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## FUEL SUPPLY CONTROLLING MEANS FOR BURNERS

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8 Claims. (Cl. 137-139)

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The invention relates to new and useful improvements in a controlling apparatus for liquid fuel burners and has particular relation to valve means for governing the fuel flow to the burner.

In the type of oil burner system where the oil fuel is delivered to a spray nozzle, the fuel is generally supplied by a positive displacement pump delivering fixed quantities of fuel. A valve means is ordinarily employed to limit the maximum fuel pressure on the nozzle by by-passing all fuel delivered by the pump in excess of that quantity required to maintain a desired nozzle pressure. The fuel which is by-passed by the valve means is delivered either to the inlet side of the pump or back to the supply source.

In the operation of the usual system of this general character, the motor driven fan supplying air for combustion is mounted on the same shaft as the fuel delivery pump. Depending upon the rate of acceleration of motor speed in starting, there is a time delay after closure of the motor switch before the motor obtains its rated speed. Also, depending upon the rate of deceleration, there is a time delay between breaking of the energizing motor circuit and the time when the motor rotor comes to rest or stops.

In view of the fact that safety has demanded pump delivery in excess of burner requirements (often in excess of ten times), there is delivered to the burner, full fuel delivery with pump rotation of several hundred R. P. M. which occurs shortly after the motor starts and well before the motor reaches its rated speed or R. P. M. On the other hand, air for combustion does not reach its required delivery for proper combustion until the motor has reached its rated R. P. M.

Following a period of burner operation, terminated by breaking of the motor circuit, the motor speed decelerates and with deceleration, there immediately starts a reduction in air delivery by the fan. Fuel delivery, however, remains relatively at a constant until such time as the R. P. M. of the motor has reduced to that at which the displacement rate is less than that which will pass through the spray nozzle at the established maximum pressure regulated by the previously referred to by-pass valve. During this same period between start of deceleration and that R. P. M. at which fuel delivery is reduced, there is a continued and rapid decrease in amount of air delivered to the burner. This results in a period at the expiration of any burner heating or operating cycle in which air for combustion is not delivered in sufficient quantity, resulting in incomplete combustion with attendant carbon monoxide and free carbon.

Putting the above into actual quantities which might be existent, a fuel pump operating at 1800 R. P. M. has, say, a positive displacement at its rated R. P. M. of 18 gallons per hour (g. p. h.).

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This is the equivalent of a delivery rate of one g. p. h. per 100 R. P. M. If the nozzle is rated at two g. p. h. at 100# pressure and all fuel delivered in excess of that which will pass through the nozzle at 100# pressure is by-passed, then the motor R. P. M. can decrease from 1800 to 200 R. P. M. with no reduction in delivery through the nozzle. The only difference being gradual reduction in quantity of fuel by-passed until at 200 R. P. M., 100# pressure is still maintained and no fuel is by-passed. During this period of deceleration from 1800 to 200 R. P. M., the air delivery is materially reduced with the result of incomplete combustion as above noted.

The present invention provides a control means by which irrespective of the quantity of fuel delivered by the pump or by the pressure resulting from such delivery, the instant that deceleration starts by breaking of the motor energizing circuit, all fuel flow to the nozzle is discontinued. And in lieu of insufficient air, there results the advantageous effect of continuance of air delivery following discontinuance of fuel delivery. During the period of initiation of operation, there is established in the present invention, a time delay in the delivery of fuel from the pump to the fuel burner nozzle, thereby providing a time period during which the air supply is increased.

It will be understood from the above that one object of the invention, therefore, is to provide an improved means for controlling the flow of oil from the pump to the nozzle so that the above mentioned undesirable relationships of oil and air delivery may be obviated.

Another object of the invention is to provide an improved oil control for the purpose mentioned wherein the oil flow is immediately cut off as soon as the pump motor energizing circuit is broken so as to prevent a continuance of fuel flow during a period of reduced air delivery.

Another object of the invention is to provide a device for obtaining these results automatically and through means controlled by the oil pressure.

Other objects of the invention will become apparent from the following specification, from the drawings forming a part thereof, and from the claims hereinafter set forth.

For a better understanding of the invention reference may be had to the accompanying drawing wherein:

The single figure illustrates one form of the invention in cross section with certain parts shown diagrammatically so as to illustrate the manner in which the burner operates.

Referring to the figure, an ordinary gun type burner is illustrated which includes a barrel adapted to extend into the combustion chamber of a boiler or furnace, a blower housing and a motor. This motor is drivinely con-

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ected to a pump 13 and normally the pump and a blower within the casing 11 will be connected to the motor shaft so as to be driven thereby. Wires 14 and 15 leading to the motor 12 may be connected to lead-in lines 16 and 17 by a double pole switch 18, although normally suitable thermostatically controlled means will be used to make and break the motor circuit depending upon the temperature of the space heated by the furnace.

