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PULVERIZED COAL FIRING SYSTEM

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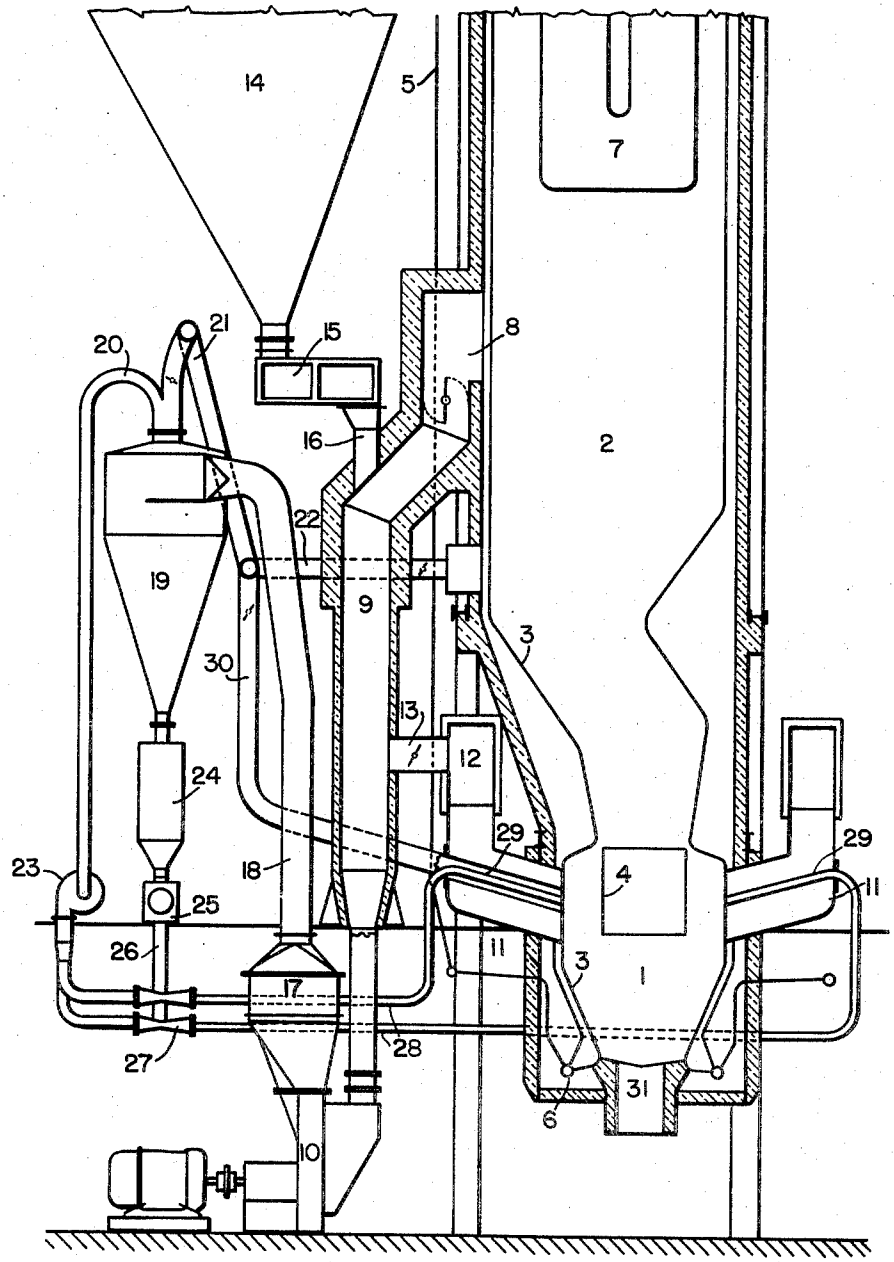

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PULVERIZED COAL FIRING SYSTEM

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The invention relates to a system for firing pulverized coal in the furnace of a radiant steam generator or the like having pulverizing mills and in which the fuel residue is discharged from the combustion chamber in liquid form. More particularly the invention is concerned with a system in which the fuel while being ground in the puverizing mill is at the same time dried by a heating gas stream from which the coarse materials then are separated in an air sifter and returned to the mill.

In pulverized coal furnaces designed for liquid discharge of the fuel residue or ash from the combustion chamber, it is necessary to produce temperatures in the melting zone exceeding the average slag melting point of the coal being fired.

With direct firing mills this condition can be fulfilled only when fuels of a low water content—say 15%—are fired, since a higher water content lowers the temperature in the combustion chamber to such an extent that slag no longer drains off readily from the slightly inclined or horizontal floors of the melting chamber.

However, for economic reasons the operators of such furnace installations are forced to fire also fuels of a water content higher than 15%. To meet those conditions it had been proposed to carry out the combined grinding and drying of the fuel in an atmosphere consisting of a mixture of furnace gases and hot air and to introduce the stream of the pulverized coal-gas mixture issuing from the pulverizing mills into a centrifugal separator or the like and there to separate the pulverized fuel from the conveying gas stream. The separated pulverized fuel was then injected into the melting chamber with combustion air, while the vapors were discharged into the stack or a dust removal plant.

