Sept. 5, 1967 A. P. SAHA 3,339,613

FLAME STABILIZATION

Filed Jan. 4, 1965

FIG. 1

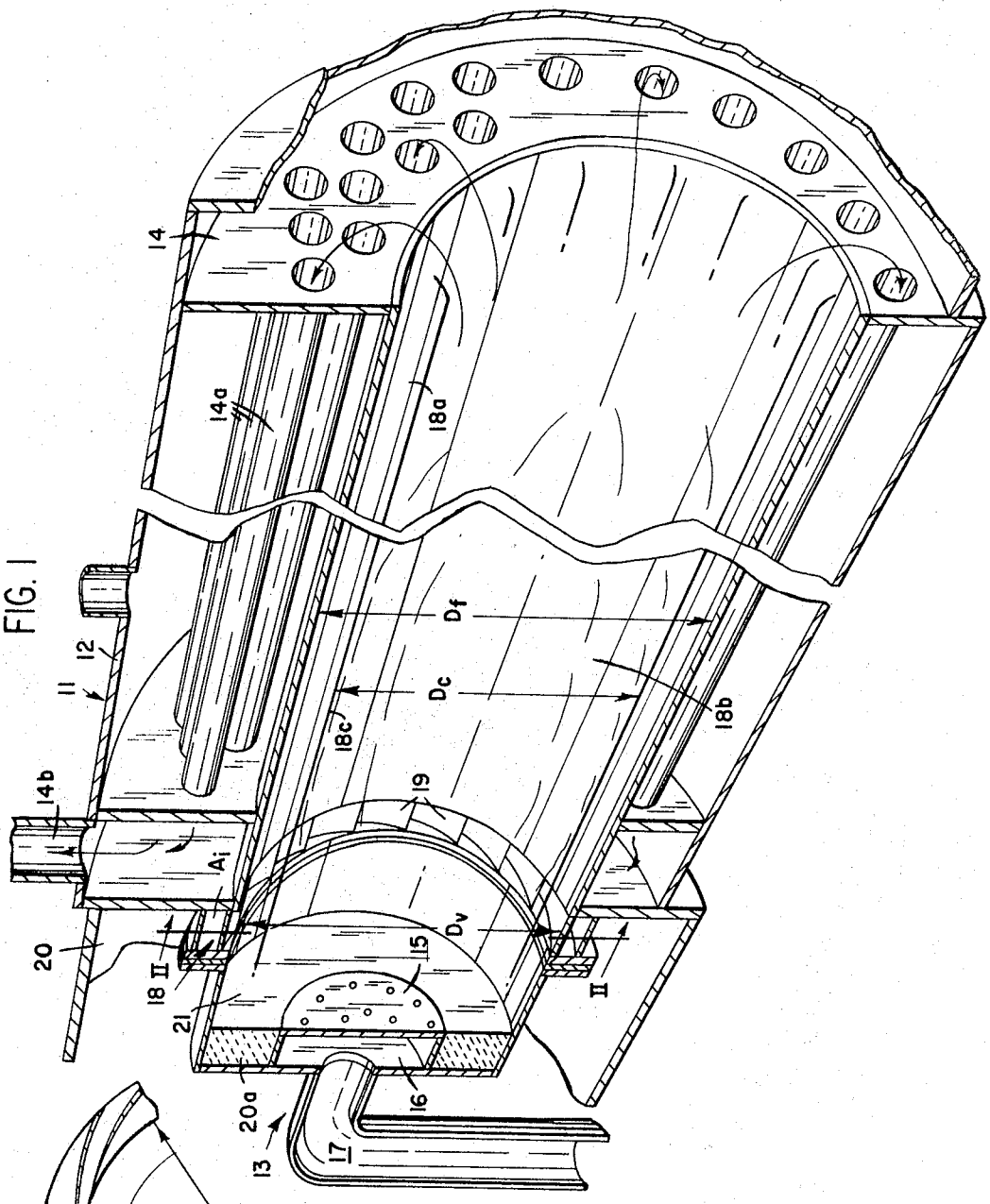
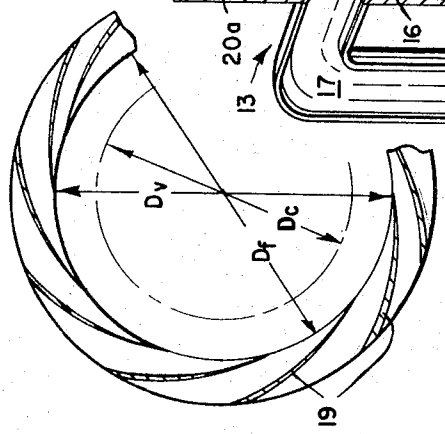


