July 4, 1950 W. W. HALLINAN 2,513,720

THERMOSTATICALLY CONTROLLED, CONSTANT OUTPUT ATOMIZING FUEL NOZZLES

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Fig. 1.

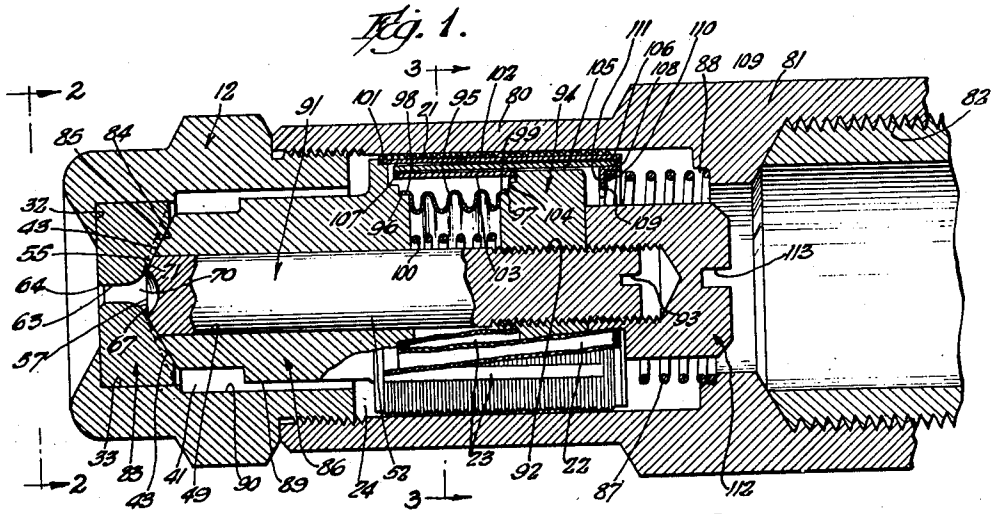


Fig. 2.

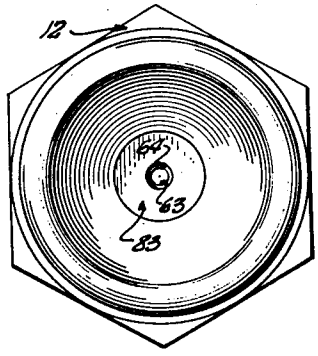
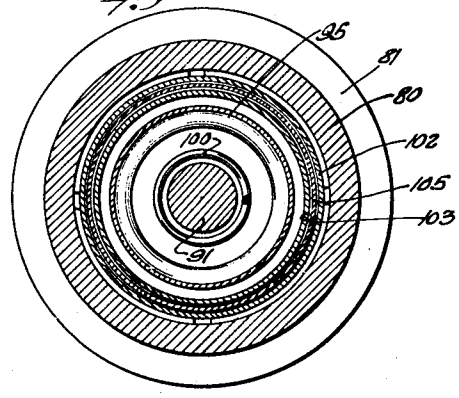


Fig. 3.



INVENTOR.

William W. Hallinan

BY

Robert H. Wendt

Atty.

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THERMOSTATICALLY CONTROLLED, CONSTANT OUTPUT ATOMIZING FUEL NOZZLE

William W. Hallinan, Racine, Wis.

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9 Claims. (Cl. 158—73)

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The present invention relates to atomizing nozzles, and is particularly concerned with atomizing nozzles adapted to be used for oil burners and the like.

One of the objects of the present invention is the provision of an improved atomizing nozzle for oil burners that is adapted to be manually adjusted as to its capacity within the range of the maximum and minimum burning rates of the oil burner, and which also may be employed for automatically controlling the flow through the nozzle responsive to certain variable factors, such as, for example, the temperature or the pressure of the liquid fuel supplied to the nozzle.

Another object of the invention is the provision of a nozzle or atomizer for liquids, the discharge spray of which is adjustable as to its flow capacity to the proper flow for a predetermined number of different sizes of combustion chambers or furnaces, whereby the same nozzle may be used upon installations of different sizes, and it is not necessary to keep in stock nozzles of different capacities.

Another object of the invention is to provide an improved nozzle by means of which the flow of oil through the nozzle in pounds of oil per hour may be automatically maintained substantially constant, even though the temperature of the oil flowing through the nozzle increases or decreases throughout a predetermined range.

