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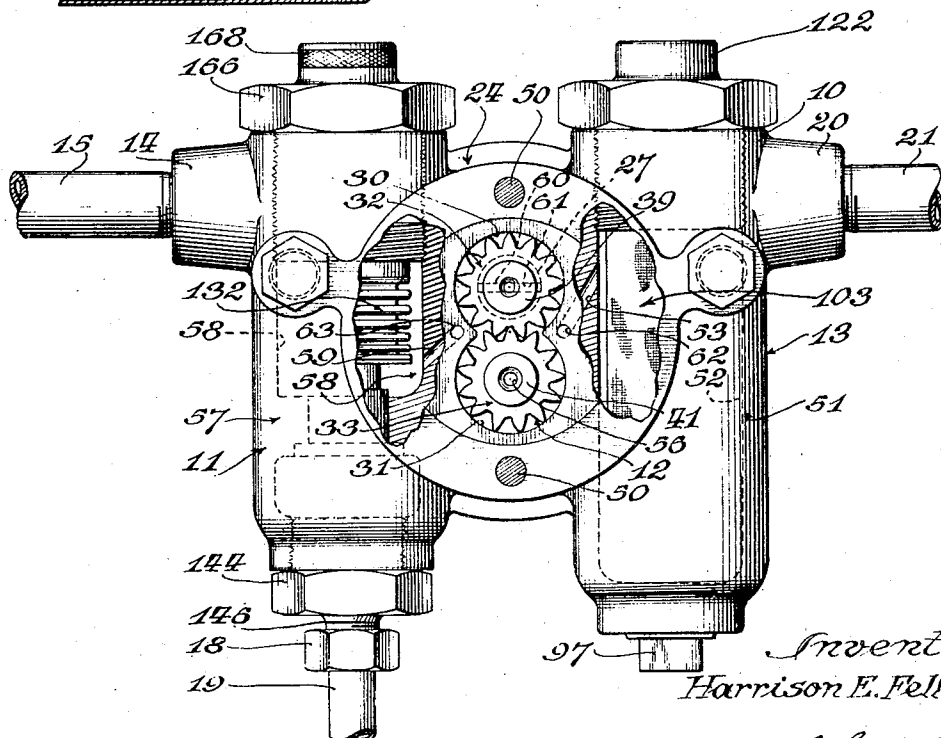
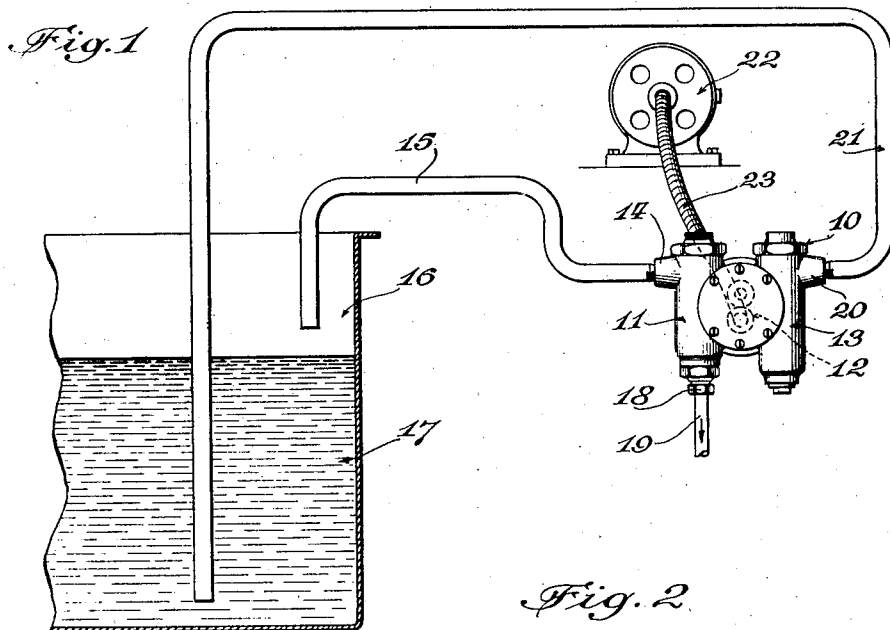
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2,090,035

FUEL SUPPLY UNIT FOR OIL BURNERS

Filed Feb. 8, 1936

3 Sheets-Sheet 1



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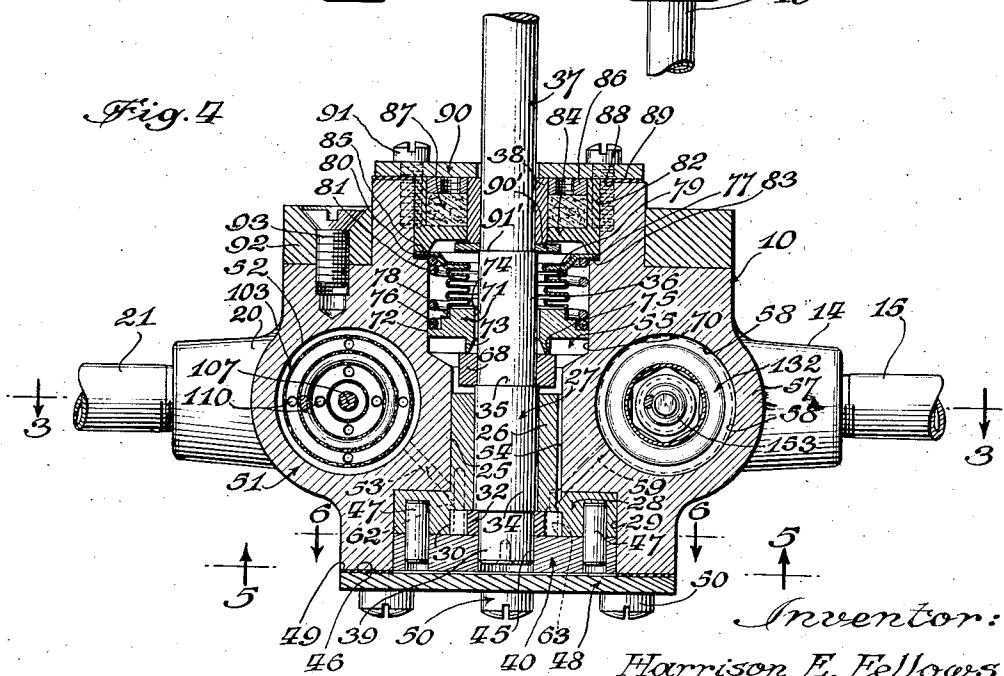
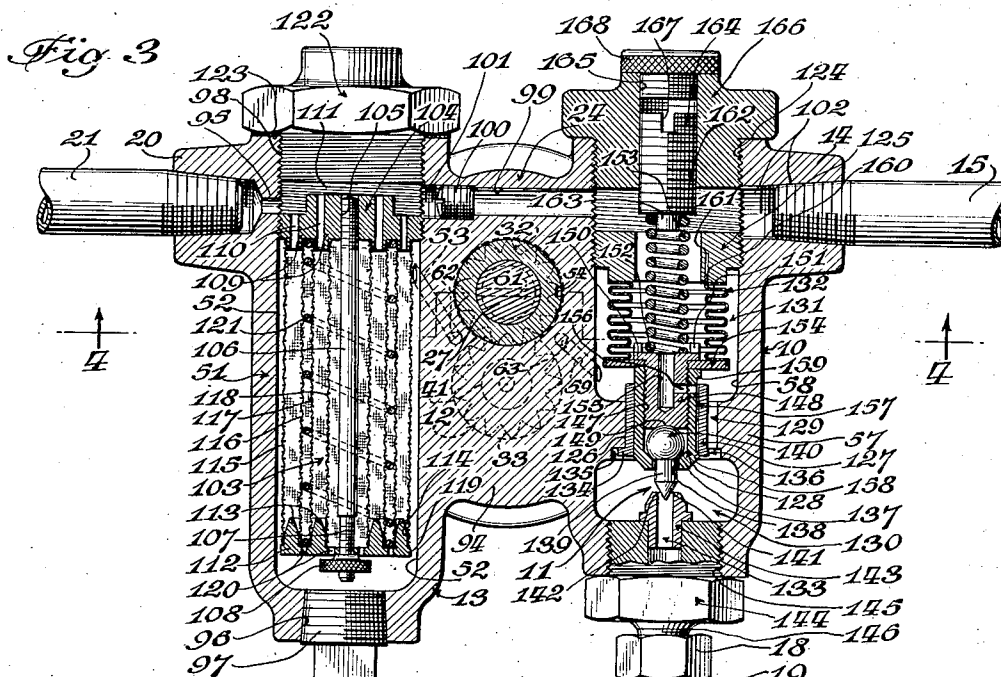
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FUEL SUPPLY UNIT FOR OIL BURNERS

