Aug. 9, 1955 J. D. ANDREW, JR 2,714,877

HIGH PRESSURE PRIMARY AIR HEATER

Filed Sept. 1, 1950 4 Sheets-Sheet 1

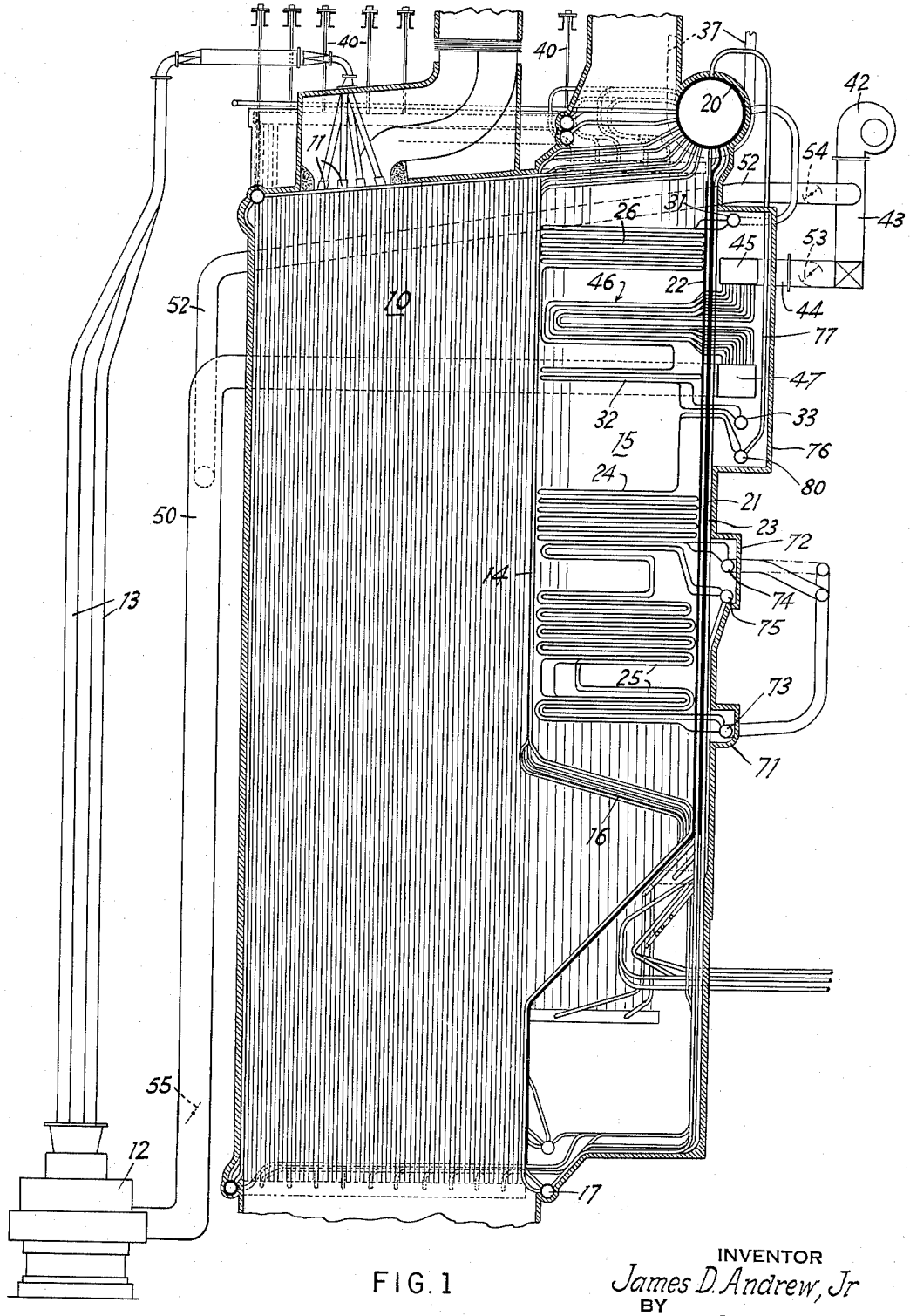

FIG. 1

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HIGH PRESSURE PRIMARY AIR HEATER

