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3,299,841

BURNER IMPELLER

Filed Oct. 13, 1965

2 Sheets-Sheet 1

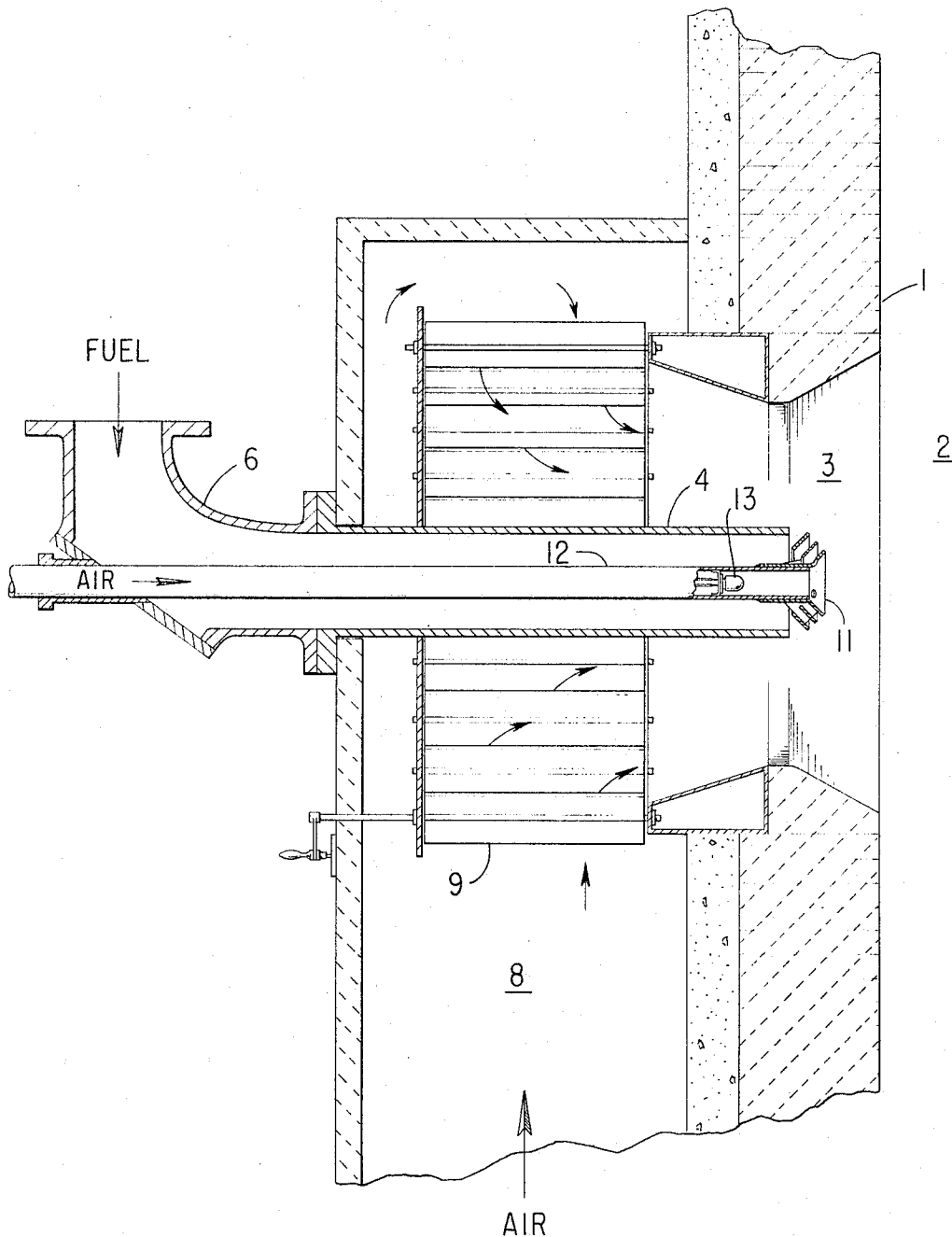


FIG. 1

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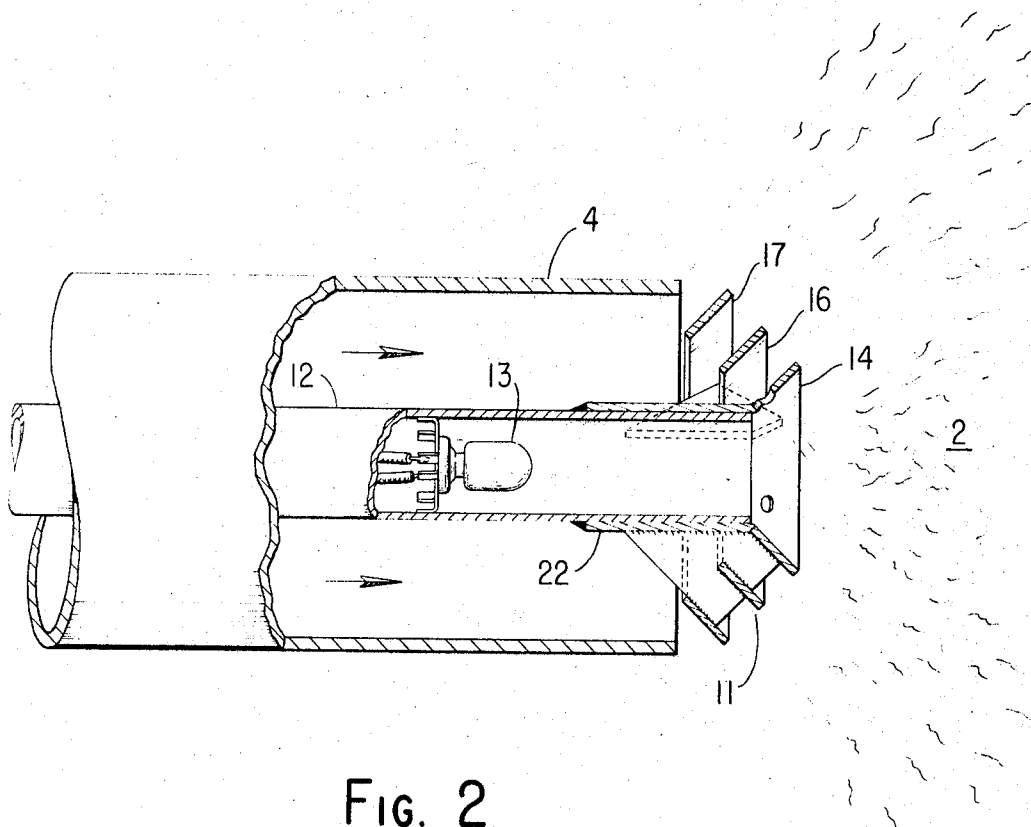


FIG. 2

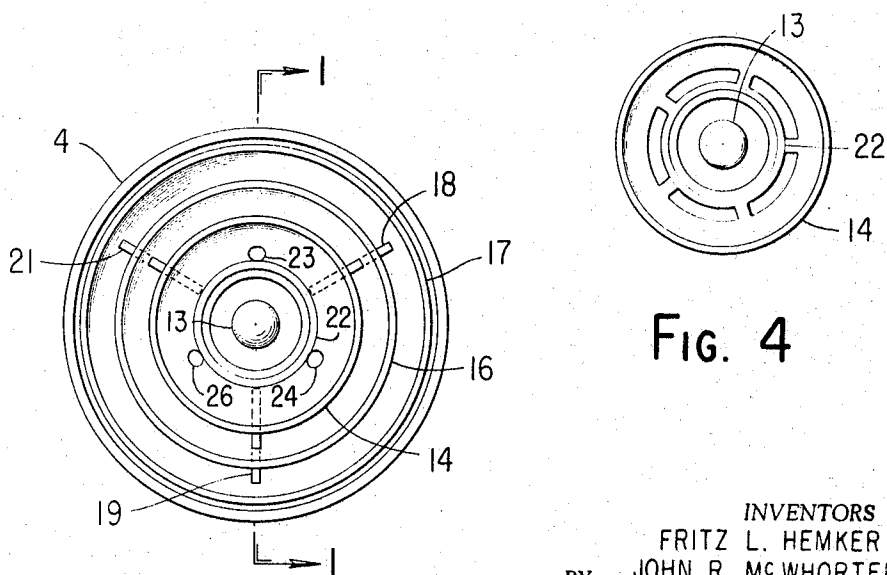


FIG. 3

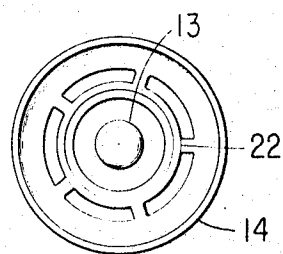


FIG. 4

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BURNER IMPELLER

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11 Claims. (Cl. 110—28)

This invention relates to fuel burners and more particularly to burners utilizing a fuel capable of being projected into the combustion zone of a furnace in a fluent stream.

