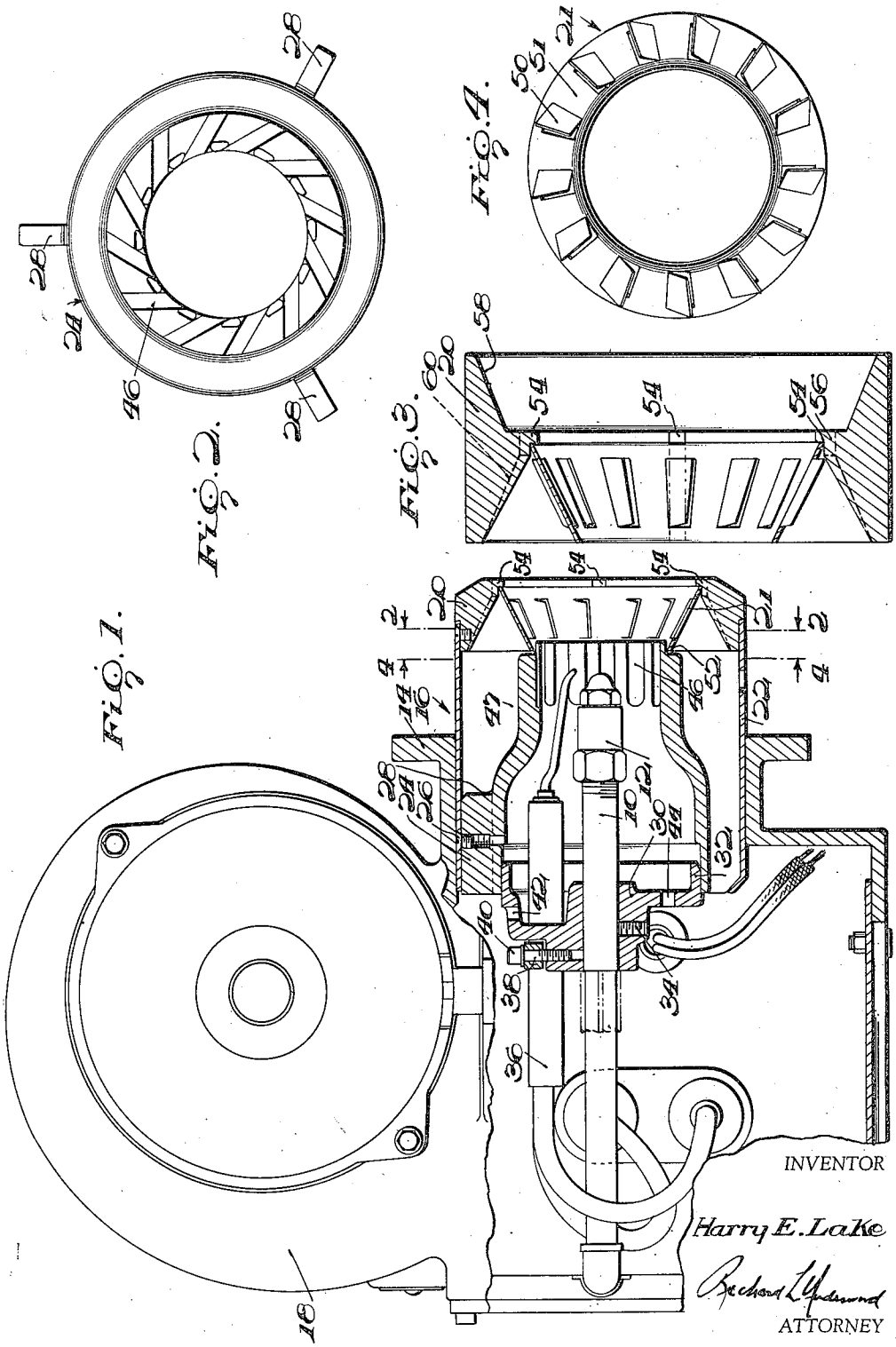
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HYDROCARBON BURNER HEAD

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HYDROCARBON BURNER HEAD

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This invention relates to burners for hydrocarbons and has particular reference to an improved method and apparatus whereby intimate and efficient mixing of the air necessary for combustion is obtained in conjunction with hydrocarbon fuel which is atomized under pressure.

