May 20, 1952 B. WOYNAR 2,597,423

STEAM GENERATOR

Filed Dec. 17, 1948 5 Sheets-Sheet 1

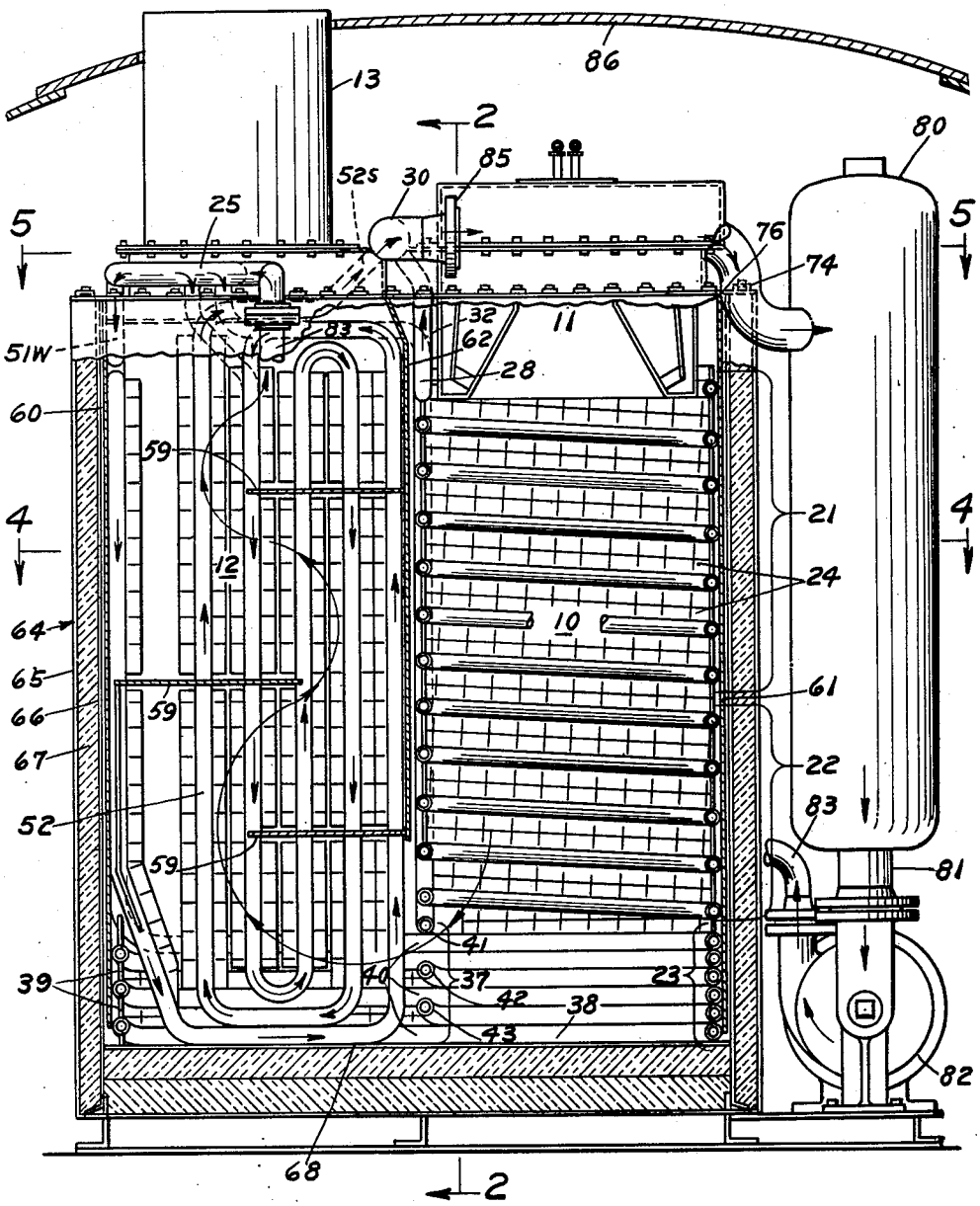


Fig. 1.

