

April 19, 1960

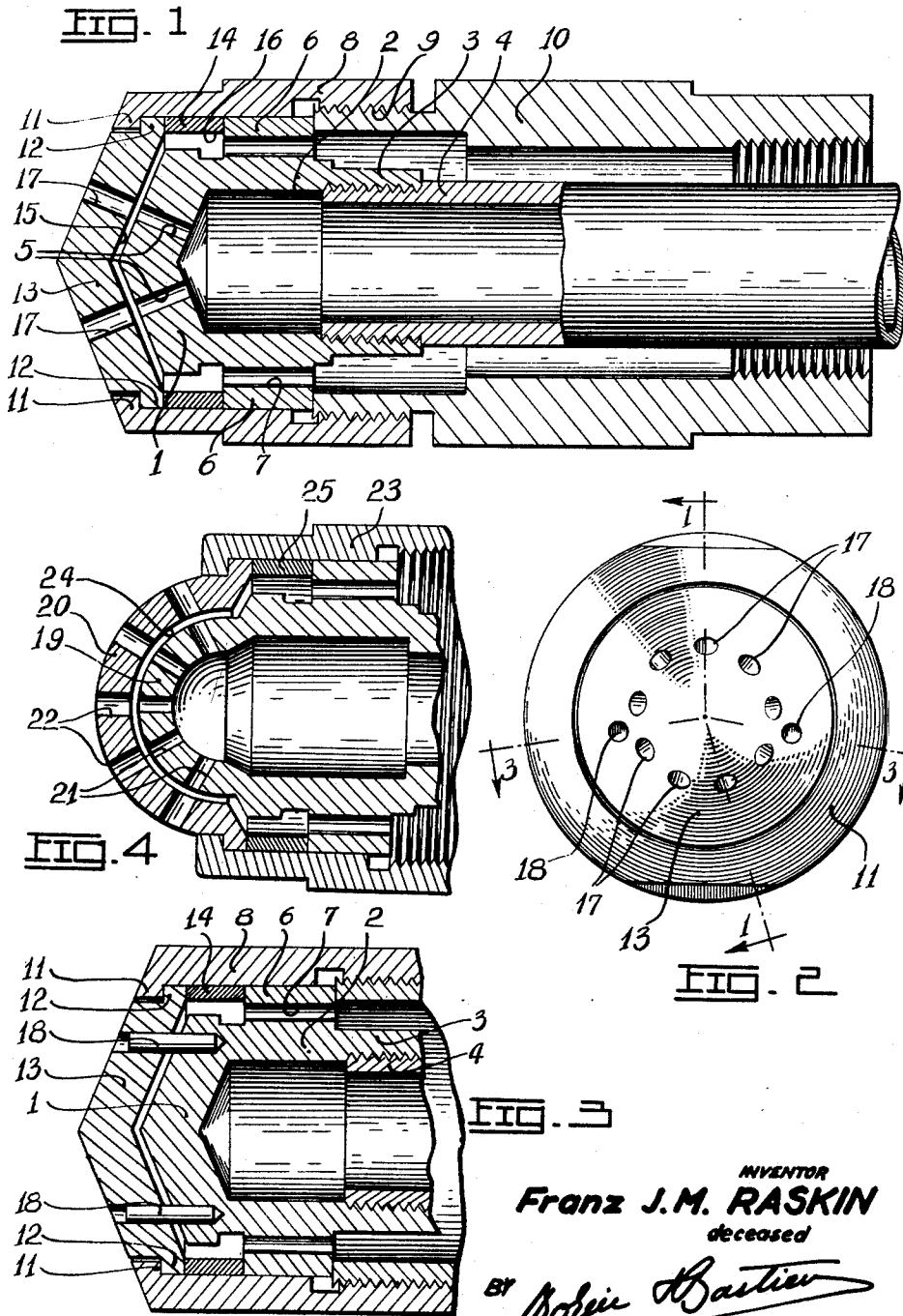
F. J. M. RASKIN

2,933,259

NOZZLE HEAD

Filed March 3, 1958

3 Sheets-Sheet 1



INVENTOR
