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T. W. MURPHY

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PRESSURE REGULATING AND UNLOADING VALVE

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Fig. 1.

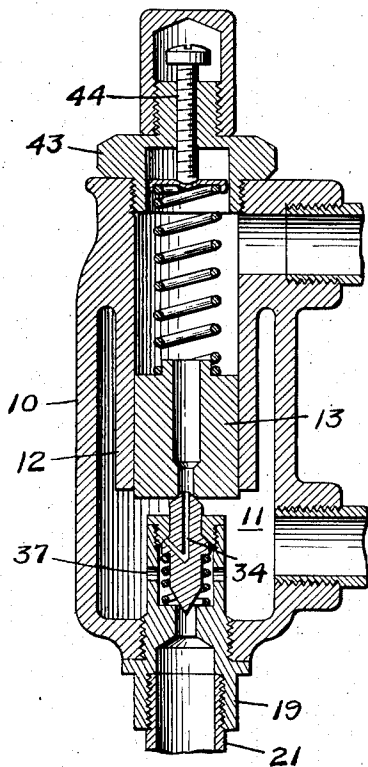


Fig. 2.

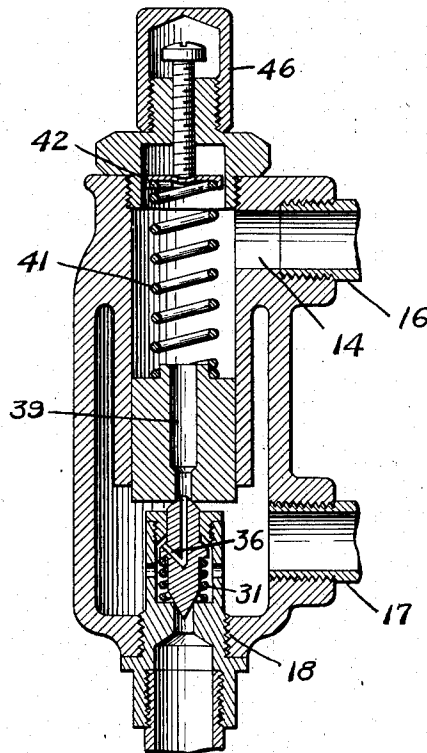


Fig. 3.

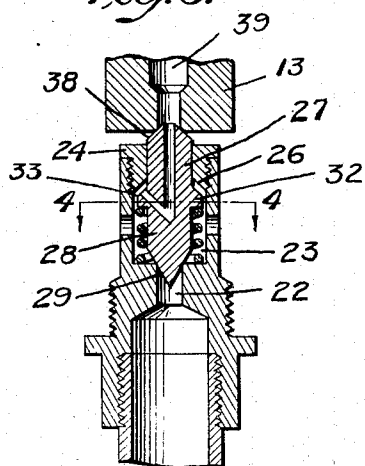
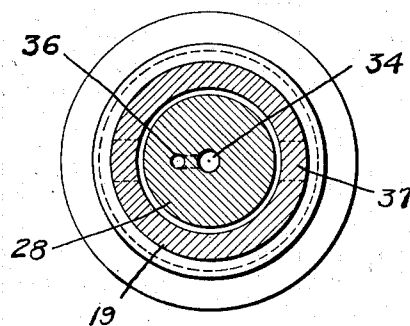


Fig. 4.



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PRESSURE REGULATING AND UNLOADING
VALVE

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This invention relates to pressure regulating devices for liquid systems, and more particularly to an improved pressure regulating valve adapted to also function as an air unloading device under certain conditions.

The instant invention will be discussed in connection with an oil burner system, although not limited thereto. My device is adapted to control the pressure at which fuel oil is delivered to the burner nozzle, to control the by-passing of excess oil pumped thereto, and under certain conditions to unload or assist in unloading air from the system in an improved manner. The conventional oil burner system includes a supply tank, a pump, a pressure regulating device, a burner nozzle, and fan means for delivering air to the burner nozzle.

Two general types of installations are employed, one wherein the supply tank is disposed below the pump and another wherein the supply tank is disposed above the pump. Installations having the supply tank disposed below the pump should be provided with a return pipe from the pressure regulating device to the supply tank, since it is undesirable to return excess liquid pumped directly to the suction side of the pump.