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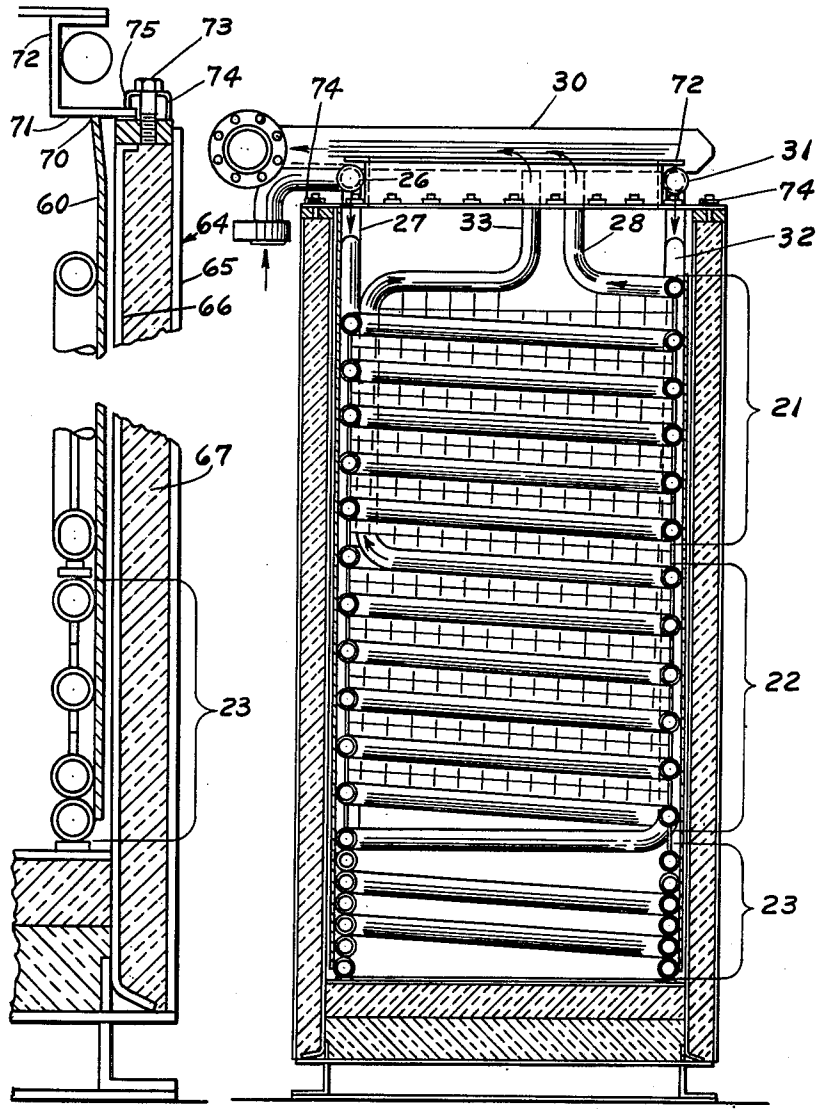


Fig. 3. Fig. 2.