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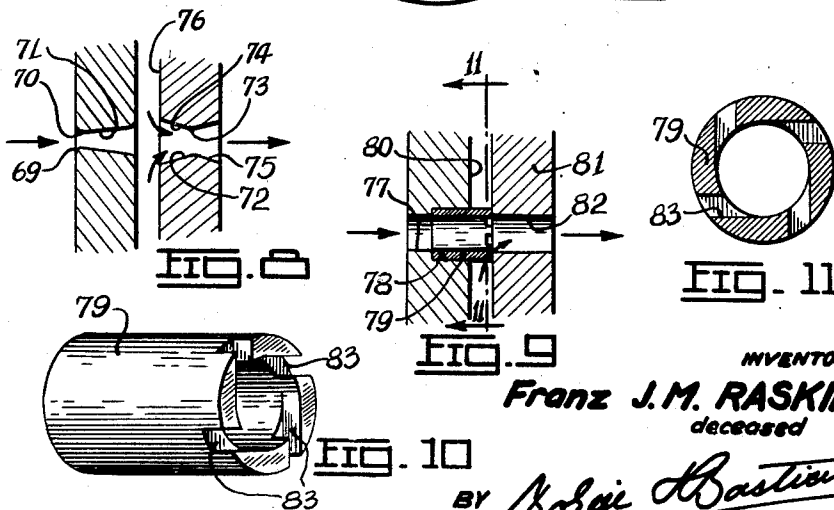
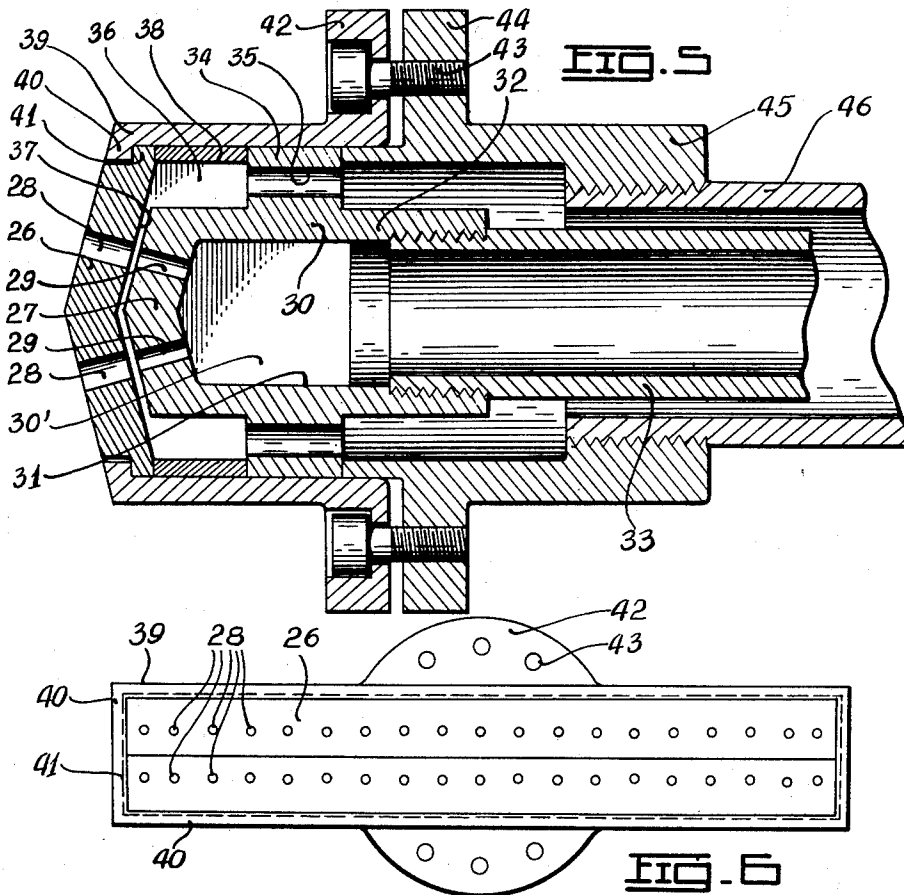
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NOZZLE HEAD

