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CONTROLS FOR FUEL BURNERS

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Fig. 1.

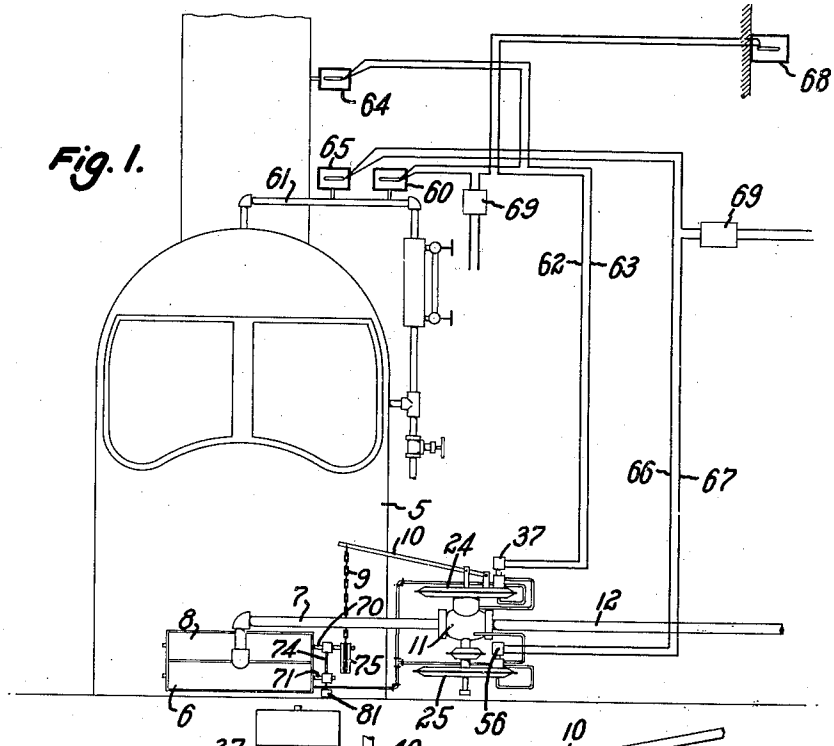


Fig. 2.

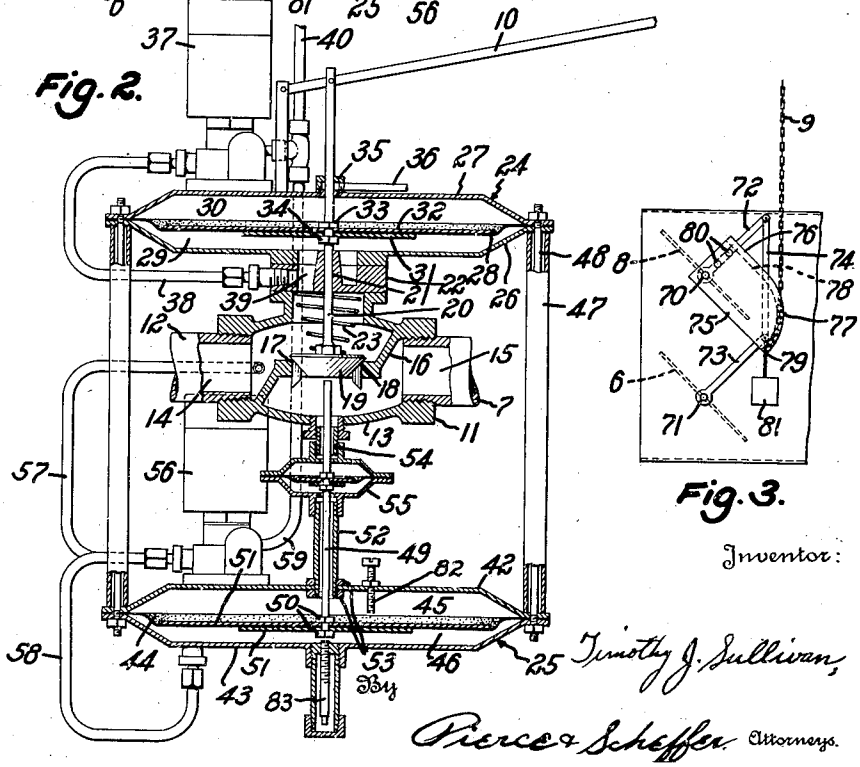


Fig. 3.