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STEAM GENERATOR

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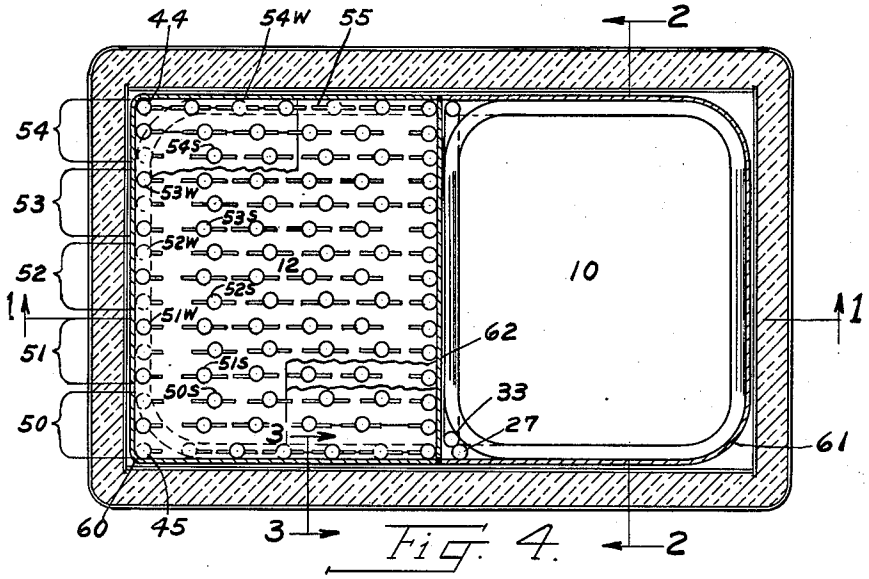


Fig. 4.

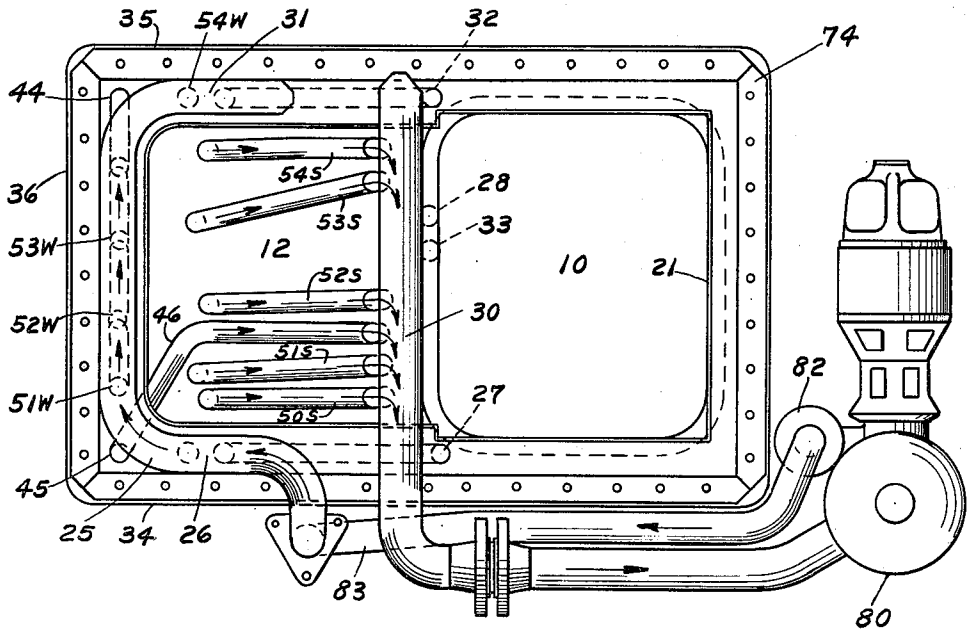


Fig. 5.

