Aug. 16, 1960 E. C. MILLER 2,949,099

FLY ASH SEPARATION

Filed April 21, 1958 2 Sheets-Sheet 1

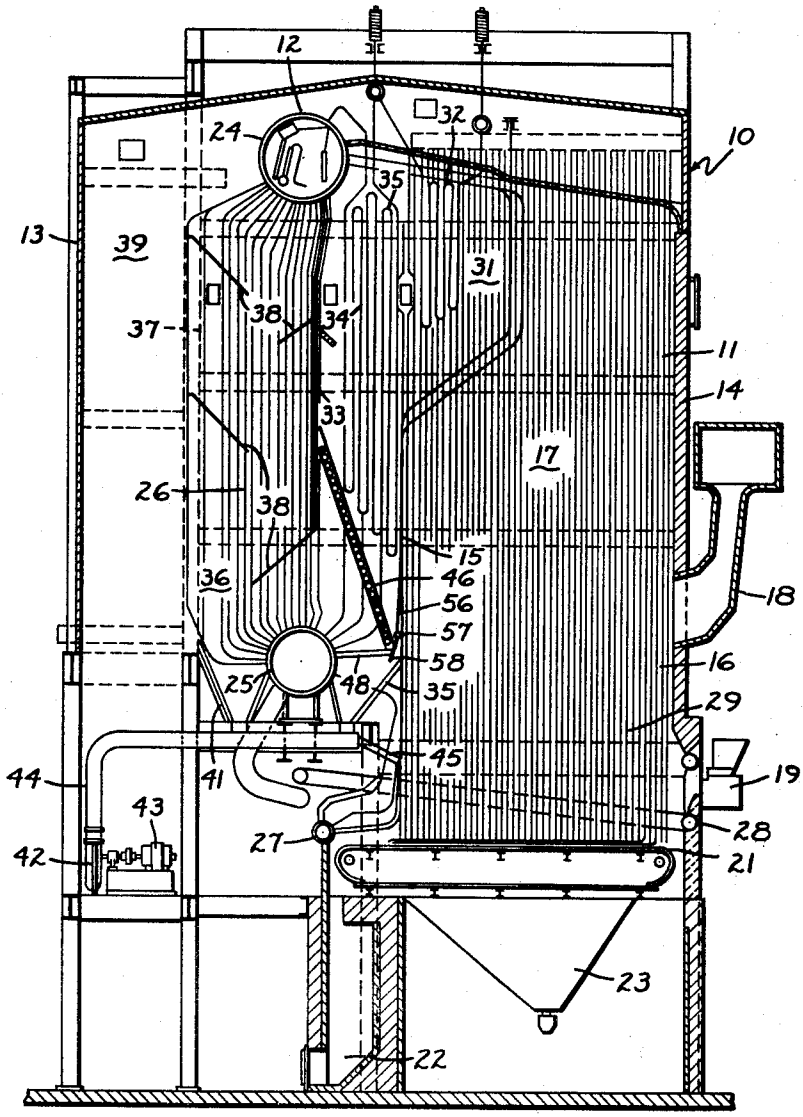


Fig. 1

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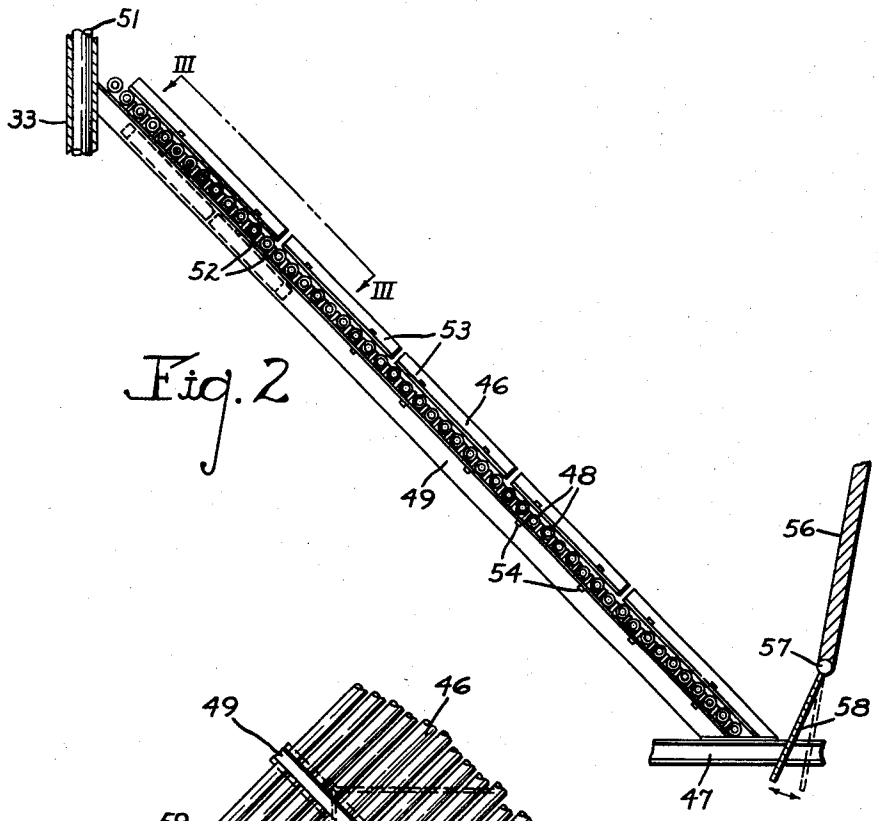