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3 Sheets-Sheet 2



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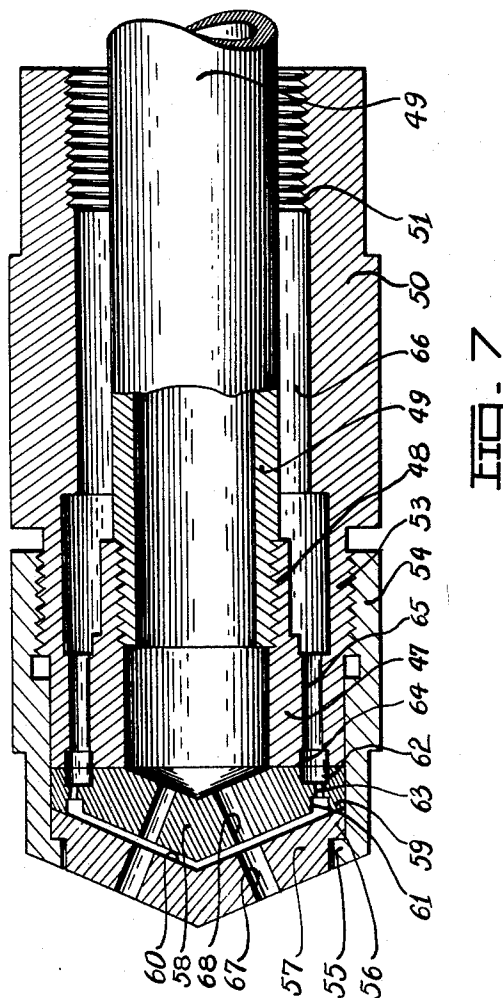
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NOZZLE HEAD

Filed March 3, 1958

3 Sheets-Sheet 3



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2,933,259

NOZZLE HEAD

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5 Claims. (Cl. 239—405)

The present invention relates to a nozzle head for discharging under pressure a mixture of two or more gases, or a spray of liquid or pulverized solid.

The nozzle head in accordance with the present invention is more particularly applicable for use in burner equipment for atomizing a liquid fuel or for mixing a gaseous fuel with air or other combustible.

The nozzle head of the present invention can also be used to produce a spray of any liquid such as a fine water spray, or a spray of fine solid material such as pulverized coal.

In some conventional oil spray burners, the oil is mixed with steam or air to form an atomized mixture which is discharged as a single jet of relatively large capacity. However, this mixture is very often nonhomogeneous in both the size variation of the liquid particles of the atomized liquid and also the distribution of said liquid particles in the carrier gas.

To obviate this disadvantage, it has been suggested to replace the single discharge opening of the spray plate by a plurality of smaller sized discharge openings and to associate each discharge opening with individual steam or air and oil supply tubes so that a plurality of atomized oil jets combine to form the spray issuing from the nozzle. A more homogeneous mixture results from such a nozzle and also the modulating capacity of the nozzle is increased; however, in such nozzles, the individual oil feeding tubes communicate with one side only of the air or steam feeding tubes so that the spray issuing from each discharge opening is nonhomogeneous. Also, such nozzles are very difficult to manufacture because of the necessity of correctly aligning small bores arranged in pairs and which communicate at an angle to each other.

The design of an oil atomizer for an oil burner should be such that with one basic design, variations in the size and proportions of the parts of the oil atomizer will give control over the following characteristics:

(a) The quality of atomization, in other words, atomization from coarse to extremely fine;

(b) The shape of the oil spray, such as a rectangular flat spray of any size, a flat spray of fan tail shape, a conical spray of any included angle and solid or hollow; and

(c) The capacity which may be required from a single atomizer.