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STEAM GENERATOR

Filed Dec. 17, 1948 5 Sheets-Sheet 4

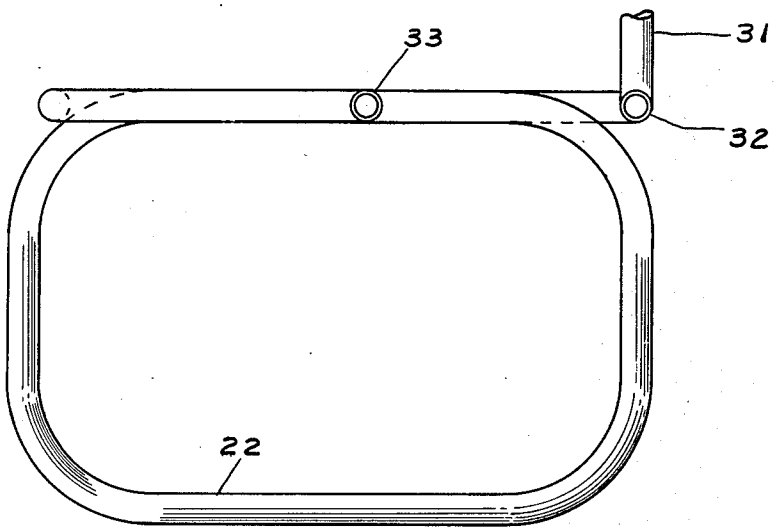


Fig. 7.

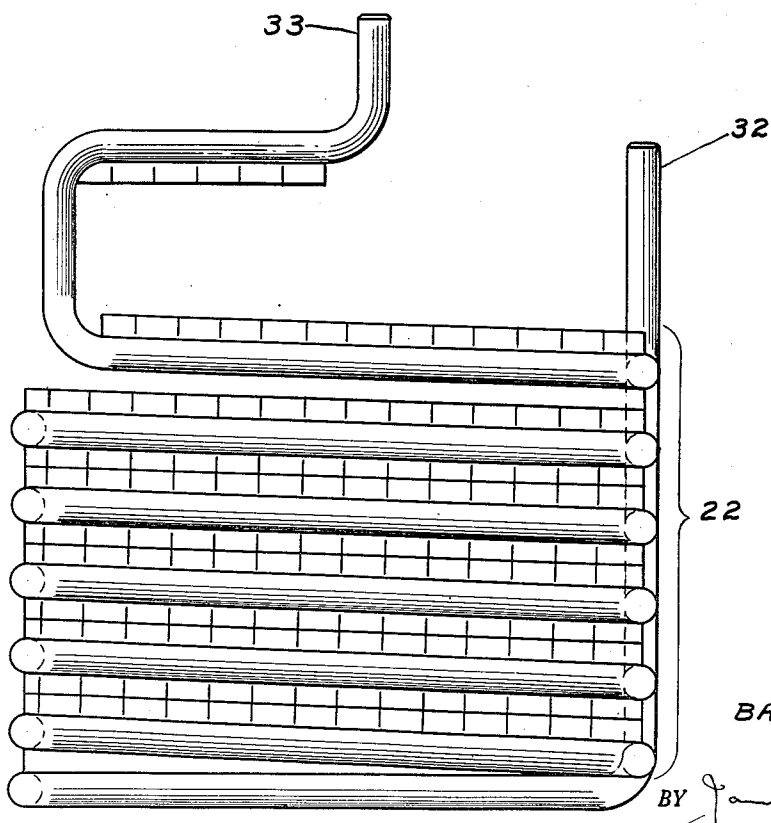


Fig. 6.

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STEAM GENERATOR

Filed Dec. 17, 1948 5 Sheets-Sheet 5

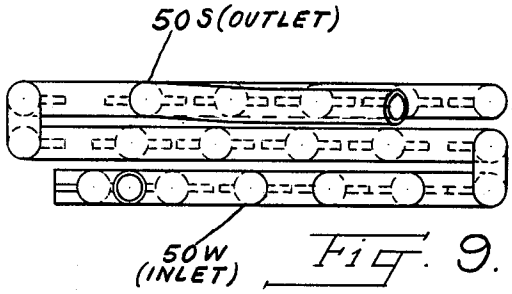


Fig. 9.

