April 15, 1969 W. OTT 3,438,346

STEAM GENERATOR FIRING SYSTEM AND METHOD OF CONTROLLING SAME

Filed Oct. 31, 1966

Fig. 1

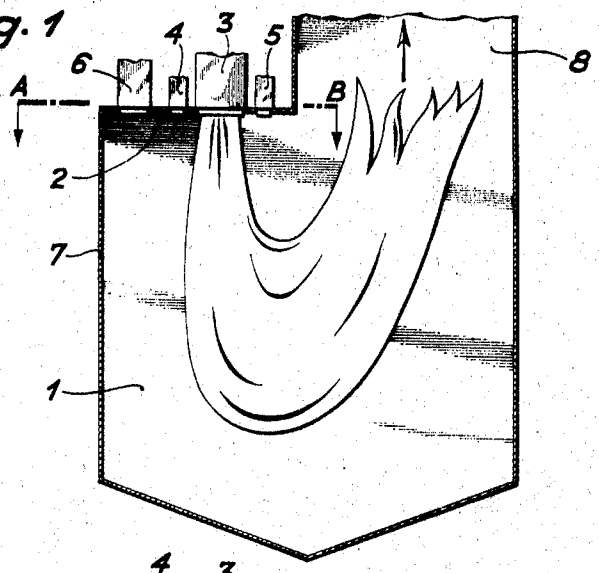
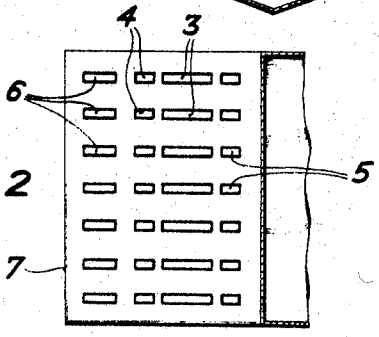


Fig. 2



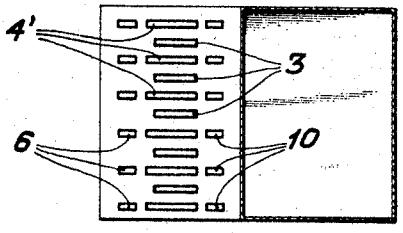


Fig. 3

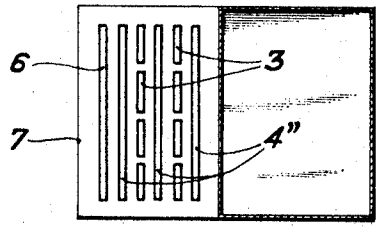


Fig. 4

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STEAM GENERATOR FIRING SYSTEM AND METHOD OF CONTROLLING SAME

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U.S. Cl. 110—28 8 Claims

ABSTRACT OF THE DISCLOSURE

A flow of guiding air is directed into the combustion chamber between the wall and the burner nozzle in order to pull the downwardly directed part of the U-shaped flame toward the wall and thus further down into the combustion chamber. The longer downward length of the flame allows complete combustion of the combustion particles.

The invention relates to a steam generator firing system and a method of operating same. More particularly, the invention relates to a steam generator firing system utilizing a coal dust entrained combustion air stream to form a U-shaped flame and a method of controlling the flame.

Generally, coal dust firing systems have relied on a U-shaped flame wherein coal dust has been blown downwardly through a burner nozzle into a combustion chamber by means of an entrainment air stream. Because the flame density has been low relative to the ambient atmosphere, the U-shaped flame has tended to reverse upwardly immediately downstream of the burner nozzle. In order to achieve a sufficiently long combustion path for the coal dust particles, particularly in the combustion of coal dust prepared from lean coal, it has been necessary for the flame to extend a great distance downwardly but reversing direction. However, the achievement of such has not been successfully accomplished in a simple efficient manner. In several cases, the entrainment air along with a supply of secondary air has been introduced into combustion chambers at a high flow velocity. In other cases, the downwardly directed part of the flame has been guided in a vertical direction by methods incorporating the blowing of a high velocity tertiary air stream to a position near the central plane of the U-shaped flame, that is, between the downwardly directed and upwardly directed parts. However, in the latter cases while the flame has been pressed downwardly, combustion has been unsatisfactory since a large quantity of unburnt coal dust is passed into the smoke gas flue of the steam generator. This phenomenon has been found to be due to the formation of eddies resulting from the large velocity differences between the entrainment air stream and the secondary air stream, on the one hand, and the tertiary air stream blown in near the central plane of the U-shaped flame, on the other hand, so that the coal dust reaches the convention cool zone above the combustion chamber by way

of a short path. Based on this finding, it became necessary to provide a method for operating a coal dust firing system with a U-shaped flame in which the downwardly directed part of the U-shaped flame remains near the combustion chamber wall adjacent thereto for the greatest possible distance while avoiding poor combustion.