Characteristics (b) and (c) apply also to a mixer for mixing gaseous fuel with air; furthermore, such a mixer should be so designed that the enclosed volume of the air gas mixture should be as small as possible in order to prevent flashback of an explosive nature such as sometimes occur in large capacity gas burners.

Accordingly, an important object of the present invention is the provision of an atomizing head for liquid which is so constructed as to obtain a much improved homogeneity of the particle size and distribution of the atomized liquid.

Another important object of the present invention is the provision of a nozzle head of the character described in

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which the atomized or mixed jet issuing from the head is composed of a plurality of individual atomized or mixed small jets of substantially uniform concentration and homogeneity.

5 Still another important object of the present invention is the provision of an atomizer of the character described which can be proportioned to obtain the desired degree of atomization.

Yet another important object of the present invention 10 is the provision of an atomizer and/or mixer head of the character described in which the individual jet openings may be so disposed as to provide any desired shape for the overall jet or spray.

Yet another important object of the present invention 15 is the provision of a nozzle head of the character described in which the capacity can be varied at will by varying the number of individual jets and, within certain limits, the size of said individual jets.

Yet another important object of the present invention 20 is the provision of a mixer of the character described which is so arranged that, when used as a gas burner, the gas fuel is mixed with the air only in small volume chambers whereby the danger of explosive flashbacks is eliminated.

Another object of the present invention is the provision 25 of a nozzle head of the character described which is very simple and easy to manufacture and in which the individual bores may be formed with the optimum size and shape for utmost atomization and/or mixing efficiency.

Yet another important object of the present invention 30 is the provision of a device of the character described which may be used to atomize liquids other than fuel, such as, for atomizing water to produce a water spray.

The foregoing and other important objects of the 35 present invention will become more apparent during the following disclosure and by referring to the drawings in which:

Figure 1 is a longitudinal section of a first embodiment 40 of the nozzle head in accordance with the present invention, said section being taken along line 1—1 of Figure 2.

Figure 2 is a front view of the embodiment of Figure 1;

Figure 3 is a partial longitudinal section of the first embodiment taken along line 3—3 of Figure 2;

Figure 4 is a partial longitudinal section of a second 45 embodiment;

Figure 5 is a partial longitudinal section of a third embodiment;

Figure 6 is a front view of the embodiment of Figure 5;

Figure 7 is a longitudinal section of still another embodiment of a nozzle head in accordance with the present 50 invention;

Figure 8 is an enlarged cross-section of a modified shape of an individual nozzle;

Figure 9 is an enlarged longitudinal section of still another modified form of an individual nozzle;

Figure 10 is a perspective view of the sleeve-like insert 55 used in Figure 9; and

Figure 11 is an enlarged cross-section taken on line 11—11 of Figure 9.

Referring now more particularly to the drawings in 60 which like reference characters indicate like elements throughout, the nozzle head, in accordance with the present invention, essentially consists of an inner and an outer plate-like element maintained in spaced relationship so as to provide a gap therebetween of substantially uniform width, said two elements being provided with a plurality of through bores arranged in axially aligned pairs, that is, the bores of one element register with an associated bore of the other element; said elements being 65 associated with means to admit a first fluid substance under pressure to the inlets of the through bores of the inner element and a second fluid substance under pressure

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to the gap between the two elements whereby the first substance under pressure is discharged through the aligned bores of the two elements as individual high speed jets and the second substance supplied to the gap is fed to the bores of the outer element from points distributed over the entire periphery of the jets to be completely mixed with or atomized by said jets.

Referring to the embodiment of Figures 1, 2 and 3, the inner element consists of a frusto-conical member 1 having an integral skirt 2 which is inwardly threaded at its inlet end portion 3 to be secured to an inner pipe 4 adapted to supply a first substance under pressure, such as air, steam or gas. The frusto-conical member 1 is provided with a plurality of cylindrical through bores 5 which are circularly arranged about the axis of the skirt 2 and which are disposed at right-angles to the frusto-conical member 1.