Fig. 2

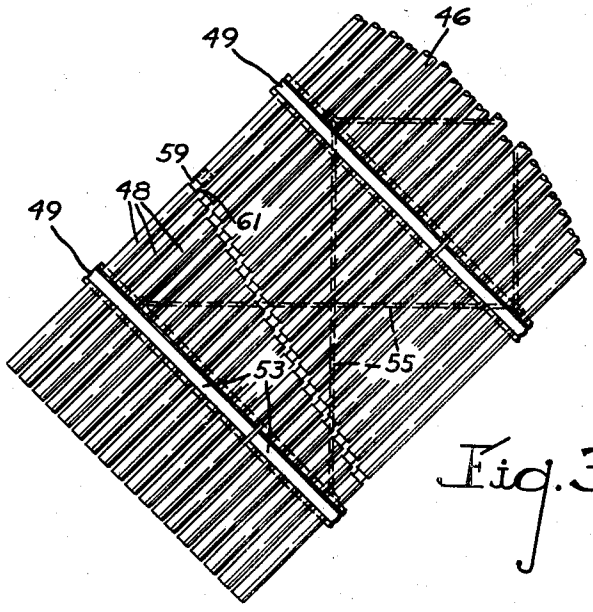


Fig. 3

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FLY ASH SEPARATION

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3 Claims. (Cl. 122—235)

This invention relates to fly ash separation and more particularly to apparatus arranged to remove particles of unburned fuel and the like from the gas flow of the furnace of a steam generating unit.

In the generation of steam it is common practice to increases the heat transfer between the products of combustion and the water or steam in the tubes of the boiler by introducing into the flow of gas a series of baffles which cause the gas to move sinuously across the bundles of tubes; however, with some types of fuel and with certain methods of firing the fuel, large amounts of fly ash and foreign matter are entrapped in the flow of gas. These particles are extremely hard and are of an abrasive nature and, when the products of combustion are reversed over the boiler tubes, it quite often happens that the boiler tubes become quickly eroded. These and other difficulties experienced with prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the present invention to provide a fly ash separating means for use in a steam generating unit to reduce appreciably the erosion of boiler tubes.

Another object of the invention is the provision of apparatus for removing fly ash from products of combustion in a steam generating unit and returning them to the furnace for more complete combustion.

A still further object of this invention is the provision of a fly ash separating apparatus for use in a steam generating unit in which the elements of the apparatus may be readily replaced when necessary.

It is another object of the instant invention to provide a fly ash separating means of simple construction which is readily manufactured from easily-obtained materials which is simple in construction, which may readily be installed in existing steam generating units or the like, and which is capable of a long life of useful service with a minimum of maintenance.

While the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which:

Figure 1 is a vertical sectional view of a steam generating apparatus embodying the principles of the present invention,

Figure 2 is an enlargement of a portion of the apparatus shown in Figure 1, and

Figure 3 is a view of the apparatus shown in Figure 2 taken on the line III—III of that figure.

Referring first to Figure 1, wherein are best shown the general features of the invention, a steam generating unit, indicated generally by the reference numeral **10**, is shown as comprising a furnace **11**, and a boiler **12** mounted in the usual supporting structure **13**. The furnace **11** consists of a front wall **14**, a rear wall **15**, and side walls **16** defining

