Dec. 18, 1956 H. J. JANKOWSKI 2,774,340

VAPOR GENERATOR

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Fig. 1.

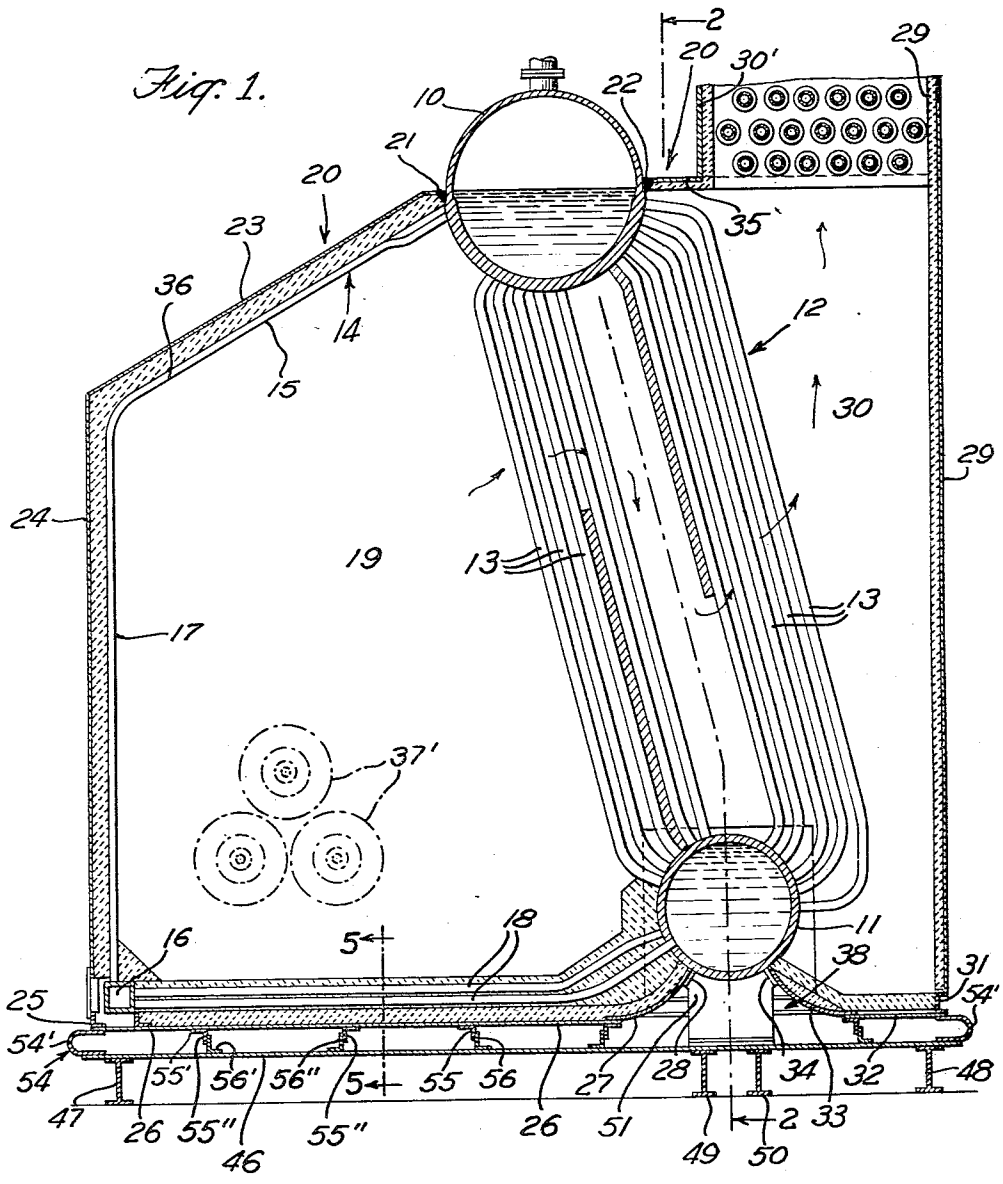

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Fig. 2.