The skirt 2 is further provided with a radially outwardly projecting peripheral flange 6 which is perforated with a plurality of through bores 7. A cylindrical sleeve 8 is slidably fitted over the outer cylindrical surface of the flange 6 and is provided at its rear end portion with inner threads 9 to threadedly engage a nipple 10 adapted to be connected to an outer pipe (not shown) for supplying a second substance under pressure, such as a liquid or gas fuel.

The forward end of the sleeve 8 forms an inwardly directed lip 11 engageable with a shoulder 12 made at the periphery of the outer element or face plate of the nozzle head which consists of a second frusto-conical member 13. The latter has the same included angle as the first frusto-conical member 1. The two members 1 and 13 are maintained at a predetermined distance apart by means of a spacer sleeve 14 engageable between the flange 6 of the skirt 2 and the peripheral portion of the inner face of the member 13. Thus a gap 15 of substantially uniform width is formed between the two frusto-conical members 1 and 13. This gap is in communication at the periphery of the two frusto-conical members with a pressure equalizing chamber 16 surrounding the skirt 2, and said chamber 16 is in turn in communication with the nipple 10 through the axial bores 7 made in the flange 6.

The second frusto-conical member 13 is provided with a plurality of cylindrical through bores 17 respectively axially aligned with the through bores 5 of the inner frusto-conical member 1 and of a diameter slightly greater than said through bores 5.

As shown in Figure 3, the inner and outer frusto-conical members 1 and 13 are maintained by means of dowel pins 18, in a fixed angular relationship and against rotation with respect to each other, so that the through bores 5 and 17 are always maintained in exact axial alignment.

When the nozzle head, in accordance with the first embodiment, is used to atomize a liquid fuel, steam air or any other suitable gas such as natural gas at the conventional pressure is supplied by the inner pipe 4, while the fuel oil is supplied by the outer pipe connected to nipple 10. The steam or gas under pressure passes at high velocity through the aligned bores 5 and 17, while the liquid fuel normally under pressure although said pressure may be very small or nonexistent for small capacity atomizers completely fills the gap 15 and is drawn by and mixes with the steam or air jet from around the entire periphery of said jet for each individual pair of through bores 5 and 17. The liquid fuel pressure for each individual jet is equal and the air or steam pressure for each jet is also equal, so that the several jets all have uniform compositions and uniform distribution of the fuel therein.

It has been found that because the liquid fuel is supplied from an annular feed ring, a much more uniform size of the atomized liquid droplets is obtained than in a mixing tube wherein the liquid would be supplied from one side only. The through bore 17 has a slightly larger diameter than the through bore 5 to prevent the production of a counter pressure in the gap 15 to produce a Venturi effect creating suction of the fuel from within

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said gap 15. The through bores 5 and 17 are very easily machined: they can be made in exact alignment and, furthermore, they can be finished to the exact required diameter because the two members 1 and 13 are detachable. Also, the skirt 2 may be made of such a length as to clear a tool inserted through the inlet end of the through bores 5.

With the embodiment 1 of Figures 1, 2 and 3, there results a hollow substantially conically shaped flame having a rather restricted included angle. However, it is possible to vary the shape of the flame due to the simple design in accordance with the present invention.

Referring to Figure 4, the inner element 19 is in the form of a semi-spherical member which is concentric with a semi-spherical member 20 which constitutes the outer element. The members 19 and 20 are provided with a plurality of through bores 21 and 22 which are axially aligned in pairs, the through bores 22 of the outer member 20 having a slightly greater diameter than the through bores 21 of the inner member 19. The outer member 20 is detachable and is retained by the sleeve 23 to which is threadedly connected the nipple 10 of Figure 1.

The inner member 19 is connected to a steam or air supply pipe (not shown).

The gap 24 between the two semi-spherical members 19 and 20 is of substantially uniform width throughout and is in communication with the nipple 10 connected to the liquid-fuel pipe. The outer member 20 is maintained in fixed relation with respect to the inner member 19 by means of the spacer sleeve 25. This embodiment will form a solid conical fire having a wider included angle than the embodiment of Figure 1.

