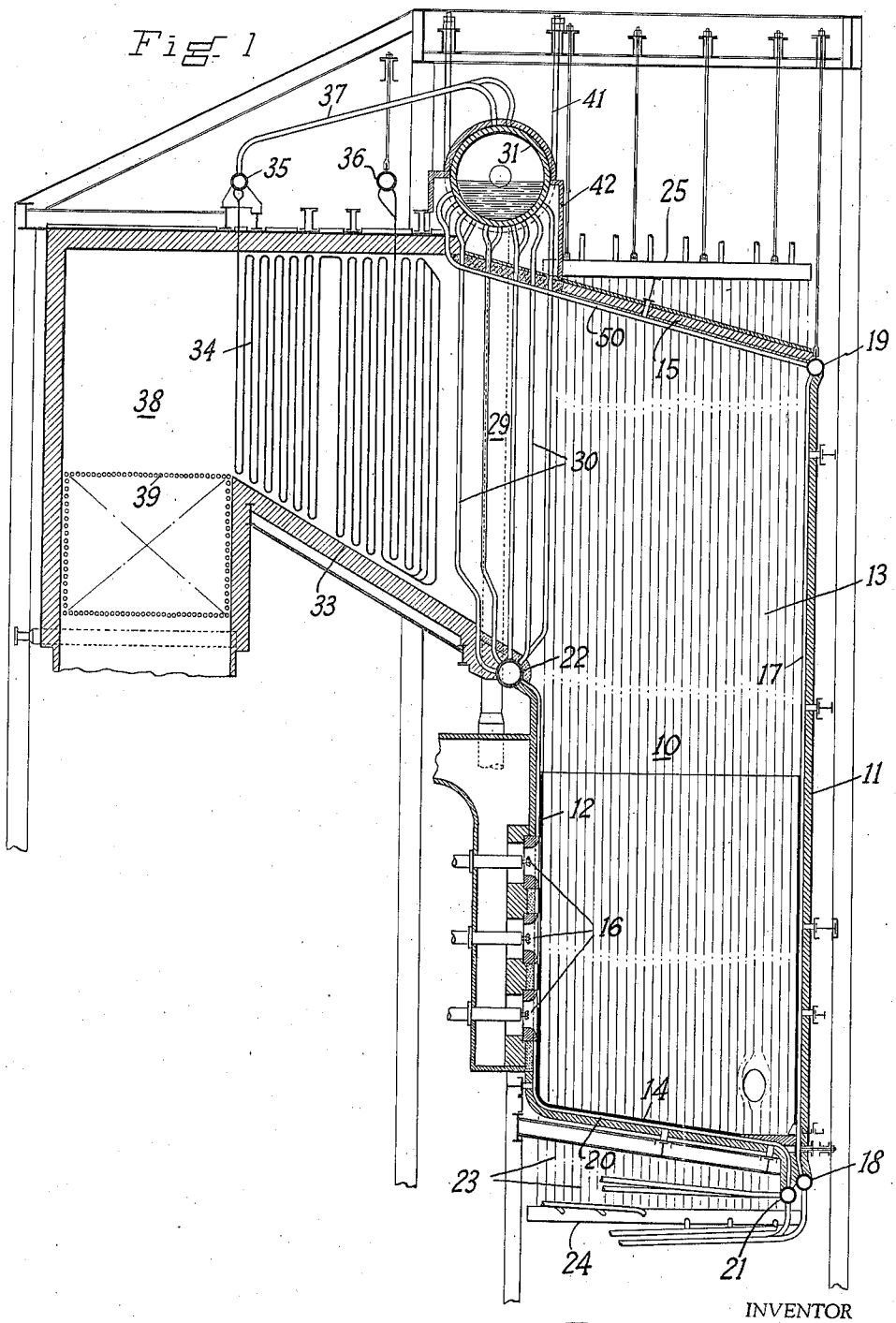
Aug. 12, 1941. P. R. CASSIDY 2,252,061

FLUID HEATER

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Fig. 1



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Fig. 2

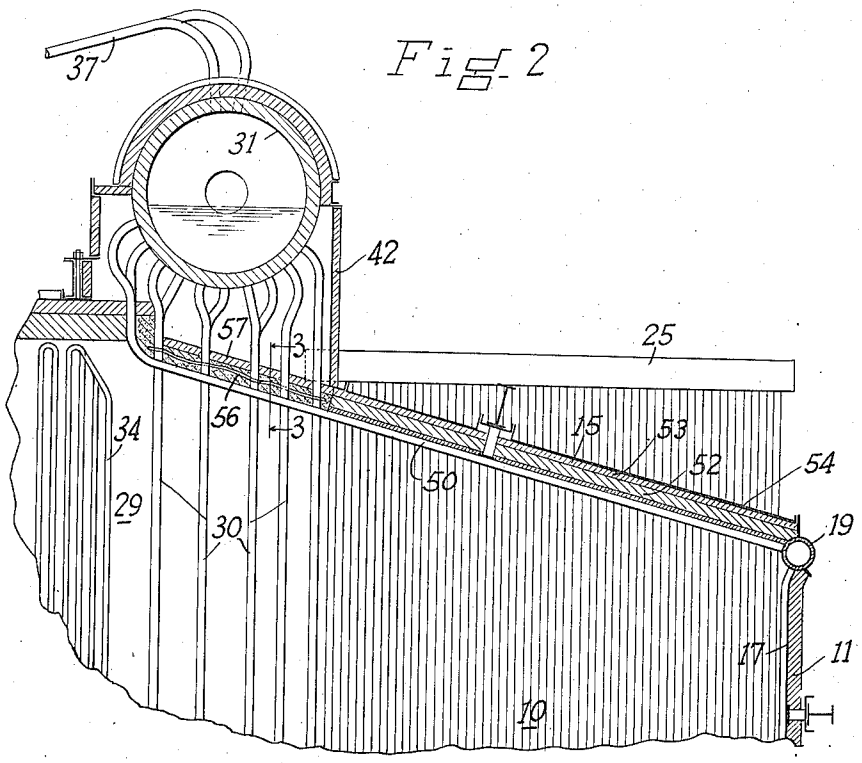
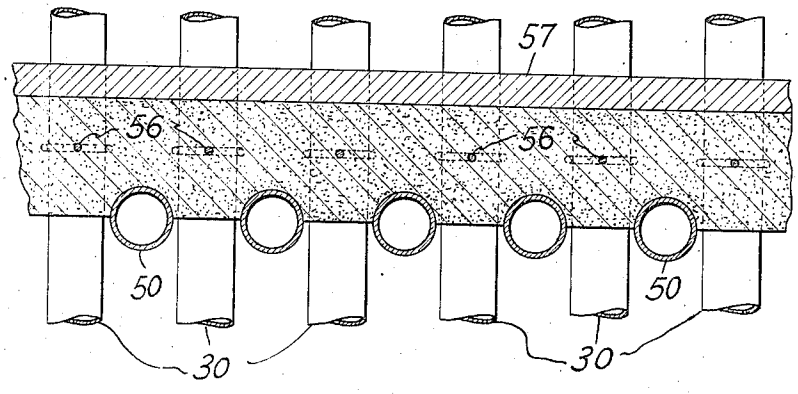


Fig. 3



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FLUID HEATER

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Application September 2, 1938, Serial No. 228,088

5 Claims. (Cl. 122—235)

The present invention relates to the construction and operation of fluid heaters, and more particularly to fluid heaters designed for high capacity generation of steam at high temperatures and pressures. Steam generating units of this type ordinarily include one or more thick-walled drums associated with the gas swept portion of the tubular steam generating surface and usually located in the unit where at least a part of the drum surface is contacted by high temperature heating gases. The substantial differential between the heating gas temperature and that of the fluid in the drum will create a temperature gradient through the wall of the drum. The thickness of the drum wall requires that such temperature gradients be maintained at an acceptable minimum. Any increase above the allowable temperature gradient will produce temperature stresses that in combination with pressure stresses may approach or perhaps exceed the elastic limit of the drum metal. If these stresses above the elastic limit occur frequently enough, cracks in the metal and ultimate failure of the drum will result.

The main object of my invention is the provision of a steam generating unit of the general character described which is constructed and arranged to adequately protect the drum from undesirable temperature stresses. A more specific object is the provision of a steam generator in which a thick-walled drum is so located and provided with protective means as to minimize the temperature gradient through the drum wall and maintain it at all times within the acceptable safe range.

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 a preferred embodiment of my invention.

Of the drawings:

Fig. 1 is a sectional elevation of a steam generator incorporating the invention;

Fig. 2 is an enlarged view of a portion of the structure shown in Fig. 1; and

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 2.

