Dec. 8, 1959 P. ARANT 2,916,022

AIR INTERLOCK CONTROL FOR GAS BURNING APPARATUS

Filed April 17, 1951 2 Sheets-Sheet 1

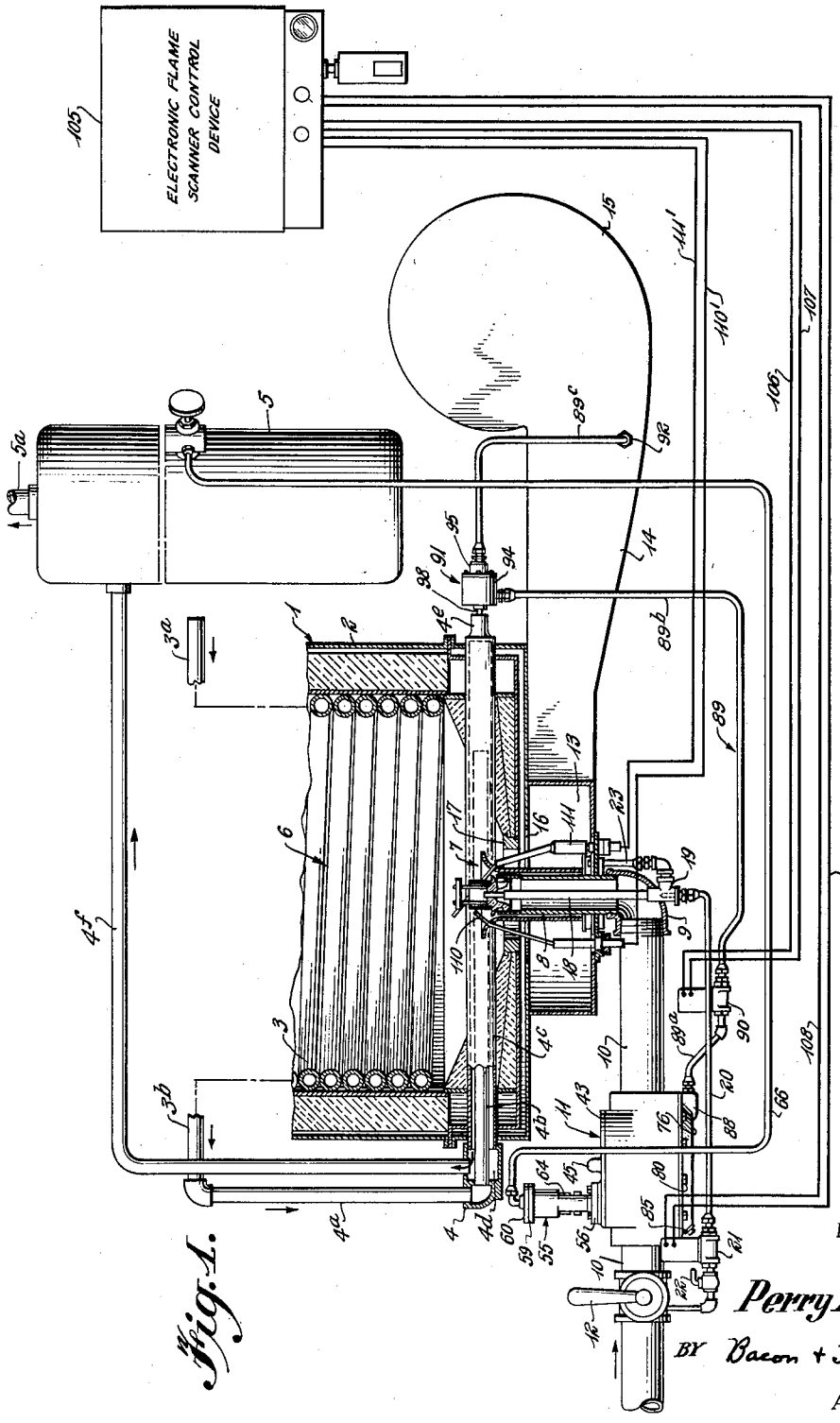

Fig. 1.

