Feb. 1, 1966 J. A. SCHUSS ETAL 3,232,332

FUEL BURNER CONTROL ARRANGEMENT

Filed Dec. 30, 1963 3 Sheets-Sheet 1

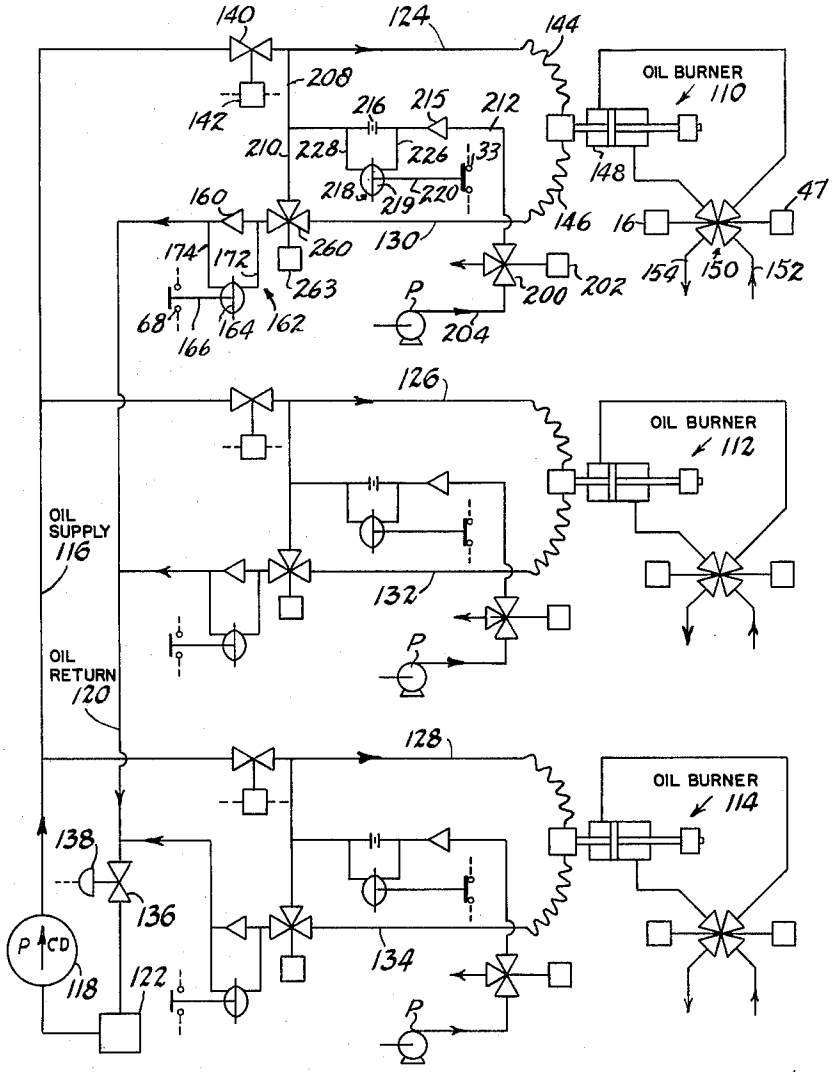


FIG. 1

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FUEL BURNER CONTROL ARRANGEMENT