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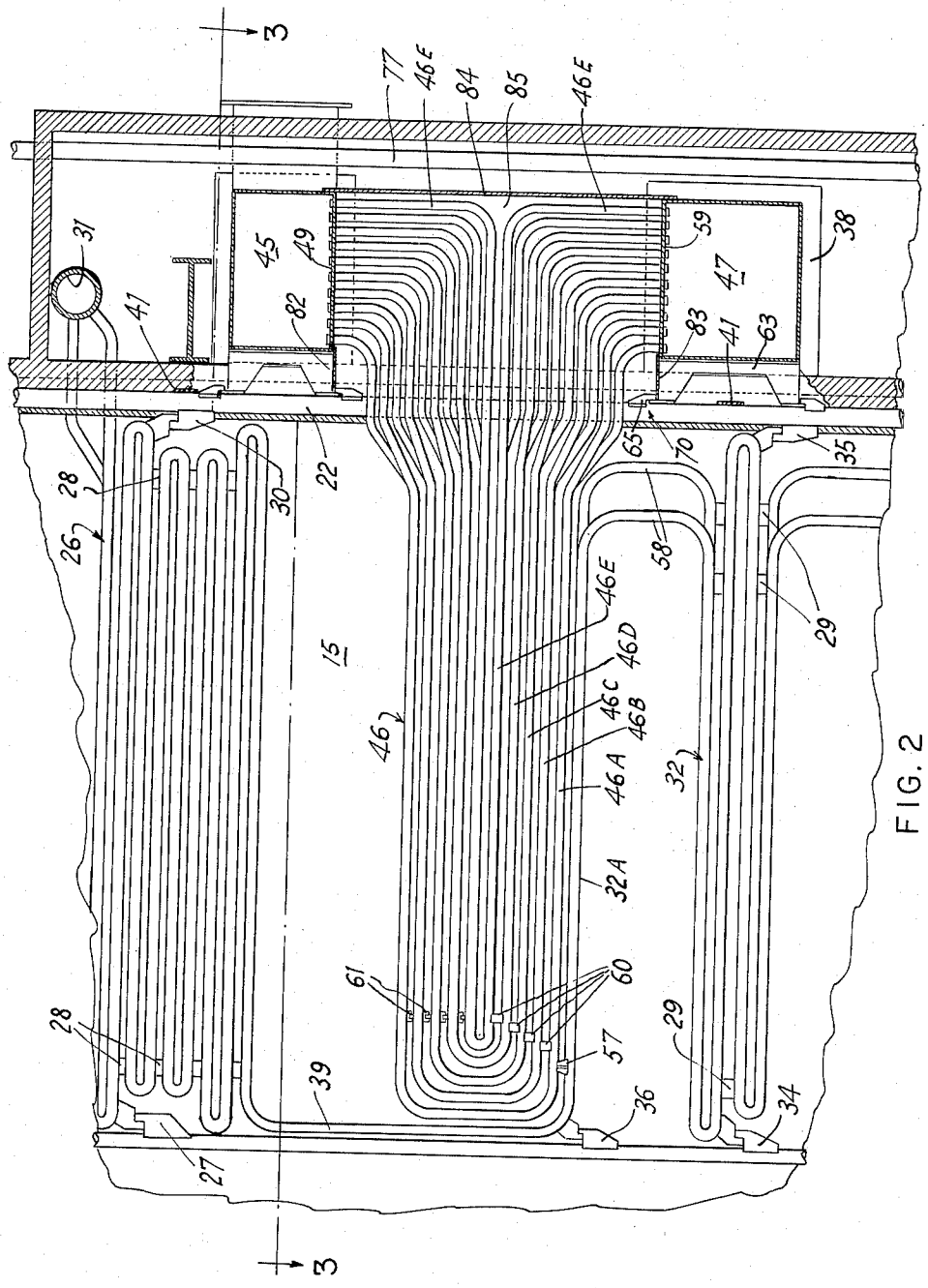

FIG. 2

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HIGH PRESSURE PRIMARY AIR HEATER

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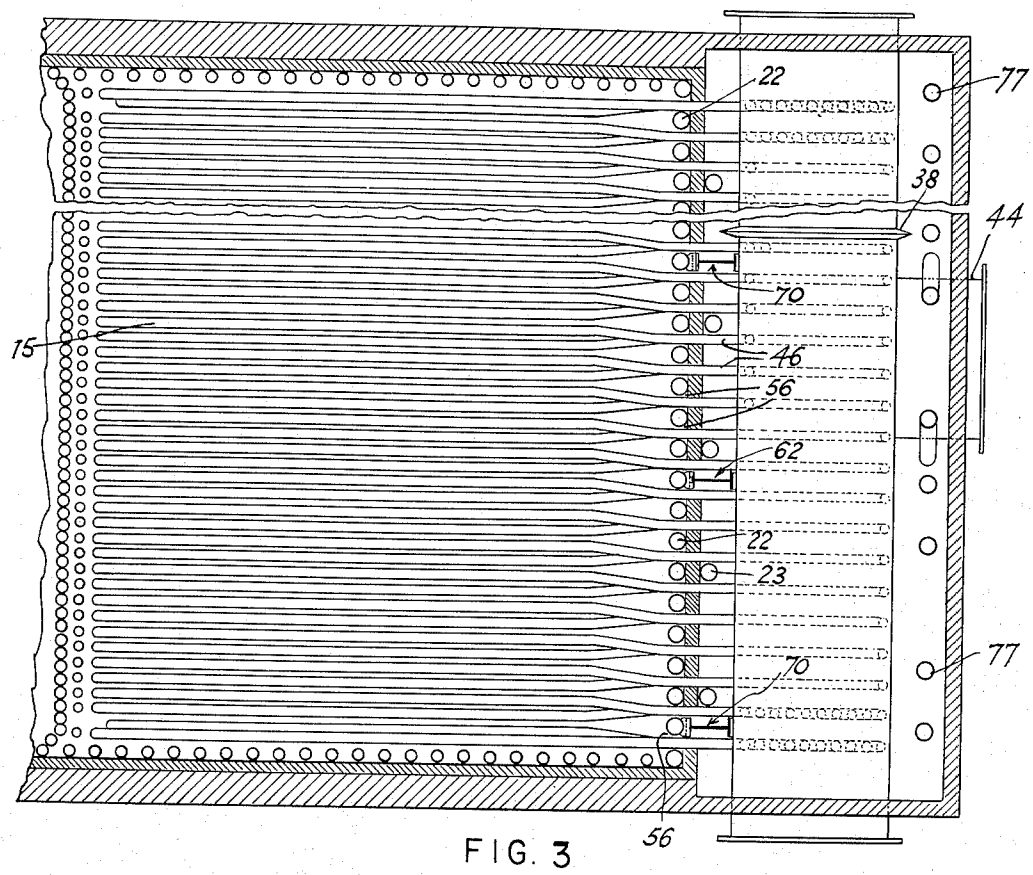