Another object of the invention is the provision of an improved atomizing nozzle, the housing parts of which may be provided with interchangeable parts for doubling or changing the discharge capacity of the nozzle by merely substituting one part for another.

Another object of the invention is the provision of an improved atomizer or nozzle in which the amount of machine work and threading is reduced to a minimum, thereby reducing the cost of manufacture.

Another object of the invention is the provision of an improved atomizing nozzle, with which it is not necessary to use tools to assure the proper tightness between the nozzle tip and the plug, this condition being automatically maintained by the structure of the nozzle.

Another object of the invention is the provision of an improved nozzle in which perfect alignment is achieved between the nozzle tip and the nozzle plug which engages it by means of a suitable clearance, permitting an automatic concentric adjustment between these parts, and by means of the application of a suitable resilient pressure driving the plug into concentric position.

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Another object of the invention is the provision of an improved atomizing nozzle which has included in it as a unit a rigid strainer or filter of such fine mesh, the passages of which are formed to a size approximately one-half of the size of the smallest oil groove, to assure the filtering out of all solid matter that might tend to clog the feeder grooves, the strainer being made in single or multiple stages, as desired.

Another object of the invention is the provision of an improved atomizing nozzle unit which includes as a part of it a relatively fine mesh strainer adapted to assure the straining out of all particles that might clog the nozzle and also adapted to perform the function of a thermostat for regulating the oil discharge capacity of the nozzle.

Another object of the invention is the provision of a plurality of improved forms of atomizing nozzles, which are simple in structure, adapted to be manufactured economically, with a minimum number of machine operations, interchangeable as to their parts, manually or automatically adjustable in flow capacity, and adapted to be used for a long period of time without necessity for repair or cleaning operations.

Another object of the invention is the provision of an improved atomizer for oil burners having a self-cleaning arrangement which automatically opens the smallest portions of the oil feeder grooves when the oil pressure is cut off, and automatically closes them when the pressure is again applied, thus allowing the oil which flows through the larger portion of the grooves to wash or flush out any dirt particles which may have become lodged in the smaller portions of the grooves.

Another object of the invention is the provision of an improved atomizing nozzle for oil burners or the like which is adapted to maintain a constant flow through the nozzle in pounds per hour automatically, irrespective of any increase or decrease in the head pressure of the fuel applied to the nozzle between predetermined minimum and maximum pressures which may be expected in the operation of oil burners.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawings, in which similar characters of reference indicate similar parts throughout the several views.

Referring to the single sheet of drawings:

Fig. 1 is an axial sectional view taken through an oil burner nozzle constructed according to the invention;

Fig. 2 is an end elevational view of the nozzle,

taken from the left end of Fig. 1, on the plane of the line 2—2;

Fig. 3 is a transverse sectional view, taken on the plane of the line 3—3 of Fig. 1, looking in the direction of the arrows.

Referring to Fig. 1, this is an axial view of a nozzle embodying the invention, in which the initial rate of flow of the nozzle may be adjusted, but the nozzle is also provided with thermostatic means for varying the rate of flow in accordance with the temperature of the liquid fuel passing through the nozzle, and with pressure responsive means for withdrawing the adjustable plug whenever the pressure is removed from the liquid fuel in the nozzle, thus opening up the grooves to permit the removal of solid particles by a subsequent flushing operation, which also takes place automatically, as will be further described.

In this nozzle the cap 12 is carried by a cylindrical housing 80, having a noncircular portion 81 provided with an axial threaded inlet opening 82. The nozzle tip 83 has a conical inner face 84 provided with the tapered grooves 85. A cylindrical discharge orifice 63, ending in a frusto-conical spray-directing surface 64, is employed; and the nozzle tip is mounted in a cylindrical bore 33 against an annular surface 32. The fixed plug 86 forms a part of an assembly which is spring-pressed toward the nozzle tip 83 by means of a compression spring 87 engaging an annular shoulder 88 on the inside of the housing 80.

The spring 87 is a relatively stiff and short spring of such length that it allows the cap 12 to enter a few threads of the housing 80 before compression is applied; but when the housing 80 is threaded home on the cap 12, full compression is applied to the spring 87, which maintains the nozzle tip in its socket and urges the fixed plug toward the nozzle tip in concentric alignment.

