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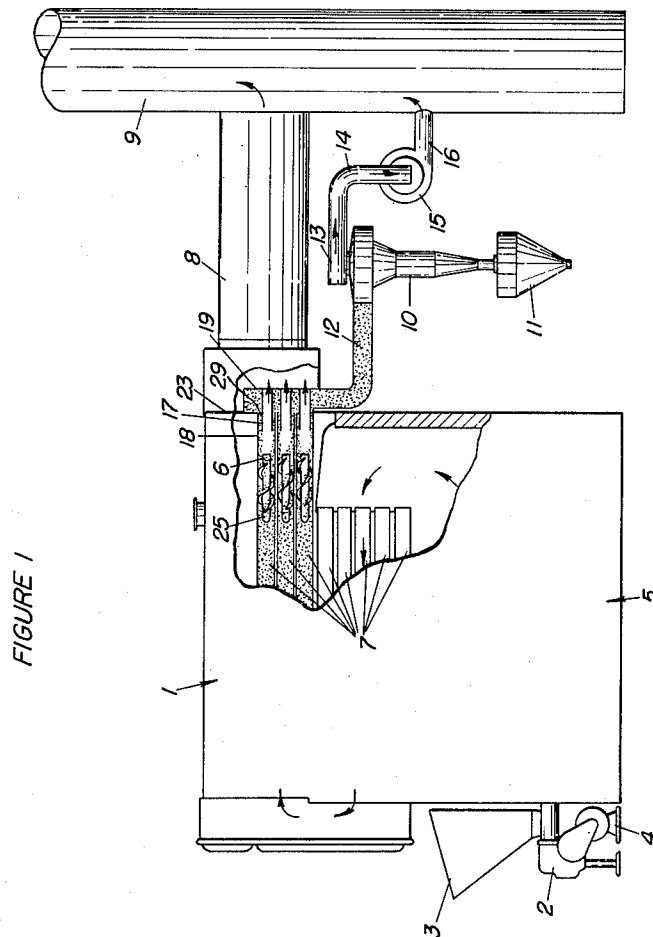
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2,647,588

BOILER TUBE FLY ASH COLLECTOR

Filed Jan. 16, 1950

3 Sheets-Sheet 1



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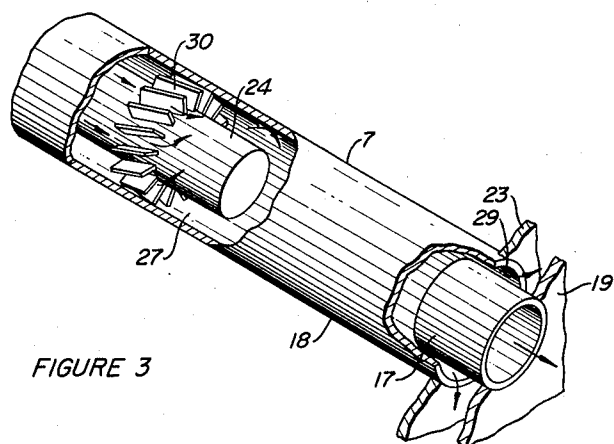
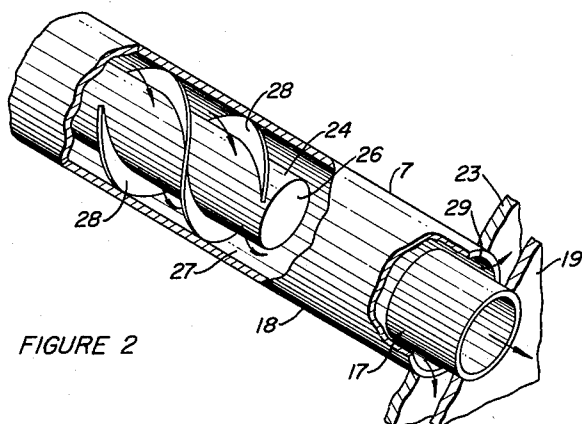
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BOILER TUBE FLY ASH COLLECTOR

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3 Sheets-Sheet 2



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BOILER TUBE FLY ASH COLLECTOR