In general the improvement consists of spraying the fuel in a fine mist and progressively subjecting it to separate bombardments of air in limited quantities, which not only produces good mixing of the air with the oil mist because of the turbulence, but also prevents impingement of the mist with the enclosing means because of rotating air columns around the spray.

An object of the invention is to increase the efficiency of combustion. This is to a large extent accomplished by supplying air for combustion progressively at predetermined stages of atomization and in regulated quantities determined by the stage of combustion.

While the invention is operable in conjunction with any type of hydrocarbon fuel, such as oil or gas, the description herein will be simplified by reference to the generally understood type of oil burner using mechanical atomization.

The secret of whether a burner will give satisfactory results lies not in the controls, motors, fuel units, transformers, etc., but rather in the method of mixing oil and air. The items of assembly mentioned are essential but do not in themselves determine how good an oil burner is.

My effort has been toward perfecting a combustion head that would eliminate the large amount of excess air required by most burners of this type.

Burners in the past have provided essentially a nozzle assembly partially atomizing the fuel oil by forcing it through a small orifice at a pressure of 100 pounds. This partially atomized oil had only a small portion of the air needed for combustion and was fed into the combustion chamber with air supplied by the fan. The result was a core of partially atomized oil in the center with a cylinder of air surrounding it pushed into the combustion chamber without any force to make the two mix. The result was that a large part of the air never mixed with the oil for combustion, but did pick up heat and was discharged out of the chimney without doing anything but create waste. Some of the oil found air so that it could be burned, but a large quantity was immediately turned to oil vapor when it hit the hot combustion chamber and went through the boiler in the form of vapor. This resulted in waste fuel, oil odors, and complaints from housewives of a smudge from oil burners.

When using my burner head, air is supplied in small jets at an angle to penetrate the core of the oil spray and with enough pressure to penetrate to the center. This is accomplished by ports or valves to meter or restrict the air supply and at the same time built up enough static pressure to force the air to intimately mix with and aid in completely atomizing the oil. This process has to be done quickly and thoroughly before entering the combustion chamber.

Many claims have been made that a whirler or gimmick will spin the air and the turbulence of this will give a good mixture. The fact is that the amount of air per minute is so small when fed through the large pipe used that the velocity is too low to do any useful mixing or turning.

This invention renders the combustion head an integral part of the oil burner with only a slightly larger air tube giving evidence. This is necessary, not only to properly house the head, but also so that it, along with the electrode assembly, can be easily removed through the rear of the burner assembly without disturbing any part of the installation.

Various meritorious features of the invention will become apparent from the following description taken in conjunction with the drawings, wherein like numerals refer to like parts throughout the several figures, and wherein:

Fig. 1 is a side elevation, partly in section, of a conventional burner embodying my improved head;

Fig. 2 is an elevation of one element of the assembly, the air distributor head taken on line 2—2 of Fig. 1;

Fig. 3 is a section through a combustion head ring of modified design and the combustion head cone adjacent thereto, and

Fig. 4 is an elevation of the combustion head cone taken on line 4—4 of Fig. 1.

Referring now to Fig. 1, wherein the elements of a conventional oil burner have been illustrated more or less diagrammatically, the numeral 10 designates an oil pressure feed line to the extremity of which is secured a mechanical atomizing nozzle 12. Positioned within the opening in furnace plate 14 is my improved burner head generally designated by the numeral 16. The head is supplied with air from a fan within casing 18.

The burner head 16 comprises a combustion head ring 20 secured in suitable fashion to the outer end of a tubular jacket 22 and an air distributor head 24 suitably secured within the other end of said jacket. In the form illustrated the air distributor head is secured within the jacket by means of screws 26 which extend through openings in the jacket and into lugs 28 which are circumferentially spaced and extend radially outwardly from the generally cylindrical air distributor head.

