Jan. 21, 1947. J. FLETCHER 2,414,459

FLUID FUEL BURNER APPARATUS

Filed Jan. 28, 1944

Fig. 1

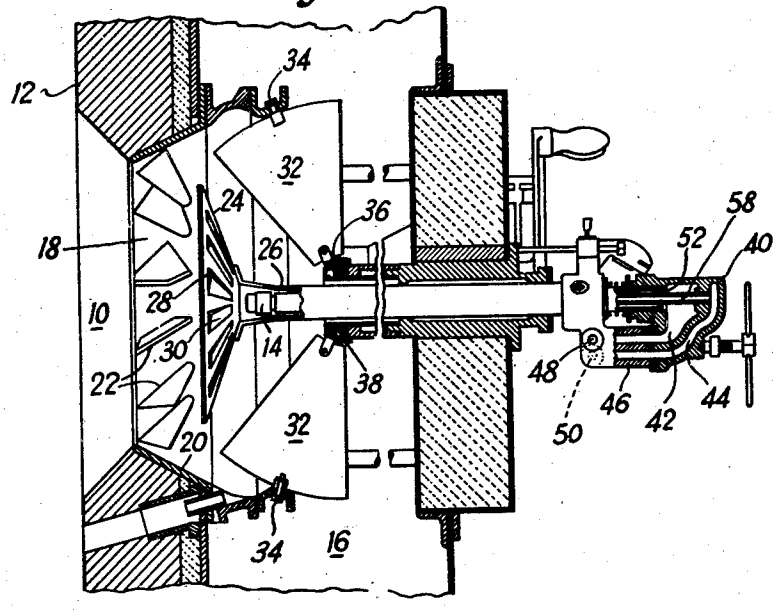


Fig. 3

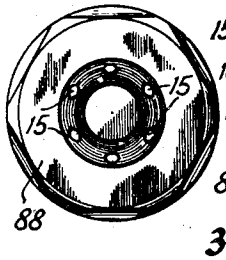


Fig. 2

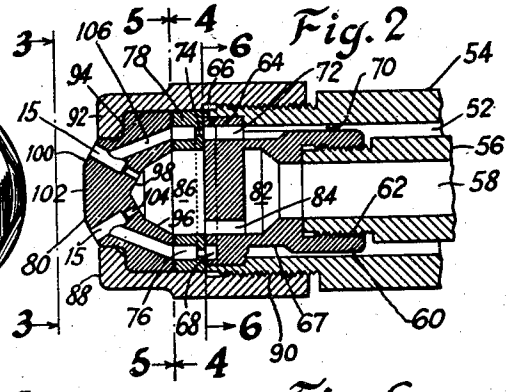


Fig. 4

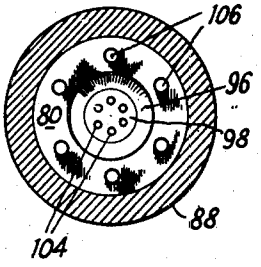


Fig. 5

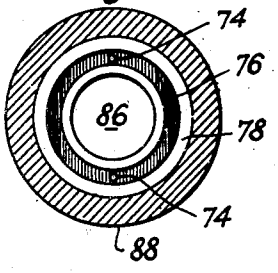


Fig. 6

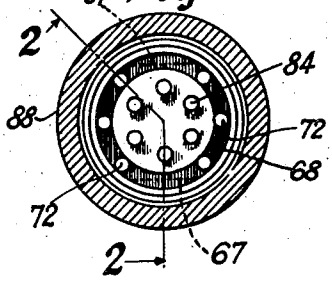
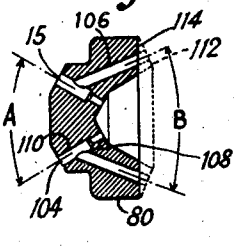


Fig. 7



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FLUID FUEL BURNER APPARATUS

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Application January 28, 1944, Serial No. 520,012

12 Claims. (Cl. 158—1.5)

1

The invention herein disclosed relates to burner apparatus adapted for the utilization of fluid fuels of liquid or semi-liquid character including especially hydrocarbon oils of various densities and viscosities.