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3 Sheets-Sheet 2



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FUEL SUPPLY UNIT FOR OIL BURNERS

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3 Sheets-Sheet 3

Fig. 5

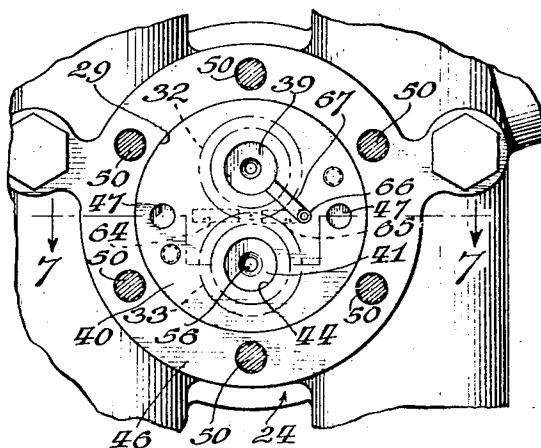


Fig. 6

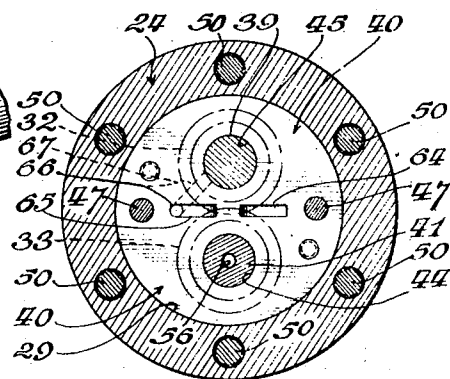


Fig. 7

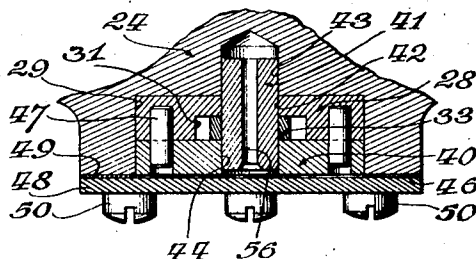


Fig. 8

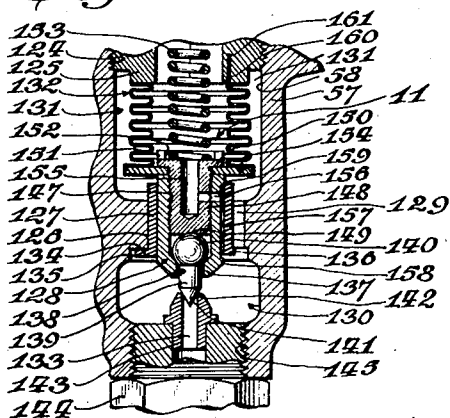
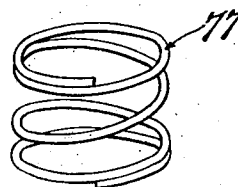


Fig. 9



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UNITED STATES PATENT OFFICE

2,090,035

FUEL SUPPLY UNIT FOR OIL BURNERS

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Application February 8, 1936, Serial No. 62,971

9 Claims. (Cl. 137—153)

The present invention relates to fuel supply units for oil burners, and is particularly concerned with fuel supply units preferably including a pump of the gear type, a strainer, and a pressure regulating valve.

The pump may be of the single stage or double stage type, but in the present embodiment only the single stage pump has been illustrated.

One of the objects of the invention is the provision of an improved fuel supply unit in which the regulating valve is of the type which bypasses back to the tank or to the intake line any excess of fuel oil over that required to supply the burner, and in which the by-pass is effected through a port located in some part of the movable bellows which is used to control a needle valve for the burner port.

Another object of the invention is the provision of an improved fuel regulator valve of the class described, having a bellows for controlling a by-pass valve and a burner valve which has the safety feature of permitting by-pass of any fuel oil which might leak through the bellows in case the bellows should fail.

Another object of the invention is the provision of an improved regulator valve of the bellows type in which valves are provided for the burner port and a by-pass port, and which has a special arrangement for effecting a quick closure of the burner port upon shutting down of the motor.

When a burner is shut off, the air supply to the combustion chamber decreases very rapidly, but unless some special provision is made, the pressure in the regulating valve decreases quite slowly, with the result that fuel is still supplied in inefficient combustion, causing excessive combustion gases or smoke, and the excess gases cause pulsating back pressures in the flues, which makes the furnace puff and rattles any loose parts of the furnace.

