April 10, 1945. L. C. HUFF 2,373,564

WASTE HEAT BOILER

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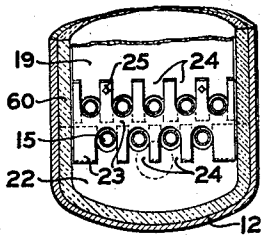


FIG. 2

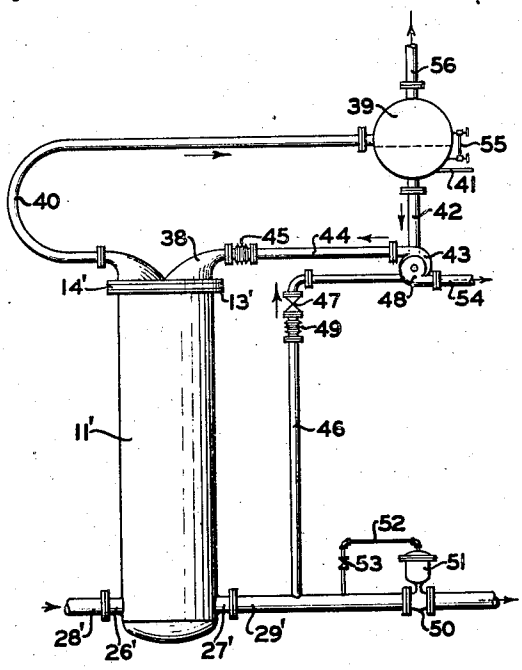


FIG. 4

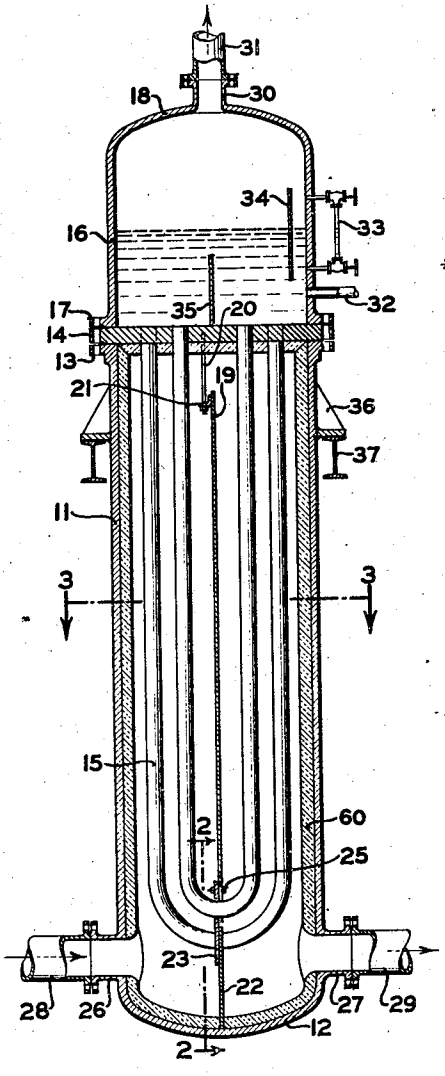


FIG. 1

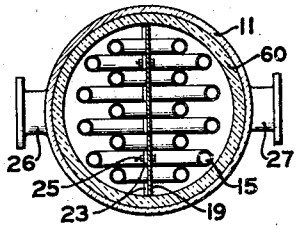


FIG. 3

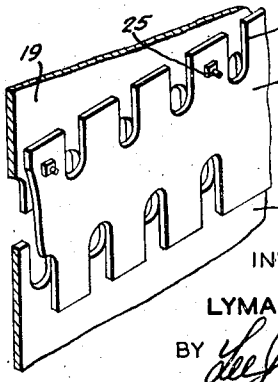


FIG. 5.

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WASTE HEAT BOILER

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2 Claims. (Cl. 122—34)

This invention relates to an improved form of heat exchange apparatus the features of which make it particularly advantageous for use in reclaiming heat from hot combustion gases.