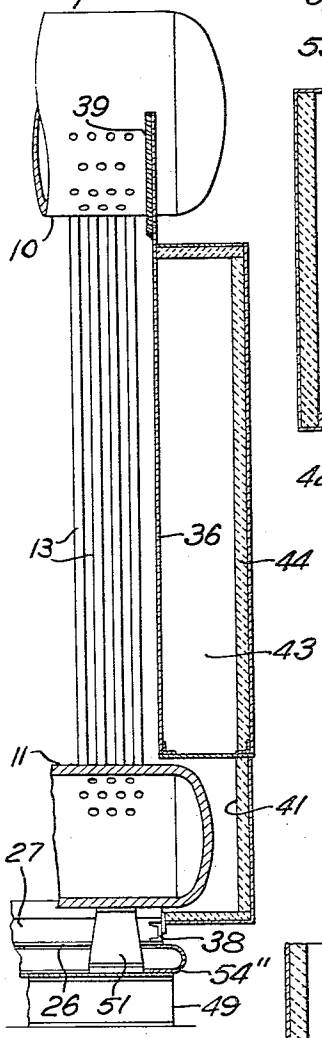


Fig. 3.

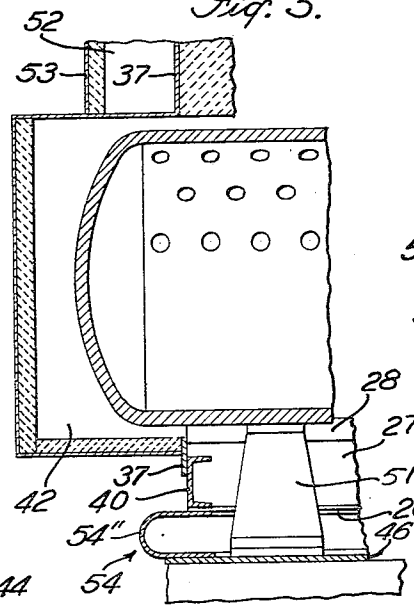


Fig. 5.

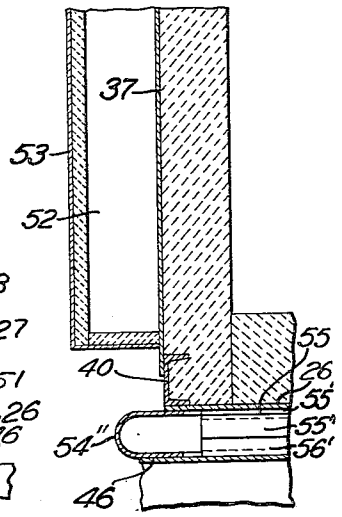


Fig. 4.

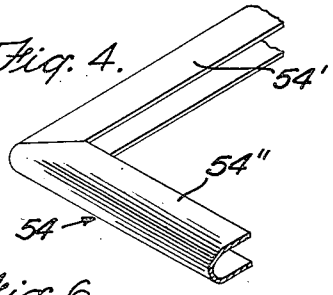


Fig. 6.

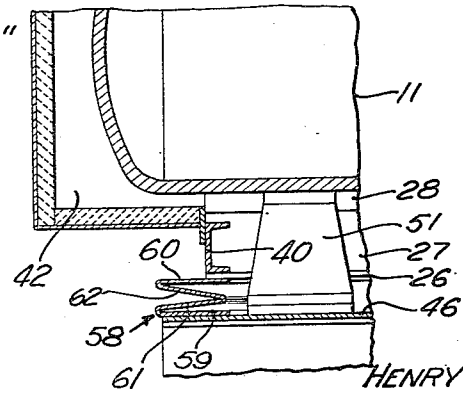
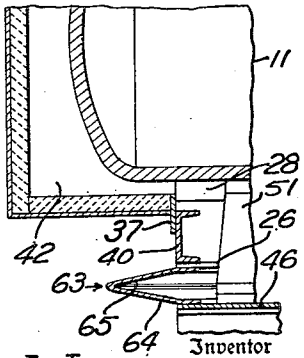


Fig. 7.