One object of the invention is the provision of an improved regulating valve which effects a quick cut-off at the burner nozzle after the motor current is cut off, thereby eliminating this inefficient combustion period and preventing the pulsating and puffing of the furnace which result therefrom.

Another object of the invention is the provision of an improved form of packing or seal for the rotating shaft of the pump, by means of which the friction drag on the pump shaft is greatly reduced and the leakage of fuel along the rotating shaft is substantially prevented.

Another object of the invention is the provi-

sion of an improved strainer arrangement and construction which is capable of more economical manufacture than the devices of the prior art.

Another object of the invention is the provision of a fuel unit arrangement which is equally adaptable for use with a two-pipe or a one-pipe system, by merely changing the connections and opening or closing a port or conduit formed in the housing.

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 three sheets of drawings,

Fig. 1 is a diagrammatic view of an installation embodying a fuel unit constructed according to the present invention;

Fig. 2 is an elevational view, partially broken away, showing the pump gears and conduits leading from the strainers through the pump to the radiator valve;

Fig. 3 is a vertical sectional view, taken on the plane of the line 3—3 of Fig. 4, showing the details of construction of the parts of the unit;

Fig. 4 is a horizontal sectional view, taken on the plane of the line 4—4 of Fig. 3, showing the details of construction of the parts of the unit;

Fig. 5 is a fragmentary sectional view, taken on the plane of the line 5—5 of Fig. 4;

Fig. 6 is a fragmentary sectional view, taken on the plane of the line 6—6 of Fig. 4;

Fig. 7 is a fragmentary sectional view, taken on the plane of the line 7—7 of Fig. 5, looking in the direction of the arrows;

Fig. 8 is a view of the regulator valve, similar to Fig. 3, but showing the parts in the position which they assume immediately after the motor has been shut down;

Fig. 9 is a view in perspective of the type of spring preferably employed for assuring distention of the bellows and uniform contact between the sliding surfaces of the seal on the pump.

Referring to Fig. 1, 10 indicates in its entirety the fuel unit, which preferably includes a housing having housing parts for the regulator valve 11, oil pump 12, and strainer 13. The device may be used with a one-pipe or a two-pipe system. In the two-pipe system the by-pass port 14 of the regulator valve is connected by a conduit 15 to the tank 16 to return the excess fuel to the fuel supply 17. The burner port 18 at the bottom of the regulator valve housing is connected by a conduit 19 to the burner. Intake port 20 of the strainer is connected by a conduit 21 to the fuel

supply 17, the end of conduit 21 being immersed in the liquid fuel. The pump 12 is driven by the same electric motor 22, which drives the electric fan and other parts of the oil burner, by means of a flexible shaft 23 or some other appropriate form of coupling, preferably flexible.

Referring to Figs. 2 to 4, the details of construction of the fuel unit are best explained in connection with these figures. The housing of the fuel unit 10 preferably consists of a single casting formed with the housing parts for the valve, pump and strainer units.

The pump is preferably disposed in the middle between the valve and strainer units, since it is adapted to receive fuel from the strainer and to deliver it to the regulator valve. Therefore, the middle part of the housing or the pump housing 24 is provided with a bore 25 for receiving a bearing sleeve 26 for the pump shaft 27.

The bearing sleeve 26 may comprise a metal member which is formed with a radially extending cylindrical portion or flange 28 which is adapted to fit in a counterbore 29. The cylindrical end portion 28 may be provided with a pair of intersecting bores 30, 31 which form the chambers for the pump gears 32, 33. These pump gears have their teeth in peripheral contact with the bores 30, 31, and are adapted to mesh with each other to carry the fuel from one side of the pump or intake to the other side or the output, thereby developing a pressure at the output side of the pump, due to the volume of fuel which is forced through the pump chamber by the gears.

The pump shaft 27 is preferably provided with an enlarged cylindrical portion 34 in the bearing sleeve 26, an annular shoulder 35, and a reduced cylindrical portion 36 extending through the seal or bellows packing.

A still smaller cylindrical portion 37 is located to engage in the bearing sleeve 38, and another smaller cylindrical end 39 is formed at the outside end of the shaft 27 for engaging in the bearing plate 40.

The gear 33 is supported upon a stub shaft 41, which has one end passing through the bore 42 in the plate 28 and extended into a registering bore 43 in the body 24. The opposite end of the stub shaft 41 extends into a bore 44 in the bearing plate 40, and the gear 33 may be mounted for free rotation on the stub shaft 41.

Bearing plate 40 has another bore 45, which is suitably located to engage the reduced cylindrical end 39 of the drive shaft 27, and the bearing plate is adapted to fit in the counterbore 29 and substantially fill the counterbore, its upper surface being flush with the outer flat surface 46 on the body 24.

The bearing plate 40 is secured in predetermined position with respect to the pump housing plate 28 by pairs of pins 47, which may have a drive fit in either of these members 28 or 40, and which are secured in aligned bores to hold these parts in proper position.

The open end of the counterbore 29 is closed by a cover plate 48, which clamps a gasket 49 against the flat surface 46 by means of a plurality of screw bolts 50, which pass through the cover plate and are threaded into bores in the body 24. The housing is provided with a portion 51 for enclosing the strainer and having a substantially cylindrical chamber 52. This chamber 52 communicates with the intake side of the pump through a diagonally extending conduit 53, which leads to the right hand side of the gears

32, 33 in Fig. 2. A slot 54 extends longitudinally of the bearing sleeve 26 and communicates with the conduit 59, providing a conduit from the bellows seal chamber 55 to the pump intake for a purpose further to be explained.

The stub shaft 41 (Fig. 7) may be provided with a longitudinally extending conduit 56, adapted to equalize pressure on both ends of this shaft for the purpose of preventing any friction on the shaft 41 or gear 33, due to unequal pressure on any side.

The housing is also provided with a portion 57 which is adapted to house the regulator valve, and which is provided with a valve chamber 58. This valve chamber communicates with the output side of the pump through a diagonally extending conduit 59 which leads to the left hand side of the gears in Fig. 2 from the valve chamber 58.

The shaft 37 may be provided with a transverse bore 60 extending through the shaft at the reduced cylindrical portion 39 and a pin 61 extends through the shaft into notches located in the gear 32 whereby the shaft 37 is adapted to drive the gear 32 and through this gear it also drives the gear 33.

Referring to Fig. 4, the intake and outlet conduits 53 and 59 of the pump are there shown in dotted lines. Conduit 53 extends diagonally from the strainer chamber 52 to the counterbore 29. The sleeve 26 has an aperture registering with the conduit 53 and also has a drilled aperture 62 which extends parallel to the axis of shaft 27 and connects conduit 53 with the inner face of the bearing plate 40.

