May 29, 1951 H. G. NEHRBAS 2,554,631

STEAM GENERATOR

Filed Feb. 20, 1947 2 Sheets-Sheet 1

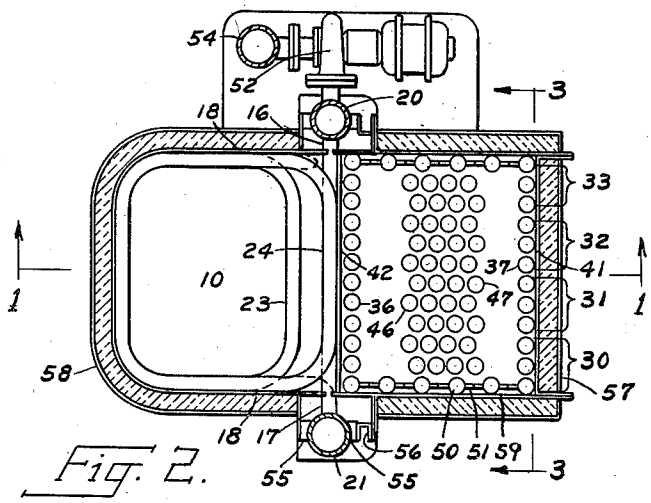


Fig. 2.

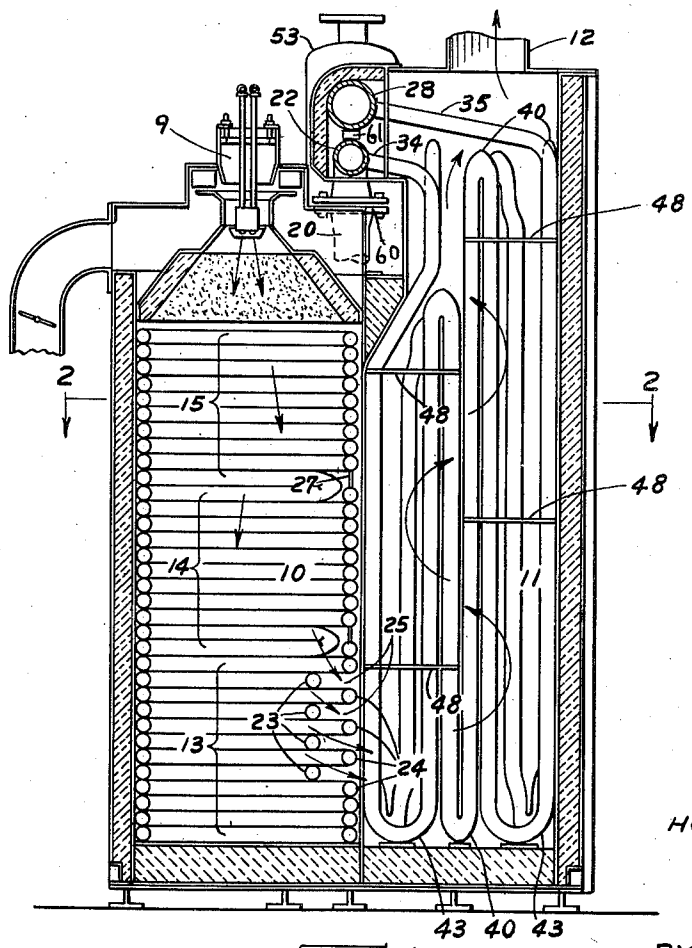


Fig. 1.

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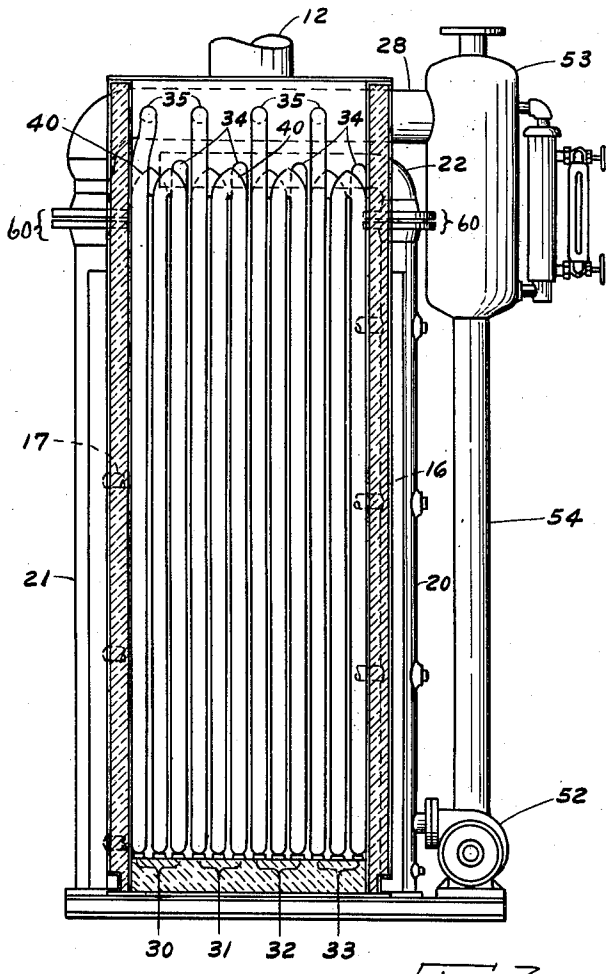


Fig. 3.

