

March 4, 1947.

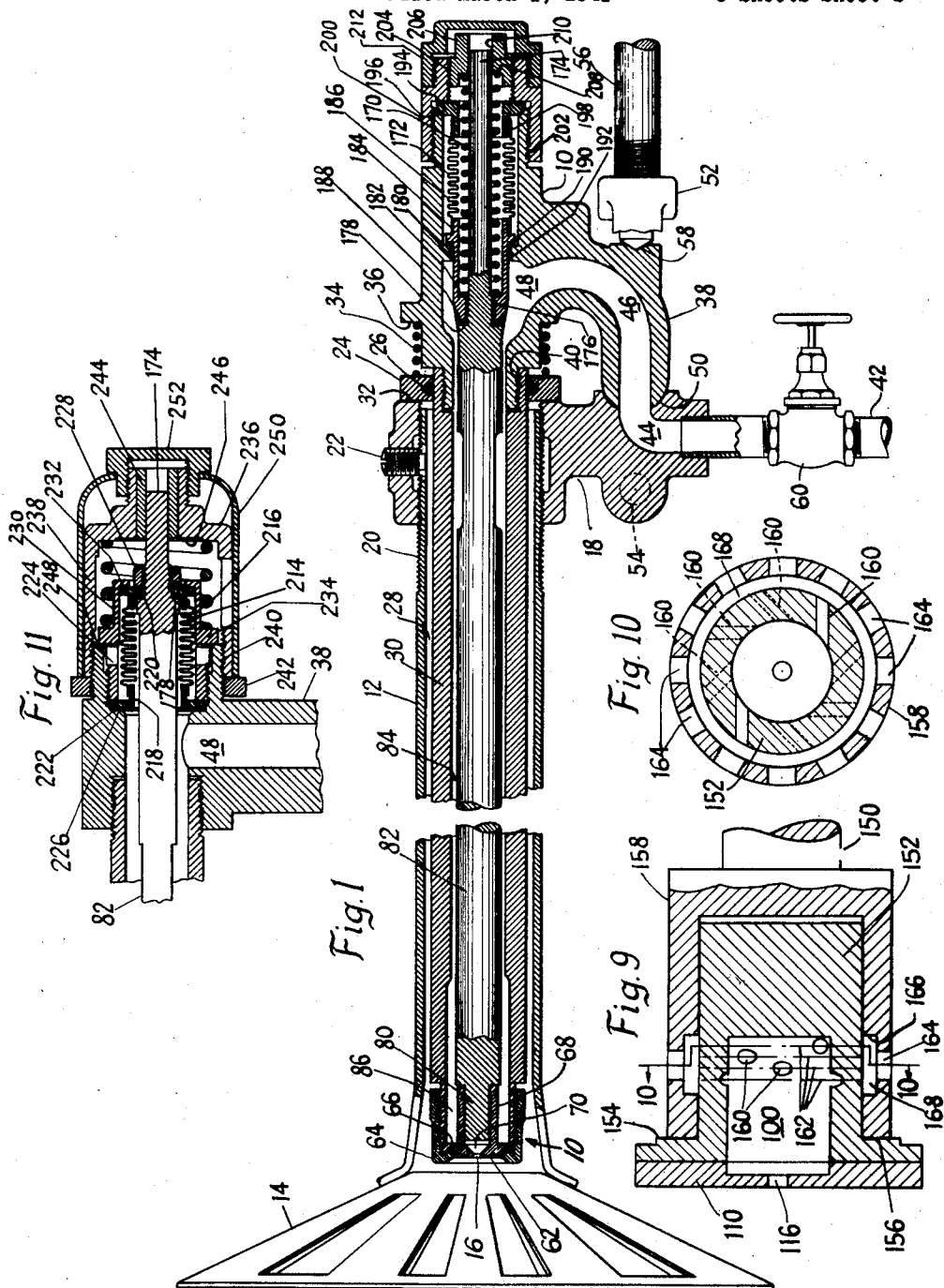
J. FLETCHER

2,416,685

ATOMIZER

Filed March 1, 1941

3 Sheets-Sheet 1



INVENTOR
James Fletcher
BY *Joseph P. Moran*
Attorney

March 4, 1947.

