May 20, 1941. C. E. LUCKE 2,242,797

METHOD OF AND APPARATUS FOR BURNING FLUID FUEL

Filed Feb. 26, 1938

Fig. 2

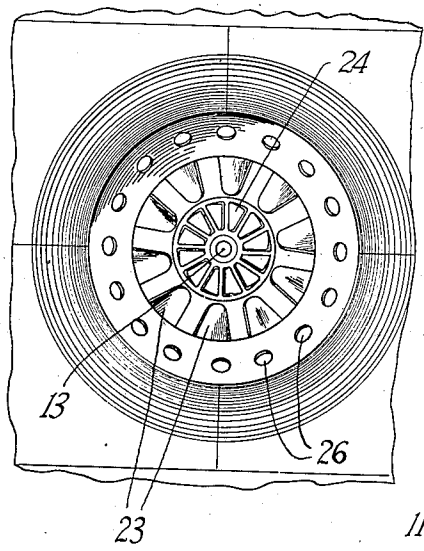


Fig. 1

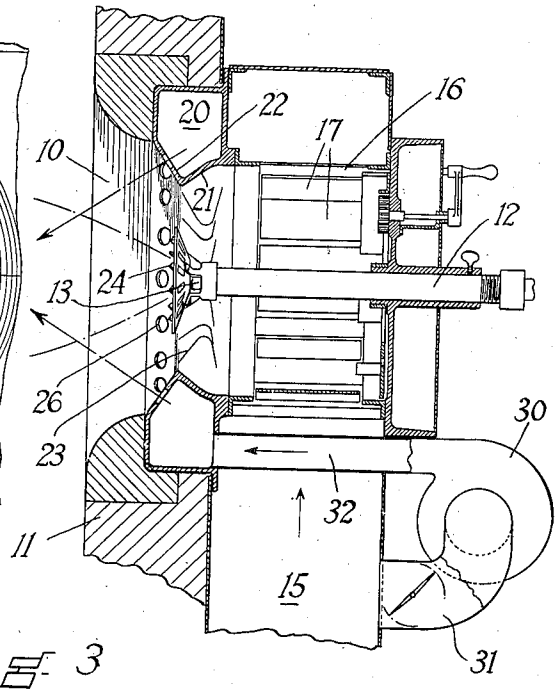
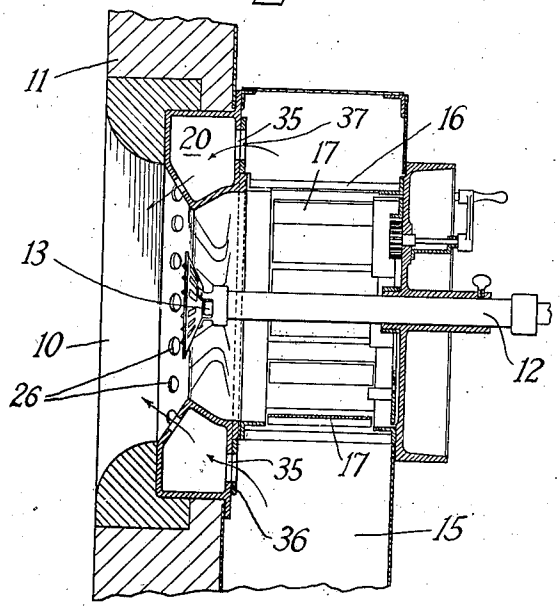


Fig. 3



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METHOD OF AND APPARATUS FOR BURNING FLUID FUEL

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12 Claims. (Cl. 158—1)

The present invention relates to the construction of fluid fuel burners, and more particularly, to fluid fuel burners arranged to discharge a stream of fluid fuel of substantial cross-sectional dimensions from a burner port and a stream of air for combustion around the periphery of the fuel stream.

In fluid fuel burners of the character described the rate of combustion largely depends upon the rapidity of mixing of the fuel and air streams. With concentric fuel and air streams, for example, the air scrubs the outer peripheral surface of the fuel stream causing the fuel particles in that portion of the fuel stream to be contacted by the air and burn on reaching ignition temperature. In burning, the air envelope tends to be replaced by an envelope of products of combustion and combustion of the particles progresses depending upon the rate at which the enveloping products of combustion are replaced by air. As either the air or the fuel stream or both together are introduced with a substantial axial velocity component, a substantial length of flame travel will necessarily be required in the furnace chamber before the fuel particles in the inner portion of the fuel stream are ignited and completely burned.