FIG. 3

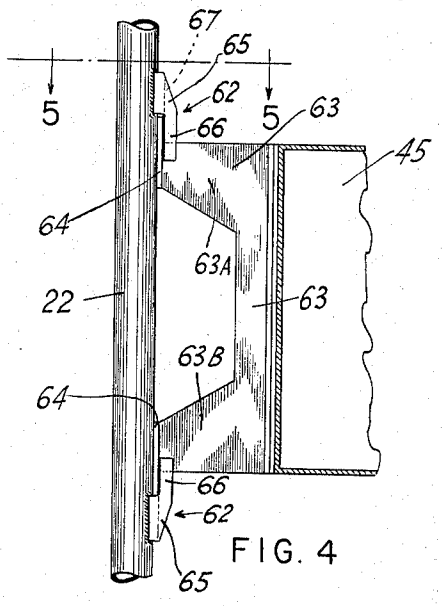

FIG. 4

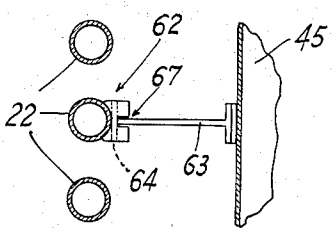

FIG. 5

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HIGH PRESSURE PRIMARY AIR HEATER

Filed Sept. 1, 1950 4 Sheets-Sheet 4

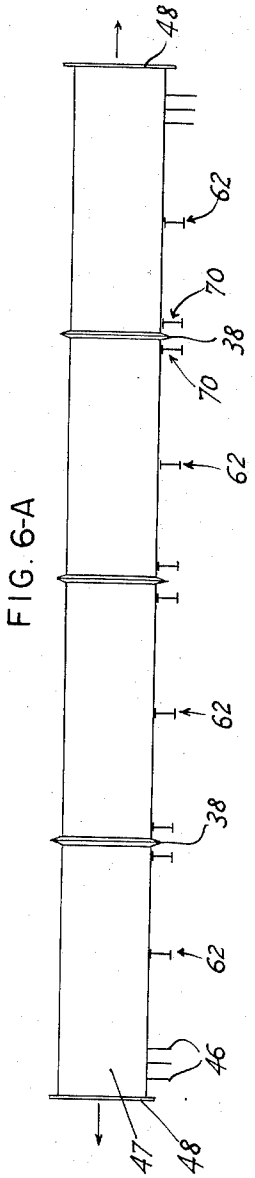

FIG. 6-A

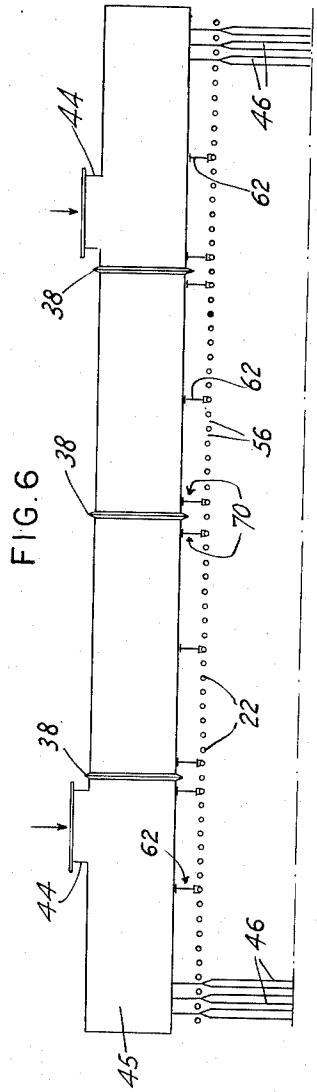

FIG. 6

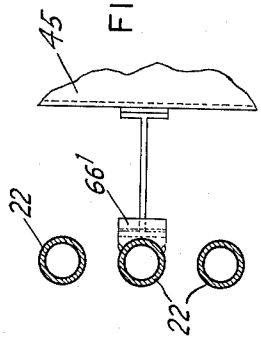

FIG. 8

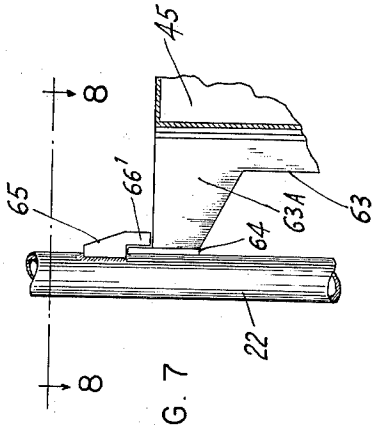

FIG. 7

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2,714,877

HIGH PRESSURE PRIMARY AIR HEATER

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Application September 1, 1950, Serial No. 182,871

8 Claims. (Cl. 122—1)

The present invention relates to fluid heat exchangers, and more particularly to a tubular type of heat exchanger installed in the convection pass of a vapor generator. The tubular heat exchanger is supported by the wall tubes of the vapor generator and provided with means for permitting the differential expansion between the supporting parts of the vapor generator and the supported tubular heat exchanger as such differential expansion is caused by temperature differences in the related parts.