The fixed plug 86 has an external cylindrical guide surface 89 which is slightly smaller than the bore 90 in the cap 12, thus permitting the conical end of the plug 86 to center itself in the conical depression which is provided by the surface 84 of the nozzle tip 83 under the influence of spring 87. At its left end fixed plug 86 has a frusto-conical surface 43. It also has a centrally located cylindrical bore 49 for receiving the movable plug 91.

Movable plug 91 has a cylindrical shank 52 slidably mounted in the bore 49, a frusto-conical surface 43, and a partially spherical depression 57 at its left end. At its right end adjustable plug 91 has a threaded portion 92, the end of which is slotted at 93 to receive a screw driver.

The movable plug 91 also includes an annular thrust member 94 spaced from the main body 86 of the plug and supported on the adjustable plug 91 by being threaded on the threads 92. The plug 86 and annular supporting member 94 are joined by a pressure responsive bellows 95. Each of the cylindrical end portions 96, 97 are soldered to complementary annular shoulders 98, 99 on the plug 86 and annular supporting member 94, respectively.

A compression spring 100 surrounding the shank of adjustable plug 91 has one end engaged against the end of plug 86 and the other end engaged against the annular supporting member 94, thus tending to urge the adjustable plug 91 toward the right.

The fixed plug 86 also has a reduced cylindrical portion 101 for receiving the end of the tubular thermostatic member 102 which has its left end seated against an annular shoulder on the plug 86.

Tube 102 is preferably made of some metal having a high coefficient of thermal expansion, which is also true of inner tube 103, having its right end butting against the annular shoulder 104 on the annular supporting member 94. The intermediate tubular member 105 between the tubes 102 and 103 is preferably made of material having a relatively low coefficient of thermal expansion, such as steel, and it has its right end soldered or welded to the outer tube 102 at 106 and its left end welded at 107 to the inner tube 103.

A thrust ring of Z-shape in cross-section is indicated at 108, and it has its outer annular flange brazed, soldered, or welded to the two tubes 102, 105 at 106. This thrust member 108 is formed with a cylindrical recess 110 forming a recess for the spring 87 and with an inwardly projecting annular flange 111 serving as a seat for the spring 87.

Spring 87 is not attached to the thrust member, but this end of the plug assembly can be moved toward the left and right, depending upon the expansion of the thermostatic tubes 102, 103 under the influence of the temperature of the oil passing through the nozzle. This leaves the thermostatic elements 102, 105, 103 free to react against the plug 86 and against the annular supporting member 94, against the pressure of spring 87, to withdraw the adjustable plug 91 from its seat to adjust the rate of flow of the nozzle thermostatically.

It should be understood that any number of brass and steel tubes may be employed in making the compound thermostat, provided they are arranged as shown to cause the expansion of the brass tubes, as differentiated from that of the steel tubes, to add up.

The outermost brass tube 102 may again be provided with threads 21, and the longitudinally extending grooves 22 and 23 which serve as conduits leading the liquid to these threads which act as a filter.

The purpose of the bellows 95 is to permit the application of pressure to the annular member 94 and adjustable plug 91, urging the adjustable plug 91 into such seating position as is permitted by the thermostats 102—103 only when there is pressure on the oil.

When the oil burner is shut off and the pressure on the oil is relieved by passing out of the nozzle opening, the reduction in pressure on the right end of the annular supporting member 94 and adjustable plug 91 permits the spring 100 to act to separate the part 94 from the part 86, thus withdrawing the adjustable plug 91 from its seat and opening the smallest portion of the grooves 85. This causes the nozzle to suck a small amount of air into the grooves, and when the burner is again turned on, and pressure is applied to the oil leading to the nozzle, this pressure acts upon the projected area of the members 94 and 91, causing the bellows 95 to collapse against spring pressure 100, but before this happens a small amount of oil has been forced through the open grooves, flushing out any solid particles which may have lodged in the smallest portion of these grooves and effecting a self-cleaning operation.

As the only part of the nozzle which is apt to be clogged with solid particles is the smallest part of the groove, this will automatically maintain the oil feed grooves in a clean condition.