In many exothermic processes quantities of heat are liberated and, unless reclaimed in some economical manner, a considerable loss of energy is suffered. For example, in the catalytic cracking of hydrocarbons a deleterious deposit of carbonaceous or heavy hydrocarbonaceous material accumulates upon the catalyst particles. This deposit must be periodically removed to restore activity to the catalyst and render it suitable for further use. This is ordinarily accomplished by contacting hot oxygen-containing gases with the catalyst to burn the deleterious deposited material therefrom. This combustion liberates considerable heat at a relatively high temperature level and, for efficient operation, a large portion of this useful heat must be recovered. Various types of equipment designed to accomplish the reclamation of heat from normally waste hot gases have been proposed. However, they fail to obviate certain structural difficulties when employed for heat exchange between fluids of widely different temperature and particularly when the temperature of one or both of the fluids is subject to wide variations. This is the condition encountered in generating and/or superheating steam, for example, by heat exchange with hot combustion gases from the regenerating zone of a catalytic cracking system.

In this invention the incoming hottest gases, instead of first contacting the tube sheet, as in the usual case, will contact the bent ends of the tubes thereby becoming cooled to a degree that they will no longer seriously affect the tube sheet. As an additional precaution insulation may be provided on the tube sheet to further reduce the harmful effects of the hot gases.

The above mentioned features and advantages as well as additional ones will be made more apparent with reference to the accompanying diagrammatic drawing and following description thereof.

In the drawing

Fig. 1 is an elevational view, shown principally in section, of a preferred form of the invention.

Fig. 2 is a sectional view of the apparatus shown in Fig. 1, as taken from the plane indicated by the line 2—2.

Fig. 3 is a sectional view of the apparatus shown in Fig. 1, as taken from the plane indicated by line 3—3.

Fig. 4 shows the piping arrangement for a modified form of the invention.

Fig. 5 is an isometric view of a baffle arrangement which may be used in applicant's invention.

Referring now to Figs. 1, 2 and 3, the apparatus is made up of an elongated shell 11, which is provided at its lower end with the head 12, and at its upper end with the flange 13. The flange 13, is adapted to receive the tube sheet 14, to which a plurality of U-shaped tubes 15 are secured. Above the tube sheet is a second elongated shell 16, which is provided at its lower end with the flange 17, and at its upper end with the head 18. The tube sheet is adapted to be secured between the two flanges 13 and 17 by means of bolts not shown.

The shell 11, is divided for a substantial portion of its length by a baffle 19, which is suspended from the tube sheet by means of a plurality of hanger rods 20, which engage tapped holes in the tube sheet 14 and drilled holes in brackets 21, attached to the baffle 19, at a point adjacent its upper end each drilled hole being large enough to permit a rod 20 to freely slide therethrough. A second baffle 22, is disposed in the lower portion of the shell 11. Both the baffle 19 and the baffle 22 are provided with slotted holes to accommodate the tubes 15. A baffle member 23, provided with the slotted holes 24, is attached to the baffle 19, by the bolts 25, in order to prevent the stream of hot gases from bypassing the tubes. This baffle arrangement is shown more clearly in Fig. 5 of the drawing.

With the baffle arrangement herein described tubes 15 are free to expand downwardly and baffle 19 is free to expand upwardly away from its point of contact with the tubes. The tubes are free to expand downwardly because of the fact that the slotted holes in baffle 22 are made oversized, in the vertical direction, to allow for thermal expansion of the tubes and baffle 19 is free to expand upwardly away from the tubes because of the slidable engagement of bracket 21 and hanger rods 20. When the apparatus is cool, baffle 19 will be supported by rods 20, but when the exchanger is hot, baffle 19 will be supported by the tubes and only maintaining in a vertical position by brackets 21 slidably engaging rods 20.

In the shell 11, on opposite sides of the baffle 22, and adjacent the head 12, the flanged openings 26, and 27, are provided as inlet and outlet respectively for the hot gas stream from which heat is to be reclaimed. Suitable conduits 28 and 29 may be secured by bolts, not shown, to the flanged openings 26 and 27 respectively to

direct the hot gas stream into and out of the heat exchanger.

The upper shell 16, which serves as a water reservoir and steam separating space, is provided with a flanged opening 30 in the head 18 to which may be secured by bolts, not shown, a suitable conduit 31, to direct the generated steam to the desired heating or power equipment. A water inlet conduit 32 is provided in the shell 16 for supplying feed water to the boiler. A gage glass 33 or other suitable level indicator may also be provided in the shell 16.

