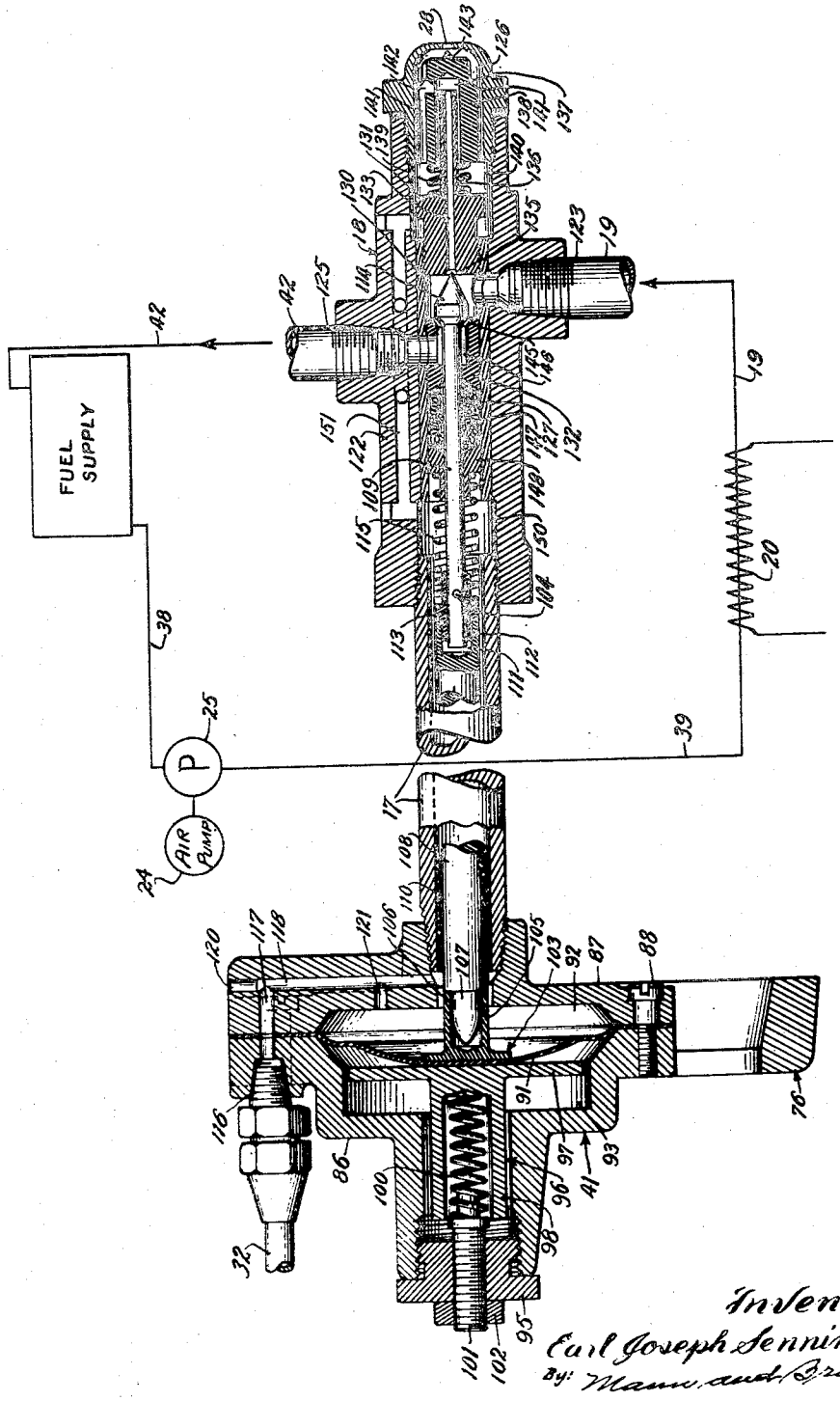
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LIQUID FUEL BURNER NOZZLE

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LIQUID FUEL BURNER NOZZLE

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While my invention relates broadly to systems for producing and discharging mixtures of liquids and gaseous fluids, with special reference to spray systems, it is especially advantageous for liquid fuel burner systems, and, for the purpose of the present disclosure, will be so described.