The invention contemplates the discharge of the fuel in a relatively thin-walled spray readily permeable by the stream or streams of air generally supplied to produce a combustible mixture, the spray being desirably of hollow frustoconical formation to afford a maximum amount of surface exposure to a surrounding envelope of combustion air.

For the successful burning of a fuel oil, regardless of its grade, it is essential that the oil be completely atomized to a very fine mist, and further that the atomized oil be thoroughly mixed with sufficient air to assure complete combustion.

In order to provide the necessary high degree of atomization, it is proposed by this invention to utilize a fluid such as steam, air, or other gaseous medium to effect atomization of the fuel, with both fluids under suitable pressures, and preferably to divide the total fuel and steam, for example, into relatively small unit quantities so that a predetermined portion of the atomizing medium may be mingled with a predetermined portion of the fuel and the separately mingled unit portions discharged individually from the burner.

It is also an object to direct divisional quantities of the fuel through a series of separate passages and to direct divisional quantities of the atomizing medium through a second series of separate passages intersecting with the first named passages, the resulting unit mixtures being discharged through a series of outlet passages in a spray of the desired formation.

An additional object contemplates a series of outlet passages diverging in the direction of discharge from a common central axis to provide a spray of hollow truncated form.

Another object is to provide a circular series of passages for the fuel and atomizing medium respectively, each passage of one series converging with a passage of the other series at an acute angle to effect atomization of the fuel at minimum pressure requirements.

A further object is to provide an atomizer having a circular series of inlet passages for each of two different fluids, one fluid being oil for example and the other a fluid atomizing medium such as steam, the passages of one series converging toward a common central axis and intersecting

2

passages of the other series; the passages of one series being extended to form a series of outlet passages for the resulting mixture.

More specific objects relate to a form of atomizer in which the series of intersecting inlet passages together with the outlet passages are formed within a single member, thereby simplifying manufacture and assembly and assuring a fixed relative disposition of passages throughout service; also, to a form of atomizer adapted for operation over a wide range of capacities under control of the applied fluid pressure or pressures.

Other objects relate to directing air in suitable relation to the discharging stream of atomized fuel to provide a fuel-air mixture of optimum combustion characteristics.

A more complete understanding of the invention will be had from the description to follow, whereby the foregoing objects and others are made more apparent, and various features of the invention more fully explained, particularly with respect to a selected embodiment of the invention as illustrated by the accompanying drawing, in which:

Fig. 1 is a longitudinal assembly view, mainly in section, of a fluid fuel burner constructed in accordance with my invention;

Fig. 2 is an enlarged longitudinal section showing details of the atomizer assembly included in Fig. 1;

Fig. 3 is an end view of Fig. 2, taken along line 3—3;

Figs. 4, 5 and 6 are vertical sections along lines 4—4, 5—5 and 6—6 respectively of Fig. 2, viewed in the directions indicated by the arrows which bear corresponding numbers; the lines 4—4 and 5—5 being in a common transverse plane; and,

Fig. 7 is a longitudinal section of the sprayer member constituting a part of the atomizer assembly shown in Fig. 2.

In Fig. 1 of the drawing, a burner embodying features of my invention is shown in operative position with respect to a circular burner opening 10 formed in an upright furnace wall 12. The burner comprises a liquid fuel atomizer 14 disposed axially of the burner opening 10 together with suitably arranged air directing elements for producing a combustible mixture within the furnace defined by wall 12, the atomizer being formed with a series of circumferentially spaced outlet openings 15 through which atomized fuel is discharged in an outwardly expanding hollow conical spray.

