April 11, 1961 N. W. YOUNG 2,979,041

VAPOR GENERATOR

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FIG. 1

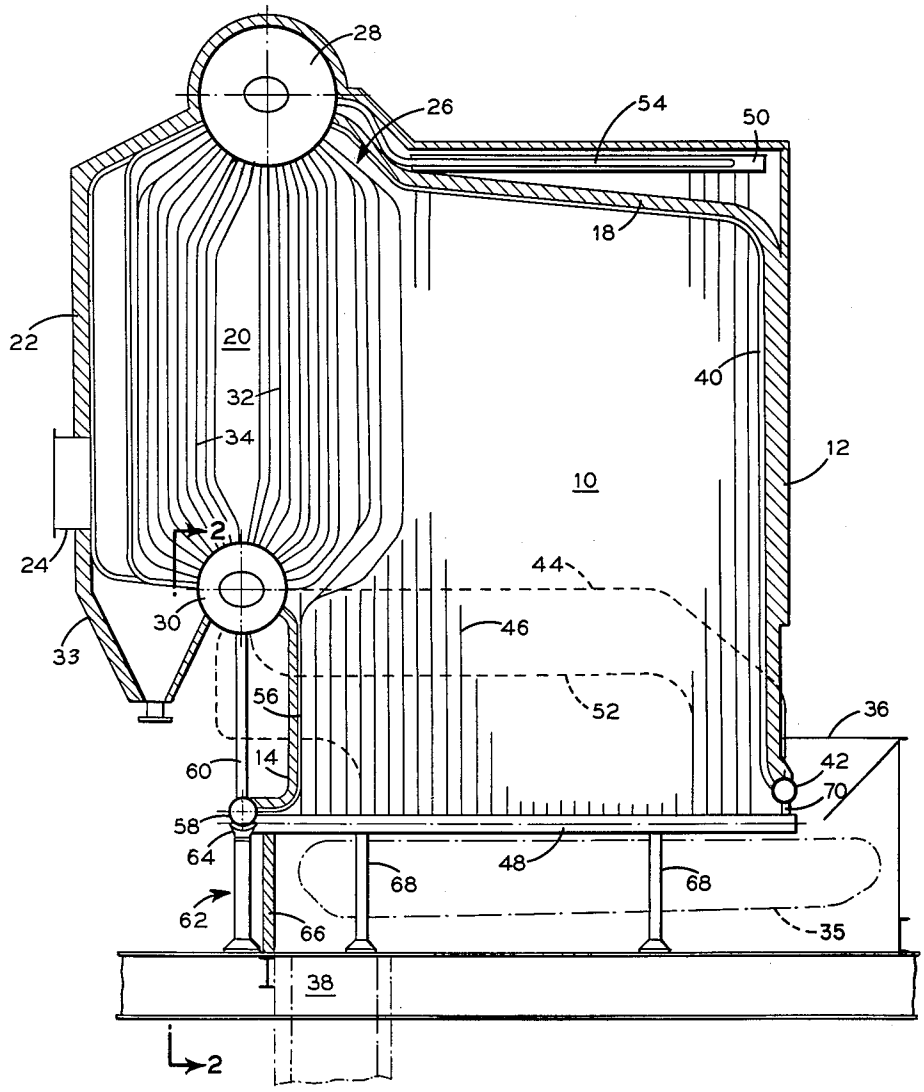

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FIG. 2

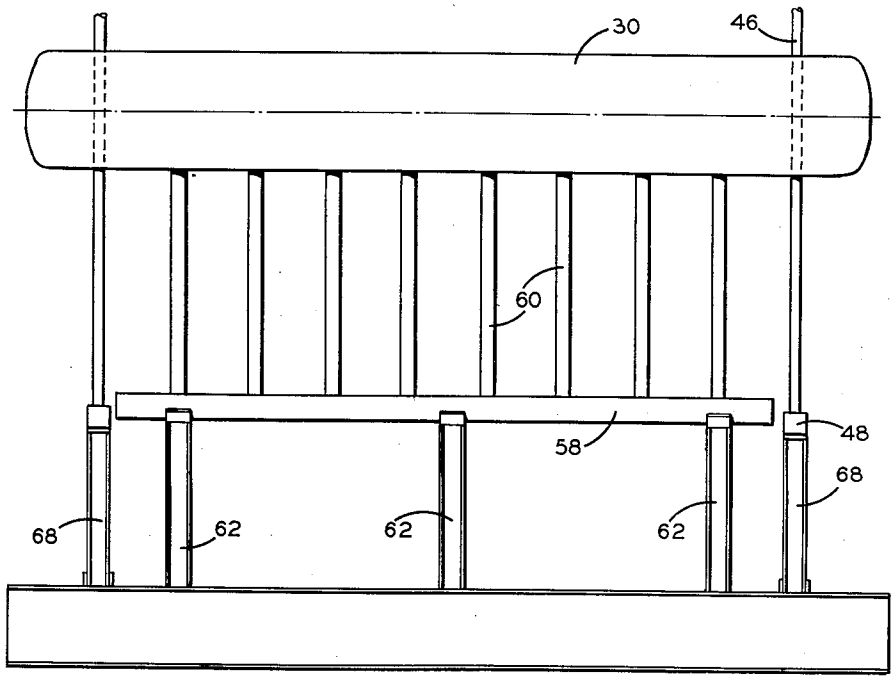
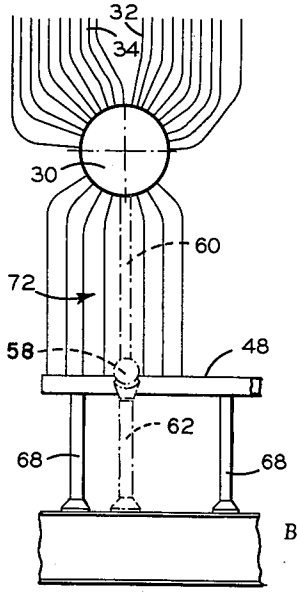


FIG. 3



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VAPOR GENERATOR

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5 Claims. (Cl. 122—510)

The present invention relates in general to the construction of vapor generators. More particularly, the invention concerns the provision of a vapor generator in which the pressure parts are entirely bottom supported and a predominant proportion of the pressure-part loading is carried by a support arrangement including fluid supply tubes of the circulation system.

Boiler and furnace wall tubes of a vapor generator are usually supported by the drums or headers to which they are connected. Some vapor generators are bottom supported from the lower drums and headers while others are suspended from the upper drums. The large quantity of vertical supporting steel required for a top supported vapor generator makes such a support arrangement quite expensive. Further, a top supported vapor generator requires relatively high headroom, and makes access difficult to some of the parts of the setting. Heretofore, in bottom supported vapor generating units, it has been necessary to limit the difference in elevation between points of vertical support of the lower drums and furnace walls to avoid excessive stresses on these and associated parts occasioned by relative vertical expansion movements. This limitation imposes a definite restriction in the height of the furnace chamber, and, consequently, a definite limitation in the steam generating capacities of such units.

In accordance with the present invention, the various boiler pressure parts are bottom supported at approximately the same elevation, with a predominant proportion of the weight of the drums and tubes extending therebetween being carried by a support arrangement which includes upright tubes extending downwardly from the lower drum and supplying fluid to at least some of the