Another feature of the thermostat 95 is that by providing a spring 100 of proper size and pressure,

this spring will move the adjustable plug 91 away from the nozzle tip 83 upon decrease of pressure, and will allow approximately the same flow in pounds of oil per hour to flow through the burner when the pressure is reduced as it would for the correct measure.

For example, the burner may be adjusted to burn properly at about 125 pounds per square inch. Then if the head pressure drops, the movement of the adjustable plug 91 will allow the grooves to pass the same amount of fuel in pounds and B. t. u.'s because retraction of the fixed plug increases the effective size of the feed grooves. Thus the present nozzle may be regulated responsive to the oil pressure between a minimum of 80 pounds per square inch and a maximum of 125 pounds per square inch to maintain substantially constant flow of fuel, even though the pressure on the oil drops off.

The present nozzle is, of course, also adjustable as to its initial rate of flow, and this adjustment is made by applying a screwdriver at the slot 93 and turning the adjustable plug 91. A turn in a clockwise direction will reduce the rate of flow, and a turn in a counter-clockwise direction will increase it.

A cap 112, which is screwed on the threaded end of 92 of the adjustable plug 91, serves both as a lock nut and to prevent leakage, and is also provided with a slot 113 for receiving a screwdriver.

The operation of the present nozzle is as follows: Oil is filtered through the fine threads 21 by passing in at the conduits or slots 22 and out of the slots 23 in the threads of tube 102, which also serves as part of the thermostat. By having the compound thermostat detached at each of its ends from the fixed plug 86 and annular member 94, but spring-pressed against shoulders by the spring 87, this permits the bellows 95 to act upon the movable plug 91 also, except that the compound thermostat limits the closing action of the movable plug 91. The thermostat does not limit the opening action of the movable plug 91.

The oil passing through the filter 102 goes into the annular space 24 and through the clearance between the cylindrical surface 89 and the bore 90 into the annular space 41. From there it passes through the tapered grooves 85 in the nozzle tip 83, and when the parts are in the position of Fig. 1 the effective size of the grooves 85 is the smallest end which is determined by the position of the cut-off edge 71 on the movable plug 91.

As the plug 91 is retracted the effective sizes of the grooves 85 become greater. While only two such grooves are shown, three or four, or any number, may be employed, and I preferably employ a multiplicity of relatively fine grooves rather than a few large grooves, to secure a more perfect atomization.

The oil discharges from the small end of the grooves 85 with the nozzle action, tangentially into the whirling chamber 70 with a high speed of rotation, and this causes the atomized liquid to spread by centrifugal action into engagement with the rounded corner 67 and the inner surface of the bore 63. From there the atomized liquid follows the conical surface 64 on the outer face of the nozzle tip 83 and forms a substantially perfect, hollow, conical spray of atomized liquid or mist.

The initial flow capacity or rate of flow may be adjusted by retracting the movable plug 91 by a screwdriver applied in the slot 93, after removing the cap 112. This initial capacity may then be maintained by using the cap 112 as a lock nut.

When the burner has been stopped, the pressure of the spring 100 causes the annular member 94 to separate from the fixed plug 86, as permitted by the bellows 95, withdrawing the plug 91 and opening the grooves 85 to their maximum.

When the oil pressure goes on, an initial amount of oil flows out of these open grooves to flush them and wash them out, and remove solid material, before the pressure builds up. When the pressure is built up, the oil under pressure acting on the projected area of the members 94 and 91 causes the bellows 95 to collapse somewhat against the compression of spring 100, and causes the adjustable plug 91 to approach the nozzle tip 83.

The degree of opening of the feeder grooves 85 will then depend upon the pressure of the liquid fuel supply to the nozzle, and will be regulated responsive to this pressure to provide substantially the same poundage of flow per hour, and the same number of B. t. u.'s of fuel burned per hour, irrespective of the variation of pressure from 125 pounds per square inch down to, for example, 80 pounds per square inch.

As the temperature of the oil increases, due to the flame and operation of the furnace, the thermostatic tubes 102, 103 will expand to a greater degree than the steel tube 105, and the ends of this compound thermostat will react against the shoulders provided on the fixed plug 86 and the annular supporting member 94 to effect a greater opening of the feeder grooves by also tending to retract the movable plug 91 beyond the position, which is caused by the drop of pressure acting on the bellows 95.

