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HIGH-LOW FUEL BURNING SYSTEMS IN CONJUNCTION
WITH PLURAL FIRE CHAMBERS

3,070,149

2 Sheets-Sheet 2

FIG. 3

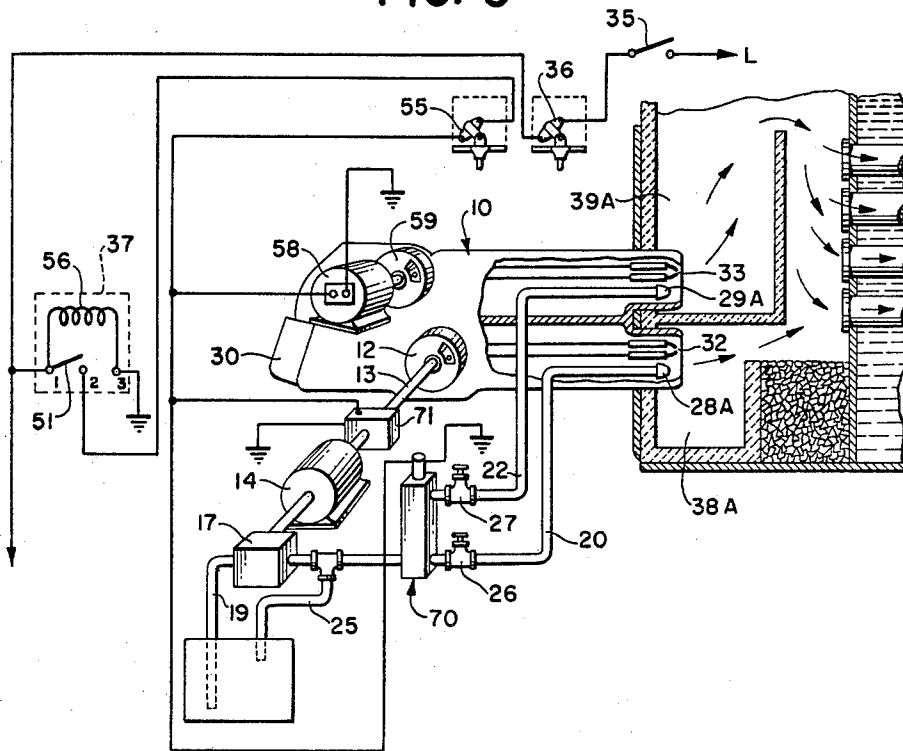
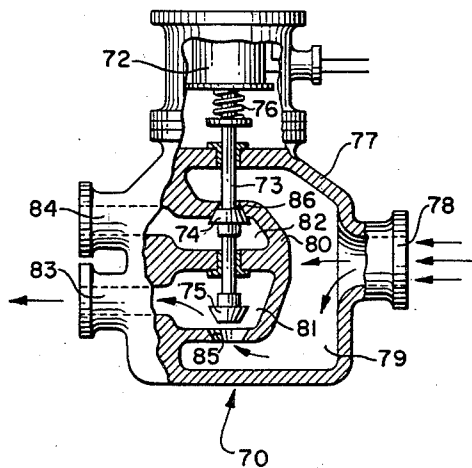


FIG. 4



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3,070,149 HIGH-LOW FUEL BURNING SYSTEMS IN CON- JUNCTION WITH PLURAL FIRE CHAMBERS

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This invention relates to burning oil by what is commonly known as the high-low flame method. Heretofore, many proposals have been made of systems to accomplish this including those of myself, which have led to U.S. Patents No. 2,794,599 and No. 2,988,279.

An object of the present invention is to feed air and oil for the high and low flame conditions in such a manner that the proper amount of air is supplied at either the high flame or the low flame condition and where the firebox itself is suited for the condition under which the air and oil are fed into the firebox.