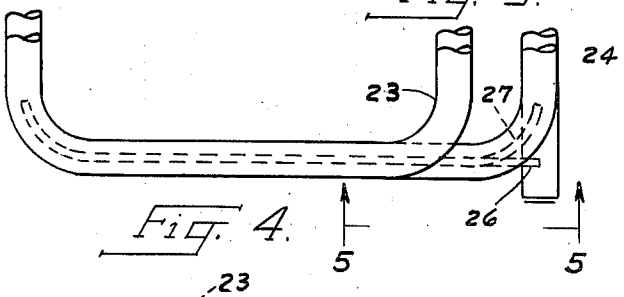


Fig. 4.

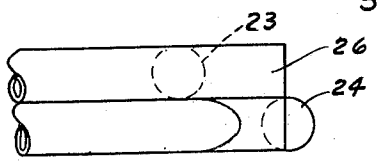


Fig. 5.

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Patented May 29, 1951

2,554,631

UNITED STATES PATENT OFFICE

2,554,631

STEAM GENERATOR

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Application February 20, 1947, Serial No. 729,761

6 Claims. (Cl. 122—248)

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The present invention relates to heat transfer apparatus and particularly to improvements in a forced circulation steam generator of high capacity.

The present invention contemplates the provision of a steam generator of high capacity which is nevertheless of simple and compact construction, adapting it for use in situations where there is only a limited amount of space to accommodate such a generator as when applied to a Diesel unit for supplying steam to heat the cars of a train. A further feature of the invention is a construction affording ready access to the steam generating elements for inspecting them or replacing them if necessary.

The invention will be best understood upon consideration of the following detailed description of an illustrative embodiment thereof when read in conjunction with the appended drawing in which:

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

Figure 2 is a transverse sectional view of the generator on the line 2—2 in Figure 1;

Figure 3 is a sectional elevation on the line 3—3 in Figure 2.

Figure 4 is a fragmentary plan view on an enlarged scale of one of the furnace coils;

Figure 5 is a side view on a still further enlarged scale of part of the coil shown in Figure 4.

In its general aspects the steam generator embodying the present invention has a U-shaped gas passage, one leg of which forms a furnace 10 downwardly fired by fuel burner means 9 and communicating through its inner side wall at the lower end thereof with the juxtapositioned convection passage 11 from the upper end of which the spent gases pass to a stack 12. The walls of the furnace chamber 10 are lined with radiantly heated steam generating surfaces comprising (as shown) three superposed helically wound tube coils 13, 14 and 15. Each of these coils is made up of a long length of small diameter tubing which is helically wound to form a coil whose successive convolutions are in contact to entirely line the side walls of the furnace chamber, although the tube convolutions might be spaced apart and the intervals closed by fins or otherwise. The coils however are not fully circular but of a roughly square shape (Fig. 2) and the inlet and outlet portions 16, 17 thereof are located at opposite corners of the inner wall. These inlet and outlet

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portions at the ends of the coils project laterally from the side walls 18 for connection to supply and collecting headers which extend vertically along the sides of the steam generator at the ends of the inner wall of the furnace or approximately in the plane marking the division between the furnace chamber 10 and the convection passage 11. As appears in Figure 3 these headers are of inverted L-shape and the ends 16, 17 of the furnace coils 13, 14 and 15 are connected to the vertically extending legs 20, 21 of these inverted L-shaped supply and collecting headers.

To provide an opening for the flow of gases from the furnace 10 into the convection passage 11 some of the tubes 23 of the lowermost radiant coil 13 are staggered or offset horizontally with respect to the adjacent tube portions 24 so as to leave gas flow openings 25 between a number of adjacent tubes in the inner wall of the furnace which otherwise is surfaced with closely contacting tube portions which in the embodiment shown are disposed in superposed relation. Filler plates 26 (Figs. 4 and 5) are provided to prevent gas leakage through the side walls of the furnace where spaces are created between adjacent tube portions by the offsetting of the tube portions 23 from the adjacent tubes 24. Other filler plates 27 are provided between contiguous tube portions of adjacent coils, as between coil 13 and coil 14, where the lateral extension of the end portions 16, 17 thereof would otherwise leave a gap due to partial interruption of the continuity of the helical formed wall surface.