In the present invention a tubular type of heat exchanger is positioned in the flow path of heating gases with the inlet and outlet headers of the heat exchanger positioned out of the path of the heating gases. The headers are supported upon tubes in a wall defining one side of the heating gas flow path, with the tubes of the heat exchanger connecting the inlet and outlet headers and extending through the intertube spaces between adjacent wall tubes and in a reverse bend across the heating gas flow path. The headers and the connecting tubes of the heat exchanger are subjected to temperature changes differing from the temperature changes of the supporting gas-pass wall tubes, and are constructed and arranged to permit relative movements in the connected parts.

The various features of novelty which characterize my 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 I have illustrated and described an embodiment of my invention.

In the drawings:

Fig. 1 is an elevation view, partly in section, of a vapor generator incorporating the tubular heat exchanger of the present invention:

Fig. 2 is an enlarged elevation view, in section, of the heat exchanger shown in Fig. 1;

Fig. 3 is a plan section of the heat exchanger taken on the line 3—3 of Fig. 2;

Fig. 4 is a further enlarged elevation view of the anchor and support means for the headers of the heat exchanger;

Fig. 5 is a plan view, in section, of the anchor and support means taken on the line 5—5 of Fig. 4;

Figs. 6 and 6A are diagrammatic plan views of the inlet and outlet headers shown in Figs. 1, 2 and 3;

Fig. 7 is an enlarged elevation view of the support means for the headers of the heat exchanger; and

Fig. 8 is a plan view, in section, of the support means taken on the line 8—8 of Fig. 7.

While the tubular heat exchanger of the present invention is useful in many heat exchange applications where the fluid to be heated differs in temperature with respect to the temperature of wall tubes supporting the heat exchanger, the invention is particularly useful in a primary air heater associated with a vapor generator.

When pulverized coal from a unit type of pulverizer is burned in a furnace to provide heat for vapor generation, the pulverized coal is transported to the furnace in a carrier air stream which also provides a portion of the air required for combustion. This carrier or primary combustion air is preheated to dry the coal during pulverization, with the temperature of the preheated air varied in accordance with the moisture content in the raw coal delivered to the pulverizer. In operation, the moisture content of the raw coal delivered to the pulverizer will vary sufficiently to necessitate a change in temperature of several hundred degrees in the preheated air delivered to the pulverizer.

In the embodiment of the invention shown in the drawings, primary pulverizer air is heated in a recuperative type of heater by heat exchange with furnace gases passing through the convection pass of a steam generator. The air heater is supported upon tubes in the walls of the steam generator, with the tubular heating surfaces of the air heater extending through the intertube spaces of a wall defining the convection gas-pass.

In the embodiment shown the air heater is associated with a steam generator having a steam flow rated capacity of 860,000 pounds per hour at 1350 p. s. i. and a superheated steam temperature of 950° F. The heater is capable of preheating 135,000 pounds of air per hour from an entering temperature of 80° F. to an output temperature of 600° F. when the steam generator is operating at full rated capacity. Such a preheater capacity is adequate to meet pulverizer requirements under maximum moisture contents of the contemplated fuel.

As shown in Fig. 1, the furnace 10 of the steam generator is fired by pulverized fuel burners 11, supplied with air borne pulverized fuel from pulverizers 12 through the conduits 13. Furnace gases pass downwardly through the furnace 10 and then turn beneath a division wall 14 and pass upwardly through a convection gas-pass 15, transversely over the surfaces of a plurality of tube banks.

The division wall 14 is formed by a row of abutting steam generating tubes with the lower end portion of the tube row spread to form a slag screen 16 with the tubes opening into a lower header 17. The upper end of the division wall tubes open into the steam and water drum 20. The rear wall 21 of the convection gas pass is formed of tube and refractory construction, where the tubes 22 are equi-spaced and form downcomers supplying the lower headers, including the header 17, of the tubes lining the walls of the furnace 10. A transverse section view of a portion of the convection pass 15 is shown in Fig. 3. The downcomer tubes 22 are provided with refractory materials filling the intertube spaces, and providing a covering on the gas-pass side thereof for at least a portion of their length. The refractory tube facing is omitted from the wall areas adjacent the inlet and outlet tube connections with the separate tube banks, for example, as shown in Fig. 2. A second row of downcomer tubes 23 is positioned on the exterior side of the wall tubes 22 and connected with the lower headers of the wall tubes of the furnace 10.

The fluid heating tubes in the convection gas-pass 15 include primary and secondary superheater tube banks, 24 and 25 respectively, and banks of economizer tubes 26 and 32. A majority of the economizer tubes are supported in the gas-pass in the conventional manner by the supports 27 and 30 mounted upon the division wall 14 and the rear wall tubes 22, respectively, and the link members 28, to discharge into the outlet header 31. This construction is illustrated in Fig. 2. The economizer tube row is extended downwardly, as at 39, parallel to the division wall 14, and is bent transversely across the convection pass to form a lower group 32 of reverse bend tubes opening into an economizer inlet header 33. The lower group of economizer tubes is also supported from the division wall 14 and rear wall tubes 22, as shown at 34 and 35, respectively, and by the link members 29.