furnace wall tubes. The support arrangement of the invention permits the setting of the furnace height without limitation imposed by the difference in elevation between the lower drum and the point of support of the furnace wall tubes, provides complete freedom for necessary expansion and minimizes relative vertical expansion movements between the furnace wall tubes and the boiler drums and tubes. Moreover, the supporting members of the invention reflect a simplification in the support arrangement of bottom supported vapor generating units that eliminates superfluous steel and provides easy access to all parts of the setting for inspection and repair. The invention is particularly advantageous with stoker firing since there is no need for the slip type sealing joints heretofore required in the wall support arrangement of units so fired.

The various features of novelty which characterize the invention are pointed out with particularly 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 certain specific embodiments of the invention are illustrated and described.

Fig. 1 is a somewhat diagrammatic sectional elevation of a vapor generating unit embodying the invention;

Fig. 2 is a sectional rear elevation of the lower half of the illustrated embodiment taken along the line 2—2 of Fig. 1; and

Fig. 3 is a fragmentary sectional side elevation showing a modification.

Figs. 1 and 2 illustrate an embodiment of my invention in the form of a vapor generator comprising a two-drum water-tube boiler deriving heat from a stoker-fired furnace. The vapor generator enclosure or setting is of substantially rectangular cross-section and comprises a vertically extending furnace chamber **10** defined by fluid cooled walls including a front wall **12**, a lower rear wall **14**, side walls **16**, and an upper wall or roof **18**. The rear portion of the setting includes a boiler space **20** laterally adjoining the upper portion of the furnace chamber **10** and defined by lateral extensions of the side walls **16** and an upper rear wall **22** rearwardly offset from the lower rear wall **14**. The upper rear wall **22** is formed with an outlet **24** for discharge of gases from the setting.