Air is admitted to the burner from a duct 16 and is directed into the combustion zone through

a metal ring structure 18 having an inwardly tapering inner end portion 20 disposed within the burner opening 10 and fitted internally with circumferentially spaced air directing vanes 22. An impeller plate or diffuser cone 24 is mounted adjacent the inner extremity of the atomizer 14, being supported on a tubular distance piece 26 by which its longitudinal position relative to the atomizer and burner opening may be adjusted, the impeller plate being formed with circumferentially spaced openings 28 through which a central portion of the combustion air is admitted to the spray of atomized fuel upon discharge from the atomizer, the air passing through the impeller plate openings 28 being circumferentially deflected by blades 30 bent inwardly from the metal of the cone 24 in forming the openings 28. The supply of air to the burner is under control of a series of louvre plates 32 pivoted at their outer edges as at 34 adjacent the outer end of the ring structure 18 and at their inner edges as at 36 in a ring member 38 constituting a part of the operating mechanism by which the pivotal positions of the plates 32 may be adjusted. Reference may be had to U. S. Patent 2,260,062, T. B. Stillman, issued October 21, 1941, for a more detailed disclosure of the air directing elements above identified.

The atomizer 14 includes a body portion 40 at its outer extremity formed with fluid chambers or passages 42 and 44 communicating with corresponding passages in a coupling member 46 wherein inlet connections 48 and 50 are provided for the admission of fluids to the respective passages. For the specific embodiment illustrated, the passage 42 will be described as intended for fuel oil and the passage 44 for a gaseous atomizing medium such as steam, the passage 42 communicating with an annular passage 52 formed between the outer tube or barrel 54 of the atomizer and a central inner tube 56, and the passage 44 communicating with the central passage 58 constituting the bore of tube 56.

A sprayer head or nozzle 60 is removably secured at one end to the inner end of tube 56 as by threads 62 and at its opposite end is formed with a flange 64 seated within the counterbore 66 at the inner end of the atomizer barrel 54, the nozzle having flattened areas 67 at opposite sides for engagement by a wrench.

The face of the nozzle is formed with an annular groove 68 which is connected with the annular space 70 surrounding the nozzle and thereby with the annular fuel space 52 by means of a series of circumferentially spaced holes 72 extending through the flange 64. Fuel thus delivered to the groove 68 is admitted through diametrically positioned holes 74 to an annular groove 76 in the face of an intermediate annular plate 78 assembled adjacent the base of the sprayer plate 80. The nozzle is formed with a receiving chamber 82 of circular cross section for the atomizing fluid, the chamber being in open communication with the central atomizer passage 58 and being connected by means of circumferentially spaced holes 84 with the centrally disposed space 86 interiorly of the annular plate 78 and adjacent the base of the sprayer plate 80.

A cap 88 having a threaded connection 90 with the barrel 54 is formed with an inwardly extending flange portion 92 engaging a conforming shoulder portion 94 of the sprayer plate 80, to thereby maintain the sprayer plate 80, the intermediate plate 78 and the nozzle 60 in their proper assembled relation adjacent the counterbored end of the atomizer barrel 54.

The sprayer plate 80 is machined from a solid block of metal, the base of the plate being recessed to provide successive conical wall portions 96 and 98 of different angularity and the outer face being beveled as at 100 to provide a conical surface area for the location of the outlet openings 15, the area 100 being concentric with the surfaces 96 and 98 and of substantially the same inclination as the inner surface 98, the central area 102 of the face being imperforate and substantially normal to the central axis.

The sprayer plate 80 is drilled with two sets of circumferentially spaced passages 104 and 106 which intersect within the body of the block in substantially Y-formation, the passages 104 extending entirely through the plate 80 normal to the inner and outer surfaces 98 and 100 respectively and thus being inclined outwardly from the central axis in the direction of flow, the passages 106 extending partially through the plate 80 and being inclined inwardly toward the central axis to intersect and form junctures with the passages 104. Each passage or port 104 or 106 is preferably of cylindrical formation throughout with its longitudinal axis a straight line in a plane with the central axis of the sprayer plate, the longitudinal axes of each port 104 and its intersecting or connecting port 106 lying in a common plane.

The inner end sections 108 of passages 104 serve as inlet passages for fluid entering from the central space 86 while the passages 106 serve as inlet passages for fluid entering from the annular groove 76 with which their inner ends are in register. If preferred, the groove 76 may be formed in the base of the sprayer plate 80 instead of in the plate 78, in which case the plate 78 may be made somewhat thinner since only the holes 74 need be formed therein. In certain instances, the plate 78 may be omitted entirely and the sprayer plate 80 placed in contact with the nozzle 60, the passages 106 then receiving fluid direct from the annular recess 68. Similarly, at the joint between the nozzle and intermediate plate, the annular groove 68 may, if desired, be formed in the adjoining face of the plate 78 instead of in the nozzle 60 as shown, or when plate 78 is omitted, in the base of the sprayer plate 80.

