LIQUID HANDLING BY-PASS SAFETY CONTROL

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This invention relates to a liquid pumping system wherein supply or quantitative differential of the liquid supplied to one part of the system is controlled by the amount of liquid by-passed by the pumping member of the system.

More particularly, the invention pertains to a safety device for a high-low oil burning system wherein the size of the fire is controlled by the pressures developed in the by-pass channels emanating from the pumping member of the system.

An object of the present invention is to provide valve means in such an aforesaid system that will prevent undue pressure being built up through mechanical failure or by accident, in the discharge line from the pumping member of the system.

Another object is to make "fool-proof" the adjustments incorporated in such a system to regulate the circulation and delivery of fluid matter within and from such a system.

Another object is to bring to a fuller degree of perfection a system disclosed in my Patent No. 2,794,599, issued June 4, 1957, of burning fuel by the "high-low" method through control of the amount of liquid fuel by-passed either from the discharge side of the pumping member to its suction side or from its discharge side to the fuel supply tank. Such a system in actual practice is subject to fire fluctuation and vibration when reliance is placed on a plurality of opening and closing by-pass passages for one size of fire even though opening and closing of such plural passages is purportedly controlled simultaneously by electrical limit controls, no provision is made for positive simultaneously mechanical movement and hence said movement is affected by acceleration or retardation in one part as opposed to another part, this acceleration or retardation sometimes being brought about by friction, mechanical defects due to wear, etc.

This condition (fire fluctuation and vibration) is most likely to occur on those high-low systems controlled through the by-passes from the pumping member, where a plurality of passages are used to by-pass fuel for the determination of any one fire size. The factors behind this condition are the surging and diminishing of pressures in the pump discharge and plurality of by-passes as they tend to seek an equilibrium. This defect is immediately remedied by providing a single, continuous, by-pass passage for each size of fire desired and making possible the easy and positive transition from one fire size to another by providing means whereby it is impossible to open a by-pass passage for one size of fire without exactly simultaneously closing a by-pass passage that results in a different size of fire.

In accordance with the present invention I provide a liquid handling valve in which is incorporated a normally closed passage and a normally open passage. Said valve may be so constructed as to be actuated by hand, by mechanical, hydraulic, electrical or other means but for the purpose of the embodiment of the invention as herein illustrated I prefer to present an electrically operated valve of the solenoid type.

In conformity with the above the valve that I provide is installed by normal mechanical methods and with ordinary by-pass conduit leading from an elevated oil fuel pump, said by-pass conduit being connected at its other end either into the suction line of said pump or into the fuel supply tank.

The said by-pass conduit from said pump is connected into the inlet chamber of the provided valve body, said inlet chamber being an unistructure to the aforementioned normally open and normally closed passages of the valve, each of said passages having closeable orifices consisting of valve seats, said valve seats being closeable by valve seat closers suitably affixed to an electrically actuable valve stem mounted within the said valve body, said valve seat closers being arranged on the said valve stem to close the said normally open passage and to open the said normally closed passage, simultaneously, construction of the valve being made in a well known manner so that it is impossible to close both passages within the valve at the same time.

The outlet from the valve is, as heretofore mentioned, connected either into the pump suction line or into the fuel supply source at the fuel oil tank.

In operation, oil is drawn from the supply tank into the suction intake of the pump by action of its gears, vanes or impeller and delivered by action of the same to its discharge outlet. A quantity of the oil is delivered into a discharge conduit or fire tube where it may be held by a closed valve until such time as it may be released by opening the said closed valve and releasing the oil to a nozzle or cup wherein it may be suitably atomized or dispersed into a combustible mixture. A certain amount of the oil delivered by the pump to its discharge outlet is returned through the by-pass connection, said quantity being determinable by quantitative adjusting means provided either on the pump discharge system, the pump by-pass system, or both. When pressure or temperature conditions in the boiler or fuel supply tank being fired call for a change in fire size the dual purpose valve in the pump by-pass is actuated to close off one passage while simultaneously opening another passage, the resultant pressure change of the oil in the by-pass passages being immediately reflected in the quantity of oil being delivered by the pump to the said fire tube.

