Feb. 6, 1962 I. B. CAMPBELL 3,019,990

ATOMIZING OIL BURNER NOZZLE

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FIG. 1

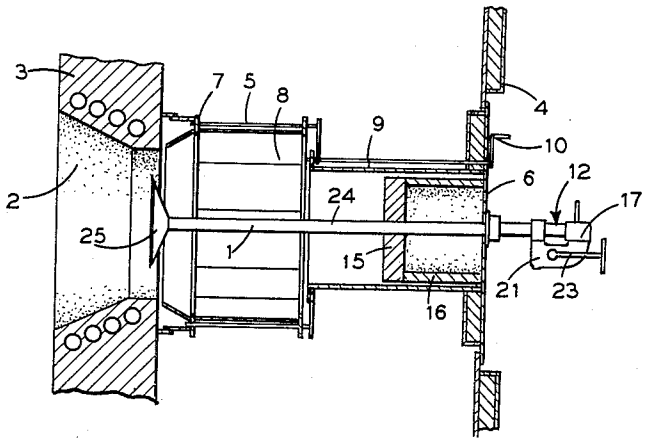
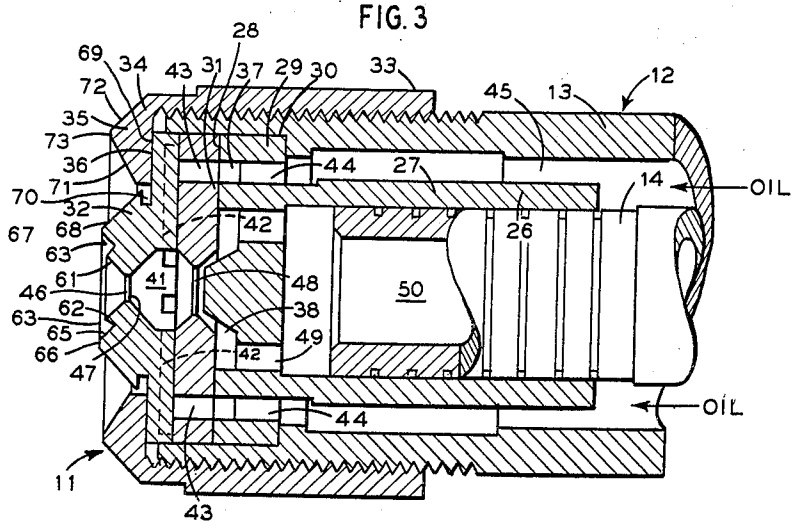


FIG. 3



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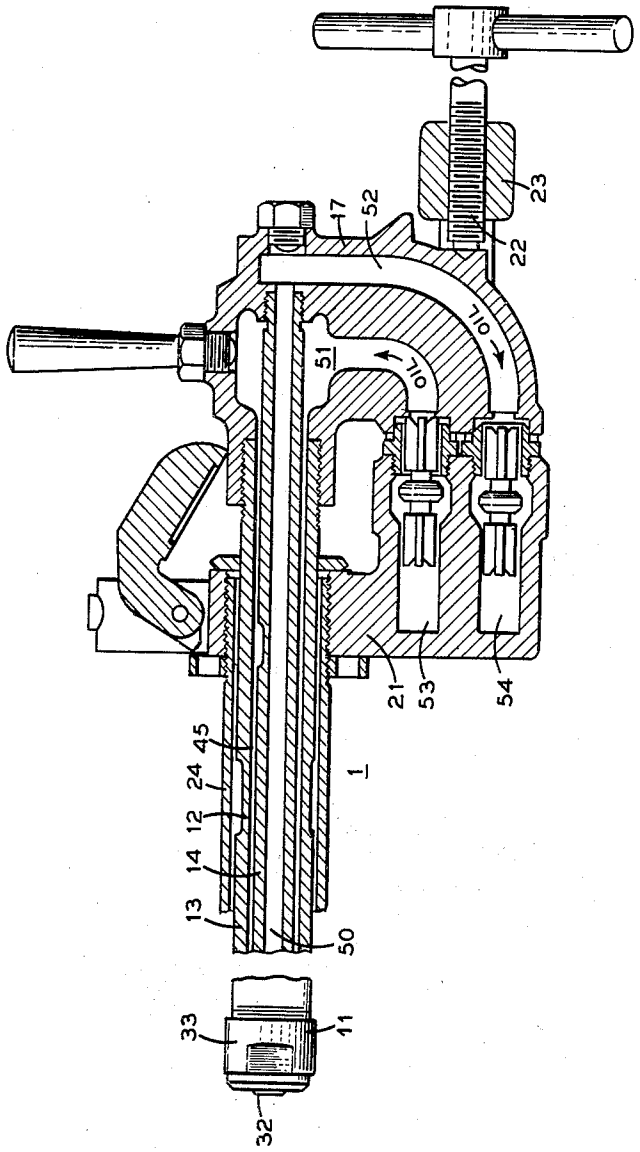
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FIG. 2



