May 6, 1958 J. KRUG 2,833,230

PULVERIZED COAL FIRING SYSTEM

Filed April 22, 1954 2 Sheets-Sheet 1

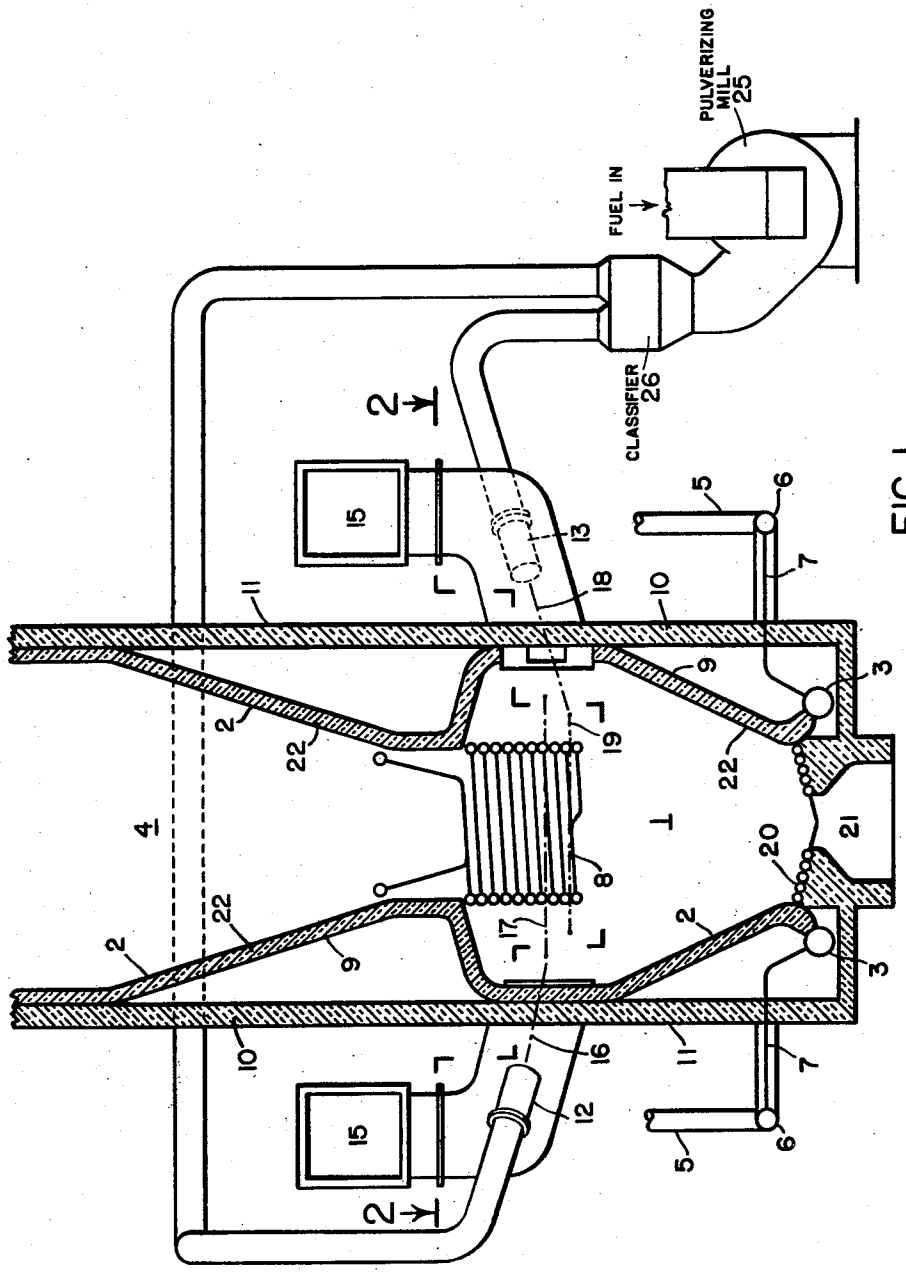


FIG. 1

INVENTOR:
JULIUS KRUG
BY
ATTORNEY

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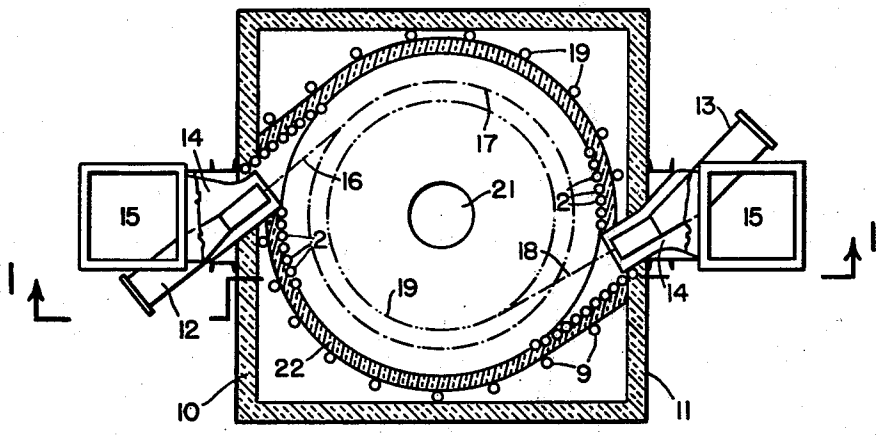


FIG. 2

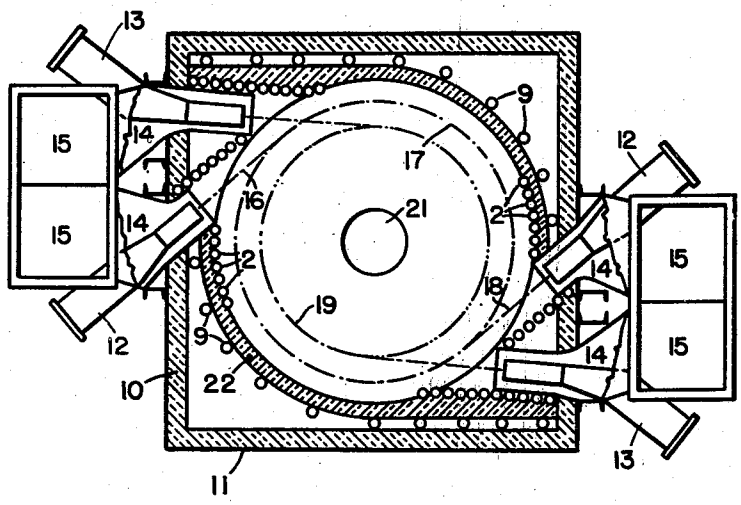


FIG. 3

INVENTOR:
JULIUS KRUG
BY
ATTORNEY

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PULVERIZED COAL FIRING SYSTEM

Julius Krug, Stuttgart, Germany, assignor to Kohlenscheidungs-Gesellschaft, m. b. H., a corporation of Germany

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6 Claims. (Cl. 110—28)

This invention relates to an improvement in pulverized fuel firing and is more specifically concerned with the firing of a pulverized fuel in the cyclone furnace of a steam generator in which the ash is discharged from the slagging chamber of the furnace in a molten condition.

In a steam generator of this type the furnace is generally lined with fluid cooled tubes. The gas carrying the pulverized fuel and the secondary air is usually introduced separately into the cyclonic slagging chamber by streams which are directed tangentially to an imaginary firing circle concentrically located within the slagging chamber.

The carrier gas by means of which fuel is thus introduced into the furnace may be preheated air, furnace gas or a mixture of both depending on whether preheated air, furnace gas or a mixture of both is utilized for drying the moisture laden fuel as it is pulverized in the mill. This carrier gas and fuel when entering the furnace chamber has a temperature of between 200 and 240° F. which temperature significantly affects the ignition and combustion of the fuel within the furnace. Moreover, in cases where the furnace gases are used for drying and transporting the fuel an additional difficulty is presented by the fact that these oxygen poor furnace gases render it more difficult to attain satisfactory mixing of fuel with oxygen rich combustion air.

According to the invention a considerable improvement in this respect can be achieved by dividing the fuel carrying gases into separate streams of different dust density and/or particle fineness and introducing these streams into the combustion chamber at separate locations in the peripheral wall thereof and directed to separate firing circles having diameters of different size. In this respect it was found to be of considerable advantage to direct the stream having the greater density or carrying fuel of larger sizing tangentially to a small firing circle while the other streams carrying lesser fuel or fuel of finer sizing are directed tangentially to successively larger firing circles.

In this manner a gas and fuel stream containing relatively small dust quantities and/or particles of small size follows a spiral path adjacent the peripheral walls of the slagging chamber within a zone of the chamber where the cooling effect of the wall tubes is most effective. Moreover, a comparatively large quantity of combustion air is injected into this zone through secondary air nozzles thus causing the fuel in that zone to ignite easily and to burn more completely. The other separate streams containing large quantities of fuel and/or larger size follow a path which is within the flame zone of the outer above mentioned stream. Consequently ignition of the coarser fuel is also easily accomplished and any fuel particles which fail to burn within said flame zone are carried therethrough outwardly by centrifugal force to establish contact with additional air for complete combustion in the outer ignition zone.