The device of my invention is most useful in installations of this type wherein a return pipe for excess liquid extends to the supply tank. However, the majority of installations having the supply tank disposed above the pump do not employ a return line extending to the supply tank, but merely a suction or feed line extending from the supply tank to the pump and excess oil pumped is returned directly to the suction side of the pump, and this practice is commonly termed "looping." A "looping" installation saves the cost of the return line and permits the oil to be frictionally heated by the pump gears to a greater extent than otherwise, thereby decreasing the viscosity, and permitting the oil to be more easily atomized and burned. However, any air in an installation of this type is simply repeatedly passed through the pump, and may eventually become emulsified and discharged through the burner nozzle or atomizer, but cannot be directly discharged. In this instance, my improved device functions solely to regulate pressure and to return excess liquid pumped to the suction side of the pump. The same condition is true as to unloading any air in the system, when the supply tank is below the level of the pump, and a "looping" installation is employed rather than a direct return line to the supply tank. In any "looped" installation, when initially installing the oil burner system, or when the sup-

ply tank has been permitted to become empty and draw air into the system, it is customary to have a service man "bleed" the air from the system to prevent the pump from becoming air-locked. Of course, after the air has been completely removed, the system remains filled with oil and the problem of removing air is not present until such time as the supply tank again becomes empty. During normal operation of a "looped" installation employing my improved regulating device sufficient oil is by-passed upon start-up to reduce the starting load on the motor and permit the motor and fan to achieve substantially full speed before oil is delivered to the atomizer, thereby insuring sufficient air for proper combustion as contrasted with an arrangement wherein the motor and pump at start-up are operating against substantially maximum pressure. Also, upon shut-down due to the relatively large by-pass through the unloading device, pressure is permitted to rapidly drop and quickly cut off oil flow to the burner nozzle.

In any system wherein a return line to the supply tank is used, my improved device is adapted to rapidly unload air automatically, either when air is present in the system, at installation, due to the supply tank becoming empty, or due to faulty operation of a check valve. In inside installations or wherein the supply tank is disposed above the pump and a return line to the supply is used, it is common practice to employ a check valve in the return line to prevent reverse flow of oil from the supply tank when the pump is not operating. However, due to improper functioning of the check valve because of dirt and the like air frequently enters the suction line and this air must be unloaded before oil can be delivered to the burner nozzle.

Gear type pumps are usually employed in an oil burner system, and while efficient for pumping oil are not efficient for pumping air, particularly if the air must be subjected to pressure. Therefore, it is necessary that means be provided for rapidly unloading the air under minimum pressure.

I am familiar with prior pressure regulating valves of the piston type wherein in addition to the piston having a relatively loose fit with the cylinder, a needle valve on the by-pass side is scored whereby air may escape and be by-passed back to the supply tank. However, either or both methods permit of a continuous by-pass of oil during operation of the system and correspondingly penalize the pump volume.

Other prior systems of which I am familiar

employ a piston type regulating valve and provide ports in the side wall of the piston chamber which are opened and closed by piston movement, but this arrangement does not provide a complete shut-off to the by-pass and correspondingly penalizes the pump capacity.

Another method employed to unload the air is to provide a pump having four gears operating in sets of two, one set being primarily utilized for unloading air by discharging into a sump chamber which has a connection at the top portion with the by-pass port. The second set of gears is connected at the suction side with the bottom of the sump chamber, whereby oil is delivered to the pressure regulating valve under pressure and a portion is then delivered to the spray nozzle and the remainder is carried to the by-pass port. It will be apparent that in this system the pump is heavily penalized to the extent that the capacity thereof may be reduced more than fifty per cent since the first set of gears are usually pumping more oil than the second set.

I have devised an improved pressure regulating valve which eliminates the foregoing disadvantages and wherein the by-pass port remains fully open until the pump places the oil under a predetermined pressure, and at this time the by-pass port is completely closed, so that the pump capacity is utilized in delivering oil to the burner nozzle at a predetermined pressure. This arrangement of unloading either air or oil or both on start-up, relieves the motor of excess starting load or starting torque, thus permitting the motor to more rapidly attain full speed to assure that the blower unit, which is also operated by the motor will deliver sufficient air for proper combustion at the time oil is delivered to the atomizing nozzle.

It is a primary object of my invention to provide an improved device for rapidly unloading air or the like from a pressure liquid system.

Another object of my invention is to provide an improved pressure regulating valve for a liquid system adapted to rapidly unload accumulated air upon each start-up to a by-pass and thereafter completely shut off unloading communication with the by-pass whereby the full pressure capacity of the system, after expulsion of the air, is utilized in delivering liquid at a predetermined pressure.

Another object of my invention is to provide an improved pressure regulating valve for an oil burner system adapted upon each start-up to unload a sufficient amount of oil before working pressure is attained to place a minimum starting torque on the motor to permit the motor to rapidly attain full operating speed.

Another object of my invention is to provide an improved pressure regulating valve for a liquid system wherein accumulated air in the system may be initially and rapidly unloaded through a restricted passage, and thereafter said passage is maintained closed during operation of the system while the by-passing of excess oil to the supply point through a relatively enlarged passage is permitted.

