

July 9, 1957

H. SEIDL

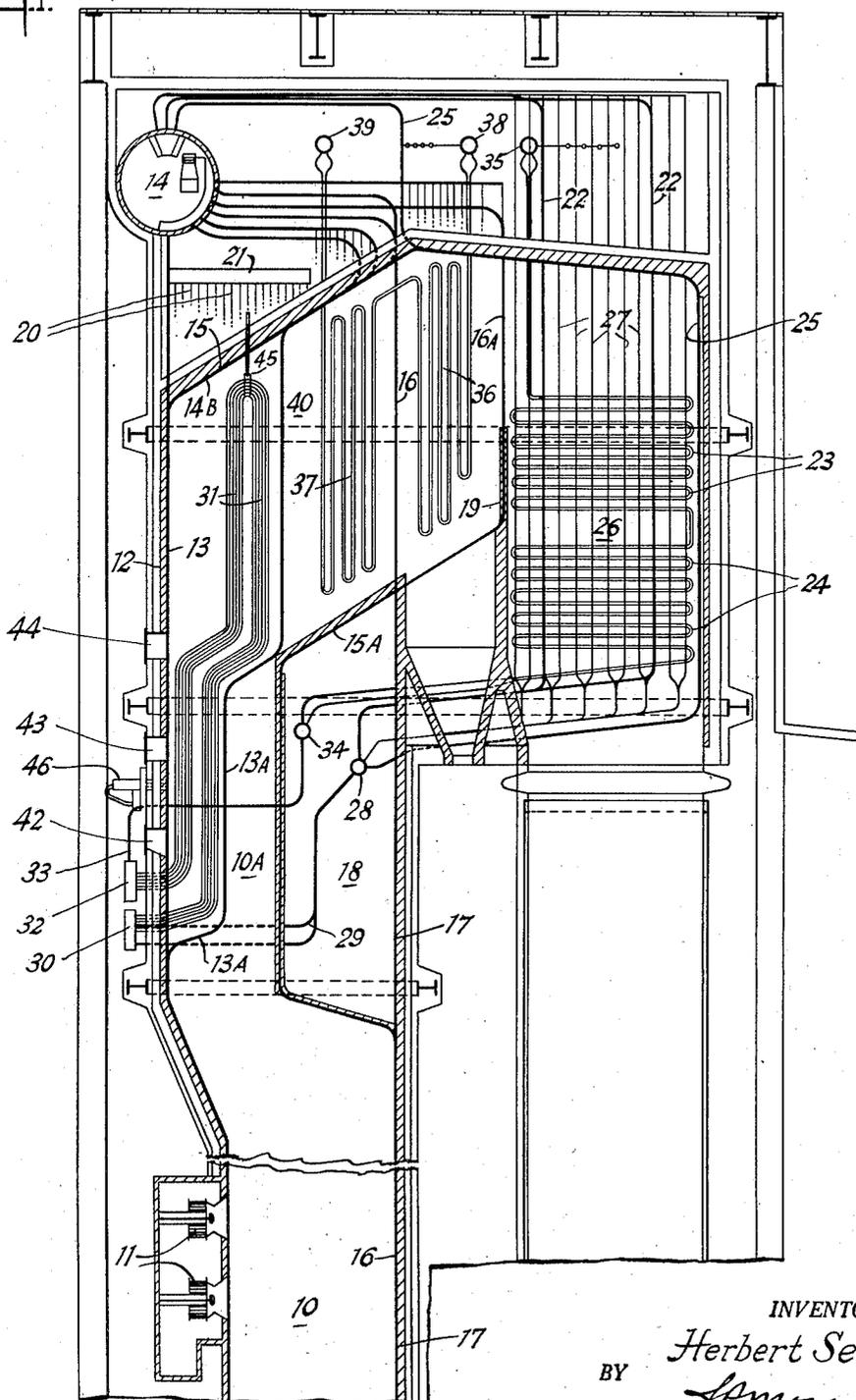
2,798,464

VAPOR GENERATORS HAVING VAPOR HEATERS

Filed Feb. 6, 1953

2 Sheets-Sheet 1

Fig. 1.