The embodiment of Figures 5 and 6 is designed to produce a rectangular flat spray which may have any width and/or thickness. In this embodiment the outer element 26 and the inner element 27 are each in the form of a rectangular plate of V shaped cross-section having equal included angles. The two elements 26 and 27 are provided with two rows of aligned through bores 28 and 29 respectively. The inner element 27 has flat side walls 30 and flat end walls 30', which form an elongated rectangular chamber 31 provided at the middle thereof with a circular nipple 32 in threaded engagement with a steam or air supply pipe 33. The walls 30 and 30' are provided with an outwardly projecting rib 34 having a plurality of spaced axial through bores 35 for the passage of the fuel into the pressure-equalizing anti-chamber 36 which communicates with the gap 37 between the inner and outer elements 27 and 26. The anti-chamber 36 extends around the entire periphery of the inner element 27. A spacer member 38 of rectangular shape abuts against the rib 34 and serves to space the outer element 26 so as to maintain the required width for the gap 37. The outer element 26 is removably retained in position by means of the retaining member 39 having the form of a rectangular box without bottom and top and having an inward lip 40 at its forward end engageable with a shoulder 41 extending around the entire periphery of the outer element 26. The retaining member 39 is provided at the centre thereof with opposite top and bottom segmental flanges 42 adapted to be removably secured by means of bolts 43 to the flange 44 of a flanged collar 45 which is threadedly connected to a liquid supply outer pipe 46.

In the embodiment illustrated, there are two rows of individual jets, but obviously more rows could be provided or only one single row. Also, it is obvious that the length and/or width of the nozzle can be increased or decreased.

It has been found that very wide nozzles can be manufactured in accordance with the present invention, and still the fuel and the air or steam will be supplied to the individual nozzles at a substantially uniform pressure, thereby obtaining individual jets of combustible mixture of uniform composition and of uniform atomization.

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Thus a long single row of holes 28 may be provided to produce a thin, rectangular, even spray of any width required, which is highly desirable for some installations such as an open hearth furnace, or by providing more rows of holes, it is possible to have a thick rectangular spray. Obviously, the capacity of the entire spray can be varied by varying the number of component jets.

Figure 7 shows still another embodiment of the nozzle head, in accordance with the present invention, in which both the inner and outer elements are detachable for ease of machining the through bores thereof.

As shown in Figure 7, a sleeve 47 is threadedly connected at its inlet end 48 to an inner pipe 49 for the supply of a first substance, such as steam or air under pressure. The sleeve 47 is part of and forms an inner annular projection at the forward end of an elongated nipple 50 which spacedly surrounds the inner pipe 49 and is in threaded engagement at its inlet end 51 with an outer pipe for the supply under pressure of the second substance such as liquid fuel.

The nipple 50 has at its forward end an externally threaded portion of reduced outside diameter, as shown at 53, which is in threaded engagement with a sleeve-like retaining member 54 provided at its forward end with an inwardly directed lip 55 engageable with a shoulder 56 of the outer element 57 of the nozzle head.

The inner element 58 of the nozzle head is detachable and is sandwiched between the outer element 57 and the sleeve 47. Thus, the two elements 57 and 58 are maintained in secured position by means of the retaining member.

The inner element 58 is provided at the periphery of its outer face with an outwardly projecting rib 59 engageable with the peripheral portion of the inner face of the outer element 57 so as to maintain between elements 57 and 58, a cap 60 of required width. Radially inwardly of the rib 59, there is provided a peripheral groove 61 serving as means for distributing the oil within the gap 60; the groove 61 is continuous around the periphery of the element 58 and is in communication with a groove 62 at the inner face of the element 58 by means of a plurality of passages or holes 63.

The groove 62 is opposite a groove 64 made in the front face of the sleeve 47. The grooves 62 and 64 form a pressure equalizing chamber around the element 58 for the oil supplied thereto by means of axial passages 65 made in the sleeve 47 and communicating with the annular chamber 66 defined between the inner tube 49 and the nipple 50.