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FIG. 4

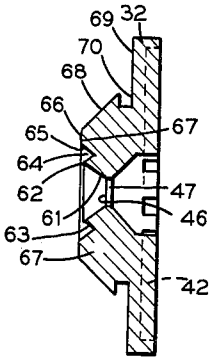


FIG. 5

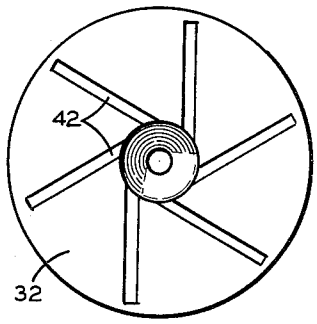


FIG. 6

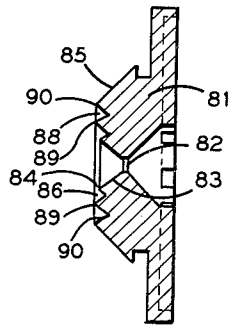


FIG. 9

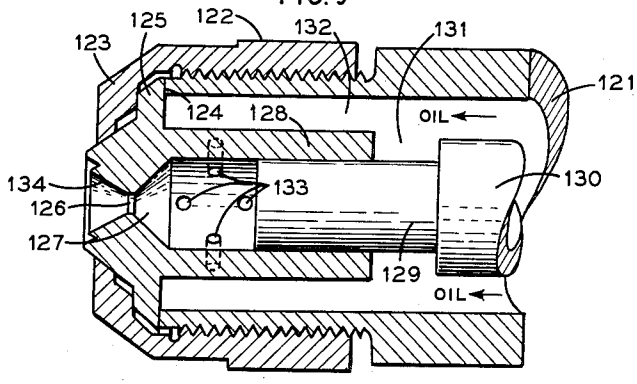
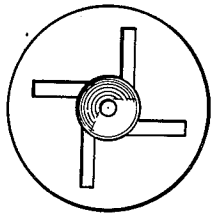


FIG. 8



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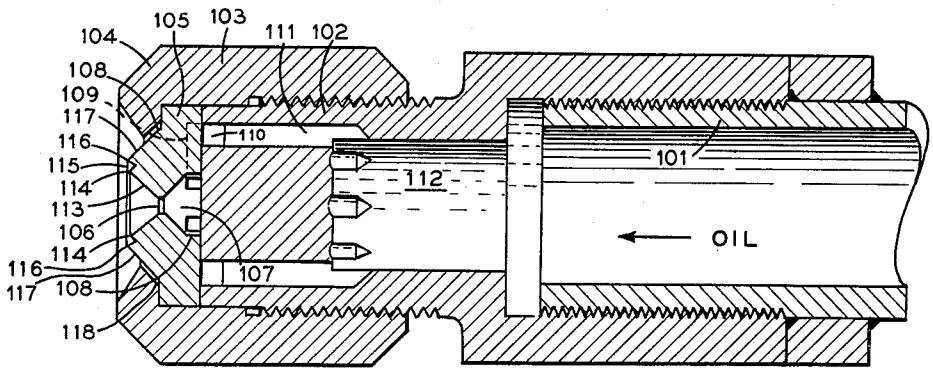
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FIG. 7



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3,019,990

ATOMIZING OIL BURNER NOZZLE

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Filed Apr. 8, 1959, Ser. No. 804,912
3 Claims. (Cl. 239—125)