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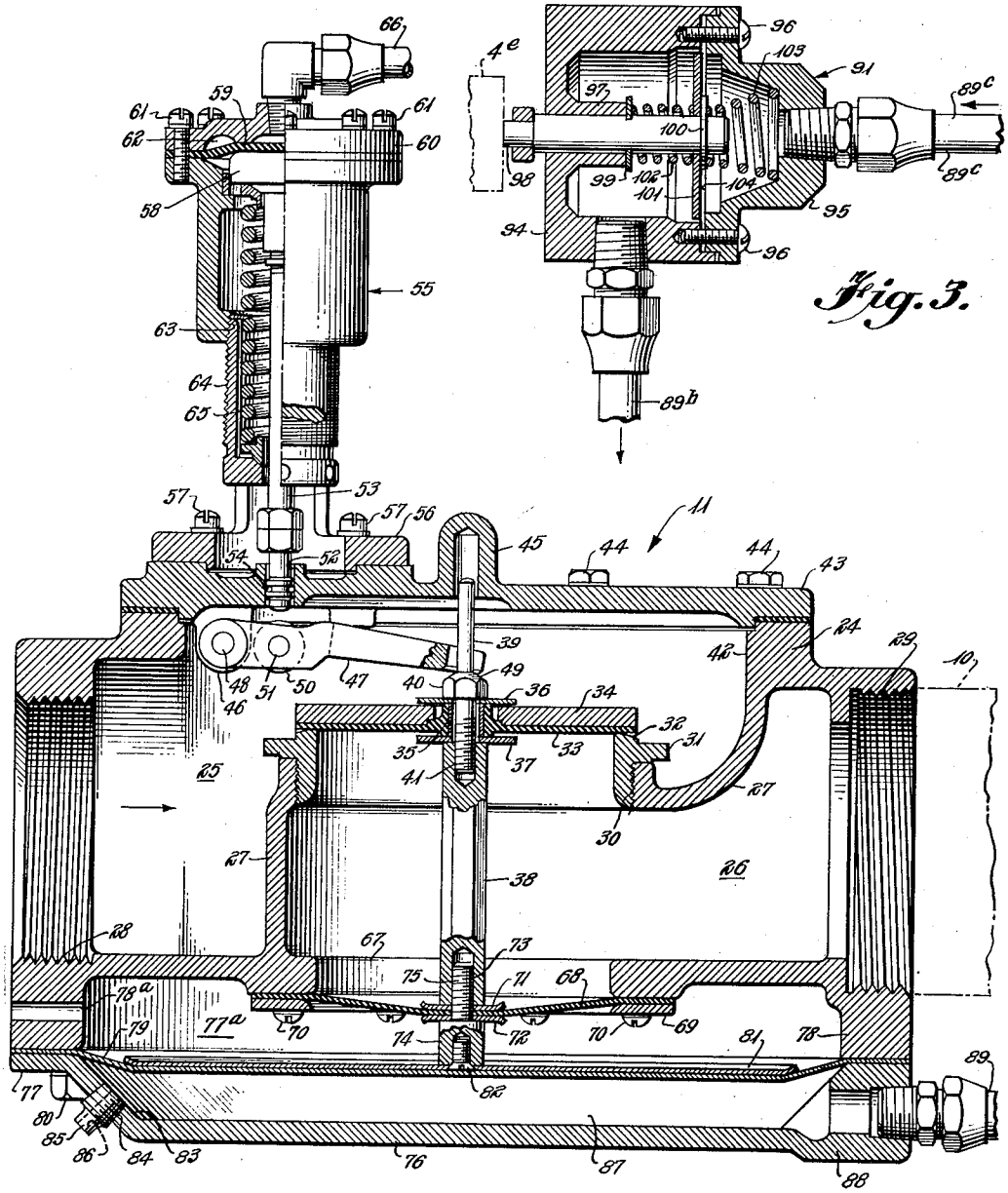

Fig. 3.