In the convection pass 11 the steam generating surface is formed by four vertically disposed coils 30, 31, 32, 33, each having multiple grid-like layers with their ultimate inlet and outlet portions 34 and 35 connected to the horizontally disposed sections 22, 23 of the inverted L-shaped supply and collecting headers. Each convection coil 30—33 comprises several series connected grid-like flat coils in turn made up of a number of parallel tubes connected by return bends at their contiguous ends and arranged in rows extending across the gas pass and located in a vertical plane, each row forming a flat grid, several of which (three for example) being connected in series to form a complete convection coil which has its ultimate end portions 34 and 35 connected to the shortor horizontal legs 22, 23 of the inverted L-shaped supply and collecting headers respectively. The major part of each coil 30—33 is located centrally in the con-

vection pass 11 inasmuch as the parallel tube portions of the two central coils 31, 32 have their contiguous end portions interconnected by closely coupled integral return bends 40 while those tube portions 36, 37 which run vertically along the end 41 of the convection passage and the opposite side 42 thereof forming the boundary between the convection passage and the adjacent furnace chamber are connected to the contiguous tube portions by return bends or loops 43 of wide radius. A similar coupling arrangement is followed for the inwardly positioned grids of the coils 30 and 33. Thus the greater number of parallel tubes of each coil are closely spaced in the center of the convection passage while the wider spacings of the tube portions 36 and 37 from the tube portions 46, 47 leave spaces for gas flow along the coils in a vertical direction in the convection passage as the gases are directed back and forth across the convection coils by the deflecting baffles 48 which extend part of the way across the convection passage from the end wall 41 and the inner wall 42 thereof. The outermost grid portions of the two convection coils 30 and 33 being located adjacent the side walls of the convection passage have tubes 50 thereof uniformly spaced and provided with fins 51 to close the spaces therebetween and close in the side walls of the convection passage.

The circulating pump 52 for the steam generator is supplied with water from a separator drum 53 through a downcomer 54 and discharges into the lower end of the vertically disposed portion 29 of the inverted L-shaped supply header. From this vertical portion 29 of the supply header the water enters the end portions 16 of the three radiantly heated coils 13, 14, 15 and flows in parallel therethrough, passing downwardly through the helical convolutions of each coil to be discharged from the lower ends of the three coils into the vertically disposed portion 21 of the collecting header from which the mixture of steam and water flows upwardly and through the horizontal portion 28 of the collecting header into the steam and water separating drum 53. Simultaneously with the supply of water to the radiant coils 13—15 the water passing upwardly through the vertically disposed portion 20 of the supply header enters the horizontally disposed portion 22 thereof and from the latter passes through the inlet portions 34 into each convection coil 30—33 and in parallel through the latter. Having flowed downwardly and upwardly a plurality of times through the parallel tube portions of each convection coil in the several parallel grid-like sections thereof the steam and water mixture is finally discharged through the end portion 35 at the top of each coil into the horizontal part 28 of the collecting header and mixing with the steam from the radiant coils 13—15 passes into the separating drum 53.

Diametrically located on opposite sides of the vertical portions 20 and 21 of the supply and collecting headers, respectively, are mounting strips or brackets 55 to which are attached flange portion 56 on the inner edges of the sides 59 of U-shaped casing sections 57, 58 for enclosing the generator.

In the event that it should become necessary to replace any part of the radiantly heated tubes in the furnace, access may be readily had to the latter by unbolting the two side flanges 56 and casing section 58 from the header carried mounting strips 55 and then withdrawing the entire casing section and insulation to afford direct access to the convection coils 13 to 15. If necessary, any one of these may be readily removed by simply cutting it off between the joints between its end portions 16 and 17 and the nipples attached to the vertical portions 20, 21 of the supply and collecting headers. Likewise, access may be had to the convection section by first removing the bolts from the flanges which connect with the vertically disposed parts of the supply and collecting headers and then drawing the section 57 and its insulation away from the generator so that the convection coils are exposed.

The entire radiant section including the coils 13, 14, 15 connected to the vertical legs 20 of the headers may be removed as a unit (coils and vertical headers together with or without casing section 58 attached) upon unbolting the flanges 60 between the vertical and horizontal header sections and also unbolting the section 57 for the convection section from the mounting strips on the headers 20, 21. Likewise the convection section may be withdrawn as a unit (coils 30, 31, 32 and headers 22, 28) upon unbolting the flanges 60 and also unfastening the radiant casing 58 from the headers 20, 21.