Although it has thus been possible to obtain in the melting chamber a combustion temperature which resulted in a liquid discharge of the fuel residues, the use of this method involved considerable disadvantages. In fact, the preheated air which was used for drying the coal and which after separation from the pulverized fuel had been discharged into the atmosphere was therefore not used for combustion. This air had to be replaced by additional air in order to completely burn the pulverized fuel in the combustion chamber. This of course increased the air preheater heating surfaces. Also, larger fans had to be employed for conveying the air and for setting up sufficient secondary air pressure. Finally, the use of larger amounts of air beyond what was absolutely necessary for combustion had also the disadvantageous effect of lowering the efficiency of the furnace installation.

According to the invention, these disadvantages are avoided by separating the finely ground fuel from the heating gases, dividing the heating gases into two streams, one of which is again charged with the separated pulverized fuel and is conveyed into the ignition or melting zone of the combustion chamber, and the other stream is passed directly into the secondary combustion zone.

In practicing the invention, also, nearly the entire moisture content is removed from the fuel during the drying and grinding phase. However, after separation of the pulverized fuel from the vapor laden gases, only a small portion of the vapor gas is again utilized as a carrying medium for the pulverized coal which subsequently is suspended therein. This portion is made large enough to be able to carry the pulverized fuel into the ignition or melting zone of the combustion chamber. The moisture content of the pulverized fuel is thereby somewhat increased. However this increase is only a fraction of the total moisture, since the amount of water vapor carried into the secondary combustion zone by the portion of vapor laden gases free of coal is much greater than the amount of water vapor carried by the gases required for the injection of the pulverized fuel. Therefore the combustion chamber is still fired with a fuel and air mixture whose moisture content is no more than is permissible for a satisfactory operation of a furnace installation designed to discharge the fuel residues in a molten state. Thus a minor portion of the heated air taken from the secondary air duct for the drying of the fuel in the mill is discharged with the fuel into the ignition or melting zone and a major portion thereof is introduced into the secondary combustion zone. The very fine dust still contained in the vapor laden gases passing to the secondary combustion zone is burned therein in the presence of a high excess of air. Air therefore is available in sufficient quantity for the combustion of the unburned dust particles entrained by the rising flue gases leaving the melting or ignition zone.

The overall percentage of excess air, therefore, can be held to a minimum in a furnace installation incorporating the invention. These conditions become even more favorable as more hot furnace gases are added to the drying air.

According to the invention, a portion of the dust-freed heating gas stream is conveyed to the suction side of an injection fan arranged on the down stream side of the mill and the cyclone separator with respect to gas flow. After leaving the fan the gas may be divided into two or more streams, which are then again charged with the pulverized fuel. Thus the injection fan conveys only dust-free heating gas, so that wear of the rotor of the fan is thereby held to a minimum.

If the furnace is to be fired with coals of various grades, it must be designed for low grade or wet coal. If relatively dry coal is then to be fired in such a plant, and the fuel drying is being carried out simply by the use of preheated combustion air, then the feeding of the vapor laden gases into the secondary combustion zone may not be necessary.

Furthermore it would be advantageous to burn all types of fuels in the melting chamber, while discharging the ash in liquid form.

According to the invention this is achieved by providing, in addition to the damper controlled conduit leading to the secondary combustion zone, another, also damper controlled conduit, which communicates with the ignition or melting zone and which also carries vapor laden heating gases.

When dry fuel is being fired, the damper in the conduit connected to the secondary combustion zone is closed, while the damper in the conduit leading to the ignition or melting zone is opened, so that all the drying air enters the ignition or melting zone either as secondary or primary air.

A throttling of the air to the mill to suit load conditions can in this case be dispensed with, thereby avoiding a lowering of the flow velocity in the mills, in the sifters, and in the fuel pipes, and hence also avoiding variations in fineness and reduction of the separating efficiency of the dust separator. Such decrease in flow velocity would result in an undesirable increase in the amount of dust settling out in the conduit leading to the secondary combustion zone.

Further details and advantages of the invention will become apparent from the drawing and the following description of an illustrative embodiment of the invention.

The drawing shows a vertical partial section taken through a radiant steam generator.

The radiant boiler is equipped with a cylindrical melting or ignition chamber 1 of circular cross section and a secondary combustion zone 2, both of which are lined on all sides with water-circulated cooling tubes 3. A circular cylindrical flame outlet 4, likewise formed of water-circulated tubes, projects into the melting chamber. The cooling tubes 3 are supplied with water from an upper drum (not shown) by way of down take tubes 5 and headers 6, while the flame outlet 4 is preferably cooled by feed water. The secondary combustion zone is followed by other gas passages of the radiant boiler, in which there may be disposed in addition to the radiant superheater 7 other heat absorbing surfaces such as a convection superheater, an economizer and/or an air preheater (not shown).