Modern furnace design is based upon the economic desirability of burning the maximum amount of fuel with the least possible amount of air in excess of the theoretical amount required for complete combustion of the fuel in the smallest furnace capable of withstanding the operating conditions without excessive maintenance.

The main object of my invention is to provide an improved method of and apparatus for burning fluid fuel in suspension which are characterized by the introduction of the combustion air in an amount approximating the theoretical air requirement for complete combustion of the fuel in such a manner that substantially all portions of the fuel stream receive air for combustion during the initial portion of the flame path to effect rapid combustion of the fuel and a consequent shortening of the length of flame travel and furnace chamber space required, or alternatively an increased fuel burning capacity for a furnace of given size.

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 drawing and descriptive matter.

Of the drawing:

Fig. 1 is a partly diagrammatic sectional elevation of a preferred form of fuel burner construction for carrying out the method of my invention;

Fig. 2 is a furnace end view of the apparatus shown in Fig. 1; and

Fig. 3 is a view similar to Fig. 1 illustrating a modified burner construction.

In accordance with my method of burning fluid fuel in suspension a stream of fluid fuel, such as sprayed oil, gas, or a mixture of pulverized fuel and primary air, is introduced through a fuel burner port of a furnace chamber in a stream of substantial perimeter of cross-section and preferably circular or annular. Combustion air approximating in amount the theoretical air requirements of the amount of fluid fuel to be burned is introduced through the burner port in two parts. The major portion of the combustion air is introduced in a stream surrounding the fuel stream. As the fuel and this air stream enter the furnace chamber with the air flowing in contact with the peripheral portions of the fuel stream a scrubbing of the fuel stream takes place at a rate depending upon the relative linear and angular velocities of the two streams. Mixing or diffusion of the fuel and air streams will occur, and on ignition combustion will proceed at a relatively rapid rate.

With the combustion air introduced as a stream around the periphery of the fuel stream, the fuel particles inside the periphery would ordinarily be the last to be scrubbed or mixed with the air stream. In accordance with my invention combustion of this portion of the fuel stream is expedited by the introduction of the remaining portion of the combustion air in a series of adequate velocity jets directed in converging paths across the peripheral air stream and impinging on the peripheral surface of the fuel stream. The effect of the impinging air jets on the fuel stream will depend primarily on their velocity relative to that of the peripheral air stream and fuel stream. It is preferred that air pressure conditions be maintained such that the jets will penetrate the air stream and the peripheral surface of the fuel stream and mix with the fuel particles in the interior thereof. I consider it less advantageous, although resulting in improved combustion conditions in comparison to fuel burners without such air jets, to maintain on the one hand higher air jet velocities causing the air jets to also penetrate

the opposite peripheral surface of the fuel stream or on the other hand lower velocities causing the air jets to distort but not to penetrate the peripheral surface of the fuel stream. Under all three conditions however, the air contact area of the fuel stream is increased and combustion conditions thereby improved.

With the air jets penetrating the fuel stream, combustion will proceed simultaneously on the peripheral and in the central portions of the fuel stream, whereby substantially all portions of the fuel stream will receive their air requirements for combustion in a relatively short time, causing combustion to progress at a rapid rate and substantially shortening the length of the flame path required in the furnace chamber or alternatively, more fuel can be burned in the same furnace chamber. The required volume of the furnace chamber for a given burning capacity will be thus reduced, with consequent advantages in the reduction of the cost and floor space requirements of the associated furnace.

