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F. L. HEMKER
FLAME DETECTOR ARRANGEMENT

3,280,882

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FIG. 1

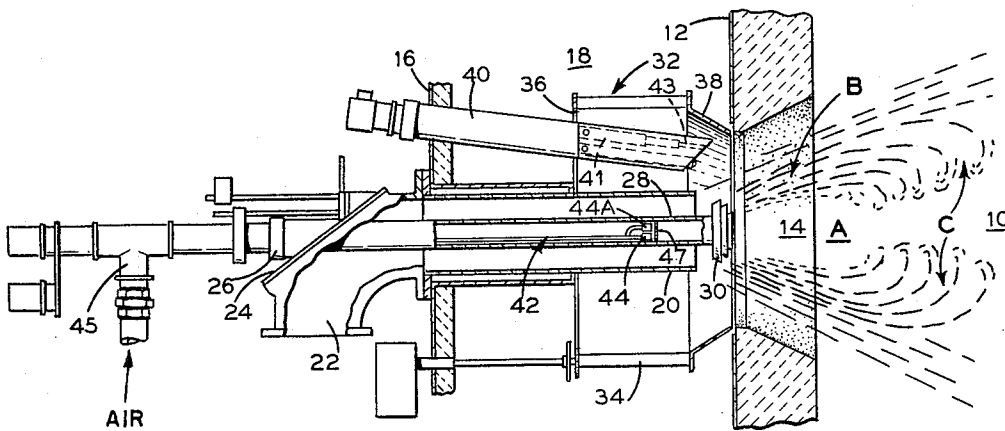


FIG. 2

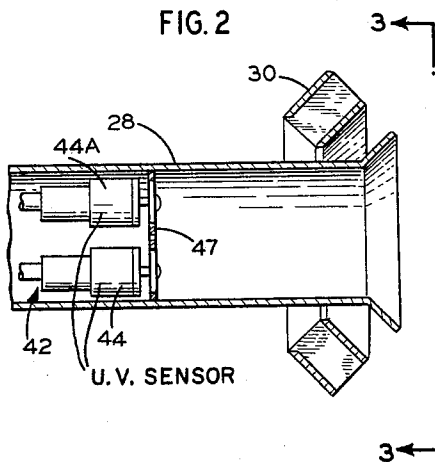
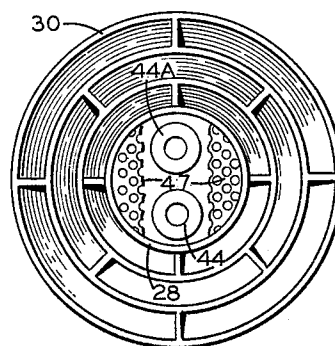


FIG. 3



INVENTOR.

Fritz L. Hemker

BY

J. P. Moran
ATTORNEY

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3,280,882

FLAME DETECTOR ARRANGEMENT

Fritz L. Hemker, Wadsworth, Ohio, assignor, by direct and mesne assignments, of one-half to The Babcock & Wilcox Company, New York, N.Y., a corporation of New Jersey, and one-half to Bailey Meter Company, Wickliffe, Ohio, a corporation of Delaware
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4 Claims. (Cl. 158—28)

This invention relates to fuel burners and more particularly to a system for monitoring the flames of combustion produced by a pulverized coal burner in a closed combustion chamber.

In the past, the accurate monitoring or detection of a flame within a combustion chamber or furnace has been a substantial problem from a safety consideration as well as from an efficiency or economical standpoint. For example, if during start-up a burner in a furnace fails to ignite, a hazardous accumulation of fuel could result which would not only impair the safety of operating personnel but also delay use of the equipment while the situation is remedied. Similar results would occur upon accidental extinguishment of a burner.

Heretofore, many different devices have been exploited in attempts to accurately monitor the flame in a closed combustion chamber. Devices such as thermocouples and flame rods responsive to heat and conductivity of flame have been utilized. Light sensitive devices such as photoelectric tubes have also been widely used. In practically all instances, however, these devices have been unreliable, frequently forcing the operator to rely on crude devices such as sighting tubes to monitor the combustion flame. Thermocouples and flame-rod devices deteriorate rapidly from erosion and corrosion. Photoelectric tubes are unreliable because they respond to light from any source and not only to light from the flame being monitored.