In addition, a support **36**, mounted on the division wall **14** maintains the position of the economizer tube row, relative to the wall **14**, at the lower end portion of the downward extension **39** of the economizer.

In the illustrated embodiment of the invention, the boiler unit is supported at its upper end portion, so that thermal expansion of the walls will be downward. As illustrated in Fig. 1, the drum **20** is suspended by the supporting straps **37**, and the walls by hangers **40**, from overhead structural steel work (not shown). As will hereinafter become apparent, the steam generator can be supported from the bottom, or at some position intermediate the top or bottom of the unit, without affecting the supporting means or the function of the primary air heater.

Expansion of the drum **20** and the headers of the circulatory system of the unit will also occur in a horizontal direction. Such expansion movement will increase the spacing between adjacent wall tubes. The tubes are maintained in alignment by tie bars associated with the tubes. The tie bars **41** of the tubes **22** in the rear wall **21** are illustrated in Fig. 2, where the bars are welded to the outer surface of the tubes **22** at vertically spaced positions. With the tie bars **41** in thermal contact with the tubes **22**, the metal in each will be maintained at substantially equal temperatures, and the heat expansion of the bars will be comparable with the horizontal heat expansion of the drum **20** and the lower headers.

Primary air for the pulverizer **12** is delivered under pressure by the fan **42** to the inlets **44** of a manifold or inlet header **45**. Thereafter the air is heated in passing through rows of tubes **46** extending across the convection gas pass **15** and discharges into the manifold or outlet header **47**, and flows through a duct **50** to the pulverizer.

The headers **45** and **47** have substantially equal horizontal dimensions, but with cool air entering the header **45** and hot air leaving the header **47**, the latter header has an increased vertical dimension to permit handling the greater volume of air passed therethrough. Although only one pulverizer **12** is shown in Fig. 1, it will be understood two or more pulverizers may be installed to serve the furnace **10**, and a second duct **50** (not shown) will be installed on the opposite side of the steam generator.

Since the temperature of the air delivered to the pulverizer must be varied in accordance with the moisture content of the raw coal, a by-pass duct **52** is installed around the air heater. The division of air flow between the header **45** and the by-pass duct **52** is regulated by the dampers **53** and **54**. When substantially dry coal is delivered to the pulverizer **12**, practically all of the air will pass through the by-pass duct **52**, while with wet coal substantially all of the air will pass through the tubes **46** of the primary air heater. It will be appreciated that with a wide variation in the amount of air heated in the primary air heater the temperature therein will also vary with air flow therethrough while the heating gas flow over the tubes **46** will not necessarily change in either temperature or volume of flow.

With the wide variation in temperature conditions to which the primary air heater is exposed, the heater must be constructed and arranged to permit differential movement of the air heater relative to the associated parts of the boiler unit. The air inlet and outlet headers are supported on the tubes **22** of the convection pass rear wall **21**. The headers will move with the tubes **22** in a substantially vertical direction from their supported position which, in the embodiment shown, is downwardly from the drum **20**. Due to the vertical spacing between the headers **45** and **47**, the extent of their movement with the tubes **22** will differ. For example, the header **45** will move downwardly approximately ⅝" while the header **47** will also move downwardly approximately 1", between cold and operating conditions within the boiler.

As shown in Figs. 2 and 3, the U-shaped or reverse bend air heater tubes **46** are connected into the tube sheets **49** and **59**, respectively, of the headers **45** and **47**. The

tube sheets **49** and **59** are parallel and in vertically spaced relationship, with the end portions of each tube **46** vertically disposed in their connections therewith. The end portions of the tubes **46** are arranged in rows lying in parallel vertical planes which are normal to the plane of the row of tubes **22**, with the row to row centerline spacing substantially equal to the tube center spacing of the tubes **22**. In the embodiment shown in the drawings, the end portions of ten tubes **46** are arranged in each row, with each tube bent in the same vertical plane through an angle of 90° from the vertical to the horizontal to extend through an intertube space **56** between adjacent tubes **22**.

Within the convection pass **15**, alternate tubes **46** in each row are horizontally displaced to one side while the remaining tubes are horizontally displaced in the opposite direction forming two rows of five tubes each on a horizontal centerline to centerline spacing one half the tube **22** center to center spacing. In the embodiment shown the horizontal center to center spacing of the tubes **22** is 7 inches, as is the centerline to centerline spacing of the tube **46** connections with the tube sheets **49** and **59**, and the horizontal spacing between the centerlines of each tube row within the convection pass **15** is 3½ inches. As shown in Fig. 2, the tube **46** portions on the convection gas-pass **15** side of the wall **21**, with the exception of tube **46E**, are also vertically displaced to closely spaced vertical positions within the convection pass. As shown in Fig. 3, only one set of alternate tubes **46** is horizontally displaced out of alignment with the intertube space **56** adjacent the side walls of the convection pass **15**.