Heretofore, many high-low and modulating systems for burning oil have utilized one firebox of a fixed size, wherein the oil is burned under all flame conditions with various arrangements provided to suit the amount of air to the quantity of oil being fired. However, provision has not been made to overcome the defeat of the principle that flame size must be adapted to the firebox size for proper combustion, said principle being brought into perspective in that a small flame will not keep the refractories, etc., of a firebox or furnace proportioned for a larger flame, at the proper temperature for perfect combustion.

This nowise conflicts with the practice of the firing into two or more separate furnaces or fireboxes under or within a boiler or other vessel wherein separate burners are utilized. Also not in question here is the practice of having a plurality of separate burners firing into a common furnace nor of using a high-low flame system wherein two different fire sizes are alternately maintained in a firebox usually suited to only the larger flame.

The present invention is concerned with adapting one oil burner or the like, to a firebox means, where said firebox means are of the proper size for the different flame sizes. Others objects and advantages will appear herein-after.

For a better understanding of the invention, references should be made to the drawings, in which:

FIG. 1 shows an oil burner with adjuncts of the firebox and a boiler connected thereto;

FIG. 2 is a perspective view of a firebox;

FIG. 3 shows an oil burner, etc., as in FIG. 1 except that certain changes have been made so that each chamber of the firebox is fired separately for high and low flame, and FIG. 4 is a view of a dual-acting solenoid valve used with the embodiment of FIG. 3.

In FIG. 1 an embodiment of the invention is shown in which an oil burner 10 of the "gun" or "high pressure" type is formed of a substantial casting 11 having a unitary blower 12 mounted therewith, and said blower being driven through shaft 13, said shaft being given rotation by motor 14. Blower 12 has an adjustable intake louver 15 to allow for air adjustment according to the amount of oil supplied to the lower firebox 38. Shaft 16 actuates pump 17 causing the pump to draw oil from storage tank 18 through oil suction conduit 19, oil being forced under pressure from the pump discharge through conduit 20, T 21 and conduit 22 to delayed action, normally closed solenoid valves 23 and 24, said solenoid valves acting as shut-off valves to prevent oil drip from the nozzles 28 and 29 when said nozzles are not emitting oil.

A by-pass conduit 25 returns excess oil from the pump 17 to the oil storage tank. A pressure regulating valve

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25a maintains a desired oil pressure in p.s.i. in conduit 20 and at calibrated nozzles 28 and 29. It should be understood that said by-pass conduit could equally well be taken from a special by-pass outlet usually provided on present day pumps. It should also be understood that the by-pass conduit 25 could be connected into the suction conduit 19 with approximately the same result.

Oil regulating valves 26 and 27 provide for adjustment of oil flow in conduits 20 and 22 respectively if a finer adjustment than that given by nozzles 28 and 29 is desired. However, it is to be understood that nozzles 28 and 29 are of the standard type and may be procured almost anywhere with orifices of suitable size and shape to provide the correct amount of oil therethrough for perfect flame condition according to the size and shape of the firebox, and the predetermined amount of air selected.

Electrical connections for the primary, low-flame oil burner circuit are not shown in the interest of clarity. These electrical connections would embrace the motor 14, ignition transformer 30 and solenoid valve 23. Other switches, such as stack switches, hot oil switches, air switches and the like having been omitted entirely as having little pertinence herein, their use being well known and common in various standard and approved electrical hookups, so that anyone familiar with the art would have no difficulty in applying them to the present invention. It should be pointed out moreover, that provision of an integral timer delay in solenoids 23 and 24 is optional.

Ignition cables 31 lead from the secondary winding of the transformer 30, to igniter sets 32 and 33 across the air gaps of each set of which a spark is caused to exist whenever said transformer is energized, the pressures on the primary and secondary windings of said transformer being usually 110–220 volts and 8,000–10,000 volts respectively, although this voltage may be varied somewhat with satisfactory results.

The metal igniters are insulated by ceramic tubes 34 except at the end near their tips to prevent short circuiting from the igniters to the burner frame.