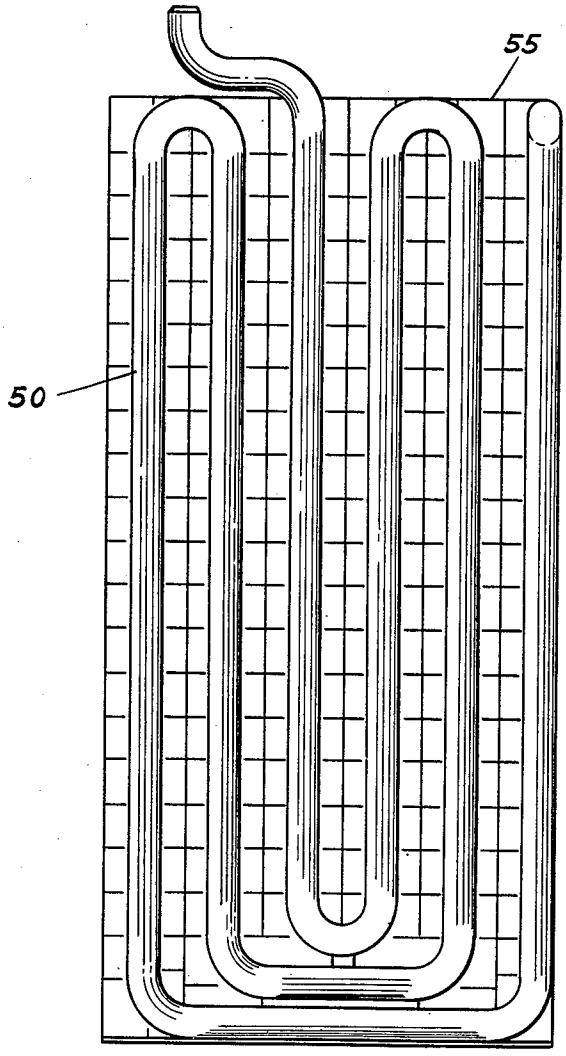


Fig. 8.

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Patented May 20, 1952 2,597,423

UNITED STATES PATENT OFFICE

2,597,423

STEAM GENERATOR

Basil Woynar, Chicago, Ill., assignor to Combustion Engineering-Superheater, Inc., a corporation of Delaware

Application December 17, 1948, Serial No. 65,761

2 Claims. (Cl. 122—250)

1

The present invention relates to an improved steam generator of the forced circulation type which is of high capacity and compact construction.

The limited space allocated by builders of electric or diesel-electric locomotives for the mounting of steam generators to heat cars of a train and for other purposes makes it difficult to obtain access to the heat absorbing elements of such generators for inspection or repair and accordingly it is desirable to provide in the generator construction for the ready removal of such elements to permit their inspection and/or repair.

In accordance with the present invention compactness of construction is obtained in part by utilizing forced circulation of water through the heat absorbing elements of the generator together with a novel arrangement of these elements which not only minimizes the space that they occupy but also facilitates the removal of a worn element from the generator when required without substantially disturbing other parts such as auxiliaries of the steam generator or of the diesel motor installation itself.

Although the tubular elements through which water is circulated under pressure by the circulating pump afford some protection against the high temperatures at which combustion of fuel takes place, it is desirable to further protect the casing enclosing the generating elements against heat and flames to which it may be exposed in through spaces and interstices between the tubular elements.

How the above and other advantages are attained will be best understood upon consideration of the following detailed description of an illustrative embodiment thereof when read in conjunction with the accompanying drawings in which:

Figure 1 is a sectional elevational view of a steam generator constructed in accordance with the present invention.

Figure 2 is a sectional view of the steam generator as viewed in elevation on the accordingly designated section line in Figure 1.

Figure 3 is a partial sectional view on an enlarged scale taken on line 3—3 in Figure 4.

Figures 4 and 5 are plan views corresponding to Figure 1; Figure 4 being in section, some parts being omitted in each view for clarity of illustration.

Figure 6 is a side elevational view and Figure 7 a corresponding plan view of one of the radiantly heated steam generating coils; and

Figure 8 is an elevational view and Figure 9

2

is a corresponding plan view of an exemplification of the convection heated coils of the steam generator.

