

Oct. 18, 1960

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2,956,527

COMBUSTION APPARATUS FOR ASH CONTAINING FUEL

Filed June 20, 1956

3 Sheets-Sheet 1

FIG. 1

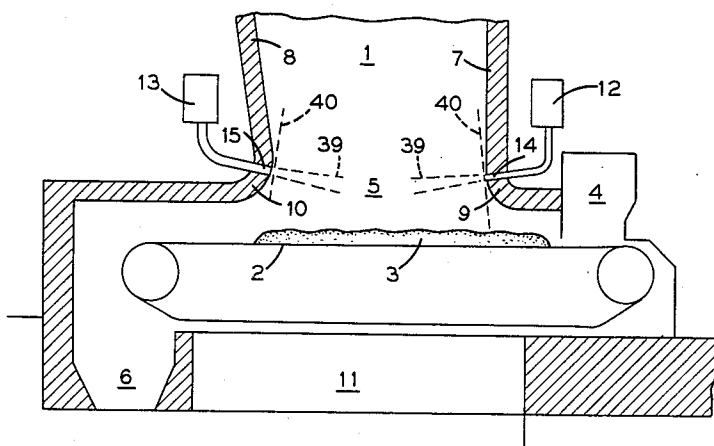
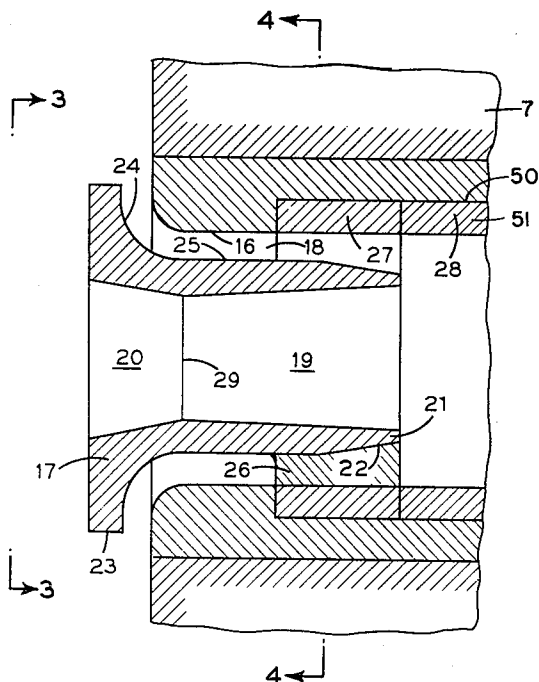


FIG. 2



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3 Sheets-Sheet 2

FIG. 3

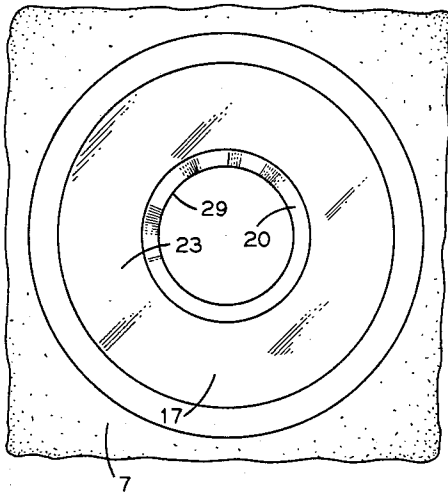
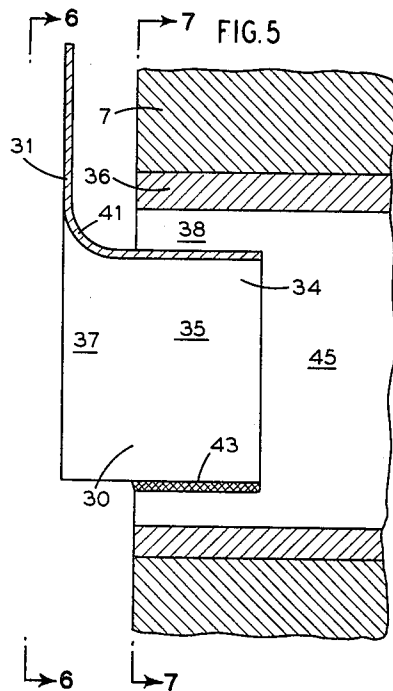
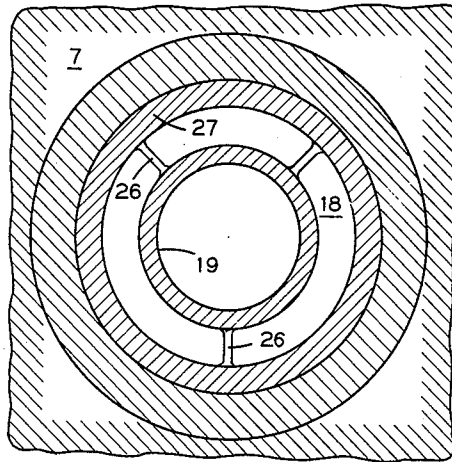


