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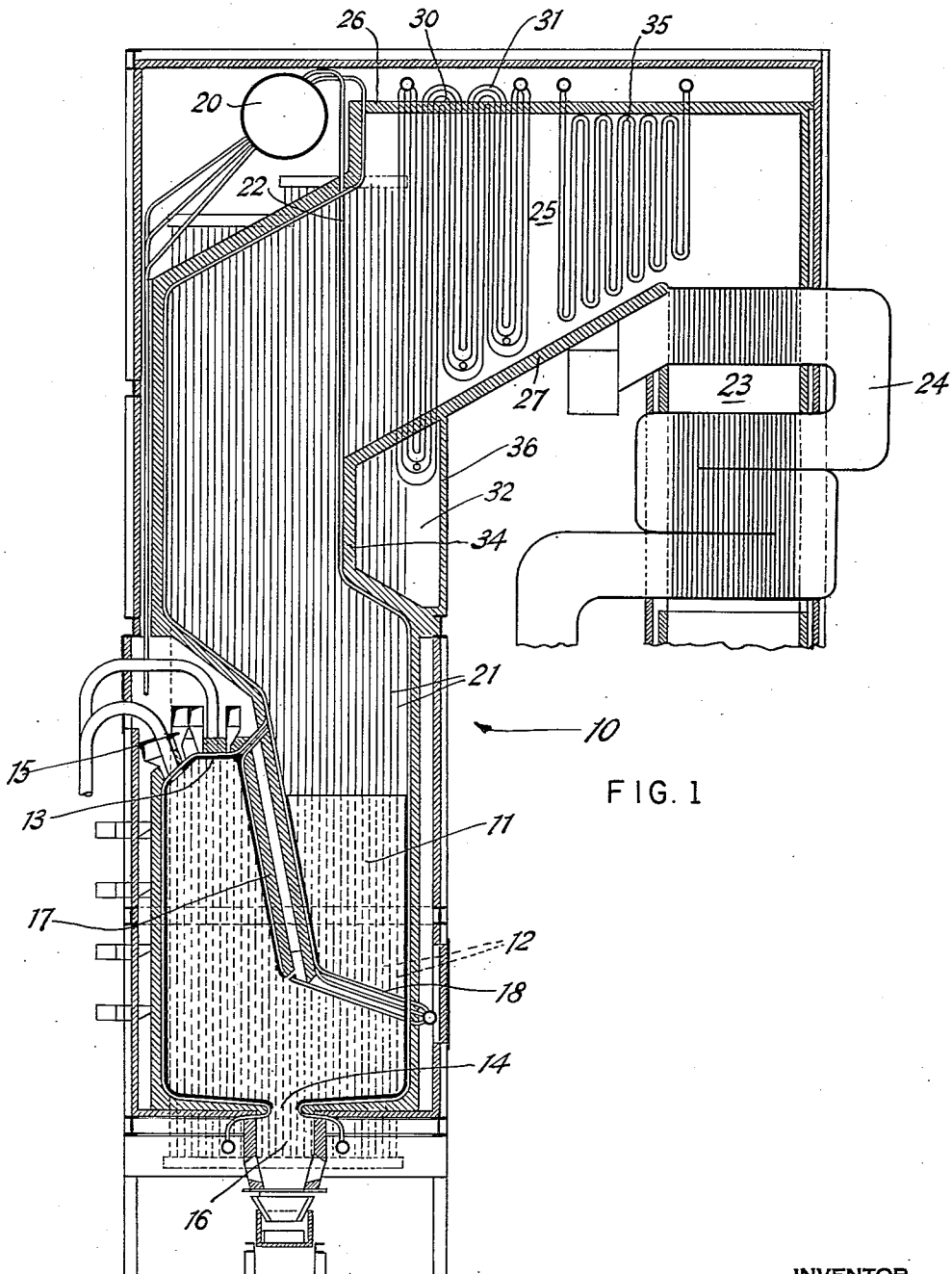


FIG. 1

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SHAKING DEVICE FOR TUBE PLATENS OF SUPERHEATERS

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6 Claims. (Cl. 122—379)

This invention relates to apparatus for cleaning the gas contacted surfaces of tubular heat exchangers by vibrating elements of said heat exchangers sufficiently to dislodge the solids therefrom. More particularly, the invention is directed to novel arrangements for effecting such vibration of the heat exchange elements.

In one important class of tubular heat exchangers, heat transfer is effected by heated gases flowing over the exterior surfaces of metal tubes through which flow relatively cooler liquids or vapors. A typical example is a water tube steam boiler or vapor generator, in which heat from combustion gases flowing over the tubes is used to convert the liquid to vapor and frequently to superheat the vapor. The combustion gases may be further utilized to reheat cooled vapor, to preheat the combustion air, and to preheat the liquid entering the generator.