The system (shown in FIG. 1) operates as follows: Voltage is received from the line and when manually operated switch 35 is closed, electrical power is transmitted through primary mercury switch 36 to the standard primary oil burner circuit and to contact 1 of warp switch 37. The motor 14 and transformer 30 are energized and pump 17 and unitary or primary blower 12 are in operation due to the action of the motor. Normally closed solenoid 23 also receives electrical energy and due to a standard time delay switch incorporated therein the said valve does not open until a predetermined time interval has elapsed. After said time interval has come to an end, solenoid 23 opens, permitting passage of oil through conduit 20 and valve 26 to the nozzle 28 wherefrom the oil is emitted in a fine spray.

The said oil being ignited by the spark from the igniters 32, the burner is now on the low flame condition, said low flame condition being suited by the size of the orifice of nozzle 28 and by proper regulation of air admitted into and discharged by blower 12 to mix with said oil spray in the low flame firebox chamber 38, air intake door 15 being used to adjust the air supply. Regulation of oil and air supplied to the firebox is a simple matter to those skilled in the art, and is governed to a great extent by the size of said firebox, the flame being adjusted thereto.

In FIGS. 1 and 2 the firebox complete consists of the low flame chamber 38 and the upper chamber 39, which last said chamber when fired in conjunction with the low flame chamber constitutes the placing of the burner to operate under the high flame condition.

A lid 40 is pivotally mounted on a hinge 41 affixed to the wall 42 dividing the chambers of the firebox, said lid

falling onto shelf 44 by gravity when chamber 39 is not being fired. A stop 43 is attached to wall 42 to prevent the lid from falling backward. The lid mentioned herein as part of the present embodiment will not be essential on most forms of the invention as in almost all instances firebox 39, when not being fired will have little or no effect on the firing of the low flame chamber 38. However, if it is desirable to use said lid, it must be of a lightweight, heat resistant material that will swing to its upward position when said chamber 39 is fired. The lid is not shown in FIG. 2. Holes 62 and 63 are for entrance of burner's air tubes.

It should be pointed out at this time that it is obvious that by changing the solenoid valves herein employed (solenoids 23 and 24 both being of the normally closed type) so that one solenoid is of the normally open type or by use of the dual-acting solenoid valve previously mentioned, in conjunction with other mechanical and electrical alterations a system can be effected that will fire each chamber separately for a high-low method suitable to the sizes of two different chambers. This is brought out in FIG. 3 and will be described in more detail hereinafter.

Referring again to the operation of the embodiment of FIG. 1, at both the high and low flame conditions, the gases resulting from combustion in either the low firing chamber 38 or from both chambers 38 and 39 pass from same and enter into and against the various heating spaces and surfaces of the boiler.

A fire tube boiler is shown, the fire tubes 45 being affixed to tube sheets 47 with the spaces 46 between the tubes comprising part of the water, and steam forming and holding spaces within the boiler. The boiler front plate 49 and base plate 65 form part of the exterior confines of the boiler as does the side plate 52, the firebox chamber plurality being suitably disposed within said confines.

The firebox may be made of brick or other refractory having the necessary heat resistant properties. In the embodiments shown in FIGS. 1 and 2 the chamber plurality is a casting capable of withstanding several thousand degrees of heat, F. It has a backing 48 of mica pellets and the boiler front plate 49 is protected by the refractory wall 50 of the firebox. The boiler base plate 65 of the furnace part of the boiler is protected by the refractory floor 50a. Other refractory parts are the back wall 53 fronting the mica pellets which protect the lower parts of the boiler from the direct heat of combustion and the gases thereof, the floor 54 of the upper chamber which isolates it from the lower chamber, the side walls 66 and the shelf 44, already mentioned.

In the embodiment of FIG. 1, when the high flame condition is called for by switch 55 closing, electrical energy is transmitted simultaneously to motor 58 which turns blower 59, and to normally closed solenoid valve 24, allowing a predetermined amount of oil to flow through conduit 22, regulating valve 27, and to nozzle 29 from which it is emitted in a fine spray (usually in the form of a cone) and intermixed with air from burner 59. At this moment two separate flames, the sizes of which are determined by the size of the orifices of nozzles 28 and 29 with possible additional regulation by means of valves 26 and 27, and with the proper amount of air to support combustion of the oil from each of said nozzles furnished by blowers 12 and 59, take place, one in each firebox. The combining of the flue gases of the separate flames, or the combining of the separate flames or parts thereof, depending on the sizes and shapes of the firing chambers, establishes the high flame condition.