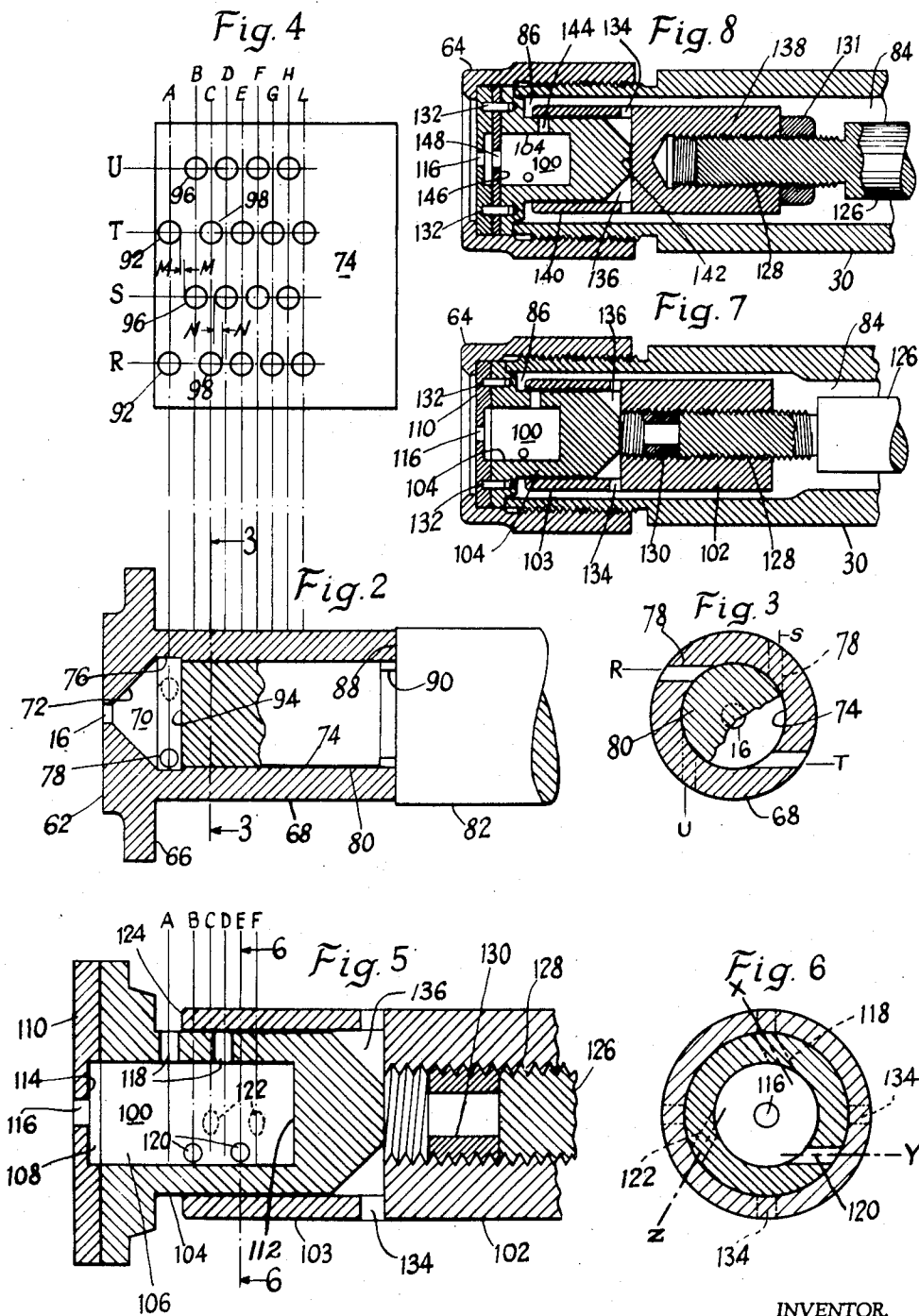
J. FLETCHER

2,416,685

ATOMIZER

Filed March 1, 1941

3 Sheets-Sheet 2



INVENTOR.

James Fletcher

BY

Joseph P. Moran
Attorney

March 4, 1947.

