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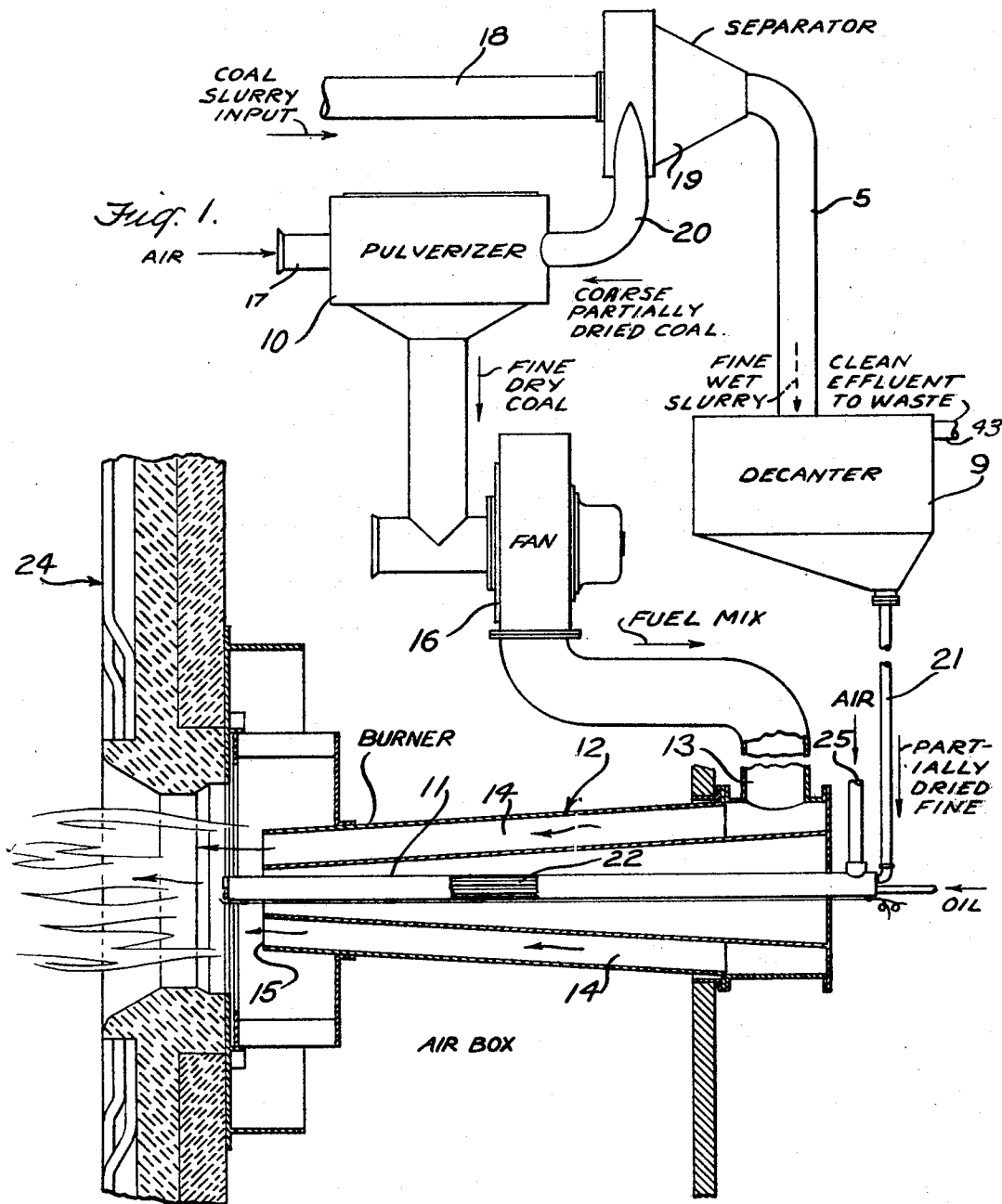
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3,393,650