A combustion head plate 30 having a centrally disposed opening through which the fuel feed line 10 extends is provided with a flange 32 which extends into the rear opening of air distributor head 24. The nozzle is positioned by means of set screw 34. The combustion head plate is provided with centrally offset openings through which ignition electrodes 36 extend. The electrodes may be removably and adjustably held in place within the opening by a clamp bar 38 secured against an outer face of the electrodes by means of bolts 40, the element 38 being in the nature of a saddle and provided with an arcuate under surface overlying the surface of the electrode.

The assembly comprising the combustion head plate 30 together with the fuel line 10 and electrodes 36 integral therewith is accurately positioned by inserting flange 32 of the head plate into the rear open end of distributor head 24. To clean the nozzle the head plate 30 may be withdrawn by simply removing the back cover of the housing assembly, breaking the oil pipe union at the rear, and disconnecting the electrode and photocell wires. Since the assembly is integral, reinsertion of the flange 32 in distributor head 24 will automatically locate the nozzle properly.

There are three equalizing holes in the combustion head plate 30, one of which is shown at 42, for the purpose of preventing a vacuum ahead of the plate which would interfere with the free flow of air through the slots and into the atomized oil in the manner to be hereafter described; in other words, the space immediately surrounding the atomizing nozzle and extending rearwardly on the fuel

line side thereof is closed substantially to the passage of any air. One of the three holes is located in the vertical wall as indicated at **44** and functions as a porthole for a flame-responsive element such as a photocell which is placed in the rear of the hole in a cool and vapor-free position, but in direct line with the flame.

At the forward end of the air distributor head **24** are chordal slots **46** open at their forward end remote from the nozzle through which air under pressure passes from the surrounding annular passage **47** formed by jacket **22** and air distributor head **24**. In the arrangement illustrated these slots are located in substantial alignment with and include in their zone of discharge the point of nozzle discharge, as may be clearly seen from Fig. 1, and the air passing through them from the annular air passage **47** is directed in a rotary path which lies in a plane substantially normal to that of the direction of nozzle discharge. Thus it mixes with the oil spray immediately ahead of the nozzle tip and represents the initial mixing step.

Combustion head cone **21** contains tangential slots which permit additional air under pressure to pass therethrough, which air rotates in the same direction as that discharged through the slots in the air distributor head. These slots may be formed by portions **50** which are struck up from the wall of the cone and serve as vanes which direct the air discharged through the slots in the manner aforesaid. The air passing through these slots represents the second in the sequence of progressive mixing steps.

The cone **21** is preferably positioned by setting its smaller end in a circular shoulder **52** formed at the front end of the air distributor head and its larger end in shoulders **54** formed in circumferentially spaced lugs **56** which are located around the inner face of the combustion head ring **20**.

The outer end of combustion head ring **20** may be tapered as in the modified design of Fig. 3 on its under surface as indicated at **58** to form a limiting baffle for combustion. The adjacent inner face of the ring is tapered as at **60** and through the relatively narrow annular space between it and the outer face of cone **21** the remaining air from jacket **47** passes to complete the third and final stage of progressive mixing.

It will thus be seen that air is fed for combustion purposes in progressive stages. The first stage is a rotary discharge of air through slots **46** into a plane substantially normal to the direction of nozzle discharge and in advance of the point of discharge. A second and entirely separate stage is afforded by the passage of air through the slots in cone **21**, the air discharge through these cones being similar to the discharge through slots **46**, i. e., in a rotary path located in a plane sbstantially normal to the axis of nozzle discharge and adjacent to but more remote from the point of such discharge. The third stage constitutes the air passing between the cone **21** and the combustion head ring **20**, which issues substantially parallel to the axis of nozzle discharge in the form of a hollow cylindrical wall from and through an annular orifice adjacent to the second rotary discharge point and located outwardly therefrom.