J. FLETCHER

2,416,685

ATOMIZER

Filed March 1, 1941

3 Sheets-Sheet 3

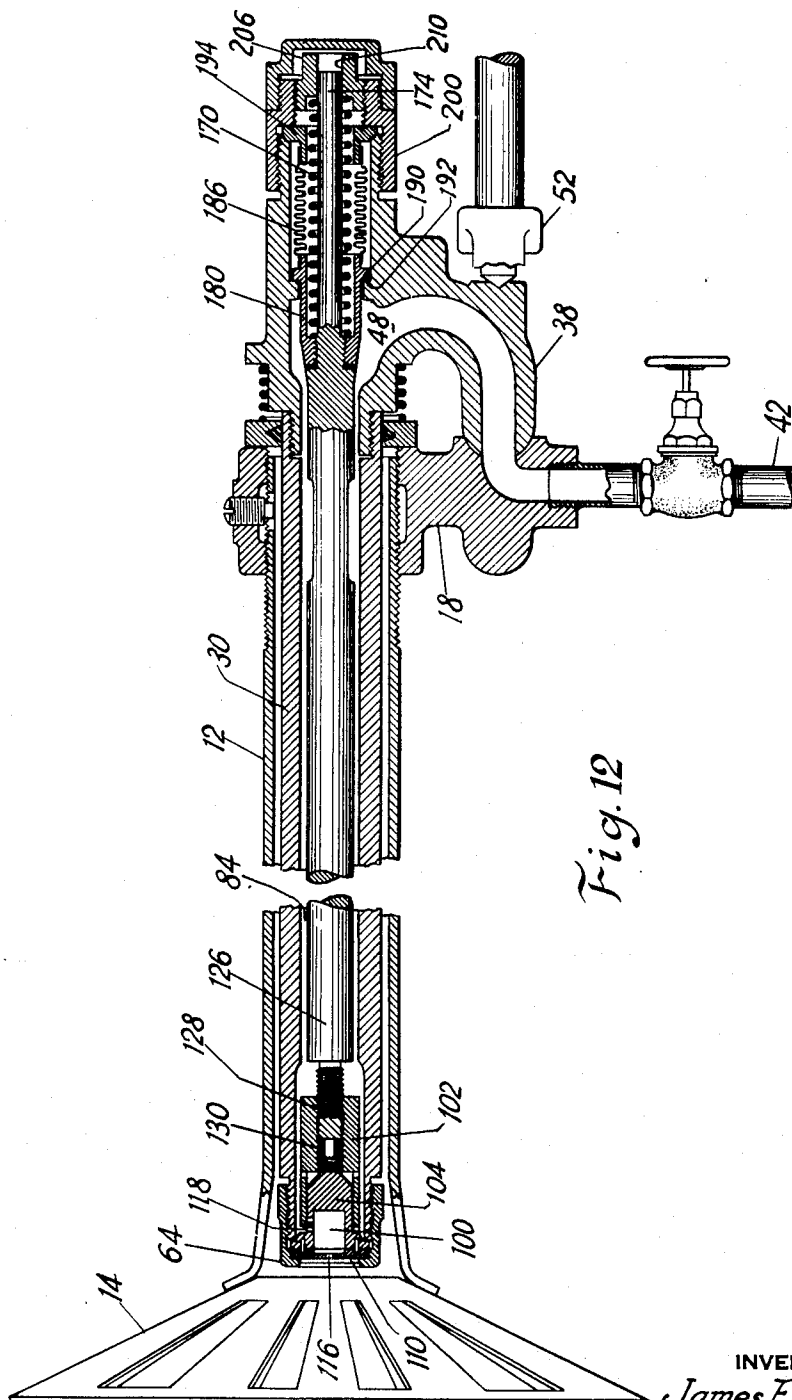


Fig. 12

INVENTOR
James Fletcher
BY
J. P. Moran
ATTORNEY

UNITED STATES PATENT OFFICE

2,416,685

ATOMIZER

James Fletcher, Akron, Ohio, assignor to The
Babcock & Wilcox Company, Newark, N. J., a
corporation of New Jersey

Application March 1, 1941, Serial No. 381,217

12 Claims. (Cl. 299—119)

1

The subject of this invention is an atomizer and its associated controls especially adapted for use in a burner for liquid fuel whereby an acceptable quality of atomization may be maintained over an extended range of capacities for optimum combustion characteristics. The atomizer is broadly of the mechanical type in which a liquid under pressure is sprayed from an orifice under the influence of centrifugal force, the atomized fluid being discharged from the orifice in the form of a cone.

An object of the invention is to provide a mechanical atomizer operable at different flow capacities and capable of producing a spray of efficient combustion characteristics throughout the entire capacity range. A related object is to achieve such operation without alteration in the structure of individual atomizer components.

An additional object is to provide a gradation of capacities subject to an adjustment of atomizer parts, or to an adjustment of the pressure at which the liquid to be atomized is supplied; or, if desired, to a combination of such adjustments. The adjustment of atomizer parts is intended primarily to make available at different capacities a different flow area of passages through which the fluid is directed to impart the degree of rotational velocity necessary for satisfactory atomization. It is contemplated that the adjustment of flow area may be effected manually, or preferably by automatic means subject to a pressure characteristic of the liquid supply. The latter method, particularly in the case of a burner, may include the regulation of the supply pressure in automatic relation to a demand for fuel, as indicated by an operating characteristic of the heat-receiving apparatus with which the burner may be associated.

Another object is to maintain as nearly as possible a substantially constant divergence of spray throughout an extended capacity range, the general tendency in atomizers of the mechanical type being to spray liquid at a relatively wide angle at low capacities and at a relatively narrow angle at high capacities.

Other objects of the invention pertain to the incorporation of an atomizer in a burner assembly providing automatic control of the atomizer operation, the parts being so constructed and arranged as to facilitate assembly and disassembly and to permit ready access for inspection or replacement.

The various objects and advantages of the invention, and the means whereby such objects may be achieved, are more fully disclosed in the description which follows, and in the accompanying drawings, wherein:

2

Fig. 1 illustrates, in longitudinal section, an embodiment of the invention in a burner;

Fig. 2 is an enlarged fragment of Fig. 1 showing the relation of parts adjacent the spray orifice;

Fig. 3 is a transverse section of Fig. 2 along line 3—3;

Fig. 4 is a diagram illustrating a detail of Fig. 2;

Fig. 5 is a fragmentary longitudinal section showing a modification;

Fig. 6 is a transverse section of Fig. 5 along line 6—6;

Fig. 7 is an assembly in longitudinal section, incorporating the elements of Fig. 5;

Fig. 8 is an assembly in section indicating a modification of parts shown in Fig. 7;

Fig. 9 shows a modification of atomizer components in longitudinal section;

Fig. 10 is a section of Fig. 9 along line 10—10;

Fig. 11 is a modification of the operating mechanism of Fig. 1; and

Fig. 12 is a modified assembly, similar to Fig. 1, incorporating the atomizer structure shown in Figs. 5 and 7.

In detail, and referring particularly to Figs. 1, 2 and 3, the atomizer assembly 10 may be mounted within a hollow distance piece 12 which carries an impeller plate 14 for providing an intimate mixture of combustion air with the atomized fuel issuing from the orifice 16. An atomizer coupling 18 is secured to the distance piece 12 as by threads 20 to provide longitudinal adjustment of the atomizer relative to the impeller plate, the desired adjustment being maintained by set-screw 22. A collar 24 including the inner packing ring 26 prevents leakage of air through the annular space 28 between the barrel 30 of the atomizer and the distance piece 12; the collar being held in contact with the coupling face 32 by means of the spring 34 which is seated against the shoulder surface 36 on the atomizer body 38; the packing ring 26 bearing against the outer surface of the barrel 30 which may be removably secured to the atomizer body as by threads 40.

Fuel is supplied to the atomizer through a pipe connection 42 which leads from a suitable source (not shown) of liquid fuel under pressure, the fuel entering through the coupling passage 44 and flowing through the body passage 46 to the interior body space 48. The joint 50 between the body and coupling is maintained pressure-tight by means of a quick-detachable clamping device comprising the yoke 52 which is hinged to the coupling at 54 and carries a bolt 56 which may be screwed against the body as at 58. A valve 60 in the connection 42, for controlling the pressure

and quantity of fuel admitted to the atomizer, may be of a manually operated type as shown, or of a suitable automatic type, as may be determined by requirements of the installation.