In a fuel burner system of the present type fuel, oil and compressed air is delivered to a fuel nozzle by separate passages for intermixture and ultimate discharge in spray form, the liquid fuel usually being subjected to preliminary heating, for example by an electric heating element.

One common need for improvement in these systems is the venting of the liquid passages and the deaeration of the liquid preliminary to operating periods. This need is especially marked in burner systems that characteristically operate only intermittently, as in the case of domestic heating systems operating under thermostatic control. Between operating periods air pockets tend to form in the static liquid, with consequent faulty fuel discharge upon resumption of combustion operation.

One object of my invention is to meet this need by providing for automatic preliminary deaeration flow of the liquid through a nozzle bypass in preparation for each period of combustion operation. The location of the by-pass is important because placing the by-pass for deaeration any distance from the burner nozzle necessarily means omitting a portion of the fuel line from the deaeration effect.

A second need for improvement in systems of the present type is to avoid nozzle leakage arising from residual heat after the termination of an operating period. When the burner system is deenergized the heating element maintains a relatively high temperature for a short period of time, and the consequent local expansion and evaporization in the associated fuel line usually displaces fuel toward the burner nozzle with consequent dripping and carbon formation at the nozzle orifice.

Another object of my invention is to prevent this delayed-action displacement to the nozzle orifice during idle periods by placing a valve in the fuel line between the heating element and the nozzle orifice. Fortuitously the locating of the fuel by-pass at the nozzle to meet the first-mentioned object of the invention, viz: complete

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aeration of the fuel line, facilitates the attainment of this second object of preventing drip. In this regard a feature of the invention is the employment of a three-way nozzle valve having one position for normal combustion operation and a second position for idle periods at which second position the three-way valve completely cuts off the nozzle orifice and places the fuel line in communication with the by-pass.

One difficulty in spraying some kinds of liquids in fuel burner systems, as well as in other systems, is the tendency for the liquid valves to become clogged, especially when highly viscous liquids are employed.

A further object of my invention is to avoid this difficulty, along with certain other troubles, by periodically flushing the liquid valve with a gaseous fluid. In the preferred practice of the invention it is my purpose to flush the nozzle valve periodically by reverse air flow.

A still further object and feature of my invention is to employ a three-way nozzle valve so constructed as to provide automatically for the reverse air flow at an intermediate position of the valve both immediately before and immediately after a period of combustion operation.

The above and other objects and advantages of my invention will be apparent in the following detail description taken with the accompanying drawing.

In the drawing, which is to be regarded as merely illustrative, the accompanying figure is a longitudinal sectional view of an air tube and burner nozzle employed in the preferred practice of the invention, certain pertinent parts of the system associated with the nozzle being shown diagrammatically.

This invention may be applied to any conventional oil burner, although I prefer to use it in conjunction with the type of oil burner shown in my prior patents Nos. 2,397,986, 2,397,987, and 2,397,988, of which this case is a continuation-in-part, and my copending application Ser. No. 657,359, filed March 27, 1946, the disclosures of which patents and application are incorporated herein by reference. Referring now to the drawing, the oil burner nozzle assembly comprises a primary air supply line or tube 17, a nozzle 18, an oil supply line 19, a heater 20 associated with the oil supply line 19, and a pair of electrodes 21

