FUEL SUPPLY UNIT FOR OIL BURNERS

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The present application relates to fuel supply units, and is particularly concerned with the type of fuel supply unit including a fuel pump and a regulator valve of the type adapted to supply liquid fuel at substantially constant pressure to a burner, by-passing the excess of fuel back to the intake of the pump or the source of fuel supply. In particular, the fuel supply unit details of the regulator valve, strainer, and the major part of the pump may correspond to those disclosed in my prior application, Serial No. 118,794, filed January 2, 1937, on Fuel supply units for oil burners, the disclosure of which application is hereby incorporated by reference thereto.

Fuel units of the present type are adapted to be used in the gun type of burner which is provided with a motor, a fan blower, ignition devices, a nozzle, and one of the present fuel units, all of which is controlled by suitable electrical controls. In such case the oil burner is shut down by shutting off the motor, which stops not only the fan but the gear pump, and upon reduction of the liquid fuel pressure, due to the stoppage of the gear pump, the regulator valve closes the burner port and shuts off the oil to the nozzle.

One of the disadvantages of such prior art devices is that when the burner is shut off, pressure in the regulator valve decreases more slowly, and not in proportion to the decrease of air being supplied to the combustion chamber. The result is that insufficient combustion occurs, causing excessive combustion gases, which cause pulsating back pressures in the lines and rattle the loose parts of the furnace. The same phenomenon may take place when the burner is turned on, in a lesser degree, after the pressure is built up to such a point that the burner port is opened by the regulator valve.

This violent puffing at the end of the firing period, which has been called "locomotive action" or "furnace flutter", is particularly evident in some of the furnaces which are now being marketed and which have narrow air passages. If the oil is permitted to spray into the furnace while the motor is reducing its speed, which may occur with the ordinary type of valve, in spite of a leakage slot across the piston, the reduced fan speed does not give sufficient air to burn this oil completely.

The result is not only a smoky flame, but this violent puffing action at the end of the firing period.

One of the objects of the present invention is the provision of an improved fuel supply unit which is adapted to eliminate completely such locomotive action or furnace flutter.

Another object of the invention is the provision of an improved fuel unit of the class described, in which the pressure at the fuel pump outlet is very quickly reduced to a negligible amount as soon as the controls operate to shut down the burner, thereby positively preventing continuance of the spray of liquid fuel while the motor is reducing its speed.

Another object is the provision of an improved attachment for fuel supply units of the type disclosed in my prior application, which is adapted to eliminate locomotive action or furnace flutter in furnaces having very narrow air passages, when used with such a unit.

Another object is the provision of a fuel supply unit attachment having a solenoid-operated valve of an improved structure, by means of which valve chatter, valve seat destruction, valve leakages, and 60-cycle hum at the valve are eliminated.

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 drawings, of which there are two sheets,

Fig. 1 is a vertical sectional view, taken on the plane of the axis of the pump shaft, showing the details of structure of an arrangement constructed according to the present invention;

Fig. 2 is a vertical sectional view, taken on a plane at right angles to the axis of the pump shaft and in the axes of the strainer and regulator valve;

Fig. 3 is a wiring diagram;

Fig. 4 is a wiring diagram of a modified form of delayed control.

Referring to Fig. 2, the fuel unit is indicated in its entirety by the numeral 10, and it comprises a housing, usually of cast metal, which is provided with a strainer unit 15, a regulator valve housing 12, joined together by a pump housing portion 13.

The details of construction of these parts of the unit are fully disclosed in my prior application, and therefore will only be described briefly here. The strainer housing is provided with a partition 14, which supports a strainer unit 15, for the purpose of removing solid matter from the fuel as it passes through the strainer housing 11. Thus the port 16 may be used as the strainer
inlet, the liquid fuel passing through the separate strainers, and through ports in the partition 14, into the space 17 above the partition. The horizontally extending pipes 28 and 39 are used for gauges. The space 17 above the partition communicates with the intake of the pump shown in Fig. 1.

The pump of Fig. 1 is driven by a shaft 16, which is rotatably mounted in the pump housing 13 and provided with two sets of gears, the low pressure gears 19, and the high pressure gears 20. The low pressure gears 19 are preferably thicker than the high pressure gears 20, and therefore adapted to pump up from the source of supply an excess of liquid fuel over that required to supply the high pressure gears. The excess fuel is delivered into a reservoir 21, which preferably surrounds the pumping gears and tends to deaden the sound, and thus the high pressure gears are provided with a constant supply of liquid from the reservoir 21.