The barrel 30 is fitted with a sprayer plate 62 at its forward end to provide the cylindrical orifice passage 16 from which fuel is discharged in a fine mist or spray of hollow conical formation, the orifice plate being conveniently held in position by an internally threaded cap 64 which clamps the circumferential flange 66 against the end of the barrel. The plate is preferably formed with a hollow cylindrical extension or collar 68 to provide a recess or whirl chamber 70 of circular cross-section having its outlet in the axially adjacent orifice 16 from which atomized fuel is discharged, the interior wall surface of the recess including a conical portion 72 having its apex preferably within the orifice 16 and a cylindrical portion 74 for the remainder of its length, the cylindrical surface portion being annularly grooved as at 76 to approximately the maximum diameter of the conical surface portion.

Fuel is admitted to the chamber 70 through a series of passages or ports 78 which extend through the cylindrical extension 68 in a direction generally tangent to the inner wall surface 74 and preferably in planes normal to the common longitudinal axis. The port area available for flow of fuel into the whirl chamber is regulated by the axial movement of a plunger 80 which is actuated in accordance with the movement of an operating spindle 82 extending longitudinally of the barrel 30 and spaced inwardly of the barrel to provide the annular space 84 for fuel flow from the interior body space 48 to the region 86 surrounding the tangential ports 78.

In the form shown, the plunger 80 is made an integral part of the operating spindle and being of a smaller diameter than the spindle provides a shoulder 88 which when moved into contact with the end of the sprayer plate extension 68 limits the forward movement of the plunger 80 and determines the minimum limit of fuel port area open to the chamber 70. The plunger may be annularly grooved as at 90 to enable the shoulder 88 to be seated firmly against the extension 68 to permit close adherence to a predetermined minimum capacity setting. A movement of the plunger to the rear of the recess, that is, toward the right as seen in Fig. 2, will increase the area available for fuel flow into the chamber by uncovering a greater area of the same port or ports, or by uncovering additional ports, at successive longitudinal positions.

A selected arrangement of ports 78 is indicated in Fig. 4 by a diagrammatic development of the inner cylindrical surface 74 which is slidably engaged by the plunger 80, the ports being disposed in nine successive transverse planes A, B, C, etc., and being directed tangentially of the chamber in four tangential planes R, S, T and U, each tangential plane being displaced substantially 90° from the one circumferentially adjacent. Each transverse and preferably normal plane A, B, C, etc., contains two ports 180° apart, and in alternate transverse planes the ports are in parallel tangential planes to enter the chamber at diametrically opposite locations; for example, in one group of alternate planes A, C, E, G, and L, the ports are in parallel tangential planes such as R and T; and in the remaining group of alternate planes B, D, F, and H, the ports are in parallel tangential planes S and U.

In the illustrated arrangement, the ports 92 in

plane A are fully uncovered when the plunger face 94 is at the extreme limit of travel toward the orifice, thus establishing a predetermined minimum fuel flow area for low capacity operation. In this position all other ports are blocked off including the ports 96 in the adjacent plane B since there is a definite longitudinal spacing between the perimeters of ports 92 and ports 96 as indicated by the dimensional arrows M—M. As the plunger is moved away from the orifice, and the plunger face 94 reaches plane B at the center of ports 96, or a position slightly beyond plane B, the ports 98 in plane C are gradually uncovered along with the remaining portions of ports 96 in plane B. Thus, the ports in adjacent planes B and C, C and D, etc., overlap longitudinally to the extent indicated by the arrows N—N in order to maintain a progressive and substantially uniform variation in port area exposure for successive positions of the plunger. It will be noted that the variation in port area is accompanied by a variation in the depth of the whirl chamber, due to the different positions assumed by the plunger face 94 which forms the base of the chamber.

Fig. 5 shows a modified arrangement of whirl chamber and plunger wherein the whirl chamber 100 is of a fixed axial dimension and the plunger 102 includes a hollow extension or sleeve portion 103 which telescopes exteriorly with the sprayer head 104 to regulate the port area available for fuel flow into the chamber. The whirl chamber 100 is cylindrically formed throughout to include the cylindrical recess 106 within the sprayer head and the cylindrical recess 108 within the sprayer plate 110, the base 112 of the chamber being normal to the axis and imperforate, while the opposite end wall 114 which is also normal to the axis, provides the entrance to the cylindrical outlet orifice 116 in the sprayer plate 110. In this arrangement a single port is disposed in each of the transverse planes A, B, C, D, E and F, and in each plane the port is directed tangentially of the whirl chamber as indicated in Fig. 6; the ports 118 in the transverse planes A and D lying in the tangential plane X, the ports 120 in planes B and E lying in plane Y, and the ports 122 in planes C and F lying in plane Z. The circumferential spacing of successive tangential planes X, Y, Z is approximately 120°.

The longitudinal spacing of the transverse planes A to F, and the diameters of the ports 118, 120, 122 in those planes, are preferably so selected as to provide a longitudinal clearance between the perimeters of ports 118 and 120 in planes A and B corresponding to the dimension M—M in Fig. 4; also, to provide an overlap corresponding to the dimension N—N between ports 120 and 122 in planes B and C, and between similarly adjacent ports in the succeeding planes D, E and F. Thus, port 118 in plane A may be fully uncovered without exposing any portion of port 120 in the adjacent plane B, when for example, for minimum capacity, the forward edge 124 of the plunger 102 is advanced to the position shown in Fig. 5; and, as the plunger is retracted, for increasing capacities, to approximately the center line of a port such as 120 in plane B, the next succeeding port such as 122 in plane C is about to be exposed, and so on throughout the series in a manner similar to that described in connection with Fig. 4.

The extreme forward position of the spindle 126 is fixed by means to be described hereinafter and since the plunger and spindle are connected

5

as at 128, the extreme position to which the plunger may be advanced is also determined and thereby the amount of port area available at the minimum capacity setting. An adjustment may be made however to provide a greater or lesser minimum value of exposed port area, by screwing or unscrewing the plunger relative to the spindle at the threaded connection 128 and maintaining the adjusted relation of the parts by means of the hollow lock nut 130.