In the upper portion of the secondary combustion zone there is provided a heating gas outlet 8, through which the self-aspirating beater-wheel mill 10 disposed facing the boiler front wall draws heating gas for the drying of the coal through the shaft 9. Hot air in adjustable quantity is admitted via a duct 13 to the heating gas stream from the secondary air duct 12 leading to the burner corners 11.

The raw coal is conveyed from the coal bunker 14 by a chain conveyor 15 to a conduit 16 into the shaft 9 of the mill 10. On its way to the mill 10 the coal comes into close contact with the heating gas stream and is being pre-dried. The rest of the drying occurs during the grinding of the coal in the mill. The vapor laden heating gases then convey the pulverized coal into the air sifter 17 of the mill, where the coarse materials are separated from the drying gas and fuel mixture and are returned to the mill.

From the air sifter, the fuel and gas mixture flows through duct 18 into a cyclone separator 19, wherein the pulverized fuel is separated from the heating gases. The separated vapor laden gases are then divided into two branch conduits 20 and 21 which are provided with flow regulating devices. Conduit 21 continues via conduit 22 to the secondary combustion zone where it discharges a portion of the moisture laden gases, while conduit 20 leads to the intake side of the injection fan 23.

The separated pulverized fuel passes from cyclone 19 into an intermediate tank 24, from where it is conveyed to the venturi nozzles 27 by way of the roll feeders 25 and the pipes 26. Thence the pulverized fuel passes through nozzles 27 into fuel pipes 28, carrying the portion of vapor laden gases discharged from fan 23 for delivery to the burners 29. These burners feed the fuel and gas mixture into the melting chamber in streams tangential to an imaginary circle being co-axial with the vertical axis of the chamber.

The fine dust accumulated in the intermediate tank 24 forms a gas- and pressure-proof dust cushion between the roll feeders 25 and the cyclone 19. For operation with relatively dry fuels, when hot air exclusively—such as from duct 12—is utilized for grinding and drying the fuel, there is provided in addition to conduit 22 a flow controlled conduit 30. The end portion of this conduit is enlarged to surround burner 29 and delivers the vapor laden gases from conduit 21 into the melting chamber as secondary air.

Combustion of the pulverized coal is carried on with intensive turbulence in the melting chamber, whereby the liquid slag particles are hurled against the walls of the melting chamber which is preferably provided with a heat-retaining layer of refractory. The slag then flows down the walls of the melting chamber and through the outlet aperture 31. The combustion gases pass upwardly through the secondary combustion zone and continue through other gas passes of the boiler all the while transferring heat to the heating surfaces of the boiler. The gases are finally discharged to the atmosphere by way of an induced draft fan and a stack (not shown).

Although in the foregoing the invention has been described in connection with a radiant steam generator, the application thereof is not limited to such generators. The invention can with equally beneficial results be used also in connection with other heat exchangers, such as air heaters, or hot gas generators.

I claim:

1. In a system for firing pulverized fuel the combination of a furnace having an ignition and ash melting chamber in one portion thereof, including a liquid ash discharge opening, and having a secondary combustion chamber adjoining said one portion on the downstream side thereof with respect to gas flow; fuel burning means operatively communicating with said furnace; a fuel grinding and fuel drying mill in operative communication with said fuel burning means; a hot gas duct supplying said mill with hot gases for drying the fuel; a separator for separating the pulverized and dried fuel from the vapor laden drying gases; first duct means for communication with the gas outlet of said separator and said secondary combustion chamber; second duct means communicating with said separator gas outlet and said burner means; feeder means for feeding the separated fuel from said separator into said second duct means for entrainment by the vapor laden gases conveyed therein and for delivery to said burner means and ash melting chamber; and pumping means for moving said drying gases, pulverized fuel and fuel and gas mixture into the furnace.

2. A system for firing pulverized fuel as defined in claim 1, which system additionally includes a source of preheated air, and wherein said hot gas duct supplying hot gases to the mill communicates with said furnace and with said source of preheated air and is provided with flow regulating means for proportioning the flow of furnace gas and the flow of preheated air to said mill for drying.

3. The method of drying, grinding and burning pulverized coal in a slagging bottom furnace wherein the temperature of the slag discharge must be maintained at a temperature above the fusion temperature of the ash, comprising the steps of pulverizing and drying the coal in an atmosphere of heated gases, separating the moisture laden gases from the pulverized dried coal, dividing said freed moisture laden gases into at least two streams, dispersing the separated pulverized coal in one of said streams and burning said dispersed coal in a melting combustion zone at a temperature which will result in a discharge of the ash in fluid form and injecting said other stream into a secondary combustion zone following said melting zone with respect to gas flow.

4. The method according to claim 3 wherein said heated gas atmosphere for drying the coal is produced by performing the additional step of mixing combustion gases and preheated air.

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