The most successful devices for monitoring a combustion flame are those which respond to invisible radiation such as ultraviolet or infrared emitted by a flame. Even these, however, have given difficulty in their application. In the case of the infrared detector, refractory materials within the furnace emit infrared radiation and the detector will respond to infrared radiation emitted by brickwork in addition to that emitted by the flame being monitored.

In prior applications of detectors of the ultraviolet type to pulverize coal burners, the detector has been mounted in the burner windbox and sighted at the exterior portion of the primary combustion or ignition zone of the burner being monitored. The signal level obtained by windbox-mounted detectors always depends to a great degree on the location of the main burning zone, which in turn is affected by a number of variables, such as pulverizer rating, fuel-air temperature, coal analysis, coal moisture, and number of burners in service. As any one or a combination of these variables can move the burning zone out into the furnace, the signal provided by a detector so sighted will be adversely affected by the shielding effect of coal in various stages of combustion in the fuel and air mixing zone. This frequently results in a false indication of loss of ignition and consequent interruption of burner fuel supply.

Thus, the main object of the present invention is the provision of a flame detector so positioned relative to the burner it is supervising as to positively discriminate between the monitored burner and adjacent burners and to provide a sensitivity sufficient not to cause false interruptions of burner fuel supply due to the normal variations in burner operation. In accordance with the invention, an ultraviolet flame sensing device is associated with a fuel

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burner assembly including a tubular burner nozzle adapted to pass a stream of pulverized coal and carrier air through a port formed in a boundary wall of a furnace, with provisions for mixing additional combustion air with and dispersing the fuel as it passes through the burner port. Fuel dispersal provisions include an impeller normally located outside of and close to the discharge end of the burner nozzle and supported by and attached to one end of a pipe extending coaxially through the burner nozzle. The flame sensing device comprises a detector tube disposed within the impeller support pipe and contiguous to the impeller and looking directly into the bright ignition zone immediately downstream of the impeller. This detector tube location provides a clear and unobstructed view of the ignition zone and a flame signal of optimum reliability in respect to sensitivity and discrimination.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

Of the drawings:

FIG. 1 is a sectional side view of a burner and burner monitoring device arranged in accordance with the invention;

FIG. 2 is an enlargement of a portion of the showing of FIG. 1; and

FIG. 3 is a front view taken along line 3—3 of FIG. 2.

While the drawings show one burner firing a furnace and associated with a flame sensing device, it will be understood that the furnace is provided with several burners of the same type associated with the same furnace boundary wall and each provided with a similar flame sensing device. In the burner construction illustrated, a furnace 10 is bounded in part by an upright wall 12 of refractory material formed with a frusto-conical burner port 14 diverging in the direction of the furnace. An insulation lined upright metallic wall 16 is spaced outwardly from wall 12 and forms part of a casing associated with and suitably connected to wall 12 and cooperating with wall 12 to provide a windbox 18. Wall 16 is formed with an opening through which extends a horizontally arranged cylindrical burner pipe or nozzle 20 positioned coaxially of burner port 14 and having its discharge end located at the outer side of and close to burner port 14. Pipe 20 has its inlet end connected to wall 16 and an elbow 22 adapted to be connected to a suitable source of pulverized coal and primary air. Elbow 22 has its upper portion closed by a cover 24 formed with a collar 26. A horizontal impeller pipe 28 extends through and is supported by collar 26 and is arranged concentric with and disposed in most part within pipe 20. Pipe 28 has its inner or furnace end formed with an impeller 30 normally positioned slightly beyond the discharge end of pipe 20 and ahead of the inlet end of port 14 and arranged for axial adjustment by sliding movement of pipe 28 within collar 26. Impeller 30 is of the type illustrated and described in U.S. Patent 2,380,463 and comprises an assembly of concentric frusto-conical vanes of gradually decreasing inner and outer diameters in the direction of the furnace.