Comparing the forms shown in Figs. 2 and 5, where in one case the plunger is reciprocable interiorly of a ported element 68 and in the other exteriorly of a ported element 104, it will be noted that the ports are arranged in a different number of transverse planes A, B, C, etc., and that the number and circumferential spacings of the ports in such planes are different. In addition to detail variations of this general character, it is contemplated that other variations may be made within the scope of this invention to include for example variations in the size and form of the ports, variations in the longitudinal spacing of the ports, and variations in the angle relative to the longitudinal axis at which the ports are directed tangentially of the whirl chamber; the factors governing such permissible variations including the total range of port area required within the range of plunger movement, and the rate of port area variation for different capacities in relation to the rate of plunger movement.

Fig. 7 shows an assembly of the elements of Fig. 5 within the burner barrel 30, the sprayer plate 110 being centered with respect to the sprayer head by dowels 132 and the parts being maintained in their assembled relation at the end of the barrel by cap 64. Fuel under pressure flows through the annular barrel space 84, as in Fig. 1, to the annular space 86 adjacent the entrances to the tangential ports in the successive transverse planes A to F; the extent to which such ports are uncovered for flow of fuel into the whirl chamber 100 being regulated by the longitudinal movement of the hollow plunger 102 which is actuated by spindle 126, as already described. One or more holes 134 extend through the wall of the plunger sleeve 103 from the outer space 86 to the inner space 136 at the rear of the sprayer head 104, to maintain a balance of pressures conducive to normal operation of the plunger.

In Fig. 8, as in Figs. 5 and 7, the regulation of tangential port area is effected by the reciprocation of a plunger 138 relative to the sprayer head 104, the hollow extension or sleeve portion 140 of the plunger telescoping with the circumferential wall of the whirl chamber 100 and the base surface 142 within the sleeve abutting the end of the sprayer head in the fully advanced position of the plunger to provide a minimum capacity setting. The tangential ports such as 144 may conveniently be of such dimensions and arrangement as to provide full exposure of at least one port at the minimum setting and to provide an overlapping relation between ports at successive longitudinal locations. The plunger may be adjustably connected to the spindle 126 as at 128 and secured in position by lock nut 131.

An orifice plate 146 is positioned inwardly of the sprayer plate 110 to provide an inner orifice 148 which may be spaced axially from the outer orifice 116 an amount equal to the depth of the sprayer plate recess 108. The combination of a plurality of orifices as shown enables a more

6

sharply defined angle of spray to be maintained at minimum capacity than with the single orifice 116; the effect being to minimize irregular dispersion of fuel particles outside of the definite angle of cone formation, and thereby eliminate the possibility of carbon being formed on the burner or furnace wall as a result of the impingement of such particles. The relative areas of the inner and outer orifices are preferably determined in accordance with the capacity at which the atomizer is to be operated; for example, for a unit having a maximum capacity rating of 3000 lbs. of oil per hour the areas of both orifices may be equal whereas for a 2000 lb. unit the ratio of inner orifice area to outer orifice area may be $1\frac{1}{2}:1$, and for a 1000 lb. unit 2:1.

Figs. 9 and 10 illustrate a further modification wherein a hollow plunger 150 is movable in telescoping relation with a sprayer head 152 for varying the extent of tangential port area exposed for fluid flow into the whirl chamber 100. A sprayer plate 110 provides the outlet orifice 116. The plunger may be suitably connected to an operating spindle 126, and the parts assembled in cooperation with other burner parts, as in Fig. 7 or Fig. 8. In this form the effective port area is increased as the plunger is advanced and decreased as the plunger is retracted; the flange 154 of the sprayer head 152 providing a convenient stop for the front end 156 of the plunger sleeve 158 to determine the extreme position of forward movement when the maximum amount of port area is uncovered. A suitable stop may also be provided to limit the extent to which the plunger may be retracted in order that the effective port area will not be reduced below a predetermined minimum. The ports 160 are shown in a selected substantially balanced arrangement wherein two ports enter the whirl chamber 100 tangentially at each of a succession of longitudinally spaced locations as indicated by the transverse planes 162. The ports at one location may overlap those at an adjacent location somewhat in the manner of Fig. 4. The sleeve 158 is perforated at intervals about its periphery with holes 164 extending to the inner circumferential groove 166 which provides an annular space 168 adjacent the entrances to the tangential ports 160. The width of the groove 166 is preferably greater than the width of the circumferential band occupied by the ports to insure that the total area of all ports is exposed when the plunger is in the fully advanced position as indicated in Fig. 9. Fuel entering the holes 164 from barrel space 86 flows into the annular groove space 168 and from thence into and through the ports 160 into the whirl chamber 100.

Referring again to Fig. 1, the mechanism for causing reciprocation of the spindle and plunger to regulate port area is preferably housed within the atomizer body 38 and constitutes a simple and compact assembly of components readily accessible for inspection and adjustment. A spring 170 exerts a continuous pressure longitudinally of the spindle 82 tending to maintain the plunger 80 in the position of minimum effective port area while a bellows unit 172 subject to pressure of the fuel supply acts in opposition to the spring pressure to move the plunger toward the position of maximum effective port area.