In a similar manner the outlet conduit 59 communicates with a drilled aperture 63 located in the sleeve 26 and extending to the face of bearing plate 40 on the other side or output side of the gears. These apertures can also be seen at 62 and 63 in Fig. 2, and it will be noted that they do not yet communicate directly with bores 30 and 31 surrounding the gears.

Referring to Fig. 6, this is a sectional view which shows the inner or upper surface of the bearing plate 40 of Fig. 4. It will be noted that the bearing plate has apertures 45 and 44 to provide bearings for the shaft portions 39 and 41. It is also provided with a pair of diametrically extending slots 64 and 65 which are so located that the outer ends of these slots register with the drilled apertures 62 and 63. The inner ends of the slots 64, 65 extend to points on the sides of the gears 32 and 33 at points between the teeth of the gears, thereby communicating with the spaces between the teeth of the gears from the side of the gears.

Of course the gears 32, 33 are of the same thickness as the depth of the bores 30 and 31, fitting closely against the inner surface of the bearing plate 40. The bearing plate 40 is also preferably provided with another conduit 66, which leads from the slot 65 diagonally over to the bore 45. Actually, this conduit 66 comprises a drilled aperture extending through the plate 40, and another slot 67 located on the outer surface and leading to the bore 45.

It should be noted that the outer end of the bore 45 is thus connected with the input side of the pump, and the pump is adapted to suck the fluid or fuel oil which may leak out to the end of shaft 27 back to the intake of the pump, thereby preventing the building up of any pressure under the cover plate 48 at this end of the shaft and keeping that pressure at about atmospheric

to balance the pressure on both ends of the shaft 27.

The conduit 54 (Fig. 4) also enables the pump to take from the bellows seal chamber 55 any such fluid as may leak past the space between the shaft 27 and the sleeve 26, thereby preventing the building up of pressure in the chamber 55 and making the conditions under which the shaft must be sealed by the bellows still much less rigorous than they would otherwise be. The packing or seal need only seal against the leakage under a very low pressure, since the leakage is always carried back to the intake side of the pump.

The fuel unit is preferably provided with an improved seal for the shaft 27, which may be constructed as follows: A metal sealing ring 68 has a close frictional fit on the reduced cylindrical portion 36 of the shaft 37 against the annular shoulder 35.

The present fuel unit is preferably provided with a counterbore 70 surrounding shaft 27 and communicating with bore 25, and counterbore 70 is adapted to slidably receive a second sealing ring 71, having an outer cylindrical surface 72 for engaging the walls of bore 70. Sealing ring 71 preferably has an axially extending sleeve 73, and is provided with a bore 74 for passing the shaft portion 36.

Shaft portion 36 preferably does not engage the walls of bore 74, the position of the ring being determined by its slidable engagement of its outer surface 72 in the bore 70. The sleeve 73 is preferably beveled at its inner edge, thereby providing a narrow flat engaging surface 75, which engages the flat end surface of the sealing ring 68. The periphery of the sliding ring 71 is formed with a plurality of steps, the outermost step 76 of which forms a seat for a compression spring 77 located in the counterbore 70. The next step 78 on the ring 71 provides an annular seat and a cylindrical supporting surface for the end of a bellows 79.

The cylindrical end flange of the bellows 79 may be soldered, brazed, or otherwise permanently secured to the cylindrical end portion of the ring 71. The spring 77 is preferably formed with a complete turn of one of its coils, engaging the seat 76 so far as possible for the purpose of equalizing the spring pressure on all sides of the ring 71 and preventing the ring 71 from having a tendency to cock. The same is true of the opposite end of the spring 77 where it engages a seat 80 formed in a sheet metal cap member.

Referring to Fig. 9, this is a view which shows the spring in perspective, and it will be observed that the spring consists essentially of two closely coiled annular portions, one at each end, joined by the widely spaced coils of the spring between them. These closely coiled annular portions assure substantially equal spring pressure on all parts of the members which this spring engages.

The cap member 81 comprises a substantially circular metal member which is adapted to fit in a counterbore 82 and which is provided with an aperture adapted to receive a portion of the bellows 79; that is, the cap member 81 may be received between two of the folds of the bellows on the outside of the bellows, and the last or uppermost fold may be soldered, brazed or otherwise permanently secured with a liquid-tight joint to the cap member 81.

The cup shaped formation in the cap member 81 enables the provision of a special annular seat 80 for the spring. The outermost portion of the

flange of the cap member 81 rests against annular shoulder 83 in counterbore 82 and may rest against a suitable gasket to provide a fluid-tight joint at this point. The bore 82 is adapted to slidably receive a substantially cylindrical clamping member 84, which may provide a self-lubricating bearing for the reduced cylindrical portion 37 of shaft 27. This clamping member preferably has an axially extending annular flange 85 projecting from its lower side wall. The flange 85 engages the outer and upper surface of the cap member 81 and clamps this member against the annular seat 83, thereby fixedly securing one end of the bellows 79. The opposite end of the bellows and the ring 71 are mounted for free axial movement, rotation being prevented by its securement to the housing by the flange 85. The actual sealing surface is between the end surface 75 of the annular sleeve 73 and the rotating ring 68.

It should be noted particularly that in this seal the spring is located outermost, and the sealing surface innermost with respect to the radial distance from the center of the shaft. Furthermore, the bellows is fixedly mounted and prevented from rotating as distinguished from devices of the prior art where the bellows was mounted for rotation. Where such a bellows is mounted for rotation, there is a tendency, if the bellows or its ring should get slightly off center, for this defect to become accentuated by the action of centrifugal force. Therefore, it is of great advantage to mount the bellows fixedly on the housing and to mount only the non-resilient and non-deformable metal ring 68 for rotation.

The self-lubricating bearing 84 comprises a substantially cup-shaped metal member having a cylindrical outer wall which fits in the counterbore 82. It is closed by a closure plate 86 which may have a pressed fit in the top of the cup, and both it and the closure plate 86 have a centrally located aperture for receiving the bearing sleeve 38.

The bearing sleeve 38 may consist of a porous bronze bushing which is adapted to transmit lubricant that is contained within the reservoir 87, which may be filled with felt or other wicking impregnated with liquid lubricant or semi-solid lubricant, such as vaseline.