INVENTOR.
Herbert Seidl
BY *J. Moran*
ATTORNEY

July 9, 1957

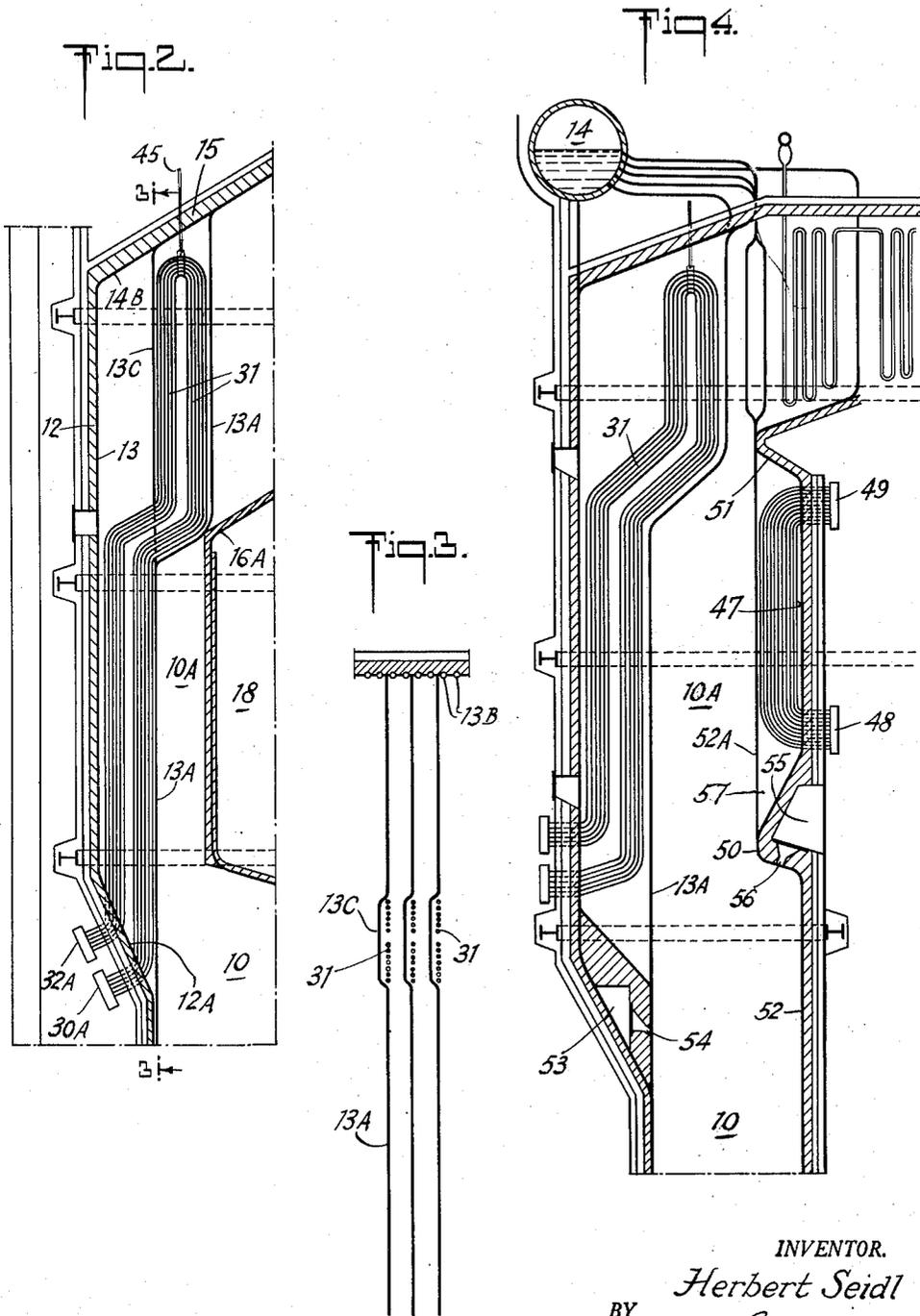
H. SEIDL

2,798,464

VAPOR GENERATORS HAVING VAPOR HEATERS

Filed Feb. 6, 1953

2 Sheets-Sheet 2



INVENTOR.
Herbert Seidl
BY *J. Moran*
ATTORNEY

1

2,798,464

VAPOR GENERATORS HAVING VAPOR HEATERS

Herbert Seidl, Oberhausen, Germany, assignor to The Babcock & Wilcox Company, New York, N. Y., a corporation of New Jersey

Application February 6, 1953, Serial No. 335,494

4 Claims. (Cl. 122-478)

This invention relates to the construction and operation of fluid heaters having a large amount of vapor heating surface therein and more particularly to the arrangement of a radiantly heated draining type vapor heater in a high temperature section of such fluid heaters.

In order to heat large quantities of vapor to the high temperatures now desired in steam generating units, for example, it is usually necessary to take advantage of the high heat content of high temperature combustion gases. However, in cases where radiant vapor heating elements are positioned directly in the highest temperature section, tube metal failures may result and, in cases where a slag-forming fuel is burned, the tubes may become fouled with slag. Such accumulations of slag soon reduce the heat transfer rate to a point at which the advantages of placing the elements in a high temperature section may even be overcome.