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VAPOR GENERATOR

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Application March 15, 1954, Serial No. 416,283

6 Claims. (Cl. 122—510)

This invention relates to vapor generators and more particularly to vapor generators having a casing enclosing said generators.

Generally vapor generators or boilers of the type to which the present invention relates are enclosed within a metal casing designed to be gas-tight and to withstand certain pressures. The casing also provides a means for supporting refractory and insulating materials lining the combustion chamber of the vapor generator. The relatively rapid expansion and contraction of the pressure parts of the vapor generator during operation creates undue stresses in the casing causing cracks and breaks therein which results in gas leakage.

The present invention provides a vapor generator in which expansion and contraction of the various parts thereof will not adversely affect the casing or refractory and insulating materials lining the combustion chamber of the vapor generator.

This invention also provides a vapor generator having an expansion joint permitting movement of the casing with the pressure parts and preventing cracks and breaks in the casing which would result in gas leakage.

The present invention further provides a vapor generator having sliding support legs which permit free movement of the parts thus supported.

The invention will be best understood from the following description when considered in connection with the accompanying drawings forming a part thereof and in which:

Fig. 1 is a more or less diagrammatic view of a transverse vertical section of a steam generator embodying the invention;

Fig. 2 is a partial longitudinal vertical sectional view taken on line 2—2 of Fig. 1 and illustrating the rearward portion of the generator;

Fig. 3 is an enlarged, fragmentary, longitudinal vertical sectional view of the forward lower end of the generator;

Fig. 4 is a perspective view of the expansion joint illustrated in the embodiment of the invention shown in Fig. 1;

Fig. 5 is an enlarged vertical sectional view taken on line 5—5 of Fig. 1;

Fig. 6 is a view similar to Fig. 3 illustrating another form of expansion joint; and

Fig. 7 is a view similar to Figs. 3 and 6 illlustrating still another form of expansion joint.

Like characters of reference refer to the same or to similar parts throughout the several views.

Referring to the drawings, the vapor generator illustrated comprises an upper steam and water drum 10, a lower water drum 11 below said upper drum 10 and vertically offset to the right (Fig. 1) in relationship thereto. The upper and lower drums are in communication with one another through a bank 12 of tubular members 13. As shown, in Fig. 1, waterwall tubes 14 extend outwardly from drum 10 to the left thereof to a

point in spaced relationship with drum 11 thereby to form a roof lining portion 15. From roof portion 15, the waterwall tubes extend vertically downwardly to lower header 16 thereby to provide a side wall lining portion 17. Floor tubes 18 extend substantially horizontally between lower header 16 and lower drum 11. The space to the left of tube bank 12 (Fig. 1) and bordered by portions 15 and 17 of tubes 14, floor tubes 18 and bank 12 provides a furnace chamber 19.

The vapor generator is enclosed by a metallic casing lined with refractory which casing comprises a metallic roof, opposite sides, opposite ends, and a floor. The roof 20 is welded to drum 10 longitudinally of said drum on opposite sides thereof at 21 and 22 and has an inclined section 23 extending diagonally downwardly from the drum which is in spaced relationship and above portion 15 of tubes 14. Section 23 of the roof is attached to side wall 24 of the casing which side wall, as shown, extends substantially parallel to and in spaced relationship with portion 17 of waterwall tubes 14 thereby providing one side wall for this casing. At the bottom, side wall 24 of the casing is attached to an upright leg of an L-shaped member 25, the horizontal leg of which member is attached to sheet metal floor section 26 of the casing which section extends in a horizontal plane in spaced relationship with floor tubes 18 and is attached to a segmentally-shaped flexible metallic plate 27 which engages the upper surface of floor portion 26 and the inner surface of a lug 28 extending longitudinally of drum 11. Opposite side wall 29 of the casing is also of sheet metal and is in spaced relationship with tube bank 12 to the left thereof (Fig. 1) to provide a combustion gas outlet passage 30 which communicates with stack 30'. At the bottom thereof, side wall 29, as shown, is attached to a channel member 31 extending in the same direction as drum 11, that is, longitudinally of the casing. Member 31 is also secured to section 32 of the floor of the vapor generator. Floor section 32, like floor section 26, supports flexible platae 33, similar to plate 27, flexible plate 33 bearing against a longitudinal lug 34 which is similar to lug 28. The roof 20 of the setting has a horizontally extending portion 35 projecting between weld 22 and the side wall of flue 30' the opposite side of which is provided by wall 29.