a combustion chamber **17**. On the front wall **14** are mounted fuel burning apparatus such as an intertube burner **18** and a spreader stoker **19**. Underlying the combustion chamber **17** is a traveling grate **21** discharging into an ash pit **22** and having an air plenum chamber **23** underlying its lower run. The boiler **12** consists of a steam-and-water drum **21** and a mud drum **25** joined by downcomer tubes **26**. Connections are made between the mud drum **25** and headers **27** and **28** lying at the bottom of the combustion chamber **17**. Water wall tubes **29** rise vertically from these headers and cover the walls **14**, **15**, and **16** of the furnace **11**. The tubes of the boiler are so configured as to form a horizontal upper pass **31** extending at right angles to the top of the combustion chamber **17** and containing a high temperature superheater **32**. A vertical baffle **33** extends vertically downwardly from the steam-and-water drum **24** and forms a downpass **34** in which is located a low temperature superheater **35**. The mud drum **25** is located below the lower end of the baffle **33** and is separated therefrom by a considerable distance. A hopper **35** lies between the rear wall **15** of the furnace and the mud drum **25**. The space between the mud drum **25** and the lower end of the baffle **33** affords an entrance into a back pass **36** formed between the baffle **33** and a back wall **37** of the unit. The back pass **36** contains the downcomer tubes **26** and is also provided with baffles **38** which extend from the baffle **33** rearwardly and from the back wall **37** forwardly to produce a sinuous flow of gases over the tubes **26**. A passage at the upper part of the back pass **36** leads to the upper end of an economizer **39** of the usual type and the lower end of this is connected to the stack, not shown, in the usual manner.

Underlying the back pass **36** and extending between the mud drum **25** and the back wall **37** is a hopper **41**. Mounted on the rear part of the supporting structure **13** is a fan **42** driven by an electric motor **43** and having attached to its output a duct **44** which extends upwardly and then horizontally to pass under the hoppers **41** and **35** and terminate at the rear wall **15** of the furnace by connection to a series of overfire air nozzles **45**. Suitable connections are made from the hoppers **35** and **41** to the duct **44**. Situated in the lower part of the first pass **34** and overlying the hopper **35** is a separator **46** supported at its lower end on beams **47** extending between the mud drum **25** and the back wall **15**. At its upper end the separator **46** is attached to the forward side of the baffle **33**.

Referring next to Figures 2 and 3, which show the details of the separator **46**, it can be seen that separator consists mainly of a series of steel pipes **48** arranged side by side in slightly spaced relationship. The tubes extend transversely of the furnace and parallel to the steam-and-water drum **24** and they rest on a series of inclined angles **49** which are welded to water tubes **51** forming part of the baffle **33**. The lower ends of the angles **49** are welded to the beams **47**. Extending upwardly from the angles **49** are a series of steel pegs **52** which serve to locate the pipes **48** and maintain them in spaced relationship. Overlying the pipes **48** are a series of angle irons **53** which serve to clamp the pipes to the upper surface of the angles **49** and this is accomplished by means of bolts **54** which extend through the angles **53** between the pipes **48** into the angle irons **49**. As is evident in Figure 3, a number of inclined braces **55** extend between the angle irons **49** to maintain them in spaced rigid relationship. Furthermore, each of the tubes **48** is provided with a slip joint **56** consisting of a peg **57** welded in one end of a section of the tube and slidably fitted in the end of the other section of the tube. Fastened to the rear surface of the rear wall **15** of the furnace **11** is a plate **56** which extends downwardly and rearwardly with its end above and spaced from the lower

end of the separator 46. A vane 58 is attached in the lower end of the plate 56 by means of a hinge 57. The vane being moveable from a position closely adjacent the lower end of the separator 46 to another position generally parallel to the rear wall 15 of the furnace. The vane may be actuated externally of the steam generating unit in the usual manner.

The operation of the apparatus will now be readily understood in view of the above description. Fuel emanating from the burner 18 and the spreader stoker 19 are burned in the combustion chamber 17 and the products of combustion flow upwardly in the combustion chamber and leave through the horizontal pass 31. The products of combustion then move downwardly through the first pass 34 and are reversed in the lower portion thereof and pass through the space between the lower end of the baffle 33 and the mud drum 25. The gases then move upwardly through the backpass 36 in a sinuous flow over the tubes 26, the flow being determined by the baffles 38. The gases then leave the unit in the usual manner through the stack. Water, of course, flows from the steam-and-water drum 24 downwardly through the downcomer tubes 26 into the mud drum 25 where it is distributed to headers 27 and 28 and moves upwardly through the water wall tubes 29. Steam generated in the tubes is released in the steam-and-water drum 24 and is eventually superheated in the primary superheater 35 and the secondary superheater 32 before passing to the turbine, not shown, in which steam energy is converted to mechanical energy. As the tubes move downwardly through the first pass 34 they eventually strike the separator 46 and pass between the tubes. Because of the pressure drop which occurs behind the tubes, according to the usual aerodynamic principles, it is possible for the fly ash and other fine matter to agglomerate and fall downwardly into the hopper 35. Because of the resistance introduced into the flow of gases by the separator 46, a high rate of flow may be produced in the space between the lower end of the separator 46 and the vane 58 by moving the vane slightly away from its position against the separator. It is well known that the greatest proportion of fly ash particles reside at the outer part of any reversal of flow, this being brought about by centrifugal force. Therefore, by permitting this portion of the flow of gases to flow into the hopper 35 by means of manipulation of the vane 58 it is possible to remove a considerable portion of the fly ash in this way. Therefore, the gases which enter the backpass 36 through the opening between the lower end of the baffle 33 and the mud drum 25 are comparatively free of fly ash. Because of the downwardly directed position of the lowermost baffle 38 there is a reversal of gases above the hopper 41 which produces further fallout of fly ash. The fan 24 produces a flow of air through the duct 44 and outwardly into the combustion chamber 17 through the overfire nozzles 45. The flow of air through the duct 44 picks up fly ash from the hoppers 35 and 41 and projects it into the furnace where it takes part in the combustion process, some falling onto the traveling grate 21 for movement into the ash pit 22.