FIG. 2



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FLAME STABILIZATION

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This invention relates to combustion of dispersible fuels and, more particularly, to stabilizing and effectively preventing lifting of the flame from a dispersible fuel burner.

The term "dispersible fuel" includes fuels such as solid fuels in powdered or pulverized form such as powdered coal, and fluid fuels such as gaseous, vaporous or liquid fuels, for example, combustible gases and vapors as well as combustible liquids such as fuel oils, capable of being atomized as by spraying and the like.

Pulsations of the flame produced by dispersible fuel burners cause uneven transfer of heat and intermittent periods or cycles of incomplete combustion, as is more fully discussed in my prior United States Patent 2,539,165, and the present invention is an improvement thereon.

The present invention is directed to improved combustion in a dispersible fuel burner by provision of a pocket extending from a fuel nozzle to an air inlet through which a vortex of air is introduced into a furnace. The pocket is an improvement on the sleeve-like flame stabilizer which is the subject of my aforementioned patent.

It is a primary object of this invention to provide a new and improved apparatus and method for the combustion of dispersible fuel and, more particularly, for stabilizing and effectively preventing lifting of the flame at a dispersible fuel nozzle.

Another object is provision of new and improved apparatus for burning dispersible fuel including a furnace and a nozzle at one end of the furnace for passing dispersible fuel into the furnace to generate a flame, with an air inlet axially spaced from the nozzle for passing a vortex into the furnace to combine with the fuel and move axially through the furnace, and a pocket extending about the nozzle to the air inlet for holding a portion of the vortex to stabilize and effectively prevent lifting of the flame at the nozzle.

Still another object is provision of a new and improved method of stabilizing and effectively preventing lifting of a flame from a dispersible fuel nozzle by establishing about the nozzle a vortex substantially devoid of axial velocity and generally coaxial with the nozzle.

Additional objects and advantages of the invention will be apparent from the following description and drawing in which:

FIGURE 1 is a fragmentary, longitudinal sectional view of a furnace and a burner for dispersible fuel; and

FIGURE 2 is a vertical sectional view, taken generally along the line II—II in FIGURE 1.

Referring to the drawing, a furnace **11** is illustrated in generally cylindrical form within a boiler shell **12**. The furnace **11** has a dispersible fuel burner **13** at one end and at an opposite end opening into a flue gas header **14**. From the header flue gas may pass through return fire tubes **14***a* to a flue **14***b*, or alternatively, directly to a flue.

The burner **13** includes a fuel dispersing nozzle **15**, here in the form of a flat perforated plate facing into the furnace **11** on its front side and on its rear side facing a fuel chamber **16** communicating with a suitable fuel line **17** for passage of dispersible fuel through the perforations and into the combustion chamber of the furnace.

Vortex forming means includes an air inlet **18** for providing substantially a rapidly rotating, annular combustion air stream **18***a* moving along the inner surface of the combustion chamber and about a relatively slowly rotating core **18***b* delimited from the stream **18***a* by a

flame front **18***c* and all moving axially along the longitudinal axis of the furnace **11**. The inlet **18** opens into the end of the furnace adjacent the nozzle **15** and may be of any suitable type, for example, as shown in my Patent 2,097,255, and in FIGURE 2 wherein the inlet includes a plurality of vanes **19** having inner ends defining an imaginary circle with a diameter D_v which may be the same as or suitably larger or smaller than the cylindrical vortex confining furnace wall diameter D_f. The vanes **19** receive air through an air plenum **20** from a suitable blower (not shown) and discharge the air through open areas A_i between the inner ends of the vanes which are generally tangent to the imaginary circle.