The outer and inner elements 57 and 58 are provided with pairs of axially aligned through bores 67 and 68 respectively, both having a cylindrical shape, and the outer bores 67 having a slightly greater diameter than the inner bores 68.

When the nozzle arrangement, in accordance with the present invention, is used as a gas burner, the combustion air may be supplied through the central pipe and the gas through the outer pipe or vice versa. The individual jets will thoroughly mix the two different gases for combustion to any desired proportions, so as to produce the exact type and shape of flame required. Because the combustible mixture is formed in individual, small capacity mixing tubes, which are bores of the outer element, there is at no time any large volume of combustible mixture which, in conventional gas burners, often causes accidents when a flashback occurs. Also, it has been found that the individual jet arrangements, in accordance with the present invention, produce very efficient mixing of the combustible gas and combusive air.

It is possible due to the simple design of the outer element in all the embodiments, and both the outer and inner elements in the embodiment of Figure 7, to make said elements of refractory material, thereby making it possible to have a very hot and very short flame without damaging the burner.

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In all the embodiments described hereinabove, the component jets have been shown as cylindrical bores, the bores of the inner element acting as jet tubes, and the bores of the outer element acting as mixing tubes. However, it will be noted that, due to the simple detachable construction of the inner and outer elements, the design lends itself to the economical machining of accepted forms of expanding nozzles for the most efficient type of jets, as well as shaping the mixing tubes to obtain the most efficient induction of the fuel and the desired discharge characteristic of the mixture.

The embodiment of Figure 8 shows one preferred form of an individual component jet in which the air or steam under pressure enters the jet tube 69 which has a restricted throat 70 and an expanding portion 71, while the mixing tube 72 has a throat 73 and two flaring portions 74 and 75, the flaring portion 74 having a maximum diameter greater than the maximum diameter of the jet tube 69. Thus, the liquid fuel is induced from the gap 76, as shown by the arrows, and the throat 73 produces a very thorough and uniform mixing and atomizing of the liquid fuel in the air or steam jet issuing from the jet tube 69.

Instead of inducing the liquid fuel or the gas through a Venturi effect it is also possible, in accordance with the present invention and referring to Figures 9 to 11 inclusive, to feed the fuel as jets with kinetic energy. This is achieved by inserting in the jet tube or through bore 77 of cylindrical shape and provided with an enlarged portion 78 at its outlet portion, a cylindrical insert 79 extending across the gap 80 and abutting against the inner face of the outer element 81 and having an inside diameter slightly less than the diameter of the mixing tube 82.

The insert 79 is provided with a plurality of square notches 83 directed tangentially to the cylindrical inner surface of said insert 79; thus the liquid fuel enters the aligned through bores or tubes tangentially and at high velocity so as to effect a whirling action on the fuel. The combination of the kinetic energy of fuel and the kinetic energy of the atomizing gaseous substance, plus the whirling action of the fuel, results in a very thorough mixing and atomizing of the fuel in the gaseous substance.

The notches 83 may be semi-circular or square in cross-section so as to have in practice, as far as possible, a profile of which the ratio of the circumference to the surface is a minimum to provide for minimum clogging of the opening by liquid fuel as it has been found that liquid fuel normally tends to deposit sediments on the edge of an orifice.

From the foregoing, it will be clear that the atomizer and/or mixer nozzle, in accordance with the present invention, clearly fulfills the requirements noted above: its basic design can be adapted for varying the quality of atomization, varying the shape of the atomized oil spray and varying the capacity of the oil spray.

As to the shape of the spray, several embodiments of nozzles, in accordance with the present invention have already been described.

The capacity of the spray may be varied by varying the number of component jets.

The quality of atomization may be varied by changing any one or any combination of the following three variables:

(a) The diameters of the jets, smaller diameter jets producing fine atomization and larger diameter jets producing coarser atomization;

(b) The width of the gap between the outer and inner elements, a narrower gap producing finer atomization and a wider gap producing coarser atomization;

(c) The difference of diameters of the jet and mixing tubes.

