof.

4. A steam generator comprising walls including fluid heating tubes forming a setting, a pair of partition walls dividing said setting into a pair of heating gas passes and a substantially unobstructed furnace chamber, each of said heating gas passes extending along a portion of the length and width of said setting, said furnace chamber extending along the length of said setting and having one portion extending the full width of said setting and another portion disposed intermediate and opening to one end of each of said gas passes and extending along only a portion of the width of said setting, an upper steam and water drum, a lower water drum, a bank of steam generating tubes in each of said heating gas passes extending between and connected to said drums, and burner means for supplying heating gases directly to said one furnace portion and effecting a flow of heating gases longitudinally and successively through said one furnace portion and said other furnace portion and then reversely and in parallel through said heating gas passes, each of said partition walls including a wall portion which comprises fluid heating tubes and projects inwardly to form a portion of an imperforate baffle wall extending across said furnace and positioned adjacent to and upstream gaswise of said lower drum for the shielding of said lower drum from the high temperature heating gases.

5. A steam generator comprising walls including fluid heating tubes forming a setting, a pair of partition walls dividing said setting into a pair of heating gas passes and a substantially unobstructed furnace chamber, each of said heating gas passes extending along a portion of the length and width of said setting, said furnace chamber extending along the length of said setting and having one portion extending the full width of said setting and another portion disposed intermediate and opening to one end of each of said gas passes and extending along only a portion of the width of said setting, an upper steam and water drum, a lower water drum, a bank of steam generating tubes in each of said heating gas passes extending between and connected to said drums, burner means for supplying heating gases directly to said one furnace portion and effecting a flow of heating gases longitudinally and successively through said one furnace portion and said other furnace portion and then reversely and in parallel through said heating gas passes, a superheater disposed across the gas discharge and inlet ends of the furnace and heating gas passes respectively and comprising a plurality of horizontally spaced tube panels arranged in vertical planes and extending across substantially the full width of the setting, a superheater support tube connected at its opposite ends to said drums and positioned between and extending across said panels of said superheater, and means for supporting said panels from said support tubes, said last named means including lugs secured to said support tubes and each having a recess adapted to carry a superheater tube, with the lugs cooperating to restrain lateral and vertical movements of

the superheater tubes while permitting completely free longitudinal movement thereof.

6. A steam generator comprising walls including front, rear and side walls forming a setting, a pair of partition walls dividing said setting into a pair of heating gas passes and a substantially unobstructed furnace chamber, each of said heating gas passes extending along a portion of the length and width of said setting, said furnace chamber extending along the length of said setting and having one portion extending the width of said setting and another portion disposed intermediate and opening to one end of each of said gas passes, an upper steam and water drum extending the length of said setting, a lower water drum, a bank of steam generating tubes in each of said heating gas passes extending between and connected to said drums, burner means for supplying heating gases directly to said one furnace portion and effecting a flow of heating gases longitudinally and successively through said one furnace portion and said other furnace portion and then reversely and in parallel through said heating gas passes, a transverse lower header extending along the front wall of said setting, said front wall including a row of upwardly extending steam generating tubes connected at their opposite ends to said upper drum and to said front wall header, means for bottom-supporting said steam generator including means for bottom-supporting said lower drum, means for bottom-supporting said upper drum comprising an upright downcomer tube outside of siad furnace extending along said front wall and directly connected at its opposite ends to said upper drum to said front wall header for supply of fluid to said front wall steam generating tubes, said downcomer tube being of sufficient diameter and thickness to resist bending moment stresses in carrying the upper drum and to withstand the compression forces transmitted to it, and means for bottom-supporting said front wall header.