Our invention will be used primarily in connection with pulverized fuel burners of the circular type wherein we arrange to discharge a fluent mixture of solid fuel particles into the center area of the burner. Of course our invention could be used in oil and gas burners but the advantages gained by its use will not be as outstanding.

Impellers of circular fuel burners provide even distribution of the fuel and primary air as the mixture enters the combustion area of a furnace. In addition, it disperses the fuel-primary air mixture into the secondary air flow and thereby promotes thorough mingling of the fuel and air prior to combustion. The flame pattern of an impeller equipped circular fuel burner is in the form of a cone with the cone vertex in the impeller end. Unfortunately, the cone shaped flame of circular fuel burners sometimes creates an area immediately adjacent to the impeller end where the flame is not present.

In the past it has proven extremely difficult to successfully monitor the cone shaped flame of a circular burner in a multiple burner furnace. Mounting the flame detection device outside the burner proper makes it difficult to distinguish the flame of one burner from another. With the detector mounted in the impeller pipe, there is either the problem of burner discrimination or lack of a flame for the detector to monitor. If the impeller-mounted detector is located close to the burner end of the impeller there exists the problem of discrimination. Mounting the detector back from the end of the impeller pipe limits its view to that area of the burner where no visible flame is present.

To eliminate the flameless area of the burner, we have modified the standard circular burner impeller, such as disclosed in U.S. Patent No. 2,380,463, to permit a small amount of fuel and primary air to pass into the furnace without deflection. This undeflected fuel-air mixture mixes with the air supplied through the impeller pipe to form a combustible mixture that burns in the area immediately in front of the impeller end. Thus, the principal object of our invention is to provide an impeller that passes a small amount of fuel to the combustion zone of the furnace without deflection.

Another object of our invention is to provide an impeller having a series of passages in the innermost vane to permit a small amount of fuel to pass into the combustion zone of a furnace without deflection.

Still another object of our invention is to provide an impeller that eliminates the flameless area created in circular burners and permits a small amount of fuel to enter the combustion zone immediately in front of the impeller pipe.

Various other objects and advantages will be apparent from a reading of the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a sectional assembly view of a circular burner employing the impeller of our invention and an impeller-mounted detector;

FIG. 2 is an enlarged view in section of our impeller showing the inner vane passages;

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FIG. 3 is the end view of the impeller of FIG. 2 as seen from the furnace end.

FIG. 4 is the end view of the impeller of FIG. 2 with rectangular passages instead of circular.

Referring to FIG. 1, we show a burner in association with a furnace wall 1 of refractory material and forming part of a combustion zone 2. The burner delivers fuel and air through a port 3 having circumferential wall surfaces converging inwardly to form a venturi-like passage providing a burner throat of restricted diameter.

Coal and primary air are supplied to the combustion zone 2 through a horizontally mounted fuel pipe 4 coaxially located with respect to the venturi-like passage. Attached to the supply end of the fuel pipe 4 is an elbow 6 adapted to be connected to a suitable source of pulverized coal and primary air. The pulverized coal and primary air mixture enters the pipe 4 after striking the 45° angle of the elbow 6 thereby developing a turbulent flow to provide a substantially uniform supply of fuel and air to the outlet of the fuel pipe 4 and to the combustion zone 2.

The volume of primary (or carrier) are mixed with the pulverized coal for purposes of transportation of said coal is insufficient to produce complete combustion. To insure complete combustion of the pulverized coal, secondary air is supplied to the burner throat by means of a windbox 8 connected by suitable ductwork to a source of pressurized air. Control of the secondary air is by means of a series of registers 9 also functioning to impart a whirling motion to the secondary air as it enters the burner throat and mixes with the pulverized coal-primary air mixture.

To insure a proper fuel-air mixture for complete and rapid combustion, an impeller 11 is mounted on an adjustable horizontal impeller pipe 12 coaxially positioned within the fuel pipe 4 by means of supports. The impeller 11 is centrally positioned within the fuel pipe 4 and disposed in most part within said pipe at its discharge end. Positioned within the impeller pipe 12, some distance from the furnace end, is a radiation detector, such as an ultra-violet sensitive tube 13, as part of a flame detection device, not shown. FIG. 2 shows in greater detail the position of the ultra-violet tube 13 with respect to the impeller 11.