FIG. 4



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3 Sheets-Sheet 3

FIG. 6

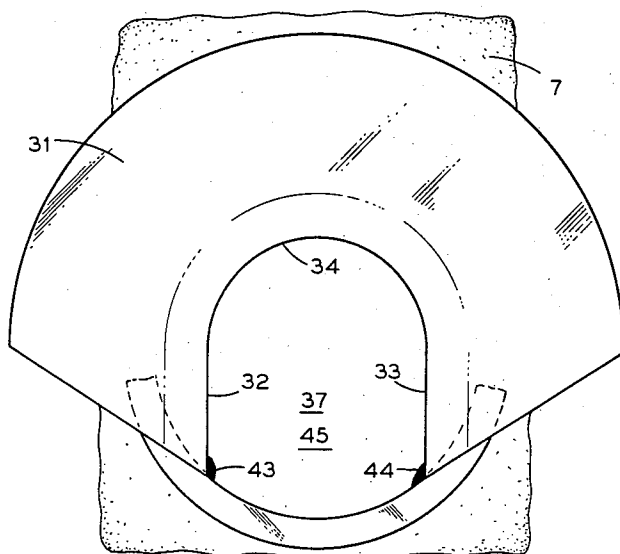
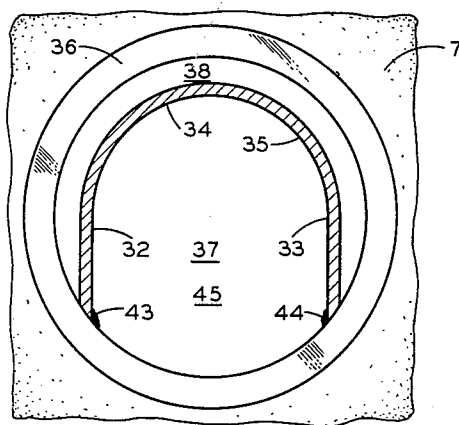


FIG. 7



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COMBUSTION APPARATUS FOR ASH CONTAINING FUEL

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3 Claims. (Cl. 110—75)

This invention relates to the combustion of ash-containing fuels, and more particularly to the introduction of secondary combustion air into furnaces supplied with ash-containing fuel and operated under temperature conditions wherein the ash is in a stick or molten state. The invention is particularly applicable to furnaces wherein solid ash-containing fuels are burned on a grate and overfire air is employed.

In the operation of a stoker fired boiler furnace, for example, jets of secondary air discharged above the burning fuel may be employed in order to promote turbulence and rapid and complete combustion within the furnace chamber. In practice, the difficulty sometimes occurs that slag deposits build up upon the furnace chamber wall surface adjacent the secondary air nozzle. It is believed that the jets of secondary air directed forwardly from the outlets induce a rearward movement of the flame, with the result that particles of sticky or molten slag impinge upon the furnace chamber wall surface particularly above the nozzles. Whatever the cause, ash deposits are liable to form which interfere with the proper direction and flow rate of the jets of secondary air projected into the furnace chamber, with the result that imperfect combustion in the furnace chamber occurs. As a consequence of delayed combustion and abnormally high temperatures adjacent convection heat exchanger tube surfaces in the gas flow path leading from the furnace chamber, serious fouling of those surfaces may occur.

The present invention includes a furnace chamber having firing means for the combustion of an ash-containing fuel with the furnace chamber being adapted to operate with temperatures of combustion such that particles of incombustible matter in the furnace gases are liable to occur in a sticky state adjacent to a side wall of the furnace chamber in which are provided secondary air discharge means for supplying secondary air to the furnace chamber. Provision is made for directing a gaseous fluid over the inner surface of the furnace chamber wall adjacent to and at least above the secondary air discharge means, the gaseous fluid being relatively cool with respect to the particles of sticky slag in the furnace.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a partly diagrammatic sectional side elevation of the lower portion of a furnace chamber arranged for grate firing and constructed and arranged according to the invention;

Figure 2 is an enlarged sectional side elevation of one form of secondary air nozzle and a fragment of the furnace chamber wall shown in Fig. 1;

Figure 3 is a front view of the nozzle shown in Figure 2;

Figure 4 is a section taken on the line 4—4 of Figure 2 viewed in the direction of the arrows;

2

Figure 5 is a sectional side elevation of an alternative form of secondary air nozzle;

Figure 6 is a front elevation of the nozzle shown in Figure 5; and

Figure 7 is a section taken on the line 7—7 of Figure 5 viewed in the direction of the arrows.