The herein disclosed invention is of particular importance when applied to the burning of coal in cyclone

furnaces because, as is well known, the amount of heat radiated from the peripheral walls of these furnaces to the entering fuel is comparatively small rendering it difficult to quickly ignite and completely burn some types of fuels.

In accordance with the invention the separate firing circles mentioned above can be arranged in series with respect to the direction of flame travel in which case the stream having a lower dust density and/or carrying fuel of finer sizing, would be directed into the slagging chamber through the peripheral wall thereof preferably ahead of the other streams. These separate streams as above described could be produced by various well known means such as for example by means of a reverse flow classifier in which the various layers of classified material having different fineness are separately maintained.

It is accordingly one object of the invention to provide a pulverized fuel firing system having a furnace with a cyclonic slagging combustion chamber in which the fuel is introduced through the peripheral wall thereof in separate streams and directed to firing circles of different diameters.

It is another object of the invention to introduce the fuel into a cyclone furnace through the peripheral wall thereof in separate streams and directed to separate firing circles of different diameters, one of said streams containing fuel in large quantities and/or coarser fineness than the remaining streams.

Still another object of the invention is to direct through the peripheral wall of a cyclone chamber a first fuel carrying gas stream containing a large quantity of fuel and/or large sizing toward a firing circle of comparatively small diameter and directing at least one other stream containing fuel of lesser quantity and/or finer sizing toward a firing circle that is larger than said first fuel carrying gas stream.

It is a further object of the invention to provide a fuel burning system of the type above described in which the stream containing the lower dust density and/or finer sizing is directed into the slagging or combustion chamber through the peripheral wall thereof at a location with respect to flame travel ahead of the point of introduction of the other streams having higher dust density and/or carrying fuel of coarser sizing.

With these and other objects in view which will become apparent from the following description reference is made to the accompanying drawing forming a part of this specification and illustrating my invention as applied to a pulverized coal firing furnace without intention of limiting the invention to any particular form or use.

In the drawings:

Figure 1 is a vertical section through the lower portion of a radiant boiler equipped with a cyclone furnace taken on line 1—1 of Fig. 2.

Figure 2 is a horizontal cross section through the cyclone furnace of Fig. 1 taken on line 2—2.

Figure 3 is a section similar to Fig. 2 but of an embodiment having four burners.

As shown in Fig. 1 the furnace is equipped with a cyclone slagging chamber 1 the circumference of which being lined with fluid cooling tubes 2 which are fed from a ring header 3. The water for cooling and generating steam is supplied to the ring header 3 from a downcomer header 6 from which the water flows through connecting tube 7 into ring header 3. Projecting into the cyclone combustion chamber is a cylindrical gas outlet 8 formed by spirally arranged tubes through which water is made to circulate from a source not shown.

The steam generating tubes 2 extend from the cyclonic combustion chamber 1 upwardly into the upper radiant portion of the furnace chamber 4 and terminate in a steam and water drum, not shown, wherein separation of steam and water takes place. Downcomer pipes 5 of

which only the lower portion is shown carry water from the drum downwardly into header **6**. In addition some of the water passes from the drum through tubes **9** which line the outer surface of the furnace portions **4** and **1** forming wall **22** and terminate in ring header **3**. This wall **22** is provided with fire-proof material arranged between steam generating tubes **2** and feeder tubes or downcomer tubes **9**. In addition the cyclone furnace chamber is surrounded by an outside wall **10** having a metallic outer casing **11**.

In the preferred embodiment of my invention illustrated in Fig. 1 the fuel carrying gas and fuel enters the mill **25** from a source not shown. After grinding to a suitable fineness the fuel and gas enters a separator or classifier **26** wherein it is separated into two streams and delivered to the cyclone chamber **1** by way of two fuel nozzles **12** and **13**. The air for combustion is introduced by way of secondary air nozzles **14** receiving preheated air from a source not shown by way of air duct **15**. The fuel carrying gas stream **16** issuing from nozzle **12** contains a fuel and gas mixture of relatively low density and/or small particle size. This stream is directed tangentially to a comparatively large firing circle **17**. Fuel nozzle **13** carrying, on the other hand, a fuel and gas stream **18** of higher density and/or a coarser fuel sizing is directed tangentially to a firing circle **19**. According to the invention the fuel issuing from nozzle **12** enters the furnace chamber ahead of the fuel passing through fuel nozzle **13** with respect to the travel of the flame which follows a spiral path first in a generally downward direction. This is accomplished in the embodiment shown in Fig. 1 by locating the firing circle **17** which is associated with fuel nozzle **12** above the firing circle **19** associated with fuel nozzle **13**.