SLURRY BURNER

Filed Aug. 24, 1964

2 Sheets-Sheet 1



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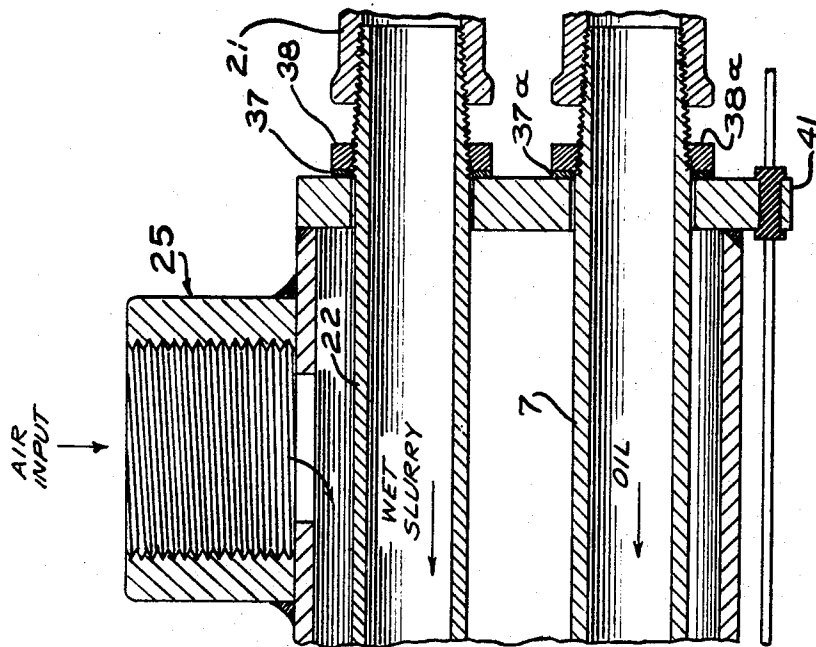


Fig. 2.

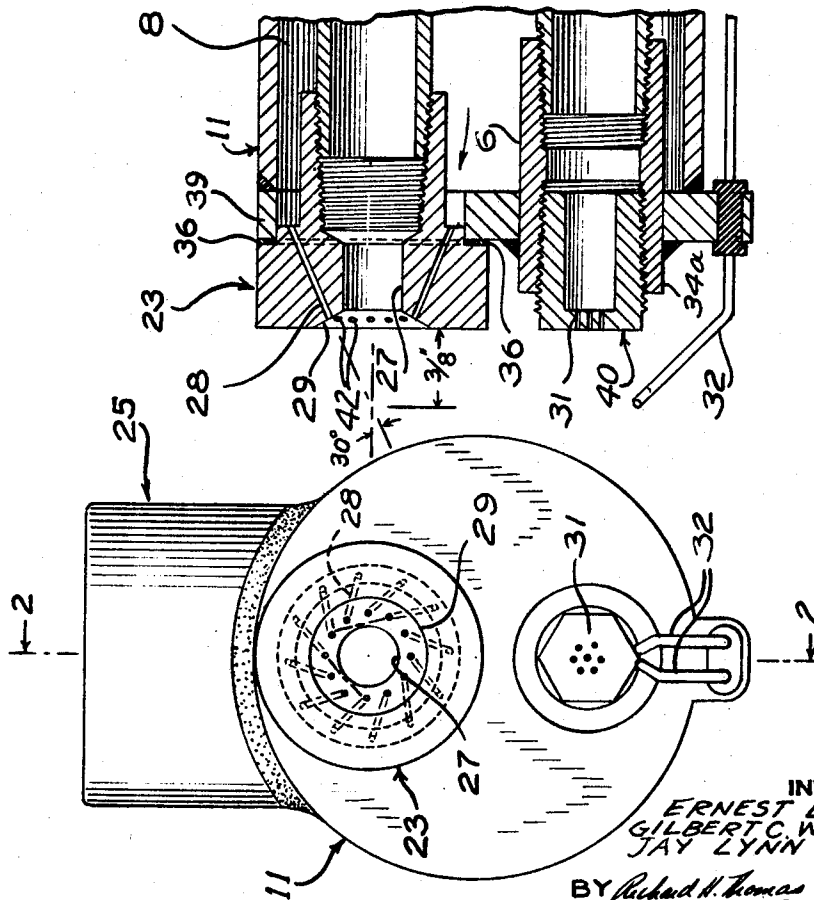


Fig. 3.

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3,393,650

SLURRY BURNER

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ABSTRACT OF THE DISCLOSURE

A coal burner for burning slurry mixtures of coal and water in which dry coal is supplied and burned in the vicinity of an atomized slurry mixture. The burner is provided with a nozzle outlet having a frustoconical section, and a multiplicity of jet channels communicate with the frustoconical section and a source of pressurized air.

The transmission of coal in pipe lines as a water slurry for power plant use is becoming economically feasible.

Present methods for burning wet coal depend upon drying the wet coal before the entry of the coal into a burner for combustion. The present invention is designed to eliminate this drying operation.