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CONTROL FOR FUEL BURNERS

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12 Claims. (Cl. 236—1)

This invention relates to controls for fuel burners and particularly to controls for regulating the supply of gas to the boilers of power plants, heating plants and the like.

An object of the invention is to provide valve control means effective to supply gas to the burner of a boiler or the like so as to operate the burner on low fire when initially starting up until the stack is heated and when there is less demand upon the system and on high fire after the system is heated up to take up the peak demand and when there is a high demand upon the same.

Another object of the invention is to so relate the operation of the gas supply valve and secondary air supply damper as to insure adequate air supply at all times.

Another object of the invention is to provide a control system effective to operate the burner on high fire or low fire in response to demand and which will prevent operation of the burner on high fire regardless of demand until the flue is heated sufficiently to make high fire operation safe.

Another object is to provide a novel gas control valve construction and arrangement of diaphragm operating means therefor.

Other objects and advantages of the invention will become apparent during the course of the following description with reference to the accompanying drawing, wherein:

Fig. 1 is a semi-schematic view of a system embodying the invention;

Fig. 2 is an axial sectional elevation of the control valve and operating means therefor, and

Fig. 3 is a side elevation of the secondary air door operating connections.

Referring more particularly to the drawing, the invention is shown as applied to a steam boiler 5 equipped with a gas burner 6 fed with gas through supply main 7 and equipped with a secondary air door 8 for controlling the admission of air thereto. The secondary air door 8 is adjusted by a chain 9 and lever 10 in accordance with the setting of the main gas supply valve 11, hereafter described in detail. Gas is supplied to the diaphragm valve 11 through pipe 12 and the regulated flow from the valve 11 flows to the burner 6 through the pipe 7.

The casing 13 of the valve, which is provided with an inlet port 14 connected with the line 12 and an outlet port 15 connected with the line 7, includes a partition wall 16 provided with a valve port 17 forming a valve seat 18. A tapered valve plug 19 carried by a valve stem 20 cooperates with the seat 18 to open or close the valve port 17 and to regulate the amount of gas flowing therethrough, depending on the position of adjustment of the tapered valve plug 19 with respect to the seat.

The valve stem 20 extends through a guide channel 21 in a cap 22 fastened on the valve casing 13 and the valve plug is normally urged to its seat by a compression spring 23 confined between the plug 19 and the cap 22.

The flow of fuel through the valve 11 is controlled by pressure motors 24 and 25 which regulate the position of the valve plug 19. The pressure motor 24 comprises a lower casing member 26 secured on the valve cap 22 and an upper casing member 27 with a diaphragm 28 clamped between them and defining a pressure chamber 29 beneath the diaphragm and a chamber 30 above the diaphragm, with the latter constituting a movable wall of each of the chambers.

The valve stem 20 passes through the diaphragm 28 and through pressure plates 31 and 32 clamped thereon and is fixed to the diaphragm and pressure plates by lock units 33 and 34 so that movement of the diaphragm 28 will be imparted to the stem 20 and the valve plug 19 carried thereby. The stem 20 passes out through the wall of the casing member 24, through a packing gland 35 and at its upper end is connected to the operating lever 10 of the secondary air door. The gland 35 is provided with a vent 36 leading to the furnace so as to discharge any gas which might leak through the packing around the stem 20.

The operation of the pressure motor 24 is under control of a solenoid operated pilot valve 37 which controls the admission of gas pressure from the supply side to the pressure chamber 30, gas pressure being supplied to the pilot valve by a tube 38 tapped into the valve cap 22. The pressure chamber 29 beneath the diaphragm is constantly under pressure of the gas supply main through the communicating passage 39. Gas pressure above the diaphragm is vented to the furnace through pipe 40 when the pilot valve 37 closes to shut off communication of gas pressure from the supply side to the pressure chamber 30 to permit the pressure in diaphragm chamber 29 to raise the diaphragm and valve plug against the pressure of spring 23.