To prevent the agitation of the main body of water in the reservoir from affecting the reading of the gage glass a baffle 34 may be provided disposed longitudinally in the shell 16. Another baffle 35 is disposed transverse the shell 16, to facilitate the circulation of water downward through that portion of the tubes 15 located on the outlet side of baffle 19 and upwardly through that portion of the tubes disposed on the inlet side of the baffle 19.

The entire heat exchanger may be supported by the lugs 36, secured to the shell 11 by welding or other suitable means, and the structural members 37.

The inner wall of the shell 11, and that portion of the tube sheet exposed to the hot gases may be covered with a suitable insulating or refractory material 60 to eliminate heat losses through the shell and prevent the tube sheet from attaining excessive temperatures.

In Fig. 4 a modified arrangement of the invention is shown wherein a positive water circulation through the tubes is maintained.

In this arrangement an inlet and outlet header fitting 38 is substituted for the upper shell 16 and attached in its place to the tube sheet 14' and flange 13' by bolts not shown. A reservoir and steam disengaging drum 39 is connected to the outlet side of the fitting 38 by means of conduit 40. Water is fed to the reservoir by means of the conduit 41 and is drawn from it by means of conduit 42, which connects to the suction side of pump 43. From the pump 43 water is directed to the inlet side of the fitting 38 by means of conduit 44. A suitable expansion joint 45 may be provided in conduit 44 to provide means for dissipating any thermal expansion in said conduit.

In many regenerating processes the reactivating gases are maintained at relatively high pressures in the neighborhood of about 100 pounds per square inch. When this is the case a portion of these gases may be directed from conduit 29' by means of conduit 46 and valve 47 to a suitable turbine 48 to supply power to drive the water circulating pump 43. A suitable expansion joint 49 may be provided in conduit 46 to allow for the thermal expansion of said conduit. In order that suitable pressure will be maintained in the outlet conduit 29' to operate the turbine 48 a back presure regulating valve 50 may be provided in said conduit, the diaphragm 51 of said valve being connected to conduit 29' by means of conduit 52 and valve 53.

Spent gases from the turbine 48 may be exhausted to atmosphere by means of conduit 54. The drum 39 may be provided with a gage glass 55 or other suitable level indicating device, and steam generated in the boiler 11' and separated from the water in said drum may be directed to suitable heating or power equipment by means of conduit 56.

The above description of the invention in two of its preferred forms is used merely as an illustration to point out some of its many features and advantages and is not intended as a limitation of its scope.

I claim as my invention:

1. In a heat exchanger of the class described having U-shaped tubes secured at their open ends to a tube sheet and extending downwardly into an elongated vertical shell, a reservoir positioned above said tube sheet in communication with the open ends of said tubes, a longitudinally disposed baffle extending within said shell from a point adjacent its lower end to a point spaced from said tube sheet intersecting said tubes at approximately the mid-points of their bends comprising an upper section, a lower section and a third section secured to said upper section and slidably engaging said lower section, said sections being slotted to receive said tubes and arranged to prevent passage of said heat convective fluid at the point of contact with said tubes, means for directing a heat convective fluid into said shell at a point adjacent its lower end and on one side of said baffle, means for withdrawing said fluid from said shell at a point on the opposite side of said baffle, means for introducing a vaporizable fluid into said reservoir and means for withdrawing evolved vapors from said reservoir.

2. In a waste heat boiler having an elongated vertical shell with closure means at its lower end and a tube sheet disposed transversely near its upper end, a plurality of U-shaped boiler tubes secured at their open ends to said tube sheet and extending downwardly into said shell, a water reservoir positioned above said tube sheet in communication with the open ends of said tubes, a vertical baffle disposed within said shell extending from adjacent said lower closure means to a point spaced from said tube sheet and perpendicularly intersecting each of said tubes at their lower extremities comprising an upper section, a lower section and a third section secured to said upper section and slidably engaging said lower section, said sections being slotted to receive said tubes and arranged to prevent passage of said heat convective fluid at the point of contact with said tubes, means for directing a heat convective fluid into said shell at a point adjacent its lower end and on one side of said baffle, means for withdrawing said fluid from said shell at a point on the opposite side of said baffle and adjacent the end closure means of said shell, a feed water conduit in communication with said reservoir and a steam withdrawal conduit in communication with said reservoir.

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