The inlet side of the pump 13 is connected by means of a conduit 20 to an oil tank 21, while the discharge side of the pump is connected by a conduit 22 to a casing 23. Oil from the casing flows through a valve opening 24 and into a conduit 25 extending through the barrel 10 and which has a nozzle 27 at the end of the barrel. Any suitable ignition may be employed for igniting the oil sprayed from the nozzle 27, such as the usual electrical igniting device or a suitable form of pilot device.

According to the present invention, a valve stem 30 in the casing 23 has a conical end or head 31 engageable with a seat provided by the end of the outlet conduit forming the valve opening 24 so as to close the opening. The stem, at its other end, projects into a centrally disposed tubular supporting member 33 having a bottom wall or partition 34. The stem 30 has its lower portion forming an armature and is slidably guided in the member 33. The stem is resiliently urged toward valve closing position by a coil spring 36 disposed in an upward extending axial bore or opening 37 in the stem. This spring, at its upper end, as shown, abuts the bottom or end wall of the opening 37 and at its lower end abuts the wall 34, being held under compression therebetween.

The supporting member 33, at its upper end, projects through and is firmly connected and sealed to the central portion of an annular diaphragm or pressure responsive member 40 while the outer peripheral portion of the diaphragm is tightly held and sealed against an annular shoulder 41 in the casing by a ring 42 threaded into the casing as indicated at 43. The diaphragm may be constructed of any suitable and flexible material and in the event rubber is employed, the material will be oil resistant. From this now, it should be evident that the upper part of the casing into which the conduit 22 discharges and which forms a pressure chamber, is sealed from that part below the diaphragm and that the valve stem is normally urged by the spring into valve closing position so as to prevent the oil from flowing from the casing 23 to the nozzle 27.

Below the diaphragm, a solenoid coil 45 of an electromagnetic means surrounds and is mounted rigidly on and for movement with the supporting member 33. Wires 47 and 48 leading to the wires 15 and 14 respectively and thereby connected to the switch 18 are connected respectively to one end of the solenoid coil and to a threaded stud 50 adjustably screw-threaded through and insulated from a removable cover 51 on the lower end of the casing 23. A contact 52 adjacent the upper end of the stud 50 is electrically connected to the other end of the solenoid coil 45 which is opposite the end connected to the wire 47. The contact 52 is engageable with the contact formed by the upper inner end of the stud 50 so that when contact 52 engages the stud the solenoid is energized, providing the switch 18 is closed, thereby causing the metal valve stem 30 to be

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pulled downwardly, provided it is out of engagement with the wall 34.

Below the wall 34, the supporting member 33 has a shorter tubular portion 54 which houses one end of a second helical spring 55 engaging at one end the lower side of the wall 34 and its other an adjustable access plug 56 threaded into the cover 51. The spring 55 is sufficiently strong to hold the parts in the position shown until a predetermined pressure acts against the diaphragm and in this connection it may be stated that the spring 36 is relatively weak so as not to undesirably affect the action of spring 55 while still being strong enough to quickly move the valve to closed position when the solenoid is de-energized.

At one side of the casing, a conduit 60 is connected into the pressure chamber or upper part of the casing and this conduit has a by-pass valve 61 therein normally held in a closed position by a spring 62. The by-pass valve 61 acts to maintain or limit the maximum pressure in the casing to a predetermined pressure which, for instance, may be one hundred pounds per square inch, and when the pressure exceeds this amount the valve will automatically open and some oil will be allowed to escape to a line 63 which leads back to the supply tank 21 or may lead to the inlet conduit 20. Any suitable by-pass valve may be used which allows oil to flow back to the tank or inlet side of the pump when a predetermined pressure is reached. When the pressure drops below this predetermined pressure, the by-pass valve 61 closes.

If it be assumed now that the switch 18 is closed, the motor 12 and pump 13 will start operating and oil will be pumped from the tank 21 into the casing 23. As the pressure increases in the casing 23, the diaphragm 40 is flexed downwardly inside its outer margin and as it moves downwardly, the contact 52 approaches the upper end of the stud 50. The distance between the contacts may be varied by adjusting the stud 50 so that more or less movement will be required before engagement of the contacts occurs and hence engagement of the contacts may be caused to occur at different pressures acting on the diaphragm. The pressure at which the contacts 50, 52 are closed may also be regulated by adjusting the plug 56 which determines the force of the spring 55. When the pressure on the diaphragm reaches a predetermined amount the contacts 50 and 52 engage each other and then the solenoid 45 becomes energized.

In the meantime, while the supporting member 33 is moving downwardly away from the end of the valve stem, the spring 36 holds the valve closed. However, as soon as the solenoid is energized the stem 30 is moved through magnetic attraction downwardly into the member 33 until its end again engages the wall 34. This action occurs quickly, as will be readily understood and the end 31 of the stem quickly opens the valve opening 24 so that oil flows from the casing to the nozzle 27. The pressure at which the valve opens may be substantially that established by the by-pass relief valve 61, but must, of course, be something less.