This invention relates to liquid fuel burners of the pressure atomizing type. Such burners commonly have an atomizer head incorporating a sprayer plate formed with an accurately reamed fuel discharge orifice leading from a whirl chamber, the forward end of the discharge orifice being flush with a plane front surface of the sprayer plate. Any spillage of liquid fuel that may take place from the discharge orifice over the said sprayer surface, which faces the radiant heat from the furnace being fired, and over adjacent parts of the atomizer head, is objectionable, since it may lead to carbon formation, deterioration of atomization and the necessity of frequent discontinuation of burner operation in order that the burner may be withdrawn and cleaned. Another difficulty, experienced more particularly with burners of kinds in which the whirl velocity of fuel at the discharge orifice is maintainable for efficient atomization although the quantity of fuel discharged may be substantially reduced, is the considerable change in the angle of the spray from the burner between full load and minimum load condition, which may lead to impingement of fuel on the refractory throat of the burner port; an increase in spray angle may also conduce to oil spillage from the discharge orifice.

An object of the invention is the provision of a burner sprayer plate, and of a burner incorporating a sprayer plate, with which the danger of fuel deleteriously carbonizing on the atomizer head is reduced or eliminated.

Another object is the provision of a pressure atomizing burner capable of efficient operation over a wide range of loads with only a small variation of the angle of spray.

The invention includes a liquid fuel burner sprayer plate in which extending outwardly from the fuel discharge orifice is a flaring outlet terminating in a sharp annular edge.

The invention also includes a liquid fuel burner of the pressure atomizing type having a sprayer plate in which extending outwardly from the fuel discharge orifice is an outlet flaring frusto-conically at an angle of the same order as the normal spray angle of the burner.

The invention moreover includes a liquid fuel burner of the pressure atomizing type, having a sprayer plate in which extending outwardly from the fuel discharge orifice is a flaring outlet terminating in a sharp annular edge and in which the outer face of the sprayer plate is formed outwardly of an annular groove therein concentric with the axis of the discharge orifice with an annular surface sloping rearwardly in a radially outward direction.

The sharp annular edge at the termination of the flaring outlet extending outwardly from the discharge orifice promotes separation of liquid fuel from the sprayer plate. Where the sprayer plate outer face is formed outwardly of an annular groove therein with an annular surface sloping rearwardly in a radially outward direction, such annular face favors air flow over the sprayer plate which tends to prevent liquid fuel spread away from the sharp annular edge; the said annular surface may suitably be frusto-conical with a semi-vertical angle in the range from 30° to 45°.

Where the flaring outlet is frusto-conical of a vertical angle of the same order as the normal spray angle of the burner, it serves, without interfering or greatly interfering with atomization conditions at full load, to control the increase of spray angle which would otherwise be expected in the case of burners of kinds in which the whirl velocity of the fuel is maintainable for efficient atomization although the quantity of fuel discharged may be substantially reduced. For best results, the vertical angle of a frusto-conical flaring outlet should be the same as or slightly less than the normal spray angle of the burner. It has been found, for example, that if the normal spray angle of a return-flow oil burner adapted at full loads to burn less than a thousand pounds per hour is 75° to 80°, the vertical angle of the flaring outlet should be 65° to 70°, while if the normal spray angle of a return-flow oil burner adapted at full load to burn 1,500 to 3,500 pounds per hour is 75° to 80°, the vertical angle of the flaring outlet should be 75° to 80°; and that if the normal spray angle of a plunger type oil burner adapted at full load to burn 1,000 to 3,000 pounds per hour is 68°, the vertical angle of the flaring outlet should be 60°.

For a pressure atomizing burner of simpler kind, operating neither with return flow nor with the aid of a port-controlling plunger, if the normal spray angle is 75° to 80°, the vertical angle of the flaring outlet should be 75°, while if the normal spray angle is 60° to 70°, the vertical angle of the flaring outlet should be 60°.

The invention will be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 diagrammatically illustrates in sectional elevation an arrangement of return-flow oil burner at a port in a furnace wall.

FIG. 2 is an elevation mostly in section of the oil burner.

FIG. 3 is a sectional elevation to a larger scale of front parts of the burner including the atomizer head.

FIG. 4 represents separately, to a large scale, the sprayer plate included in FIG. 3.

FIG. 5 is an end elevation of the sprayer plate of FIG. 4.

FIG. 6 is a sectional elevation of a modified sprayer plate.

