United States Patent

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[54] **DRAINABLE SHIELD FOR HEAT EXCHANGERS**
8 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **165/135,** 165/145
[51] **Int. Cl.** **F28f 13/00**
[50] **Field of Search** ..... 165/105, 110, 114—118, 115, 145, 113, 5, 135, 122, 263; 62/288, 285; 202/185, SWC; 210/(Inquired); 122/(Inquired)

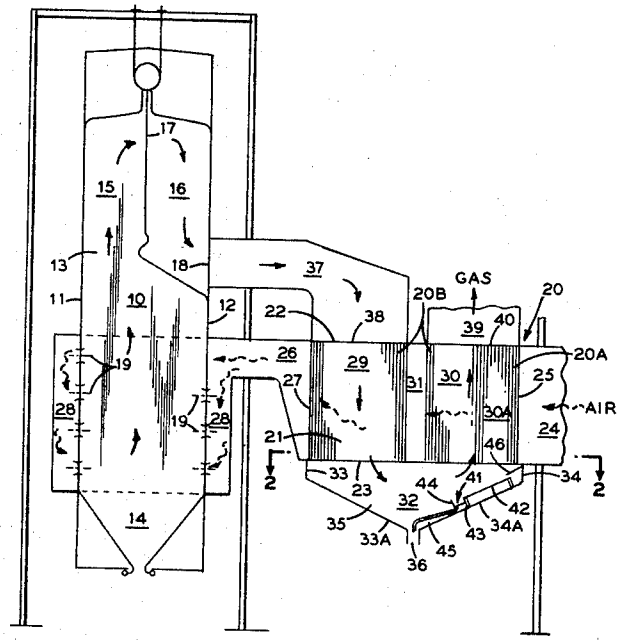
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ABSTRACT: A drainable shield for protecting the metal casing of a hopper from the quenching effect of condensate formed at each cold end section of a heat exchanger use in conjunction with a steam-generating unit. The drainable shield forms a water-shielding cover over the hopper casing and collects the condensate for discharge through the hopper drain. Flue gases are allowed to flow above as well as below the shield thereby insuring that all of the hopper casing will be maintained at substantially the same operating temperature.