Pressure is maintained in the casing 23 by the pump delivery being in excess of nozzle capacity, requiring normally a continuous by-pass opening sufficient for flow of all excess fuel delivered by the pump to the valve chamber. The resistance of the by-pass spring 62 requires a pressure to open the by-pass which is slightly in excess of

that required to make circuit at contacts 50, 52 so that the metal valve 30 remains open. It might be mentioned in connection with the by-pass valve that it may be suitably adjustable so as to allow for varying the desired limiting or by-pass pressure in the casing.

When the electrical circuits are broken by the operation of the switch 18 or thermostat control governed by the temperature of the space heated, the motor and pump stop operating and at the same time the circuit through the solenoid is broken. As soon as the solenoid is thus de-energized, the spring 36 immediately acts to close the valve 30 so that the flow of oil to the nozzle is sharply cut off. This closing of the valve by opening of switch 18 occurs while the oil in the casing 23 is still under desirably high operating pressures and as a result there is no progressively decreasing flow of oil at the nozzle. In other words, when the valve closes, the full oil spray at the nozzle is quickly and completely stopped and therefore there is no continuance of a progressively decreasing amount of oil under progressively decreasing pressures. This eliminates the continuance of fuel delivery during a period of reduction in quantity of air delivered.

Generally, it may be observed that nozzle delivery is dependent on two conditions in lieu of the customary one condition. There must be established both fuel pressure and the energizing circuit to the pump operating motor. Discontinuance of either results in immediately stopping all further nozzle delivery.

Although only one form of the invention has been illustrated and described in detail, it will be apparent to those skilled in the art that various modifications may be made without departing from the scope of the appended claims.

What is claimed and is desired to be secured by Letters Patent of the United States is:

1. A valve for controlling the flow of fluid under pressure comprising a casing having an inlet and an outlet, a valve member cooperable with and normally closing said outlet and having an armature, means urging said valve member toward closed position, electro-magnetic means cooperable with said armature and operable when energized to overcome said urging means and move said valve member to open position, a circuit for said electro-magnetic means, a pressure operated switch in said circuit, means responsive to fluid pressure in said casing and operable to close said switch at a predetermined pressure in said casing, and means supporting said electro-magnetic means on said responsive means.

2. A shut-off valve for the fuel supplied to an oil burner, comprising a conduit for fuel flow, means responsive to fuel pressure in said conduit, a switch controlled by said means, electro-magnetic means carried by said pressure responsive means and having a circuit controlled by said switch, and a valve controlling the flow of fuel under pressure through said conduit and held in open position by said electro-magnetic means when energized.

3. A control valve device comprising a casing, a diaphragm across the casing, an inlet and outlet in the casing at one side of the diaphragm, a valve carried by and movable relative to said diaphragm and operable to close the outlet, spring means normally urging the valve to a closed position independently of the diaphragm, a solenoid carried by said diaphragm for opening the valve

against the action of the spring means, and means for causing the solenoid to be energized when the diaphragm has moved a predetermined amount.

4. A control valve device comprising a casing, a diaphragm across the casing, an inlet and outlet in the casing at one side of the diaphragm, a tubular element extending centrally through the diaphragm and to the other side thereof and having its end at such other side closed, a valve disposed in and being reciprocatory in said element for closing the outlet opening, spring means in the tubular element for urging the valve to closed position, a solenoid coil around the element at said other side of the diaphragm, and means for closing a circuit through the solenoid when the diaphragm is moved a predetermined amount by pressure so as to effect opening movement of the valve through magnetic forces.

5. A control valve device comprising a casing, a movable diaphragm dividing said casing into a pressure chamber and a coil chamber, said pressure chamber having inlet and outlet ports, a valve member cooperable with one of said ports and having an armature adjacent said diaphragm, an electro-magnetic coil in said coil chamber and cooperable with said armature to actuate said valve member, and a switch in said coil chamber and operable by said diaphragm and controlling current flow through said coil.

6. A control valve device comprising a casing having a pressure chamber with inlet and outlet ports, a valve member cooperable with and controlling flow through one of said ports and having an armature, a pressure responsive movable member closing a side wall opening of said chamber, an electro-magnetic coil carried by said responsive member and cooperable with said armature, and means operable by movement of said responsive member and controlling current flow through said coil.

7. A control valve device comprising a casing having a pressure chamber with an inlet and an outlet, a valve member in said chamber and normally biased to outlet closing position, a pressure responsive movable member closing a side wall opening of said chamber, cooperable electro-magnetic members for opening said valve member and including a coil carried by said responsive member and an armature carried by said valve member, a circuit for said coil, and a switch operable by said responsive member and controlling said circuit to energize said coil and open said valve member.

8. A control valve device comprising a casing having a pressure chamber with an inlet and an outlet, a valve member in said chamber and controlling said outlet, a pressure responsive movable member closing a side wall opening of said chamber, cooperable electro-magnetic members for opening said valve member and including a coil carried by said responsive member and an armature carried by said valve member, a circuit for said coil, a spring compressed between said valve member and said responsive member and holding said valve member closed upon movement of said responsive member away from said valve member by pressure increase in said chamber, and a switch operable by said responsive member upon increase of pressure in said chamber and controlling said circuit to energize said coil and open said valve member.

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