The depth of the self-lubricating bearing member 84 is such that it projects slightly above the gasket seat 88 when the parts are assembled. Therefore, a gasket 89 may be employed below a cover plate 90, which is secured to the housing by a plurality of screw bolts 91 passing through the cover plate 90 and threaded into the body. The gasket 89 is sufficiently compressible so that when the screw bolts 91 are driven home the self-lubricating bearing member 84 is forced into its bore, and flange 85 engages cap member 81 and compresses its gasket so as to provide a fluid-tight seal between the cap member 81 and the body of the housing.

A washer 90' may be located on the reduced portion of the shaft 37 at the annular shoulder 91' inside the bearing 38, thereby providing a thrust bearing for preventing axial movement of the shaft outward and preventing final thrust from acting upon the bellows 79.

The pressure on both ends of the shaft is, however, substantially equalized by the action of the bleeding conduits which lead to the intake of the pump and prevent the building up of any pressure on the end 39 of the shaft. The member 92 surrounding the portion of the housing which forms the wall of counterbore 82 comprises

a supporting member for the pump, which is secured to the pump body by a plurality of screw bolts 93.

Referring to Fig. 3, the general shape of the housing 24 is that of a central cylindrical portion 94 having its axis in a horizontal plane, and attached to vertically extending cylindrical portions 57 and 51 which form the chambers for the strainer and regulator valve respectively. The strainer housing portion is preferably provided with an inlet port 95 at the top which leads to the chamber 52. Chamber 52 may comprise a substantially cylindrical bore, the lower end of which is provided with a threaded clean-out opening 96 closed by a screw plug 97, and the upper end of which is threaded as at 98. The threads 98 preferably extend down past the inlet conduit 95 and below the auxiliary conduit 99 which leads to the upper threaded portion of the valve chamber 52.

The purpose of the auxiliary conduit 99, which is closed by a slotted screw plug 100 disposed in the threaded end 101 of conduit 99, is to adapt the device for one-pipe and two-pipe systems. In the one-pipe system the by-pass outlet 102 of the valve chamber 58 is closed by a plug, and the plug 100 is removed from the auxiliary conduit 99. The excess of oil which is by-passed then passes through the conduit 99 back to the strainer, and thence to the inlet side of the pump, where it may be pumped over again. It is, therefore, unnecessary in such a system to use the return conduit 15 because the excess liquid fuel is returned to the supply of oil in the strainer chamber 52.

The strainer assembly is indicated in its entirety by the numeral 103, and it comprises a threaded supporting plug or plate 104 which supports the strainer members and is adapted to be supported in the strainer chamber 52 by being threaded home in the threaded portion 98 of the chamber.

The threads are so arranged that when the plug 104 is threaded to the lower limit of the threads the strainer unit 103 is properly situated in the chamber, and the plug 104 is below the conduits 95 and 99.

Plug 104 is provided with a centrally located threaded bore 105 which supports a threaded rod 106 that has its upper end threaded home into the plug 104. The rod 106 has a reduced threaded lower end 107 that is provided with a suitable knurled nut 108 for securing the strainers in place.

Plug 104 is provided with a plurality of depending annular ribs 109. The number of annular ribs provided would depend upon the number of strainers used in the unit. In the present embodiment two such ribs are used with four round strainer members. Each of the ribs 109 has a multiplicity of cylindrical bores 110 drilled through it to provide communication between the space 111 above the plug and the proper parts of the strainer unit in the chamber 52.

The reduced cylindrical portion 107 of the rod 106 supports a second strainer plate 112 which has a centrally located aperture for receiving the rod portion 107. This lower strainer plate 112 has a plurality of upwardly projecting concentric annular ribs 113, which are two in number in the present embodiment, since the four strainers may be located on the opposite sides of the two ribs.

The ribs 113 are preferably tapered from both sides toward the top so that as the plate 112 is inserted into the strainer members, and the assembly is secured by tightening the nut 108 on

rod portion 107, the ribs 113 cam the strainers into their proper position. The ribs are, however, provided with outer and inner cylindrical surfaces 114 for engaging the strainer members.

The strainer members 115, 116, 117 and 118 comprise cylindrical members of fine wire mesh screen which are formed by bringing parts of the screen adjacent two opposite edges into contact with each other to form a cylinder and soldering these edges together in that form. The upper and lower edges of these cylindrical screens are protected by being dipped into solder so as to provide these edges with a border of soldered screen which effectively prevents any unraveling and provides a slightly stiffer supporting edge for the strainers.

This solder does not reduce the area of the screen because so much of the screen as is covered with solder at the edges necessarily engages the ribs 109, 113 anyhow. The screen members 115—118 are of such size that they fit against the walls of the annular ribs 109 and 113. Thus screen member 118 fits against the innermost wall of ribs 109, 113, and screen 117 fits against the outer wall of the innermost rib.

The screen plate 112 is provided with sufficient body projecting beyond the outermost rib 113 at 119 to form a seat for the outermost screen 115. The plate 112 is also provided with suitable oil apertures 120 located at the central portion of the plate inside the screen 118 and located between the ribs 113 so as to provide communication to the space between screens 116 and 117.

Since the screens 116, 117 are so close together, there is a possibility that these two screens might collapse, and therefore a helical spacing spring 121 has been placed between screens 116 and 117 to prevent collapse and insure spacing of these screens at all points.

The screens are assembled with their supporting plates by first putting the screens on the plate 104, with the spring and the rod 106 in proper position, and then placing the lower plate 112 on rod 106 and locating the ribs 113 between the proper screen members by means of the beveled camming surfaces on these ribs. The nut 108 may then be threaded on rod portion 107 to clamp the plate 112 against the ends of the screens and force the ends of the screens toward the plug 104, thereby forming a cylindrical removable unit.

The plug 104 is provided with a transverse slot for receiving a screw driver, and the complete screen assembly may be inserted into the screen chamber 52 by inserting the screen first and then threading the plug down from the top of the threads 98 until it reaches the position of Fig. 3.

The top of the chamber 52 and space 111 is closed by a suitable screw plug 122, which preferably has a laterally projecting flange overlying the border of the threaded bore 98 and engaging a suitable gasket which is clamped against the gasket seat 123.

The course of travel of the liquid fuel through this strainer is as follows: The liquid fuel is sucked in at the intake conduit 95, and passes downward through the apertures 110 between screens 117 and 118 and between the screens 115 and 116. The liquid fuel passes through these screens and is discharged into the space 52 surrounding the screen unit and through the apertures 120, which lead from the spaces between screens 116 and 117 and from the interior of screen 118.

The strainer chamber 52 communicates with the pump through the conduit 53, which leads to the intake side of the pump, and thus all of the fuel supplied to the pump is first strained by the strainer unit 103. Should the strainer unit become clogged at any time, it may be removed and cleaned by taking off the strainer members and brushing them or subjecting them to air pressure, and the sediment may be removed at any time by means of the clean-out opening 96.

