A gun type oil burner tip having a series of orifices or nozzles annularly arranged in pairs on the end of the gun in such manner that each nozzle pair projects an air stream, the respective nozzles in each pair being in close juxtaposition such that the projected air streams cross or intersect each other immediately forward of the nozzle such as to intertwine and define an expanding, rotating cone of gases comprised of discrete swirling streams having turbulent areas there between.

7 Claims, 3 Drawing Figures
OIL BURNER TURBULATOR END CONE, AND METHOD FOR GENERATING COUNTER-ROTATING AIR FLOW PATTERNS

This is a continuation-in-part application of my original application Ser. No. 93,347, filed on Nov. 27, 1970 now abandoned.

The present invention relates to an oil burner and particularly to the arrangement of the flame producing elements of the oil burner to improve the operation thereof, and to reduce the amount of smoke produced.

In particular, the invention relates to the type of oil burner conventionally used for home and commercial operations. In such burners a spray nozzle and ignition means are arranged in a blast tube which conducts a blast of air. The air blast or draft, as well as the source of power for the ignition device and the supply of fuel oil to the spray head, being created and supported by pumps, blowers and other means, form no part of this invention.

It further relates to a method for promoting a cleaner and more efficient combustion of an air-fuel mixture. The method includes the introduction of atomized fuel flow into the center of an oil burner. Simultaneously, a swirling cone formed of discrete air streams is introduced to surround the fuel flow. Said discrete streams are formed by a series of air nozzle pairs so arranged to form jets of air which intersect with a swirling mass.

In accordance with the present invention the blast tube of the burner is provided with an exit or end cap or cone having a central chamber which receives the burner spray head. Around the periphery of this chamber on the cap or cone which covers the blast tube are two annular rows of nozzles or exit tubes or openings, which function as orifices for the air blast or draft.

The exit tubes or orifices are set in two annular belts coaxially of the burner tube. Said tubes are spaced radially, or respectively so directed as to emit radially spaced jets of air. One annular belt comprises tubes or orifices which are aimed downstream at an acute angle to the tangent of the annular belt. Each of said orifices is set in approximately the same annular direction, and slightly downstream. Stated otherwise, said tubes are so directed that each jet of air from this annular belt of orifices is emitted tangentially or annularly in a common rotational direction and slightly downstream.

The other or second annular belt of orifices or tubes is aimed annularly at an angle which is also slightly downstream but, however, in the opposite rotational direction.

The orifices or tubes of each annular belt are radially indexed to cause the jet of air issuing from a tube of one annular belt to be directed obliquely across and adjacent to the path of air issuing from a tube of the other annular belt. Thus, each orifice tube of one annular belt is arranged to pair in juxtaposition with the adjacent or corresponding orifice of the other annular belt. The air issuing forth from these orifice pairs expands in a swirling stream. The resulting frictional interaction at the edges of the two swirling streams of air creates a high level of turbulence and shear. Each pair of orifices thereby sets up a rotational sheath or cone of air flow or air blast which rotates in the same direction as the adjacent orifice pair form. Thus, the marginal contact between adjacent pairs induces substantial additional turbulence.

Into this region of turbulence a fine spray from the burner nozzle or spray head is directed so that intermingling of the fuel with air in the turbulent area is highly efficient and complete. The result is that a high degree of combustion is achieved.

Referring now to the figures of the drawing, there is shown a specific example of a burner embodying the present invention.

In the drawings FIG. 1 illustrates a perspective detail of the extremity of the blast tube of a burner constructed in accordance with the present invention. A broken away portion of the combustion chamber is also shown.

FIG. 2 is an elevational view, taken diametrically from the left hand extremity of the burner as shown in FIG. 1.

FIG. 3 is a vertical sectional elevation taken centrally thru the burner.

It is noted that in the present embodiment, conventional details of the burner, such as the arrangement of the air pump or blower and its metering device, the oil pump, and the bulk of the electrical equipment and controls have been omitted for the reason that, per se, they are not a part of the present invention.

Suffice to say that the air blast is delivered via blast tube 10 which is associated in a known manner with the blowers, pumps, controls, etc.

The present invention has to do mainly with the extremity or tip 12 of the blast tube, sometimes referred to as an end cone.

