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(54) **Coal-water burner assembly and method.**

(57) A burner assembly and method for burning a mixture of coal and water in which a high velocity swirling mass of air is introduced around the mixture as the latter discharges from a burner. A low velocity swirling mass of air is also introduced between the discharging coal-water mixture and the high velocity air.

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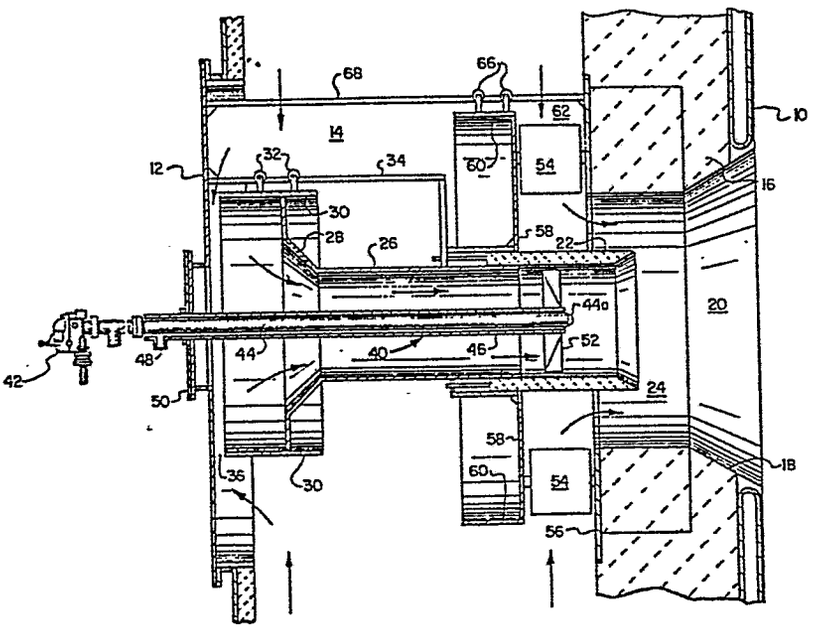
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COAL-WATER BURNER ASSEMBLY AND METHOD

BACKGROUND OF THE INVENTION

This invention relates to a burner assembly and method for burning a mixture of coal and water and more particularly, to such an assembly and method in which both high velocity air and low velocity air are introduced to support the coal-water mixture in the combustion process.

Coal-water mixtures, i.e., pulverized coal mixed with up to 30% water, provide an attractive alternative to natural gas or oil for use in burners in boilers, vapor generators, or the like, since a coal-water mixture can be pumped, stored and atomized like a liquid fuel, yet is not as expensive.

However, to burn such a fuel requires a design approach different from that used in conventional liquid fuel burners since the latter have comparatively high flame propagation rates in the primary combustion zone providing the capability of easy ignition and flame stabilization. High flame propagation rates allow for the use of high velocity combustion air, and traditionally this type of burner uses a single stream of high velocity combustion air.

However, this design approach has proved unsuitable in burning coal/water mixtures resulting in the inability to stabilize the flame without the use of high capacity oil or gas-fired ignitors and in heavy fall-out of unburned coal particles from the flame envelope.

It is therefore an object of the present invention to provide a burner assembly and method for a coal-water mixture burner in which acceptable ignition and flame stability are achieved.

It is another object of the present invention to provide an assembly and method of the above type in which fall-out of unburned coal particles from the flame envelope is minimized.

It is a further object of the present invention to provide an assembly and method of the above type which eliminates any adverse effect on the injection nozzle.

It is a still further object of the present invention to provide an assembly and method of the above type in which adequate residence time of the mixture in the combustion area is insured.

It is a still further object of the present invention to provide an assembly and method of the above type in which a compact, low velocity, high temperature "drying zone" is provided wherein the coal particles can be sufficiently dried before release to the main flame envelope.