Referring first to Figure 1, the steam generator has a U-shaped gas passage, one leg of which forms a furnace chamber 10 downwardly fired by fuel burner means 11. The furnace 10 communicates through its inner side wall at the lower end thereof with the adjacent convection passage 12 from the upper end of which spent gases pass to a stack 13. The walls of the furnace chamber 10 are lined with radiantly heated steam generating surface comprising steam generating coils 21, 22 and 23 of rectangular configuration (Fig. 4) whose successive tube convolutions are superimposed in vertically spaced relation to form a generally spiral path for fluid flow. These three convection coils are connected to receive a supply of water from a horizontal generally U-shaped supply tubular header 25 that extends along the three outer sides (Fig. 5) of the convection passage 12 at the top of the rectangular shaped generator at the left hand end thereof. One end of the tubular header 25 is closed off or blind while the other end is connected by piping to the pump provided for the recirculation of water as will appear later. The three coils 21, 22 and 23 are superimposed in the furnace chamber 10 and the various convolutions of each coil have fins 24 that fill the spaces between the tube convolutions and provide substantially solid walls bounding the combustion chamber. The parts of the coil convolutions on the inner side of the combustion chamber 10 form a wall dividing it from the convection passage 12.

The uppermost coil 21 receives water from the outer end of the leg 26 of the U-shaped header 25 through the coil lead 27 (Figs. 2, 4 and 5). The opposite end of this coil discharges steam and water through the outlet lead 28, at a position partway along the dividing wall between the furnace and convection passages 10, 12, into a steam and water collecting header 30 which extends transversely across the top of the generator in a plane above and to the right of the water supply header 25 and in a horizontal position above and adjacent the dividing wall between the furnace chamber 10 and the convection passage 12. The middle radiant coil 22 (Figs. 6 and 7 also) receives its supply of water from near the outer end of the other leg 31 of the U-shaped header through a supply lead 32 (Figs. 2 and 5) and its discharge end 33 is likewise connected into the collecting header 30 about midway across

the wall between the convection passage and furnace chamber.

The lowermost radiant coil **23** is of special construction as is disclosed in the copending application of Joseph F. Griffin, filed November 12, 1948, under Serial No. 59,630, now abandoned. Alternate convolutions of this coil (Fig. 1) are extended so that they lie along the side walls **34, 35** and the outer end wall **36** of the convection passage **12** near the bottom thereof, the tube portions along the side walls extending through a gas outlet **37** which places the lower end of furnace **10** in communication with the convection passage **12**. The coil **23** is disposed so that its lowermost convolution **38** lies against the bottom or floor of the furnace and convection chambers to afford cooling protection to these regions. By extending parts of the lower radiant coil **23** into the convection passage **12** protection is afforded to the lower walls of the latter which in the operation of a generator having a U-shaped gas passage are forcibly impinged upon by the stream of gases emerging from the furnace **10** through the communicating outlet **37** to then turn upwardly and flow through the convection passage **12** to the stack **13**. By providing that alternate convolutions of the coil **23** extend into the convection passage, the spaces **40** between the remaining convolutions **41, 42** and **43** in the inner wall of furnace **10** leave slot-like spaces in the inner side wall of the furnace chamber to form the outlet **37** through which the gases may flow into the convection passage. Inasmuch as those portions of the convolutions of coil **23** that lie against the side and outer walls of the convection chamber are spaced apart because of the alternate location of these parts in the coil fins **39** parallel to the walls are provided to fill these gaps and space the convolutions. Because of such extension of the lowermost radiant coil **23** into the convection passage **12** it is supplied from the water header **25** through a lead **44** (Figs. 4 and 5) located at the back outside corner of the convection passage and extending downwardly along the outer end wall in this corner. The steam and water discharge lead **45** from the opposite end of this coil extends upwardly along the opposite wall of the convection passage **12** in the other outer or front corner, the extreme end portion of the discharge lead **46** of this coil being bent to extend inwardly at an angle and then across the top of the convection passage to the steam collecting header **30** which, as mentioned, is located centrally along the top of the wall that divides the convection passage **12** and the furnace **10**.