Only a limited amount of air, approximately 20% of that needed for combustion, is discharged through the chordal slots **46** adjacent the point of nozzle discharge. This limited air mixing produces a rich mixture of the fuel which is easy to ignite and is not chilled by such a relatively small amount of cool oxidizing agent.

After this rich mixture is ignited, it is fed additional swirling air to support the progressing combustion and to prevent impingement upon the enclosing means. The initial discharge through slots **46** of course also prevents impingement on the enclosing means. By the time the burning mixture leaves this second chamber, which is fed by the discharge through slots in cone **21**, the particles of fuel atomized from the nozzle are intimately mixed with the oxidizing agent and by the heat of combustion have become gas particles ready for complete combustion. This is accomplished by admitting the balance of the oxidizing agent required for the purpose in close proximity to the burning envelope, i. e., through the annular passage between the outer margin of cone **21** and the inner margin of combustion head ring **20**.

It should be noted that the annular opening or orifiice through which passes the air discharge constituting the final stage of progressive mixing is a comparative slit. It permits only a relatively small volume of air to pass at any given pressure, and creates a substantial blockage of air passing into passage **47**. Thus a substantially static head of pressure is built up in annular passage **47**, which head feeds the air through the slots in head **24** and cone **21**. In effect the first two stages of progressive air feed, through the slots in the head and the cone, are discharged from a substantially static pressure head and are devoid of appreciable force components except those directed towards the axis of nozzle discharge.

The effect of this progressive mixing can best be illustrated by the fact that in a domestic gun type burner using a pressure atomizing nozzle with about 100 lbs. per square inch oil pressure, where the oil has a solid discharge spray of around 70° included angle, this spray angle is entirely destroyed by the time the spray reaches the point of complete mixing of the oil with the required amount of air for complete combustion. The flame, instead of being in the nature of a blowtorch with a conical flame, is in the form of a hollow rosette conforming to the surrounding combustion chamber and without flame in the middle. By using a narrower fuel spray, the typical conical flame can be obtained with high combustion efficiency.

The nature of the mixing of fuel oil and oxidizing agent is illustrated by the fact that when using grade 2 fuel oil in conjunction with this burner head, which oil has a theoretical CO_2 of about 15%, a CO_2 of better than 13% can be obtained from samples of the combustion gases. The mixing of air and oil accomplished in the first two progressive steps is so complete that the air does not have to be rotated when passing through the third or last port of discharge.

Usually in a burner of this type a motor-driven fan is used for supplying air under pressure. This same motor usually drives the fuel pump that supplies the oil under pressure. However, in a combustion chamber which is maintained under a pressure below atmospheric, air would flow through the progressive slots without the need for a fan or blower. This is true when an induced draft fan is used to exhaust the products of combustion from the combustion chamber.

For various amounts of fuel burned in this type of equipment the dimensions of the parts will change even though the principle is identical. This is also true of the standard domestic gun type burner as well as other types such as the rotating cup. Within a certain range the same dimensions can be maintained and the required results of efficient control obtained by controlling the pressure differential between the inlet and outlet sides of the progressive air slots. This may be done by a shutter on the inlet or discharge side of the fan supplying the pressure or by the operation of a damper applied to the induced draft, which are conventional structures in oil burners regardless of the head used. A five-inch burner such as that illustrated will operate between one and two gallons per hour simply by using an air adjustable inlet damper on the fan supplying the air under pressure, and the same high combustion efficiency can be obtained under these varying conditions.

This description of operation in conjunction with atomized liquid fuels is also applicable when gaseous fuel is used. The described mixing of air or oxidizing agent has been found the most advantageous means yet developed for obtaining complete mixing of fuel with air where the air moves at low velocity because of the low pressure applied to it. The fuel, being projected at high velocity and to a relatively large combustion space, quickly loses that velocity by expansion. For that rea-

son the later stages of progressive mixing are at substantially the same velocity of fuel and oxidizing agent.