Air adjustment for auxiliary blower 59 is provided by means of an adjustable louver or door 60. Ignition is accomplished for oil sprayed into chamber 39 by means of high tension leads 31a hooked up in parallel with leads 31 from transformer 30. Igniters 33 function in the same manner as do the igniters 32, already described. In the

present embodiment, igniters 33 spark at the same moment as do igniters 32, this function may be varied of course by providing an additional transformer or an interrupting switch across the high tension cables leading to igniters 33, said additional transformer being energized or interrupting switch closed at the closing of mercury switch 55 and said additional transformer or interrupting switch receiving electrical potential simultaneously with motor 58 and solenoid valve 24.

As shown in FIG. 1, the burner must perform make each start at the low flame condition, even though the high flame condition is called for.

For instance, if the boiler pressure is at zero pounds, both mercury switches 36 and 55 will be closed, switch 35 being also closed. Electrical power is immediately transmitted to motor 14 driving pump 17 and blower 12, and to normally closed solenoid valve 23. Before electrical energy can be transmitted to terminal contact 2 of switch 37, a delay in time is caused by coil 56 before warp switch blade 51 closes on said terminal contact 2 and electrical pressure brought to motor 58, driving blower 59, and to normally closed solenoid 24.

When a predetermined boiler pressure is reached, say of nine pounds, whereupon the burner is to go on the low flame condition, mercury switch 55 having been set at nine pounds cut out pressure, upon said nine pounds pressure being attained in the boiler, mercury switch 55 immediately opens and cuts off electrical potential to motor 58 and normally closed solenoid valve 24 and the flame period in the firebox chamber 39 is ended and the burner is then on the low flame condition.

According to the sizes of fireboxes chambers 38 and 39 and the size of flame suited thereto, the burner will either continue to build up pressure (but at a much lower rate than at the high flame condition), until the cut out point for the low flame condition is reached, as determined by the cut out setting of mercury switch 36, set to cut out for example, at say, 12 pounds.

Normally, however, and preferably, when the low flame condition is established by the mercury switch 55 reaching its cut out point, the boiler pressure will gradually decrease until mercury switch 55 reaches its cut in point, say for example, at seven pounds. The high flame condition will be reestablished and the burner will again start to build up steam pressure in the boiler.

This cycle will be repeated continuously, without the burner being shut down completely and it will hold the boiler within strictly defined limits of pressure or temperature. This control of pressure or temperature is very desirable in all heating applications, but most particularly in processing operations where it may be necessary to hold the pressure within a 1/2 to 1 pound range.

The benefits of high-low operation are too well known to need to be cited here, although it should be stated that economies effected in fuel savings, saving on wear and tear of equipment due to constant recycling of parts, etc., are further augmented by the system described herein.

An embodiment of the invention in combination with a dual action solenoid regulating valve described in the aforesaid patent No. 2,988,279 is shown in FIG. 3. The dual purpose regulating solenoid valve, as depicted in said patent, is shown in FIG. 4.

For convenience, parts of the system illustrated in FIG. 3 which are identical with those shown in FIG. 1 will bear the same reference number. Parts which are similar but that have been modified to a certain extent, will be given the same reference number followed by the letter "A."