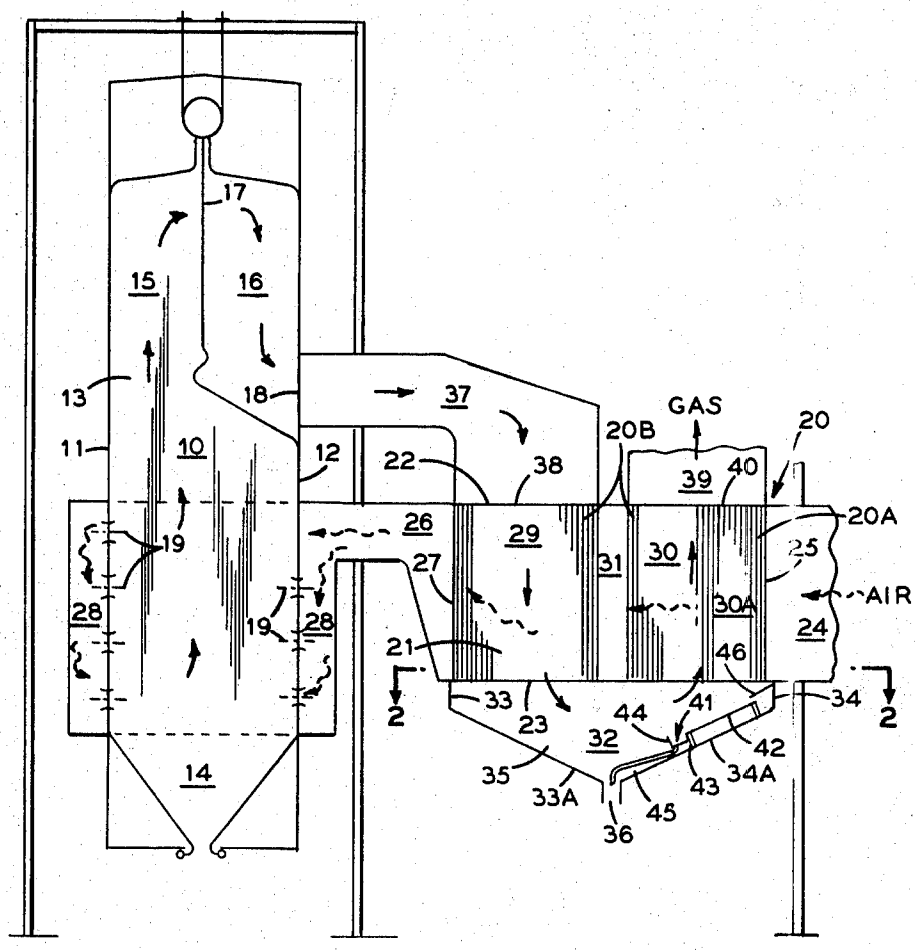


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SHEET 1 OF 2

FIG. 1



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FIG. 2

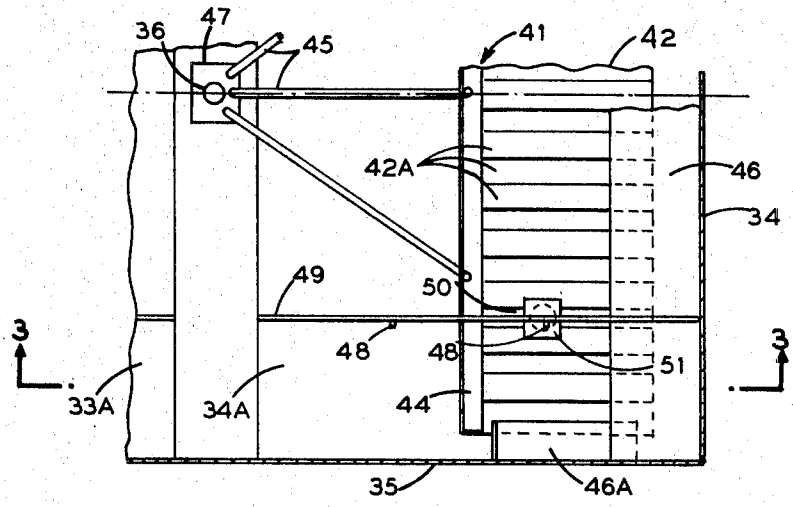


FIG. 3

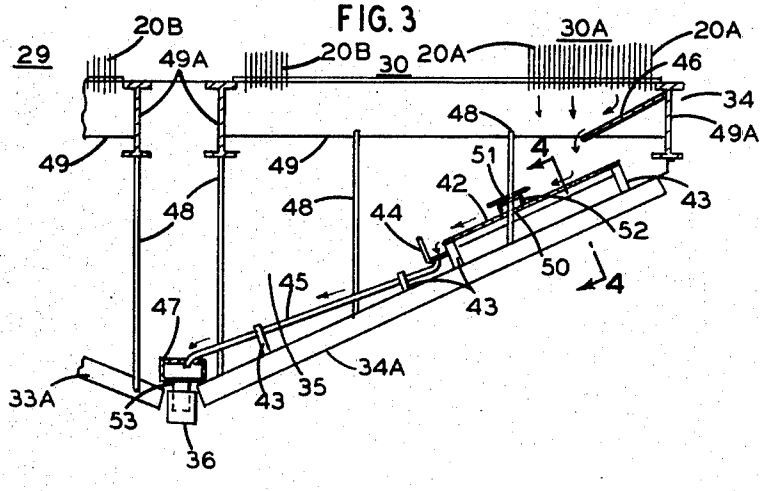
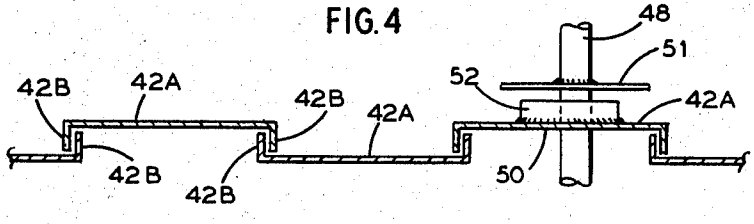


FIG. 4



DRAINABLE SHIELD FOR HEAT EXCHANGERS

This invention relates in general to steam generators firing a high moisture, low sulfur fuel and more particularly to a shielding arrangement for deflecting and collecting the moisture which condenses out of the flue gas as the temperature of the gas approaches the dew point.