Fig. 2.

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AIR INTERLOCK CONTROL FOR GAS BURNING APPARATUS

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Application April 17, 1951, Serial No. 221,417

4 Claims. (Cl. 122—504)

The present invention relates to automatic burner control apparatus and more particularly to control apparatus for use with forced draft gas-burning equipment, such as gas-burning steam cleaners, steam generators, space heaters, and the like.

More specifically, the invention relates to "air interlock" means for controlling the operation of the main gas valve, and which means will prevent opening of the main gas valve and the flow of gas to the burner, unless the blower providing the forced draft is in operation.

The control means comprising the present invention is particularly adapted for use as a further safety device in conjunction with known safety controls, such as stack switches, pressure switches, thermostats, thermo couplings, automatic ignition and spark control devices, electronic flame rod rectifiers, etc., which provide for shutting down of the apparatus, or ignition "proving" before restarting, but do not afford protection against the possible flow of gas to the burner when the apparatus is "standing by" or not in operation at all. Experience has shown that a number of combustion chamber explosions have occurred, even with machines equipped with ignition failure checking devices, due to the lack of adequate gas flow control means effective during an off period, thus making it possible for the combustion chamber to become filled with explosive gas before the unit is restarted.

The principal object of the invention is to provide auxiliary safety control means which will positively prevent the flow of gas to the burner of gas-fired apparatus, unless the blower furnishing air for forced draft is in operation.

Another object of the invention is to provide auxiliary control means for a gas burner which will automatically shut off the flow of gas to the burner whenever the apparatus is shut down, either manually or automatically.

Another object of the invention is to provide a safety control for gas burning equipment employing forced draft, which includes "air interlock" means associated with the blower and main gas valve for preventing the flow of all gas to the burner in the event that the air pressure developed by the blower is below a given minimum.

Another object of the invention is to provide a main gas supply valve which will automatically close and prevent gas flow to the burner in the event of excessive pressure occurring in the gas supply line.

Another object of the invention is to provide an air-pressure operated (diaphragm) main valve for gas-burning equipment wherein gas flow to the combustion chamber is shut off in event of diaphragm failure.

Still another object of the invention is to provide a safety control for gas burning equipment which is independent of, although adapted for use in conjunction with, the usual safety controls including those employed for ignition "proving" and which latter do not afford protection against the flow of gas to the burner during an "off" period.

Still another object of the invention is to provide a gas supply control valve which will not open except in response to the operation of means actuated by air pressure created by operation of the blower.

Other objects and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 diagrammatically illustrates a preferred form of burner control system for a gas-fired steam generator embodying the principles of the present invention;

Fig. 2 is a vertical sectional view taken through the air-pressure operated main gas control valve shown in Fig. 1; and

Fig. 3 is a vertical sectional view through a normally open, spring-loaded air control valve, adapted to be closed by a thermally expansible element, also shown in Fig. 1.

Referring now to Fig. 1 of the drawings, the reference numeral **1** generally identifies a steam generating apparatus including a housing **2** containing a heating coil **3** having an inlet end **3a** and a discharge end **3b**. The discharge end **3b** of the heating coil **3** is connected to a stationary housing **4** by a pipe **4a**. A tube **4b** has one end thereof secured to the housing **4** and constitutes a continuation of the pipe **4a**. A thermally responsive element **4c** surrounds the tube **4b** and has one end thereof communicating with a chamber **4d** in the housing **4** and its other end **4e** is closed but free to move for a purpose explained later. A discharge pipe **4f** communicates at one end with the chamber **4d** and its other end is connected to a conventional steam separator **5**. A conduit **5a** conducts the steam from the separator **5** to the point of use. The thermally responsive element **4c** extends across a combustion chamber **6** having a gas burner **7** projecting upwardly into the lower end thereof. The burner **7** includes a tubular portion **8** which is connected by an elbow **9** to one end of a gas supply pipe **10**, the opposite end of said pipe being connected with a main gas supply control valve **11**, which will be described in detail later. A manually operable main gas cock **12** is connected in the gas pipe **10** ahead of the valve **11**. The valve **11** is designed to control the flow of gas at a feed pressure equal to a 3" to 10" water column. An air supply chamber **13** surrounds the tube **8** of the burner **7** and is disposed below the combustion chamber **6**. Forced draft or air under pressure is supplied to the chamber **13** through a duct **14** by a conventional volute blower **15**. Air from the chamber **13** passes through an opening **16** in the housing **2** and through a sleeve **17** disposed above the opening **16** into the combustion chamber **6** for admixture with the gas supplied to the burner **7** for effecting complete combustion of the gas and heating of the water in the coil **3**.