Another object of my invention is to provide an improved pressure regulating valve for an oil burner system adapted to rapidly close the burner port upon shut-down.

Another object of my invention is to provide a combined pressure regulating and air unloading valve of the above type which is relatively simple of construction and operation, and wherein easily accessible adjustment means are provided

for varying the pressure at which liquid will be delivered.

According to the invention, air, which has accumulated in the oil supply line is delivered to a chamber provided in a pressure regulating valve, and is then unloaded through a passage to a by-pass leading back to the supply tank while the burner port is maintained closed. After unloading the air, pressure is rapidly built up in the chamber, and at a predetermined pressure, oil is permitted to flow to the burner port. Upon a continued increase in chamber pressure, the passage is closed so that the full capacity of the pump is utilized in supplying oil to the burner. Means are additionally provided for transmitting excess oil directly to the by-pass with the passage closed.

The drawing illustrates an embodiment of the invention, and the views therein are as follows:

Figure 1 is a longitudinal sectional view of a valve structure embodying my invention,

Figure 2 is a view similar to Figure 1 but with the valve parts in different operative position,

Figure 3 is an enlarged longitudinal sectional view showing part of the structure of Figure 1, and

Figure 4 is a transverse section along line 4-4 of Figure 3.

Referring now to the drawing, I have indicated at 10 a generally cylindrical valve housing having a chamber 11 provided therein, and a cylindrical sleeve 12 extends downwardly from the top portion of the housing, which is adapted to receive a piston 13. The upper portion of the housing has a lateral by-pass port 14 therein which communicates with the supply tank or the suction side of the pump through a conduit 16. The lower portion of the housing has a lateral oil supply port therethrough whereby oil may be delivered to chamber 11 under pressure through a conduit 17. The base of housing 10 is provided with a threaded perforation 18 to sealingly engage a generally cylindrical valve member 19. Valve member 19, at its lower end, is provided with a threaded opening adapted to sealingly engage a pipe 21 leading to the burner whereby oil under predetermined pressure may be delivered to the burner nozzle. Communicating with pipe 21 is a relatively reduced port 22 extending from an enlarged chamber 23. The upper portion of chamber 23 is sealed by a threaded element 24 having an annular inclined surface 26, and a central opening therethrough slidably receives the upper portion 27 of a needle valve element 28.

Valve element 28 at its lower end is provided with a generally conical valve portion 29 adapted to engage the upper end of port 22 and prevent communication with the burner nozzle. Encircling the lower portion of valve element 28 is a spring 31 having the bottom convolutions thereof abutting the base of chamber 23 and the top convolutions engaging the underside of a circular shoulder 32 provided on valve element 28, whereby the valve element will be continuously urged in an upward direction. The top surface 33 of shoulder 32 is inclined at substantially the same angle as the surface 26 of element 24 to form an effective seal between these surfaces when they are in engagement. A relatively small passage 34 extends preferably axially through valve element 28 to communicate with an inclined passage 36 whereby air or oil, which may enter chamber 23 through laterally disposed ports 37, will be delivered from chamber 23

through passages 36 and 34 when valve element 28 is maintained in a position to provide an inclined annular passage between the surfaces 26 and 33.

The upper end of valve element 28 is also generally conical in form, as indicated at 38, to engage the lower end of a central axial port 39 provided in piston 13. Piston 13 is preferably provided with an upstanding circular flange at the top surface thereof adapted to engage the lowermost convolution of a spring 41, the top convolution of spring 41 engaging a circular disk 42 preferably provided with a downturned peripheral flange. The top portion of valve housing 10 is provided with a threaded recess coaxial with piston 13 and spring 41 to receive a nut element 43 having a central threaded perforation there-through engaging an adjustment screw 44 and the lower end of the adjustment screw is preferably rounded to seat within a cup-like depression provided in disk 42 whereupon rotation of screw 44 will alter the force directed by spring 41 against piston 13 and determine the pressure required in chamber 11 to move piston 13 against the force of spring 41. A suitable protective cap member 46 threadably engages a threaded stem portion of element 43 whereby the cap element may be easily removed to provide access to adjustment screw 44.

The operation of the air unloading and pressure regulating valve will now be described. First, I will assume that the installation is one wherein the tank is buried or disposed beneath the pump so that the pump is under suction lift and that the return line 16 extends to the supply tank rather than to the suction side of the pump. Upon start-up the system is filled with air and the pump must first expel the air from the suction line and then lift the oil and place the same under pressure. This air must be expelled as rapidly as possible to prevent the electrical equipment from shutting down the motor on safety, since this would require manual re-starting of the motor. If the suction line is neither too long nor too large this can be accomplished. I have found that a single stage pump with the unloading device described can unload a given volume of air in substantially the same time as a two stage pump (four gears). In either arrangement, the motor may have to be started more than once to expel all air from the suction line due to the time limit for delivering oil to the nozzle under proper pressure, but generally the air will be expelled on the first start-up of the motor. The pump evacuates the suction line rapidly by discharging the air through conduit 17, chamber 11, ports 37, passages 36, 34 and 39, and conduit 16 back to the supply tank.