The lower pressure motor 25 comprises upper and lower casing members 42 and 43 with a diaphragm 44 clamped between the edges thereof to define chambers 45 and 46 above and below the diaphragm, respectively. The diaphragm motor 25 is supported from the motor 24 by spacer pipes

47 extending between the rims thereof and tie bolts 48 extending through the pipes and rims. A valve operating rod 49 is secured to the diaphragm 44 by lock nuts 50 engaging pressure plates 51 on opposite sides of the central portion of the diaphragm. The valve operating rod 49 extends through an opening in the wall 42 and through a nipple 52 fastened in the opening by lock nuts 53 and at its upper end extends into the valve casing 13 to a point beneath the valve plug 19. A nipple connection 54 tapped into the bottom of the valve casing and a sealing diaphragm 55 for the operating rod prevent escape of gas from the casing.

A solenoid pilot valve 56 mounted on the wall 42, controls the admission of gas pressure to and the venting of the pressure chamber 46 beneath the diaphragm 44. Gas under pressure from the supply side of the valve 11 is supplied to the pilot valve 56 through tube 57 and from the pilot valve to the chamber 46 through tube 58. When the pilot valve shuts off the gas pressure to the chamber 46, the same is vented to the furnace through tube 58 and vent tube 59 leading from the pilot valve casing to the furnace.

The solenoid operator of pilot valve 37 is the high fire controller and is controlled by a pressure switch 60 responsive to steam pressure in the boiler pipe 61. The control switch 60 is connected to the solenoid 37 by wires 62 and 63 and is connected in series with a stack thermostat 64 which maintains the circuit to solenoid 37 open until the stack is heated to a desired temperature with the burner operating on low fire regardless of the demand on the system.

The solenoid operator of pilot valve 56 is controlled by a pressure switch 65 also responsive to steam pressure in boiler pipe 61 and connected to the solenoid by wires 66 and 67.

If desired the high fire solenoid pilot valve 37 may also be made responsive to the outside temperature so as to cause operation on high fire in extreme temperatures. This is accomplished by connecting an outdoor thermostat 68 in series with stack switch 64 and with the circuit of pressure switch 60. Transformers 69 supply current for operating the solenoids.

In order to insure ample secondary air supply with partial gas valve opening, accelerated action connections are provided between the lever 10 and the secondary air control louvers 8. The louvers 6 and 8 are mounted on spaced parallel shafts 70 and 71 journalled in the walls of the burner casing. Parallel toggle arms 72 and 73 rigidly fastened on the protruding ends of the shafts 70 and 71, respectively, are connected by a toggle link 74 which is pivotally connected to the ends of the arms to provide a parallel linkage effecting operation of the louvers in unison.

An elongated operating cam member 75 is mounted on the end of shaft 70. The cam 75 has a vertical face 76, offset from a vertical plane through the shaft 70, and a curved lower face 77 which extends across the bottom to the opposite edge. The faces 76 and 77 are grooved as indicated at 78 to seat the operating chain 9 which latter is fastened at its lower extremity to the cam at the lower extremity of the curved face 77 as indicated at 79.

The cam 76 is fast on the shaft 70 and is preferably provided with a number of holes 80 spaced across the top thereof, for reception of the shaft end, by which its position may be adjusted to regulate the amount of opening of the louvers resulting from the same movement of the operating lever 10. A weight 81 suspended from the lower pivot of link 74 serves to return the louvers to the closed position as limited by the chain 9. However, if the chain should break, the weight would open the louvers by its pull down on the linkage past the neutral center position.

The effect of the cam arrangement as shown is to effect a differential motion of the louvers, that is, when opening from the closed position the louvers will be opened a greater amount per unit of movement of the valve for the period of motion from closed to low fire position than for the remainder of its motion. This is because when the louver doors are closed, the chain is close to the pivotal centers of the doors and upward movement of the arm 10 will open the doors in proportion. As the arm rises, the cam moves the chain out further from the center, thus slowing the movement of the doors as they approach full open position. This differential motion insures quick opening of the louvers to the point of supplying adequate quantities of secondary air for low fire even though the valve stem of the gas valve is moved only a very short distance, as in the case of disc valves.