The use of the pegs 52 as a separating means for the tubes 48 of the separator 46 brings about a very accurate spacing of the tubes and makes the separator aerodynamically accurate. At the same time, the short angle irons 53 may be readily removed by loosening the bolts 54 to permit removal of the tubes 48 and replacement thereof. It will be understood that the telescoping connection 56 permits each tube to be slightly shortened so that it may be removed from the boiler setting without cutting the tubes and without removing a portion of the boiler setting. The replacement of tubes must take place, of course, when the steam generating unit is shut down.

While certain novel features of this invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made in the forms and details of the device illustrated and in its operation without departing from the material spirit of the invention.

The invention having been thus described, what is called new and desired to secure by Letters Patent is:

1. A steam generating unit, comprising a combustion chamber having front, rear, and side walls, a horizontal convection passage extending away from the chamber and overlying the rear back wall of the chamber, a first passage extending downwardly from the said convection passage behind the said rear wall of the chamber, a second horizontal passage extending rearwardly from the lower end of the said first passage, a back passage extending upwardly from the second horizontal passage, a series of baffles causing the products of combustion to flow sinuously through the said back passage, the said second horizontal passage causing a radical change of direction of the products of combustion in passing from the first passage to the back passage, a hopper located adjacent the said second horizontal passage and generally in line with the original direction of the products of combustion as they pass downwardly through the first passage, and a separator through which the gas is passed during the said reversal located adjacent the hopper and lying in a plane inclined substantially to the original direction with its lower end located adjacent the said rear wall of the combustion chamber opposite the second horizontal passage, a narrow opening between the lower end of the separator and the said rear wall of the combustion chamber, and a damper mounted in the said opening to control the passage of gas therethrough.

2. A steam generating unit comprising a combustion chamber from which originate products of combustion containing flyash, the chamber having front, rear, and side walls, a horizontal convection passage extending away from the chamber and overlying the rear wall of the chamber, a first passage extending downwardly from the convection passage behind the said rear wall of the chamber, a second horizontal passage extending rearwardly from the lower end of the said first passage, a back passage extending upwardly from the second horizontal passage, a series of baffles located in the back passage causing the products of combustion to flow sinuously therethrough, the second horizontal passage causing a radical change of direction of the products of combustion as they pass from the first passage to the back passage, a hopper located adjacent the said second horizontal passage and generally in line with the original direction of the products of combustion before the said reversal of direction, and a separator consisting of a series of tubes arranged transversely of the unit and in spaced parallel relationship, the gases passing between the tubes during the said reversal, the separator being located adjacent said hopper and the tubes lying a plane inclined substantially to the said original direction with its lower end adjacent the said rear wall of the combustion chamber, the separator including a number of supporting elements extending under the tubes at right angles to the axes thereof, pegs extending upwardly from the said supporting elements and serving to maintain the tubes in spaced relationship, a narrow opening between the lower end of the separator and the said rear wall of the combustion chamber, and a damper mounted in the said opening to control the passage of gases therethrough.

3. A steam generating unit, comprising a combustion chamber having front, rear, and side walls, a horizontal convection passage extending away from the chamber and overlying the rear wall of the chamber, a first passage extending downwardly from the convection passage behind the said rear wall of the chamber, a second horizontal passage extending rearwardly from the lower end of the said first passage, a back passage extending upwardly from the second horizontal passage, a series of baffles causing the products of combustion to flow sinuously through the

said back passage, the said second horizontal passage causing a change of direction of the products of combustion as they pass between the first passage and the back passage, a hopper located adjacent the said second horizontal passage and generally in line with the original direction of the products of combustion before the said reversal of direction as they pass downwardly through the first passage, and a series of spaced, parallel, cylindrical elements through which the gases pass during the said reversal, and said elements being located adjacent said hopper and lying in a plane inclined substantially to the said original direction with their lower ends located adjacent the said rear wall of the combustion chamber, and adjustable means for causing a portion of the gases to pass around the said series at the said lower end, the said portion of the gases containing a high portion of the flyash.

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