The secondary air provisions for the burner include the windbox 18, which is connected by suitable ductwork to a forced draft fan for supply of high pressure air. A cylindrical air register 32 is disposed within windbox 18, surrounds the discharge portion of pipe 20, and has its circumferential wall formed by a series of pivoted

air doors 34 arranged in operation to impart a whirling motion to the secondary air as it passes from the windbox to the burner port 14. Register 32 has its outer end close by a plate 36 secured to pipe 20 and its inner end connected to a frusto-conical ring 38 converging in the direction of and registering with burner port 14.

Lighting provisions for the pulverized coal include a cylindrical pipe 40 extending through windbox 18 and register 32 in sealing relationship with walls 16 and 36, with an oil-fired lighting torch 41 disposed within pipe 40 and having its discharge end situated at the inner end of pipe 40 and superjacent the discharge end of pipe 20. Ignition of torch 41 is provided by an electrode device 43.

In the operation of the burner described, a stream of pulverized coal and primary or carrier air passes through burner pipe 20 and is dispersed by impeller 30 so as to move in a diverging conical path through burner port 14 into furnace 10. When the primary air-coal stream strikes the impeller, the velocity of a portion of the fuel particles, the finer components, is reduced so that ignition can take place. The impeller deflects most of the fuel particles into the stream of secondary air and thus a more intimate mixing of air and coal is obtained. Secondary air enters the register 32 and whirls therethrough in a high-velocity stream to and through burner port 14 for mixing with the pulverized coal-primary air stream. With the air streams and fuel entering the furnace as described, combustion of the fuel will progress at a rapid rate, which increases as the combined streams move into the furnace, with a stable ignition zone A formed immediately downstream of impeller 30. This stable ignition zone is the result of the action of the stream of primary air and pulverized coal on the impeller, which produces a relatively quiescent low pressure zone immediately downstream of the impeller into which the fine coal fractions are induced and where they burn immediately. Most of the fuel particles are deflected by the impeller into the stream of secondary air to form a turbulent-air mixing zone B surrounding the ignition zone, with the fuel and air streams so mixed gradually moving in a diverging conical path into the furnace where combustion progresses at a rapid rate in burning zone C.

In accordance with the invention, a flame detector or flame sensing device 42 is positioned within pipe 28. This flame sensing device should be of the type sensitive to the ultraviolet spectra such as the present commercially available Flamon Detector of the Baily Meter Company. A detector of this type utilizes a gas-filled detector tube or cell 44 sensitive only to ultraviolet light. This tube is provided with a pair of spaced parallel electrodes to which a predetermined potential is applied. When ultraviolet radiation is received, ionization of the filling gas will occur to cause a continuous gas discharge and current flows between the electrodes as long as the potential exists. To provide the ultimate in furnace safety, to achieve maximum operating efficiency of the flame detector, and to achieve discrimination between adjacent burners and other sources of radiation, I have found that the detector tube 44 should be located within impeller pipe 28 and contiguous to the inner or impeller end thereof. While one detector tube per burner is normally satisfactory, a second detector tube 44A is connected in series with tube 44 to provide a factor of safety for the remote possibility of one detector failing. Air from a suitable source, such as the forced draft fan, is supplied by a pipe 45 to pipe 28 for flow therethrough to cool detector tubes 44, 44A and to prevent deposition of fine particles of coal or ash on the detector tubes. Blow back of ash or fine coal particles on tubes 44, 44A is further inhibited by a screen or perforated plate 47 disposed within and across pipe 28 immediately ahead of tubes 44, 44A and proportioned to increase the velocity of the cooling air flowing through pipe 28. The location of the detector tubes relative to the furnace end of pipe 28 depends principally on coal characteristics and the arrangement of

burners in wall 12. With high-volatile coal, tubes 44, 44A can be located about 6 to 12 inches from the furnace end of pipe 28; while low-volatile coal requires the tubes to be closer to the furnace end of pipe 28.

In past use of a detector of the ultraviolet type, the practice has been to mount it in the burner windbox and to aim it at the outer flame envelope. Field experience has shown that the view of the windbox mounted detectors was obscured by solid particles of coal and ash as well as by the hydrocarbon distillates present in the outer flame envelope, and that under transient or overload conditions, signal level would drop to a burner trip level despite entirely satisfactory burner stability.