The opposite ends of the casing are enclosed respectively by rear wall 36 and front wall 37 (Figs. 2 and 5), each of which are of sheet metal. Wall 37 is provided with a plurality of burners 37' for firing the furnace. Rear wall 36 and front wall 37 are secured along their opposite sides to side wall 24 and 29, respectively, and along the bottom thereof to channel members 38 and 40, respectively, which channel members are secured to floor sections 26 and 33 at the opposite ends thereof. Along the top, rear wall 36 and front wall 37 are secured to roof portions 23 and 35 and have a semi-circular cut-out portion to accommodate the end of drum 10. Adjacent the cut-out portion, rear wall 36 and front wall 37 are welded to lugs 39 which lugs respectively are secured to drum 10 in spaced relationship to the adjacent end thereof.

Adjacent its opposite ends, drum 11 is enclosed by a box-like extension in the front and rear walls of the casing, the box-like extension 41 in rear wall enclosing the rearward end of the drum while the box-like extension 42 encloses the forward end thereof. The extensions 41 and 42 are of such size as to permit movement of the casing upwardly and downwardly in relationship to drum 11, as will hereafter be fully described. An air space 43 is provided between rear wall 36 and wall 44 while an air space 52 is provided between front wall 37 and wall 53. The vapor generator rests upon a foundation which

foundation comprises a bottom foundation plate 46 substantially coextensive with the bottom of the casing. Foundation plate 46 is below the bottom plate of the casing and in spaced relationship thereto and is supported against movement on stationary I-beams 47 and 48 which extend longitudinally along the opposite sides thereof and I-beams 49 and 50 which extend longitudinally beneath drum 11. Drum 11 is supported against downward movement on beams 49 and 50 and plate 46 by a plurality of supports 51.

So that the casing of the vapor generator will be free to move with the expansion and contraction of the vapor generator tubes, as will hereinafter be fully described, a flexible support or expansion joint is provided for the vapor generator. In the embodiment of the invention illustrated in Figs. 1 to 4, the expansion joint comprises a flexible U-shaped member 54 opposite side sections 54' coextensive with the opposite sides 24 and 29 of the casing, and opposite ends 54'' coextensive with the opposite ends 36 and 37 of the casing. The opposite end sections are joined at the opposite ends thereof to the end of the side section adjacent thereto to form a fluid tight joint between the sections. Member 54 is positioned between the underside of the bottom of casing 20 and the upperside of foundation plate 46 with the opposite legs of the U-shaped member 54 bearing against said underside and said upperside and extending inwardly of the casing bottom, the expansion joint being coextensive with the perimeter of the casing at the bottom thereof. The upper leg is secured to the underside of the casing bottom in a rigid manner while the other leg is secured in a rigid manner to the upperside of plate 46.

Positioned in the space between bottom floor sections 26 and 32 and foundation plate 46 are a plurality of substantially L-shaped sliding support members 55 and 56 arranged in pairs, the pairs being laterally spaced from and extending longitudinally of the vapor generator. Support members 55 are mounted on sheet metal floor sections 26 and 32 so that one leg 55' thereof abuts the under surface of said sections while the other leg 55'' projects downwardly to a point short of the upper surface of foundation plate 46 while members 56 have one leg 56' abutting the upper surface of foundation plate 46 while the other leg 56'' slidably engages leg 55'' of member 55 and projects upwardly to a point short of the under surface of floor sections 26 and 32.