The invention will be better understood by having reference to the accompanying drawings, in which:

FIG. 1 shows an oil burner and fuel supply system thereby embodying the present invention;

FIG. 2 is an elevation, partly cut away, showing the dual purpose valve and

FIG. 3 shows a modified outlet arrangement for the by-pass.

In the drawing an oil burner 10 is shown, which may be of any conventional type, such as a horizontal rotary burner having a unitary blower 11, geared pump 12 and rotary nozzle 13, all driven by a motor contained within the housing 14. Oil is supplied to the burner from a supply tank 15 and conduit 16 leading to the suction side of the pump 12, the oil line continuing from the output of the pump through conduit 17, normally closed solenoid valve 18 and manual quantity adjusting valve 19 to the input of the burner 10. The valve 18 is of sufficient capacity to pass the full supply of oil required for high operation of the burner. It does not serve, its duty to control quantitatively the amount of oil passed to the burner but merely to open fully when its solenoid is energized and to close completely when its solenoid is deenergized.

A by-pass is provided from the output side of the pump 12 to the tank 15 comprising conduit sections 20 and 21, a dual purpose solenoid valve 22, outlets 23 and 24 from the valve 22 and flow regulating valves 25 and 26, said flow regulating valves having means integral therein making it impossible to shut off the flow passages therethrough completely. It is to be understood that while the by-passes have been described as going to the tank 15, they
could equally well be returned to the suction side of the pump 12 as shown in FIG. 3.

With the arrangement shown it will be evident that with the valve 18 open in response to a call for heat, the flow of oil therethrough to the burner will depend upon the pressure in the conduit 17 and the setting of the manual valve 19. With valve 26 set to allow a minimum passage of oil through outlet 24 and valve 25 set to allow a greater flow of oil through outlet 23 then with the valve seat orifice 59 open and valve seat orifice 60 closed, maximum fuel will be supplied to the burner 10 to cause it to operate at high flame. However, with valve seat orifice 59 closed and valve seat orifice 60 open and valve 25 set to allow a greater passage of oil through to conduit 21 than is provided for by the setting of valve 26 the greater amount of oil diverted through the by-pass passages and pressure in the line 17 will be reduced accordingly to a minimum, said minimum being determined by the adjustment of valve 25. This reduced pressure in line 17 will cause a smaller oil flow to burner 10, corresponding to the desired low flame condition.

The blower 11 is incorporated in the system to supply sufficient air for the low flame condition only. Therefore, when high flame condition is called for it is necessary to supply supplemental air to the firing chamber. This is accomplished by secondary blower 27 which has an electric timer 28 in series with the blower motor circuit in its normally open contacts in series with the operating circuit of the dual purpose solenoid valve 22 so that solenoid coil 46 cannot be energized to open valve seat orifice 59 and close normally open valve seat orifice 60 thus reducing oil flow to flow through conduit 24, minimum by-pass flow valve 26, conduit 21 and to the oil tank until a predetermined time after starting of the blower 27. A switch 44, actuated by air flow from blower 27, prevents actuation of the solenoid 46 in case of failure of the blower to operate. A pivoted vane 44c located in the throat of the blower outlet passage has an external arm engaging the switch contacts to close the same when the vane is deflected by the blower exhaust, whenever the blower is in operation.

The high-low firing conditions are controlled by the boiler pressure through two pressure operated switches 31 and 32, which are of the titling, mercury type. Switch 31 controls the opening and closing of solenoid valve 18 and switch 32 controls the operation of dual purpose valve 22. By way of example, if it is desired to maintain a maximum boiler pressure of 16 pounds per square inch then switch 31 will be adjusted to open at 16 pounds of pressure and to reclose when the pressure is reduced to 14 pounds. In order to prevent overrunning of the boiler pressure and to decrease the frequency of operation of the controls, the switch 32 is adjusted to open at a pressure below the pressure at which switch 31 opens, say, 15% pounds and to reclose at a pressure slightly higher than that at which switch 31 recloses, say 14½ pounds. The sequence of operation of the pressure switches and the oil control valves 18 and 22 will be described subsequently.