The division wall end of the tubes **46** in each row is directly supported by the uppermost tube **32A** of the economizer tube group **32** by a saddle **57**, and through the support **36** on the division wall **14**. The saddle **57** is welded to the economizer tube **32A**, with the air heater tube **46A** slidably resting thereon. The tubes **46B**, **46C**, **46D** and **46E** are likewise each slidably supported by a saddle **60** welded on the subjacent tube. Guides **61** between adjacent tubes maintains the alignment of the upper horizontal extensions of the tubes **46**. The supporting and guiding arrangement described retains the relative spacing of tube rows and of the tubes in each row while permitting relative longitudinal movement of the tubes in a tube row, as such movements may be created by temperature changes in the tubes.

The return bend arrangement of the tubes **46** is such as to provide adequate flexibility for the vertical movement of the headers **45** and **47** during expansion and contraction of the tubes **22**. The walls **14** and **21** move vertically corresponding to the generally equal temperatures therein. However, with the economizer receiving feed water through the header **33** and discharging through the header **31** into the drum **20**, the tubes **32A** will be at a lower temperature than that prevailing in the convection pass wall tubes. Thus, there will be some longitudinal relative movement between the tubes **32A** and **46A**, as guided by the supporting saddle **57**. The close spacing in the cantilever relationship between support **36** and saddle **57** will minimize any substantial vertical movement of the saddle **57** relative to the support **36** as caused by the lower temperature in the vertical extensions **58** of the economizer tube row, as compared with tubes **22**.

In supporting the headers **45** and **47** on the tubes **22** provision must also be made for horizontal differential expansion between the headers and the rear wall **21**. The rear wall **21** will expand laterally when the unit is brought up to an operating pressure from a cold condition. With a rear wall **21** width of the the order of 40' and a temperature rise to saturation temperature within the boiler, the wall will expand approximately 2 inches in width. The actual expansion of the wall will depend upon the temperature of the tie bars **41**, although with the bars welded to the surfaces of the tubes

22, the bars will attain a temperature substantially equal to that of the tubes. However, with the varying requirements for preheated air for the pulverizer, the headers 45 and 47 need not attain the temperature of the tubes 22 and their expansion need not be equal to that of the wall tubes 22. To provide for differential expansion between the air heater and the tubes 22, each of the headers 45 and 47 is constructed in longitudinal sections, with the sections connected by expansion joints 38. To maintain alignment between the tubes 46 and the tube spaces 56, each of the header sections is anchored at its longitudinal midpoint to one of the tubes 22, so that the midpoint of each section will move with the tubes in both vertical and horizontal directions.

The arrangement of both the upper header 45 and the lower header 47 is shown diagrammatically in Figs. 6 and 6A, respectively. Each header is divided into four substantially equal sections, and the sections are connected by bellows type expansion joints 38. The inlet header 45 is provided with a pair of inlet connections 44 for incoming primary air, with each inlet positioned adjacent the section connecting end of each end section. The outlet header 47 is provided with connections 48 at each end with the ducts 50.

The header sections are each anchored and supported at their midpoints on a tube 22 as shown in Figs. 4 and 5. The construction and arrangement of the anchor support 62 is the same for both the inlet and outlet header sections, and includes a plate 63 which is welded to the midpoint of a header section side wall. The plate 63 extends vertically and perpendicularly from the header section side wall to a tube 22, and has a height substantially equal to the header section depth. A central portion of the plate 63 is omitted adjacent the tube 22 with the upper and lower portions 63A and 63B of the plate ending in a vertical plate 64 welded perpendicularly thereto and positioned in abutting relationship with the tube 22, with a vertically projecting end portion extending beyond the plate portions 63A and 63B. A lug 65 is welded to the tube 22 with two spaced depending fingers 66 engaging the plate 64 and lying on opposite side of plate 63. With the anchor support described, each section of a header is not only supported on a tube 22 for vertical movement with the tube, but is also positioned with its midpoint moved in a horizontal direction corresponding with the horizontal movement of the supporting tube 22 of the rear wall 21.

In addition to the anchor support 62, each section of each of the headers 45 and 47 is provided with a support 70 adjacent the ends of each header section near the expansion joints. Each support 70 is shown in Figs. 7 and 8, and is similar to the anchor support 62 except the finger 66′ of the lug 65 is not recessed, and the lug 65 does not extend in engaging relationship with the outer edges of the plate 63. The lower end of the support is similar to the upper end, except it is reversed in its position. With this construction the end portions of the header sections are supported for vertical movement with the tubes 22 of the wall 21. However, the header sections can move in a horizontal direction parallel to the wall 21 with the fingers 66′ maintaining the parallel spaced relationship between the wall 21 and the header section. Thus, differential temperatures between the wall 21 and either of the headers 45 or 47 will create relative movements of the ends of the header sections in a horizontal direction parallel to the wall 21, with such differential movements absorbed in the header section bellows joints 38.

In operation, the relative movements of the air heater and the rear wall 21 of the convection pass may be the result of several different combinations of temperatures in the related parts. When the vapor generator is brought up to an operating pressure, the temperature of the tubes 22 will rise to a value corresponding generally

with the saturation temperature of steam at the operating pressure of the unit. At 1400 p. s. i. gauge, for example, the saturated steam temperature is approximately 590° F., and the rise in temperature will cause a downward expansion of the tubes 22 relative to the fixed horizontal position of the drum 20. Tube expansion will cause an increase in the vertical spacing between the headers 45 and 47, with this increased vertical dimension between the opposite ends of the tubes 46 easily accommodated in the flexible arrangement of the tubes. The increase in temperatures within the vapor generator will also cause a downward expansion of the division wall 14, with a lowering of the economizer tube supports 34, 35 and 36. Thus the division wall end portions of the tubes 46, supported on the economizer tubes 32A, will also be lowered.