FIG. 7 is a sectional elevation of front parts, including the atomizer head, of an oil burner operating simply with variation of pressure of the oil supplied thereto.

FIG. 8 is an end elevation of the sprayer plate included in FIG. 7, and

FIG. 9 is a sectional elevation of front parts, including the atomizer head, of a plunger-type oil burner.

Referring to FIGS. 1 to 5 of the drawings, a return-flow oil burner 1 of which details of the atomizer head will be described is adapted to fire through a port 2 in a furnace wall 3.

The admission to the port of combustion air from a wind-box 4 is controlled by an air register 5 which consists of a circular outer plate 6 bolted to the wind-box wall, a frame 7 adjacent the furnace wall carrying a peripheral series of pivotally mounted air doors 8, and between the frame 7 and the outer plate 6 a cylindrical distancing casing 9 open at its end near the furnace; combustion air cannot attain to the port except past the air doors, which are adjustable in angular position on their pivots by a handle 10 operable to turn the air doors by an appropriate operating spindle, spur wheels and linkages. The burner atomizer head 11 is positioned in the port by an assembly 12 of an outer barrel 13 and an inner barrel 14 which extend axially of the air register frame 7 and distancing casing 9 and through an insulating wall 15 of a short casing 16 within the distancing casing and are secured in a body member 17, which body member is adapted to be held to a coupling 21 by a screw 22 in a coupling yoke 23. The barrel assembly 12 extends within a distance tube 24 secured at its rear end in the coupling 21 and bearing at its forward end an impeller 25 positioned within the port and adapted to reduce, in the

neighborhood of the atomizer head, the air speed past the atomizer head.

The forward end of the inner barrel 14 is surrounded by a rear cylindrical part 26 of a distributor head 27 of which the forward end 28 provides a flange 29 which fits in the outer end of a recess 30 in the outer barrel 13. In contact with the distributor head and forwardly thereof is a disk-like distance piece 31 having the diameter of the recess 30, and in contact with the distance piece, and forwardly thereof is a sprayer plate 32 also having the diameter of the recess 30. The distributor head 27, the distance plate 31 and the sprayer plate 32 are secured in position relative to the outer barrel 13 by a cap nut 33, which is tapped to engage the threaded forward end of the outer barrel 13, and which, at its forward end 34 is formed with a clamping flange 35 which provides a rearwardly facing surface 36 adapted to engage the sprayer plate.

The sprayer plate 32 and the distance piece 31 define the forward and rearward portions, respectively, of a whirl chamber 41 for oil. Oil is arranged to enter the whirl chamber 41 along a series of six square-section slots 42 channeled in the rear face of the sprayer plate which are nearly tangential to the whirl chamber. The outer ends of the slots 42 are in communication through aperture 43 in the distance plate 31, an annular recess 37 in the front face of the flange 29 of the distributor head 27 and apertures 44 in the flange 29 with a passage 45 between the inner and outer barrels.

The whirl chamber tapers frusto-conically forwardly and radially inwardly to a discharge orifice 46 defined by a short cylindrical wall 47, and tapers frusto-conically rearwardly and radially inwardly to an outlet 48 in communication through a further annular recess 38 and further apertures 49 in the distributor head 27 with the central passage 50 of the inner barrel 13. The passages 45 and 50 respectively communicate through passages 51 and 52 in the body member 17 with passages 53 and 54 in the coupling 21 to which oil supply and oil return hoses (not shown) are secured.

The forward and inward frusto-conical taper of the whirl chamber has a semi-vertical angle of 45° and the discharge orifice 46 is reamed out and has a diameter of 0.1405 inch and a cylindrical wall length of 0.01312 inch. The front face of the sprayer plate is formed to provide an outwardly flaring outlet 61 from the discharge orifice 46, of which the surface is polished and is frusto-conical with a semi-vertical angle of 37½° and has an axial length of 0.115 inch. The flaring outlet terminates in a sharp annular edge 62 defined by the frusto-conical surface of the outlet and by a forwardly and inwardly tapering frusto-conical surface 63 of semi-vertical angle 22½°; thus the sharp edge 62 has an angle of 60°.