The primary object of my invention is the provision of a fluid heater with an improved arrangement of a radiant draining type vapor heater therein providing a high rate of heat transfer without danger of tube damage or excessive tube slugging.

A more specific object is to provide a radiant draining type vapor heater, the tubes of which are arranged vertically for gas flow parallel to the tubes over the greatest part of their length and protected from the direct heat of the gaseous products of combustion by an improved arrangement of fluid heating screen tubes.

A further object is the provision of a fluid heater with a radiant type vapor heater disposed in a recessed position therein in combination with an improved arrangement of gas tempering means for protecting the vapor heater from excessive gas temperatures and slugging.

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 preferred embodiments of my invention.

In the drawings:

Fig. 1 is a partly diagrammatic sectional elevation of a steam generating unit constructed in accordance with my invention;

Fig. 2 is a view similar to Fig. 1 showing a modified arrangement of the superheater and screen tubes;

Fig. 3 is a vertical section taken on the line 3-3 of Fig. 2; and

Fig. 4 is a view similar to Fig. 1 of a further modification.

In the steam generating unit shown in Fig. 1, pulverized fuel and combustion air are introduced into the lower portion of a vertically elongated furnace 10 through pulverized fuel burners 11. The fuel and air are ignited and burn in the lower section 10, generating a stream of high temperature gases flowing upwardly therein. The front and rear walls of the furnace chamber 12 and 17 are bent forwardly at the upper end thereof to form a forwardly offset vertically elongated high temperature gas pass 10A having about half the depth of the furnace

2

chamber. The upper end of the gas pass 10A opens laterally at the rear side thereof into a rearwardly inclined gas pass 40 defined by an inclined roof 15 and floor 15A. The front wall 12 contains steam generating tubes 13, some of which run directly vertically into the steam drum 14 while others 14B first extend along the roof 15. Some of tubes 16 lining the rear furnace wall 17 run vertically through gas pass 40, while the others 16A are bent forwardly to line the rear wall of the gas pass 10A, thence along the floor 15A and up through a short vertical partition 19 to the drum 14. Some of the furnace side wall tubes 20 lead directly to the drum 14 while others lead first to an upper header 21. The water downcomers from the drum 14 to the lower ends of the wall tubes 15 have been omitted for clarity.

In the steam generator illustrated the steam generating section is defined by the wall tubes described while the pressure parts located in the high temperature gas passes 10A and 40 and a rear vertical gas pass 26 opening to the rear end of the gas pass 40 are employed for superheating the steam generated to a high temperature. Saturated steam flows from the drum 14 through spaced rows of superheater supporting tubes 22 in the gas pass 26 on which are suspended vertically spaced groups 23, 24 of convection heated superheater tubes, through tubes 25 which line the rear wall of the pass 26, and through tubes 27 which line the side walls of the pass 26, to a common header 28, thence through the tubes 29 to an inlet header 30 of the radiant superheater section 31. The radiant superheater 31 occupies substantially the whole height of the gas pass 10A from the exit of the furnace chamber 10 to the upper end of the entrance to the gas pass 40 and is made in the form of transversely spaced platens of nested inverted hairpin tubes with their ends connected to the header 30 and a vertically adjacent outlet header 32. The steam then flows from each header 32 through a tube 33 to a common collecting header 34, from which the steam is conducted to a convection heated superheater section in the downflow gas pass 26. The convection section is formed by vertically spaced serially connected banks of looped horizontal tubes 23 and 24 supported on the tubes 22. The uppermost tube legs of the bank 23 are connected to a common outlet header 35. The steam leaving the header 35 passes to an inlet header 38 of a secondary convection superheater section either directly or through a regulable steam attenuator of any suitable type (not shown). The secondary convection section is formed by two laterally spaced pendant superheater sections 36 and 37 in the gas pass 40.

With the described arrangement of superheater sections, the steam to be superheated first flows parallel to the gas flow in the gas pass 26 through the wall tubes 25 and 27 and support tubes 22, is then mixed in the header 28, delivered to the inlet headers 30 of the predominantly radiant section 31, where it first flows parallel to the gas flow in the pass 10A and then counter to the gas flow to the headers 32. The steam is then mixed in the header 34 and delivered to the primary convection sections 24 and 23, flowing upwardly therein counter to the gas flow in the pass 26. The superheated steam, attenuated if desired, then flows through the pendant sections 36 and 37 counter to the gas flow in the gas pass 40 wherein it receives its final superheating.