The steam generator illustrated is of the "radiant" type, similar in many respects to that disclosed in an application of Ervin G. Bailey et al., Ser. No. 137,196, filed April 16, 1937. The present unit is also particularly adapted for high capacity steam generation at high temperatures and pressures, one such unit having a designed maximum steam output of 230,000 pounds of steam per hour, an operating pressure of 1450 pounds per sq. in. and a superheated steam temperature of 950° F. As shown in Fig. 1, the steam generator comprises a completely water cooled vertically elongated furnace chamber 10 of rectangular horizontal cross-section formed by a vertically disposed front wall 11, a rear wall 12, opposite side walls 13, a sloping floor 14, and similarly sloping roof 15. The furnace is fired by a plurality of combination oil, natural gas and pulverized petroleum coke burners 16 arranged to discharge at different elevations through the rear wall 12. The walls of the furnace are fluid cooled by a row of front wall tubes 17 extending between lower and upper headers 18 and 19 respectively, a row of floor tubes 20 extending from a header 21 adjacent the header 18, along the floor 14 and upwardly along the rear wall 12 to a relatively small diameter drum or header 22. Each of the side walls is fluid cooled by a row of tubes 23 extending between lower and upper transverse headers 24 and 25. The furnace chamber tubes described are fully studded on their lower portions to a point above the level of the uppermost burner 16, the remaining portion of these tubes being partially studded. This tube construction facilitates the maintenance of very high temperatures in the lower portion of the furnace chamber and substantially lower but still high temperatures in the upper portion of the furnace.

As shown, the rear wall 12 terminates at the level of the drum 22 with the remaining portion of that side of the furnace chamber opening to a heating gas pass 29 containing the gas swept portion of the heat absorbing tube surface. Steam generators of the "radiant" type are particularly characterized by the relatively small amount of gas swept steam generating tube surface incorporated therein. In the present unit, this surface consists of four rows of vertically disposed tubes 30 extending between and bent for radial connection to the drum 22 and a horizontally arranged large thick-walled steam and water drum 31 extending longitudinally of the tube bank 30. The tube bank 30 serves as a tubular screen for reducing the temperature of the heating gases before the gases contact with the steam superheating surface and for limiting radiation to this surface from the furnace space.

The gas pass 29 radially decreases in cross-sectional area rearwardly due to the steep slope of its floor 33. The gas pass is occupied by a steam superheater of the pendent type formed by a series of flat coils of multiple-looped tubes 34 extending rearwardly in the gas pass between a steam inlet header 35 and an outlet header 36 located above the furnace roof. Tubes 37 connect the header 35 to the top of the drum 31. The rear end of the gas pass opens into the upper end of a vertical gas pass 38 in which is located a horizontally arranged bank of economizer tubes 39 formed in a multiplicity of vertically disposed flat tube coils having multiple-looped horizontally extending tube portions.

With the described construction the very high temperature products of combustion or heating gases from the lower portion of the furnace chamber 10 flow upwardly through the upper section of the furnace. The gas temperature is substantially reduced thereby by radiation to the surrounding heat absorbing surface but is still high. The gases then pass across the tube bank 30 and superheater tubes 34 and downwardly across the economizer tubes 39 to the heating gas outlet of the unit. An air heater may advantageously be located between the economizer and gas outlet if desired.

The present invention is particularly concerned with the location of the steam and water drum 31 and the provision of suitable means for protecting that drum from damaging temperature stresses. As shown, the drum 31 and the ends of the tubes 30 connected thereto are located above the level of the furnace roof 15. In a steam generator as illustrated the drum would be 60 inches in diameter with a drum wall thickness ranging between $4\frac{5}{16}$'' to $5\frac{5}{16}$''. The drum is top supported from the external supporting steel work by U-straps 41 at longitudinally spaced points. The drum and tube connections thereto above the level of the roof 15 are suitably heat insulated by an extension 42 of the unit casing. The furnace chamber roof includes a row of spaced water tubes 50 arranged transversely of the tube bank 30 and drum 31 and sloping upwardly from the front wall header 19 and their upper end portions extending through corresponding spaces between the tubes 30 to the rear side of the tube bank, at which point they are curved upwardly and radially connected to the drum 31 with the tube openings therefor in a portion of the drum wall circumferentially beyond the connections of the rearmost tubes 30. The portions of the tubes 50 between the header 19 and the first row of tubes 30 are partially studded and their intertube spaces closed by refractory. In this section the remaining portion of the roof is formed by a layer of tile 52, a layer of heat insulating material 53 and a steel casing 54.