The course of the fuel through the pump is as follows: The space 17 of the strainer housing communicates with the intake of the low pressure pump gears 19. The output from the low pressure gears 19 is into the reservoir 21, which is in communication with a by-pass conduit 22, through a conduit 23, located at the top of the pump unit so that the reservoir 21 is always full of fuel up to the oil level in the bowl, thereby assuring self-priming of the pump.

The high pressure gears 20 have their intake connected to the reservoir 21, and have their output connected to the pressure chamber 24 of the regulator valve housing 25. The regulator valve housing 22 has a burner outlet port 23 and a by-pass outlet port 26. The by-pass outlet port 26 communicates with the by-pass conduit 22 and with the space 27 above the regulator valve partition 28.

The regulator valve partition 28 supports a diaphragm 29 or pressure responsive bellows 29, to which is secured the piston 30, which is slidably mounted in a sleeve 31, forming a cylinder. The piston 30 has a port 32 adapted to serve as a valve in connection with the edge of the cylinder 31, and the port 32 communicates through the bore 35 and through an aperture 33 with the space 27 above the partition 28. Thus the port 32 is a by-pass port which by-passes excess liquid fuel through the port 32, bellows 29, aperture 33, space 27, port 26, to the bypass conduit 22.

The piston 30 supports a needle valve 34, which is adapted to cooperate with the burner port 25 to open or close the burner port. A spring 35 engages the inside of the piston and urges the piston downward, the pressure of the spring being regulated by a threaded member 36.

The needle valve 34 may be provided with a leakage slot 37 which is formed between the piston 30 and cylinder 31 by a grooved or flattened portion on the piston, and which is intended to permit the by-pass of fuel from the pressure chamber 24 until the needle valve 34 is actually tightly seated against the burner port 25.

The intake 18 of the strainer is connected by a suitable pipe to the source of fuel supply, the pipe being submerged in the liquid fuel, while the by-pass port 22 may be connected by a pipe back to the source of fuel supply so that any excess fuel from the regulator valve or from the low pressure gears is by-passed back to the tank.

The pump unit is preferably built up by means of the high and low pressure gears 19 and 20 and a plurality of metal plates 40-43, which are secured in place by screw bolts and aligned by means of pins 44, as described in my prior application.

In order to immediately relieve pressure at the high pressure gears of the pump when the burner is to be shut down, the fuel unit described in my prior application may be provided with an improved attachment. A new cover plate 45 replaces the reservoir 21 is substituted for the cover plate of my prior application, the new cover plate 45 being larger, in order to provide space for a valve 46, and being provided with a platform top 47, for the purpose of supporting a solenoid 48.

The cover 21 is again secured to the unit by means of screw bolts and with a suitable gasket 48 so as to provide a liquid-tight reservoir 21 about the pump unit and about the valve unit 46.

The last plate 43 of the pump unit may be provided with a discharge port 25 leading from the output of the high pressure gears 26 toward the reservoir 21. This outlet 50 is, however, embraced by a valve supporting plate 51, which is provided with a chamber 52 communicating with the discharge orifices. The valve supporting plate 51 is provided with the usual attaching flanges and is secured to the plate 43 by suitable screw bolts, at its upper side the valve supporting plate 51 being provided with a cylindrical bore 54 for receiving a valve sleeve 55, which may have a tight frictional fit in the upper cylindrical portion of the valve sleeve 55.

The valve sleeve 55 is provided with a valve port 56, comprising a cylindrical bore centrally located in the sleeve and communicating with the chamber 52. The discharge port 50 from the high pressure gears 26 into the reservoir 21 has no access to the reservoir 21 except through the port 56.

The valve sleeve 55 supports a cylinder sleeve 57, comprising a tube having a cylindrical bore with a tight frictional fit on the upper cylindrical portion of the valve sleeve 55.

The tube 57 may be provided with discharge ports 58 located above the valve port 56, and it slidably supports a piston 59 provided with a needle valve 60 having a conical point. The needle valve 60 is adapted to form a liquid-tight closure in connection with the circular edge at the upper end of the valve port 58 when the piston 59 is in its lower position, as shown in Fig. 1.

The piston 59 is adapted to slide freely in the cylinder 57 and is urged upward by a relatively light helical spring 61, which is of sufficient strength to lift the valve 60, piston 59, spring 62, and solenoid core 63, when the solenoid 48 is not energized.