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3 Sheets-Sheet 3

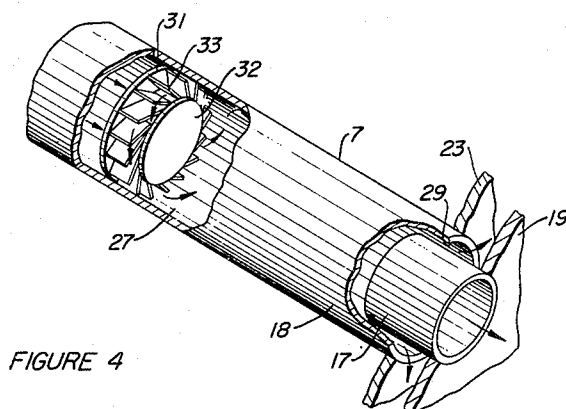


FIGURE 4

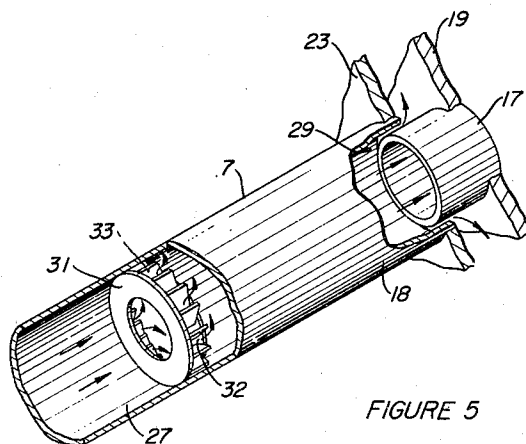


FIGURE 5

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UNITED STATES PATENT OFFICE

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BOILER TUBE FLY ASH COLLECTOR

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3 Claims. (Cl. 183—80)

1

This invention relates to fly ash concentration, and more particularly to a combination fly ash concentrator and a fire tube boiler.

The problem of atmospheric pollution by fly ash and cinders has been solved to a great extent in the past by the use of various types of mechanical collectors and concentrators. However, in the prior art, every device which has been suggested or used has materially increased the size of the boiler, and the cost of installation. Cost of installation and size are primary considerations in the installation of any type of boiler. Moreover, the size of the boiler becomes a much more important factor in determining its desirability when the boiler is installed in a vehicle, such as a locomotive or a ship, where space often is at a premium. Consequently, a fly ash concentrating or collecting device which utilizes a considerably smaller amount of space than collectors or concentrators in the prior art, is an extremely desirable addition to the art of smoke abatement.

It is therefore one object of this invention to provide a combination fly ash concentrator and fire tube boiler.

It is another object of this invention to provide a combination fly ash concentrator and fire tube boiler which occupies a minimum amount of space, and which can be fabricated at a minimum cost, for a particular boiler rating.

It is a further object of this invention to provide such a device wherein the overall efficiency of the boiler is materially increased.

It is a still further object of this invention to provide such a device wherein the quantity of fuel consumed is materially reduced.

Various other objects and advantages of this invention will become apparent to those skilled in the art upon reading the following specification in conjunction with the accompanying drawings in which:

Fig. 1 is an elevation view, partly in section, illustrating this invention;

Fig. 2 is a fragmentary perspective view, partly in section, with portions broken away, showing a particular portion of this invention;

Fig. 3 is a fragmentary perspective view, partly in section, with portions broken away, showing a modification of a particular portion of this invention;

Fig. 4 is a fragmentary perspective view, partly in section, with portions broken away, of a further modification of a particular portion of this invention; and

Fig. 5 is a further fragmentary perspective view of the device shown in Fig. 4.

2

Referring now to the drawings, and more particularly to Fig. 1, a fire tube type boiler is indicated generally at 1. This particular embodiment is a horizontal return tubular boiler, but it is to be understood that the invention is equally adaptable to any other type of fire tube boiler. In the embodiment shown in Fig. 1, the boiler is provided with a stoker 2, a feed hopper 3, and a motor 4. While there has been shown a stoker fired, coal burning boiler, oil fired boilers and other forms of stoker fired boilers are to be considered as coming within the scope of this invention. The fire bed is in the general area indicated at 5 and the hot gases, formed by the combustion of the fuel, flow upwardly and then through the tubes in the directions indicated by the arrows. A primary fly ash concentrator 6 is located in each fire tube 7 near the discharge end thereof. Breaching 8 conducts the cleansed gases from the fire tubes to the stack 9. In this particular embodiment of the invention a cyclone air separator 10, with an air tight receptacle 11 attached thereto, is connected to the discharge side of the fire tubes 7 by means of duct 12. The cleansed gases leave the cyclone air separator at 13 and flow in the direction indicated by the arrows through duct 14, fan 15, and duct 16 into the stack 9.