In the drawing I have illustrated two forms of fluid fuel burning apparatus for carrying out the described method. In the construction shown in Figs. 1 and 2 an inwardly flaring burner port 10 of frusto-conical shape extends through a furnace chamber wall 11. A liquid fuel burner barrel 12 is arranged axially of the burner port 10 and provided with a spray nozzle 13 at its inner end for discharging a hollow substantially conical spray stream of liquid fuel through the burner port 10 into the furnace chamber. An air supply casing 15 extends along the furnace wall 11 for delivering combustion air to the burner port. An air register 16 of cylindrical shape is arranged coaxially with the fuel burner barrel 12 and provided with a series of curved pivoted doors or dampers 17 for controlling the passage of air from the air casing 15 to the burner port 10. The air register dampers are externally operable simultaneously to move them into and out of their closing position. The air register and damper construction described is well known in this art, and a more detailed description is unnecessary.

An annular air casing or manifold 20 of heat resistant material surrounds the burner port 10 at its outer side. The inner peripheral surface of the air chamber 20 is defined by an inwardly converging outer section 21 and an adjoining inwardly flaring inner section 22. The outer casing section 21 registers with the discharge end of the air register 16 so that air entering through the register openings will flow inwardly through the air casing 20 around the discharge end of the burner barrel 12. The burner barrel carries an impeller or deflector plate 24 on its inner end with the impeller blades arranged to direct part of the air inwardly toward the fuel stream and the remaining portion around the impeller. The outer section 21 of the air casing inner peripheral wall is provided with a series of inwardly extending blades or vanes 23 which are set at similar angles to the axis of the burner port so that a whirling motion will be given to the incoming air as it passes into the burner port.

In accordance with my invention the inner section 22 of the air casing inner peripheral wall is flared inwardly and provided with a circular series of symmetrically arranged orifices 26 having their discharge axes defining an inwardly tapering cone coaxial with the burner port, as diagrammatically illustrated in Fig. 1. The orifices 26 are arranged to discharge a symmetrical circular series of converging jets of sufficient velocity to cross the annular stream of air flowing through the burner port and penetrate into the interior of the hollow conical fuel stream discharged by the nozzle 13.

To secure a higher air pressure in the air casing 20 I have provided a booster fan or blower 30 having its inlet 31 connected to the air casing 15 at a point therein at the inlet side of the air register 16 and its outlet 32 connected to the air chamber 20. With the fan 30 in operation the pressure of the air in the chamber 20 can be readily maintained substantially higher than the air pressure within the air register 16. With this construction an adequate supply of combustion air can be introduced into the interior of the liquid fuel stream and combustion will take place therein simultaneously with the combustion along its peripheral surface.

In the modified construction illustrated in Fig. 3, the booster fan 30 and connecting parts are eliminated and the chamber 20 provided with a series of relatively large air inlet openings 35 in its outer wall and an annular shut-off damper 36 having openings 37 therein adapted to register with the openings 35. In operation the air register dampers 17 may be partly closed to create an air pressure within the air register substantially lower than the air pressure in the casing 15 and chamber 20. The operation is otherwise similar to that previously described.

It will be understood that the air chamber 20 alone may be supplied with forced draft air and the flow of the peripheral air stream caused by natural draft, and that in any case control of one or both of the two supplies of air will permit of regulation of the fraction of the total air that enters as jets through the orifices 26.

While in accordance with the provisions of the statutes I have illustrated and described herein various embodiments of my invention now known to me, those skilled in the art will understand that changes may be made 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.

I claim:

1. The method of burning fluid fuel in suspension in a furnace chamber which comprises introducing the fuel through a burner port into the furnace chamber in a stream of relatively large cross-sectional area, and introducing air for combustion partly in a stream of air through the burner port surrounding the fuel stream and partly in a series of jets at a higher velocity than and directed across the surrounding air stream and impinging on said fuel stream.

2. The method of burning fluid fuel in suspension in a furnace chamber which comprises introducing the fuel through a burner port into the furnace chamber in a stream of circular cross-section, and introducing air for combustion partly in an annular stream of air through the burner port around the fuel stream and partly in a series of converging jets at a higher velocity than and directed across the annular air stream and penetrating into the interior of said fuel stream.

3. The method of burning fluid fuel in suspension in a furnace chamber which comprises introducing the fuel through a burner port into the furnace chamber in a hollow stream of circular cross-section, and introducing air for combustion partly in an annular whirling stream of air through the burner port around the fuel stream and partly in a circular series of con-

verging jets at a higher velocity than and directed across the annular air stream into the interior of said fuel stream.