The said dual acting solenoid is constructed with a normally open passageway therethrough and a normally closed passageway therethrough. The valve cannot have both passageways open or partially closed, the normally open passageway being closed off when the solenoid is energized, at the same time, the normally closed passageway is opened fully. This allows then, oil to be discharged through either one or the other of said passageways at

one time and thus provides a means of allowing a greater or lesser amount of oil or other material to reach a point past the discharge ports of said valve. In the present instance, oil from one passageway of the valve would be discharged by means of a nozzle with a large orifice into one of the firebox chamber plurality for the high flame condition and, alternately, according to the boiler pressure or temperature, oil from the other passageway of the valve would be discharged by means of a nozzle with a smaller orifice into the other, smaller sized member of the chamber plurality. The chambers would each be fired separately, one for the high flame condition, the other for the low flame condition. The auxiliary blower would provide air for the oil emitted from the nozzle with the smaller orifice while the primary blower would provide the air for combustion of the oil emitted from the nozzle with the larger orifice. The primary blower, in this instance, would have to be disconnected from its source of rotation, and, in the embodiment shown in FIG. 3 clutch means are used for this purpose. Various other means exist to prevent air being supplied to both firebox chambers when only one chamber is being fired. Among these are: A trap door in the air tube leading into a said chamber, automatic positioning of the fan blades to the closed position, the provision of a separate motor unit for each blower independent of the oil supply means, etc., etc. In a system where the oil is supplied to the burner by gravity means a separate motor for each blower independent of other moving parts of said system would be provided in the natural order of things.

In the embodiment of the invention shown in FIG. 3 electrical energy is received from the line and if mercury switch 36 is in the closed position energy is transmitted over the primary burner circuit to motor 14 which supplies rotative power to pump 17 and primary blower 12. The transformer 30 is also energized at this moment and igniter sets 32 and 33 are caused to have a high tension spark occur across their air gaps because of the high voltage transmitted to said igniter sets from the secondary winding of the transformer. At this same moment terminal 1 of the time delay warp switch 37 receives full energy from the line which is transmitted across heating coil 56 to terminal 3 of switch 37 and thence to ground.

Dual acting solenoid valve 70 allows passage of oil received from pump 17 through its normally open passageway, through regulating valve 26, oil conduit 20 and nozzle 28A, from which it is emitted as a fine spray into firebox chamber 38A. It will be noted that dual acting valve 70 has replaced the normally closed solenoid valves 23 and 24, shown in FIG. 1. It should also be noted that the lower firebox chamber 38A of FIG. 3 has been reduced in size so that it is the smaller of the chamber plurality, whereas in FIG. 1 the lower chamber 38 is the larger of the plurality. Nozzle 28A will correspondingly deliver an amount of oil suitable for proper combustion in chamber 38A while nozzle 28 of FIG. 1 delivers the larger amount of oil of the two nozzles 28 and 29.

The burner (FIG. 3) is thus on the low flame condition. If at this time mercury switch 55 is in the closed position and if warp switch contact 51 has been warped into connection with terminal 2 of warp switch 37, energy is immediately transmitted to dual purpose solenoid 70 and said solenoid closes its normally open passageway and opens its normally closed passageway allowing oil to be forced by action of the pump to nozzle 29A where it is emitted as a fine spray into fire box chamber 39A, the larger of the chamber plurality of 38A and 39A.

Simultaneously with the energization of solenoid 70 motor 58 also receives electromotive force and causes fan 59 to rotate, delivering air to chamber 39A where it is intermixed with the oil emitted from nozzle 29A and ignited from air gap spark of igniter set 33. Also simultaneously with the energization of solenoid valve 70 is the energization of electrical clutch unit 71 which frees the shaft 13 driving primary blower 12 and allows the

primary blower to come to rest. The burner is thus on the high flame condition, but only one of the fire-chamber plurality is utilized. The burner unit from this point on fluctuates between the on and off cycle and when functioning upon the on cycle, operates between the high and low flame conditions previously described in the operation of the burner depicted in FIG. 1.