The forwardly and inwardly tapering surface 63 defines the inner face of an annular V-section groove 64 the outer face 65 of which diverges forwardly and outwardly frusto-conically with a semi-vertical angle of 37½°. The groove outer face 65 extends to a narrow plane annular face 66 of a forward annular ridge 67 on the sprayer plate, which ridge projects axially forwardly beyond the sharp edge 62, to which therefore the ridge affords a degree of protection. The ridge 67 lies between the groove 64 and an annular surface 68 which slopes frusto-conically rearwardly in a radially outward direction; the semi-vertical angle of the surface 68 is 45°.

The surface 36 on the cap nut clamping flange 35 engages a surface 69 of the sprayer plate which lies outwardly of and to the rear of the surface 68. Between the surface 68 and the surface 69 the sprayer plate is formed with an annular outwardly facing groove 70 of utility when withdrawing the sprayer plate from the atomizer head after the cap nut has been removed.

The forward face of the cap nut clamping flange is defined by an inner frusto-conical surface 71 sloping rearwardly in a radially inward direction, an outer frusto-conical surface 72 sloping rearwardly in a radially outward direction with a semi-vertical angle of 45°, and a narrow annular plane surface 73 between the surfaces 71 and 72.

In the operation of the burner, oil is supplied under pressure through the oil supply hose to the coupling 21, passes through the passages 53, 51 and 45 and enters the whirl chamber 41 through the slots 42 so as to whirl in the whirl chamber. Some or all of the oil passes forwardly, while whirling about the atomizer axis, through the discharge orifice 46 and issues forwardly from the sprayer plate in the form of a diverging spray into combustion air which, after supply to the wind-box 4, is allowed by adjustment of the air doors 8 to pass through the port 2 into the furnace in quantity suited to the amount of oil to be burnt.

The burner is adapted for operation with return-flow, through the whirl chamber outlet 48 and passages 50, 52 and 54 and oil return hose, of some of the oil supplied to the whirl chamber 41 through the slots 42. Seeing that the speed of oil flow through the slots 42 which determines the velocity of whirl in the whirl chamber, upon which velocity the efficiency of atomization depends, can be maintained high whatever the rate at which oil is to be burnt, the burner is effectively operable over a wide range.

If the forward end of the discharge orifice 46 lay flush with a plane front face of the sprayer plate, the diverging oil spray formed ahead of the atomizer head would have a conical form the conical angle of which adjacent the spray plate would depend upon the ratio between the whirl velocity of the oil issuing through the discharge orifice and the axial velocity of said oil. Said angle may be referred to as the natural spray angle. The burner described is designed for a natural spray angle of 75° when normally operated at full load. The natural spray angle at full load may be referred to as the normal spray angle. It will be observed that the angle of the frusto-conical flaring outlet 61 is the same as the normal spray angle of the burner.

A return flow burner with a natural spray angle of 75° at full load will when operated for efficient atomization have a considerably larger natural spray angle at low loads, e.g. 100°. The burner illustrated has an actual spray angle of 75° at full load and when operated for efficient atomization an actual spray angle at low loads which departs little if at all from 75°. The sharp annular edge 62 helps to ensure a complete separation of the oil from the sprayer plate over a wide range of loads.

Since the spray angle does not greatly increase as load is reduced, the likelihood, when the atomizer head is axially positioned in a suitable position for high load operation, of oil spray at low loads impinging, unless the atomizer head is repositioned, upon the furnace refractory at the port 2 is reduced.

Oil does not tend to carbonize upon the flaring outlet 61 and thus the discharge orifice 46 remains clear. There tends to form over the frusto-conical surface 68 a forwardly and inwardly converging air flow towards the oil spray which tends to prevent oil from spreading over the said surface and across the groove 64 instead of detaching itself from the spreader plate. Such air flow is favored by the inclined surface 72 on the cap nut. It will be observed that substantially all of the surface area facing the furnace head radiation is inclined at an acute angle to the burner axis. Thus the radiant heat absorbed falls upon a relatively large surface area which is swept over and cooled by air flow, and this feature also reduces the risk of oil carbonization on the atomizer head.