The increase of temperature of the tubes 22 will cause a horizontal expansion of the tie bars 41 with a small increase in the horizontal spacing of the tubes 22 in the wall 21. With each of the sections of the headers 45 and 47 anchored at the section midpoint with a tube 22, the longitudinal center of each section will also be moved horizontally to a position corresponding with the movement of its anchor supporting tube 22. Under the steam pressure conditions given, and with a rear wall width of over 40 feet, the total horizontal movement of the wall 21 will approach two inches.

However, the flow or lack of flow of air through the heater will effect the relative movement of the headers 45 and 47 with respect to the wall tubes 22. Two extremes of pulverizer 12 operation can occur. With wet fuel, 600° F. primary air temperature may be required; while with dry fuel, all of the primary air may by-pass the primary air heater so that no air flow will occur in the heater. In the usual situation, some air will pass through the primary air heater with the air heated to 600° F. or thereabouts and the necessary primary air tempering will be accomplished by the use of by-pass air passed through the duct 52 and blended with the hot air for delivery at the desired temperature to the pulverizer.

Under conditions of no air flow through the air heater the tubes 46 will attain substantially the same temperature as that of the heating gases flowing thereover. This temperature may vary 150° F. with a variation in unit steam output between one quarter and full capacity. Under these conditions the headers 45 and 47 will be heated by conduction and convection from both the heating gases and the adjacent tubes 22 and 23. With the headers surrounded by an enclosure 76 as hereinafter described, the temperature of the header walls will approximate the temperature of the tubes 22.

With flow through the air heater, the temperature of the inlet header 45 will correspond to that of the incoming air, so that the temperature of the header 45 may be as much as 300 to 400° F. under that of tube 22. Under these conditions, bellows 38 will be expanded. The header supports 70 permit relative horizontal movement between the header and the tubes 22 of the wall 21. With the contraction of the header 45 sections toward the midpoint anchor positions, the tubes 46 at the ends of the sections will not be centered with respect to the corresponding intertube spaces 56. However, with the tubes 22 being 4 inch O. D. on 7 inch center spacing, and the tubes 46 being 2½ inch O. D. sufficient clearance is allowed in the space 56 to permit full movement of the tube 46, without distortion by reason of contact with the wall tube 22.

While the header 45 will be cooled by the incoming air, the header 47 will be maintained at a temperature substantially equal to the temperature of the tubes 22 and practically no relative horizontal movement will occur therebetween.

It is customary in the vapor generating art to provide refractory enclosures on the exterior surfaces of the unit to enclose the inlet and outlet headers of the superheater and the economizer. This is done to avoid leakage of air

or gases into or from the boiler setting through the wall openings accommodating the tubes connecting the exterior headers with the heating surfaces within the setting. This is illustrated in Fig. 1 by the enclosures **71** and **72** enclosing the primary superheater outlet header **73** and the secondary superheater inlet and outlet headers **74** and **75**, respectively. An enclosure **76** encloses the economizer inlet header **33** and the outlet header **31**, the air heater headers **45** and **47**, as well as a portion of the saturated steam conduits **77** and the primary superheater inlet header **80**.

With the relative movements of the tubes **46** in the intertube spaces **56**, hereinbefore described, the open area in the rear wall **21** between the levels of the opposing surfaces of the headers **45** and **47** is appreciable, and it is advantageous to seal the vestibule **85** so formed in the enclosure **76**. This is accomplished by the use of upper and lower seal plates **82** and **83**, respectively, and a rear seal plate **84** engaging the outer surfaces of the headers **45** and **47**. The plates **82** and **83** are fastened to the tubes **22**, with the refractory material of the wall **21** terminating in surface contact therewith. Since the relative movement between the wall **21**, and the headers **45** and **47** is in a horizontal direction the plates **82** and **83** have a sliding contact with the opposing edge surfaces of the headers **45** and **47**. The rear seal plate **84** is secured to the outer surface of the header **45** and is slidingly in contact with the outer surface of the header **47**. The sliding movement of the header **47** relative to the plate **84** will be in both a vertical and a horizontal direction.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form and mode of operation 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.

I claim:

1. In air heating apparatus, tubes of a fluid circulating system disposed in the walls defining a heating gas-pass, at least one of said walls formed of spaced tubes and refractory construction, inlet and outlet headers supported in spaced relationship upon the spaced tubes of said tube and refractory wall and out of the path of heating gas flow, rows of return bend tubes connecting said inlet and outlet headers, each tube row extending through an intertube space between adjacent tubes of said tube and refractory wall and in a return bend across said heating gas-pass, and means for supporting the return bend end portions of said row of tubes on separate tubes of a wall of said heating gas pass opposite from said tube and refractory wall, said separate tubes being maintained at a low temperature relative to said heating gas, said supporting means including means for supporting the lowermost tube of each row from a corresponding separate wall tube and saddles welded to each tube of said rows and having a sliding guide engagement with each upwardly adjacent tube of each row.