The heating gases are produced by the combustion of a suitable fuel, usually coal, gas, or fuel oil, in the presence of combustion supporting air. Depending upon the characteristics of the fuel and upon the efficiency of combustion, the resultant combustion gases flowing through the gas passes of the heat exchanger carrying a certain amount of solids in suspension. A typical solid customarily present is fly ash.

As the gases flow over the relatively cooler tubes, the solids tend to deposit on the tube surfaces. As these deposits build up, they correspondingly reduce the efficiency of heat transfer from the gases to the tubes and, if not removed, may eventually bridge intertube spaces and partially block the gas passes. Hence, it is desirable to remove these deposited solids either at intervals whose frequency is determined by the rate of growth of the solids or at regular intervals.

One arrangement for removing deposits from tube surfaces of heat exchange elements, particularly where such elements are in the form of relatively widely spaced, suspended platens or panels, involves shaking or vibrating the free or lower ends of such platens in a direction perpendicular to the planes of the platens. This is effected, for example, by securing a relatively rigid bar to the free ends of all the platens disposed across a gas pass, with the bar extending transversely of the gas pass and out through a lateral wall thereof. The outer end of the bar is arranged to have vibrations imparted thereto to reciprocate the bar transversely of the gas pass. Such vibrations may be imparted merely by striking the end of the bar with a hammer, or mechanical vibrating means may be operatively connected to the outer end of the bar. This type of shaking arrangement, while effective for its intended purpose, can be used only where the temperatures in the gas pass are at a relatively low level. At relatively high gas temperatures, the shaking bar will upset and bend, due to the high heat, or may even burn through or melt.

The present arrangement is directed to shaking arrangements of the aforementioned type particularly applicable to shaking heat exchange elements suspended in

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gas passes where the gas temperatures are at very high levels. The invention arrangement is characterized by provisions for mitigating the effects of the high gas temperatures on the shaking bars or protecting the shaking bars against the high gas temperatures. In a preferred embodiment, relatively rigid extension or vibration means included with the free ends of the heat exchange sections extend through relatively restricted aperture means in a wall of the gas pass, and vibration imparting means are operatively associated with the extension means and disposed exteriorly of the gas pass. In this preferred embodiment, the shaking arrangement, being exterior of the gas pass, is not exposed to the high gas temperatures in the gas pass.

This preferred embodiment may be effected, for example, by extending the tubes of the heat exchange sections through the restricted apertures and rigidly interconnecting the extended tubes, with vibration means being operatively associated with such rigid interconnection. Alternatively, bars or the like may be secured to the heat exchange sections within the gas pass and extend through the restricted apertures to a space exteriorly of the gas pass for application of vibration imparting means thereto. In both instances, a bushing is preferably adjustable along the extension within the aperture means to form a node point for the heat exchange sections. This node point, by its relation to the point at which the vibrations are imparted to the extensions, determines the node points along the length or vertical height of the heat exchange sections, and thus determines which portions of such lengths have the greatest amplitude of vibration. By shifting the bushing, the node point may be shifted to assure the greater amplitude of vibration occurring at selectively adjustable points along the heat exchange sections.

For an understanding of the invention principles, reference is made to the following description of typical embodiments of the invention as illustrated in the accompanying drawings.

In the drawings:

Fig. 1 is a transverse vertical sectional view through a portion of a vapor generator embodying the invention;

Figs. 2 and 3 are partial transverse sectional views through a gas pass of the vapor generator of Fig. 1, illustrating two different embodiments of the invention shaking arrangement; and

Fig. 4 is an enlarged partial transverse sectional view of the gas pass illustrating the adjustable bushing.

Referring to Fig. 1 of the drawings, the invention is illustrated as incorporated in a familiar type of vapor generator generally indicated at 10 and having a refractory lined combustion chamber 11 whose walls include liquid carrying cooling tubes such as 12. Suitable burners, generally indicated at 13, supply fuel and primary air through an upper wall 13 of combustion space 11, the burners being illustrated as firing downwardly toward a slag outlet 14 leading into a discharge hopper 16. Combustion chamber 11 includes a generally downwardly extending partition wall 17 so that the heating gases flow downwardly through the combustion space and then upwardly therethrough to the right of wall 17, a radiant heat exchange section 18 being disposed across the path of upward flow of the heating gases. A liquid-vapor drum 20 is connected to the tubes 12 and also to the tubes 21 forming the wall of a radiant heat absorption section disposed above combustion chamber or space 11. The radiant heat absorption section communicates, at its upper end, with a generally laterally extending gas pass 25 containing the secondary superheater 30 and the primary superheater 35, these superheater sections being described more fully hereinafter. Screen tubes 22 are

disposed across the entrance to gas pass 25. The gases leaving gas pass 25 flow downwardly through a gas pass 23 across which is disposed an air heater generally indicated at 24. The gases leaving air heater 24 flow, in any desired manner, through other heat exchange sections such as economizers to a discharge stack or the like. The elements beyond air heater 24 have not been illustrated as they may be of conventional construction and arrangement and have no bearing on the present invention.