Therefore, it is an object of the present invention to provide a combustion system and coal burner which are capable of utilizing and burning wet coal.

According to the present invention, an economical system for burning slurry mixtures of coal and water includes the following concepts. The slurry mixture is first separated into an approximately 20% moisture coarse coal stream and a slurry stream of fine coal and the latter is decanted to an approximately 50% moisture content fine coal slurry. The reduced moisture content slurry is injected into an oil and slurry burner tip located in the central portion of an otherwise conventional burner which has, as its main fuel supply, the dry coal now pulverized. The oil is used to light off the pulverized coal which in turn continuously maintains combustion of the reduced moisture content slurry.

The invention and advantages will become apparent from a description of a preferred embodiment of the present invention, as shown in the drawings wherein:

FIGURE 1 shows a general flow diagram of the combined oil and slurry burner system.

FIGURE 2 is an enlarged transverse sectional view of the central portion of the burner of FIGURE 1 taken along the line 2—2 of FIGURE 3.

FIGURE 3 is a side elevational view of the combined oil and slurry burner tip of FIGURE 2.

Referring now to FIGURE 1, there is shown an oil and slurry burner tip 11 which is mounted within the interior of a conventional pulverized coal burner housing 12, for instance, of the type described in Patent No. 2,912,942, issued to Gilbert C. Whitney and Jay L. Clark, dated Nov. 17, 1959. Similar to a conventional pulverized coal burner, dry pulverized fuel and air enter through the pulverized fuel and primary air inlet 13, into outer annular passageway 14, and exit at annular end region 15 projecting a flame into the furnace indicated by furnace interior wall 24. The pulverized coal entering inlet 13 is drawn from pulverizer 10 by fan 16. Secondary intake air is provided through air inlet 17.

Coal slurry mixtures of water and coal transported from the coal fields to the ultimate boiler user through pipe lines indicated by 18, are sent into a centrifuge separator 19. The centrifuge separates coarse approximately 20% moisture coal from the slurry as received, leaving fines and water, the coal exiting from the centrifuge through conduit 20 to pulverizer 15 for pulverization. It is then trans-

ported by fan 16 into the burner annular portion 14 as described above.

The fine wet coal leaves separator 19 through conduit 5 to decanter 9, the latter reducing the moisture content of the fine coal to approximately 50%. The reduced moisture coal leaves decanter 9 through conduit 21 and enters wet slurry burner tube 22 located in the central burner assembly 11 for burning at the hot end of tube 22. Clear water is rejected via effluent duct 43.

Reference may now be made to FIGURES 2 and 3 for an assembly view of portions of the burner. The wet fine coal passing through tube 22 exists through nozzle 23, entering the furnace through throat 27 centrally located in the nozzle 23. Pressurized air enters chamber 8 from air supply conduit 25, and exits through air jet passages 28 in the nozzle into frustoconical section 29 through equally spaced openings 42 defining a circle adjacent the narrowmost portion of section 29. The air jets 28 are oriented to direct pressurized air into the frustoconical section 29 in three vectorial components. One component is tangential to the circle formed by openings 28 as may be readily seen in FIG. 3. The second component is in a direction parallel to the axis of the frustoconical section, and the third component is radial to the axis of the frustoconical section. Together they cause a helical swirling air movement within the area bounded by the frustoconical portion 29 to cause the coal passing through throat 27 to enter the furnace as an atomized spray. The wet fine coal exiting from throat 27 is caught up in this swirling air movement becoming dispersed and spray atomized.

Oil is supplied to fuel oil tube 7 and exits through nozzle orifices 31 near conventional igniter electrode shown at 32 for initially igniting the oil leaving orifices 31. The ignited oil provides a high temperature secondary ignition system for igniting the dry pulverized fuel leaving annular portion 14 (as shown in FIGURE 1) at hot end 15 as accomplished in a conventional pulverized burner. After ignition is sufficiently established in the dry pulverized fuel so as to be self sustaining, the oil supply is turned off.

The burning of the pulverized fuel flame provides a continuous primary ignition or heat source and continuously ignites and causes the wet fine slurry spray from nozzle 23 to burn, the latter being unable to maintain by itself stable combustion. Burning of the slurry is maintained by sustained ignition, and the self sustaining combustion of the dry pulverized fuel provides the source required. The atomizing action of nozzle 23 provides sufficient slurry surface area to promote complete evaporation of the water in the slurry and subsequent combustion of the fine dry coal in the slurry.