The ambient temperature surrounding the ultra-violet tube 13 is higher than its safe operating condition during furnace operation. To maintain the ambient temperature surrounding the tube below its maximum safe operating temperature, air is supplied through the impeller pipe 12 by means of an air connection. This air enters the impeller pipe 12, flows past and cools the ultra-violet tube 13 to a safe operating condition, and exits at the furnace end where it mixes with the small amount of coal not deflected by the impeller 11.

Referring to FIGS. 2 and 3, we show in detail the features of our impeller including a series of passages for allowing a portion of the pulverized coal-primary air mixture to enter the combustion zone 2 without being deflected. Again we show the impeller pipe 12 centrally positioned within the fuel pipe 4 and having the impeller 11 mounted at the discharge end. The impeller itself consists of three vanes 14, 16 and 17, each formed substantially as the frustum of a hollow cone having its vertex at the side remote from the outlet of the fuel pipe 4. These vanes are supported in concentric spaced relationship by means of ribs 18, 19 and 21 mounted radially and equally spaced circumferentially around a hub 22. Spacing of the impeller vanes and its distance from the fuel pipe end may be varied to suit particular operating conditions and characteristics of the fuel being used. For example, when using gas it probably will be desirable to

reduce the vane spacing as compared with the spacing when a fluent mixture of pulverized coal and air is used.

Particular attention is called to the innermost vane 14, vane 14 has an inside diameter approximately equal to the outside diameter of the hub 22. Spaced approximately 120° apart are three circular passages 23, 24 and 26. These passages allow a fraction of the total pulverized coal-primary air mixture flowing through the fuel pipe 4 to enter the combustion zone 2 without deflection by the vanes of the impeller 11. The radial distance from the center of the impeller pipe 12 to the circular passages 23, 24 and 26 is approximately equal to the outside diameter of the hub 22.

In operation of the burner described, a stream of pulverized coal and primary air passes through the fuel pipe 4 and is dispersed by impeller 11 so as to move in a diverging conical path through the burner port 3 into the combustion zone 2. The impeller deflects most of the fuel particles into the stream of secondary air and thus an intimate mixing of coal and air is obtained. Secondary air enters the registers 9 and passes therethrough in a high-velocity stream to and through the burner port 3 for mixing with the pulverized coal-primary air stream. With the air streams and fuel entering the furnace as described, combustion of the fuel and air mixture will progress at a very rapid rate, which increases as the combined streams move into the furnace, with a stable cone shaped ignition zone formed immediately downstream of the impeller. Most of the fuel particles entering the combustion zone are deflected by the impeller into the stream of secondary air to form a turbulent coal-air mixing zone. There is, however, a small fraction of the total fuel entering the furnace passing undeflected through the passageways of the innermost vane 14 and mixed with air exiting from the impeller pipe 12. Combustion of this fuel-air mixture takes place adjacent to the open end of the impeller pipe in front of the ultra-violet detector tube 13. The fuel and air streams so mixed move into the furnace where combustion takes place at a rapid rate. The main flame, as mentioned, moves in a diverging conical path from the impeller while the supplemental flame burns in an area immediately ahead of the furnace end of the impeller pipe 12.

When the small supplemental flame burns at the open end of the impeller pipe 12, the ultra-violet detection tube mounted within said pipe will be directly in line with the radiation emitted by said flame. Direct in-line observation of the flame enables the detector tube to be mounted in the cool end of the impeller pipe away from the furnace combustion zone. Mounting the ultra-violet detector tube away from the combustion zone improves its operation by: first, lowering the tubes operating temperature and second, restricting the view of the tube to the flame of only one burner, namely, the one in which it is mounted.

The amount of coal required to pass through the innermost vane 14 would vary with the application. Some influential factors would be: coal characteristics (high or low volatile), impeller pipe size, velocity of air through the impeller pipe and the burner rating. Thus, although we have described a 3-hole impeller, it is not necessarily the only or most desirable design for every application. We tried other hole configurations and arrangements, one such design had five substantially rectangular slots formed in a circular pattern around the outside diameter of the hub 22, such as shown in FIG. 4. If, however, too much coal axially enters the combustion zone 2 it will tend to "coke-up" the impeller pipe and innermost vane; incomplete combustion will result that may well block the ultra-violet wave lengths from the detector tube 13. If the velocity of the air exiting from the impeller pipe is too great, because of the large volume required to mix with the undeflected fuel, it may blow-out the supplemental flame. On the other hand, too small a coal flow through the impeller causes the ultra-violet radiation level to diminish for low firing rates and a flame failure may be indi-

cated. Thus, it can be seen that many factors must be considered in designing the particular innermost vane to be used, a 3-hole version is but one variation.