When the supply tank is located below the pump and the return conduit 16 extends to the supply tank, a check valve should be installed to prevent reverse flow of oil from conduit 17 to the supply tank. If the check valve should leak for any reason, air will be pulled in through conduit 16, and may wholly or partially fill the suction line. This air as in the original start-up or installation must be expelled before oil can be delivered from the pump. Now, under these conditions when the thermostat calls for heat, the pump starts and in start-ups including the original and subsequent start-ups, the unloading passage 36 will be opened to discharge air as previously explained from conduit 17 through the device to return conduit 16. Upon start-up the chamber 11 of the regulating valve is not under

pressure since, if the system has been in operation, pressure will have been relieved by the unloading of oil through piston passage 39 and escapement around the piston. Thus prior to start-up, piston 13 under the influence of spring 41 will maintain conical portion 29 of valve element 28 in sealing contact with the upper portion of port 22 whereby no oil will be permitted to pass through conduit 21 to the burner nozzle until chamber 11, and conduit 17 are again put under a predetermined pressure. It will be noted that under these conditions, when port 22 is sealed by valve element 28, that air from chamber 11 is passed through ports 37 in the chamber 23 and upwardly around shoulder 32 to enter the annular space intermediate surfaces 26 and 33. The air will then be transmitted through passages 36 and 34 to port 39 of piston 13 and then by-pass port 14 and conduit 16 back to the supply tank of the system.

Upon a demand for heat, the thermostatic switch will cut the motor and resultantly the pump into operation and the pump will force any air, which has accumulated in the system into chamber 11, and in a manner previously explained, back to the supply tank. However, since passages 36 and 34 are relatively restricted, after the air has been expelled, pressure will immediately begin to build up in chamber 11, and at a predetermined pressure, piston 13 will be moved upwardly and valve element 28 will also move upwardly with piston 13 under the compulsion of spring 31, whereby oil may flow to the burner through port 22. Upon continued upward movement of piston 13, surface 33 of valve element 28 will be brought into engagement with surface 26 of element 24 and communication between chamber 23 and the by-pass will be shut off, and the entire capacity of the pump utilized.

Although I have shown and described a preferred form of my invention, I contemplate that numerous and extensive departures may be made therefrom without departing from the spirit of my invention and the scope of the appended claims.

The invention is hereby claimed as follows:

1. A valve element for use in a pressure regulating valve having a generally conical valve seat at each end thereof, an annular valve seat at an intermediate portion of the element, and the element having a passage therein effecting communication between the annular valve seat and one end of said element.

2. A pressure regulating device for liquid systems comprising a housing having a chamber therein adapted to receive liquid under pressure, the housing having a discharge port and a by-pass port therein, pressure responsive means in the housing operably responsive to liquid pressure in the chamber, the pressure responsive means having a passage therethrough forming the sole means of effecting communication between the by-pass port and chamber, valve means controlled by the pressure responsive means having a passage therein adapted to effect communication between the chamber and the pressure responsive means passage, the valve means being movable to a fixed position to open the discharge port and close the passage therein, and the pressure responsive means being movable independently of the valve means to effect communication directly between the chamber and by-pass port.

3. A pressure responsive device for liquid systems comprising a housing having a chamber

therein adapted to receive liquid under pressure, the housing having a discharge port and a by-pass port therein, a piston slidably mounted in the housing and operably responsive to liquid pressure in the chamber, the piston having a passage therethrough forming the sole means of effecting communication between the by-pass port and chamber, valve means controlled by the piston having a passage therein adapted to effect communication between the chamber and the piston passage, the valve means being movable to a fixed position to open the discharge port and close the passage therein, and the piston being movable independently of the valve means to effect communication directly between the chamber and the by-pass port.

4. A pressure regulating device for liquid systems comprising a housing having a chamber therein adapted to receive liquid under pressure,

a cylinder in said housing, a piston in said cylinder operably responsive to liquid pressure in the chamber, a by-pass port communicating with the cylinder, a discharge port communicating with the chamber, the piston having a passage therethrough forming the sole communicating means between the chamber and by-pass port, a valve element controlled by the piston and controlling the discharge port, the valve element having a passage therein adapted to effect communication between the chamber and piston passage, the valve element being movable to a fixed position to close the passage therein and open the discharge port to a maximum degree, and the piston being movable independently of the valve element to effect communication directly between the chamber and the piston passage.

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