It is common practice in the art of steam generation to increase efficiency of the steam-generating unit by preheating the feedwater and the combustion air. This is normally accomplished through the use of direct or indirect type heat exchangers located in the path of outgoing flue gases. In order to achieve the maximum rate of heat transfer, these heat exchangers are usually designed to have at least a part of the heating surface in counterflow relationship between the heating fluid, which may be boiler flue gas and the fluid to be heated, for example, an air heater for heating the combustion air. A hopper is located beneath the heat exchanger in communication with the flue gas to collect and discharge residue that falls out of the gas stream.

The heat exchanger section here referred to is located immediately ahead of the flue gas outlet adjacent to the economizer feed inlet or air inlet to the air heater and is referred to as the cold end section since it is the zone where the gas temperature is in its lowest temperature range and the heat exchanger metal thus is at its lowest operating temperature. This metal temperature is of a critical nature in that should it drop below the temperature corresponding to the dew point of the flue gas, the water vapor in the flue gas will condense and cascade onto local portions of the metal hopper casing, quenching it, and causing high temperature differentials between the wetted portions and the remainder of the associated casing. The stresses arising from these high temperature differentials will cause casing failures as evidenced by casing tears and cracked welds.

While the present accent in steam generator design is on increased thermal efficiency it is necessary, for practical considerations, to design these units with an average cold end metal temperature set conservatively above the dew point of the flue gas. This has required the use, of supplemental equipment such as steam or hot water coil heaters for preheating the incoming cold, ambient combustion air, and/or bypass systems for reducing the quantity of combustion air or feedwater flowing through the heat exchanger. Notwithstanding these precautionary measures occasions have arisen when, due to varying load operation or a change in fuel characteristic, the cold end metal temperature has dropped below the water vapor dew point of the flue gas. On these occasions, condensate was formed at the cold end section of the heat exchanger and difficulties were encountered with hopper casing failures.

Accordingly, the present invention provides a drainable shield which forms a watertight cover over that portion of hopper casing which is directly exposed to condensate cascading from the heat exchanger cold end section. The main cover of the drainable shield is formed by a series of flanged plates supported from the hopper casing and arranged to permit the flow of heating gases above as well as below the shield. Additional plates are located above the main cover to complete the shielding of the affected portion of the hopper casing. The main cover is fitted with a trough and equipped with drain pipes for discharging the condensate through the hopper drain.

A main object of the invention is to eliminate hopper casing failures due to metal quenching thereby lowering maintenance costs and increasing the availability of the steam-generating unit.

Another object of the invention is to appreciably reduce the design tolerance between the operating cold end temperature and the dew point of the flue gas. This would permit more heat to be absorbed from the outgoing flue gases and result in an increased overall steam generator efficiency.

A further object of the invention is to effect capital investment savings by eliminating the need for the additional equipment required on present day units to maintain the conservative tolerances between the operating cold end temperature and the dew point of the flue gas.

In the drawings:

FIG. 1 is a diagrammatic sectional side view of a steam-generating unit embodying the inventive drainable shield;

FIG. 2 is a partial sectional plan view of the drainable shield taken along line 2–2 of FIG. 1;

FIG. 3 is an enlarged sectional side view of the drainable shield taken along line 3–3 of FIG. 2; and

FIG. 4 is a detailed view of the shield plates taken along line 4–4 of FIG. 3.

The drainable shield of the present invention is illustrated with respect to a tubular-type air heater. However, it is to be understood that this drainable shield is equally well-adapted for use with a variety of other types of heat exchangers.