The diagrammatic circuit for this device is shown in Fig. 3, and it will be observed that the usual controlling devices in a control box 64 are used for controlling the burner motor 65 and the solenoid 48.

The motor 65 and solenoid 48, being connected in parallel in this figure, the solenoid is shut off as soon as the motor is cut out of circuit. Thus the valve 60 opens as soon as the solenoid 48 is de-energized, or as soon as the burner is shut off.

The housing 45 is conveniently shaped at its upper end to provide space for the valve assembly 46, and at its upper end may be provided with a flat wall 66 used for supporting the solenoid. The flat wall 66 is provided with a recess 67, the axis of which is aligned with the needle valve 61, surrounding a smaller bore 68, which passes through the wall 66.

The bore 68 is adapted to receive the coil spring 70.
62. The lower end of the coil spring 62 is seated in a cylindrical recess 68 in the piston 58. The upper end of the spring 62 is seated in a similar cylindrical recess 70 in the solenoid core 69. The solenoid may be supported by means of a non-magnetic metal sleeve 71, which has a lower radially extending attaching flange 72 fitting in the recess 67 above a gasket 73. The sleeve 71 is adapted to slideably receive the core 63, which may be hexagonal, pyramidal, or cylindrical.

The attaching flange 72 is held in the recess 67 by a metal plate 74 which has a centrally located bore for passing the sleeve 71 and counter-sunk securing apertures 75 for receiving the body and head of the screw bolts 76 which clamp the plate 74 to the upper wall 86.

The upper end of the tube 71 may be secured in a threaded cap 77 which has a bore 80 that may be cylindrical for slidably receiving the core 63. The bore 80 forms a continuation of the bore in the sleeve 71.

A housing 78, which may be made of cast metal or sheet metal, surrounds the solenoid coil 48, and has a centrally located bore 80 for passing over the cap 77. The lower edge of the cylindrical housing 78 is open, and the edge engages the top wall 86.

At one side the housing 78 is formed with an aperture 81, which may be provided with a fitting 82 having a threaded bore for receiving the usual metal conduit pipe 83 for enclosing the wires 84.

The threaded ferrule 85 has a threaded bore 86 fitting the threaded surface on the cap 77 so that the ferrule may be driven down against the housing 79 to secure it in place. The core 63 is made of magnetic metal such as steel, and the housing 78 may also be made of magnetic metal for completely the magnetic circuit outside of the coil 48.

The ferrule or nut 85 is of magnetic metal.

The coil 48 may be prewound to the shape shown, and the length of the core 63 is such that it projects beyond the upper end of the coil 48 more than it does at the lower end when it is in the dotted line position of Fig. 1, or in the full line position. Thus, when the solenoid is energized, the core 63 is drawn downward and tends to assume a central position with respect to the coil 48, exerting a downward force at all times.

The spring 62 between the core armature and the needle valve 66 is relatively stiff compared to the spring 61, which is a relatively light spring, compressed between the valve sleeve 55 and the piston 59.

Spring 61 is not of sufficient strength to resist movement of the armature 63 by the coil 48 while the spring 62 bears a relation in strength to the force exerted by the solenoid, so that after the needle valve 61 is moved into closed position, the core 63 moves farther in that direction, such as, for example, by about one-sixteenth of an inch, compressing the spring 62. The movement of the needle valve might be about one thirty-second of an inch.

The operation of the fuel unit is as follows: The pump operates in the usual way, described in my prior application, providing the burner with a substantially constant supply of liquid fuel under substantially constant pressure, and by-passing the excess back to the reservoir or tank. When the burner is turned on by the controlling apparatus, that is, when the burner motor is started, solenoid 48 is also energized, forcing armature 63 downward and closing the needle valve 66.

The fuel unit then supplies the burner with the liquid fuel until the controlling apparatus shuts down the burner or deenergizes the motor.

As soon as the motor is cut out of circuit, the solenoid 48 is also cut out of circuit, releasing its armature 63 to slide upward to the dotted line position of Fig. 1 under the action of the spring 61. The needle valve 60 is thus promptly opened as soon as the motor is shut off, and the liquid fuel from the output of the high pressure pump 54 gears 20 is immediately released into the reservoir 21.

The reservoir 21, of course, is in communication with the by-pass conduit 22, which leads back to the supply tank.

While the motor comes to a stop and the air supply is being diminished at a faster rate than the oil supplied from the high pressure gears 20, this oil supply is immediately bypassed into the reservoir, diminishing the oil supplied to the burner port to zero.