associated with the nozzle for igniting the mixture of oil and air in starting the burner. An air pump shown diagrammatically at 24 supplies primary air to the nozzle through fitting 32, a blower (not shown) supplies secondary air, and a motor (not shown) drives an oil pump 25 which provides oil under pressure to the nozzle. The fluid course or gaseous supply passage for the primary air has relatively large storage capacity, which capacity insures an even flow to the nozzle. It is important that the fluid course have a sufficiently large total volume relative to the flow capacity of the nozzle orifice 28 to serve as a reservoir for maintaining flow through the nozzle orifice for a substantial period of time after the air supply to the fluid course is cut off. Oil for fuel is stored in a suitable fuel supply tank and is led therefrom through pipe 38 to the oil pump 25, which is preferably combined with an air pump 24 in the manner disclosed in my copending application Ser. No. 657,359, entitled Dual pump, filed concurrently herewith. Where gravity feed cannot be used, an auxiliary pump (not shown) should be provided to boost oil from the supply tank to the oil pump. The oil pump 25 delivers the fuel oil through the supply line 39 and the previously mentioned pipe 19 to a three-way valve that is concealed in the nozzle 18 as shown in the drawing. The three-way valve is governed by an actuator or automatic valve control 41. At the idle or non-operating position of the three-way valve, the end of the oil supply pipe 19 at the nozzle 18 is placed in communication with a by-pass pipe 42 that leads from the nozzle 18 back to the fuel oil supply tank. In response to rise in pressure in the air supply pipe 32 the automatic control 41 moves the three-way valve to its normal operating position, thereby to place the end of the oil supply line 29 at the nozzle 18 in communication with the nozzle orifice 28. When operation of the described arrangement is started, oil discharged from the pump 25 through the supply pipes 39 and 19 is initially by-passed at the nozzle back to the supply tank through the by-pass pipe 42. As soon as sufficient pressure is built up in the fluid course to insure proper delivery of primary or atomizing air to the nozzle 18, the pressure-responsive actuator will react to the rise in air pressure by operating the three-way valve in the nozzle 18 to cut off the by-pass pipe 42 and to open communication to the nozzle orifice 28, whereupon a fuel mixture of oil and air is sprayed from the nozzle for combustion. When, for any reason, the air pressure in the fluid course drops below that for which the device is designed and adjusted, the pressure-responsive actuator 41 will operate the three-way valve in the nozzle to cause the oil discharged by the pump 25 to be returned to the supply tank by the by-pass pipe 42.

Automatic valve control

As shown in the drawing, the interior of the housing formed by the two body sections 86 and 87 of the valve control 41 is divided by a flexible diaphragm 91 into what may be termed an air chamber 92 and a spring chamber 93. The spring chamber 93, which is closed at its outer end by a bushing 95, encloses a spring follower 96, which spring follower has a circular head 97 and a tubular stem 98. A suitable spring 100, housed in the tubular stem 98, is provided to urge the follower 96 against the diaphragm 91. For adjustably varying the effect of the spring 100 a suitable adjustment screw 101, carrying a lock nut 102, extends through the bushing 95 in abutment with the outer end of the spring 100.

The inner body section 87 of the valve control 41, into which the air tube 17 is threaded, encloses a second smaller follower 103 in abutment with the diaphragm 91. This second follower 103 has a tubular stem 105 that is slidingly guided by the bore leading to the air tube 17, and preferably suitable grooves 106 are formed in the surrounding guiding walls to provide free communication between the air chamber 92 and the interior of the air tube 17.

Seated in the tubular stem 105 of the follower 103 is the reduced end 107 of a valve control rod 108 that extends through the air tube 17 and forms with the air tube an annular air passage 110. In the other end of the control rod 108 a socket 111 is formed to receive a tubular fitting 112, the tubular fitting having a radial flange 113 in abutment with the end of the rod. A suitable helical spring 115 is seated against the radial flange 113 to continuously urge the control rod 108 toward the diaphragm 91, but this spring 115 is substantially weaker than the previously mentioned spring 100. Seating in the tubular fitting 112, and secured therein by a pin 104, is the stem 109 of the valve member 114 of the previously mentioned three-way valve in the nozzle.

A suitable fitting 116 is threaded into the outer body section 86 for connection with the previously mentioned pipe 32. Suitable registering bores in the two body sections 86 and 87 form a longitudinal passage 117, which passage joins a radial bore 118 to provide for air flow from the fitting 116 to the annular air passage 110 in the air tube 17. The radial bore 118 is closed at its outer end by a suitable plug 120, and is in communication with the air chamber 92 through a short bore 121.

It is apparent that pressure changes in the previously mentioned fluid or air course that includes an air chamber in the burner, the pipe 32, and the air tube 17 will be transmitted to the air chamber 92 to act against the diaphragm 91. The air pressure against the diaphragm is reinforced by the spring 115. The relative magnitudes of the forces involved is such that in the absence of substantial pressure in the air chamber 92 the spring 100 will cause the control rod 108 to hold the valve member 114 in its outer limit position, i. e., the limit position to the right as viewed in the drawing. When the pressure in the air chamber 92 rises in response to rise of pressure in the air supply pipe 32, the spring 100 is compressed and the valve member 114 moves to its inner limit position, or to the left as viewed in the drawing.