Referring, now, to the regulator valve unit of Fig. 3, the regulator valve housing 57 is preferably formed with a laterally protruding boss at the top, having a threaded bore for an intake opening 102.

The housing chamber 58 has an upper threaded portion 124, which extends substantially below the intake opening 102 and below the auxiliary conduit 99 so that the bellows supporting plug 125 may be in position to avoid interference with these conduits.

The regulator valve chamber 58 is preferably formed with an inwardly projecting annular shoulder 126 near the bottom to provide a support for a piston valve sleeve 127 which slidably receives the piston valve 128. The annular shoulder 126 has a cylindrical bore passing through it so that it is adapted to receive the sleeve 127 which is secured in the bore by a close frictional fit. The right hand portion of the annular shoulder 126 is provided with a slot or aperture 129 extending from the lower space 130 of the regulator valve chamber to the upper space 131.

This communication between the parts of the valve chamber permits the liquid fuel under pressure to act not only on the bellows 132 but on the piston 128, and also provides means for conducting the liquid fuel to the burner outlet port 133.

The sleeve 127 may have a radially projecting flange 134 at its lower edge for determining its final position in the bore of the shoulder 126.

The shoulder 126 may be provided with a counterbore 135 for receiving this flange 134, and a small portion of the flange is preferably cut away at 136 in registry with the slot 129 so as to leave the passage through the slot 129 open. The sleeve 127 is provided with an inner cylindrical bore adapted to slidably receive the piston 128.

Piston 128 comprises a metal member of cylindrical form having its lower end wall 137 provided with an enlarged cylindrical bore 138 for passing a valve stem 139. The valve stem 139 is substantially smaller than the bore 138 so as to allow a limited universal movement of the ball 140, which carries the stem 139. The lower end of the piston 128 may be substantially frusto-conical to house the ball 140.

The lower end of the stem 139 is provided with a frusto-conical point 141, forming a valve surface which is adapted to seat in a complementary valve seat 142 formed in the end of a ferrule 143. Ferrule 143 may be made of brass, bronze, or other suitable material, and may have a pressed or screw fit in a fitting plug 144, which is threaded into the threaded lower end 145 of the housing space 130, and has a non-circular portion for engagement of a wrench.

Fitting 144 also has a threaded tubular portion 146 for engagement with suitable fittings and pipes. The piston 128 has its bore 147 threaded at the upper end for reception of a

supporting plug or body 148. This plug or body may be provided with a partially spherical socket 149 at its lower end for engaging the ball 140, and it comprises a substantially cylindrical threaded member having a radially extending flange 150 at the top and having a slot 151 for engagement with a screw driver. It may also have a counterbore 152 in the top flange, forming a seat with a confining shoulder for the compression spring 153.

The radial flange 150 also serves the purpose of clamping the end plate 154 of the bellows 132 to the piston 128. The plug 148 is also preferably hollowed out or provided with an inner conduit 155 for the purpose of discharging by-passed fuel through the bellows, and after the plug 148 is in place and the bellows plate 154 is clamped to the piston, the plug may be locked in place by drilling the discharge aperture 156 through the wall of the piston 128 and plug 148, as appears at the right side of the piston in Fig. 3.

The piston is also preferably provided with a longitudinally extending bleeder aperture 157, by merely flattening the piston 128 from a cut-off shoulder 158 adjacent the lower outer edge of the piston to a point 159, which is above the aperture 156. The purpose of this bleeder slot will be explained in greater detail hereafter, as it affects the operation of the valve and permits the burner port to be closed more quickly by means of the valve 141 than is accomplished by the devices of the prior art.

The bellows 132 comprises a flexible sheet metal member which is responsive to pressure when properly closed at its ends. It is mounted on the bellows plate 154 by having one of its horizontal folds engage the upper surface of the plate and one of its outer bends hooked outside the edge of the circular plate 154. The plate 154 and bellows 132 may be secured together permanently by soldering, brazing or any convenient fastening means which will assure a liquid-tight joint at this point. The opposite end of the bellows 132 is provided with a cylindrical extension 160 which may be inserted in a cylindrical bore 161 in the plug 125.

The horizontal end flange of the bellows and the cylindrical flange 160 may be soldered, brazed or otherwise secured to the bellows supporting plug 125 so as to provide a fluid-tight joint at this point.

Bellows supporting plug 125 comprises a substantially cylindrical member, the outer surface of which is threaded complementarily to the threaded bore 124. It has a bore 161 extending through it for passing the spring 153, and when the plug 125 is threaded home in the bore 124 the bellows supporting plug 125 and bellows 132 are properly positioned in the chamber 58, below conduits 102 and 99.

The cylinder 128 is preferably urged downward to effect a closure of the valve 141 by means of compression spring 153, the lower end of which is seated in the counterbore 152, and the upper end of which is seated against the annular shoulder 162 and about the reduced cylindrical end 163 of an adjustment screw 164. Adjustment screw 164 is threaded into a threaded bore 165 in the closure plug 166, which closes the upper end of threaded bore 124.

Plug 166 may be similar in construction to plug 122 in that it has a radially extending flange for extending the top of the housing and clamping a gasket against the housing. The adjust-

ment screw 164 has a slot 167 for receiving a screw driver, and the upper end of bore 165 may be closed by a cap screw 168 which is threaded into the bore. The adjustment of the screw 164 determines the state of compression of the spring 153, and therefore determines the pressure at which the valves controlled by bellows 132 will open.

The operation of the regulator valve is as follows: When the motor driving the burner fan and pump is started, fuel is drawn in through the strainer chamber to the pump and discharged under a suitable high pressure into the valve chamber 58. When the pressure has built up to a predetermined point, which is determined by the adjustment of the spring 153, the fluid under pressure acts on the bellows 132 and area of piston 128 and causes the piston to rise. This opens the burner port 133 first, and oil under pressure is supplied to the burner, and the piston continues to rise until the by-pass aperture 156 is opened and until the excess of oil is by-passed through this aperture from the chamber 58.

The bellows and piston achieve an equilibrium when sufficient oil is by-passed to reduce the pressure in the chamber to that equal to an amount necessary to move the piston to its final position.

The course of the by-passed fuel in the case of a two-pipe system is through the aperture 156, through bore 155, through bellows 132, bore 161, and out of by-pass port 102, through the by-pass conduit 15, back to the tank 16.

In the case of a one-pipe system, the aperture 102 is plugged up, and the plug 100 is removed so that the by-passed fuel passes back through auxiliary conduit 99 to the strainer chamber 52, where it is used over again by the pump.