The designed firing rate of vapor generator 10 is such that, despite the heat absorption by cooling tubes 12, the gas temperature in combustion chamber 11 lies above the slag melting point and may be about 1650° C. (3002° F.). The gases leaving the radiant heat absorption section comprised by tubes 21, and entering gas pass 25, is still at a temperature of about 1300° C. (2372° F.). Thus, the gas temperatures in gas pass 25 are sufficiently high that, if the usual means for vibrating the superheater tubes were utilized, such means would at least bend and deform and probably would burn through or melt. Nevertheless, it is important that means be provided to clean the tubes of the superheater section, as such superheater sections are particularly susceptible to deposition of gas carried solids on their surfaces.

In the particular arrangement illustrated, the secondary superheater section 30 directly exposed to the very high temperature gases entering gas pass 25 comprises a series of platens 31 suspended from the upper wall 26 of gas pass 25 and with their planes parallel and extending longitudinally of gas pass 25. These platens have a center-to-center clearance from each other of about 800 mm. (32 in.), being thus relatively widely spaced for flow of gases therebetween. For a purpose to be described, an enclosed space 32 is provided beneath the lower wall 27 of gas pass 25. This pass also includes lateral walls such as 28, all of the walls and the roof of the gas pass being lined with refractory 29 in the usual manner.

In the embodiment of the invention shown in Fig. 2, the free ends of the tubes of platens 31 are extended through apertures 33 in lower wall 27 of gas pass 25. Referring to Fig. 4, the apertures 33 are somewhat larger than the outer diameters of the tubes of platens 31, and a bushing 40 is mounted on each of the tubes in surface engagement therewith and with the surface of aperture 33. These bushings are adjustable along the platen tubes within the aperture 33 to form the node points during vibration of the tube platens.

The space 32 is circumscribed by a supporting wall 34 of radiant heat absorption section 21, the bottom wall 27 of gas pass 25, outer wall 36, and side walls 37. In the arrangement of Fig. 2, the free ends of platens 31 extend into space 32 and are interconnected by a relatively rigid bar 41 forming part of a platen vibrating means generally indicated at 45. Such securement of bar 41 to platens 31 may be effected, for example, by mounting stop means 42 on the bar 41 on either side of each platen 31. Bar 41 extends transversely of space 32 and thus transversely relative to gas pass 25. A lateral wall 37 of space 32 has an opening 43 therein receiving a bushing or lining 44. This bushing or lining has secured thereto a bracket 46 supporting the vibration means 45.

Vibration imparting means 45 includes a spur gear 47 freely rotatable on rod 41 and supported in a bearing 48 of bracket 46. Spur gear 47 has formed therewith a clutch jaw 49. A pinion 51 meshes with gear 47 and is secured to a shaft 52 mounted in bracket 46 and having a pulley 53 on its outer end arranged to be driven by a suitable motor or the like. Clutch element 49 is intermeshed with a cooperating clutch element 54 which is fixed against rotation on rod 41 and biased into engagement with clutch element 49 by a compression coil spring 56.

When the pinion 51 is driven to rotate gear 47, the projections of clutch element 49 will ride over the projections of clutch element 54 moving the latter clutch ele-

ment axially in a series of repeated sharp impulses. Following each movement of element 54 to the right, the compressed gear spring 56 will snap clutch element 54 to the left to re-mesh the clutch elements. Thus, shaft 41 is snapped axially of itself to correspondingly vibrate the free ends of platens 31. These platens are vibrated with a vibration wave having its length determined by the position of bushing 40. By adjusting these bushings along the tubes of the platens, the node point may be pre-selected so that the points of large amplitude of motion of the platens may be selectively adjusted periodically to assure vibration of the entire length of the platens to dislodge the solids therefrom.