According to the invention an air stream (guiding air stream) having a velocity of at least 1.8 times that of the secondary air stream is blown into a combustion chamber to extend between the downwardly directed part of the U-shaped flame and the combustion chamber wall adjacent to the downwardly directed flame part; the velocities relating to the exit cross section of the appropriate nozzles. It has been found that complete success is achieved by means of this very simple measure, that is, the blowing into the system of the guiding air stream of high velocity between the combustion chamber wall and the downwardly directed part of the U-shaped flame since the flame remains near the wall for a substantial length while, at the same time, the quantity of unburnt material is reduced to an insignificant amount.

It may be of advantage in the method according to the invention to blow a tertiary air stream of slightly higher velocity than the secondary air stream between the downwardly and the upwardly directed part of the U-shaped flame. In such a case and in accordance with an embodiment of the invention, the velocity of the guiding air stream is at least 1.5 times that of the air stream blown in between the downwardly directed and upwardly directed part of the U-shaped flame. It has been found that blowing in of the tertiary air stream between the downwardly directed and upwardly directed part of the U-shaped flame is not detrimental as heretofore but instead assists in the guiding of the downwardly directed part of the U-shaped flame towards the adjacent combustion chamber wall.

The invention provides a steam generator with at least one nozzle which is disposed between a burner nozzle of the firing system and the combustion chamber wall adjacent to the downwardly directed part of the U-shaped flame emitted from the burner nozzle in order to blow a guiding air stream, that is, a stream of auxiliary air, into the combustion chamber substantially parallel to the downwardly directed part of the U-shaped flame. As regards combustion, particularly favorable results are obtained if the spacing of adjacent edges of the guiding air stream nozzle and the burner nozzle is at least equal to the extension of the guiding air stream nozzle in the direction of the plane into which the U-shaped flame extends but is greater than 250 mm.

It is an object of the invention to increase the downward path of a U-shaped flame of an air entrained firing system of a steam generator.

It is another object of the invention to provide a simple efficient method of controlling the U-shaped flame of an air entrained firing system of a steam generator to substantially eliminate unburnt material in the flame.

It is another object of the invention to provide a steam generator firing system with at least one nozzle for blowing air into the steam generator combustion chamber between a U-shaped flame and the adjacent combustion chamber wall.

It is another object of the invention to blow air into a steam generator combustion chamber between a U-shaped flame and an adjacent chamber wall at a higher velocity than auxiliary air stream adjacent the flame.

It is another object of the invention to provide a stream of air between a U-shaped flame and a combustion chamber wall of a steam generator and another stream of air between the downwardly directed and upwardly directed parts of the flame.

It is another object of the invention to provide an efficient U-shaped flame from a coal dust entrained air stream in a simple manner in a steam generator combustion chamber.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a vertical section through a steam generator combustion chamber fired with a U-shaped flame;

FIG. 2 illiustrates a horizontal section taken on line A–B of FIG. 1; and

FIGS. 3 and 4 illustrate sections through modified embodiments according to FIG. 2.

Referring to FIGS. 1 and 2, the combustion chamber **1** of a steam generator has a burner shield **2** on which is disposed at least one burner nozzle **3** through which an air stream entrained with coal dust is blown downwardly into the combustion chamber **1** to form a U-shaped flame and a pair of nozzles **4**, **5** through which a conventional supply of secondary air is blown to either side of nozzle **3**. The burner nozzles **3** are distributed over the entire combustion chamber width in an aligned row, for example, in the combustion chamber shown, seven burner nozzles **3** are arranged adjacently in a row. A nozzle **6** is allocated to each burner nozzle **3** and disposed at a certain spacing between the burner nozzle **3** and the adjacent combustion chamber wall **7**. A duct **8** through which the flame and smoke gases are discharged is disposed next to the burner shield **2** and connected to the combustion chamber **1** (FIG. 1). The combustion chamber **1** and the duct **8** are lined, in a manner not shown in detail, with pipes through which the working medium of the steam generator flows. The combustion chamber pipes positioned in the hottest flame part, particularly the pipes of the combustion chamber wall **7**, are generally studded and covered with a refractory compound. The pipes may also be protected with refractory blocks disposed in front.