Nozzle construction

The nozzle 18 has a tubular body 122, with a threaded radial port 123 for connection with the oil line 19, and a second threaded radial port 125 for connection to the by-pass 42, the two ports being offset from each other longitudinally of the tubular body. The inner end of the tubular body 122 is threaded onto the primary air tube 17, and into the outer end is threaded a nozzle fitting 126 having the previously mentioned nozzle orifice 28. Fixedly mounted in the interior of the tubular body is a cylindrical liner 127 that is cut away as shown at the two ports 123 and 125.

The three-way valve that responds to the valve control 41 includes a valve chamber 130 opposite the port 123, which valve chamber is formed by the liner 127, a bushing 131 threaded into the outer end of the liner, and a valve core 132 that

is fixedly mounted in the liner. The bushing 131 has an axial bore 133 for flow of fluid from the valve chamber 130 to the nozzle orifice 28. The inner end of this axial bore forms a valve seat 135 for the valve member 114, while the outer end of the bore is continued forward by a small tube 136 integral with the bushing.

The small tube 136 extends with circumferential clearance, as well as end clearance, into an axial bore 137 in a nozzle core 138 that is seated in the nozzle fitting 126 and is held in place by a suitable helical spring 139 in compression between the nozzle core and the bushing 131. It will be noted that the bushing 131 is smaller in diameter than the surrounding cylindrical wall of the tubular body 122, and that the bushing together with the small tube 136 forms an annular chamber 140 in the tubular body. The annular chamber 140 communicates with the nozzle orifice 28 through a series of channels formed by peripheral grooves 141 in the nozzle core 138, and also communicates with the nozzle orifice through the axial bore 137 and one or more openings 142 from the axial bore 137 to the periphery of the nozzle core. It will be noted that the forward end of the nozzle core is spaced inward from the nozzle orifice 28 and is formed with a small conical projection 143 coaxial with the nozzle orifice 28.

The valve core 132, which is bored to slidingly embrace the valve stem 109, is formed with a valve seat 145 at its forward end and is cut away to provide a fluid passage 146 from the valve seat to the port 125 in which the by-pass pipe 42 is threaded. Preferably the valve stem 109 is surrounded by suitable packing 147, which packing is placed between the valve core 132 and a suitable annular member 148. The previously mentioned spring 115 is in compression against the annular member 148 to place the packing 147 under suitable pressure.

Air from the annular passage 110 in the tube 17 flows into an annular chamber 150 surrounding the valve stem 109 and is then conducted to the forward annular chamber 140 through a passage 151 formed in the wall of the tubular body 122.

The drawing shows the valve member 114 in an intermediate position. When the valve member 114 is in its forward limit position, i. e., to the right as viewed in the drawing, it is seated in the forward valve seat 145 to cut off the valve chamber 130 from the nozzle orifice 28. At such time fuel oil may flow from the oil line 19 through the valve chamber 130 and through the fluid passage 146 into the by-pass 42. On the other hand, when the valve member 114 is in its extreme rearward position, or to the left as viewed in the drawing, it is seated in the valve seat 145 to cut off the valve chamber 130 from the by-pass 42. At such time fuel oil may flow from the oil line 19 into the valve chamber 130 and through the axial bore 133 of the bushing 131 into the interior of the nozzle core 138 for ultimate discharge through the nozzle orifice 28. In moving from one of the two valve seats to the other the valve member 114 passes through a short range of intermediate positions, at which positions the valve chamber 130 is simultaneously in communication with the oil line 19, the by-pass 42 and the nozzle orifice 28.

The nozzle action

The normal air pressure in the fluid course for conducting atomizing air to the nozzle 18 will vary, say, from five to thirty pounds per square inch for different installations. For the purpose of explanation let it be assumed that the normal operating pressure for the air supply is fifteen pounds. The normal operating oil pressure may be of approximately the same magnitude.