From the foregoing it will also be seen that absolute uniformity of all component sprays is insured because all the jet tubes are similar, all the mixing tubes are similar,

all the fuel entry rings are similar and the atomizing pressure and distribution to all the jets is uniform and the fuel oil supply to all the jets is also uniform with respect to pressure and distribution, thus a very high degree of homogeneity of the spray is obtained.

Also the nozzle has an extensive turn-down ratio or modulating range while still maintaining substantially complete combustion.

The nozzle head, in accordance with the present invention, can easily be taken apart for cleaning.

Obviously, the head in accordance with the present invention, may be used to vapourize other liquids than fuel oil and may be found useful, for instance, for vapourizing or atomizing water to produce a fine spray.

Such a water spray could be used, for example, for fire-fighting as it is now known that a water spray or fine water droplets is much more efficient for fighting fires than a water jet.

The nozzle head of the present invention may also be used to produce a jet of fine solids such as pulverized coal.

In actual tests carried with the nozzle head of Fig. 1 it has been found a very good atomization of No. 6 (bunker C) oil was obtained with a gap of about $\frac{1}{32}$ " between the two plate-like elements.

When the burner was operated on a stop and start basis it was found desirable to purge at each stop the oil remaining in the nozzle head by providing a relief valve, not shown, on the inner tube 4 to admit purging air or steam into the outer pipe 10 in order to prevent carbonization within the gap 15.

While preferred embodiments in accordance with the present invention have been illustrated and described, it is understood that various modifications may be resorted to without departing from the spirit and scope of the appended claims.

I claim:

1. A nozzle head comprising an inner and an outer plate-like element spaced from each other to define a continuous gap therebetween extending over a major portion of said elements, said outer element constituting the face plate of said nozzle head, said elements having a plurality of through bores, each through bore of one element being axially aligned with a through bore of the other element to define pairs of through bores, means to admit a first fluid substance under pressure to the inlets of the through bores of said inner element and means to admit a second fluid under pressure to said gap whereby said first substance will be discharged as jets passing through said pair of bores and said second substance will enter said jets through said gap to be mixed with said

jets, sleeve-like members extending across said gap in alignment with the bores of each pair of bores to establish communication between said bores across said gap, said sleeve-like members having apertures made therethrough to communicate the interior of said sleeves with said gap.

2. A nozzle head as claimed in claim 1, wherein said bores and said sleeve-like members have a cylindrical shape.

3. A nozzle head as claimed in claim 2, wherein said apertures open in the interior of said sleeve members tangentially to the inner surface of the latter.

4. A nozzle head for burners and the like comprising an inner casing having an inlet for admission of a first fluid under pressure and having a wall thereof perforated with a plurality of bores through which said fluid escapes in the form of jets, an outer casing having an inlet opening for admission of a second fluid under pressure and having a wall thereof disposed in spaced relationship with the wall of said inner casing to provide a gap between said walls, the wall of said outer casing having a plurality of bores, each axially aligned with a bore of the wall of said inner casing, whereby said second fluid enters said outer casing, fills said gap and contacts and mixes with said jets from points around the periphery of the same as said jets escape from the bores of the wall of the inner casing, the mixing continuing as said jets pass through the bores of the wall of said outer casing to issue therefrom, said bores having a cylindrical shape and the bores in the wall of said outer casing having a slightly greater diameter than the diameter of the bores of the wall of the inner casing, the bores in the wall of said inner casing having enlarged end portions adjacent said gap and further including sleeve-like members inserted in said enlarged end portions and projecting across said gap to join with the inlet ends of the bores of the outer casing and each sleeve-like member further having notches made in the end thereof disposed within said gap to establish communication between the interior of said sleeve-like member and said gap.

5. A nozzle head as claimed in claim 4, wherein said notches have a square cross section and open with said sleeve-like members tangentially to the inner surface thereof.

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