A two-drum natural circulation boiler **26** is positioned at the rear of the setting and arranged for single-pass gas flow therethrough in a generally horizontal direction. The boiler pressure parts include horizontally disposed upper and lower drums **28** and **30** having their longitudinal axes lying in substantially the same vertical plane; and upright boiler tubes arranged in horizontally spaced banks **32**, **34** and connected at their upper and lower ends to the upper and lower drums **28** and **30**, respectively.

The lower rear portion of the boiler space **20** is formed by a series of hoppers **33** extending between the side walls **16**, with each hopper having its inclined rear and front walls extending convergently from the bottom of the rear wall **22** and from the drum **30**, respectively.

The furnace chamber **10** is fired by a conventional chain grate stoker including a traveling chain grate **35** located at the bottom of the furnace chamber **10** and having its top run arranged to move toward the rear wall **14**. The grate **35** is arranged to receive solid fuel, such as crushed coal, from suitable fuel delivery apparatus including a hopper **36** disposed superjacent the front end of the grate **34**. Air for combustion is delivered in suitable known manner to the space between the upper and lower runs of the grate. An ash discharge hopper or pit **38** is provided subjacent the rear end of the grate **35**. Other fuels such as oil or gas may be burned, in which case the furnace may be easily adapted in known manner for such firing.

The boiler pressure parts also include fluid cooled tubes for all the furnace walls, the front wall **12** and roof **18** having a row of tubes **40** connected at their lower ends to a header **42** and at their upper ends to the drum **28**, with fluid supply being provided by tubes **44** extending between the lower drum **30** and the header **42**; each side wall **17** having a row of tubes **46** connected at their opposite ends to headers **48** and **50**, with fluid supply being provided by tubes **52** extending between the lower drum **30** and the header **48** and fluid discharge being provided by tubes **54** extending between the header **50** and the upper drum **28**; and the lower rear wall having a row of tubes **56** connected at their lower ends to a header **58** and at their upper ends to the upper drum **28**, with the upper portions of these tubes being arranged to form a screen ahead of the boiler tube bank **32** and with fluid supply being provided by upright tubes **60** extending between the lower drum **30** and the header **58**.

In accordance with the invention, the pressure parts of the boiler and its associated furnace are specially arranged for bottom support at substantially the same elevation to minimize relative expansion movements between different pressure parts. The points of fixed support indicated in Figs. 1 and 2 are at the lower rear wall header **58** and at the side wall headers **48**, so the pressure parts are free to expand upward and laterally. The predominant proportion of the weight of the drums **28**, **30** and tube banks **32**, **34**, preferably substantially all of the weight of these parts, is taken by a support arrangement including the upright supply tubes **60** disposed at spaced positions along the length of the drum **30**, the lower header **58**, and upright steel columns **62** at spaced positions along the length of the header **58** having saddles **64** at their upper ends placed under the header **58**. Thus the tubes **60** function as supply tubes in the fluid circulation system and as, in effect, part of the support columns for the boiler pressure parts. These tubes are provided in sufficient number and are of sufficient diameter and thickness to resist bending moment stresses in carrying the weight of the boiler tubes and drums and to withstand the compression forces transmitted to them.

The rear end of the stoker is enclosed by a refractory wall **66** extending transversely of the furnace chamber **10** between the side walls.

The provisions for supporting the furnace wall tubes and associated headers, as well as the remainder of the weight of the drums and tubes extending therebetween not supported as described above, comprises a air of support castings or columns **68** placed under and expansibly secured in known manner to each side wall header **48**, with a point of fixed support being at substantially the same elevation as the corresponding point for the boiler drums and tube banks. The header **42** is connected to and supported from the ends of the headers **48** by short drain tubes **70**.