Mercury switch 31 when closed connects power from the high side of line L through terminal 1 of a thermal delay switch 33, the bridging contact 34 of the switch, contact 2 and conductor 35 to the winding of solenoid valve 18 and thence by conductor 36 and delay switch to terminal 3 to the grounded side of the line. The heating coil 37 of delay switch 33 is connected from power to ground across terminals 1 and 3. As a consequence, upon closing of mercury switch 31 there is a delay of from 20 to 30 seconds before closing of contact 34 energizes the solenoid valve 18.

Auxiliary blower 27 is energized from line L, contact 34, switch 32 when closed, conductor 39, motor of blower 27 and electric timer 28 to ground. Timer 28, after a slight delay, completes a circuit to dual purpose valve 22 through the air flow actuated contacts of blower 27, in parallel to the blower 27.

The operation of the system is as follows: With pressure in the boiler below the desired maximum of, say, 16 pounds, mercury switches 31 and 32 will be closed. Let it be assumed that the boiler is cold and the main line switch 42 is closed to start the system into operation. Power will then be supplied through mercury switch 31, terminal 1 of the thermal delay switch and conductor 43 over the conventional burner circuits, not shown, to energize the motor of the burner 10 and the burner ignitor. Warp switch contact 34 will be open at this time but after a delay sufficient to bring the burner motor up to speed and to develop oil pressure in the conduit 17, the contact 34 closes thus energizing solenoid valve 18 to open the same. At the same time blower 27 is started and after a definite time delay the timer 28 operates, energizing the coil 46 of solenoid valve 22, causing the valve stem of solenoid valve 22 to rise and valve seat closer 50 to close valve seat orifice 60 while simultaneously, valve seat closer 51 is removed from contact with valve seat orifice 59 allowing a free passage for the oil through valve intake 54 into the anti-chamber 55 of the valve body. Said body consists of the outer walls 56 and antechamber 55 which is formed by the perpendicular extension of interior wall 58 which has a horizontal affixed component serving to divide the outlet side of the valve into two separate chambers 56 and 57, said chambers leading respectively 61 and 62 through open valve seat orifice 59, into chamber 56 and thence out through valve outlet 62, to valve outlet pipe 24 and thence to minimum flow valve 26, said flow through valve 26 causing an increase in pressure in conduit 17 and resultant high flame under the boiler. Prior to the rising of valve stem 49, bringing valve seat closer 50 and 51 to their upper positions, the pressure in the line 17 is that corresponding to low flame, as determined by the passage of oil through valve intake 54, into anti-chamber 55, through normally open valve seat orifice 60, through chamber 57 and out through valve outlet 61, thence to oil by-pass pipe 23 and into adjustable maximum flow valve 25 whence it would continue its passage through conduit 21, causing as aforesaid, low pressure in line 17.

Therefore, upon opening of the valve 18 the burner 14, starts under low flame fuel supply conditions. This starting on low flame is a safety precaution and the adjustment of the electric timer 28 should be such that the burner nozzle will be heated up and the low flame condition established before the burner is started by the opening of normally closed valve seat orifice 59 and the closing of normally open valve seat orifice 60 starts. It also insures the provision of an adequate supply of air from blower 27 at the time this additional fuel is supplied. As a consequence, the development of maximum oil pressure in conduit 17 is delayed for a short interval after which the burner operates on high flame. When the pressure in the boiler approximates the desired maximum pressure of 16 pounds, that is, at 15½ pounds in the example given, mercury switch 32 opens its contacts interrupting the circuit to blower 27 and dual purpose solenoid valve 22. Valve 23 thus restores valve 51 to its normally closed position and valve 60 to its normally open position, reducing the pressure in oil line 17 to thereby produce the low flame condition. Simultaneously the secondary air from blower 27 is also interrupted.