7. A steam generator comprising walls including front, rear and side walls forming a setting, a pair of partition walls dividing said setting into a pair of heating gas passes and a substantially unobstructed furnace chamber, each of said heating gas passes extending along a portion of the length and width of said setting, said furnace chamber extending along the length of said setting and having one portion extending the full width of said setting and another portion disposed intermediate and opening to one end of each of said gas passes and extending along only a portion of the width of said setting, an upper horizontally arranged steam and water drum extending the length of said setting, a lower horizontally arranged water drum extending the length of said other portion of the furnace, a bank of steam generating tubes in each of said heating gas passes extending between and connected to said drums, burner means for supplying heating gases directly to said one furnace portion and effecting a flow of heating gases longitudinally and successively through said one furnace portion and said other furnace portion and then reversely and in parallel through said heating gas passes, a transverse horizontally arranged lower header extending along the front wall of said setting, said front wall including a row of upwardly extending steam generating tubes connected at their opposite ends to said upper drum and to said front wall header, and means for bottom-supporting said steam generator including means for bottom-supporting said lower drum, means for bottom-supporting said upper drum comprising a plurality of upright downcomer tubes outside of said furnace extending along said front wall and directly connected at their opposite ends to said upper drum and to said front wall header for supply of fluid to said front wall steam generating tubes, said downcomer tubes being of sufficient diameter and thickness to resist bending moment stresses in carrying the upper drum and to withstand the compression forces transmitted to them, and means for bottom-supporting said front wall header.

8. A steam generator comprising walls including front, rear and side walls forming a setting, a pair of upright partition walls including fluid heating tubes dividing said setting into a pair of heating gas passes and a substantially unobstructed furnace chamber, each of said heating gas passes extending along a portion of the length and width of said setting, said furnace chamber extending along the length of said setting and having one portion extending the width of said setting and another portion disposed intermediate and opening to one end of each of said gas passes an upper steam and water drum, a lower water drum extending the length of said other portion of the furnace, a bank of steam generating tubes in each of said heating gas passes extending between and connected to said drums, burner means for supplying heating gases directly to said one furnace portion and effecting a flow of heating gases longitudinally and successively through said one furnace portion and said other furnace portion and then reversely and in parallel through said heating gas passes, and a pair of longitudinal lower side wall headers, each of said partition walls including a wall portion projecting inwardly from the adjacent side wall with some of the tubes of each of said partition wall portions having their lower ends connected in alternation to said lower side wall headers and bent laterally and inwardly to form a portion of an imperforate baffle wall extending across said furnace and positioned adjacent to and upstream gas-wise of said lower drum for the shielding of said lower drum from the high temperature heating gases.

9. A steam generator comprising walls including front, rear and side walls forming a setting, a pair of upright partition walls including fluid heating tubes dividing said setting into a pair of heating gas passes and a substantially unobstructed furnace chamber, each of said heating gas passes extending along a portion of the length and width of said setting, said furnace chamber extending along the length of said setting and having one portion extending the width of said setting and another portion disposed intermediate and opening to one end of each of said gas passes, an upper horizontally arranged steam and water drum extending the length of said setting, a lower horizontally arranged water drum extending substantially only the length of said other portion of the furnace, a bank of steam generating tubes in each of said heating gas passes extending between and connected to said drums, burner means for supplying heating gases directly to said one furnace portion and effecting a flow of heating gases longitudinally and successively through said one furnace portion and said other furnace portion and then reversely and in parallel through said heating gas passes, and a pair of longitudinal horizontally arranged lower side wall headers communicating with said lower drum for supply of fluid therefrom and disposed on opposite sides of the furnace, each of said partition walls including a wall portion projecting inwardly from the adjacent side wall with some of the tubes of each of said partition wall portions having their lower ends connected in alternation to said lower side wall headers and bent laterally and inwardly to form a portion of an imperforate baffle wall extending across said furnace and positioned adjacent to and upstream gas-wise of said lower drum for the shielding of said lower drum from the high temperature heating gases.