The outer end sections 110 of passages 104 which provide the outlet openings 15 are counterbored to provide a greater flow area than the inner end sections 108 to accommodate fluid admitted from the space 86 through such inlet passages 108 together with fluid admitted from the annular groove 76 through the inlet passages 106, the outlet section 110 of each passage 104 thus constituting an individual mixing chamber for divisional unit quantities of the fuel and atomizing medium. Each passage 106 joins a passage 104 adjacent the base of the outlet section 110 and thus at a sufficient distance in advance of the outlet opening 15 to afford a positive directional influence on the issuing mixture.

Where the passages 106 are used for oil, and the passages 104 for steam, the oil pressure at the juncture of the streams need only be sufficient to keep the oil in contact and converged with the steam at this point, any excess of oil pressure tending to be more detrimental than beneficial to satisfactory atomization. Since it is desirable to maintain a relatively high pressure in the oil supply line for control purposes, the plate 78 is inserted as described, with a small

number of holes 74 of small total flow area, to serve as a restrictor for reducing the oil pressure to the value required at the mixing zone.

The machining of the holes or passages 104 and 106 may be completed in a minimum number of operations due to each having a straight line central axis throughout its length, and since the holes are cylindrical and have intersecting axes, it is convenient to machine all holes to a predetermined uniform size for any given series, and to form juncture openings of uniform size and shape at the intersections between holes of different series, to provide uniformity of fluid flow in all groups of passages. The machining of the passages 106 is further facilitated by leaving an excess of metal on the original blank, as indicated by the broken lines in Fig. 7, for example, to provide a beveled drilling surface 112 normal to the central axis of each such passage, the excess of metal being subsequently removed to provide the finished base surface 114.

The provision of conical surfaces 98 and 100 normal to the axes of holes 104 at their ends facilitates the accurate drilling of these holes besides enabling their inlet ends to be kept separate and providing substantially circular edges at both ends for uniform distribution of fluid to such holes and for symmetrical discharge of fluid from each and throughout the group.

The specific sizes of holes 104 and 106, their number and disposition relative to the central axis are governed principally by the conditions to be met including for example, the kinds of fluids to be handled, their density or viscosity values, the capacity or range of capacities under which the atomizer is to be operated, and the ultimate character and angularity of spray desired. When the fluids involved are oil and steam, it is customary to utilize the outer series of holes 106 for the oil, and the inner series of holes 104 for the steam, the two fluids being thoroughly mingled in the enlarged section 110 of passage 104 and the resultant mixture including the atomized fuel being discharged through the circular series of outlet openings 15 in the form of a thin walled conical spray. Under certain conditions, and with due regard for their relative sizes, the fuel may be directed into the inner series of holes 104 and the atomizing fluid into the outer series 106. The atomizer may also be employed for mixing and spraying other fluids including for example a condition wherein both fluids are of a combustible character or, if desired, wherein neither fluid is combustible.

Under conditions wherein oil is admitted to the outer series of holes 106 and steam as the atomizing agent is admitted to the inner series 104, it is desirable to make the oil inlet passages 106 of greater cross section than the steam inlet sections 108 of the passages 104, the mixing and outlet section 110 of the passage 104 having a cross section larger than the cross section of either of the passages 106 or 108 to provide a flow area for the common outlet section 110 approximately the same or somewhat less than the combined flow area of the separate inlet sections 106 and 108. In the form shown, the included angle of divergence A of the inner series of passages 104, including steam inlet and common outlet sections, is approximately seventy degrees, and the included angle of convergence B of the outer series of passages 106, for oil, about forty-five degrees.