Thus, either the increase in temperature or the decrease of pressure may cause a greater opening of the feeder grooves; and the present nozzle automatically takes care of any drops of pressure or any increase of temperature of the fuel oil to maintain a constant delivery of oil in pounds per hour and a constant fuel consumption and heat output in B. t. u.'s per hour.

It will thus be observed that I have invented an improved nozzle which is provided with thermostatic means for automatically adjusting the rate of flow of the nozzle responsive to the temperature of the oil so as to maintain a substantially constant flow in the pounds of fuel per hour, irrespective of the variations in the temperature of the oil, and in spite of the expansion and increase in volume of the oil which would otherwise reduce the output in pounds.

A constant flow of oil may be maintained through the nozzle in pounds of oil per hour, irrespective of increases or decreases in the oil temperature flowing through the nozzle. The rate of flow through the nozzle may be maintained constant, irrespective of increases or decreases in pressure on the oil between a minimum of 80 pounds and a maximum of 125 pounds per square inch.

My nozzles may also be so constructed as to have an automatic self-cleaning structure by means of which the smallest portion of the oil feeder grooves are automatically opened when the oil pressure is cut off, and automatically closed when the pressure is again applied. During this open period of the grooves the oil flowing through the larger portion of the tapered grooves washes or flushes out any dirt or solid particles

that may have become lodged in the smaller portions of the grooves.

The structure of my nozzles permits a manufacturer to use interchangeable parts which may double the discharge capacity of a nozzle by merely substituting one part for another. The machine work and threading involved is reduced to a minimum in my nozzles, thus reducing the manufacturing cost. Furthermore, it is unnecessary to use tools to achieve the proper tightness between the nozzle tip and the plugs, as this condition is automatically maintained in certain nozzles of my construction.

Another advantage of my nozzles is that a perfect alignment is achieved between the frusto-conical plugs which engage the frusto-conical nozzle tip by virtue of the clearances that are provided and of the self-aligning feature of two frusto-conical engaging surfaces.

Another important advantage of my nozzles lies in the provision of the fine mesh strainer structure which is adapted to strain out particles which are larger than one-half the size of the smallest oil groove, and which can be constructed in single or multiple stages, to substantially eliminate any clogging of the nozzle as long as the strainer is maintained open enough to supply the nozzle.

While I have illustrated a preferred embodiment of my invention, many modifications may be made without departing from the spirit of the invention, and I do not wish to be limited to the precise details of construction set forth, but desire to avail myself of all changes within the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a self-cleaning and volume-adjustable nozzle, the combination of a cylindrical housing provided with a discharge opening surrounded by an annular shoulder at one end and having a liquid inlet at the opposite end, a nozzle tip member of cylindrical shape mounted in a bore in said housing engaging said annular shoulder, said nozzle tip member having a central cylindrical discharge bore and having an inner frusto-conical surface with a flaring, convexly curved surface from said bore to said frusto-conical surface, said housing having a bore, and a cylindrical plug member of smaller size than said bore in said housing, forming an annular distribution chamber, said plug member having a complementary frusto-conical end engaging said nozzle tip, said nozzle tip having a plurality of tapered grooves leading from said distribution chamber to said convexly curved surface and arranged tangentially to said convexly curved surface to discharge liquid in a rotary direction in a whirl chamber, of which said convexly curved surface forms a part of the wall, an adjustable member mounted in a bore in said plug member and also having a frusto-conical surface engaging that of the nozzle tip member, resilient means for withdrawing said adjustable member from said nozzle tip member to enlarge said whirl chamber and increase the amount of liquid passing into said whirl chamber, and pressure responsive means acted on by pressure inside said housing against said resilient means to urge said adjustable member into engagement with the nozzle tip member to permit the grooves to be opened and flushed out by the first liquid passing through the nozzle, and thereafter to be closed to a smaller size as pressure builds up in the nozzle.