The burner **7** includes a pilot tube **18**, arranged concentrically in the tube portion **8**, and having its upper end extending into the combustion chamber **6** and having its lower end connected with one side of a 3-way boss **19** formed integral with the elbow **9**. The opposite side of the boss **19** is connected to one end of a conduit **20**, the other end of which is connected with the inlet side of the main gas cock **12**. A conventional solenoid valve **21** is connected in the conduit **20** for controlling the flow of gas to the pilot tube **18**. A manually operable pilot shut-off cock **22** is connected in the conduit **20** at a point between the solenoid operated valve **21** and the main gas cock **12**. A pilot pre-mix air tube **23** has one end thereof connected with the stem of the boss **19** and its other end in communication with the air supply chamber **13** so that air is mixed with the pilot gas supplied to the pilot tube **18** before it reaches the combustion chamber **6**.

The main gas supply control valve **11** is illustrated in detail in Fig. 2 to which reference will now be made. This valve comprises a body portion **24** having an inlet

chamber 25 and an outlet chamber 26 separated by a partition 27. A portion of the gas pipe 10 is received in a threaded opening 28 on the inlet side of the valve 11, and another portion of said pipe is received in a threaded opening 29 on the outlet side of said valve. The partition 27 has a threaded opening 30 in which a threaded annular member 31 is mounted. The upper surface of the member 31 is beveled to provide a seat 32 engaged by a rubber sealing member 33 carried by a valve disc 34. The sealing member 33 is centrally apertured to receive a cylindrical sleeve 35 engaged at its opposite ends by washers 36 and 37. A valve stem 38 is engaged at its upper end with the washer 37, and a valve stem extension 39 has a hexagonal portion 40 intermediate its ends engaged with the washer 36 and a part that extends through the washer 36, sleeve 35 and washer 37 into a threaded opening 41 formed in the upper end of the valve stem 38, and thus serves to fixedly secure the valve disc 34 to the valve stem 38.

The valve body 24 has an opening 42 formed therein above the valve disc 34, this opening is closed by a cover plate 43 secured to said body portion by a plurality of cap screws 44. A centrally located hollow projection 45 is formed on the cover 43 and is adapted to receive the upper end of the valve stem extension 39. A lug 46 extends downwardly from the inner face of the cover 43 and serves as a support for one forked end of a lever 47, said lever being pivotally connected to the lug 46 by a pin 48. The opposite or free end of the lever 47 is also forked and portions thereof extend around the valve stem extension 39 and engage with a convex surface 49 formed above the hexagonal portion 40 of said valve stem extension. A roller 50 is mounted upon the lever 47 adjacent the lug 46 by a pin 51. The free end of the lever 47 rests upon the convex surface 49 and normally tends to urge the sealing member 33 into engagement with the seat 32 by gravity to prevent the flow of gas through the valve.