In both cases, however, liquid fuel is by-passed through the bellows 132; and should the bellows spring a leak, the liquid fuel leaking through such a break in the bellows would merely be carried back to the tank or to the intake side of the pump, and there would be no possibility of pressure building up in the bellows chamber behind the bellows in such manner as to close the valves and cut off while the motor is running. This is a safety feature which is of the utmost importance.

Where the bellows is not opened to the by-pass as in the present case, there is always a possibility that if the bellows springs a leak the pressure inside and outside of the bellows would be equalized, and the spring would close both the by-pass port and the burner port, thereby shutting off the burner, but the motor would still continue to run, and since there was no outlet through to the burner or by-pass, under these conditions pressure would build up in the valve and conduits leading from the pump to such an extent that something would have to break. Such an accident would never occur with the present construction, as the interior of the bellows is at all times in communication with a free by-pass outlet and conduit back to the tank or the intake side of the pump.

The bleeder aperture 157 acts as follows:

When the pump motor is shut down, the supply of air to the burner stops quite quickly, but the motor and pump usually run for a short time thereafter, supplying oil to the burner, with insufficient oxygen in the devices of the prior art.

In the present device the decrease in pressure of oil in the valve chamber causes the piston 128 to be extended by spring 153, first closing the by-pass aperture 157 and then closing the burner port 133. This action is accelerated, and the pressure in the valve chamber is reduced to atmospheric by reason of the bleeder aperture 157, which becomes open to the lower part 130 of the valve chamber as soon as the shoulder 158 passes the lower edge of sleeve 127. Of course, this flattened portion is opened to the upper part of the chamber 131 by reason of the flattening above the aperture 156, and consequently the pressure in the chambers 130, 131 does not remain above atmospheric, but such liquid fuel as is in these chambers has a free opening through aperture 157 and by-pass aperture 156 to the by-pass port 102. The result is that the fluid pressure in the valve chambers is quickly reduced to atmospheric when the pump motor is stopped and the burner is shut off practically as quickly as the air fan, thereby preventing any further burning of fuel with insufficient oxygen.

This is of great importance in the operation of such a device, because the devices of the prior art are very noisy when the motor shuts down, due to the fact that the combustion with insufficient oxygen results in a puffing or pulsating action in the combustion chamber. This pulsating or puffing action reverberates throughout the entire heating system and is very annoying, as it occurs every time the burner is shut off in the devices of the prior art.

The present device is therefore adapted to operate in a substantially noiseless way, and is not only safer than the devices of the prior art, but more quiet, certain and positive in its action.

Another function of the bleeder opening 157 is to purge the system of air when the burner is turned on. The slight opening at the bleeder 157 will permit air to pass back to the tank before the pump builds up sufficient pressure to raise the piston to uncover the aperture 156 at the top of the piston. When the air is forced out so that the pump receives solid oil, the volume delivered to the regulator valve is greatly in excess of the amount which can leak through the opening 157, as will be evident from the fact that a special by-pass conduit is usually employed. Therefore, the pressure will build up in the valve chamber and the by-pass piston will rise. As the piston rises the opening of the bleeder 157 at shoulder 158 is closed, and therefore the piston will continue to rise until a sufficient amount of the aperture 156 is exposed to maintain a predetermined pressure.

This construction causes the piston to rise sufficiently to lift the cut-off needle valve 139 well off its seat to prevent throttling at this point.

The operation of the present device should be carefully distinguished from devices in which a small groove has been cut in the by-pass valve so that there is always a definite leakage to the by-pass. In such cases the piston would rise only a trifle to increase the opening at 156 for regulation, and the bleeder would tend to prevent the maximum movement of the piston so that the cut-off needle valve or burner valve 139 would not lift off its seat sufficiently to permit free flow of the oil to the nozzle.

When the burner is shut off, pressure in the regulator valve decreases slowly, and not in proportion to the decrease of air being supplied to the combustion chamber, with the result that inefficient combustion occurs, causing excessive

combustion gases. The excess gases cause pulsating back pressures in the flues and rattle any loose parts in the furnace. It is, therefore, desirable that the pressure in the regulator valve chamber decrease as quickly as possible to accomplish a quick cut-off at the burner nozzle after the motor current is shut off.

The flattened portion or groove in the by-pass piston will open at 158 as the piston moves downward, permitting oil to escape and accomplishing a quicker cut-off at the nozzle than if the oil could only escape through the opening at 159. This cut-off position of the regulator valve is shown in Fig. 8.

It will thus be observed that I have invented an improved fuel oil unit having a regulator valve which is adapted to give a quick cut-off and a wide range of movement of the cut-off valve so as to prevent throttling when the cut-off valve is opened.

The present unit is adaptable for one-pipe or two-pipe systems, and its oil seal on the rotating shaft has a very low friction, due to the improved structure and arrangement of the parts. The oil seal is also substantially leak-proof and requires no repair, not only due to the specific construction, but to the arrangement with the pump whereby leakage to the oil seal chamber is carried back to the pump.

The strainer unit is simple and inexpensive and easy to clean out and assemble, and the entire system is so arranged that it will quickly eliminate any air in the system when the pump is started. The cut-off valve closes so quickly on stopping the pump motor that there is none of the pulsating or puffing action in the furnace due to inefficient combustion at that time, such as is experienced with the devices of the prior art.

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 fuel unit for oil burners, the combination of a supporting body having a chamber formed therein, a burner outlet in said chamber, an inlet to said chamber, a by-pass outlet in said chamber, a pressure responsive bellows located in said chamber having the space around one side of said bellows communicating with the inlet port of the chamber and the space adjacent the other side of the bellows communicating with the by-pass outlet, valve means controlled by said bellows for controlling said burner outlet port, and by-pass valve means controlled by said bellows for controlling a port leading from one side of the bellows to the other side of the bellows whereby oil is discharged from the burner outlet port at a predetermined pressure and the excess is by-passed through the bellows to the by-pass outlet, and in the event of leakage of said bellows the leakage is carried away through said by-pass outlet port, said by-pass comprising a piston having an aperture communicating with the interior of the bellows and with the space exterior of the bellows when the by-pass port is opened.

2. In a regulator valve, the combination of a housing having a by-pass outlet, having a pressure inlet and a burner outlet, a pressure regulating bellows located in said body and having its

interior in communication with said by-pass outlet, valve means controlled by said bellows for controlling said burner outlet and for controlling a port leading from the exterior of said bellows to the interior of said bellows whereby excess oil is by-passed through said bellows to said by-pass port and any leakage of the bellows is merely discharged through the by-pass outlet without danger of pressure building up in the housing, said valve means comprising a needle valve for controlling the burner outlet and a piston valve for controlling the by-pass port, and bleeder means for said piston adapted to be cut off promptly upon opening of the burner port valve to assure a wide opening of the burner port valve.