2. In a self-cleaning and volume-adjustable nozzle, the combination of a cylindrical housing provided with a discharge opening surrounded by an annular shoulder at one end and having a liquid inlet at the opposite end, a nozzle tip member of cylindrical shape mounted in a bore in said housing engaging said annular shoulder, said nozzle tip member having a central cylindrical discharge bore and having an inner frusto-conical surface with a flaring, convexly curved surface from said bore to said frusto-conical surface, said housing having a bore, and a cylindrical plug member of smaller size than said bore in said housing, forming an annular distribution chamber, said plug member having a complementary frusto-conical end engaging said nozzle tip, said nozzle tip having a plurality of tapered grooves leading from said distribution chamber to said convexly curved surface and arranged tangentially to said convexly curved surface to discharge liquid in a rotary direction in a whirl chamber, of which said convexly curved surface forms a part of the wall, an adjustable member mounted in a bore in said plug member and also having a frusto-conical surface engaging that of the nozzle tip member, resilient means for withdrawing said adjustable member from said nozzle tip member to enlarge said whirl chamber and increase the amount of liquid passing into said whirl chamber, and pressure responsive means acted on by pressure inside said housing against said resilient means to urge said adjustable member into engagement with the nozzle tip member to permit the grooves to be opened and flushed out by the first liquid passing through the nozzle, and thereafter to be closed to a smaller size as pressure builds up in the nozzle, and additional resilient means acting on said plug for urging the plug and adjustable member into engagement with the nozzle tip member to effect a self-centering and liquid-tight seating of the complementary frusto-conical surfaces on said members.

3. In a self-cleaning and volume-adjustable nozzle, the combination of a cylindrical housing provided with a discharge opening surrounded by an annular shoulder at one end and having a liquid inlet at the opposite end, a nozzle tip member of cylindrical shape mounted in a bore in said housing engaging said annular shoulder, said nozzle tip member having a central cylindrical discharge bore and having an inner frusto-conical surface with a flaring, convexly curved surface from said bore to said frusto-conical surface, said housing having a bore, and a cylindrical plug member of smaller size than said bore in said housing, forming an annular distribution chamber, said plug member having a complementary frusto-conical end engaging said nozzle tip, said nozzle tip having a plurality of tapered grooves leading from said distribution chamber to said convexly curved surface and arranged tangentially to said convexly curved surface to discharge liquid in a rotary direction in a whirl chamber, of which said convexly curved surface forms a part of the wall, an adjustable member mounted in a bore in said plug member and also having a frusto-conical surface engaging that of the nozzle tip member, resilient means for withdrawing said adjustable member from said nozzle tip member to enlarge said whirl chamber and increase the amount of liquid passing into said whirl chamber, and pressure responsive means acted on by pressure inside said housing against said resilient means to urge said adjustable member into engagement with the nozzle tip member to permit the grooves to be opened and

flushed out by the first liquid passing through the nozzle, and thereafter to be closed to a smaller size as pressure builds up in the nozzle, and thermostatic means subjected to the heat of liquid in the nozzle and responsive to the temperature of said liquid reacting against said plug and acting on said adjustable member upon increase of temperature to increase the area of the discharge openings into said whirl chamber upon increase of temperature and expansion of the liquid fuel so that a greater volume will be discharged to maintain discharge of substantially the same poundage as the temperature of the nozzle and the fuel increases.

4. A combined pressure responsive and temperature responsive nozzle comprising a housing having a discharge aperture communicating with a whirl chamber and having supply conduits for liquid to said whirl chamber extending tangentially of the whirl chamber at all times, said supply conduits tapering in depth toward the whirl chamber, and an adjustable member for increasing the amount of liquid passing into said whirl chamber upon retraction of said member, resilient means for retracting said latter member, and pressure responsive means for advancing said latter member, the retraction being to open the grooves on one side so that the initial supply of liquid flushes them out, the pressure responsive means tending to close the grooves at their minimum ends, and thermostatic means acting in the opposite direction to retract said adjustable member to increase the amount of liquid supplied to said whirl chamber upon increase of temperature, said thermostatic means being subjected to the heat of the liquid in the nozzle.