We developed our invention using an impeller substantially as shown in FIGS. 2 and 3. Dimensionally, the three passages are 1/2" in diameter and have a total open area of 0.59 square inch; they are located 120° apart. In the development of our 3-hole direct-flow impeller, we worked with passageways ranging from 1/4" to 3/4" in diameter and having a total open area varying from 0.15 square inch to 1.325 square inches. Although these limits are not critical, we did find that with the 1/4" diameter passageways the supplemental flame was nearly extinguished at low rates of fuel flow. With the 3/4" passageway size, the amount of air required to produce a combustible mixture was excessive.

In accordance with the patent statutes, we have described our invention in terms of a preferred embodiment. The invention may be practiced otherwise than as described and still be within the scope of the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A fuel burner, comprising:

a furnace wall formed with a burner port;

means for supplying fuel and combustion air to said furnace including a tubular burner nozzle adapted to pass a stream of fuel into said furnace and having its discharge end disposed adjacent to said burner port;

an impeller pipe concentrically mounted within said burner nozzle; and

an impeller attached to one end of said pipe at the discharge end of said nozzle, said impeller having a series of stationary axially spaced annular vanes of progressively decreasing diameters, the innermost vane having a plurality of openings for passing undeflected a small amount of fuel into said furnace in an area immediately adjacent to the furnace end of said impeller pipe.

2. A fuel burner as set forth in claim 1 wherein the total open area of the plurality of openings in said innermost vane varies between a lower limit of 0.15 square inch and an upper limit of 1.3 square inches.

3. An impeller for a fuel burner, comprising:

an impeller pipe;

a hub attached to the end of said impeller pipe; and

a plurality of stationary axially spaced annular vanes attached to said hub, said annular vanes terminating in free outer circumferential edges of which said free edges are of progressively increasing diameters at progressively increasing distances from the end of said hub, the innermost vane having a plurality of passages for passing undeflected a small amount of fuel to an area immediately adjacent the end of said impeller pipe.

4. An impeller for a fuel burner as set forth in claim 3 wherein the passages of said innermost vane are three equally spaced openings.

5. An impeller for a fuel burner as set forth in claim 4 wherein the three equally spaced openings of said innermost vane are circular in shape and have a diameter varying between a lower limit of 0.25 inch to an upper limit of 0.75 inch.

6. An impeller for a fuel burner as set forth in claim 5 wherein the three circular shaped openings in said innermost vane are spaced 120° apart.

7. In combination:

a fuel burner including a burner nozzle;

means for supplying pulverized coal and combustion air to said burner;

an impeller pipe concentrically mounted within said burner nozzle;

a flame sensing device including a detector tube disposed within said pipe and aimed at the burner end of said impeller pipe; and

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- an impeller attached to the burner end of said pipe, said impeller having a series of stationary axially spaced annular vanes of progressively decreasing diameters, the innermost vane having a plurality of openings for passing undeflected a small amount of fuel for combustion in said burner, said detector tube sensitive to the radiation emitted by the burning of said undeflected amount of coal.
8. The combination of claim 7 including means for passing air around said detector tube and out the burner end of said impeller pipe to form a combustible mixture with the undeflected amount of fuel from said innermost vane.
9. The combination of claim 7 including means for adjusting the position of said detector tube to vary its viewing area.
10. The combination of claim 7 wherein the openings of said innermost vane are rectangularly shaped and arranged in a circular pattern.
11. An impeller for a fuel burner, comprising:
an impeller pipe;

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- a hub attached to the end of said impeller pipe; three vanes of decreasingly smaller diameter each formed substantially as the frustum of a hollow cone having its vertex at the side remote from the end of said hub to which they are mounted, said innermost vane having three circumferentially arranged equally spaced circular passages for passing an amount of fuel undeflected to an area at the end of said impeller pipe; and
- three ribs radially mounted to said hub and equally spaced circumferentially for concentrically mounting said vanes to said hub.

References Cited by the Examiner

UNITED STATES PATENTS

2,380,463	7/1945	Poole	110—104
3,208,502	9/1965	Carlson	110—28 X
3,256,842	6/1966	Vigneron et al.	110—22

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