In accordance with my invention, the radiant superheater section 31 is constructed and arranged in the gas pass 10A to provide a high rate of heat transfer thereto predominantly by radiation from the high velocity high temperature gases flowing upwardly therein and with a minimum deposition of slag thereon. For this purpose the surface is arranged in platens spaced transversely at least several tubes diameter, as indicated in Fig. 3, with

the platens having a special configuration in the gas pass 10A and the inlet and outlet headers 30 and 32 positioned externally of the gas pass.

The upper half of the tube platens of the radiation superheater 31 occupy the rear half of the gas pass 10A directly in front of the gas pass 40. At the lower level of the gas pass 40 the superheater tubes are bent at an angle downwardly and forwardly substantially parallel to the angle of the roof 15 and floor 15A, and then downwardly so that the lower vertical half of the platens occupy the forward half of the gas pass 10A adjacent the front wall 12. The lower end portions of the superheater tube platens are again bent forwardly through the front wall 12 to the external headers 30 and 32. Some of the steam generating tubes 13A of the front wall 12 are bent inwardly from the wall and extend upwardly along the inner side of each superheater platen so as to protect the superheater tubes from direct impact of the furnace gases.

Hangers 45 support corresponding superheater platens from the roof 15. Access openings, 42, 43 and 44 in the front wall 12 are arranged to permit cleaning of the lower half of the superheater platens 31 where the tubes are subject to the highest gas temperatures and where slagging is likely to occur. Tube blowing devices 46 are also located in this section.

As shown in Fig. 1 the superheater is arranged close to the front wall in the lower portion of the gas pass 10A where the gas temperatures are highest. The gases tend to be hottest toward the center and rear of the furnace. The gases flowing upwardly between the platens 31 pass along the vertical length of the tubes with relatively small heat transfer by convection in proportion to their temperatures. A high rate of heat transfer by gaseous radiation provides a substantial steam superheating effect. The provision of the rear wall forward extension and the forwardly offset upper portion of the superheater platens causes the hot gases to flow over the bent portions of the tubes and then partly in back of the upper half of the platens before passing forwardly over the upper half of the platens. This arrangement provides a superheater section of high superheating capacity without the likelihood of overheating the tubes or excessive slagging.

In the construction shown in Figs. 2 and 3 the lower vertical portions of the superheater platens 31 are continued along the front wall 12 to the inclined wall section 12A below the gas pass 10A and then bend through the inclined wall section to the external headers 32A and 30A. The gas flow characteristics are improved by eliminating the lower horizontal stretches of the tubes in the gas pass adjacent the headers in Fig. 1. Besides eliminating the possibility of a slag collecting pocket, the Fig. 2 arrangement permits a continued straight vertical extension of some of the wall tubes in the front wall 12 along the rear side of the lower half of the platens. Some of these tubes 13C may be bent around the inclined sections of the platens, as shown in Fig. 3, to extend along the forward side of the upper half of the platens, while the remaining tubes 13A are bent rearwardly along the rear sides of these platen sections.

Referring to Fig. 4 where additional superheating surface is necessary, a supplementary radiant superheating surface 47 may be placed in a recess 55 formed in the rear wall 52 by vertically spaced inwardly projecting wall portions 50 and 51. The radiant superheater 47 is formed by C-shaped tubes nested to form transversely spaced platens, each connected to headers 48 and 49. The tubes 52A along the rear wall are carried across the wall projections 50 and 51 to protect corresponding tube platens of the superheater 47.

Ducts 53 and 55 to which either recirculated flue gas or air may be supplied are located below the radiant superheaters 31 and 47. Sets of nozzles 54 and 56 are connected to the ducts 53 and 55 respectively and are provided to discharge the recirculated gas or excess air, or a mixture of the two, at a downward angle, into the

upwardly flowing stream of the gaseous products of combustion. The velocity of the gas or air directed into the furnace through either set of nozzles may be used to vary the position of the stream of hot gases of combustion relative to the corresponding radiant superheater and thus the rate of heat transfer thereto.

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 the use of other features.