In operation, when the vapor generator is fired, the gases of combustion flow from furnace chamber 19 in heat exchange relationship with tube bank 12 and waterwall tubes 14 thereafter passing out of the vapor generator through gas outlet passage 30 and stack 30'. The hot gases passing in heat exchange relationship with tubes 14 and tube bank 12 increase the temperature of the tubes and cause them to expand thereby increasing their length. Since lower drum 11 rests upon a plurality of supports 51 which are immovable downwardly and in turn rest on the foundation plate 46, itself supported against movement by stationary I-beams, the expansion of the tubes will be longitudinally upwardly which will push or raise upper drum 10 in an upwardly inclined direction. For example, the temperature of the gases may reach a point sufficient to heat the tubes and expand them longitudinally to raise drum 10 an inch in height from its original position. As drum 10 moves upwardly, roof 20, because it is rigidly fastened to the drum, is carried upwardly therewith which in turn moves opposite sides 24 and 29 and opposite end walls 36 and 37 upwardly. Upward movement of side 24 moves floor section 26 upwardly against the tension of flexible metallic plate 27 while upward movement of side 29 moves floor section 32 upwardly against the tension of flexible metallic plate 33. Longitudinal expansion of wall tubes 17 moves header 16 and floor tubes 18 upwardly.

When the vapor generator casing comprising the roof, floor sections, opposite sides and opposite end walls is thereby raised upwardly, the upper legs of sections 54' and ends 54'' of U-shaped members 54 attached to the bottom of the casing are in turn pulled upwardly spreading the opposite legs of members 54 apart against the tension in said members, the bottom leg of the members being held against movement. The overall length of the opposite vertical side walls and opposite end walls of the casing is thusly increased while the tensile stress set up therein is decreased. Thus, the expansion joint permits movement of the casing with the pressure parts of the vapor generator as these parts move due to expansion and contraction thereby preventing cracks and breaks in the casing wall which would result in gas leakage. As the bottom of the casing moves upwardly, the upright leg 55'' of the L-shaped members 55 attached to bottom sections 26 and 32 move upwardly with the bottom slidably engaging legs 56'' of members 56. Since the upright legs 55'' of adjacent L-shaped members 55 attached to the bottom of the casing are positioned on opposite sides of the abutting upright leg 56'' of adjacent L-shaped members 56 attached to plate 46, the casing 20 will be prevented from developing a side movement or sway as it moves upwardly.

When the temperature of the products of the gases of combustion in furnace chamber 19 is reduced, tube bank 12 and tubes 14 are cooled and the tubes contract or decrease in length thereby permitting drum 10 to move downwardly to its original position. At this time, the upper legs of sections 54' and ends 54'' of U-shaped members 54 move downwardly by tension of the metal thereby decreasing the overall length of the vertical wall portions of the casing and member 54 to relieve the compressive stress set up therein due to the decrease in the overall length of the pressure parts of the generator brought about through expansion of the pressure parts. Legs 55'' of L-shaped members 55 move or slide downwardly with the casing to their original position.

In the embodiment of the invention shown in Fig. 6, the structure and operation is substantially the same as that in Fig. 1 except that an expansion joint comprising flexible members 58 are provided, which members are W-shaped in cross section and have longitudinally extending base legs 59 and 60 and longitudinal extending intermediate legs 61 and 62. One longitudinal edge of leg 61 is integral with the adjacent longitudinal edge of base leg 59 while the opposite longitudinal edge is integral with the adjacent longitudinal edge of the intermediate leg 62. The opposite longitudinal edge of leg 62 is integral with the adjacent longitudinal edge of base leg 60.

In Fig. 7, the embodiment of the invention is similar to that in Figs. 1 to 4 and the operation substantially the same with the exception that the expansion joint comprises flexible members 63 V-shaped in cross section, which members 63 have longitudinally extending diagonally opposed legs 64 and 65.

Inasmuch as changes may be made in the form, location and relative arrangement of the several parts without departing from the essential characteristics of the invention, it will be understood that the invention is not to be limited excepting by the scope of the appended claims.