A concentric pipe 17 is fitted within each of the fire tubes 7 near the discharge end 18 thereof. This concentric pipe is also shown in Figs. 2, 3, 4 and 5. Pipes 17 are securely fastened in the tube sheet 19, and the upper fire tubes 7 are securely fastened in the tube sheet 23, which is positioned parallel to tube sheet 19. Tube sheets 19 and 23 are spaced, and the space between them opens into duct 12.

Referring now more particularly to Fig. 2, 24 is a cylindrical member, preferably having a hemispherical end 25 (see Fig. 1) and a flat end 26, which lies in a plane perpendicular to the axis of the fire tube 7. The gas flow is in the direction indicated by the arrows. Cylindrical member 24 is equally spaced from the inner wall 27 of the fire tube 7, and within which it is secured, by helical vanes 28. It will be apparent from Figs. 2, 3, 4 and 5, that pipe 17 is only slightly spaced from fire tube 7 at the discharge end 18 thereof, thereby providing a small annular space 29.

A modification of the device shown in Fig. 2 is shown in Fig. 3. In this modification, there is provided a similar cylindrical member 24, coaxial with and secured within the fire tube 7. However, this particular concentrator differs from

that shown in Fig. 2 in that this concentrator has straight vanes 30 which equally space the cylindrical member 26 from the inner surface 27 of the fire tube 7.

A further modification is shown in Figs. 4 and 5. In this particular embodiment of the concentrator 6 shown in Fig. 1, an annular member 31 is provided, secured within the fire tube 7, and lying in a plane perpendicular to the axis of the fire tube 7. Spaced from this ring 31, and having its periphery equi-spaced from the surface 27 of the fire tube 7, but lying in a plane parallel to the plane in which the ring 31 lies, is a disc 32. Disposed between the ring and the disc and firmly attached thereto are a plurality of vanes 33, which are planar, longitudinally extending, and would be tangent to a cylinder coaxial with said fire tube, but of a smaller diameter than disc 32.

While this invention has been shown in its preferred embodiments, it is to be understood that it is not to be considered limited to the mere embodiments disclosed herein. For instance, the boiler may be of a type other than horizontal return tubular. The stoker could be of any type; the cyclone air separator 10 could be replaced by an electrostatic air separator, and the fuel could be other than coal, such as oil or gas. It is essential that there be a pressure drop between the discharge ends 18 of the fire tubes 7 and the secondary concentrator or separator 10. However, such a pressure drop might be accomplished by means other than a fan 15. For instance, in the case of a locomotive installation, it might be very desirable to use a steam jet, utilizing waste steam, thereby providing the necessary pressure drop. Moreover, the cleansed gases do not necessarily have to go to the stack, as has been shown in Fig. 1, but if their heat values are high they might very well go to an air preheater.

Furthermore, this invention is not to be considered limited to the particular embodiments of the primary fly ash concentrating device as disclosed in Figs. 1, 2, 3, 4 and 5. The broad concept of this invention includes any type of concentrating and separating device which is located within a fire tube and functions to concentrate fly ash and separate gas from fly ash by moving the fly ash toward the outer periphery of the fire tube, and thence removing the fly ash from the fire tube, while the greater portion of the gases move toward the center of the tube.

In operating this device, the hot fly ash laden gases pass through the fire tubes in the directions indicated by the arrows, and when they reach the concentrator 6 are given a whirling motion. Since the particles of fly ash or other solids are heavier than these hot gases, these particles are thrown toward the inner surfaces of the tube 7, but continue to travel in a longitudinal direction. In effect, the path of the gases and the fly ash is somewhat of a helix after their direction has been changed by the primary concentrator 6. When the gases and the fly ash reach the end section 18 of the tube 7, the essentially pure gases pass through the pipe 17, and thence out to the stack. The fly ash, which has a small amount of gas associated therewith, is skimmed off through the annular space 29 and is drawn down into the duct 12, due to the drop in pressure between the secondary concentrator 10 and the fire tubes 7. In the secondary concentrator 10, a final separation is effected between the fly ash and the gases which are associated therewith. The fly ash drops down into the

sealed receptacle 11, while the gases then travel through ducts 14 and 16 to the stack 9.