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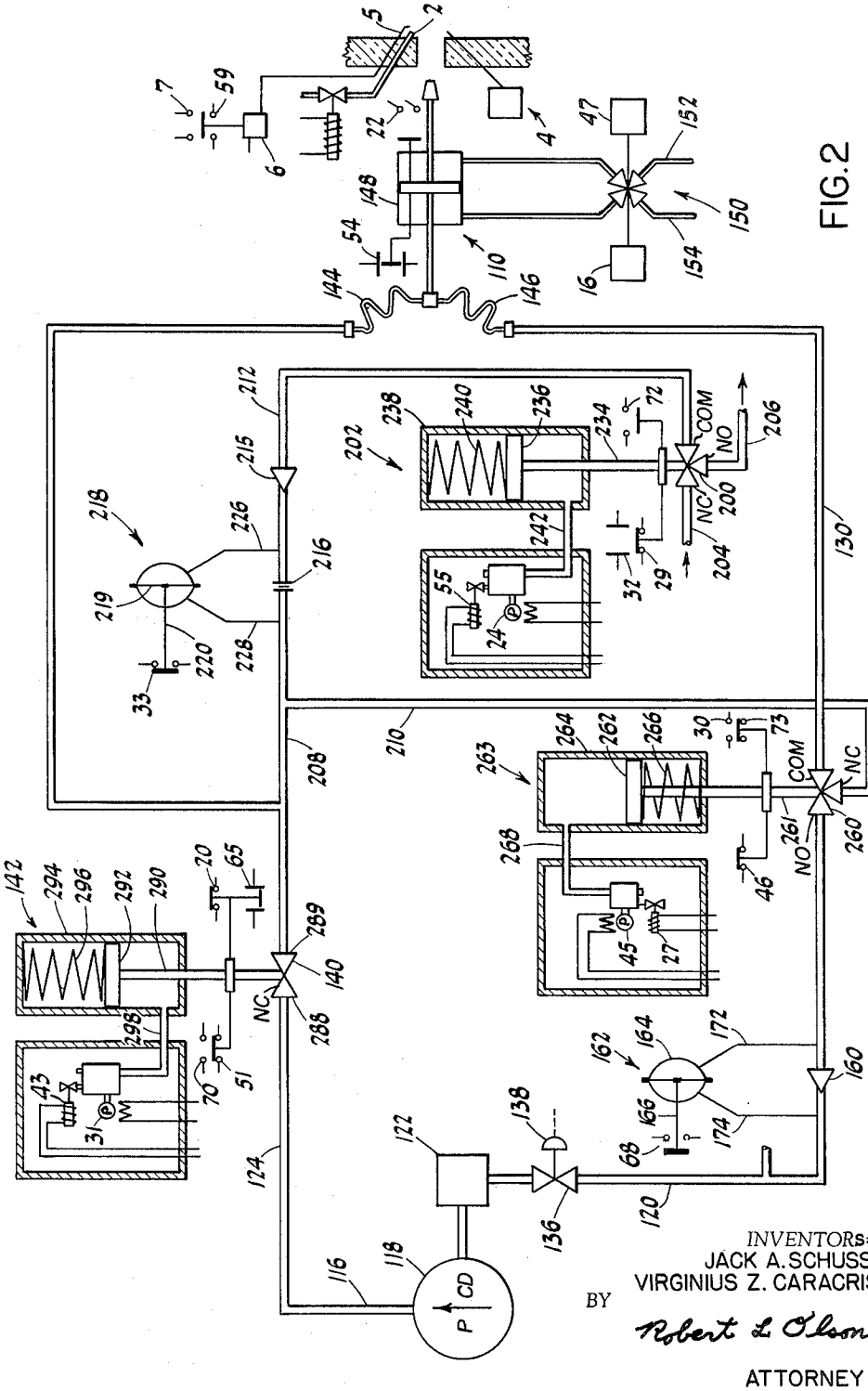


FIG. 2

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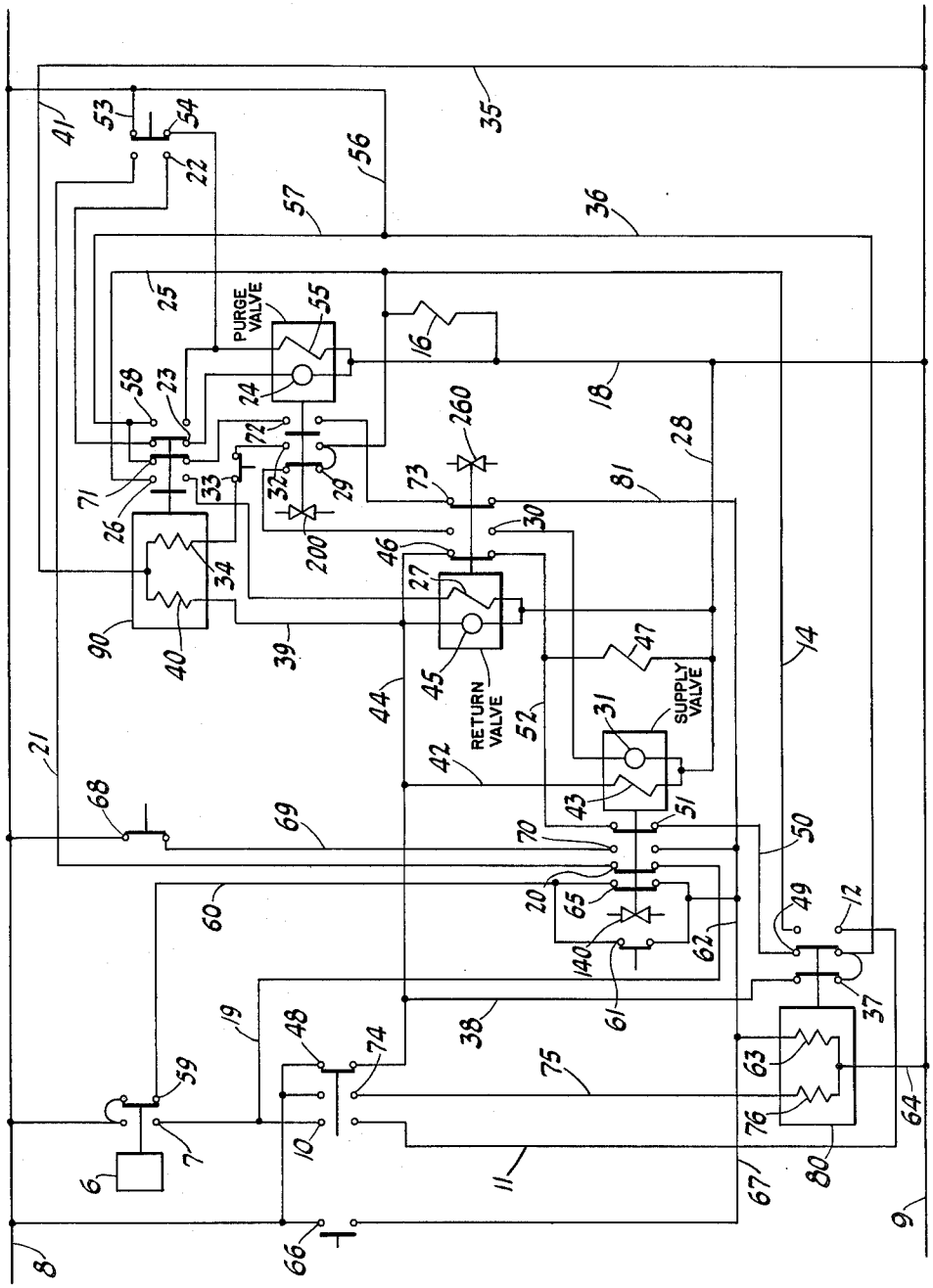