Thus there is no supply of liquid fuel to the burner in a manner disproportionate to the supply of air during the shutting down of the burner, and there is no puffing of the furnace or smoke, or what is termed “locomotive action” or “furnace flutter”. When the burner is turned on, the valve 61 is immediately closed, and pressure builds up in the manner described in my prior application.

Referring to Fig. 4, this is a modified form of control, in which the motor 65 and solenoid 48 are indicated by the same indicia. This embodiment has a thermostatically actuated bi-metallic switch arm 59, which is surrounded by a heating coil 91 that is in parallel with the energizing circuit of the motor 65.

The contacts 92, 93 are adapted to be closed by the switch arm 90 when the bi-metallic switch arm 90 becomes heated. Contact 93 is connected to solenoid 48, and the other end of the solenoid is connected to the supply circuit 94. Contact 92 is connected by means of a flexible lead or pigtail 95 to the conductor 96, which leads to the controlling device 64.

The operation of this embodiment is as follows: When the control 64 energizes the circuits 94, 96, the motor 65 starts, and the heater 91 is energized. The motor is thus permitted to come up to speed first, because the circuit of the solenoid 48 is opened at the contacts 92, 93. After the heater 91 has been energized for a predetermined period of time, sufficient heat has been transferred to the bi-metallic thermostat 90 to cause it to bend and close the contacts 92, 93. Then the solenoid 48 is energized and it acts to close the by-pass valve 66. From this point on, the pump supplies oil to the regulator valve, and pressure builds up in the regulator valve. The solenoid circuit is maintained in closed position as long as the motor circuit is energized.

When the circuit 94, 96 is de-energized by the control, the solenoid 48 is, of course, immediately de-energized, and the by-pass valve 66 is immediately opened, relieving the pressure at the pump and stopping the supply of liquid fuel under pressure to the regulator valve and to the burner at once.

The thermostat 90 then returns to the position of Fig. 4 so that it is ready for a new starting cycle.

The present device is thus adapted to stop the supply of oil under pressure to the regulator valve and to the burner as soon as the motor circuit is de-energized. There is no possibility of the con...
tinuance of oil being supplied to the burner after
the supply of air has ceased.

It will thus be observed that I have invented
an improved fuel unit by means of which “loco-
motive action” or “furnace flutter” is eliminated.

While I have illustrated a preferred embodi-
ment 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 Pat-
ent of the United States, is:

1. In a gear pump for oil burners, the combina-
tion of a support with bearings for a drive shaft,
said support carrying a plurality of plates, and
certain of said plates having gear recesses, gears
in said recesses, one of said gears being carried
by said drive shaft, an electric motor for driving
said shaft and a housing for enclosing all of said
plates, said housing carrying a solenoid energized
from the motor circuit and said housing forming
a by-pass reservoir about said pump, a cover
plate in said latter housing completing said
pump, said pump having an inlet communicat-
ing with said reservoir and an outlet, said cover
plate being provided with a passage communicat-
ing the pump outlet with the reservoir and having a
slidably mounted valve member controlling said
passage and operated in the closing di-
rection by said solenoid, said valve member being actuated to open position by spring means, said
solenoid having a movable core member and
spring means between said core member and said
valve, the spring means between said valve mem-
ber and said core member being of greater
strength to actuate said valve to closed position, whereby the valve
is closed when the motor circuit is closed and the
solenoid is energized and the valve is opened as
soon as the solenoid is de-energized to permit
immediate reduction of pressure in the supply
from said pump when the motor is de-energized

2. In a gear pump for oil burners, the combina-
tion of a support with bearings for a drive shaft,
said support carrying a plurality of plates, certain
of said plates having gear recesses, gears in
said recesses, one of said gears being carried by
said drive shaft, an electric motor for driving
said shaft, a housing for enclosing all of said
plates, said housing carrying a solenoid energized
from the motor circuit, said housing forming
a by-pass reservoir about said pump, and a
cover plate in said latter housing completing said
pump, said pump having an inlet communicat-
ing with said reservoir and an outlet, said cover
plate being provided with a passage communicat-
ing the pump outlet with the reservoir and having a slidably mounted valve member controlling
said passage and operated in the closing di-
rection by said solenoid, said valve member being actuated to open position by spring means, said
solenoid having a movable core member and
spring means between said core member and said
valve, the spring means between said valve mem-
ber and said core member being of greater
strength to actuate said valve to closed position, whereby the motor may be first brought up to
speed before the valve means is closed, thereby
facilitating the quick starting of the pump.

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