The steam generating surface in the convection passage **12** consists of several coil units **50, 51, 52, 53** and **54**, (Fig. 4) each made up of parallel tube lengths serially interconnected for fluid flow by return bends and having the component tubes disposed in spaced relation in several parallel rows or layers so that the tubes of each element are distributed among several parallel planes (three in this instance) as will be seen in Fig. 9, which is a plan view of the coil **53** that is illustrated in elevation also in Fig. 8. Horizontal gas deflecting baffles **59** extend transversely part-way across the convection passage in alternation from its inner and outer boundary walls so as to cause the gases to flow tortuously through the passage and intimately contact the heat absorbing surface afforded by the convection coils. Some of the tubes of the various coils **50** to **54** are disposed to lie against and form a lining for the outer walls **34, 35** and **36** of the convection passage and the spaces between adjacent tubes extending along the wall are closed by fins **55** on the tubes. For purposes of convenience the water inlet leads for these various coils are designated by adding the suffix "*w*" to the coil numerals in Fig. 4 and the steam and water discharge ends of these coils have the suffix "*s*" applied thereto. The entire assembly of radiant and convection coils is received within a casing **64** which is made up of metal walls **65** and **66** separated by insulation **67** with the metallic wall sheets welded together and to a bottom sheet **68** to form a gas-tight rectangular boxlike casing open at its top for receiving the generating coils.

Although the contiguous convolutions of radiant coils **21—23** have fins **24** which are in contact to form a substantially solid metallic wall around combustion chamber **10** and the parts of the convection coils **50—54** that lie against the outer walls **34, 35, 36** of passage **12** have similar fins **55** which with the tubes constitute a continuous wall surface, the high rate of fuel combustion might cause gases to still leak between the fins and seep between the coils and walls of casing **64** or otherwise be diverted from their normal path of flow between furnace **10** and stack **13**.

A metallic plate of heat resistant steel alloy bent to U-shape forms a shroud **60** surrounding the convection passage **12** and a similar shroud **61** surrounds the furnace chamber **10**. Both are welded at the distal ends of their U-legs to a metal baffle sheet **62** that extends downwardly between the furnace chamber **10** and convection passage **12** as far as the gas outlet **37**.

As shown in Fig. 3 the upper end edge of shroud **60** is welded at **70** along its entire U-shaped perimeter to the under side of the lower flange **71** of the channel-shaped rectangular dome structure **72** that extends around the entire upper end of the generator casing and is fastened to the latter by the bolts **73** that extend through the rectangular clamping channel **74** whose inner leg **75** clamps the flange **71** of the dome structure against the top of the casing. The shroud **61** for the furnace chamber coils **21** to **22** is likewise welded at **76** on its upper end edge all around its U-shaped perimeter to the under side of the flange **71** of the dome structure. The supply and collecting headers **25** and **30** are carried by the dome structure which thus supports both the radiant and convection coils depending into the furnace **10** and convection passage **12** with the shrouds **60** and **61** extending to the floors of the furnace and convection passage. As stated above, the distal ends of the two U-shaped shrouds **60** and **61** are welded to the baffle that extends between the furnace chamber and convection passage from the top of the generator to the gas outlet **37** of the furnace so that the furnace coils and those in the convection passage are both boxed in by the U-shaped shrouds **60** and **61** and the baffle **62** located between the latter.

The arrangement of the coils in the furnace chamber and convection passage and their connection for water supply to the U-shaped header **25** extending along the top of the generator on the outer marginal edges of the convection passage and for steam and water discharge to the steam collecting header **30** that extends transversely across the generator substantially midway between the furnace **10** and convection passage **12**, permits the entire coil assembly depend-

ing from the headers 25 and 30 with the dome structure 72 supporting the headers to be lifted vertically out of the casing as a unit.