FIG. 3

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FUEL BURNER CONTROL ARRANGEMENT

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2 Claims. (Cl. 158—36.3)

This invention relates to a novel system for controlling fuel burners of a vapor generator, and in particular to such a system for automatically and safely controlling the startup and shutdown of such burners.

In large vapor generators in which fuel is burned in a plurality of burners, it is becoming more and more important that the burners are capable of controlling and monitoring themselves during startup, shutdown, and normal operating procedures, utilizing a minimum of human supervision. Vapor generators are becoming so large, and utilize such a large number of burners, that in many instances it is no longer possible for an operator to manually control such burners in a safe and efficient manner.

It is an object of this invention to provide a control system for automatically controlling a burner system whereby a minimum of human supervision is required.

It is a further object to provide a control system whereby all external timing devices are eliminated therefrom, with the inherent characteristics of the valve actuating devices within the burner system performing the timing functions, thus resulting in a system with fewer components. This elimination of components results in increased reliability, while achieving efficient, orderly control in an economical manner.

Other objects and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a diagrammatic illustration of a burner system incorporating the invention;

FIG. 2 is a diagrammatic illustration of one burner of the system shown in FIG. 1;

FIG. 3 is a diagrammatic illustration of the electrical control circuit of the burner shown in FIG. 2.

Referring to FIG. 1, numerals 110, 112 and 114 designate three oil burners of an oil burner system. Although only three burners have been illustrated, any number of burners could be tied into the common system. For example, the burner system could be utilized at a steam generating site where the burners would supply fuel to the boiler furnace, the heat generated by the burning of such fuel being utilized to generate steam. In such a system, it would not be uncommon to utilize as many as twelve or twenty-four individual oil burners in the burner system, or even more.

As illustrated, oil is supplied to each of the burners by means of oil supply lines 124, 126 and 128 all of which extend from a common oil supply manifold 116. Constant delivery pump 118 supplies oil to the manifold 116 at a constant pressure, for example 1000 p.s.i. Extending from each of the oil burners 110, 112 and 114 are oil return lines 130, 132 and 134 all of which are connected to a common oil return manifold 120. This returned oil flows into an oil sump or storage tank 122 which is connected to the upstream side of constant delivery pump 118. A valve 136 is positioned in oil return manifold 120 downstream of all of the individual oil return lines, and this valve can be modulated to thus vary the oil pressure in each of the oil burners. Control 138 is indicated for varying the position of valve 136. This control 138 can receive a signal from any central control point where the amount of fuel to be fired in the burners is determined.

The details of an individual burner and its associated elements will now be explained. Since each burner of the entire burner system is identical in construction and operation, only one of such burners will be described. Looking to FIG. 2, positioned within supply line 124 is valve 140, the actuator of which is indicated at 142. Forming a portion of the supply line 124 is flexible hose 144. Flexible hose 146 forms a portion of the return line 130. These two flexible hoses are necessary in order to enable the oil burner 110 to be extended into and retracted from a furnace interior.

As shown, oil burner 110 may be moved either in a forward or backward direction by means of the piston-cylinder arrangement 148. Four-way valve unit 150 controls the admission and venting of air to the opposite sides of piston 148. Suitable actuators 16 and 47 allow the connection of air supply line 152 or vent line 154 to either the left-hand or right-hand side of piston 148 as desired.