The fluid in the portion of the circulation circuit including the tubes **60** is water at or close to the saturation temperature corresponding to the drum pressure, while the fluid in the portions of the circulation circuits including the furnace wall tubes is a mixture of steam and water also at the saturation temperature corresponding to the drum pressure. With the drums and tube banks and furnace wall tubes supported as described there is little or no relative expansion between the furnace wall tubes and the boiler drums and tubes since the points of fixed support of all pressure parts are set at substantially the same elevation and since the inside surfaces of all pressure parts of the setting are at or close to the temperature corresponding to the drum pressure. This arrangement allows establishment of the furnace height without regard to the difference in elevation between the lower drum and the point of support of the furnace wall tubes. Further, simplicity and compactness are enhanced with the supporting members so arranged. Headroom requirements are relatively low because overhead beams or other building tie-in steelwork are eliminated. There are no steel supporting members to interfere with operations adjacent to the vapor generating unit and access to any part of the unit is facilitated.

In the operation of the vapor generating unit described, the supplies of air and fuel are fed to the furnace in controlled quantities, and combustion of the fuel takes place at a relatively rapid rate. All of the heating gases generated flow upwardly through the furnace chamber, then substantially horizontally over the screen tubes and the tube banks **32**, **34** to the gas outlet **24**. The last four or five rows, with respect to gas flow, of the tube bank **34** serve as downcomer or fluid supply tubes for the remaining portion of the bank and for tube bank **32**, and the supply tubes **44**, **52**, **60** deliver adequate supplies of water to the furnace water walls.

In the embodiment illustrated in Fig. 3, the boiler pressure part supporting members include a group of upright fluid supply and support tubes **72** arranged at each end of the drum **30**, with the tubes of each group having their drum connection ends circumferentially spaced, their opposite ends connected to rearward extensions of the lower side wall headers, and their centerlines lying in substantially a single vertical plane extending generally normal to the vertical plane including the longitudinal axis of the drum **30**; and steel columns **68** at spaced positions along the length of each side wall header **48** having saddles at their upper ends placed under the respective headers. While this support arrangement is adapted to carry the entire weight of the drums, tube banks, and furnace walls, part or substantially all of the support of the drums and tube banks may be provided by the supporting members for the corresponding parts in the main embodiment of Figs. 1 and 2, that is, by the columns **62**, header **58** and tubes **60**. Like the embodiment of Figs. 1 and 2, the points of fixed support of all pressure parts are set at substantially the same elevation and there is little or no relative expansion between different parts.

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

What is claimed is:

1. A bottom supported vapor generating unit having a natural circulation fluid circulation system and comprising walls forming a setting containing pressure parts including horizontally disposed upper and lower drums, and a bank of upwardly extending tubes connected at their opposite ends to said drums; some of said walls including fluid cooled tubes and forming sides of a furnace chamber laterally adjacent and opening to said tube bank; column support means constructed and arranged to provide column strength sufficient to support at least a predominant proportion of the weight of said drums and tube bank; said column support means constituting horizontally extending header means disposed below said lower drum, a plurality of laterally spaced upright tubes disposed along the length of said lower drum and connected at their opposite ends to the lower drum and to said header means, and means for bottom supporting said header means; said upright tubes being of sufficient diameter and thickness to resist bending moment stresses in carrying said drums and tube bank and to withstand the compression forces transmitted to them; said upright tubes, said header means, and said bottom support means for said header means constituting the normal support means for the predominant proportion of the weight of said drums and tube bank; means connecting said fluid cooled tubes and said header means into said fluid circulation system; and means for bottom supporting said fluid cooled wall tubes at approximately the same elevation as the means for bottom supporting said header means to thereby minimize relative vertical expansion movements between said fluid cooled wall tubes and said drums and tube bank.

2. A bottom supported vapor generating unit having a natural circulation fluid circulation system and comprising walls forming a setting containing pressure parts including horizontally disposed upper and lower drums having their longitudinal axes in substantially the same vertical plane, and a bank of vertically extending tubes connected at their opposite ends to said drums; some of said walls including fluid cooled tubes and forming sides of a furnace chamber laterally adjacent and opening to

said tube bank; column support means constructed and arranged to provide column strength sufficient to support at least a predominant proportion of the weight of said drums and tube bank; said column support means constituting horizontally extending header means disposed below said lower drum, a plurality of laterally spaced upright tubes disposed along the length of said lower drum and connected at their opposite ends to the lower drum and to said header means, and means for bottom supporting said header means; said upright tubes being of sufficient diameter and thickness to resist bending moment stresses in carrying said drums and tube bank and to withstand the compression forces transmitted to them; said upright tubes, said header means, and said bottom support means for said header means constituting the normal support means for the predominant proportion of the weight of said drums and tube bank; means connecting said fluid cooled tubes and said header means into said fluid circulation system; and means for bottom supporting said fluid cooled wall tubes at approximately the same elevation as the means for bottom supporting said header means to thereby minimize relative vertical expansion movements between said fluid cooled wall tubes and said drums and tube bank.