The spindle is formed with an extension 174 having a threaded portion 176 adjacent a shoulder 178 to receive the internally threaded hollow flange member 180 which provides a seat 182 for

the spring 170 and a rim 184 to which one end of the bellows 186 is connected and sealed. A packing washer 188 seals the joint between the spindle shoulder 178 and the flange member 180 to prevent leakage of pressure from the body space 48 to the interior of the bellows 186. The peripheral flange 190 on member 180 overlaps the interior body flange 192 in a radial direction to limit the displacement of the spindle 82 and connected parts from their normal longitudinal positions of adjustment, particularly during assembly and disassembly when the holding cap 64 is detached from the barrel. The flanges 190 and 192 are normally spaced apart as shown to allow the shoulder 88 at the forward end of the spindle to seat against the end of the sprayer plate collar 68 for minimum capacity setting.

A flange member 194 seated against an end surface 196 of the body 38 includes a rim portion 198 having a pressure-tight connection with the opposite end of bellows 186. The bellows flange 194 is held stationary by the coupling nut 200 which is detachably secured to the body as at 202 and internally threaded as at 204 to receive the adjusting nut 206; the nut 206 having a recess 208 within which the outer end of spring 170 is seated, and an axial bore 210 to provide a bearing support and guide for the spindle extension 174. The closure cap 212 is made removable to permit adjustment of spring pressure if desired by means of the adjusting nut 206, and to permit an inspection to be made of the operation of the internal mechanism by noting the travel of the spindle extension 174 within the bore 210. Since the longitudinal movement of the spindle and bellows unit is relatively small and may not exceed one quarter of an inch, it is not essential that the space interiorly of the bellows be vented to the atmosphere, the compressive effect on the enclosed air being negligible and in any event subject to correction by means of the spring adjustment.

A modified form of operating mechanism is shown in Fig. 11 wherein the pressure of fuel within the body space 48 is exerted inwardly of the bellows 214, in opposition to the continuous pressure of spring 216, to move the spindle 82 and the associated plunger toward the extreme retracted position, whereby, with an arrangement of plunger and sprayer head as in Fig. 1, the effective port area is increased with increased retractive movement of the spindle.

The bellows 214 is connected and sealed at its opposite ends to flange members 218 and 220 respectively; the flange 218, and gasket 222 if required, being held in place by the bellows nut 224 to form a pressure-tight joint with the body as at 226; and the flange 220 being seated against the spindle shoulder 178 where in conjunction with a suitable gasket it may be held stationary by nut 228 to form a pressure-tight joint.

A spring retainer 230 of cylindrical form surrounds the bellows 214 and the bellows flange 220; an inwardly extending flange portion 232 of the retainer overlapping the outer face of flange 220, and an outwardly extending flange portion 234 forming a seat for the spring 216. A cage housing 236 having a plurality of circumferentially spaced ribs 238 may be adjustably positioned and secured relative to the atomizer body 38 as by threads 240 and locknut 242, and may be fitted with a bushing 244 to provide a bearing and guide for the spindle extension 174. The inner surface 246 of the housing provides an abutment for the outer end of spring 216

whereby the spring retainer 230 is maintained in contact with the end surface 248 of the body, and thereby the spindle 82 in the fully advanced position until the pressure of fuel within the body and acting interiorly of the bellows is sufficient to overcome the loading spring pressure. The cage formation of the housing 236 renders the working parts of the mechanism visible upon removal of the enclosing shell or cup 250 which is detachably mounted between the lock nut 242 and the end cap 252. As explained in connection with Fig. 1, the relatively short plunger travel makes it unnecessary to specifically provide an atmospheric vent for the enclosed space at the low pressure side of the bellows, in this case, the space exteriorly of bellows 214.

Fig. 12 illustrates a further modification combining the sprayer head and plunger assembly of Figs. 5 and 7 with the plunger operating mechanism of Fig. 1, each of which components has been previously described in detail. Plunger 102 is shown at a position of predetermined minimum capacity where, for example, a single port 118 is fully exposed for fuel flow into whirl chamber 100. In this position, the peripheral flange 190, fixed in relation to the spindle 126, is in contact with the interior flange 192 on atomizer body 38, the body flange 192 thus serving as a stop to fix the extreme position to which plunger 102 may be advanced during normal operation to insure a predetermined minimum value of port area exposure. Various values of minimum effective port area may be provided by suitable adjustment of the plunger-to-spindle connection 128.

In the operation of mechanical atomizers of the type described, wherein the effective flow area of fuel passages may be varied to regulate flow capacity, it is important to eliminate any possibility of the area being reduced to such an extent that combustion would be interrupted, either through faulty operation or failure of the regulating mechanism. Accordingly, where the valving means is a plunger, as disclosed, a suitable stop is advantageously provided to prevent the plunger being moved to a position where the effective port area would be reduced below a predetermined minimum. If the atomizer is to be shut down entirely, it is preferable to cut off the supply of fuel to the atomizer by means of a valve in the fuel supply line under control of the operator.

A desirable method of operating the foregoing atomizers over a wide range of capacities may include the regulation of capacities over a selected portion of the range solely by varying the pressure at which the fuel is supplied, and over another portion of the range by varying the tangential port areas in combination with fuel pressure variations. If desired, the regulation of capacities by pressure alone may be effected over separated portions of the total capacity range, and the regulation by pressure and port area over an intermediate portion. A pressure loading spring 170, for example, of a suitable selected rate, may be suitably adjusted by means of nut 206 to maintain the plunger 80 in the position of minimum effective port area irrespective of variations in fuel pressure below a predetermined pressure limit. In practice, with an available operating range of fuel pressures from about 50 lbs. per square inch to about 250 lbs. per square inch or more, the spring loading pressure may be so adjusted as to hold the plunger stationary while fuel pressure is being increased from the initial value of about 50 lbs. to an intermediate value of about 125 lbs., or approximately 40% to 60% of

the maximum available pressure. As pressures are increased above 120 lbs., the force exerted by the bellows unit 172 is sufficient to overcome the spring loading pressure and the plunger is moved to positions of increased port areas. If the setting of the spring is such that the maximum port area is uncovered before the maximum available fuel pressure is utilized, the range of capacity may be further extended solely by additional increases in fuel pressure to the available limit of 250 lbs. or above. The pressure at which plunger movement is initiated may be suitably adjusted for different maximum pressure values; for example, while 120 lbs. may be best adapted for a 250 lb. limit, a pressure of approximately 150 lbs. might be preferred for a 300 lb. limit.