While the invention is illustrated in the drawings as applied to a stoker fired furnace having overfire air nozzles, it will be understood that the principles of the invention can be applied to other forms of ash-containing fuel supply to a combustion space; as for example, to a pulverized fuel burner or the like.

In Figure 1 of the drawings a furnace chamber 1 is provided with a combustion space 5 arranged to be fired with fuel 3 supplied from a fuel hopper 4 to a travelling grate 2. Below the grate is an air passage 11 for the supply of combustion or primary air to the furnace chamber. The grate is arranged to discharge ash, after combustion of the fuel, into an ash pit 6 formed below the grate at an end thereof remote from the fuel hopper 4.

The furnace chamber is provided with a front wall 7 and a rear wall 8 of firebrick formed with respective arches 9 and 10. In each of the walls 7 and 8, immediately above the respective arches, are provided means for the supply of over-fire or secondary air to the furnace chamber comprising respective rows of slightly downwardly inclined air discharge ducts or nozzles 14 and 15. The row of ducts associated with the front arch 9 is arranged to be supplied with air from an air supply conduit 12 and the row associated with the rear arch 10 is arranged to be supplied from an air supply conduit 13. Suitable known means are provided for effecting control of the streams of secondary air.

Each secondary air discharge duct is provided at its outer end with a nozzle including deflecting means for directing some of the secondary air over the furnace chamber wall surface, as is shown by the broken lines 40, and as is described below in connection with Figures 2 to 4, whilst the remainder of the secondary air is discharged as a jet into the combustion chamber as is shown by the broken lines 39.

Referring to Figures 2 to 4, the outlet end 28 of an air discharge duct is arranged to discharge through a port 16 of circular or substantially circular cross-section formed in refractory material 51 lining a passage 50 extending through the wall 7 of the furnace chamber. Centrally positioned in the port 16 is a nozzle insert 17 suitably formed of cast iron and supported at its inlet end on a relatively short locating sleeve 27 concentrically spaced therefrom by webs 26 radially outwardly extending from the nozzle insert 17, and of inner diameter substantially equal to that of the outlet end 28 of the air discharge duct. The locating sleeve is located in the port 16 with its inner end abutting the outer end 28 of the air discharge duct and may be held in position by spigots, or a flange (not shown) outwardly extending into the plastic refractory material lining the port. The positioning of the locating sleeve by such means serves to facilitate the adaptation of an existing installation, but in the construction of a new installation the sleeve 27 and the end 28 of the air discharge duct may be formed with respective flanges at their abutting ends, and bolted together.

The nozzle insert 17 is formed with a longitudinally extending inner venturi shaped passage 29 comprising a convergent inlet part 19 and a divergent discharge part 20. At its outlet or furnace chamber end the nozzle insert is provided with deflecting means comprising a concentrically disposed annular radial flange 23 parallel to and spaced from the adjacent surface of the furnace chamber wall and of larger outer diameter than the diam-

eter of the port 16. The flange 23 on its inner face is smoothly curved as at 24 to merge into the cylindrical or substantially cylindrical outer wall 25 of the nozzle insert, which wall is spaced inwardly from the port 16 to provide the longitudinally extending annular passage 18 between the nozzle insert 17 and the port 16. The passage extends forwardly to an outwardly flaring discharge end provided by the deflecting means comprising the flange 23 arranged to direct secondary air flowing through the passage 18 outwardly across the furnace chamber wall surface. At the inlet end of the nozzle insert 17 the outer surface of the wall separating the passages 18 and 29 is bevelled to provide a tapering portion 22 presenting a narrow annular end face 21 to the flow of air from the duct 28 and a convergent inlet portion to the outer passage 18. Suitably the webs 26 are similarly narrowed at the inlet end of the passage 18 to facilitate the free flow of air into said outer passage.

Thus the nozzle means provides an internal passage 29 for the discharge of secondary or overfire air forwardly into the furnace chamber and in parallel with said passage, a second passage 18 having at its outlet end deflecting means for directing secondary air outwardly across the furnace chamber wall surface adjacent to the nozzle.

In the operation of the furnace chamber described, a part of the secondary air is discharged at the desired velocity from the respective first passages 29 of the nozzles to create the desired turbulence within the combustion space 5 of the furnace chamber 1 and the remainder of the secondary air is directed from the respective second passages 18 over the surfaces of the furnace chamber walls 7 and 8 in the vicinity of the respective rows of nozzles 14 and 15, the said air subsequently mixing with the flame and taking part in the combustion process. The air directed over the furnace chamber wall surface tends to blow the furnace gases and particles entrained therein away from the nozzles and in the neighborhood of the nozzles forms a screen of relatively cool fluid covering the furnace chamber walls, with the result that particles penetrating the screen are cooled to a temperature below that at which they are sticky, so that the particles do not adhere to the furnace walls in the neighborhood of the nozzles. Consequently the formation of slag deposits liable to interfere with the proper operation of the secondary air jets is avoided.