4. The method of burning fluid fuel in suspension in a furnace chamber which comprises introducing the fuel through a burner port into the furnace chamber in a hollow conical stream, and introducing air for combustion in an air-fuel ratio approximating the theoretical air requirements for complete combustion partly in an annular whirling stream of air under pressure through the burner port around the fuel stream and partly in a circular series of converging high velocity jets under a substantially higher pressure than and directed across the annular air stream into the interior of said fuel stream.

5. In combination with a furnace wall having a fuel burner port therein, a fluid fuel burner comprising nozzle means constructed to discharge a stream of fluid fuel of relatively large cross-sectional area through said burner port, means causing a stream of combustion air to flow through said burner port surrounding said fuel stream, and means for discharging a series of air jets at a higher velocity than and through said surrounding air stream and impinging on said fuel stream.

6. In combination with a furnace wall having a fuel burner port therein, a fluid fuel burner comprising nozzle means constructed to discharge fluid fuel in a stream of circular cross-section through said burner port, means for discharging a stream of combustion air through said burner port around said fuel stream, and means for discharging a plurality of air jets at a higher velocity than and through said annular air stream and impinging on said fuel stream.

7. In combination with a furnace wall having a fuel burner port therein, a fluid fuel burner comprising nozzle means constructed to discharge fluid fuel in a stream of circular cross-section through said burner port, means causing an annular stream of combustion air to flow through said burner port around said fuel stream, and means for discharging a series of converging air jets at a higher velocity than and through said annular air stream and penetrating into the interior of said fuel stream.

8. In combination with a furnace wall having a circular fuel burner port therein, a fluid fuel burner comprising nozzle means constructed to discharge a hollow conical stream of fluid fuel through said burner port, an air casing for discharging an annular whirling stream of combustion air through said burner port around said fuel stream, and means for discharging a symmetrically arranged circular series of converging air jets at a higher velocity than and across said annular air stream and into the interior of said conical fuel stream.

9. In combination with a furnace wall having a fuel burner port therein, a fluid fuel burner comprising nozzle means constructed to discharge a stream of fluid fuel of circular cross-section through said burner port, an air casing for discharging an annular stream of combustion air through said burner port around said fuel stream, and means for discharging a series of converging air jets at a higher velocity than and across said annular air stream and into the interior of said fuel stream, said last mentioned means including an annular air chamber surrounding said nozzle means and provided with a circular series of air discharge orifices directed towards said fuel stream.

10. In combination with a furnace wall having a fuel burner port therein, a fluid fuel burner comprising nozzle means constructed to discharge a stream of fluid fuel of circular cross-section through said burner port, an air casing for discharging an annular stream of combustion air through said burner port around said fuel stream, and means for discharging a series of converging air jets at a higher velocity than and across said annular air stream and into the interior of said fuel stream, said last mentioned means including an annular air chamber surrounding said nozzle means and provided with a circular series of air discharge orifices directed towards said fuel stream, and means for creating an air pressure in said chamber higher than in said air casing.

11. In combination with a furnace wall having a fuel burner port therein, a fluid fuel burner comprising nozzle means constructed to discharge a stream of fluid fuel of circular cross-section through said burner port, an air casing for discharging an annular stream of combustion air through said burner port around said fuel stream, and means for discharging a series of converging air jets at a higher velocity than and across said annular air stream and into the interior of said fuel stream, said last mentioned means including an annular air chamber surrounding said nozzle means and provided with a circular series of air discharge orifices directed towards said fuel stream, and fan means arranged to withdraw air from said casing and deliver said air at a higher pressure to said air chamber.

12. In combination with a furnace wall having a fuel burner port therein, a fluid fuel burner comprising nozzle means constructed to discharge a stream of fluid fuel of circular cross-section through said burner port, an air casing, an air register in said casing for discharging an annular stream of combustion air through said burner port around said fuel stream, and means for discharging a series of converging air jets at a higher velocity than and across said annular air stream and into the interior of said fuel stream, said last mentioned means including an annular air chamber surrounding said nozzle means and opening to said casing beyond said air register and provided with a circular series of air discharge orifices directed towards said fuel stream, and damper means for creating an air pressure within said air register lower than in said air chamber.

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