A check valve 160 is positioned within return line 130, which allows flow only in the direction from the oil burner 110 to the oil return manifold 120. Numeral 162 designates a pressure differential measuring device. This device consists of a flexible diaphragm 164 having a stem 166 connected thereto which contains an electrical contact member thereon. The contact member contained on stem 166 is positioned so as to come into contact with contacts 68 when certain conditions exist, as more fully described hereafter. When the contact member on stem 166 engages contacts 68, a circuit is completed, as will be more fully explained in the description of FIG. 3. The pressure measuring device 162 contains pressure taps 172 and 174 connected to the upstream and downstream sides of check valve 60, respectively.

In FIG. 2, the notations NO, NC, and COM have been indicated for the various valves. These notations mean: NO, a normally open port when the actuator is de-energized; NC, a normally closed port when the actuator is de-energized; and COM, a port common to the other two ports in a three-way valve.

The operation of the above apparatus will now be described. Oil at a constant pressure is supplied to each of the oil supply lines 124, 126 and 128 (shown in FIG. 1) by constant delivery pump 118. Valve 140 in the oil supply line 124, is moved to its open position by means of actuator 142 (shown in FIG. 2). Valve 140 is opened in a predetermined sequence in relation to the opening of each of the other corresponding valves in the system. This can be accomplished from the control center for the plant. Three-way valve 260, which is in the oil return line 130, is in a position preventing flow into line 210, but allowing flow from line 130 to the oil return manifold 120. When the oil burners of the system are to be operated at their highest firing capacity, control 138 will receive a signal from the central control point which will move variable valve 136 to its fully closed position. Under these conditions, the highest pressure possible exists in the burner tip chambers. Thus the oil in the chamber is forced through the nozzle opening into the furnace interior at its highest rate. When it is desired to reduce the firing capacity of the burners, control 138 will move valve 136 to a position other than its fully closed position, thus allowing some of the oil to return to storage tank 122. This reduces the pressure in the burner chambers, thus reducing the firing rate of each individual burner.

When the flexible hoses 144 and 146 of the oil burner 110 are in good condition and contain no leaks or breaks, and when the burner nozzle is properly attached and not badly worn, the pressure differential measuring device 162 will not act upon actuator 142. When the valve 136 in oil return manifold 120 is completely closed, there will be no flow through oil return line 130, nor in any of the

other return lines. Thus the pressure differential across check valve 160 will be zero. When valve 136 is in an open position, there will be some flow through oil return line 130, and thus pressure differential measuring device 162 will sense a higher pressure in pressure tap 172 than it will in pressure tap 174, due to the slight restriction formed by check valve 160.

If one of the flexible hoses 144 or 146 ruptures or springs a leak, or if the burner tip becomes badly worn so that the oil is not issuing therefrom in a fine atomized spray but is gushing therethrough, pressure differential measuring device 162 will energize actuator 142 so as to close the valve 140. Because there are a number of oil return lines that feed into the common oil return manifold 120, a back pressure always exists in the manifold 120 during operation of the burner system, and in each of the oil return lines 130, 132 and 134 (shown in FIG. 1) upstream of the check valves placed therein. If one of the hoses breaks, or the burner tip becomes badly worn, all of the oil will be flowing through such break or badly worn tip, and the pressure on the upstream side of the check valve will be greatly reduced. The back pressure existing in oil return manifold 120 will under these conditions tend to cause the oil to flow in a reverse direction against check valve 160, of the particular oil burner where the hose break or badly worn burner tip exists. Thus the pressure in pressure tap 174 will exceed the pressure in pressure tap 172, moving the diaphragm 164 along with its connected stem 166 to the right. The contact member on stem 166 will engage the contacts 68, completing the circuit to actuator 142, thus closing valve 140 under these conditions. The above condition will also act to energize other components of the burner valve cluster, as will be further explained in connection with the description of FIG. 3.

Thus if the pressure measuring device measures a zero pressure differential or a differential with the highest pressure on the upstream side of the check valve, the burner is in good condition, and it is allowed to continue to operate. If the pressure measuring devices senses a higher pressure on the downstream side of the check valve than on the upstream side thereof, the valve in the supply line of that particular burner is closed. The remaining burners in the system will continue to operate, and the only burner that will be removed from operation is the one containing the ruptured hose or badly worn burner tip.