FIG. 6 is a sectional elevation of a modified sprayer plate 81 for a return-flow burner similar to that described with reference to FIGS. 1 to 5. The sprayer plate 81 differs from the sprayer plate 32 in that it is designed for operation with a higher pressure in the burner whirl

chamber at full load and the diameter of the discharge orifice is therefore made less than the diameter of the discharge orifice 46. The outlet 83 flaring frusto-conically outwardly from the discharge orifice 82 has a semi-vertical angle of 37½° and its diameter at the front end thereof is less than the corresponding diameter at the front end of the outlet 61. Between the sharp edge 84 at the front end of the outlet 83 and an annular surface 85 which slopes frusto-conically rearwardly in a radially outward direction and corresponds to the surface 68 are formed two annular V-section grooves 86 and 88; between the inner groove 86 and the outer 88 is a sharp annular edge 89 and between the outer groove 88 and the annular surface 85 is a sharp annular edge 90. The edges 89 and 90 lie in a common plane forwardly of the plane of the sharp edge 84. It will be observed that surfaces on the sprayer plate at right angles to the burner axis and facing the furnace radiation are avoided.

FIGS. 7 and 8 refer to the atomizer head of an oil burner operating simply with variation of pressure of the oil supplied thereto. The oil is supplied to the interior of a barrel 101 the forward end of which is threaded for the reception of the rear part of a distributor head 102. The forward end of the distributor head 102 is threaded for the reception of a cap nut 103 similar to the cap nut 33 of the return-flow oil burner described with reference to FIGS. 1 to 4. Between the clamping flange 104 formed at the forward end of the cap nut 103 and the forward end of the distributor head 102 is clamped a sprayer plate 105 providing an oil discharge orifice 106 from a whirl chamber 107.

The whirl chamber tapers to the discharge orifice frusto-conically inwardly and forwardly, with a semi-vertical angle of 45°, from a rear part of the whirl chamber which is defined by a cylindrical wall 108. Oil is arranged to enter the whirl chamber along a series of four square-section slots 109 channelled in the rear face of the sprayer plate which are nearly tangential to the whirl chamber cylindrical wall 108. The outer ends of the slots are in communication with an annular channel 110 in the forward face of the distributor plate, which channel is supplied with oil through a series of bores 111 parallel to the burner axis leading from a common axial bore 112 in the distributor head which is in communication with the interior of the barrel 101.

The front face of the sprayer plate is formed to provide a frusto-conical flaring outlet 113 from the discharge orifice 106, the outlet having a semi-vertical angle of 37½° and terminating in a sharp edge 114 on the outer side of which is an annular V-section groove 115 of bottom angle 60°; on the outer side of the groove 115 is a sharp edge 116 at the forward end of an annular surface 117 which slopes frusto-conically, with a semi-vertical angle of 45°, rearwardly in a radially outward direction. The edge 116 projects forwardly beyond the sharp edge 114. The inner face 118 of the cap nut clamping flange is bevelled to conform with the annular surface 117 of the sprayer plate.

As with the burner of FIGS. 1 to 5, the likelihood of the carbonization of oil on the atomizer head surfaces facing the furnace heat is reduced or avoided.

FIG. 9 is a sectional elevation of the atomizer head of a plunger-type oil burner. The oil for the atomizer head is supplied through a barrel 121 the forward end of which is threaded for the reception of a cap nut 122 formed at its forward end with a clamping flange 123. Between the clamping flange 123 and the extreme forward end 124 of the barrel 121 there is clamped a sprayer plate 125 providing an oil discharge orifice 126 from a whirl chamber 127.

The whirl chamber tapers to the discharge orifice frusto-conically inwardly and forwardly, with a semi-vertical angle of 45°, from a rear part of the whirl chamber which is defined by a cylindrical rearward extension 128 of the sprayer plate and by the front surface of a plunger

129 which occupies part of the space within the cylindrical extension 128. The plunger 129 is integral with an operating spindle 130 which extends axially of the barrel 121 and at its outer end is provided with means (not shown) comprising a sealing bellows and a biasing spring adapted so that the axial position of the plunger depends upon the pressure of the oil supplied to the space 131 between the spindle and the barrel and is more forward the lower said oil pressure is. The space 131 communicates with the space 132 between the sprayer plate extension 128 and the barrel 121, from which latter space ports 133 lead into the space within the sprayer plate extension. The ports 133 enter the space approximately tangentially and are axially distributed so that upon axial movement of the plunger in the forward direction some of said ports are covered. The number of effective ports is increased, on the other hand, upon axial movement of the plunger rearwardly consequent upon an increase in oil pressure.