The collecting header 30 discharges the mixture of steam and water into a separator drum 80 from which the water flows through a downcomer 81 to the intake of the circulating pump 82 to be fed by the latter through a pipe 83 into the supply header 25. Thus, water taken from the separator drum 80 by the circulating pump 82 passes from the distributing header 25 in parallel through three circuits comprising the coils 21 to 23 lining the furnace walls, all of which coils discharge into the collecting header 30. The supply header 25 also feeds the convection circuits comprising the five coils 50 to 54, inclusive, whose tubes are disposed in the passage 12.

In the event it becomes necessary to remove any of the steam generating surface, breaking of the various piping connections including that at 85 between collector header 30 and drum 80 and removal of bolts 73 and clamp 74 permits the entire steam generating surface surrounded by shrouds 60, 61 to be lifted out of the casing with headers 25, 30 and removed through a hatch 86 in the roof of the engine. The detachment of stack 13 and the burner assembly 11 may not always prove desirable or necessary when removing the coils both in the furnace 10 and convection passage 12. If only a single coil requires replacing it may be detached after cutting its leads from connection with the supply and collecting headers.

In both radiant and convection sections the shrouds 60, 61 provide additional protection for the inner lining of the generator casing. Since they fit the tubes snugly, these shrouds afford protection that would be lacking if the bare inner casing plates 66 which are located somewhat farther away from tubes were exposed to the sweeping action of gases leaking through the slots in the fins, which can be compared with the action of a torch, particularly in the radiant section of the generator. In the convection section, in addition to the above protection the shrouds guarantee the desired gas flow and make it impossible for gases to bypass portions of the heating surface by following the path of the least resistance between the tubes and the casing, particularly at the back of the convection section.

What is claimed is:

1. In a steam generator having a vertical furnace fired from its top end by fuel burners and communicating through its inner wall at its lower end with a contiguous convection passage; an upright casing enclosing said furnace and convection passage; a tubular water supply header bent into a U-shaped loop and disposed so as to extend along the marginal edges of one end of said casing at its top, said header being closed at one end and having a water supply connection communicating with the opposite end of said header; a collecting header mounted to extend transversely of said casing adjacent the distal ends of the legs of said U-shaped header; radiantly heated tubular steam generating elements connected at opposite ends thereof to said supply and collecting headers, respectively, and depending therefrom in superimposed spirally wound convolutions to lie against the walls of said furnace with the portions at one side of each convolution disposed in contacting relation substantially beneath said collecting header to form a wall dividing the interior of said casing to form said furnace and adjacent convection passage; and other tube coils depending vertically from said supply and collecting headers into said convection passage, whereby all of said steam generating surface depends from said headers and may be removed from the casing with the latter.

2. In a steam generator having a vertical furnace fired from its top end by fuel burners and communicating through an outlet in its inner wall at its lower end with a contiguous convection passage; an upright casing enclosing said furnace and convection chamber; a tubular water supply header bent into a U-shaped loop and disposed so as to extend along the marginal edges of one end of said casing at its top; a collecting header mounted to extend transversely of said casing adjacent the distal ends of the legs of said U-shaped supply header; radiantly heated tubular steam generating elements connected at opposite ends thereof to said supply and collecting headers respectively and depending therefrom in superimposed spirally wound convolutions to lie against the walls of said furnace with the portions at one side of each convolution disposed in contacting relation substantially beneath said collecting header to form a wall dividing said furnace from said adjacent convection passage; other tube coils depending vertically from said supply and collecting headers into said convection passage; a frame extending around the perimeter of said casing at the top thereof and supporting said headers; a baffle extending across said casing adjacent said wall from the outlet of said furnace to said frame and attached thereto along its upper edge; and a pair of vertically disposed substantially U-shaped shrouds extending closely around the outer sides of the groups of radiant and convection elements, respectively, from top to bottom of said casing and attached along the perimeters of their upper ends to said frame and along the distal ends of their U-leg portions to the baffle lying between the furnace and convection passage.

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