As shown more clearly in FIGS. 2 and 3, cone 12 is provided with a central, axially extending cylindrical chamber 14 which accommodates the fuel spray head or nozzle 16. The latter, in turn, is supplied with fuel from pipe conduit 18. Bracket 20, supported on conduit 18, carries one or more insulators 22 which, in turn, carry electrode or electrodes 24.

Apart from the fact that aperture or apertures 26 are provided to accommodate insulators for the ends of electrodes 24, the interior of the nozzle chamber 14 is not otherwise in communication with the interior of tube 10 except by means of an annular row of small apertures 27. The latter pass constricted air streams which function to cool the fuel nozzle, and to blow the spark to a suitable position for good ignition characteristics.

Tubes 10, by virtue of a continuous supply of air under pressure from a fan or blower not shown, is maintained under substantial pressure by the cap or end wall 28 of the burner tip or end cone 12.

The air flow pattern which characterizes the present invention is created by nozzle or orifices 30 and 32. In the present embodiment, said orifices comprise short lengths of tubing welded to the end face 28 of the burner cone as shown.

A significant and essential feature of nozzles 30 and 32 is that they are arranged such that adjacent pairs function together. Thus, air streams, or jets, passing from each nozzle of a pair, intertwine to establish a swirling, expanding flow. Said flows rotate in the same direction as adjacent pairs thereby inducing substantial turbulence at the point of tangency.

To establish the desired turbulent area, at least two, and preferably a plurality of said nozzle pairs are provided. As shown, the present arrangement provides for four pairs of cooperating nozzles equi-spaced about tip 12. Tubes 30 are set in an annular pattern upon axes which face in the same annular direction but which
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make an acute angle in a downstream direction with a plane normal to the axis of the tube 10.
The second annular row of tubes 32, on the other hand, is identically arranged but in an opposite rotational direction.

The respective orifices or tubes of each annular belt are radially indexed to cause the jet of air issuing from a tube of one annular belt to be directed obliquely across, and closely adjacent to the jet of air issuing from a tube of the other annular belt. Thus, each jet of one annular belt is arranged to pair with the adjacent jet of the other annular belt. Air streams issuing from these jet pairs intertwine, expand, and swirl. The interaction of two adjacent streams of swirling air creates a high level of turbulence and shear along the contacting margins thereof.

In effect, the net result is dual air flows consisting of rotating, expanding streams of air. Preferably from the nature of this arrangement these rotational, annularly spaced streams or sheaves of air tend to expand and be conically disposed.

Therefore, at the interface or margins between the adjacent rotating cones, a zone 34 is established (as shown in FIG. 2) where a shearing action takes place between the oppositely moving streams. In this section, a high degree of turbulence is generated. It is into this area that spray nozzle 16 projects the highly atomized fuel oil.

Thus, as shown in FIG. 3, nozzle 16 projects, in the typical operation, a hollow, spray pattern of atomized fuel oil indicated by the reference numeral 36. As indicated, the spray pattern is typically conical in shape, emerging from the tip of the nozzle as at 38 and expanding outwardly therefrom. At the turbulent interface 34 the atomized spray particles enter the turbulent section. Due to the high degree of shearing action, the fuel particles are further reduced thereby to effect a more ideal mixture for combustion.

As a result of the excellent mixing characteristic of the stream, very clean combustion takes place. Actually, tests on this equipment have shown that zero smoke formation is readily maintainable at excess air figures as low as 15 percent.

By way of example, parallel tests were run using a standard or conventional, widely distributed type of home oil burner.

The zero smoke number of this conventional burner was determined at an excess air value of 45 percent. Then, the end member of the burner (referred to as the star), and the internal air turbulator (referred to as the lily), were removed and replaced by the end cone shown and described above. A high speed motor (3,450 rpm) replaced the standard (1,725 rpm) motor and therefore drove the standard blower to produce a higher than normal pressure in the burner plenum.

This modified, standard burner was then tested to determine its smoke number, starting with high excess air values. Since the smoke number was zero at all air values comparable with that of the original burner, the amount of excess air was lowered to 15 percent to produce the following comparative results.