The preferred method of regulating capacity in a plurality of stages thus utilizes the available fuel pressure to the best advantage in the maintenance of an acceptable quality of atomization throughout a wide range of capacities. If capacity variation were the sole objective, irrespective of the spray characteristics, it would be feasible to utilize the entire pressure range for plunger movement alone and thereby obtain the minimum capacity variation per increment of pressure change. If quality of atomization were the sole consideration, it would be desirable to maintain maximum fuel pressure at all capacities. Therefore, by maintaining a constant and relatively small effective port area for the lower capacity stage at fuel pressures ranging from 50 to 120 lbs., a reasonable pressure for adequate atomization is built up before the effective port area is increased for higher capacities; and, further, as fuel pressures are increased beyond 120 lbs. for the higher capacity stage, where pressure variations are coordinated with variations in effective port area, a reasonable capacity variation is obtained per increment of pressure variation throughout the remainder of the available pressure range.

The coordination of pressure variations with variations in port area also tends to maintain a more nearly uniform angle of spray throughout the entire capacity range.

While the invention has been disclosed more particularly with reference to certain selected embodiments, it is to be understood that the invention may take other forms, and that certain features of the invention may be applied individually, or in various combinations, within the scope of the appended claims.

I claim:

1. In a liquid atomizer, means forming a whirl chamber having an outlet orifice in an end wall thereof and a series of tangentially directed inlet ports for liquid distributed longitudinally thereof in an enclosing cylindrical wall, means for varying the effective flow area of said ports comprising a plunger telescoping with said first named means and having a valving edge movable forwardly in the direction of said orifice for progressively decreasing the amount of port area effective for the flow of liquid into said chamber, means for moving said plunger including a movable spindle having an axially adjustable connection therewith, and means limiting the forward movement of said spindle and thereby the port area decreasing movement of said valving edge to a position rendering a predetermined amount of said port area continuously effective.

2. In a liquid atomizer, means forming a whirl chamber having an outlet orifice in an end wall thereof and a series of tangentially directed inlet

ports for liquid distributed longitudinally thereof in an enclosing cylindrical wall, and means for varying the effective flow area of said ports comprising a hollow plunger telescoping exteriorly with said first named means and having a valving edge movable forwardly in the direction of said orifice for progressively decreasing the amount of port area effective for the flow of liquid into said chamber, said plunger having a transverse surface portion movable into contact with a transverse surface portion of said first named means for limiting the forward movement of said valving edge to a position more remote from said orifice than a port of said series.

3. In a liquid atomizer, means forming a whirl chamber having an outlet orifice in an end wall thereof and a series of tangentially directed inlet ports for liquid distributed circumferentially and longitudinally throughout a circumferential band in an enclosing cylindrical wall, means for varying the effective flow area of said ports comprising a plunger sleeve telescoping exteriorly with said first named means and axially movable in opposite directions for progressively increasing and decreasing the amount of port area effective for the flow of liquid into said chamber, said sleeve having an inner circumferential recess cooperating with said first named means to form an annular space adjacent the entrances to said ports, said sleeve having means for admitting liquid to said annular space, said recess extending longitudinally of said sleeve a distance at least equal to the width of said band of ports, and means for moving said sleeve axially to and from a position wherein said recess entirely embraces all ports within said band.

4. In the mechanical atomization of liquid fuel for combustion purposes wherein the fuel is directed tangentially of a whirling zone under pressure and is discharged from said zone through an orifice to form a divergent spray of atomized fuel particles, the method of controlling the flow of fuel to said zone and through said orifice, for rates of flow throughout a wide operating range, which comprises, regulating the rate of fuel flow into said zone for lower rates of flow within said operating range by varying the pressure of the fuel while maintaining a predetermined minimum effective fuel flow area; and, for higher rates of flow within said operating range, by regulating the area effective for fuel flow into said zone simultaneously with variations in fuel pressure.

5. In a liquid atomizer arranged for wide range operation, means forming a whirl chamber having an outlet orifice, means forming inlet ports circumferentially and longitudinally displaced for admitting liquid to said chamber under pressure, said ports being displaced in one of said directions to an extent placing a group of ports in overlapping relation in said one direction and at least one other port spaced in its entirety in the same direction from all ports of said group to provide an intervening unported space, valving means movable in said one direction of displacement for varying the effective flow area of said ports, and stop means arranged interiorly of said atomizer for positively limiting the movement of said valving means to a position within the limits of said unported space for maintaining the entire flow area of at least said one other port continuously effective.

6. In a liquid fuel atomizer arranged for operation over a wide range of capacities, means forming a whirl chamber having an annular wall and an outlet orifice in alignment along a common

axis, means forming a plurality of inlet ports distributed about said chamber for admitting liquid to said chamber under pressure, said ports being longitudinally displaced to an extent providing an unported annular wall space separating at least one of said ports from all remaining ports of said plurality, and valving means arranged for and substantially limited to rectilinear sliding movement relative to said annular wall for varying the effective flow area of said ports, said means forming said whirl chamber and said valving means having transversely arranged portions adapted to be brought into contact for preventing port-area reducing movement of said valving means beyond the limits of said unported space, thereby establishing a predetermined minimum capacity effective flow area of constant value through at least one of said ports and confining the variation in effective flow area for higher capacities to said remaining ports.