The roof is continued directly below the steam and water drum 31 and this portion of the roof through which the tubes 30 pass is formed by a monolithic non-metallic refractory mixture supported by corresponding portions of the tubes 50 above their centers and in which is embedded strips of heat and chemically resistant metal 56 intertwined between the tubes 30. The top of the monolithic structure is covered by one or more layers of heat insulation material 57. The bottom of the monolithic structure extends between and in contact with the upper portions of the tubes 50, the lower portions of the tubes being bare. This portion of the roof joins at its rear end to the roof of the gas pass 29, providing a heating gas flow path out of contact with the underside of the drum 31 and the tube connections thereto.

The described construction insures a relatively low temperature differential between the outer and inner sides of the drum wall, and consequently a temperature gradient through the drum wall within the safe range. Temperature stresses in the drum wall are accordingly minimized, and the unit can be safely operated under the imposed operating conditions.

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 the invention may sometimes be used to advantage without a corresponding use of other features.

I claim:

1. In a steam generator, a furnace chamber, means defining a high temperature heating gas pass opening to said furnace chamber, a bank of vertically disposed steam generating tubes extending across said gas pass, a horizontally arranged thick-walled drum extending longitudinally of said tube bank above said gas pass and having the upper ends of said tubes connected thereto, and a row of water tubes extending along the roof of said furnace chamber and having upper end portions extending between the tubes of said tube bank adjacent said drum and connected to said drum.

2. In a steam generator, a furnace chamber, means defining a high temperature heating gas pass opening to one side of said furnace chamber, a bank of vertically disposed steam generating tubes extending across said gas pass, a horizontally arranged thick-walled steam and water drum extending longitudinally of said tube bank above said gas pass and having the upper ends of said tubes radially connected thereto, and a row of water tubes extending along the roof of said furnace chamber and having end portions extending between the tubes of said tube bank adjacent said drum with the upper ends of the tubes in said row radially connected to the water space of said drum at the side of said tube bank drum connections opposite said furnace chamber.

3. In a steam generator, a furnace chamber, means defining a high temperature heating gas pass opening to one side of said furnace chamber, a bank of vertically disposed steam generating tubes extending across said gas pass, a horizontally arranged thick-walled drum extending longitudinally of said tube bank above said gas pass and having the upper ends of said tubes connected thereto, a row of water tubes extending along the roof of said furnace chamber and having end portions extending between the tubes of said tube bank adjacent said drum with the ends of the tubes in said row connected to said drum at the side of said tube bank connections opposite said furnace chamber, and means supported on the tubes in said row and arranged to close the spaces between said tubes and the tubes in said tube bank to form a continuation of said furnace chamber roof below said drum.

4. In a steam generator, a furnace chamber, means defining a high temperature heating gas pass opening to said furnace chamber, a bank of

vertically disposed steam generating tubes extending across said gas pass, a horizontally arranged thick-walled drum extending longitudinally of said tube bank above said gas pass and having the upper ends of said tubes radially connected thereto, a row of water tubes extending along the roof of said furnace chamber and having end portions extending between the tubes of said tube bank adjacent said drum with the ends of the tubes in said row radially connected to said drum at the opposite side of said tube bank drum connections, a monolithic refractory structure supported on the tubes in said row and arranged to close the spaces between said tubes and the tubes in said tube bank to form a continuation of said furnace chamber roof below said drum, and wires of heat and corrosion resistant metal extending between the tubes of said bank and embedded in said refractory structure.

5. In a steam generator, a furnace chamber having a roof and vertical walls, means defining a high temperature heating gas pass opening to said furnace chamber, a bank of vertically disposed steam generating tubes in said gas pass, a horizontally arranged drum extending longitudinally of said tube bank above said gas pass and having the upper ends of said tubes connected thereto, a row of water tubes extending along one of the vertical walls of said furnace chamber and arranged to receive radiant heat therefrom, and a row of water tubes extending along said furnace chamber roof and connected to the upper ends of said wall tubes, said roof tubes having upper end portions extending between the tubes of said tube bank adjacent said drum and connected to said drum at the side of said tube bank drum connections opposite said furnace chamber.

PERRY R. CASSIDY.