The embodiment of such an atomizer in a burner as shown provides a combination whereby

relatively high operating capacities are made available utilizing parts of relatively small dimensions; for example, with sprayer plate passages of suitable size and relationship, and with steam and oil pressures of suitable operating values, capacities up to about 2000 pounds of oil per hour being available with outlet openings 15 at a diameter of about three-quarters of an inch, for an overall barrel diameter of about one and one-half inches; capacities up to about 4500 pounds of oil per hour being available with outlet openings 15 at a diameter of about one inch, for an overall barrel diameter of about one and three-quarter inches.

The angle of spray is substantially the same for all capacities due to the directional effect afforded by the outlet ends of the diverging passages 104, and thus the spray cuts across each column or layer of combustion air at constant angle. Moreover, the oil is atomized close to its exit through openings 15 and is therefore in a state of complete atomization upon discharge when it is immediately contacted by a whirling current of air directed through the impeller plate openings 28 to initiate combustion close to the atomizer tip; in practice, the normal adjustment of atomizer being to place the tip end flush with the furnace face of the impeller cone 24, forward of the position indicated in Fig. 1.

The small size of sprayer plate required results in a minimum area of the atomizer tip being exposed to direct heat of combustion, this being the central imperforate area 102 which is flat and subjected to the cooling effect of the atomizing steam in the closely adjacent chamber 86; the conical recess in the base of the plate serving to shorten the heat conducting path by reducing the thickness of metal between the exposed outer surface 102 and the inner wall surface 98; the introduction of fluid to the chamber 86 through circumferentially spaced holes 84 adjacent its maximum diameter tending to maintain an active steam flow condition over the entire wall area of the recess for maximum absorption of heat from the metal of the plate; the introduction of steam to the chamber 86 through a circle of holes 84 as shown also tending to maintain a condition of uniform steam pressure at the entrances to the passages 104 for uniform distribution of steam to such passages.

The burner may be operated over a considerable range of capacities, in general, for a steam-atomizing oil burner of this description, the capacity being varied by regulating both the oil and steam supply pressures up to a predetermined capacity value, and above that value by regulating oil pressure alone. Over the range where both oil and steam pressures are varied, it is customary to maintain a steam pressure at about 15 or 20 p. s. i. in excess of the oil pressure until the oil pressure reaches approximately 125 p. s. i. For higher capacities, as the oil pressures are increased, there is ordinarily no further increase required in steam pressure. It will be understood that the variations in oil or steam pressures or both for various capacities are to be accompanied by suitable adjustments of the combustion air supply. When a steady pressure of oil is available, the burner may be operated at extremely low capacity requiring for example an oil pressure of approximately only 2 p. s. i. As an alternative to the above method of operation the steam pressure may be held constant at about 125 p. s. i., a nominal value for maximum capacity operation, and the capacity varied by varying the oil

pressure only. While this simplifies the method of control to a certain extent it is somewhat less economical of steam than the method first mentioned, particularly when operating at the lower capacities.

I claim:

1. A combination atomizing and spraying member of one-piece construction adapted to atomize liquid received therein and to discharge said liquid in an atomized state in a series of annularly arranged jets, said member having oppositely disposed transversely arranged inner and outer surfaces and having a series of circumferentially spaced ports extending therethrough from one of said surfaces to the other, each of said ports being of circular cross section throughout and having its axis of flow extending in a straight line normal to at least the inner of said surfaces, said member having a series of circumferentially spaced ports extending partially therethrough from the inner of said surfaces and terminating at locations intermediate said surfaces in junctures with ports of said first named series, at least one of said series of ports being tapered to effect said junctures and the ports of said first named series terminating in said outer surface in a series of discharge openings arranged in a circle about a central imperforate area.

2. A sprayer plate of one-piece construction for atomizing a liquid and for spraying said liquid in an atomized state in jets angularly spaced about a central axis, said plate having axially displaced transversely arranged inner and outer surfaces and having a tapering series of circumferentially spaced ports extending therethrough from one of said surfaces to the other, said plate having a tapering series of circumferentially spaced ports extending partially therethrough from the inner of said surfaces and terminating at locations intermediate said surfaces in junctures with ports of said first named series, each of said ports being of circular cross section throughout and having its axis of flow in a straight line substantially coplanar with said axis, the ports of said first named series diverging in the direction of said outer surface and forming a circle of outlet openings in said outer surface marginal of a central imperforate area.