7. In a liquid fuel atomizer arranged for operation over a wide range of capacities, means forming a whirl chamber having a cylindrical enclosing wall and having an outlet orifice in an end wall thereof in alignment with the central axis of said chamber, means forming a series of inlet ports distributed longitudinally of said enclosing wall and opening therethrough substantially tangentially into said chamber, said series of ports including a port section comprising at least one port of circular cross section throughout longitudinally displaced in its entirety from a port section comprising the remaining ports of said series to provide an intervening unported annular space between said port sections, said cylindrical wall terminating in an annular surface arranged transversely of said axis at the end opposite said orifice, means for varying the total effective flow area of said ports comprising a plunger telescoping with said enclosing wall and having a valving edge movable forwardly in the direction of said orifice for progressively decreasing the amount of port area effective for the flow of liquid fuel into said chamber, and means comprising a shouldered portion of said plunger adapted to engage said annular end surface for preventing forward movement of said valving edge beyond the limits of said unported annular space.

8. In a liquid atomizer, means forming a whirl chamber having an outlet orifice in an end wall thereof and a series of tangentially directed inlet ports for liquid distributed longitudinally thereof in an enclosing cylindrical wall, means for varying the effective flow area of said ports comprising a plunger telescoping with said first named means and having a valving edge movable forwardly in the direction of said orifice for progressively decreasing the amount of port area effective for the flow of liquid into said chamber, means for moving said plunger including a movable spindle having an axially adjustable connection therewith, and means limiting the forward movement of said valving edge to a position more remote from said orifice than a port of said series.

9. In a liquid atomizer, means forming a whirl chamber having an outlet orifice, means forming a succession of inlet ports for admitting liquid to said chamber at varying pressures, means for progressively increasing the effective flow area of said succession of ports from a predetermined minimum to an available maximum simultaneously with increases in pressures and solely in response to pressures above a predetermined pressure, said means including a valving member movable across said ports, said valving member

and said first named means having transversely arranged portions adapted for mutual contact to establish said minimum effective flow area, means for holding said transversely arranged portions in contact at pressures below said predetermined pressure, and adjustable means for rendering said contact holding means operable with respect to different predetermined pressure values.

10. In a liquid fuel burner, a hollow body member having a tubular extension, means forming a whirl chamber having an outlet orifice removably assembled within the free end of said extension, said means providing a series of longitudinally distributed inlet ports for admitting fuel to said chamber, means for supplying fuel at varying pressures to said body and through said tubular extension to said ports, a valve member longitudinally movable across ports of said series for increasing and decreasing the effective flow area of said ports, means for moving said valve member comprising a spindle connected thereto and extending longitudinally of said tubular extension from within said body member, means for actuating said spindle comprising an element responsive to variations in fuel pressure within said body, said whirl chamber having a surface forming a stop for positively limiting the port area reducing movement of said valve member to a position of predetermined minimum effective port area, means arranged to exert a loading pressure on said spindle opposing the port area increasing movement of said spindle and thereby of said connected valving member, and means associated with said body member for supporting an end portion of said spindle and for adjusting the loading pressure of said last named means.

11. In a liquid fuel burner having a valve member movable longitudinally of a series of whirl chamber ports for rendering varying amounts of port area effective for the flow of fuel into said chamber, a hollow body member adapted to receive fuel at varying pressures and having a tubular extension for conducting said fuel to said ports, a spindle for moving said valve member extending from within said body member longitudinally of said tubular extension, means for actuating said spindle comprising an element responsive to variations of fuel pressure within said body member, a spring arranged to exert a loading pressure opposing movement of said spindle resulting from exposure of said element to increasing fuel pressures, a housing connected to said body member for supporting an end portion of said spindle having means for adjusting said spring loading pressure, and a removable enclosing cover for said housing, said housing having an opening therein rendering the movement of said spindle and spring visible upon removal of said cover.

12. In a liquid fuel atomizer arranged for wide range operation, means forming a whirl chamber having an annular wall and an outlet orifice in alignment along a common axis, means forming a plurality of longitudinally displaced inlet ports in said wall for admitting fuel to said chamber under pressure, said ports being longitudinally displaced to an extent providing an unported annular wall space separating at least one of said ports from all remaining ports of said plurality, longitudinally movable valving means for varying the effective flow area of said ports, and stop means for positively limiting port area reducing movement of said valving means to a

position within the limits of said unported space.

JAMES FLETCHER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date	
1,452,264	Binks -----	Apr. 17, 1923	10
1,904,509	Morse -----	Apr. 18, 1933	
2,223,055	Bergey -----	Nov. 26, 1940	
759,320	Schutte -----	May 10, 1904	
1,969,954	Taylor -----	Aug. 14, 1934	15
1,996,159	Kittredge -----	Apr. 2, 1935	
1,102,552	Peabody -----	July 7, 1914	

Number
1,051,908
1,076,708
1,180,907
5 Re. 20,027
1,901,415
1,725,381
2,349,221
2,345,402

Name	Date
Normand -----	Feb. 4, 1913
Schorr -----	Oct. 28, 1913
Coen -----	Apr. 25, 1916
Wettstein -----	June 30, 1936
Schneider -----	Mar. 14, 1933
Thomas -----	Aug. 20, 1929
Gorrie -----	May 16, 1944
Lubbock -----	Mar. 28, 1944

FOREIGN PATENTS

Number	Country	Date
636,590	French -----	1928
415,274	British -----	Aug. 23, 1934
35,375	Norwegian -----	July 24, 1922
300,253	Italian -----	Sept. 3, 1932