In order to stabilize the flame and for effectively preventing lifting of the flame at the nozzle **15**, a ceramic end wall **20***a* forms a pocket **21** with the furnace and extends to the air inlet **18** so that a portion of the vortex created at the air inlet is established rearwardly of the inlet and is substantially static in an axial direction to provide a quiescent zone about the nozzle to hold and stabilize the flame at the nozzle. The pocket **21** should have a diameter greater than the diameter of the core of the vortex at the inlet so that the vortex may be established and maintained in the pocket.

The diameter of the core of the vortex is a function of the vortex forming means and is related to a Vortex Constant C_v which is the sum of the tangential area or areas A_i of the discharge passage at the outlets between the vanes divided by the product of the inlet or inner diameter across the vane circle of the vortex forming means D_v times the diameter of the furnace D_f, that is

$$C_v=\frac{A_i}{D_v D_f}$$

Within normal working limits, for a given Vortex Constant the pocket diameter must be more than the potential core diameter D_c at the flame front **21***a* and may be stated as a percent of the diameter of the furnace or other confining surface as follows:

C_v:	D_c=percent D_f
.15	75
.10	80
.05	85

By passing the fuel into the vortex in the form of discrete jets, the centrifugal force imparted to the jets by the core cause better dispersal of the fuel and more even combustion than occurs with a single, large jet normally injected into the center of the core where centrifugal force is negligible. The quiescent zone of the vortex in the pocket **21** provides for slow combustion of the entering fuel from the nozzle through interdiffusion of the fuel and air in the vortex in the pocket, and absence of axial velocity of the air in the pocket effectively prevents the flame from being lifted from the nozzle.

By providing adequate flame holding and stabilization of the flame, higher axially velocity of the flame can be tolerated in the furnace without lifting of the flame, so that for a given furnace area or volume the heat release is greater while facilitating uniform heating without peaking and permitting a reduction in the diameter of the combustion chamber for a given heat output.

While a preferred embodiment of the invention has been described and illustrated, it will be understood the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim.

1. An apparatus for burning dispersible fuel comprising a furnace having a combustion chamber, a nozzle at an end of said furnace for passing dispersible fuel into said combustion chamber of the furnace to mix with air and generate a flame, means including an air inlet between

said nozzle and said combustion chamber for providing in said combustion chamber a vortex of air moving axially therethrough and generally along the wall thereof and mixing with said fuel, and means for receiving said vortex and providing a quiescent zone stabilizing and effectively preventing lifting of the flame at the nozzle including a pocket about said nozzle extending from said nozzle to the annular origin of said air stream at said air inlet.

2. An apparatus for burning dispersible fuel comprising means defining a furnace having a combustion chamber for the passage of a vortex having an annular portion rotating relatively rapidly along the wall thereof and about a relatively nonrotating core with the vortex moving axially through said combustion chamber, means including a nozzle at an end of said furnace for passing dispersible fuel into said combustion chamber to mix with the air in said vortex and generate a flame, means including an air inlet between said nozzle and said combustion chamber and spaced axially of said furnace from said nozzle for providing said vortex in said combustion chamber, and means for receiving said vortex and providing a quiescent zone stabilizing and effectively preventing lifting of the flame at the nozzle including a pocket about said nozzle and extending substantially from said nozzle to said air inlet and having a diameter at said inlet greater thn the diameter of the vortex core.

3. An apparatus for burning dispersible fuel comprising a nozzle for passing dispersible fuel to mix with air and generate a flame, means including an air inlet downstream of said nozzle for providing a vortex including a rotating, annular air stream about a core for mixing with said fuel, and means for stabilizing and effectively preventing lifting of the flame at the nozzle including a pocket about said nozzle and extending to the annular origin of said air stream, said pocket having a diameter at said inlet greater than the diameter of said core.

4. A method of stabilizing and effectively preventing lifting of a flame from a dispersible fuel nozzle comprising the steps of passing dispersible fuel through said nozzle, and establishing about said nozzle a substantially axially static vortex of combustion air generally axially aligned with said nozzle.

5. A method of stabilizing and effectively preventing lifting of a flame from a dispersible fuel nozzle comprising the steps of passing dispersible fuel through said nozzle, downstream of said nozzle generating a vortex of combustion air generally axially aligned with said nozzle, and establishing about said nozzle a portion of said vortex substantially devoid of axial velocity.

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