Fig. 3 illustrates an alternative and simplified arrangement, in which corresponding elements have been given the same reference character primed, and identical components have been given identical reference characters. In this arrangement, relatively rigid bars 60 are secured to each platen to extend through the apertures 33 to the exterior of gas pass 25. The bushings 40 are mounted on rod 60 in the same manner as for the arrangement of Fig. 2. In this arrangement, the tubes are vibrated merely by striking the ends of bar 60 with a hammer or the like. It will be noted that the operating ends of bars 60 are disposed exteriorly of gas pass 25 and thus are not subject to the high gas temperatures within the gas pass.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the invention principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. In a tubular heat exchanger having walls defining a substantially horizontally extending gas pass, a plurality of platen type tubular heat exchange sections suspended in said gas pass in substantially parallel, transversely relatively widely spaced relation, and fuel burning means in communication with said gas pass to supply the latter with high temperature heating gases, said gases carrying solids in suspension which tend to deposit on the gas-contacted surfaces of said heat exchange sections; means for dislodging such solids from the gas-contacted surfaces of said sections comprising, in combination, portions of the lower free ends of said sections extending exteriorly of the gas pass through relatively restricted openings in the lower wall of said gas pass for engagement by vibration imparting means exteriorly of said gas pass to vibrate said sections to dislodge such solids therefrom; and bushings adjustable along such portions within the apertures and in contact with said portions and the apertures to set the node points of the vibration waves of said sections.

2. In a tubular heat exchanger having walls defining a substantially horizontally extending gas pass, a plurality of platen type tubular heat exchange sections suspended in said gas pass in substantially parallel, transversely relatively widely spaced relation, and fuel burning means in communication with said gas pass to supply the latter with high temperature heating gases, said gases carrying solids in suspension which tend to deposit on the gas-contacted surfaces of said heat exchange sections; means for dislodging such solids from the gas-contacted surfaces of said sections comprising, in combination, portions of the lower free ends of said sections extending exteriorly of the gas pass through relatively restricted openings in the lower wall of said gas pass; vibration imparting means operatively associated with said portions to vibrate said sections to dislodge such solids therefrom, said last named means being disposed entirely exteriorly of the gas pass; and bushings adjustable along such portions within the apertures and in contact with said portions and the apertures to set the node points of the vibration waves of said sections.

3. In a tubular heat exchanger having walls defining a substantially horizontally extending gas pass, a plurality of platen type tubular heat exchange sections suspended

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in said gas pass in substantially parallel, transversely relatively widely spaced relation, and fuel burning means in communication with said gas pass to supply the latter with high temperature heating gases, said gases carrying solids in suspension which tend to deposit on the gas-contacted surfaces of said heat exchange sections; means for dislodging such solids from the gas-contacted surfaces of said sections comprising, in combination, portions of the lower free ends of said sections extending exteriorly of the gas pass through relatively restricted openings in the bottom wall of said gas pass; means relatively rigidly interconnecting the free ends of said portions exteriorly of the gas pass and extending transversely relative to the gas pass; vibration imparting mechanism disposed entirely exteriorly of the gas pass and operatively associated with said last named means to vibrate said sections to dislodge such solids therefrom; and bushings adjustable along such portions within the apertures and in contact with said portions and the apertures to set the node points of the vibration waves of said sections.

4. In a tubular heat exchanger having walls defining a substantially horizontally extending gas pass, a plurality of platen type tubular heat exchange sections suspended in said gas pass in substantially parallel, transversely relatively widely spaced relation, and fuel burning means in communication with said gas pass to supply the latter with high temperature heating gases, said gases carrying solids in suspension which tend to deposit on the gas-contacted surfaces of said heat exchange sections; means for dislodging such solids from the gas-contacted surfaces of said sections comprising, in combination, portions of the free ends of said sections extending exteriorly of the gas pass through relatively restricted openings in the bottom wall of said gas pass; vibration imparting means operatively associated with said portions to vibrate said sections to dislodge such solids therefrom, said last named

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means being disposed exteriorly of the gas pass; and bushings disposed on said portions and engaged with the surfaces of said openings, said bushings being adjustable along said portions to set the node points of the vibration waves of said sections.

5. In a tubular heat exchanger having walls defining a substantially horizontally extending gas pass, a plurality of platen type tubular heat exchange sections suspended in said gas pass in substantially parallel, transversely relatively widely spaced relation, and fuel burning means in communication with said gas pass to supply the latter with high temperature heating gases, said gases carrying solids in suspension which tend to deposit on the gas-contacted surfaces of said heat exchange sections; means for dislodging such solids from the gas-contacted surfaces of said sections comprising, in combination, said sections including rigid vibration means at the lower ends thereof, said vibration means extending through relatively restricted aperture means in the lower wall of said gas pass for engagement by vibration imparting means exteriorly of said gas pass to vibrate said sections; and bushings adjustable along the vibration means within the apertures and in contact with the vibration means and the apertures to form node points determining the amplitude of the vibration waves of said sections.

6. Solids dislodging means as claimed in claim 5 in which said vibration means comprises relatively rigid bars secured with each heat exchange section to extend through said apertures and bushings with their operating ends exteriorly of the gas pass.

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