Another feature of this invention is a prechecking system by means of which the flexible hoses and the burner tip of each of the burners can be pretested prior to the time when oil is actually supplied thereto, to determine whether or not such elements are in good condition. The testing medium is fluid other than the fuel oil. Advantage is taken of the availability of air or steam for post-shutdown gun scavenging so that it can also be utilized as a gun integrity test medium. As illustrated in FIG. 2, three-way valve 200 is connected to a suitable source of fluid under substantially constant pressure by supply line 204. Numeral 202 denotes a suitable actuator for valve 200. Vent line 206 is shown leading from the valve 200. The downstream side of the valve 200 is connected to a line 212 containing check valve 215 and a restriction 216, for example an orifice, therein. This line 212 branches off into line 208 which is connected to the oil supply line 124 downstream of valve 140, and also line 210 which is connected to oil return line 130 through three-way valve 260. Actuator 263 positions three-way valve 260 to either allow flow from oil return line 130 to oil return manifold 120, or from line 210 into oil return line 130. Numeral 218 indicates a differential pressure measuring device, positioned in air line 212 which consists of flexible diaphragm 219 having a stem 220 connected thereto, and pressure taps 226 and 228 positioned on the upstream and downstream sides of restriction 216 respectively. Stem 220 contains a contact member which coacts with contacts 33. When these two members are out of engagement during the precheck period, it prevents the later opening of the fuel supply valve 140.

This prechecking system operates in the following manner. Three-way valve 200 is actuated to its position connecting line 212 to the supply line 204. As used throughout the rest of the specification, this position of valve 200 will be referred to as its open position; and when valve 200 is positioned to prevent flow from 204 to 212, but allowing fluid to drain from line 212 to vent 206, this will be referred to as its closed position. Valve 260 is in its shutdown position, allowing flow from line 210 to line 130, and valve 140 is in its closed position. As used in the specification, when the valve 260 allows flow from the right-hand portion of return line 130 to the left-hand portion thereof, this is its open position; when valve 260 prevents flow as described above, but allows flow of steam or air from line 210 to the right-hand portion of return line 130 this is its closed position. If there are no breaks in the hoses 144 and 146, and if the burner tip is not badly worn, a predetermined pressure differential will be established across orifice 216. If there is a break in one of these lines, or if the burner tip is bady worn, the flow through line 212 will be greatly increased, resulting in an increased pressure differential across the orifice 216. When this pressure differential exceeds a predetermined maximum, indicating an unusually high rate of flow, contacts 33 will be disengaged by the contact member carried by stem 220. This condition will result in the restrictive interlocking of actuator 142, as further explained below.

When actuator 142 is interlocked, it will not be possible for the valve member 140 to be actuated to its open position by means of a later signal from the central control point. Thus before valve 140 can thereafter be opened, it will be necessary for the operator to repair the broken hose or replace the worn burner tip, thus removing the restrictive interlock. Startup must then be reinitiated. The prechecking system that has been shown is also used as the purging system for the burner. In other words, when the burner system is shut off by closing the valves in the oil supply lines, some oil will be trapped in the lines adjacent to the burners. By forcing steam of air through the purging system, this oil can be forced out of both the oil supply lines and the oil return lines and out of the burner tip into the furnace interior.

Supply valve 140 is a slow opening but rapid closing valve which permits the gradual increase of fuel from zero to rated flow upon opening and an abrupt cessation of flow upon shutdown. It requires approximately twenty-five seconds for the valve to fully open. Gradual introduction of fuel to the furnace is required in order to prevent subjecting the furnace chamber to an undesirable pressure shock upon ignition.

In order to effect valve operation in this manner, the preferred embodiment of the invention employs a valve 140 having an electro-hydraulic operator 142. Such a valve comprises a valve body having an inlet 288 and an outlet 289. Within the body a valve plug is operated to slowly open, thus permitting passage of fuel through the line 124. To effect this slow opening of supply valve 140, the valve plug is connected to an hydraulically actuated piston 292 by means of valve stem 290 and operates against the force of a spring 296. Fluid is supplied to the underside of the piston 292 through inlet line 298 by means of a pump 31 which is driven by an electric motor. The valve stem 290 contains switches which coact with contacts 20, 51, 65 and 70. The purpose of these switches and contacts will be further explained in the description of FIG. 3.

Even after deactuation of the motor for pump 31, fluid pressure remains within the actuator cylinder 294 until an internal relief valve is opened by means of a sole-

noid 43 thereby releasing the fluid beneath the piston 292 and permitting the valve plug to become seated within the valve body. Valve closure is accomplished by the force of the spring 296 which operates against the top side of the piston 292 to seat the valve plug very rapidly.

Purge valve 200 is similar to supply valve 140 in that it is slow opening but rapid closing. However, it is designed so that the period of time is much less than twenty-five seconds, as is the case with the supply valve. The purge valve 200 moves to its fully open position in about five seconds.

In order to effect valve operation in this manner, valve 200 has an electrohydraulic actuator 202. Hydraulically actuated piston 236 is connected to the valve by stem 234. Hydraulic fluid is pumped to housing 238 below the piston through inlet line 242 by the motor driven pump 24. When the valve 200 is to be closed solenoid 55 is energized to open its associated relief valve to allow the hydraulic fluid to escape from housing 238. The spring 240 then rapidly closes valve 200.

Line 204 is connected to a suitable source of purging fluid, steam or air, and 206 indicates a vent line.