Assembly or housing 11 having hot end wall 39 and cold end wall 41 is arranged for convenient adaptation to existing conventional burners. Air tight tapered pipe threads are provided to seal tubes 22 and 7 to nozzles 23 and 40 respectively. Atomizer nozzle 23 and tube 22 are held in place against hot end wall 39 by spanner nut 38 at the cold end, the latter sealed by gasket 37 adjacent the inlet end of the slurry tube. Gasket 36 is provided to seal the hot end of air chamber 8 between nozzle 23 and hot end wall 39. Oil burner nozzle 40 is connected to oil tube 7 via coupling 6 which is welded to wall 39. At the cold end, the tube 7 is sealed in place by gasket 37a against cold end wall 41 and spanner nut 38a.

Although not restricted thereto the present invention was found to operate successfully under the following conditions. A slurry mixture of coal in semi-ground form mixed with water in the proportion of approximately 60% coal to 40% water by weight was utilized. The coal content of the slurry mixture contained coarse and fine coal in the following percentages: 100% pass through

a No. 19 U.S. standard sieve, 94% through a No. 16 screen, 63% through a No. 50 screen, 49% through a No. 100 screen, 40% through a No. 200 screen, and 33% through a No. 325 screen.

This mixture is initially sent to the separator 9 and is separated into a fine wet slurry effluent and a coarse coal stream. The fine wet slurry leaving the separator through line 5 contains 90% water and 10% fine coal. The fine coal consists approximately of 100% through a No. 100 screen, 95% through a No. 200 screen and 90% through a No. 325 screen. The remainder of the coal, i.e., the coarser coal leaving the separator through line 20, contains 18% water. The remainder is passed to the pulverizer where it is dried by hot air passing through the pulverizer and is pulverized sufficiently for use in the type burner shown in U.S. Patent No. 2,912,942.

The percentage of fine coal passing through line 5 relative the coarse coal passing through line 20 is 5% and 95% respectively. The fine wet slurry is sent to decanter 9 which reduces the moisture content of the effluent to approximately 50% water to 50% fine coal. This mixture is then passed directly into the slurry burner tube 22 at pressures from approximately 25 to 100 p.s.i. so that the velocity of the slurry in the tube 22 is about 10 to 20 feet per second.

The diameter of the nozzle throat 27 is $\frac{7}{16}$ inch and the frustoconical section forms a 60° angle of rotation with the frustoconical axis. The nozzle 23 of this embodiment contains 12 jet channels, sloped at 30° with respect to the axis of the nozzle to intersect with the axis of the nozzle at $\frac{3}{8}$ inch from the exposed front face of the nozzle (FIGURE 2), and angled so as to be tangential to the outline of the throat 27 as shown in FIGURE 1. The jet openings are drilled to .082 inch. The nozzle 23 is centrally placed in a conventional burner of the type described in Patent No. 2,912,942.

Compressed air under pressures of about 70 to 80 p.s.i., for the jet channels, is found suitable to atomize the slurry passing into the center of the nozzle.

Where desirable, a separate supply of dry pulverized fuel may be used as an igniter for the wet fines instead of taking it from the original slurry mixture.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangements of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A burner for burning a slurry mixture of coal and water including an atomizer nozzle for atomizing said slurry mixture of coal and water, said atomizer nozzle comprising

- a source of pressurized air,
- a nozzle tip having a passageway and an outlet portion for exiting the slurry from the passageway, said outlet portion forming a frustoconical section having an axis, the section narrowing up to the passageway, the passageway being circular in cross section,
- a multiplicity of jet channels communicating with the source of pressurized air and the frustoconical section at equally spaced positions around the periphery of the frustoconical section, said channels each oriented to direct pressurized air into the frustoconical section in a direction having a component parallel to the axis of the section and a component tangential to a circle, the circle defined by the intersection of a plane perpendicular to the frustoconical axis and the frustoconical section, at each position of communication of the channels with the frustoconical section, each tangential component being in the same direction of rotation relative said circle associated therewith, so that a helical swirl-

ing current of air disperses and exits with the slurry passing through the nozzle tip.