Toward the fulfillment of these and other objects, the burner assembly and method of the present invention features the introduction of a "dual velocity" combustion air system. The first zone provides a "primary combustion and drying zone" and has extremely low (less than 15 ft./sec.) velocity swirling air applied around the injected coal/water mixture. This zone is a substantial part of the total burner throat area and is lined with refractory material. The secondary zone provides the main mass of combustion air which is introduced at relatively high rotating velocity (up to 150 ft./sec.) around the periphery of the first zone.

The above brief description as well as further objects, features and advantages of the present invention will be more fully appreciated by reference to the following detailed description of presently preferred but nonetheless illustrative embodiments in accordance with the present invention when taken in conjunction with the accompanying drawings which is a partial schematic, partial cross-sectional view depicting the burner assembly of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The assembly and method of the present invention will be described in connection with a vapor generator for the purposes of example, with the reference numeral 10 in FIG. 1 of the drawings referring to a wall which forms a portion of the furnace section of the generator.

A casing wall 12 extends in a spaced, parallel relation with the wall 10 to define an interior portion 14, it being understood that the latter is bounded by upper and lower walls, as viewed in FIG. 1, to define an enclosure, or windbox, which receives air from a source, such as a fan, with the direction of the air flow being shown in general by the flow arrows in FIG. 1.

An annular refractory collar 16 extends adjacent and within an opening formed in the wall 10 with its inner surface being shaped to define a throat portion 18 surrounding a combustion zone 20.

A tubular refractory throat 22 is provided adjacent the combustion zone 20 and together with the refractory throat 18 de-fines an annular passage 24. A tubular extension 26 is provided on the throat 22 and has an outwardly flared annular end portion 28 which

supports a circular slide damper 30. A pair of rollers 32 are mounted on the slide damper 30 and are in a rolling engagement with a track 34 for permitting slidable movement of the damper 30 relative to the casing wall 12 to define and selectively vary the size of an inlet 36 defined between the flared end portion 28 of the extension 26 and the casing wall 12. As a result, some of the air from the windbox 14 will pass through the inlet 36, and into and through the extension 26 and the throat 22.

A burner assembly, shown in general by the reference numeral 40, extends through the casing wall 12 with its discharge end being located a slight distance inwardly from the corresponding end portion of the throat 22. The burner assembly 40 includes a fuel gun 42 having a barrel 44 extending within a tubular casing 46 in a slightly spaced relationship, and an air inlet 48 adapted to introduce cooling air between the barrel 44 and the casing 46. The discharge end 44a of the barrel extends slightly outwardly from the casing 46 and is adapted to inject a mixture of coal and water in a substantially conical pattern into the combustion zone 20 and the interior of the furnace. It is understood that an atomizer (not shown) is provided on the discharge end 44a to atomize the fuel from the gun 42. The casing 46 is supported by a support structure 50 disposed on the exterior surface of the casing wall 12, and a stationary swirler stabilizer, shown in general by the reference numeral 52, is disposed on the leading end portion of the casing 46. The function of the swirler stabilizer 52 will be described in detail later.

A plurality of register vanes 54 are journaled between a first annular plate 56 disposed adjacent the refractory collar 16, and a second annular plate 58 extending outwardly from, and supported by,

the refractory throat 22. Although only two vanes 54 are shown in the drawing, several additional vanes are disposed in a circular relationship around the latter throat. The plates 56 and 58 thus define a passage for secondary air from the windbox 14 that passes through the register vanes 54, through the annular passage 24, and into the combustion zone 20.

A slide damper 60 is provided which defines, and varies the size of, an inlet 62 for the air passing through the register vanes 54. The slide damper 60 is supported by the annular plate 58 and has two wheels 66 that ride on a track 68 for selectively varying the size of the inlet 62 and therefore the amount of secondary air passing through the register vanes 54, the path 24 and to the combustion zone 20.