The valve stem 234 contains switches thereon for coaction with contacts 29, 32 and 72, which will be hereinafter further explained in the description of FIG. 3.

The actuating mechanism of return valve 260 is essentially the same as valves 140 and 200 with the exception that its operator 263 is arranged so as to effect rapid opening but slow closure. The valve is designed so that it closes in approximately one minute. To accomplish this the operator 263 is arranged with the fluid inlet line 268 communicating with the cylinder 264 above the piston 262 and the spring 266 is located so as to force the piston 262 in an upward or opening direction. Thus, actuation of the motor and associated pump 45 admits fluid to the cylinder 264 in a manner which will serve to close the valve 260 gradually. When it is desired to open the valve, the solenoid 27 is actuated to open the relief valve which releases the fluid from cylinder 264 permitting the piston 262 to be forced upwardly by spring 266. Valve stem 261 contains switches which coact with contacts 30, 46 and 73, which will be explained in more detail hereafter with reference to FIG. 3.

Still referring to FIG. 2, numeral 2 designates an igniter burner for initially igniting the fuel issuing from the main burner 110. A flame detector 5 associated with the igniter burner 2 controls a relay 6, which is energized when the igniter flame goes out. An optical flame scanner 4 detects the presence or absence of flame at the main burner 110. The function of these flame detectors will be further explained hereinafter.

Startup operation

Looking now to FIG. 3, the manner in which the various components are energized and de-energized will be explained. When it is desired to start up the burner, a flame is first established at the igniter 2. This flame is sensed by the flame detector 5, energizing relay 6, thus moving its associated switch arm to a position closing contacts 7. The main control board switch is then moved to its "start" position or a signal is sent from a central control computer or dispatcher, momentarily closing contacts 74. This completes a circuit through conductor 75 to energize operating coil 76 of latch relay 80, the circuit being completed from hot line 8 to the ground line 9 through conductor 64. Energization of operating coil 76 moves the relay gang switch to the right. Relay 80 is of the latching type, i.e. when one or the other of the coils is actuated, the associated switches are mechanically latched in that position until the other relay is energized, and thus the switches remain in that position even though the first relay is later de-energized.

After a few seconds, the control board switch is moved to its "operate" position, thus closing contacts 10. This completes a circuit through conductor 11, contact 12, conductors 14 and 18 to energize the gun advance solenoid 16.

When the gun is fully advanced or extended, limit switch (LS) 22 located on the gun closes.

Closure of LS 22 will energize the pump 24 of purge valve 200 if the following conditions exist: (1) contacts 23 associated with relay 90 is closed; (2) limit switch (LS) 20 is closed indicating that the fuel supply valve is in its fully closed position; and (3) switch 7 of the igniter flame detector is closed. If these conditions are met, the pump 24 of the purge valve is energized through contacts 7, conductor 19, switch 20, conductor 21, LS 22, contacts 23, and conductor 18. The purge valve 200 thus starts opening.

When the purge valve 200 reaches about 70 percent of its fully open position, LS 32, positioned on the purge valve stem, will close. At this time the differential pressure contacts 33 remains closed if there are no breaks in the fuel line, and the burner nozzle is not defective. Closed contacts 32 and 33 completes a circuit energizing operating coil 34 of latch relay 90 through contacts 7 and 10, conductor 11, contact 12, conductor 14, contacts 32 and 33, and conductors 41 and 35. Energization of relay operating coil 34 moves the relay gang switch to the right, and it is held in that position until release coil 40 is energized.

Energization of operating coil 34 closes contacts 25 and 58 simultaneously. Closure of contact 26 completes a circuit energizing solenoid 27 of the return valve 260, thus quickly opening this valve. The circuit is completed through conductor 25, contact 26, and conductor 28. Closure of contact 58 energizes relief solenoid 55 of the purge valve 200, which quickly closes. Solenoid 55 is energized through conductors 56, 57, contact 58 and conductor 18.

Closure of the purge valve 200 closes LS 29 associated therewith. Also, LS 30 is closed when the return valve 260 is opened. Closure of these two switches completes a circuit through contacts 7 and 10, conductor 11, contact 12, conductor 14, LS 29, LS 30, and conductor 28 to energize the pump 31 of the supply valve 140. This will slowly start opening the fuel supply valve 140. Full opening of the fuel supply valve completes the startup procedure.

The above completes the startup cycle of the burner. Thus it can be seen that the burner is placed into operation automatically in a safe, efficient, orderly manner. By use of the limit switches contained on the valve stems, it is possible to eliminate all external timing devices from the control apparatus.

Normal shutdown

The manner in which a normal, orderly shutdown is accomplished will now be described. The main control board switch is moved to its "off" position, closing contacts 48. This completes the circuit to energize solenoid 43 of the supply valve 140. The circuit is completed through conductors 42 and 28. This results in closure of the supply valve 140 in less than a second.