In the operation of the system, the high-low control valve 11 may be used as the sole control or may be used in conjunction with the usual on-off control valve now commonly used. In the latter case, the valve 11 would be installed between the on-off control valve and the furnace. Assuming that the burner has been shut off and that the valve 11 is fully closed, when the system is turned on the pressure responsive switches 60 and 65 controlling the high fire solenoid pilot valve 37 and the low fire solenoid pilot valve 56 will both be closed due to the lack of boiler pressure. However, because the stack switch 64 is open, the solenoid 37 will not be energized and the gas pressure on both sides of the diaphragm 28 will remain equalized. The solenoid 56 will be energized to open its pilot valve and gas pressure will be admitted to the pressure chamber 46 beneath the diaphragm 44 to raise the valve operating rod 49 which engages the valve plug 19 to partially raise it off of its seat, thus initiating operation of the burner on low fire. As the valve 19 is raised from its seat the stem 20 thereof will raise the lever 10 thus opening the secondary air doors 6 and 8. Due to the tapered form of the valve plug, and the differential motion connections to the air doors, the secondary air doors are opened a considerable amount without the valve supplying a large amount of gas so that an ample supply of secondary air for efficient combustion is assured at all times. An adjustable stop in the form of a set screw 82 in the wall 42 limits the motion of diaphragm 44 and valve operating rod 49 so that the amount of gas supplied on low fire may be positively determined.

As soon as the stack heats up sufficiently on low fire to close the stack switch 64, the circuit to high fire solenoid 37 will be completed and its pilot valve will open to shut off the supply of gas pressure to the pressure chamber 30 above the diaphragm 28 and to vent the same to the furnace, thus permitting pressure in chamber 29 to raise the diaphragm 28 to open the valve plug 19 to its limit and admit full flow of gas to the burner.

The pressure switch 60 is set to open its circuit at a pressure of say 90 lbs. and the switch 65 is set to open at say 95 lbs. After the boiler has operated at high fire to take up the load and raise the pressure to 90 lbs., the switch 60 opens to

close the vent to the furnace and admit gas pressure through pilot valve 37 to chamber 36 above the diaphragm 28 to balance the pressure beneath diaphragm 28 which permits the spring 23 to return the valve plug 19 to low fire position resting on the end of operating rod 49. The burner then continues on low fire to maintain the boiler pressure and carry the load, or, until the pressure rises to 95 lbs. on low fire, whereupon the switch 65 opens breaking the circuit to solenoid 56 and permitting its pilot valve to close and release the pressure from beneath diaphragm 44 to permit valve plug 19 to seat and shut off the flow of gas to the burner. When the pressure again falls below 95 lbs. low fire solenoid 56 will again be energized to take up the load on low fire and the high-fire solenoid will not be energized unless the pressure falls below the 90 lb. setting of switch 60. Thus for normal operation, the burner can be run most of the time on low fire and will only be operated on high fire when starting or when required to take up peak loads or in very cold weather when the low fire setting is insufficient to satisfy the demand.

Where the outdoor thermostat is employed, the burner will be caused to operate on high fire when the outside temperature falls below a predetermined minimum for which the thermostat 68 is set.

The provision of the adjustable stop 32 permits regulation of the amount of gas supplied on low fire so that it is possible to set the same to meet normal demands on the system after the same is brought up to pressure, thereby greatly increasing the flexibility thereof and resulting in economy of operation by reducing to a minimum the periods of high-fire operation.

A manual operator 33 for opening the valve to low-fire position is provided so that the burner can be operated in case of current failure.

It will be understood that while the system has been shown and described as applied to a steam boiler, the same may also be used on a hot water heating system by substituting aquastats for the pressure responsive switches 60 and 65.

While a preferred embodiment of the invention has been shown and described by way of illustration, it will be apparent that various modifications in construction and arrangement of parts may be resorted to, and that the same are contemplated, within the scope of the appended claims.

I claim:

1. In control means for a gas burner, a gas supply main for said burner, a valve in said supply main, a pressure motor for partially opening said valve for low fire operation of the burner, a pressure motor for fully opening said valve, and means for controlling the operation of said pressure motors independently to effect operation of said first mentioned pressure motor to partially open said valve in response to a low demand for heat and to effect operation of said second mentioned pressure motor to fully open said valve in response to a high demand for heat.