From the above it will be seen that the inverted L-shaped headers act as a structural support. To render this more rigid the horizontal header sections may be fastened together as indicated at 61 in Fig. 1.

Although an illustrative embodiment of the invention has been described in detail herein there are many changes and variations that may be made without departing from the spirit of the invention and, therefore, it is desired and intended to include all such changes and variations within the scope of the appended claims.

What I claim is:

1. Heat exchange apparatus having a furnace chamber and a juxtapositioned convection passage connected at contiguous ends for series flow of the products of combustion from fuel burned in the furnace; a water supply and a steam collecting header each of L-shape disposed respectively at opposite sides of the generator approximately in the plane dividing the furnace chamber and convection passage; helically wound tube coils stacked vertically in the furnace chamber with their end portions projecting from the furnace at opposite ends of the wall that is common to it and said convection passage for connection to the longer legs of said supply and collecting headers; and other steam generating coils having opposite ends thereof connected to the shorter horizontal legs of said supply and collecting headers and mounted in said convection passage.

2. Heat exchange apparatus having a furnace chamber and a juxtapositioned convection passage connected at contiguous ends for series flow of the products of combustion from fuel burned in the furnace; a water supply and a steam collecting header each of L-shape disposed respectively at opposite sides of the generator approximately in the plane dividing the furnace chamber and convection passage; and helically wound tube coils stacked vertically in the furnace chamber with their end portions projecting from the furnace at opposite ends of the wall that is common to it and said convection passage for connection to the longer legs of said supply and collecting headers; other steam generating coils having opposite ends thereof connected to the shorter horizontal legs of said supply and collecting headers

and depending vertically therefrom into said convection passage and vertically spaced baffles extending from the wall separating the furnace chamber and convection passage and from the opposite wall of the latter part of the way across said convection coils for directing heating gases across the latter in a plurality of passes.

3. In a steam generator having a furnace chamber and a juxtapositioned convection pass connected at contiguous ends to form a U-shaped passage for series flow of the products of combustion from fuel burned in the furnace; a water supply and a steam collecting header each of L-shape disposed respectively at opposite sides of the generator substantially midway of the side walls thereof; radiantly heated heat transfer tubes lining the furnace walls with their end portions projecting from the furnace at opposite ends of the wall that is common to it and said convection pass for connection to the longer legs of said supply and collecting headers; and other steam generating tubes disposed in said convection pass with coils at opposite ends thereof connected to the shorter legs of said supply and collecting headers.

4. In a forced circulation steam generator having a furnace chamber and a juxtapositioned convection pass connected at contiguous ends to form an upright U-shaped passage into one end of which fuel is introduced and from the other end of which products of combustion are taken off; a water supply and a steam collecting header each of inverted L-shape disposed respectively at opposite sides of the generator substantially midway of the side walls thereof in the plane dividing the furnace chamber and convection passage; helically wound tube coils stacked vertically in the furnace chamber and having their end portions projecting from the furnace at opposite ends of the wall that is common to it and said convection pass for connection to the longer vertical legs of said supply and collecting headers; and other steam generating coils spaced transversely of said convection pass with opposite terminal ends thereof connected to the shorter horizontal legs of said supply and collecting headers and depending vertically therefrom into said convection pass.

5. In a forced circulation steam generator having a furnace chamber and a juxtapositioned convection pass connected at contiguous ends to form an upright U-shaped passage into one end of which fuel is introduced and from the other end of which products of combustion are taken off; a water supply and a steam collecting

header each of inverted L-shape disposed substantially with their longer vertical legs located at opposite sides of the generator substantially midway of the side walls thereof in the plane dividing the furnace chamber and convection passage and their shorter legs extending horizontally at the top of the generator; helically wound tube coils stacked vertically in the furnace chamber and having their end portions projecting from the furnace at opposite ends of the wall that is common to it and said convection pass for connection to the longer vertical legs of said supply and collecting headers; and other steam generating coils spaced transversely of said convection pass with opposite terminal ends thereof connected to the shorter horizontal legs of said supply and collecting headers and depending vertically therefrom into said convection pass.

6. Heat exchange apparatus having a furnace chamber and a juxtapositioned convection passage connected at contiguous ends for series flow of the products of combustion from fuel burned in the furnace; a water supply and a steam collecting header disposed respectively at opposite sides of the generator approximately in the plane dividing the furnace chamber and convection passage; and helically wound tube coils stacked vertically in the furnace with their end portions connected to said headers, the superposed convolutions of said coils being in contact to form a continuous lining for the major part of the furnace wall with a number of convolutions of the coil adjacent the said contiguous ends of the furnace and convection passage being staggered on the side of the furnace adjacent the convection passage to provide openings in the furnace wall for gas flow into said convection passage.

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