5. In an atomizing nozzle, a tubular nozzle housing provided with an opening at one end surrounded by an inner annular shoulder, said housing having a cylindrical bore, a nozzle tip member located in said bore against said shoulder, said tip member having a centrally located cylindrical discharge opening and having its inner face of frusto-conical shape, the inner face being joined to said cylindrical bore by a gradually curved surface which forms the outer annular wall of a whirl chamber, said nozzle tip member having a plurality of indentations in its inner face forming feed grooves which extend substantially tangentially to said whirl chamber to cause the liquid discharged through said grooves to have a whirling action in said whirl chamber, a substantially cylindrical plug of smaller size than said bore located in said bore and having a frusto-conical surface engaging the complementary frusto-conical surface of said nozzle tip and closing the sides of said grooves to form passages opening at their outer ends in an annular liquid chamber surrounding said plug, said plug having a cylindrical bore, an adjustable cylindrical member movably mounted in said bore and having a frusto-conical end surface for engaging the complementary surface on said nozzle tip, said adjustable member also having a circular cut-off edge formed on its end about a partially spherical depression, said depression forming the rear surface of said whirl chamber, and said cut-off edge engaging the nozzle tip and defining, with said tapering grooves, minimum size openings for discharge of liquid into said whirl chamber, thermostatic sleeve means attached at one end to said plug and attached at its opposite end to said adjustable member, and tending to retract said adjustable member upon increase of temperature of the liquid in said nozzle, which increases the volume of the liquid fuel so that upon increase of temperature an increased volume of liquid will be passed between the nozzle tip and the end of said adjustable member into said whirl chamber to provide a greater volume of fuel when the fuel has expanded due to heat, resilient means tending to retract said adjustable member from engagement with said nozzle tip, and a pressure responsive bellows acting upon said adjustable member to urge it toward said nozzle tip responsive to pressure of liquid in said housing, the adjustable member being retracted upon reduction in pressure to provide an increased volume of the openings leading to the whirl chamber and to maintain a constant amount of flow of fuel through the nozzle, even at reduced pressures.

6. In an atomizing nozzle, the combination of a nozzle cap provided with a circular opening at one end and an annular shoulder facing inwardly and threaded at its opposite end, said cap having a bore terminating at said annular shoulder, a nozzle tip member located in said bore against said annular shoulder and having a central cylindrical discharge opening and having an inner frusto-conical face provided with grooves tapering toward said discharge aperture, a cylindrical plug having a central cylindrical bore and a frusto-conical end surface complementary to and engaging the surface on said nozzle tip, said plug being smaller than said bore to form an annular fuel chamber about said plug communicating with the larger end of said grooves, an adjustable, slidably mounted cylindrical member in the bore of said plug and terminating in another frusto-conical end surface complementary to and engaging said nozzle tip, said adjustable member having a partially spherical depression in its end forming the rear wall of a whirl chamber and communicating with said grooves at their minimum size ends, a sleeve of thermally expansible material carried by said plug and having its remote end secured to another inner sleeve of material having a low coefficient of thermal expansion, said latter sleeve having its opposite end secured to a second innermost sleeve of thermally expansive material, the opposite end of which is secured to said adjustable member, the said thermally expansible sleeves tending to withdraw said adjustable member upon increase of temperature of the liquid in said nozzle and increasing the volume of flow into said whirl chamber so that upon heating and expansion of the liquid fuel an amount may be supplied to the nozzle of constant heating value in B. t. u.'s.

7. In an atomizing nozzle, the combination of a nozzle cap provided with a circular opening at one end and an annular shoulder facing inwardly and threaded at its opposite end, said cap having a bore terminating at said annular shoulder, a nozzle tip member located in said bore against said annular shoulder and having a central cylindrical discharge opening and having an inner frusto-conical face provided with grooves tapering toward said discharge aperture, a cylindrical plug having a central cylindrical bore and a frusto-conical end surface complementary to and engaging the surface on said nozzle tip, said plug being smaller than said bore to form an annular fuel chamber about said plug communicating with the larger end of said grooves, an adjustable, slidably mounted cylindrical member in the bore of said plug and terminating in another frusto-conical end surface complementary to and engaging said nozzle tip, said adjustable mem-

ber having a partially spherical depression in its end forming the rear wall of a whirl chamber and communicating with said grooves at their minimum size ends, a sleeve of thermally expansible material carried by said plug and having its remote end secured to another inner sleeve of material having a low coefficient of thermal expansion, said latter sleeve having its opposite end secured to a second innermost sleeve of thermally expansive material, the opposite end of which is secured to said adjustable member, the said thermally expansible sleeves tending to withdraw said adjustable member upon increase of temperature of the liquid in said nozzle and increasing the volume of flow into said whirl chamber so that upon heating and expansion of the liquid fuel an amount may be supplied to the nozzle of constant heating value in B. t. u.'s, a nozzle housing threadedly secured to said cap and having an inwardly facing annular shoulder at its opposite end, and resilient means engaging said shoulder and also reacting against said first-mentioned thermally expansible sleeve to urge the said plug into self-centering engagement with the frusto-conical surface of said nozzle tip.