10. A steam generator comprising walls including front, rear and side walls forming a setting, a pair of upright partition walls dividing said setting into a pair of heating gas passes and a furnace chamber, each of said heating gas passes extending along a portion of the length and width of said setting, said furnace chamber extending along the length of said setting and having one portion extending the width of said setting and another portion disposed intermediate and opening to one end of each of said gas passes, an upper steam and water drum extending the length of said setting, a lower water drum extending the length of said other portion of the furnace,

a bank of steam generating tubes in each of said heating gas passes extending between and connected to said drums, means for supplying heating gases to said furnace and effecting a flow of heating gases longitudinally through said furnace and reversely and in parallel through said heating gas passes, and a pair of longitudinal lower side wall headers disposed on opposite sides of the furnace, each of said side walls including a row of upwardly extending steam generating tubes communicating at their upper ends with said upper drum, some of said tubes of each side wall having their lower ends bent laterally and inwardly to form a portion of a floor for the furnace with alternate tubes of each side wall terminating in the lower side wall header on the opposite side of the furnace and the remainder terminating in the lower side wall header on the corresponding side of the furnace, each of said partition walls including upwardly extending steam generating tubes communicating at their upper ends with said upper drum, some of the tubes of each partition wall terminating in the lower drum and having their lower ends bent laterally and inwardly to form another portion of the floor of the furnace.

11. A steam generator comprising walls including front, rear and side walls forming a setting, a pair of upright partition walls dividing said setting into a pair of heating gas passes and a furnace chamber, each of said heating gas passes extending along a portion of the length and width of said setting, said furnace chamber extending along the length of said setting and having one portion extending the width of said setting and another portion disposed intermediate and opening to one end of each of said gas passes, an upper steam and water drum extending the length of said setting, a lower water drum extending the length of said other portion of the furnace, a bank of steam generating tubes in each of said heating gas passes extending between and connected to said drums, means for supplying heating gases to said furnace and effecting a flow of heating gases longitudinally through said furnace and reversely and in parallel through said heating gas passes, and a pair of longitudinal lower side wall headers disposed on opposite sides of the furnace, each of said side walls including a row of upwardly extending steam generating tubes communicating at their upper ends with said upper drum, some of said tubes of each side wall having their lower and upper ends bent laterally and inwardly to form respectively a portion of a floor and a roof for the furnace with alternate tubes of each side wall terminating in the lower side wall header on the opposite side of the furnace and the remainder terminating in the lower side wall header on the corresponding side of the furnace, each of said partition walls including upwardly extending steam generating tubes communicating at their upper ends with said upper drum, some of the tubes of each partition wall terminating in the lower drum and having their lower and upper ends bent laterally and inwardly to form respectively another portion of the floor and roof of the furnace.

12. A steam generator comprising walls including front, rear and side walls forming a setting, a pair of upright partition walls dividing said setting into a pair of heating gas passes and a furnace chamber, each of said heating gas passes extending along a portion of the length and width of said setting, said furnace chamber extending along the length of said setting and having one portion extending the width of said setting and another portion disposed intermediate and opening to one end of each of said gas passes, an upper steam and water drum extending the length of said setting, a lower water drum extending the length of said other portion of the furnace, a bank of steam generating tubes in each of said heating gas passes extending between and connected to said drums, means for supplying heating gases to said furnace and effecting a flow of heating gases longitudinally through said furnace and reversely and in parallel through said heating gas passes, and a pair of longitudinal lower side wall headers disposed on opposite sides of the furnace, each of said side walls including a row of upwardly extending steam generating tubes communicating at their upper ends with said upper drum, some of said tubes of each side wall having their lower and upper ends bent laterally and inwardly to form respectively a portion of a floor and a roof for the furnace with alternate tubes of each side wall terminating in the lower side wall header on the opposite side of the furnace and the remainder terminating in the lower side wall header on the corresponding side of the furnace, each of said partition walls including upwardly extending steam generating tubes communicating at their upper ends with said upper drum, some of the tubes of each partition wall terminating in the lower drum and having their lower and upper ends bent laterally and inwardly to form respectively another portion of the floor and roof of the furnace, the remainder of the tubes of each of said partition walls having their lower ends connected in alternation to said lower side wall headers and bent laterally and inwardly to form a portion of a baffle wall extending across said furnace and positioned adjacent to and upstream gas-wise of said lower drum for the shielding of said lower drum from the high temperature heating gases.

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