I claim:

1. A fluid heating unit comprising front, rear and side walls, defining a vertically elongated chamber, a laterally disposed gas outlet in the upper portion of said chamber, said front wall being inclined from the vertical for a portion of its height below said lateral gas pass with the upper and lower portions of said front wall being substantially vertical, means for burning fuel in the lower portion of said chamber and producing a heating gas flow upwardly therein and thence laterally through said gas outlet, said chamber having a narrow well section formed by an outward extension of the rear wall from a position above said fuel burning means to a position subjacent said lateral gas outlet, a projection in the rear of said chamber above said fuel burning means formed by a forward extension of said rear wall, said rear wall being formed to present a recessed portion extending above said projection to the bottom of said gas outlet, a radiant vapor heater disposed in said recess having a plurality of tube platens spaced across said chamber and having ends extending through said rear wall, external headers connected to the tube ends of each platen, a fluid inlet means arranged in said front and rear walls subjacent said radiant vapor heater and arranged to impinge fluid jets against the stream of heating gases, a series of vapor generating tubes extending across said recess in front of each of said platens, a radiant vapor heater having a plurality of inverted hairpin-tube parallel platens spaced transversely across said narrow upper section, each of said platens having a substantially vertical upper portion positioned a substantial distance away from said front wall and forwardly of said lateral gas opening, a middle portion bent at an angle downwardly and forwardly towards said front wall, a lower substantially vertical portion arranged close to said front wall and extending downwardly to the inclined portion of said front wall with each end bent at an angle through said inclined portion of said front wall, and external inlet and outlet headers connected to the tube ends of each platen.

2. A fluid heating unit comprising front, rear and side walls defining a vertically elongated furnace chamber; a laterally disposed gas outlet in the rear wall of the upper portion of said chamber; means for burning fuel in the lower portion of said chamber and producing a heating gas flow upwardly therein and thence laterally through said gas outlet; a radiant vapor heater having a plurality of parallel tubular platens formed of side by side tubes in panel formation and spaced transversely across said chamber; each of said platens being parallel to each other and the chamber side walls and having a lower substantially vertical portion positioned in the forward section of the furnace chamber with its forward edge immediately adjacent said front wall to minimize radiant heat input to that portion, a middle portion bent at an angle upwardly and rearwardly towards said rear wall, and a substantially vertical upper portion positioned in the rear section of said chamber immediately adjacent said lateral gas outlet and extending substantially throughout the height of said gas outlet; and external inlet and outlet headers connected to the tube ends of each platen.

5

3. A fluid heating unit comprising front, rear, and side walls defining a vertically elongated furnace chamber; a laterally disposed gas outlet in the rear wall of the upper portion of said chamber; means for burning fuel in the lower portion of said chamber and producing a heating gas flow upwardly therein and thence laterally through said gas outlet; said chamber having a narrow upper section formed by a forward extension of the rear wall from a position above said fuel burning means to a position subjacent said lateral gas outlet; a radiant vapor heater having a plurality of parallel tubular platens formed of side by side tubes in panel formation and spaced transversely across said chamber; each of said platens being parallel to each other and the chamber side walls and having a lower substantially vertical portion positioned in the forward section of the furnace chamber with its forward edge immediately adjacent said front wall to minimize radiant heat input to that portion, a middle portion bent at an angle upwardly and rearwardly toward said rear wall, and a substantially vertical upper portion positioned in the rear section of said chamber immediately adjacent said lateral gas outlet and extending substantially throughout the height of said gas outlet; and external inlet and outlet headers connected to the tube ends of each platen.

4. A fluid heating unit comprising front, rear, and side walls defining a vertically elongated furnace chamber; a laterally disposed gas outlet in the rear wall of the upper portion of said chamber; said front wall being inclined from the vertical having a portion of its height below said lateral gas outlet with the upper and lower portion of said front wall being substantially vertical; means for burning fuel in the lower portion of said chamber and producing a heating gas flow upwardly therein and thence laterally through said gas outlet; said

6

chamber having a narrow upper section formed by a forward extension of the rear wall from a position above said fuel burning means to a position subjacent said lateral gas outlet; a radiant vapor heater having a plurality of inverted hairpin tube parallel platens formed of side by side tubes in panel formation and spaced transversely across said chamber; each of said platens being parallel to each other and the chamber side walls and having a lower substantially vertical portion positioned in the forward section of the furnace chamber with its forward edge immediately adjacent said vertical front wall to minimize radiant heat input to that portion, a middle portion bent at an angle upwardly and rearwardly towards said rear wall forward extension, and a substantially vertical upper portion positioned in the rear section of said chamber immediately adjacent said lateral gas outlet and extending substantially throughout the height of said gas outlet; and external inlet and outlet headers connected to the tube ends of each platen.

References Cited in the file of this patent

UNITED STATES PATENTS

25	1,826,029	Smith	Oct. 6, 1931
	1,944,234	Hardgrove	Jan. 23, 1934
	2,685,279	Caracristi	Aug. 3, 1954

FOREIGN PATENTS

30	373,860	Great Britain	June 2, 1932
	274,037	Italy	May 9, 1930

OTHER REFERENCES

B and W Central Station Boilers Bulletin G67-A of 1950, page 41.