In the alternative form of nozzle means shown in Figures 5 to 7, the end 36 of a secondary air discharge duct extends through the wall 7 of the furnace chamber to present a circular or substantially circular air discharge passage 45 terminating at the inner face of the wall 7. Mounted at the outlet end of the passage 45 is a nozzle insert 30 suitably formed from sheet steel provided with deflecting means comprising a substantially flat fan-tail shaped radial flange 31 forming part of a circle of larger diameter than the passage 45. The fan-tail shape is arranged to extend parallel to the outer surface of the furnace chamber wall through an angle corresponding to and at least as great as that through which it is desired to direct air along the wall 7 of the furnace chamber.

The nozzle insert 30 is formed with a tunnel shaped portion 35 open at both ends and comprising flat parallel rectangular or substantially rectangular sides 32 and 33 bridged by an arcuate or semi-circular arch-like roof part 34. At its outer end the tunnel shaped portion is flared as at 41, smoothly to merge into the fan-tail shaped deflector plate 31. The nozzle insert is located in the passage 45 by welds 43 and 44 respectively uniting the lower edges of the sides 32 and 33 of the tunnel shaped portion 35 to the discharge duct 36 at the inner wall surface of the passage 45 so that the fan-tail shaped plate is spaced from and parallel to the surface of the wall 7. The roof part 34 of the nozzle insert is spaced radially inwardly from the inner wall of the air discharge duct so that within the funnel shaped portion there is provided a first passage 37 for the discharge of secondary air into

the furnace chamber and in parallel with said passage, a second passage 38 for directing secondary air onto deflecting means comprising the fan-tail shaped flange 31 for deflecting the air over the furnace chamber wall surface to sweep a sector of sufficient angle to include all areas in which deposits are likely to occur.

The minimum amount of air required to keep the wall free from deposit around the nozzle is directed along the wall and little increase in the secondary air blow pressure is required to maintain the desired flow of secondary air normal to the furnace chamber wall inner surface.

This type of nozzle insert is particularly suitable for application to existing plant. The angle through which deposits occur may be assessed by inspection of the plant on shut down, and the angle through which the fan-tail shaped plate extends may be chosen accordingly. The nozzle insert may be attached to the discharge end of the existing air discharge duct in the manner described with reference to Figures 5 to 7 so that during operation of the plant, further deposits around the nozzle will be avoided.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form and mode of operation of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. Combustion apparatus comprising walls defining a furnace, means for burning an ash-containing fuel in said furnace, wall means forming an air inlet port in a wall of said furnace, means for supplying air under superatmospheric pressure to said air port, a nozzle positioned in said port, said nozzle having a substantially unobstructed inner air passageway therein and cooperating with the boundary wall of said inlet port to define an outer air passageway therebetween, and a flange on the furnace end of said nozzle having its end portion extending in spaced parallel relation to the inner face of the furnace wall beyond the boundary of said port to deflect air from said outer passageway across the surface of the furnace wall adjoining said port.

2. Combustion apparatus comprising walls defining a furnace, means for burning an ash-containing fuel in said furnace, means forming an air inlet port positioned in a wall of said furnace, means for passing a jet of air through said port, a nozzle concentrically positioned in said port, said nozzle having its inner transverse area substantially unobstructed and its outer surface spaced from the boundary surface of said port and defining a passageway therebetween, and a radial flange positioned on the furnace end of said nozzle with the radial dimension of said flange being greater than the radial dimension of said port, the end portion of said flange extending in spaced parallel relation to the inner face of said furnace wall to deflect air passing through the outer passageway of said nozzle across the surface of said wall adjoining said port.

3. Combustion apparatus comprising walls defining a furnace, means for burning an ash-containing fuel in said furnace, means forming an air inlet port in a wall of said furnace, means for supplying air under superatmospheric pressure to said air port, a nozzle positioned in said port for the discharge of air into said furnace, said nozzle having its inner transverse area substantially unobstructed and its outer surface spaced from the inner surface of said port and defining an outer passageway therebetween, and an upwardly projecting fan-tail shaped radial flange on the furnace end of said nozzle with its end portion extending in spaced parallel relation beyond the boundary of said port to deflect air passing through the outer passageway of said nozzle at least up-

wardly across the surface of the furnace wall adjoining
said port.

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