In the method according to the invention, the coal dust firing system is operated by the blowing of a guiding air stream, that is, a stream of auxiliary air, through the nozzle **6** to extend between the combustion chamber wall **7** and the downwardly directed part of the U shaped flame parallel to the wall **7** with a velocity at least 1.8 times that of the secondary air stream supplied through the nozzles **4** and **5** to control the flame shape. The consequence of blowing in of the guiding air stream is that the downwardly directed part of the U-shaped flame is drawn against the combustion chamber wall **7** over a substantial length to permit complete combustion of the entrained coal dust.

Referring to FIG. 3, the firing system can be modified to have five burner nozzles **3** and six secondary air nozzles **4'** disposed in alternating manner across the combustion chamber width in a single row. In such a case the nozzles **6** for blowing in the guiding air stream are not disposed in the same plane as the burner nozzles **3** as indicated in FIGS. 1 and 2, but are disposed in the same plane as the secondary air nozzles **4'**. Moreover, nozzles **10** are also provided in the plane of the secondary air nozzles **4'** so that air can be blown between the downwardly directed and upwardly directed part of the U-shaped flame during operation at a smaller velocity than the guiding air stream. The guiding air stream of nozzle **6** have a velocity at least 1.5 times that of the air stream introduced through the nozzles **10**. For example, satisfactory results were obtained with this firing system using the following air velocities:

Nozzles:	M./s.
6	30
4'	10
3	10–12
10	15

The air velocity of the guiding air stream in this case is therefore greater by a factor of 3 and 2 respectively, than the velocity of the secondary air stream or of the tertiary air stream through the nozzle **10**.

Referring to FIG. 4, the firing system can also be modified to have eight burner nozzles **3** disposed parallel to the combustion chamber wall **7** in two spaced parallel rows. In this case three secondary air nozzles **4''** are provided in alternation with the rows of burner nozzles **3** parallel to the combustion chamber wall **7**. In addition, a nozzle **6** is provided between the secondary nozzle **4''**, on the left as viewed in FIG. 4, and the burner wall **7** to blow the guiding air stream between the U-shaped flame and the combustion chamber wall **7**.

It is noted that the invention can be applied not only to the simple firing system with U-shaped flame shown in FIG. 1 but also for double firing systems with U-shaped flames.

Having thus described the invention, it is not intended that it be so limited as changes may be readily made therein without departing from the scope of the invention. Accordingly, it is intended that the subject matter described above and shown in the drawings be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In combination with a steam generator having a combustion chamber and a duct communicating with one side of said combustion chamber, a firing system including at least one burner nozzle for blowing a coal dust entrained air stream into said combustion chamber to form a U-shaped flame, said flame having a downwardly directed part and an upwardly directed part directed into said duct, nozzle means for blowing secondary air into said combustion chamber on opposite sides of said burner nozzle, and at least one air nozzle disposed between said burner nozzle and a combustion chamber wall opposite said duct for blowing a stream of auxiliary air into said combustion chamber parallel to the downwardly directed part of said flame to guide the downwardly directed part of said flame along said wall.

2. The combination as set forth in claim **1** wherein said air nozzle extends into said combustion chamber parallel to the downwardly directed part of said flame, said air nozzle being spaced from said burner nozzle a distance greater than 250 mm.

3. The combination as set forth in claim **1** wherein a plurality of burner nozzles are spaced across the width of said combustion chamber in alternating relation to a plurality of nozzle means.

4. The combination as set forth in claim **1** wherein a plurality of air nozzles are disposed between said burner nozzles and said combustion chamber wall, said air nozzles being in alignment with said nozzle means.

5. The combination as set forth in claim **3** wherein a plurality of auxiliary air nozzles are positioned between said burner nozzles and said duct for blowing tertiary air between the downwardly and upwardly directed parts of said flame.

6. The combination as set forth in claim **1** wherein the distance between neighboring sides of said air nozzle and said burner nozzle equals at least the extension of said air nozzle in the direction of the shortest straight line connecting two points between said neighboring sides of said burner and air nozzles.

7. A method of controlling a U-shaped flame of a coal dust firing system in a steam generator combustion chamber comprising the steps of blowing a stream of air into

the combustion chamber parallel to the downwardly directed part of the U-shaped flame between a combustion chamber wall and the flame to guide the downwardly directed part of the flame along the wall and blowing secondary air into the flame, said guiding stream of air being blown into the combustion chamber at a velocity of at least 1.8 times that of the secondary air velocity whereby unburnt material in the flame is substantially eliminated.

8. A method as set forth in claim 7 which further comprises the step of blowing a third air stream having a velocity higher than the secondary air between the downwardly directed and upwardly directed parts of the U-shaped flame, said guiding stream of air has a velocity 1.5 times that of said third air stream.

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