Closure of contact 48 also energizes pump 45 of the return valve 260, the circuit being completed through conductors 44 and 28. It takes approximately 60 seconds for the pump to fully close the return valve.

Closure of contact 48 also completes a circuit through conductors 44, 39, 41 and 35 to energize reset coil 40 of latch relay 90. This energizes the pump 24 of the purge valve 200, thus starting the purge cycle providing ignition energy from the igniter is available.

When limit switch 46 closes, indicating that the return valve 260 is completely closed, a circuit is completed energizing the gun retract solenoid 47. This circuit is completed through conductor 44, LS 46, and conductor 23. This retracts the gun from the furnace interior. The moment the gun moves from its fully advanced position, limit switch LS 54 closes, establishing a circuit through

conductor 53, LS 54 and conductor 18, energizing the relief solenoid 55 of the purge valve, effecting a rapid closure thereof. This completes the orderly shutdown cycle.

Thus it can be seen that normal shutdown of the burner takes place in the following manner: (1) the fuel supply valve 140 is closed; (2) relay 90 is reset; (3) purge valve 200 opens; (4) return valve 260 starts to slowly close; (5) return valve 260 fully closes; (6) retraction of gun 110 is accomplished; and (7) purge valve 200 closes.

Emergency trip conditions

Under any of a number of emergency trip conditions, the burner will be shut down without a purge cycle. The following emergency trip conditions will accomplish such shutdown: (1) Loss of flame by the igniter during the startup cycle (the fuel valve is not fully open yet); (2) Loss of flame by the igniter after startup, plus indication by the optical flame scanner that no flame exists at the main burner; (3) A general boiler trip; (4) A gun assembly failure during operation; and (5) Gun assembly failure during its pre-start integrity check.

Any one of the above conditions will energize reset coil 63 of latch relay 80. Energization of reset coil 63 initiates quick closure of the supply valve 140, initiates slow closure of the return valve 260, and retracts the gun 110 following full closure of the fuel supply valve. The retraction of the gun prevents the purge valve 200 from opening, and thus introduction of fuel from the oil lines into the furnace is blocked during an emergency trip.

The completion of the various circuits by the above-mentioned emergency trip conditions will now be described:

(1) When there is a loss of flame by the igniter during the startup cycle, contact 59 is closed, completing a circuit to reset coil 63 through conductor 60, contact 65 (which would still be in the closed position since the fuel supply valve has not fully opened yet), and conductors 62 and 64.

(2) If there is loss of igniter flame after startup, plus an indication by the optical flame scanner that no flame exists at the main burner as indicated by closure of contact 61, a circuit is completed energizing reset coil 63 through contact 59, conductor 60, contact 61, conductor 62, and conductor 64.

(3) If there is a general boiler trip (due to loss of feedwater pump, forced draft fan failure, etc.) indicated by closure of switch 66, a circuit is completed energizing reset coil 63 through contact 66, conductor 67, and conductor 64.

(4) If there is a gun assembly failure (break in either flexible oil line or an unduly worn burner nozzle tip) as indicated by closure of contact 68, a circuit is completed energizing relay 63 through contact 68, conductor 69, LS 70, conductor 62, and conductor 64.

This differential pressure tripping device is disarmed while the fuel supply valve 140 is moving towards its fully open position. When the supply valve 140 has moved to its fully open position (as indicated by closure of LS 70), the pressure differential tripping device will come into play in the event of a defect. If there is an initial defect in one of the flexible oil lines or the nozzle tip, this will be sensed by the pre-start integrity check, the operation of which will now be explained.

(5) If there is a gun assembly failure during its pre-start integrity check it is indicated by contact 33 opening before contact 32 is closed by the opening movement of the purge valve, and thus relay 34 will not be energized. Hence contact 71 remains closed, and a circuit is completed energizing reset coil 63 through conductors 56 and 57, contacts 71, LS 72 and LS 73, conductors 81 and 62, and conductor 64.

Thus it can be seen that any one of the above-mentioned emergency trip conditions energizes reset coil 63. Energization of reset coil 63 results in a shutdown procedure similar to that described in a normal shutdown where quick closure (less than a second) of the fuel supply valve is initiated concurrently with the slow closure (60 seconds) of the return vaive. There is a difference, however, in the gun retract sequencing procedure. Whereas in a normal shutdown the gun retraction must wait until the return valve is fully closed (in 60 seconds). This gives ample time for quick opening of the purge valve (5 seconds) and continuous gun purging for the duration of return valve closing. Under an emergency trip condition, gun retraction will be initiated immediately upon full closure of the fuel supply valve (less than a second). As a result, opening of the purge valve will be prevented since complete gun extension is a prerequisite for purge valve opening.