When the apparatus is idle between combustion periods the valve member 114 is, of course, in its forward limit position, cutting off the nozzle orifice 28 from the valve chamber 130. In response to thermostatic control, or other control, the oil pump 25 and the air pump 24 start simultaneously, and immediately oil flows from the oil line 19 through the three-way valve into the by-pass 42 to return to the fuel supply tank. Initial by-pass flow will serve to deaerate the fuel oil that has been standing in the oil supply pipes 39 and 19. During this initial by-passing period the heater 20 is energized to raise the temperature of the by-passing oil, and the increase in temperature is helpful to a certain extent in the deaeration.

During this initial period of time in which the valve member 114 is effectively seated in its forward position the air pressure gradually builds up in the fluid course. As a result of the rising pressure the air flows with increasing velocity out of the nozzle orifice 28. When this rising air pressure reaches, say, approximately one-third of normal pressure, or five pounds per square inch, the corresponding rise of pressure in the air chamber 92 of the valve control 41 causes the valve member 114 to be moved from its forward limit position to its rearward limit position.

An appreciable period of time is required for the valve member to complete this movement between its limit positions, and during such period of time the valve chamber 130 is open not only to the oil supply line 19 and the by-pass 42 but also to the nozzle 28. Because the oil may escape from the valve chamber to the by-pass 42 with relative freedom the liquid pressure in the valve chamber, during this transition period, is relatively low and therefore a substantial portion of the air supplied to the forward end of the nozzle takes a path of relatively low resistance back through the small tube 136 and axial bore 133 into the valve chamber 130, the air passing out through the by-pass 42. This reverse flow of the air flushes out the forward valve seat 135 and produces agitation to flush out the whole valve chamber. The momentary acceleration of flow through the by-pass 42 created by the additional air also tends to flush out the by-pass 42.

When the valve member 114 completes its rearward movement to seat in the rear valve seat 145, the oil pressure in the valve chamber 130 immediately rises to the normal operating magnitude and oil is discharged forward through the small tube 136 for mixture with the atomizing air prior to discharge from the nozzle orifice 28. The nozzle core 138 is of a configuration to cause the mixed liquid and air to whirl in a vortex in the space immediately back of the nozzle orifice 28 for efficient spraying action.

At the end of a combustion period when the air pump 24 and the oil pump 25 are deenergized simultaneously the oil pressure in the valve chamber 130 drops sharply, but the air pressure in the fluid course for supplying air to the nozzle drops relatively slowly because the volume of the air course is large relative to the release capacity of the nozzle. At this time, while the valve member 114 is at its rearward position, the flow of air

to the nozzle orifice 28, through and around the nozzle core 138, tends to clear oil out of the forward spaces of the nozzle, such oil being consumed as the burner flame dies out.

When the air pressure in the fluid course drops to approximately five pounds the corresponding drop in the air chamber 92 causes the valve member 114 to be moved forward to the forward valve seat 135 to cut off the valve chamber 130 from the nozzle orifice. In the time period of appreciable duration in which this forward movement occurs, the valve chamber 130 is again open to the nozzle orifice as well as to the oil supply pipe 19 and the by-pass 42, and again reverse air flow is set up through the small tube 136 and the axial bore 133 into the valve chamber 130. The reverse flow of air sweeps residual oil in the forward portion of the nozzle with concentrated effect on the small tube 136 and the axial bore 133. At the completion of the forward movement of the valve member 114 no quantity of oil remains forward of the valve chamber 130 to cause any dripping of oil from the nozzle during the subsequent idle period between combustion operations.

After the valve member 114 reaches its forward limit position, thereby cutting off the valve chamber 130 from the nozzle orifice, residual heat in the heating element 20 continues to heat the oil in the supply pipe 19, but any expansion or evaporization arising from such delayed temperature rise cannot cause dripping from the nozzle since the nozzle orifice is cut off from the oil line. The by-pass 42 is open, however, to provide a vent or release passage for such delayed expansion or evaporization of the fuel in the supply line.

My description in specific detail of the preferred practice of the invention will suggest to those skilled in the art various changes and substitutions within the scope of the appended claims.