3. In a regulator valve, the combination of a housing having a by-pass outlet, having a pressure inlet and a burner outlet, a pressure regulating bellows located in said body and having its interior in communication with said by-pass outlet, valve means controlled by said bellows for controlling said burner outlet and for controlling a port leading from the exterior of said bellows to the interior of said bellows whereby excess oil is by-passed through said bellows to said by-pass port and any leakage of the bellows is merely discharged through the by-pass outlet without danger of pressure building up in the housing, said valve means comprising a needle valve for controlling the burner outlet and a piston valve for controlling the bypass port, and bleeder means for said piston adapted to be cut off promptly upon opening of the burner port valve to assure a wide opening of the burner port valve, said bleeder means being also arranged to be opened upon closure of said burner port valve in order to relieve the pressure in the valve chamber and effect a quick cut-off.

4. In a regulator valve, the combination of a body formed with a chamber therein, said chamber having a burner outlet, an inlet and a by-pass outlet, pressure responsive means located in said chamber comprising a bellows having the space on one side of said bellows communicating with the inlet port of the chamber and the burner outlet, and the space on the other side of the bellows communicating with the by-pass outlet, a piston valve actuated by said bellows, said piston valve having a by-pass port providing communication from one side of the bellows to the other side, valve means actuated by said piston for controlling said burner outlet port, said piston having a longitudinally extending slot communicating with said latter by-pass port, said piston and said slot being arranged in a valve cylinder in such manner that the communication between said latter by-pass port and the inlet is opened when the burner valve means is closed, and said communication is closed after the burner outlet valve means is opened a predetermined amount.

5. In a regulator valve the combination of a housing having an inlet, a by-pass outlet and a burner outlet, a pressure responsive bellows located in said housing and having its interior in communication with said by-pass outlet, valve means controlled by said bellows for controlling said burner outlet and for controlling a port leading from the exterior of said bellows to the interior of said bellows whereby excess oil is by-passed through said bellows to said by-pass port and any leakage of the bellows is merely discharged through the by-pass outlet without danger of pressure building up in the housing, said valve means comprising a piston valve fixedly secured to said bellows and slidably mounted in a

cylinder carried by said housing for controlling said by-pass port, and a second valve carried by said piston valve for controlling said burner port, said piston and cylinder being formed with a
 5 bleeder port adapted to be cut off promptly upon opening of the burner port valve to assure a wide opening of the burner port valve and said second valve comprising a needle valve having a limited universal movement with respect to said piston
 10 valve.

6. In a regulator valve, the combination of a housing having a by-pass outlet, having a pressure inlet and a burner outlet, a pressure regulating bellows located in said body and having
 15 its interior in communication with said by-pass outlet; valve means controlled by said bellows for controlling said burner outlet and for controlling a port leading from the exterior of said bellows to the interior of said bellows whereby excess oil
 20 is by-passed through said bellows to said by-pass port and any leakage of the bellows is merely discharged through the by-pass outlet without danger of pressure building up in the housing, said
 25 valve means comprising a needle valve for controlling the burner outlet and a piston valve for controlling the by-pass port, and bleeder means for said piston adapted to be cut off promptly upon opening of the burner port valve, said
 30 piston valve being slidably mounted in a sleeve carried by said housing and said housing having an inwardly extending flange for supporting said sleeve, said flange having a port providing communication between the lower part of said housing
 35 and the bellows enclosing part of said housing.

7. In a regulator valve the combination of a housing having a by-pass outlet, a pressure inlet and a burner outlet, a pressure responsive bellows
 40 located in said housing and being subjected to the pressure of fluid in said housing, valve means controlled by said bellows for controlling said burner outlet, valve means controlled by said bellows for controlling said by-pass outlet, whereby
 45 excess oil is by-passed through said bellows to said by-pass outlet and the burner outlet is supplied with liquid fuel under substantially constant pressure, said first-mentioned valve means
 50 comprising a needle valve and said second-mentioned valve means comprising a piston slidably mounted in a cylinder in said housing, said needle valve having a substantially universal connection with said piston valve and being provided with a conical point adapted to seek a fluid-tight contact with said burner outlet by virtue
 55 of the universal movement of said needle valve, said piston being provided with a port communicating with the interior of said bellows and thence to the by-pass outlet, whereby any leakage of
 60

the bellows is merely discharged through the by-pass outlet without danger of pressure building up in the housing.

8. In a regulator valve the combination of a housing having a by-pass outlet, a pressure inlet and a burner outlet, a pressure responsive bellows located in said housing and being subjected to the pressure of fluid in said housing, valve means controlled by said bellows for controlling said burner outlet, valve means controlled by said bellows for controlling said by-pass outlet, whereby
 1 excess oil is by-passed through said bellows to said by-pass outlet and the burner outlet is supplied with liquid fuel under substantially constant pressure, said first-mentioned valve means
 1 comprising a needle valve and said second-mentioned valve means comprising a piston slidably mounted in a cylinder in said housing, said needle valve having a substantially universal connection with said piston valve and being provided with a
 2 conical point adapted to seek a fluid-tight contact with said burner outlet by virtue of the universal movement of said needle valve, said piston being provided with a port communicating with the interior of said bellows and thence to the
 2 by-pass outlet, whereby any leakage of the bellows is merely discharged through the by-pass outlet without danger of pressure building up in the housing, said piston also having a flattened portion providing a bleeder outlet between the
 3 piston and its cylinder.

9. In a regulator valve, the combination of a housing having a by-pass outlet, having a pressure inlet and a burner outlet, a pressure regulating bellows located in said body and having its
 3 interior in communication with said by-pass outlet, valve means controlled by said bellows for controlling said burner outlet and for controlling a port leading from the exterior of said bellows to the interior of said bellows whereby excess oil
 4 is by-passed through said bellows to said by-pass port and any leakage of the bellows is merely discharged through the by-pass outlet without danger of pressure building up in the housing, said valve means comprising a needle valve for
 4 controlling the burner outlet and a piston valve for controlling the by-pass port, and bleeder means for said piston adapted to be cut off promptly upon opening of the burner port valve to assure a wide opening of the burner port valve, said bleeder means being also arranged to be
 5 opened upon closure of said burner port valve in order to relieve the pressure in the valve chamber and effect a quick cut-off, said bleeder means comprising a port formed between a flattened
 55 portion of said piston and a cylinder carried by said housing and having cut-off edges adjacent the opposite ends of said cylinder.

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