Energization of reset coil 63 closes contact 37. This completes the circuit to energize solenoid 43 of the supply valve 140. The circuit is completed through conductors 56, 36, contact 37, conductors 38, 42 and 28. This results in closure of the supply valve 140. Closure of contact 37 also energizes pump 45 of the return valve 260, the circuit being completed from contact 37 through conductors 38, 44 and 28. Closure of contact 37 also completes a circuit from contact 37 through conductors 38, 44, 39, 41 and 35 to energize reset coil 40 of latch relay 90.

Contact 49 closes simultaneously with contact 37, and contact 51 closes upon the closing of the fuel supply valve, at which time the gun retract solenoid 47 is energized, the circuit being completed through conductors 56 and 36, contacts 49, conductor 50, contact 51, and conductor 28. This gun retraction immediately follows closure of the fuel supply valve, and thus will prevent the purge valve from being opened, since LS 22 on the oil gun will be opened.

An automatic safety shutdown from any cause whatsoever will result in the lockout of a particular gun, and upon correction of the initiating fault (whether it is self-correcting or by maintenance action) the gun cannot return into service until a new start pulse is introduced to reset the circuit.

From the above it can be seen that no external timing devices have been utilized in the control system. Instead, the inherent characteristics of the valve actuating devices within the burner system perform the necessary timing functions.

The purge valve opened in approximately 5 seconds. The purge valve stem also contained a switch and associated contact which closed when the valve reached 70% of its open position, which takes about 3½ seconds. The 3½ second period was used for the gun integrity precheck, by pressurizing the burner with purge medium to make sure there was no ruptured hoses or worn nozzle tip. When the purge valve reaches its fully open position, after 5 seconds, if the gun did not pass the precheck, the gun is automatically retracted, the purge valve is closed again, and the gun is locked out so it cannot recycle again until another startup procedure is initiated.

The return valve opens very fast (less than a second). This allows for fast startup operation, with no wasted time. This is accomplished by reversing the actuation cycle (i.e. fast valve opening, with slow closure). On shutdown, the time is utilized as a urge timer, to accomplish purging of the burner system. When the return valve reaches its fully closed position, it initiates gun retraction. The gun retraction initiates quick closure of the purge valve, which terminates purging.

The supply valve governs timing of the cutting in of the monitoring gun check. The 25 second opening time of the supply valve is needed for gradual increase of introduction of fuel to the furnace. When the supply valve reaches 80% of its full open position, the monitoring system (differential pressure device contained in the oil return line) comes into play. The 80% time allows

a flow of fuel to be established before the monitoring system comes into play. Without this delayed time, there might be many false trips of the burner, before fuel flow is fully established.

The time the burner gun is retracted is different on a normal shutdown compared to an emergency trip. This governs whether or not there will be a gun purge on shutdown. Gun retraction also prevents recycling (gun startup cannot later be accomplished without a new start-up signal).

While we have shown and described the preferred embodiment of the invention, it is to be understood that the invention is not limited thereto, but may be otherwise variously embodied and practiced within the scope of the following claims.

What we claim is:

1. In combination an oil burner, means for moving said burner to either an extended position or a retracted position, an oil supply line for the burner, a first valve positioned in the supply line for controlling the flow of oil to the burner, a purge line connected to the oil supply line downstream of the first valve, a second valve positioned in the purge line for controlling the flow of purging medium to the burner, control means for the burner and including first means for controlling the position of the first valve, second means for controlling the position of the burner, third means for controlling the position of the second valve, first switch means actuable by an operator, being so associated with the control means that when it is moved to its open position it causes movement of the first, second and third means such that the following sequential actions take place; the first valve is moved to its closed position, the second valve is opened for a predetermined period of time, the burner is moved to its retracted position, and the second valve is closed; a flame scanner for detecting whether or not a flame is issuing from the burner, second switch means associated with the flame scanner and the control means such that when the flame scanner senses no flame the second switch means causes the following sequential actions to take place; the first valve is closed, and the burner is moved to its retracted position, and the second valve remains closed, so that the burner is not purged.

2. A fuel burning system comprising an oil pump, a first pipe connected to the downstream side of the pump, a second pipe connected to the upstream side of the pump, a burner connected to the first and second pipes, a first valve positioned in the first pipe, a second valve positioned in the second pipe, means for moving said burner to either an extended position or a retracted position, a third pipe, the inlet of which is connected to a source of purging fluid, and the branched outlet of which is connected to the first and second pipes, third valve means positioned in the third pipe, first switch means physically connected to the burner, said first switch means being positioned such that it is closed only when the burner is in its extended position, second switch means physically connected to the second valve, said second switch means being positioned such that it is closed only when the second valve is open, third switch means physically connected to the third valve, said third switch means being positioned such that it is closed only when the third valve is closed, control means for opening and closing said first valve, said first, second and third switch means being so associated with the control means such that the control means can start opening the first valve only when all of the first, second and third switch means are in their closed positions.

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