2. In control means for the gas burner of a boiler, a gas supply main for said burner, a supply regulating valve in said supply main, a pressure motor operable to partially open the valve for low fire operation of the burner, a pressure motor operable to fully open said valve for high fire operation of the burner, and means responsive to demand on said boiler for independently operating said pressure motors to effect low or high fire operation of said burner in accordance with said demand.

3. In control means for the gas burner of a boiler, a gas supply main for said burner, a supply regulating valve in said supply main, a pressure motor operable to partially open the valve for low fire operation of the burner, a pressure motor operable to fully open said valve for high fire operation of the burner, and a separate pressure switch for controlling each of said motors in response to boiler pressure whereby to independently operate said pressure motors to effect low or high fire operation of said burner in accordance with fluctuation of the boiler pressure.

4. In control means for the gas burner of a boiler, a gas supply main for said burner, a supply regulating valve in said supply main, a pressure motor operable to partially open the valve for low fire operation of the burner, a pressure motor operable to fully open said valve for high fire operation of the burner, a separate pressure switch for controlling each of said motors in response to boiler pressure whereby to independently operate said pressure motors to effect low or high fire operation of said burner in accordance with fluctuation of the boiler pressure, and a stack thermostat switch in series with the pressure switch controlling the second mentioned pressure motor effective to close its contacts only when the stack is heated to a desired degree whereby to prevent high fire operation of the burner when starting with a cold stack.

5. In control means for the gas burner of a boiler, a gas supply main for said burner, a supply regulating valve in said supply main, a pressure motor operable to partially open the valve for low fire operation of the burner, a pressure motor operable to fully open said valve for high fire operation of the burner, a separate pressure switch for controlling each of said motors in response to boiler pressure whereby to independently operate said pressure motors to effect low or high fire operation of said burner in accordance with fluctuation of the boiler pressure, and an outside thermostat switch connected in series with the pressure switch controlling the second mentioned pressure motor to effect high fire operation of the burner when the outside temperature falls below a predetermined degree.

6. In control means for the gas burner of a boiler, a gas supply main for said burner, a supply regulating valve in said supply main, a pressure motor operable to partially open the valve for low fire operation of the burner, a pressure motor operable to fully open said valve for high fire operation of the burner, means responsive to demand on said boiler for independently operating said pressure motors to effect low or high fire operation of said burner in accordance with said demand, and a stack thermostat effective to prevent operation of the second mentioned pressure motor to fully open said valve until operation on low fire has heated the stack thermostat to a desired degree.

7. In a gas fired boiler system, a gas burner having a secondary air supply door, a gas supply main for said burner, a valve in said supply main comprising a casing having a port and a valve seat, a tapered valve plug movable to and from said seat to control the flow of gas to said burner, a valve stem connected to said valve plug, a pressure motor having a movable diaphragm connected to said valve stem operable by gas pressure to move said valve plug to fully open position, a lever connected to said valve stem for opening said

secondary air door upon movement of said valve plug from its seat, a second pressure motor having a movable diaphragm and a valve operating rod carried thereby and extending into said valve casing beneath said valve plug and operable by gas pressure to move said rod into engagement with said valve plug to lift the same from its seat to partially open position, and means responsive to demand on said boiler independently to control admission of gas pressure to said pressure motors to effect operation of both of said pressure motors upon a high demand to move said valve plug to fully open position out of engagement with said valve operating rod of the second mentioned pressure motor and effective upon partial satisfaction of the demand to shut off the first mentioned pressure motor to permit said valve plug to partially close and re-engage said valve operating rod and effective to shut off said second mentioned pressure motor to permit said valve plug to close upon full satisfaction of the demand.