2. In air heating apparatus, a plurality of spaced tubes disposed in a wall formation and exposed on one side to the heat of furnace gases, inlet and outlet headers of an air heater supported at positions axially spaced along said tubes and out of the path of said furnace gases, rows of air heating tubes connecting said inlet and outlet headers, each row of air heating tubes connecting with said headers arranged in a plane normal to the plane of and to extend between adjacent tubes of said wall formation in a reverse bend in contact with said furnace gases, and sealing means to enclose the vestibule between said inlet and outlet headers including seal plates secured to said wall tubes and slidingly engaging the facing surfaces of said headers, and a seal plate lying in a plane parallel to said wall formation attached to an exterior surface of one of said headers and slidingly engaging an exterior surface of the other header.

3. In a vapor generator having a heating gas-pass, spaced upright tubes in the circulatory system of said vapor generator in a wall of said heating gas-pass, air heater inlet and outlet headers vertically spaced and positioned out of the path of heating gas flow, each of said headers constructed of header sections, expansion joints connecting adjacent header sections, rows of air heater tubes connecting said headers, said tubes extended generally horizontally through the intertube spaces between adjacent wall tubes and in a reverse bend in said heating gas-pass, and means for supporting said headers on said upright tubes of the heating gas-pass wall comprising an anchor support on an upright wall tube attached to the longitudinal midpoint of each section, and pairs of guide lugs attached to said upright wall tubes and positioned above and below each of said headers and adjacent the ends of each header section, each guide lug engaging a vertical plate attached to said header whereby the header sections move vertically with movement of the wall tubes as caused by temperature changes therein and move horizontally relative to the wall tubes from said anchor support as caused by a difference in the temperatures of said wall tubes and header sections.

4. In a vapor generator having a convection gas-pass, a plurality of banks of economizer tubes transversely positioned in said convection gas-pass, some of said economizer tubes being vertically spaced from the remaining banks thereof and connected by a row of vertically extending tubes located adjacent a wall of said gas-pass, means for supporting said economizer tube banks on opposite walls including said first mentioned wall of said gas-pass, spaced downcomer tubes in the second of said walls of said convection gas-pass, horizontally disposed air heater inlet and outlet headers supported at vertically spaced positions upon said downcomer tubes out of the path of heating gas flow, rows of tubes connecting said headers and extending through the intertube spaces between downcomer tubes in said last mentioned wall and in a reverse bend in said heating gas-pass between the spaced portions of said economizer tube banks, and means for supporting the reverse bend end portions of said tubes from the economizer tubes.

5. In a vapor generator having a heating gas-pass, spaced upright tubes in a wall of said heating gas-pass, air heater inlet and outlet headers of rectangular cross-section positioned in vertically spaced positions out of the path of heating gas flow and adjacent said wall tubes, rows of air heater tubes connecting said headers, said tubes being extended through the intertube spaces between adjacent wall tubes and in a reverse bend in said heating gas-pass, and means for supporting said headers on said wall tubes for vertical movement of the headers with the wall tubes as caused by temperature changes within said wall tubes comprising vertically spaced lugs welded to said wall tubes with each lug engaging a corresponding vertically extending plate attached to one side of a corresponding header.

6. In a vapor generator having a heating gas-pass, spaced upright tubes in a wall of said heating gas-pass, inlet and outlet headers supported upon said tubes at vertically spaced positions out of the path of heating gas flow, rows of tubes connecting said headers, each tube row connecting with said headers lying in a plane substantially perpendicular to the plane of said wall tubes and said tube rows being substantially equispaced between adjacent wall tubes, each row of header connecting tubes extending through the intertube space between the upright tubes in said wall having a reverse bend across said heating gas-pass, each header being divided into sections with adjacent sections connected by an expansion joint, support means for said headers on the wall tubes including an anchor support arranged to move the midpoint of each header section with the movement of

one of said wall tubes in both vertical and horizontal directions, and a support adjacent each end of said header sections associated with a wall tube and arranged to move said section vertically with said wall tubes and to guide the horizontal movement of said header section relative to said wall as movement is caused by temperature difference between each header section and wall tubes.

7. In a vapor generator having a heating gas-pass, spaced upright tubes in a wall of said heating gas-pass, air heater inlet and outlet headers supported in vertically spaced positions upon said tubes and out of the path of heating gas flow, rows of air heater tubes connecting said headers, each tube row extending through an intertube space between adjacent tubes in said wall and in a reverse bend across said heating gas-pass, supporting means for each of the air heater headers on said wall tubes comprising a vertical plate secured to a header wall and extended to a wall tube, coplanar perpendicular plates welded perpendicular to upper and lower end portions of said vertical plate adjacent said wall tube and projecting vertically beyond the limits of said vertical plate, and lugs secured to said wall tube to engage the header side of each of said coplanar plates beyond the limits of said vertical plate.

8. In a vapor generator having a convection gas-pass, a plurality of banks of economizer tubes transversely positioned in said convection gas-pass, some of said economizer tubes being vertically spaced from the remaining

banks thereof and connected by a row of vertically extending tubes located adjacent a wall of said gas-pass, means for supporting said economizer tube banks, horizontally disposed air heater inlet and outlet headers supported at vertically spaced positions, rows of tubes connecting said headers and extending in a reverse bend in said heating gas-pass between the spaced portions of said economizer tube banks, and means for supporting the reverse bend end portions of said tubes from the economizer tubes.

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