As shown in the drawings, the slide damper 30 is in a relatively closed position, thus defining a relatively small inlet opening 36 so that the velocity of the primary air passing into the annular passage between the burner assembly 40 and the refractory throat 22 and its casing 26 is relatively low, such as 15 feet per second. The slide damper 60 is maintained in a relatively open position permitting a higher velocity, such as 150 feet per second, of air flow through the register vane 54, the annular passage 24, and to the combustion zone 20.

In operation, the burner assembly 40 discharges the coal-water mixture in a substantially conical pattern into the combustion zone 20 and the mixture is ignited by any conventional ignitor (not shown). The primary air from the windbox 14 passes through the inlet 36 at a relatively low velocity and through the annular chamber between the burner assembly 40 and the throat 22 and its extension 26 as shown by the flow arrows. The air then passes

through the swirler stabilizer 52 where relatively low velocity vortex and strong recirculation zones are created around the discharge end 44a of the barrel 44.

Secondary air from the windbox 14 passes through the inlet 62 at a relatively high velocity and continues through the register vanes 54 where a swirling effect is imparted to the air as it passes through the annular passage 24 into the combustion zone 20 as also shown by the flow arrows. This high velocity air envelops the substantially conical discharge pattern of the coal-water mixture discharging from the burner assembly 40 and creates an optimum rotational vortex which shapes the flame and causes flow reversals of the particulate fuel back towards the discharge end 44a of the burner assembly 40. This results in superior ignition and flame stability and an adequate residence time of the fuel particles in the combustion zone. Ambient temperature cooling air is introduced through inlet 48 and passes through the annular space between the barrel 44 and the casing 46. The presence of the inner refractory throat 22 enables a high temperature zone to be maintained to insure that the water content of the fuel mixture is flashed.

It is thus seen that as a result of the foregoing, all of the advantages of the use of the mixture of coal and water can be achieved yet assuring satisfactory ignition, flame stability, adequate residence time of the coal particles, and insulation of the burner discharge nozzle.

A latitude of modification, change, and substitution is intended in the foregoing disclosure and in some instances some features of the invention will be employed without a corresponding use of other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention therein.

WHAT IS CLAIMED IS:

1. A burner assembly for burning a mixture of coal and water, comprising means for injecting said mixture in a predetermined discharge pattern, means for introducing a swirling mass of air at a relatively high velocity around said injected mixture to form a negative pressure zone and cause flow reversals of said mixture back towards said injection means, and means for introducing an additional swirling mass of air at a relatively low velocity around said injection means to insulate said injection means from said fuel.

2. The assembly of claim 1 wherein said injecting means is a an elongated burner assembly including a fuel gun and wherein said discharge pattern is substantially conical.

3. The assembly of claim 2 wherein said means for introducing said additional swirling mass of low velocity air comprises an annular throat extending around said burner assembly, means for introducing air to the area between said throat and said burner assembly and means for imparting a swirl to said air as it discharges from said area.

4. The assembly of claim 3 wherein said discharge pattern extends within an opening formed in a furnace wall with which said burner assembly is associated, and wherein said means for introducing said swirling mass of high velocity air comprises means for introducing air to the area between said throat and said opening and means for imparting a swirl to said high velocity air as it discharges from said latter area.

5. The assembly of Claims 3 or 4 wherein each of said air introducing means further comprises damper means respectively associated with each of said areas and adapted to communicate its