The front face of the sprayer plate 125 is similar to that of the sprayer plate 32 of the burner described with reference to FIGS. 1 to 5, the semi-vertical angle of the flaring outlet 134 from the discharge orifice being, however, different. Thus the semi-vertical angle of the surface of the frusto-conical flaring outlet from the discharge orifice is 30°.

The cap nut is similar, in the shape of the surfaces facing the furnace heat, to the cap nut 33 of the burner described with reference to FIGS. 1 to 5.

The burner is designed for a normal spray angle, as defined above, of approximately 68°. The angle of the flaring outlet is 60°.

When a sufficiently smaller oil pressure is applied to the burner than that which corresponds to full load, the plunger assumes a different and more forward position in which some of the ports are covered. The smaller quantity of oil entering the whirl chamber does so through a fewer number of ports than the full number, whereby the speed of oil whirl in the whirl chamber is higher than otherwise would be the case, thus the efficiency of the atomizer is automatically maintained at low loads. The spray angle does not, however, substantially increase at such loads. As with the burner described with reference to FIGS. 1 to 5, the risk of oil carbonization on the atomizer head surfaces facing the furnace heat is reduced or avoided.

While the instant invention has been disclosed with reference to a particular embodiment thereof, it is to be appreciated that the invention is not to be taken as limited to all of the details thereof as modifications and variations thereof may be made without departing from the spirit or scope of the invention.

What is claimed is:

1. In a liquid fuel burner of the pressure atomizing type, a sprayer plate comprising a body having a chamber in the rear portion thereof, a discharge orifice leading from said chamber toward the front face of the body, an outwardly flaring outlet leading from said orifice toward the front face, said outlet terminating in a sharp annular edge concentrically disposed about the axis of said orifice and disposed inwardly of the front face, a plurality of annular V-shaped grooves concentrically disposed about the axis of said orifice in the front face of said body, the innermost groove having an inner annular surface sloping rearwardly from said edge in a radially outward direction and an outer annular surface of said innermost groove sloping forwardly in a radially outward direction, the outer annular edge of said outer annular surface of said innermost groove extending forwardly beyond the outer annular edge of said inner annular surface of said innermost groove, and said front face having an outer surface sloping rearwardly and radially outward from the radially outer surface of the outermost groove whereby the outermost sloping surface of said front face directs a flow of air in a forwardly converging path thereover to prevent liquid fuel from spreading thereover.

2. A sprayer plate for use in a liquid fluid atomizer comprising a body having a frusto-conical inlet converging inwardly toward the interior of said plate defining therein a whirl chamber, and a frusto-conical outlet diverging outwardly toward the face of said plate, said frusto-conical inlet and outlet being connected at their medium to define a discharge orifice thereat, a groove formed in the face of said plate terminating in a sharp edge circumscribing said outlet, and the outer face of the sprayer plate extends outwardly of the annular groove therein and concentric with the axis of the discharged orifice, said face including disposed about said groove an annular surface sloping rearwardly in a radially outward direction, a ridge formed between the radially outer surface of the groove and the annular surface of said face, and a second ridge formed between said outlet and said radially inner surface of said groove, said first mentioned ridge projecting axially beyond the second mentioned ridge.

3. In a liquid fuel burner of the pressure atomizing type, a sprayer plate having a discharge orifice, a frusto-conical outlet connecting with said orifice and diverging outwardly therefrom, said outlet terminating in a sharp annular edge circumscribing said outlet, an annular groove formed in the outer face of said sprayer plate con-

centric to the axis of the discharge orifice, said face having an annular surface circumscribing said groove and sloping rearwardly in a radially outward direction, a ridge formed between the radially outer surface of said groove and said annular surface of said face, said ridge projecting axially beyond the sharp annular edge formed between the radially inner surface of said groove and said outlet, and a cap nut for securing the sprayer plate to a burner atomizing head, said cap including a clamping flange having an inner frusto-conical surface sloping rearwardly in a radially inward direction and an outer frusto-conical surface sloping rearwardly in a radially outward direction, and the edge formed at the junction of said inner and outer sloping surfaces of said cap being disposed axially inward of the ridge formed between annular surface of said face and said groove.

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