Under normal load conditions the steam pressure in the boiler will stop rising before the cut-off pressure of 16 pounds is reached, or, will rise at a much slower rate so that the operating period of the burner will be prolonged. If the maximum pressure of 16 pounds is ultimately reached, mercury switch 31 will open and the system will shut down and remain in that condition until the pressure has reduced to the cut in pressure which in the present example was given at 15 pounds. On such occurrence switch 31 recloses and the system restarts as previously described. Normally, however, on opening of mercury switch 32 the boiler pressure will slowly de-
crease, the rate of decrease depending on the magnitude of the low flame condition. If this is adjusted to a value which will almost carry the normal load, the rate of decrease of boiler pressure will be slow and the period of operation on low flame correspondingly prolonged. However, when the boiler pressure has decreased to a point approaching the minimum desired pressure, of, say, 14 pounds of steam, a decrease to about 14 1/4 pounds, means that switch 32 will again close its contacts to restart the blower 27 followed by the energization of the solenoid coil of dual purpose valve 22, causing same to close its normally open valve seat orifice 60 and open its normally closed valve seat orifice 59, thus restoring high flame conditions in the burner. Thus the burner may be operated over long periods between high and low flame conditions without the loss of efficiency which results from frequent starting of the burner, and at the same time maintains the boiler pressure between closely spaced upper and lower limits.

The preclusion of oil being cut off in the by passes is accomplished in this instance (as has been said previously) by restricting the inclosing of flow valves 25 and 26 mechanically, so that at all times a minimum flow passage is open through both of said valves, complete stoppage of oil flow through either one of said flow valves being accomplished through action of the dual purpose solenoid valve 22. This feature adds greatly to the safety and efficiency of the system. The fact that oil is allowed to follow only a "series" course rather than a "parallel" path through the by-pass circuit effectively reduces the fluctuations and vibrations set up in the fire by the settling down period" occasioned when the pressures built up by the pumping member seek to equalize themselves between the various frictional impediments in the system which would occur in the discharge line (equivalent to 17 in the drawing) due to the fractional balances necessitated when by-passes in parallel are used. In fact, in actual practice, it has been found that when a plurality of by-passes have been used at any one moment for the passage of liquid to regulate the flow of liquid to the discharge line, these said fluctuations do not disappear even after a little time has elapsed, in every instance. Rather, it has been found that it requires some degree of mechanical and engineering skill along with a good deal of time to obtain the desired effect on a system where these conditions exist.

On the other hand, the system as described and illustrated herein is easily installed and adapted to a great many systems for burning oil and other, already in existence, it provides a high degree of safety through provision that the by-pass channels cannot be shut off completely, through accident or otherwise; thus eliminating any chance of an excess of oil being delivered to the firing chamber and causing an explosion or a fire to go out of control. The factor of safety being of prime importance in burning fuel under boilers it is also of importance to remark that the elimination of fluctuations and vibrations from the fire serve to greatly increase the safety factor in systems that regulate fire size by the amount of oil by-passed. This element, in addition to the exact and immediate control of fire size add to the novelty and importance of this invention.

It should be noted here that although I use flow control valves to regulate the amount of oil by-passed, the same result could be as readily accomplished by using valve seat orifices of appropriate size. Other well known means could also be applicable for control of this function.

Through the dual acting solenoid illustrated in FIG. 2 would be instantly understandable to anyone familiar with the art without further explanation I will now describe the various parts of the valve in accordance with the numeral as written: 45 is the enclosing case for the electric winding 46 and coil spring 47. 48 is a seal designed to protect the winding from any oil which may pass that part of the machined casting 63 which is integral with the valve body and is designed to allow for free movement of the valve stem 51 but whose tolerance is so close around the said stem that excess oil may not enter into the casing enclosing the said stem.