The dual acting solenoid valve of FIG. 4 has main elements consisting of an electrical winding 72, valve stem 73 upon which are integral with said stem an upper valve disc 74 and a lower valve disc 75, a spring 76 which forces the valve stem upward when said winding is not energized causing said valve to have a normally open lower passageway and a normally closed upper passageway. The passageways are formed in the body 77 of the valve with an entrance port 78 which leads into a chamber 79. An irregularly shaped internal wall 80 cast integrally with the valve body serves to separate chamber 79 from chambers 81 and 82 said chambers 81 and 82 constituting principal parts of the normally open and normally closed passageways through the valve and leading to discharge ports 83 and 84 respectively. The valve seats 85 and 86 are formed partly from the finished surfaces of portions of the internal wall 80 and partly from inwardly extending, irregularly shaped portions of the wall forming the body of the valve 77. The stem is movable vertically within fixed limits by virtue of a hole drilled or broached through a horizontally extending surface of the inner wall 80. Various other parts of the valve need not be described here as the construction of solenoid valves is in general so well known that mechanics, engineers and technicians usually are familiar with the features of their construction. The valve described herein or others of a similar nature might easily be fabricated by varying only slightly the features of solenoid valves now in everyday use. Realizing that there are a great number of embodiments of the invention herein described which could be perfected by simple mechanical ingenuity and the adaptation of known parts and methods thereto, I do not wish to be limited to the embodiments described herein, but contemplate rather, all such embodiments as come within the scope of the appended claims.

What I claim is:

1. A low flame, high flame system for burning fuel comprising a furnace having a heating chamber, a first combustion chamber and a second combustion chamber, each of said combustion chambers being of predetermined size, separate fuel and air supply conduits for each combustion chamber, a pump common to said fuel conduits, fuel pressure regulating means associated with said pump, a blower individual to each air conduit, manually operable means associated with each blower for regulating the volume of air delivered thereby to its associated air conduit, a valve in each of said fuel conduits having a closed position and a single open position, means in each fuel conduit for regulating the volume of fuel delivered to each fuel conduit, when the valve associated therewith is in its open position, whereby the ratio of fuel to air may be controlled in a volume which is fixed relative to the size of the combustion chamber supplied therewith in order to obtain optimum combustion conditions, a first control means responsive to a condition indicative of one heat requirement for operating one of said blowers and its associated valve for initiating flow of air and fuel to said first combustion chamber in a constant predetermined volume of each, and a second control means operative in response to a condition indicative of a different heat requirement for operating the other of said blowers and its associated valve for initiating flow of fuel to said second combustion chamber in a constant predetermined volume of each.

2. A system as defined in claim 1 in which said first combustion chamber is larger in size than said second

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combustion chamber whereby to increase the "off" and "on" time of said second combustion chamber.

3. A system as defined in claim 1 with means for fully opening each valve simultaneously with the starting of its associated blower.

4. A system as defined in claim 1 in which said second control means is effective to cause fuel and air to be supplied to said second combustion chamber concurrently with the supply of fuel and air to said first combustion chamber.

5. A system as defined in claim 1 in which said second control means is effective in response to said different heat requirements to interrupt the supply of air and fuel to said first combustion chamber.

6. A low flame, high flame system for burning fuel comprising a furnace having a heating chamber, a first combustion chamber and a second combustion chamber, each of said combustion chambers being of predetermined size, separate fuel and air supply conduits for each combustion chamber, a pump common to said fuel conduits, a blower individual to each air conduit, manually operable means associated with each blower for regulating the volume of air delivered thereby to its associated air conduit, a valve in each of said fuel conduits having a closed position and a single open position, means in each fuel conduit for regulating the volume of fuel delivered to each fuel conduit when its valve is in the open position whereby the ratio of fuel to air may be controlled in a volume which is fixed relative to the

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size of the combustion chamber supplied therewith in order to obtain optimum combustion conditions, a first control means responsive to a condition indicative of one heat requirement for operating one of said blowers and its associated valve for initiating flow of air and fuel to said first combustion chamber in a constant predetermined volume of each, a second control means operative in response to a condition indicative of a different heat requirement for operating the other of said blowers and its associated valve for initiating flow of fuel and air to said second combustion chamber in a constant predetermined volume of each, and means for delaying the starting of the other of said blowers for a predetermined time after operation of said first control means.

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