<table>
<thead>
<tr>
<th>Excess Air</th>
<th>Smoke Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmodified, standard burner</td>
<td>45%</td>
</tr>
<tr>
<td>Modified burner</td>
<td>25%</td>
</tr>
</tbody>
</table>

It is apparent from the tabulation, that the present invention contributes measurably to the attainment of improved efficiency and clean combustion products without the need for great amounts of excess air.

The resultant pattern of gas flow from burner tip 12 thus takes a form which is illustrated more specifically in the figures of the drawing. For example, FIG. 1 shows, in segregated form, the action of the gas streams flowing from one pair of cooperating burner orifices or nozzles 30 and 32.

After issuing from the respective nozzles, the two streams obviously and typically expand to some extent. However, and surprisingly, being in close juxtaposition at the point where the crossing jets or streams of gas tend to contact or interact, they commence to spiral on one another as clearly shown in the figure. As a result, a spiral expanding cone of gas in which the shearing and turbulence reach a high degree of activity thus results.

While FIG. 1, for purposes of clarity, illustrates the cooperative action of only one pair of jet nozzles in creating a spiral, rotary, expanding cone of gas, it will be apparent that each pair of nozzles or orifices operates in the same manner. As a result therefore, the four respective pairs of nozzles continuously set up four, annularly spaced, cones of expanding, spirally intertwined gases, as clearly shown in an end view of FIG. 2.

In fact, such an action is apparent to the naked eye in the operation of this device.

FIG. 3 also illustrates by arrows, the areas of frictional interaction or turbulence which tend to be set up along the margin between the respective cones of gas. Not only does each cone operate in essentially the same rotational direction, that is to say in a counter clockwise direction as viewed in FIG. 2, but between each expanding cone of gas there are ultimately set up opposite interactions of shear between the two cones.

Further, in this connection, it is noted that due to the several rotational actions set up, the entire interior atmosphere of the furnace, namely the gaseous products issuing from the respective pairs of nozzles (and including gaseous products of combustion) all rotate likewise in a counter clockwise direction.

The result therefore is a novel operation, the basic characteristics of which are usually apparent to the naked eye and, as evident from the aforementioned example. Further, the resulting flame is blue in color, a characteristic of clean, efficient combustion as a result of the high degree of intermixing.

I claim:

1. In an oil burner comprising an elongated air blast tube having a central axis with opposed inlet and discharge ends, said tube being communicated with a source of pressurizing air, a fuel nozzle tip and ignition means in said tube to ignite an air-fuel mixture, the improvement in said oil burner which comprises;

a cap carried on the inlet end of said air blast tube, said cap being provided with orifice means comprising at least two pairs of closely spaced orifices, each orifice being communicated with a source of air, said at least two orifice pairs being spaced an-
nularly from each other about said blast tube central axis,
each orifice opening in the respective orifice pairs having a longitudinal axis directed to form an angle with a plane passing normal to said blast tube central axis, the longitudinal axes of said respective orifice openings being further biased toward each other,

whereby adjacent streams of air issuing from adjacent orifice pairs are swirled in a common rotational direction to interact and mutually form a rotatably expanding, conically shaped air stream along said air blast tube, and flowing toward the discharge end of the latter,

the respective swirling air streams from each orifice pair being spaced about said blast tube central axis to define therebetween an area of high turbulence and shear along the inner margin of the conically shaped air stream into which atomized fuel is introduced.

2. In an apparatus as defined in claim 1, wherein the respective orifices are substantially equivalent in opening to deliver substantially equivalent volumes of air.

3. In an apparatus as defined in claim 1, wherein each pair of orifices is arranged with respect to adjacent orifice pairs, whereby to form a swirling stream which rotates in the same direction as the adjacent swirling stream.

4. In an oil burner as defined in claim 1 wherein the respective air orifices axes pairs are directed in non-intersecting disposition.

5. In an oil burner as defined in claim 1 wherein said plurality of orifices are spaced annularly equidistant apart about said cap.

6. In an oil burner as defined in claim 1 wherein said plurality of air orifices are spaced radially equidistant from the center of said cap.

7. In an oil burner as defined in claim 1 wherein at least four orifice pairs are spaced annularly equidistant about said cap.

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