8. In an atomizing nozzle, the combination of a nozzle cap provided with a circular opening at one end and an annular shoulder facing inwardly and threaded at its opposite end, said cap having a bore terminating at said annular shoulder, a nozzle tip member located in said bore against said annular shoulder and having a central cylindrical discharge opening and having an inner frusto-conical face provided with grooves tapering toward said discharge aperture, a cylindrical plug having a cental cylindrical bore and a frusto-conical end surface complementary to and engaging the surface on said nozzle tip, said plug being smaller than said bore to form an annular fuel chamber about said plug communicating with the larger end of said grooves, an adjustable, slidably mounted cylindrical member in the bore of said plug and terminating in another frusto-conical end surface complementary to and engaging said nozzle tip, said adjustable member having a partially spherical depression in its end forming the rear wall of a whirl chamber and communicating with said grooves at their minimum size ends, a sleeve of thermally expansible material carried by said plug and having its remote end secured to another inner sleeve of material having a low coefficient of thermal expansion, said latter sleeve having its opposite end secured to a second innermost sleeve of thermally expansive material, the opposite end of which is secured to said adjustable member, the said thermally expansible sleeves tending to withdraw said adjustable member upon increase of temperature of the liquid in said nozzle and increasing the volume of flow into said whirl chamber so that upon heating and expansion of the liquid fuel an amount may be supplied to the nozzle of constant heating value in B. t. u.'s, said adjustable member having its end and opposite the nozzle tip threaded, an annular member threaded on said threaded end, and an expansible bellows extending from said plug to said latter annular member, the liquid pressure on said adjustable member tending to urge the adjustable member into engagement with the nozzle tip to reduce the volume of flow upon increase of pressure of liquid in the nozzle.

9. In an atomizing nozzle, the combination of a nozzle cap provided with a circular opening at one end and an annular shoulder facing inwardly and threaded at its opposite end, said cap having a bore terminating at said annular shoulder, a nozzle tip member located in said bore against said annular shoulder and having a central cylindrical discharge opening and having an inner frusto-conical face provided with grooves tapering toward said discharge aperture, a cylindrical plug having a central cylindrical bore and a frusto-conical end surface complementary to and engaging the surface on said nozzle tip, said plug being smaller than said bore to form an annular fuel chamber about said plug communicating with the larger end of said grooves, an adjustable, slidably mounted cylindrical member in the bore of said plug and terminating in another frusto-conical end surface complementary to and engaging said nozzle tip, said adjustable member having a partially spherical depression in its end forming the rear wall of a whirl chamber and communicating with said grooves at their minimum size ends, a sleeve of thermally expansible material carried by said plug and having its remote end secured to another inner sleeve of material having a low coefficient of thermal expansion, said latter sleeve having its opposite end secured to a second innermost sleeve of thermally expansive material, the opposite end of which is secured to said adjustable member, the said thermally expansible sleeves tending to withdraw said adjustable member upon increase of temperature of the liquid in said nozzle and increasing the volume of flow into said whirl chamber so that upon heating and expansion of the liquid fuel an amount may be supplied to the nozzle of constant heating value in B. t. u.'s, said adjustable member having its end and opposite the nozzle tip threaded, an annular member threaded on said threaded end, and an expansible bellows extending from said plug to said latter annular member, the liquid pressure on said adjustable member tending to urge the adjustable member into engagement with the nozzle tip to reduce the volume of flow upon increase of pressure of liquid in the nozzle.

WILLIAM W. HALLINAN.

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2,015,611	Wettstein	Sept. 24, 1935
2,017,467	Loomis	Oct. 15, 1935
2,071,143	Scott	Feb. 16, 1937
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FOREIGN PATENTS

Number	Country	Date
15,733	Great Britain	July 15, 1904
17,793	Great Britain	July 26, 1910
288,727	Italy	Sept. 19, 1931
298,252	Great Britain	Oct. 8, 1928
640,732	France	Apr. 3, 1928
780,720	France	Feb. 4, 1935