It should be borne in mind that an important phase of this invention resides in projecting a liquid or gaseous fuel under pressure from a nozzle within a housing and progressively mixing the oxidizing agent with the fuel as the fuel expands under the pressure drop as it is discharged through an increasing area, the mixture being discharged into a low pressure combustion area of sufficient size to allow for expansion due to combustion, without permitting the fuel spray to impinge on the enclosure. It should also be noted that this progressive mixing of the oxidizing agent with liquid or gaseous fuel projected under pressure may be utilized to produce a short wall flame in the form of a hollow rosette.

My improved burner head is capable of delivering higher combustion efficiency than could be obtained heretofore with pressure type burners. It operates with controlled progressive combustion. Initial combustion takes place where only 20% of the air required for complete combustion is available. This produces sufficient heat to preheat the required additional 80% of the air which is introduced to the partial combustion at the entrance to the combustion chamber. The secondary air (or 80%) completes combustion to the extent that the percentage of CO_2 in the combustion gases approximates the theoretical maximum. The heat will result in burning to complete combustion the costly light oils.

While I have described one preferred embodiment of the invention, it should be borne in mind that the inventive concept may be embodied in different structures and for that reason I wish to limit myself only within the scope of the appended claims.

What I claim is:

1. A method of burning hydrocarbon fuel discharged under pressure from an atomizing nozzle into a chamber substantially closed at its rear end portion which comprises the steps of bombarding the atomized fuel with first streams of air rotating upon initial introduction in a plane normal to the axis of atomization at locations closely adjacent to and forwardly of the point of atomization, said first streams having no forward force components upon introduction, bombarding the resultant atomized fuel and air with second streams of air rotating upon initial introduction in a plane substantially normal to the axis of atomization at locations forwardly of the first streams' locations, and subsequently supplying the balance of air for combustion in the form of a generally cylindrical envelope surrounding the mixture of air and fuel so obtained and directed substantially parallel to the axis of atomization.

2. Apparatus for burning hydrocarbon fuel discharged under pressure from an atomizing nozzle along an axis comprising a burner head having an inner and outer wall extending along said axis and a rear wall substantially closing the rear end of said inner wall, said inner wall defining a first chamber and enclosing and extending forwardly of said nozzle, said outer wall and inner wall defining a second chamber, means for supplying air to said second chamber, means for introducing streams of air from said second chamber into said first chamber adjacent to and forwardly of said nozzle, said means for introducing streams of air including guide means for directing said streams upon introduction in rotary paths in planes normal to said axis of atomization thereby to obtain an intimate mixture of fuel and air in a zone devoid of air forward force components, means for peripherally introducing a second group of streams of air moving in rotary paths substantially normal to the axis of atomization from said second chamber into said first chamber forwardly of the first streams' locations, and means for supplying the balance of air for combustion in the form of a substantially continuous annular curtain-like stream extending along said axis.

3. A burner head comprising a housing having a rear wall, an inner wall extending forwardly from said rear wall and defining a mixing chamber, said rear wall having an opening for receiving a fuel nozzle means which extends forwardly into and substantially axially through said mixing chamber, the nozzle of said fuel nozzle means being adapted for location at a predetermined fuel introduction position rearwardly of the forward end of said inner wall, an outer wall surrounding said inner wall and defining an annular air chamber, said inner wall having a series of air conduits located along an annulus transversely of the axis of said mixing chamber at said fuel introduction position, said conduits being chordal to a circle transversely of said axis and consisting of wall surfaces which extend transversely of said axis of said mixing chamber for supplying rotating streams of air from said air chamber to said mixing chamber without forward force components to facilitate deep penetration of the fuel, said inner wall having at its forward end an outwardly flared cone portion extending to and contacting the forward end of said outer wall, said cone portion having air slots for directing rotating streams of air forwardly along and transversely of the axis of said mixing chamber, said housing having a transversely substantially continuous annular opening at its forward end and located transversely outwardly of said air conduits and air slots for forwardly directing a non-rotating substantially continuous annular curtain-like stream of air into the resultant air-fuel mixture.

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