Referring to FIG. 1 there is shown a steam-generating unit including an upright furnace chamber 10 comprising fluid-heating tubes arranged to form a gastight boundary. Furnace chamber 10 is of substantially rectangular horizontal cross section defined by a front wall 11, a rear wall 12 and sidewalls 13. The lower ends of front and rear walls 11 and 12 slope inwardly to form a furnace hopper 14. The upper portion of furnace chamber 10 is divided into an uptake gas pass 15 and a downflow or rear gas pass 16. The rear wall tubes are alternately arranged to form the front and rear boundaries of the downflow gas pass 16 and include an upper screen section 17 and a lower screen section 18. The upper ends of front and rear walls 11 and 12 are upwardly inclined to form the furnace roof. Gas passes 15 and 16 will normally contain superheater, reheater and other heating surfaces (not shown). The fuel-firing equipment consists of independently operable gas fuel burners (not shown) extending horizontally along the centerline of burner throat openings 19, which are located in the front and rear walls 11 and 12 at the lower portion of furnace chamber 10.

The air heater 20 is formed with a plurality of upright, open ended tubes 20B and 20A arranged in horizontally successive rows and comprising the heat exchange surface of the air heater. The flow area encompassing the tubes 20B and 20A is referred to as the air flow side of the air heater or first passageway and is defined by sidewalls 21 and the upper and lower tube sheets 22 and 23. A cold air duct 24 (partially shown) connects the first passageway inlet 25 to a forced draft fan (not shown). A hot air duct 26 connects the first passageway outlet 27 to the burner windboxes 28.

The air heater tubes 20B are divided into two separately, horizontally spaced successive tube banks, a first bank 29 and a second bank 30. All of the tubes 20A are located in the bank 30 adjacent to the first passageway inlet 25 and form a section 30A referred to as the cold end section. A cavity 31 is provided between the first and second banks 29 and 30. A hopper 32 underlies the two tube banks and is formed with a front wall 33, a rear wall 34 and sidewalls 35. The hopper front and rear walls 33 and 34 converge downwardly toward a drain opening 36, with the sloping sections 33A and 34A forming the hopper floor. The hopper 32 serves the duel purpose of collecting residue entrained in the gas stream and of directing the flow of the flue gases flowing through the tubes of bank 29 to the entrance to the tubes of bank 30. The flow area encompassing the interior of the tubes 20B and 20A and the hopper 32 is referred to as the gas flow side of the air heater or second passageway. A hot gas duct 37 connects the lower screen section 18 to the second passageway inlet 38. A cold gas duct 39 (partially shown) connects the second passageway outlet 40 to a discharge stack (not shown). The dotted arrows indicate the flow path of the combustion air and the solid arrows indicate the flow path of the flue gases.

The drainable shield 41 is interposed between the air heater cold end section 30A and the hopper floor sloping section 34A. The drainable shield 41 includes a main cover 42 supported by struts 43 from the hopper floor section 34A. The main cover 42 discharges into trough 44 which is connected to

the hopper drain 36 by way of drain piping 45. Deflector plate 46 provides a shielding effect for the expansion clearance between the upper end of the main cover shield plates 42 and the hopper rear wall 34.

FIG. 2 shows a portion of the drainable shield 41 of FIG. 1 positioned over the hopper floor section 34A and includes deflector plate 46 attached to hopper rear wall 34 and deflector plates 46A attached to the hopper sidewalls 35. The drainable shield main cover 42 is made up of flanged shield plates 42A and trough 44. The drain pipes 45 connect the trough 44 for discharge into a collecting box 47 which contains the hopper drain 36. The tie rods 48 supportingly attach the hopper flow sections 33A and 34A to the support members 49. An opening 50 is provided in the main cover 42 for passage of one of the tie rods 48. The opening 50 is shielded by a cover plate 51.

FIG. 3 shows the hopper floor sections 33A and 34A converging toward the drain opening 36 and supportingly attached to the support members 49 and 49A by way of tie rods 48. The deflector plate 46 is attached to a support member 49A which forms part of the hopper rear wall 34. The main cover 42 is shown with a tie rod opening 50, a cover plate 51 attached to the tie rod 48 and a circular dam 52 surrounding the opening 50. A trough 44 is attached to the lower end of main cover 42. Trough 44 is connected to drain pipes 45 for discharge into collecting box 47. The opening 53 from collecting box 47 to the hopper drain 36 allows for drainage if water washing of the air heater 20 is required during shut down of the steam generator. The struts 43 supportingly attach the main cover 42 and the drain pipe 45 to the hopper floor section 34A. The bottoms of tube banks 29 and 30 are shown with the lower end of tubes 20B and 20A, the latter tubes make up the cold end section 30A. The arrows indicate the flow of condensate cascading from the cold end section 30A.