What is claimed is:

1. A vapor generator comprising two pairs of oppositely disposed walls, a roof and a floor, a casing enclosing said walls, roof and floor, means forming a furnace chamber having a combustion gas outlet for discharging combustion gases from said chamber, firing means in said chamber for producing gases of combustion, an upper drum and a lower drum, a plurality of tubular members in communication with and extending between said drums and in heat exchange relationship with gases of combustion flowing to said gas outlet, said casing being secured to said upper drum, a foundation for supporting the casing, support means for supporting said lower drum against downward movement, said casing and a pair of said oppo-

site walls adjacent the ends of said lower drum being adapted to receive therein the opposite end portions of said lower drum in spaced relationship thereto to provide vertical movement of said casing and walls relative to the lower drum upon expansion and contraction of said casing and said walls, and an expansion joint arranged between said casing and said foundation.

2. A vapor generator comprising two pairs of oppositely disposed walls, a roof and a floor, a casing enclosing said walls, roof and floor, means forming a furnace chamber having a combination gas outlet for discharging combustion gases from said chamber, firing means in said chamber for producing gases of combustion, an upper drum and a lower drum, a plurality of tubular members in communication with and extending between said drums and in heat exchange relationship with gases of combustion flowing to said gas outlet opening, said casing being secured to said upper drum, a foundation for supporting the casing, support means for supporting said lower drum against downward movement, said casing and the walls adjacent the ends of said lower drum being provided with "box-like" extensions, said extensions being formed to receive opposite end portions of said lower drum to provide vertical movement of the opposite side walls relative to said lower drum without impinging against said drum upon expansion and contraction of said casing and said walls, and an expansion joint arranged between said casing and foundation.

3. A vapor generator comprising two pairs of oppositely disposed walls, a roof and a floor, a casing enclosing said walls, roof and floor, means forming a furnace chamber having a combustion gas outlet for discharging combustion gases from said chamber, firing means in said chamber for producing gases of combustion, an upper and a lower drum arranged in said roof and said floor, respectively, a plurality of tubular members in communication with and extending between said drums and in heat exchange relationship with gases of combustion flowing to said gas outlet opening, said casing being secured to said upper drum, a foundation for supporting the casing, support means for supporting said lower drum against downward movement, flexible means secured to the portion of said casing enclosing the floor and to the lower drum to provide for upward movement of said walls without causing rupture of the floor and casing adjacent the lower drum upon expansion and contraction of said casing and said walls, and an expansion joint arranged between said casing and foundation.

4. The vapor generator of claim 3 wherein the expansion joint comprises a substantially U-shaped flexible member which extends coextensive with the perimeter of the casing.

5. A vapor generator comprising two pairs of oppositely disposed walls, a roof and a floor, a casing enclosing said walls, roof and floor, means forming a furnace chamber having a combustion gas outlet for discharging combustion gases from said chamber, firing means in said chamber for producing gases of combustion, an upper and a lower drum, a plurality of tubular members in communication with and extending between said drums and in heat exchange relationship with gases of combustion flowing to said gas outlet opening, said casing being secured to said upper drum, a foundation for supporting the casing, support means for supporting said lower drum against downward movement, flexible means consisting of at least one arcuate shaped metallic plate secured along one edge to said casing portion enclosing the floor and at the opposite edge to the lower drum support means, and an expansion joint arranged between said casing and foundation.

6. A vapor generator comprising two pairs of oppositely disposed walls, a roof and a floor, a casing enclosing said walls, roof and floor, means forming a furnace chamber having a combustion gas outlet for discharging combustion gases from said chamber, firing means in said chamber for producing gases of combustion, an upper and a lower drum arranged in said roof and floor, respectively; a plurality of tubular members in communication with and extending between said drums and in heat exchange relationship with gases of combustion flowing to said gas outlet opening, said casing being secured to said upper drum, a foundation for supporting the casing, a plurality of spaced vertical lower drum supports secured to the foundation and arranged longitudinally of the drum to prevent downward movement of the lower drum, each of said supports having spaced lugs adjacent the lower drum and extending longitudinally thereof, an arcuate shaped flexible metallic plate secured along one edge to each of said lugs and along their opposite edges to the inner portion of the casing enclosing the floor of said vapor generator, said arcuate shaped plates being convex with respect to said foundation to provide upward movement of said walls without causing rupture of the floor adjacent the lower drum.

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