Or, as illustratively shown in Fig. 3 the fuel nozzle **12** may be arranged so that it discharges fuel into the furnace chamber ahead of the point of discharge of nozzle **13** in a circumferential direction. In the design of Fig. 3 two pairs of fuel nozzles **12** and **13** are preferably used diametrically positioned with respect to each other.

In both arrangements (Fig. 1 and Fig. 3) the finely divided fuel enters the furnace chamber first through nozzle **12**, ignites and establishes favorable conditions for ignition and burning of the coarser fuel entering the furnace chamber **1** through fuel nozzle **13**.

The slag droplets formed by the combustion of the fuel are thrown by centrifugal force towards the walls of the cyclone chamber from where they flow downwardly towards the ash discharge opening **21** located in the furnace bottom.

This bottom is cooled by water tubes **20** supplied with feed water by well known means not shown. The combustion gases leave the cyclone furnace through gas discharge throat **8** and pass through the upper furnace chamber **4** from where they are conducted over additional heat absorbing surfaces, such as, superheater, reheater and air heater (not shown).

Although the invention has herein been described in connection with a radiant heat steam boiler its application is not limited to this type of apparatus but could with similar favorable results be applied to a heat exchanger heating other fluids such as oil, air or other gases. Furthermore, the application of the herein disclosed invention is not limited to the burning of coal since it could also be utilized, for example, in the combustion of other solid or liquid fuels such as concentrated black liquor as employed in the recovery of chemicals in the field of paper manufacture.

I claim:

1. In a fuel burning system for burning finely divided fuel and in which the fuel residue is discharged in a molten condition, the combination of a cyclonic furnace chamber having means forming an opening for discharging the molten fuel residue at one end thereof and means forming an opening for discharging the gases of combustion at the opposite end thereof, first burner means located in the periphery of said cyclone chamber for feeding a first mixture of fuel and fuel carrying gas and air for combustion into said furnace chamber in a direction tangential to a first firing circle, second burner means located in the periphery of said cyclone chamber for feeding a second mixture of fuel and fuel carrying gas and air for combustion into said furnace chamber in a direction tangential to a second firing circle, said first firing circle being of smaller diameter than said second firing circle, and the total outer surface of the fuel for each unit of carrying gas and pound of fuel contained in said first mixture being smaller than the total outer surface of the fuel for each unit of carrying gas and pound of fuel contained in said second mixture, whereby said first mixture is preheated by penetrating said burning second mixture, said second mixture being more readily ignitable by virtue of the larger surface thereof.

2. A fuel burning system as defined in claim 1 in which the point of entrance into said furnace chamber of said first fuel and air mixture precedes in direction of flame travel the point of entrance of said second fuel and air mixture by a circumferential distance which is less than one half of the corresponding circumference of said cyclonic furnace chamber.

3. The method of burning finely divided fuel in a cyclonic furnace chamber comprising the steps of feeding into said chamber from the periphery thereof and burning therein a first mixture of fuel and carrying gas in a direction tangential to a first imaginary firing circle concentrically arranged within said furnace chamber with respect to the longitudinal axis thereof, feeding into said chamber from the periphery thereof and burning therein a second mixture of fuel and carrying gas in a direction tangential to a second imaginary firing circle concentrically arranged within said furnace chamber with respect to the longitudinal axis thereof said second firing circle being of larger diameter than said first firing circle, the total outer surface of the fuel for each unit of carrying gas and pound of fuel contained in said first mixture being smaller than the total outer surface of the fuel for each unit of carrying gas and pound of fuel contained in said second mixture, preheating said first mixture by penetrating said burning second mixture, feeding into said chamber air for combustion, and discharging the residue of combustion from the chamber in a molten stage.

4. The method according to claim 3 wherein said first mixture contains fuel of larger particle size than said second mixture.

5. The method according to claim 3 in which the first mixture has a higher density than said second mixture.

6. The method according to claim 3 in which the admission of the second mixture into the furnace chamber takes place directly ahead of the admission of the first mixture with respect to flame travel.

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