8. In a gas fired boiler system, a gas burner, a gas supply main for said burner, a valve in said supply main comprising a casing having a port and a valve seat, a tapered valve plug movable to and from said seat to control the flow of gas to said burner, a valve stem connected to said valve plug, a pressure motor having a movable diaphragm connected to said valve stem operable by gas pressure to move said valve plug to fully open position, a second pressure motor having a movable diaphragm and a valve operating rod carried thereby and extending into said valve casing beneath said valve plug and operable by gas pressure to move said rod into engagement with said valve plug to lift the same from its seat to partially open position, means responsive to demand on said boiler independently to control admission of gas pressure to said pressure motors to effect operation of both of said pressure motors upon a high demand to move said valve plug to fully open position out of engagement with said valve operating rod of the second mentioned pressure motor and effective upon partial satisfaction of the demand to shut off the first mentioned pressure motor to permit said valve plug to partially close and re-engage said valve operating rod and effective to shut off said second mentioned pressure motor to permit said valve plug to close upon full satisfaction of the demand, and means for adjusting the range of movement of the diaphragm of said second mentioned motor to regulate the amount of opening of the valve plug for low fire operation.

9. In a gas fired boiler system, a gas burner, a gas supply main for said burner, a valve in said supply main comprising a casing having a port and a valve seat, a tapered plug movable to and from said seat to control the flow of gas to said burner, a valve stem connected to said valve plug, a pressure motor having a movable diaphragm connected to said valve stem operable by gas pressure to move said valve plug to fully open position, a second pressure motor having a movable diaphragm and a valve operating rod carried thereby and extending into said valve casing beneath said valve plug and operable by gas pressure to move said rod into engagement with said valve plug to lift the same from its seat to partially open position, and means responsive to demand on said boiler for independently controlling the operation of said pressure motors to effect operation of the second mentioned pressure motor to shift its operating rod to lift said valve plug from its seat to partially open position for low fire operation in response to a low demand, to effect operation of the first mentioned pressure motor to shift said valve stem to raise said valve plug to fully open position for high fire operation in response to a high demand, to shut off said first mentioned pressure motor to permit said valve plug to return to partially open position upon satisfaction of the high demand to provide for continued low fire operation until the demand is fully satisfied or until recurrence of high demand effects operation of said first mentioned pressure motor to return the valve plug to fully open position.

10. In a gas fired boiler system, a gas burner, a gas supply main to said burner, a gas control valve in said main including a valve casing having a port provided with a seat and a tapered valve plug movable to and from said seat to control the flow of gas to the burner, a valve stem fixed to said plug and extending from said casing, a fixed diaphragm motor mounted on said valve casing having a movable diaphragm connected to said valve stem, a solenoid operated pilot valve controlling admission to and release of gas pressure from said diaphragm motor to move said valve plug to fully open position or to permit movement thereof to its seat, a switch responsive to boiler pressure for controlling operation of said solenoid operated pilot valve, a second diaphragm motor mounted beneath said valve casing having a diaphragm and a valve operating rod carried thereby extending into said casing to a point beneath said valve plug adapted to engage the same to lift it from its seat, a solenoid operated pilot valve controlling admission to and release of gas pressure from said second diaphragm motor to raise said valve plug to partially open position or permit movement thereof to its seat, a switch responsive to boiler pressure for controlling the operation of the last mentioned solenoid pilot valve, said first mentioned pressure responsive switch being set to break the circuit of its solenoid pilot valve at a lower pressure than is the other pressure responsive switch.

11. In a system according to claim 10, an outside thermostat switch connected in series with the first mentioned pressure responsive switch for controlling the first mentioned solenoid operated pilot valve interdependently with the first mentioned pressure responsive switch, and a stack thermostat switch in series with said outside thermostat switch and the first mentioned pressure responsive switch effective to prevent operation of said first mentioned pressure motor to fully open the gas control valve until operation on low fire has heated the stack thermostat to a desired degree.

12. In control means for a gas burner having pivoted louvers controlling the secondary air supply, a gas supply valve for said burner, means for partially opening said valve for low-fire operation of the burner, means for fully opening the valve for high-fire operation of the burner, a cam lever mounted on the pivot of one of said louvers, a flexible connector extending over and fastened to said cam, and an operating member connecting said flexible connector and said valve whereby to impart greater relative opening movement to said louvers when said valve is moved from closed to low-fire position than when moved from low-fire to high-fire position.

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