3. A member of one-piece construction for effecting mixture of two fluids delivered thereto and for spraying the resulting mixture in the form of a hollow cone, said member being symmetrically formed about a central axis and having axially displaced forward and rearward surfaces, said member having concentric groups of circularly arranged inlet openings formed in its rearward surface, a series of inlet ports extending into said member from the outer circle of said inlet openings and converging toward said forward surface, a series of inlet ports extending into said member from the inner circle of said inlet openings and diverging toward said forward surface, each of said inlet ports being of circular cross-section throughout and having its central axis formed as a straight line in the plane of and inclined to the central axis of said member to cause each port of one series to merge and form a juncture with a port of the other series at a location intermediate said surfaces, the ports communicating with said inner circle of inlet openings having cylindrical extensions of constant diameter terminating in a circle of circumferentially spaced outlet openings in said forward surface, the area of said forward surface centrally of said outlet circle being imperforate.

4. A sprayer plate having an annular portion of its forward surface of conical formation and a central portion of said surface substantially flat and normal to its central axis, the oppositely disposed rearward surface of said plate comprising an annular portion normal to said axis and a central portion formed with a recess therein, said recess having a wall portion of conical formation of substantially the same angularity as the conical annular portion of said forward surface, a series of cylindrical ports extending through said plate in normal relation to said inner and outer conically formed surface portions, said ports having their inlets in a circle in the conical wall portion of said recess and their outlets in a circle in the conical annular portion of said forward surface, a series of cylindrical ports extending into said plate from the annular portion of said rearward surface and terminating in junctures with said first named ports within the body of said plate, each port of a series having its longitudinal axis in a straight line and the longitudinal axes of ports forming each juncture intersecting in a plane with said central axis.

5. In a liquid fuel burner for wide range operation adapted for mounting in a furnace wall opening of substantially circular formation about a central axis, an atomizer arranged to extend axially of said opening having a sprayer plate constructed to discharge atomized fuel into said opening at varying fuel flow capacities in a series of separate jets circumferentially spaced about said axis, said sprayer plate having a series of circumferentially spaced outlet passages diverging toward their discharge openings in the forward surface of said plate, said sprayer plate having separate sets of inlet passage for liquid fuel and for a fuel atomizing fluid respectively joined to said outlet passages within the body of said plate, each of said outlet and inlet passages having its axis of flow substantially straight and coplanar with said central axis, means for delivering combustion air through said opening in a stream surrounding said atomizer sprayer plate, and a diffuser cone coaxial with said sprayer plate for imparting rotational movement to an inner layer of said air and for directing said rotating layer into intimate contact with the peripheral surface of each of said jets adjacent their origin at said plate.

6. A sprayer plate having concentric inner and outer circles of inlet openings formed in a surface thereof for the separate admission of liquid fuel and a fuel atomizing medium, together with separate groups of inlet passages extending into said plate from said openings and forming junctures between individual passages of one group and individual pasages of the other, and a series of outlet passages extending from said junctures to an opposite outlet surface of said plate for discharging atomized fuel in a series of circumferentially spaced jets diverging in generally frusto-conical arrangement from said outlet surface, said outlet passages each being of substantially the same form and flow area throughout its longitudinal axial extent and having its axis of flow substantially coplanar with the axes of flow of the associated inlet passages, said outlet passages terminating at said outlet surface in discharge openings circumferentially spaced at distances greater

than the circumferential dimension across each of said last named openings.

7. A sprayer plate of one-piece construction having concentric inner and outer circles of inlet openings in a rearward surface thereof for the separate admission of liquid fuel and a fuel-atomizing fluid, together with a circle of outlet openings formed in a forward surface thereof at a diameter greater than the diameter of said inner circle of inlet openings, a series of passages individually connecting each inlet opening of said inner circle with one of said outlet openings, each of said passages being of circular cross section throughout and having its axis of flow extending in a straight line from one of said surfaces to the other in normal relation to at least one of said surfaces, and a series of passages individualy connecting each inlet opening of said outer circle with one of said first named passages to form a series of circumferentially spaced junctures within the body of said plate.