2. A burner for burning a slurry mixture of coal and water including an atomizer nozzle for atomizing said slurry mixture of coal and water, said atomizer nozzle comprising

- a source of pressurized air,
- a nozzle tip having a passageway and an outlet portion for exiting the slurry from the passageway, said outlet portion forming a frustoconical section having an axis, the section narrowing up to the passageway, the passageway being circular in cross section,
- a multiplicity of jet channels communicating with the source of pressurized air and the frustoconical section at equally spaced positions defining a circle adjacent the passageway, coaxial and perpendicular to the axis of the section,
- said channels each oriented to direct pressurized air into the frustoconical section in a direction having a component parallel to the axis of the section and a component tangential to the circle, each tangential component being in the same direction of rotation relative the circle, so that a helical swirling current of air disperses and exits with the slurry passing therethrough.

3. A burner according to claim 2 wherein said channels are further oriented to have a component radial to the axis of this section.

4. A burner for burning slurry mixtures of fine coal and water, comprising,

- a slurry tube for passing slurry therethrough,
- means for supplying slurry to one end of the slurry tube, an atomizer nozzle at the opposite end of the slurry tube for atomizing the slurry passing therethrough into a fine spray,
- pulverizing means for supplying a source of dry pulverized coal to the vicinity of the nozzle for burning the slurry spray when the dry pulverized coal is burning,
- means for supplying an ignition fuel in the vicinity of the dry pulverized coal for igniting the dry pulverized coal,

means to ignite the ignition fuel, said atomizer nozzle further comprising,

- a source of pressurized air,
- a nozzle tip having a passageway and an outlet portion for exiting the slurry from the passageway, said outlet portion forming a frustoconical section having an axis, the section narrowing adjacent the passageway, the passageway being circular in cross section,
- a multiplicity of jet channels communicating with the source of pressurized air and the frustoconical section at equally spaced positions defining a circle which is adjacent the narrowmost portion of the section, coaxial and perpendicular to the axis of the section,
- said channels oriented to direct pressurized air into the frustoconical section in a direction having a component parallel to the axis of the section and a component tangential to the circle so that a helical swirling current of air disperses and exits with the slurry passing therethrough.

5. A burner of claim 4, said means for supplying an ignition fuel comprising,

- an oil tube for passing oil therethrough,
- means for supplying oil to one end of the oil tube, an oil nozzle at the other end of the oil tube for passing a stream of oil therefrom,
- means for igniting the oil,
- the oil tube oriented so that the stream of oil passing from said oil nozzle is in the vicinity of the dry pulverized coal so that it ignites the dry pulverized coal when the oil is ignited.

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6. A burner for burning a slurry mixture of fine coal and water, comprising,
 a frustoconical shaped annular hollow body having an inlet and an outlet, a volute shaped inlet section having an inlet for receiving a mixture of pulverized fuel and air and having an outlet, said volute outlet being in communication with said main body inlet to pass said mixture of pulverized fuel and air tangentially into said body inlet for providing a helicoidal stream of pulverized fuel flowing through said body,
 means for continuously dispersing said helicoidal stream of pulverized fuel and uniformly distributing the pulverized fuel across the flow area of the body outlet,
 an elongated inner housing concentrically disposed within the hollow body,
 an elongated slurry tube for passing slurry therethrough having an inlet end and outlet end mounted lengthwise within the housing with the outlet end adjacent the dispersing stream of pulverized fuel,
 means for supplying a slurry mixture of fine coal and water to the inlet end of the slurry tube,
 an atomizer nozzle at the outlet end of the slurry tube for atomizing the slurry passing therethrough,
 an elongated ignition fuel tube disposed within the housing parallel to the slurry tube and having an inlet end and an outlet end adjacent the slurry tube outlet end,
 means for supplying an ignition fuel to the inlet end of the ignition fuel tube,
 a fuel nozzle located at the outlet end of the ignition tube for passing a stream of ignition fuel therefrom in the vicinity of the dry pulverized coal for igniting the dry pulverized coal, and
 means mounted within the hollow body adjacent the housing to ignite the ignition fuel.

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7. A burner of claim 6, further comprising,
 means for passing pressurized air into the housing, said atomizer nozzle comprising,
 a nozzle tip having a passageway and an outlet portion for exiting the slurry from the passageway, said outlet portion forming a frustoconical section having an axis, the frustoconical section narrowing adjacent the passageway, the passageway being circular in cross section, and
 a multiplicity of jet channels communicating with the pressurized air in the housing and with the frustoconical section at equally spaced positions defining a circle which is adjacent the narrowmost portion of the section, coaxial and perpendicular to the axis of the section, said channels oriented to direct pressurized air into the frustoconical section in a direction having a component parallel to the axis of the section and a component tangential to the circle, each tangential component being the same direction of rotation relative the circle, so that a helical swirling current of air disperses and exists with the slurry passing therethrough.

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