I claim as my invention:

1. In an apparatus of the character described for discharging a mixture of liquid and gaseous fluid, a nozzle having a discharge orifice, a gaseous supply passage leading to the nozzle, a by-pass connection, a valve chamber having two openings therein, a valve in said chamber movable between a position where said means will obstruct one of said openings to a position where it will obstruct the other of said openings, one of said openings communicating with said orifice, the other opening communicating with the by-pass connection, a liquid supply passage leading to said valve chamber, means to deliver liquid to said supply passage, and means to apply heat to the liquid supply passage, the point of heat delivery being between said delivery means and said valve chamber whereby movement of the valve to the position of obstructing the opening communicating with the nozzle causes any subsequent expansion by heat in said liquid supply passage to be relieved through said by-pass instead of through the nozzle orifice.

2. In an apparatus of the character described for discharging a mixture of liquid and gaseous fluid, a nozzle having a discharge orifice, a gaseous supply passage leading to the nozzle, a by-pass connection, a valve chamber having two openings therein, a valve in said chamber movable between a position where said means will obstruct one of said openings to a position where it will obstruct the other of said openings, a liquid supply passage leading to said valve chamber, means to deliver liquid to said supply passage, and a heater in heat exchange relationship with the liquid in said liquid supply passage, one of said openings communicating with said by-pass connection and the other opening communicating with the orifice whereby said valve means may cut off the heated liquid from said orifice.

3. In an apparatus of the character described for discharging a mixture of a liquid and a gaseous fluid, a nozzle having an orifice, a valve chamber, a nozzle passage for communication between said valve chamber and said orifice, a liquid supply passage to said valve chamber, a by-pass leading from said chamber, a valve in the chamber movable between an idle position and a normal operating position, the idle position of the valve placing the liquid supply passage in communication with the by-pass while cutting off the nozzle passage, and the normal operating position placing the liquid supply passage in communication with the nozzle passage while cutting off the by-pass from the liquid supply passage, said valve also having an intermediate position in which the liquid supply passage is in communication with both the nozzle passage and the by-pass, means for moving the valve through its range of positions, and means in communication with said nozzle passage for providing gaseous fluid under pressure to said nozzle passage, whereby when the valve is in its intermediate position, the pressure of the gaseous fluid will cause a portion to flow in reverse direction through said nozzle passage to the by-pass to thereby flush the nozzle passage.

4. In an apparatus of the character described for discharging a mixture of a liquid and a gaseous fluid, a nozzle having an orifice, a valve chamber, a nozzle passage for communication between said valve chamber and said orifice, a liquid supply passage to said valve chamber, a by-pass leading from said chamber, a valve in the chamber movable between an idle position and a normal operating position, the idle position of the valve placing the liquid supply passage in communication with the by-pass while cutting off the nozzle passage, and the normal operating position placing the liquid supply passage in communication with the nozzle passage while cutting off the by-pass from the liquid supply passage, said valve also having an intermediate position in which the liquid supply passage is in communication with both the nozzle passage and the by-pass, means for moving the valve through its range of positions, means in communication with said nozzle passage for providing gaseous fluid under pressure to said nozzle passage, whereby when the valve is in its intermediate position, the pressure of the gaseous fluid will cause a portion to flow in reverse direction through said nozzle passage to the by-pass to thereby flush the nozzle passage, and sealing means interposed between the inner end of the nozzle passage and the valve chamber for cooperating with the valve when in its idle position, whereby whenever the valve moves from normal operating position to idle position, the nozzle passage is sealed from the valve chamber after first being reverse flushed with air.

5. In an apparatus of the character described for discharging a mixture of a liquid and a gaseous fluid, a nozzle having an orifice, a liquid supply passage leading to said nozzle, means operable intermittently to supply liquid to said liquid supply passage, a valve chamber in communication with said liquid supply passage, a valve located between said chamber and the nozzle to cut off said orifice from said liquid sup-

ply passage, means to move said valve to said cut-off position automatically with time delay after said intermittent means ceases to operate, and means to force air through said valve for flushing of the valve after the intermittent means ceases to operate and before the valve moves to its cut-off position, said last named means including a low pressure by-pass port communicating with said valve chamber.

EARL JOSEPH SENNINGER.

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