3. A bottom supported vapor generating unit having a natural circulation fluid circulation system and comprising walls forming a setting containing pressure parts including horizontally disposed upper and lower drums having their longitudinal axes in substantially the same vertical plane, and a bank of vertically extending tubes connected at their opposite ends to said drums; some of said walls including fluid cooled tubes and forming sides of a furnace chamber laterally adjacent and opening to said tube bank; column support means constructed and arranged to provide column strength sufficient to support at least a predominant proportion of the weight of said drums and tube bank; said column support means constituting a horizontally extending header disposed below said lower drum, a plurality of laterally spaced upright tubes disposed along the length of said lower drum and connected at their opposite ends to the lower drum and to said header, and means for bottom supporting said header; said upright tubes being of sufficient diameter and thickness to resist bending moment stresses in carrying said drums and tube bank and to withstand the compression forces transmitted to them; said upright tubes, said header, and said bottom support means for said header constituting the normal support means for the predominant proportion of the weight of said drums and tube bank; means connecting said fluid cooled tubes and said header into said fluid circulation system; and means for bottom supporting said fluid cooled wall tubes at approximately the same elevation as the means for bottom supporting said header to thereby minimize relative vertical expansion movements between said fluid cooled wall tubes and said drums and tube bank.

4. A bottom supported vapor generating unit having a natural circulation fluid circulation system and comprising walls forming a setting containing pressure parts including horizontally disposed upper and lower drums having their longitudinal axes in substantially the same vertical plane, and a bank of vertically extending tubes connected at their opposite ends to said drums; some of said walls including fluid cooled tubes and forming sides of a furnace chamber laterally adjacent and opening to said tube bank; column support means constructed and arranged to provide column strength sufficient to support at least a predominant proportion of the weight of said drums and tube bank; said column support means constituting a horizontally extending header disposed below said lower drum and having its longitudinal axis in substantially the same vertical plane as the longitudinal axis of said lower drum, a plurality of laterally spaced upright tubes disposed along the length of said lower drum and connected at their opposite ends to the lower drum and to said header, and means for bottom supporting said header including upright columns each having a cradle at the top end thereof carrying said header; said upright tubes being of sufficient diameter and thickness to resist bending moment stresses in carrying said drums and tube bank and to withstand the compression forces transmitted to them; said upright tubes, said header, and said bottom support means for said header constituting the normal support means for the predominant proportion of the weight of said drums and tube bank; means connecting said fluid cooled tubes and said header into said fluid circulation system; and means for bottom supporting said fluid cooled wall tubes at approximately the same elevation as the means for bottom supporting said header to thereby minimize relative vertical expansion movements between said fluid cooled wall tubes and said drums and tube bank.

5. A bottom supported vapor generating unit having a natural circulation fluid circulation system and comprising walls forming a setting containing pressure parts including horizontally disposed upper and lower drums having their longitudinal axes in substantially the same vertical plane, and a bank of vertically extending tubes connected at their opposite ends to said drums; some of said walls including fluid cooled tubes and forming the side walls of a furnace chamber laterally adjacent and opening to said tube bank, with the fluid cooled tubes of said side walls having their lower ends connected to horizontally extending headers disposed at the same elevation and arranged with their longitudinal axes substantially normal to the longitudinal axis of said lower drum and with each header having a portion thereof situated below said lower drum; column support means constructed and arranged to provide column strength sufficient to support the entire weight of said drums and tube banks and fluid cooled tubes; said column support means constituting said headers, groups of upright tubes disposed adjacent both ends of said lower drum and connected at their opposite ends to the lower drum and to said side wall headers, with the tubes of each group having their centerlines lying in substantially a single vertical plane extending generally normal to the longitudinal axis of the lower drum, and means for bottom supporting said side wall headers at the same elevation including upright columns at spaced positions along the length thereof; said upright tubes being of sufficient diameter and thickness to resist bending moment stresses in carrying said drums and tube bank and to withstand the compression forces transmitted to them; said upright tubes, said header, and said means for bottom supporting said header constituting the normal support means for the entire weight of said drums and tube bank and fluid cooled tubes; and means connecting said fluid cooled tubes and said header into said fluid circulation system.

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