A spring rest 52 is turned as an integral part of the valve stem 49 upon which coil spring 47 exerts pressure tending to keep the said valve stem 49 and valve seat closers 50 and 51 in their lower positions. The coil spring 47 is constricted between the spring rest 49 and the inner top side of the electric winding enclosing case 45 when the said winding is energized causing the valve stem 49 and valve seat closers 50 and 51 to move to their upper positions such as is shown in the figure. The three inner chambers of the valve are, as hereinbefore described, the ante-chamber 55 and separation chambers 56 and 57, said separation chambers being entered into through valve seat orifices 59 and 60. The outlet from valve chamber 56 is by way of passage 62 and the outlet from chamber 57 is by way of passage 61. The walls of the three chambers are cast integrally by the outside walls 53 of the valve body and by the irregularly shaped structure 58 wherethrough are drilled the valve seat orifices 59 and 60.

While the invention has been described chiefly with reference to an electrically operated system for controlling boiler pressures, it is to be understood that it applies equally well to a temperature controlled system in which a mercury switch 31 and 32 would be thermally controlled rather than pressure controlled. It is to be understood that various other systems are known to exist wherein pressures in said systems are controlled throughout by the by-pass pressures and while said systems are controlled in the main by electrical means various mechanical, hydraulic and manual could well be employed to control by-pass pressures. Therefore, I do not desire to be limited to those details shown and described but contemplate rather all such variations as come within the scope of the appended claims.

What I claim is:

1. A high-low fuel feeding system for an oil burner comprising a fuel pump, a conduit extending from the outlet side of said pump for supplying fuel under pressure to said burner, a normally closed electrically operated valve in said conduit, a by-pass conduit extending from the outlet to the inlet side of said pump, a dual electrically operated valve in said by-pass conduit, said dual purpose valve having one normally open and one normally closed passage threethrough, and a control switch individual to each of said valves, each of said control switches being responsive to a call for high fuel by said burner to energize both first said normally closed valve, to open the same, and to energize said dual-purpose valve to open its normally closed passage while simultaneously it closes its normally open passage, said control switches also being responsive to a call for low fuel to energize both first said normally closed valve, to open the same, and to deenergize said dual-purpose valve to close its normally closed passage and simultaneously open its normally open passage.

2. A fuel feeding system as defined in claim 1 in which said dual purpose valve includes means to effect the positive opening of one passage during closure of the other.

3. A liquid handling pumping system comprising a pump, a conduit extending from the outlet side of said pump for the delivery of liquid under pressure therefrom to a point of destination, a single by-pass conduit extending from the outlet side of said pump to the intake side thereof to divert a portion only of said liquid from said point of destination, flow regulating valve means in said by-pass conduit, said valve means including a liquid exit passageway for liquid, a plurality of outlet passageways, closure means for each of said outlet passageways, operating means for said closure means, means mechanically interconnecting each of said closure means for simultaneous operation thereof, said closure means being associated with said outlet passageways to effect the opening of one passageway upon closure of another, and
separate means associated with each of said outlet pas-
segeway for controlling the quantitative flow of liquid through the associated passageway.

4. A liquid handling system as defined in claim 3 in
which said valve means comprises a single casing hav-
ing a pair of outlet orifices forming valve seats and said
closure means comprises a member operable in one di-
rection of movement to close one orifice and open the
other.

5. A liquid handling system as defined in claim 3 in
which said closure means is electrically operated to open
one passageway upon closure of another passageway.

6. A system for handling liquid comprising a supply
conduit having a liquid outlet, means for supplying liquid
to said conduit under pressure, and means for regulating
the pressure of liquid supplied to said outlet comprising
a valve having a single inlet passageway connected to
said supply conduit for liquid delivered by said conduit
and a plurality of outlet passageways independent of said
liquid outlet, means associated with each outlet passage-
way for regulating the quantitative flow of liquid there-
through, valve closure means for each of said outlet pas-
sageways and closure operating means effective to close
one of said outlet passageways only upon the simultane-
ous opening of another of said outlet passages.

7. A system as defined in claim 6 in which said valve
has one normally open and one normally closed outlet
passageway and said operating means is electrically op-
erated to simultaneously open the normally closed pas-
sageway and close the normally open passageway.

8. A fuel feeding system as defined in claim 1, having
means for supplying air of combustion to said burner
and means for varying the amount of such air when one
of the passages of said dual purpose valve is opened and
the other is closed.

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