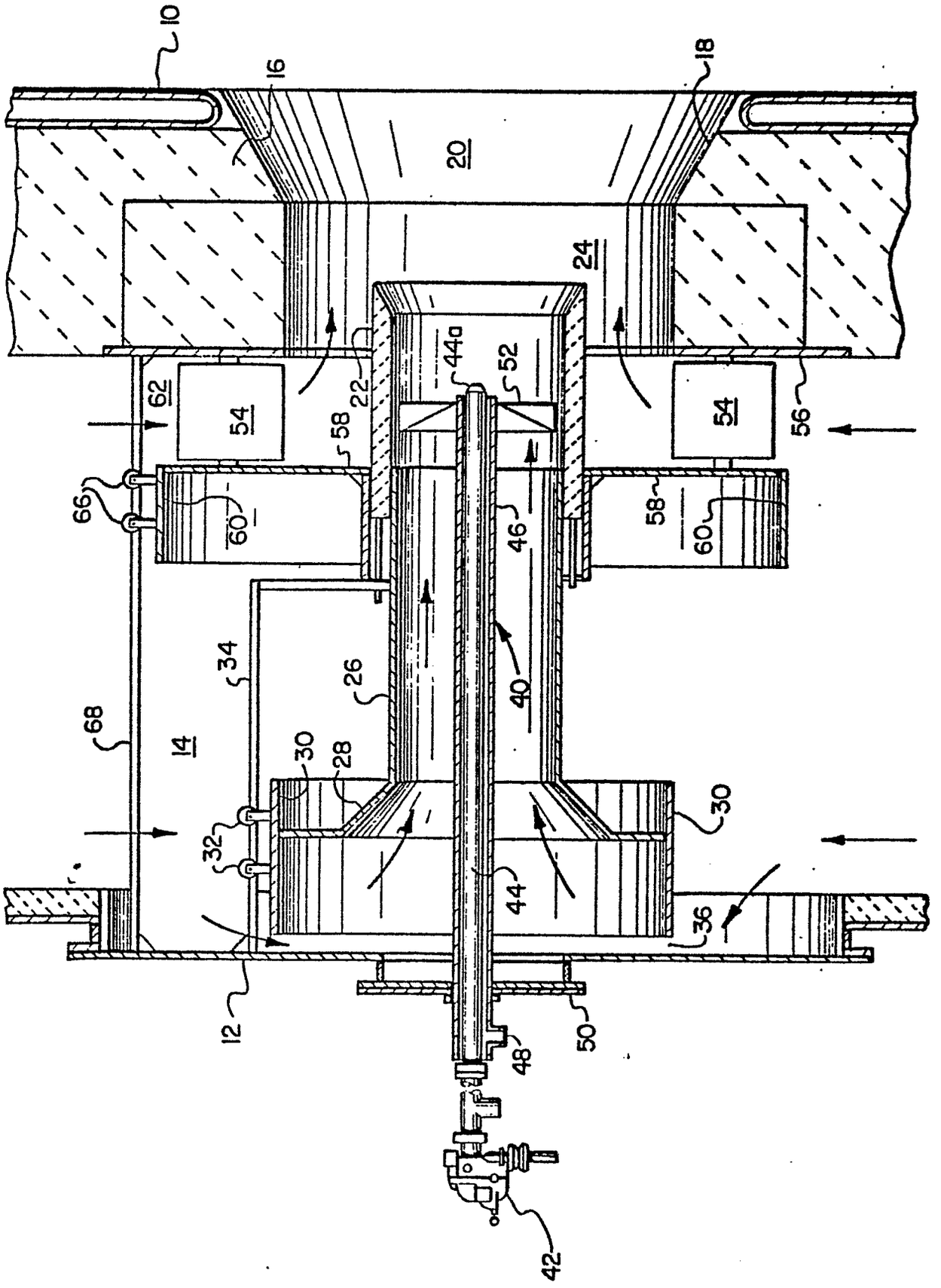
respective area with a windbox, each of said damper means being adjustable to regulate the velocities of said respective masses of air.

6. A method for burning a mixture of coal and water, comprising the steps of injecting said mixture in a predetermined discharge pattern, introducing a swirling mass of air at a relatively high velocity around said injected mixture to form a negative pressure zone and cause flow reversals of said mixture, and introducing an additional swirling mass of air at a relatively low velocity between said discharge pattern and said high velocity air.

7. The method of claim 1 wherein said discharge pattern is substantially conical.

8. The method of claim 6 further comprising the steps of regulating the velocities of said first mass of air and said additional mass of air.

9. The method of claim 6 wherein said high velocity is approximately 150 feet per second and wherein said low velocity is approximately 15 feet per second.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