FIG. 4 shows the flanged shield plates 42A alternately arranged to allow flanges 42B of adjoining plates overlap to maintain a water shielding cover over the hopper floor casing while still providing the required expansion clearance for the shield plates 42A. Tie rod 48 is shown penetrating through one of the shield plates 42A. Cover plate 51 is welded to the tie rod 48 and circular dam 52 is welded around the opening 50.

During operation of the steam generator the combustion air to be heated passes from the forced draft fan (not shown) through the cold air duct 24 to the first passageway inlet 25 of the air heater 20. It then flows laterally through the first passageway over the outside of tubes 20A and 20B to the outlet 27. The heated combustion air is conducted to the burner windboxes 28 through the hot air duct 26. It then passes through the throat openings 19 along the gas fuel burners (not shown) to mix with and promote the combustion of the gas fuel. The resultant flue gas stream travels upwardly through the furnace chamber 10 into the uptake gas pass 15 and proceeds through the upper screen section 17 downwardly through the gas pass 16 and out through the lower screen section 18 in the hot gas duct 37. The flue gas stream is directed into the upper ends of the tubes 20B of the first bank 29 through the second passageway inlet 38. After travelling downwardly through the tubes 20B of the bank 29, the gas stream, deflected and directed by the inclined walls 33A and 34A, flows above as well as below the drainable shield 41 and turns upwardly to pass through the tubes 20A and 20B of the second bank 30. The flue gas stream leaving the second passageway outlet 40 is conducted by the cold gas duct 39 to a discharge stack (not shown).

In accordance with the present invention, whenever the metal temperature of the tubes 20A in the air heater cold end section 30A drops below the water vapor dew point of the flue gas, condensate will form and cascade onto the deflector plates 46, 46A and flanged shield plates 42A for discharge into trough 44. Drain pipes 45 convey the condensate from the trough 44 to a collecting box 47 for discharge through the hopper drain 36. The condensate does not come into contact with any part of the hopper itself casing thereby eliminating the quenching problem. An added feature of the drainable shield 41 is the construction which allows a portion of the flue gases to flow underneath the drainable shield thereby further insuring that all of the hopper casing including both slopes 33A and 34A will be maintained at substantially the same operating temperature.

We claim:

1. An air heater having heat exchange means defining a separate first and second passageway, means for passing relatively low temperature air to be heated through the first passageway, means for passing a heating gas through the second passageway, a hopper located beneath the heat exchange means and in fluid flow communication with the second passageway, said hopper having at least one opening for drainage therethrough, the second passageway of said heat exchange means including a cold end section located adjacent the inlet to the first passageway, the improvement comprising an impervious shield interposed between the cold end section and a portion of the hopper in condensation receiving relationship with said cold end section, said shield including a cover member open on all sides to compensate for the expansion and contraction of said cover independent of the hopper, and draining means arranged for removing condensate from the shield substantially out of reentraining contact with the heating gas passing through the hopper and including structure for draining said condensate through the opening in the hopper floor.

2. A heat exchanger according to claim 1 wherein the cover member is spaced above the hopper floor for parallel flow of heating gases of substantially equal temperature above as well as below said cover and thereafter through the heat exchange means.

3. A heat exchanger according to claim 1 wherein the cover member includes a plurality of flanged plates alternately arranged to allow flanges of adjoining plates to overlap.

4. A heat exchanger according to claim 1 wherein said impervious shield includes deflector plates spaced between the cover and the cold end section to shield the lateral openings between the cover and the side and rear walls of the hopper, said deflector plates being attached to the sides of the hopper.

5. A heat exchanger according to claim 1 wherein the floor of the hopper converges downwardly toward the drain opening and the impervious shield extends in a direction substantially parallel to said hopper floor.

6. A heat exchanger according to claim 1 wherein the cover edge facing upstream gas flowwise is provided with a trough, and at least one drainpipe connecting said trough with the drain opening.

7. A heat exchanger according to claim 1 wherein said drain opening connects to a collecting box to receive the discharge end of the drainpipe.

8. A heat exchanger according to claim 1 wherein the cover member is supported from the shielded portion of said hopper.