With the detector tubes located as provided in the invention, the tubes look directly into the bright primary or basic ignition zone, and consequently produce a uniformly high output signal. Tubes so positioned observe the primary ignition zone without interference from coal or ash particles and positively discriminate between the burner they are supervising and the next adjacent burners because they are looking straight out into the furnace. Whether the primary ignition zone is the result of combustion of coal or of combustion of oil supplied from torch 41 is immaterial, for, should this ignition zone be lost, coal issuing from burner pipe 20 will shield the detector tubes from any flame in the furnace, resulting in a burner or pulverizer trip. Further, the primary ignition zone immediately downstream of the impeller is always present with a stable burner and is not affected by boiler or burner rating, air flow, coal characteristics, or excess air.

While in accordance with the provisions of the statutes, I have illustrated and described herein the best form and mode of operation of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. In combination, a furnace wall formed with a burner port, means for supplying pulverized coal and combustion air to said furnace including a horizontal burner nozzle of circular cross-section adapted to pass a stream of pulverized coal and carrier air into said furnace and having its discharge end disposed adjacent said burner port, a horizontal pipe disposed within and coaxially of said burner nozzle and having a radiation pervious end, means disposed at the discharge end of said nozzle for dispersing the fuel particles discharging from said nozzle through said burner port, means for supplying combustion air to said burner port for establishing a flame adjacent the discharge end of said nozzle, and flame sensing means including a detector tube disposed within said pipe at a position contiguous to the discharge end of said nozzle, said detector tube being sensitive to only invisible radiation emitted by the combustion flame and being operative to establish an electric output signal indicative of the condition of said flame.

2. In combination, a furnace wall formed with a burner port, means for supplying pulverized coal and combustion air to said furnace including a tubular burner nozzle adapted to pass a stream of pulverized coal into said furnace and having its discharge end disposed adjacent said burner port, means for dispersing the fuel upon discharge from said nozzle and promoting the formation of a fuel ignition zone in the vicinity of the burner port, said last named means including a pipe disposed within and coaxially of said burner nozzle and having a radiation pervious end, and impeller means attached to said pipe and disposed at the discharge end of said nozzle, and flame sensing means including a detector tube disposed within said pipe at a position contiguous to said impeller means and having its line of sight aimed directly into the central portion of the ignition zone, said detector tube being sen-

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sitive to only invisible radiation emitted by the ignition zone flame and operative to establish an electric output signal indicative of the condition of said flame.

3. In combination, a furnace wall formed with a burner port, means for supplying pulverized coal and combustion air to said furnace including a tubular burner nozzle adapted to pass a stream of pulverized coal into said furnace and having its discharge end disposed adjacent said burner port, means for dispersing the fuel upon discharge from said nozzle and promoting the formation of a fuel ignition zone in the vicinity of the burner port, said last named means including a pipe disposed within said burner nozzle and having a radiation pervious end, and an impeller attached to said pipe and disposed at the discharge end of said nozzle, a flame sensing device including a detector tube disposed within said pipe at a position contiguous to said impeller and having its line of sight aimed directly into the central portion of the ignition zone and sensitive to only ultraviolet radiation emitted by the ignition zone flame, and means for cooling the detector tube and for preventing the deposition of coal particles thereon, said last named means including means for passing cooling air through said pipe, and a screen in said pipe intermediate the detector tube and the impeller end of the pipe for increasing the velocity of the cooling air.

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4. In combination, a furnace wall formed with a burner port, means for supplying fuel and combustion air to said furnace including a tubular burner nozzle adapted for passing a stream of fuel into said furnace and having its discharge end disposed adjacent said burner port, means for dispersing said fuel stream and establishing an ignition zone adjacent the discharge end of said nozzle, a pipe disposed within said burner nozzle and having a radiation pervious end adjacent the discharge end of said burner nozzle, and flame sensing means comprising a radiation sensor responsive only to ultraviolet radiation and being disposed within said pipe at a position adjacent the discharge end of said nozzle so as to have its line of sight aimed through said pipe directly into the central portion of the ignition zone.

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JAMES W. WESTHAVER, *Primary Examiner*.