In the various embodiments of the primary concentrator which are shown in Figs. 2, 3, 4 and 5, preliminary concentration is effected in essentially the same manner. In each case, the concentration of fly ash in the exhaust gases is greatly increased in those exhaust gases near the inner surface of the tube 7 and practically eliminated in the interior, axial zone of the tube 7. Therefore, the interior portion of tube 7 contains practically pure exhaust gas. This is accomplished, in each case by giving the combined gas and fly ash a twisting motion, the heavier fly ash and cinder particles moving toward the inner surface of the tube 7, and the lighter exhaust gases moving toward the center axis of the tube.

A true synergistic effect is achieved by means of the novel combination constituting this invention. A substantial amount of heat is transferred in the portions of the tubes 7 between the end portions 18 thereof and the portions adjacent the ends 25 of the primary concentrators. When the fly ash particles are whirled toward the inner surface of the fire tubes, in a helical path, not only is there effected a separation of gases and fly ash, but an unexpected, important, additional result is achieved. The fly ash particles, because of their helical path, and because they skim along the inner surface of the fire tubes, remove any soot particles which cling to such inner surface and, consequently, a scrubbing and cleaning action is realized. Since the amount of heat that is transferred through the fire tubes is appreciably lowered when a layer of soot is formed on the inner surfaces of the fire tubes, the removal of this soot layer by the scrubbing action of the whirling soot particles appreciably improves the heat transfer characteristics of the fire tubes, and substantially reduces the quantity of fuel required. Therefore, the primary concentrators, in addition to functioning as concentrators and separators, when combined with fire tubes in this manner, function to clean the inner surfaces of the fire tubes.

Moreover, in addition to the fact that the fly ash is effectively separated from the exhaust gases, and the fire tubes are scrubbed clean by the fly ash, it will be apparent that a substantial reduction in size and cost is accomplished by means of this invention, since a separate, expensive, and sizable apparatus is not needed to house the primary concentrators. This reduction in size is considerable, and in some instances results in a saving in space of as much as approximately 30%.

Moreover, rather than burden the purchaser with a number of separate units, this particular invention may be purchased as a composite article with consequent savings in initial purchase cost, maintenance costs, freight charges, and sundry other expenses.

From the foregoing it should be obvious that there has been devised a new and novel combination which results in increased boiler efficiency, reduction in size of the boiler unit, reduction in fuel consumption of the boiler, reduction in the initial cost of the boiler and reduction in maintenance cost of the boiler.

While this invention has been described in its preferred embodiment, it is to be understood that the words used are words of description rather than of limitation, and that changes within the purview of the appended claims may

5

be made without departing from the true scope and spirit of the invention.

What is claimed is:

1. The combination of, a fire-tube boiler provided with a plurality of spaced fire tubes therein, each of which said tubes is adapted to conduct hot gases therethrough, and which said tubes, during operation of said boiler, are surrounded by a fluid which is to be heated, and a fly-ash collecting system comprising fly-ash and gas separating and concentrating means wholly within each of said tubes, whereby there is provided a relatively clean stream of gas centrally of each of said tubes and a stream of gas high in fly-ash particle concentration adjacent the periphery of each of said tubes, means adjacent the end of each of said tubes for separately conducting said relatively clean stream of gas and said stream of gas high in fly-ash particle concentration, fly-ash and gas separating means external of said tubes, a conduit connecting said external separating means with said means for separately conducting said stream of gas high in fly-ash particle concentration, and means for producing a flow of said stream of gas high in fly-ash particle concentration to said external separating means.

6

2. The structure set forth in claim 1 wherein said external fly-ash and gas separating means is a cyclone air separator.

3. The structure set forth in claim 1 wherein said fly-ash and gas separating and concentrating means wholly within each of said tubes comprises cylindrical means within each of said tubes and equispaced from the inner surface of each of said tubes by a plurality of radially disposed, longitudinally extending, helical vanes.

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