8. In a liquid fuel atomizer, a sprayer plate constructed and arranged to discharge atomized fuel therefrom in a series of circumferentially spaced jets diverging from a common central axis, said sprayer plate having inner and outer sets of inlet pasages extending into said plate from rearward transverse surface portions thereof and adapted to separately receive a liquid fuel and a fuel atomizing fluid, each of said fluids under pressure, each passage of one set joining with a passage of the second set to form a series of internal fuel atomizing zones from which said atomized fuel is discharged, and a restrictor plate removably joined to said sprayer plate for reducing the pressure at which one of said fluids is supplied to one of said sets of inlet passages, said restrictor plate having a central opening therethrough communicating with said inner set of inlet passages and having at least one other opening therein of considerably smaller flow area than the combined flow area of said outer set of inlet passages, and a circular recess formed at the joint between said plates for distributing fluid from said last named opening to said outer set of inlet passages.

9. A sprayer member for effecting mixture of two fluids delivered thereto and for discharging the resulting mixture in a series of jets angularly spaced about a common axis, said member having axially displaced forward and rearward surfaces and having a series of angularly spaced ports extending therethrough from one of said surfaces to the other, said member having a series of angularly spaced ports extending partially therethrough from said rearward surface and terminating at locations intermediate said surfaces in junctures with ports of said first named series, said rearward surface including a centrally disposed recessed portion having its wall formed as a surface of revolution about said axis, each port of said first named series having its axis of flow extending in a straight line substantially coplanar with said common axis and diverging obliquely therefrom in a direction normal to the wall of said recessed surface portion.

10. A combination atomizing and spraying member of one-piece construction adapted to atomize liquid received therein and to discharge

said liquid in an atomized state in jets angularly spaced about a common axis, said member having axially displaced forward and rearward surfaces and having an inner and an outer group of inlet passages extending from angularly spaced openings in said rearward surface and forming junctures within said member between individual ports of the respective groups, said member having a group of outlet passages connecting said junctures with angularly spaced outlet openings in said forward surface, each of said outlet passages being of circular cross section and providing a constant flow area throughout greater than the flow area of any one of said inlet passages, said outlet openings having spaces therebetween greater than the diameter of any one of said outlet passages, each of said inlet and outlet passages having its axis of flow extending in a straight line substantially coplanar with said common axis.

11. A sprayer member of one-piece construction for effecting mixture of two fluids delivered thereto and for discharging the resulting mixture in a series of diverging jets, said member having forward and rearward surfaces of symmetrical formation about a common central axis and having a first series of spaced ports extending therethrough from one of said surfaces to the other, said member having a second series of spaced ports extending partially therethrough from said rearward surface and terminating at locations intermediate said surfaces in junctures with ports of said first series, said rearward surface including a centrally disposed recessed portion together with an annular surface portion surrounding said recessed portion, each port of said first series having its inlet in said recessed portion and having its axis of flow in a straight line substantially coplanar with said common axis and diverging obliquely from the corresponding axis of flow of the next adjacent port, each port of said second series having its inlet in said annular surface portion.

12. A sprayer member of one-piece construction for effecting mixture of two fluids delivered thereto and for discharging the resulting mixture in a series of diverging jets, said member having forward and rearward surfaces of symmetrical formation about a common central axis and having a first series of spaced ports extending therethrough from one of said surfaces to the other, said member having a second series of spaced ports extending partially therethrough from said rearward surface and terminating at locations intermediate said surfaces in junctures with ports of said first series, each port of said first series having its inlet for one of said fluids in a centrally disposed portion of said rearward surface and having its axis of flow in a straight line substantially coplanar with said common axis and diverging obliquely from the corresponding axis of flow of the next adjacent port, each port of said second series having its inlet for the other of said fluids in a portion of said rearward surface surrounding said centrally disposed portion, the ports of one of said series including ports each having its axis of flow substantially normal to one of said portions of said rearward surface.

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