The cover member 43 is provided with an opening 52 disposed directly above the roller 50 for the reception of the lower end of a rod 53. The rod 53 is grooved and carries a sealing O-ring 54 for preventing the escape of gas from the inlet chamber 25 to the atmosphere. The stem 53 forms a part of a conventional steam pressure responsive actuator 55, which includes a housing 56 having its base secured to the cover member 43 by cap screws 57. A piston 58 is mounted upon the upper end of the rod 53 and its top surface is engaged by a flexible diaphragm 59. A cover 60 is disposed above the diaphragm 59 and is secured to the housing 56 by a plurality of screws 61. The cover 60 is hollowed out to provide a pressure chamber 62 above the diaphragm 59. A threaded opening 63 is disposed below the diaphragm 59, and an externally threaded cylindrical sleeve 64 is adjustably mounted in said opening. A compression spring 65 is arranged in surrounding relation with the rod 53 between the piston 58 and the lower end of the sleeve 64, so that the pressure required in the chamber 62 to effect downward movement of the rod 53 can be varied as desired.

One end of a conduit 66 is connected to the cover 60 in communicating relation with the chamber 62, and its other end is connected to the steam separator 5 (Fig. 1) so that the pressure in said steam separator is communicated to said chamber and acts downwardly upon the diaphragm 59 tending to effect downward movement of the rod 53 against the resistance offered by spring 65. Thus, should the steam pressure in the separator 5 exceed the pressure for which the spring 65 has been set, the rod 53 will be moved downwardly into engagement wth the roller 50 carried by the lever 47 to force the valve stem 38 downwardly and thereby cause the sealing member 33 to engage with the seat 32 to positively close the valve 11 and cut off all communication between the inlet chamber 25 and the outlet chamber 26. This action, of course, will cut off the supply of fuel to the burner 7 and provides a safety means to prevent the building up of excess steam pressure in the steam separator 5.

The valve body 24 has a bottom wall provided with an opening 67 vertically aligned with the threaded opening 30. A flexible gas seal diaphragm 68 extends across the opening 67 and is secured at its outer margin to said bottom wall by a ring 69 and a plurality of screws 70. Washers 71 and 72 are disposed upon opposite sides of the diaphragm 68 with the washer 71 engaging the lower end of the valve stem 38, which has an aperture provided with threads 73. A spacer member 74 has a shoulder adapted to engage with the washer 72 and a threaded extension 75, which extends through the washer 72, diaphragm 68 and washer 71 into engagement with the threads 73. Thus, the diaphragm 68 is firmly secured to the lower end of the valve stem 38.

A dished member or pan 76 has an outwardly extending flange 77 disposed below a cooperating flange 78 depending from the valve body 24 in surrounding relation to the diaphragm 68. A flexible air and gas impervious diaphragm 79, of a diameter substantially larger than the diaphragm 68, is disposed between the flanges 77 and 78, and cap screws 80 secure said diaphragm and the dished member 76 to the valve body 24. Thus, an intermediate chamber 77^a is formed by the valve body 24, the flange 78, and the diaphragms 68 and 79. The flange 78 has a vent opening 78^a extending therethrough for venting the chamber 77^a to the atmosphere to provide for free relative movement of the diaphragms 68 and 79. A diaphragm supporting plate 81 is disposed in the intermediate chamber 77^a and is engaged with the upper side of the air diaphragm 79 and provides a support for substantially the entire area of said diaphragm. The plate 81 is secured to the head of the spacer 74 by a screw 82 extending centrally through said plate and into a threaded opening in said spacer. The pan 76 has an outwardly and upwardly inclined side wall 83 which merges into the flange 77. The side wall 83 is provided with a threaded opening 84 in which a plug 85 is mounted. The plug 85 has a vent orifice or bleed opening 86 formed therein which serves as a bleeder for continuously establishing communication between a pressure chamber 87, jointly defined by the dished member 76 and the diaphragm 79, and the atmosphere. A boss 88 projects outwardly from the side wall 83 and has one end of a section 89^a of an air tube 89 connected thereto, the opposite end of said section being connected with the outlet of a conventional solenoid valve 90. Another air tube section 89^b has one end connected to the inlet of the solenoid valve 90 and its other end connected to the outlet of a normally open, spring-loaded "air interlock" valve 91, Fig. 1, which will be described in detail later. The inlet of the air valve 91 has one end of another air tube section 89^c connected thereto and its opposite end is connected with the air duct 14 at a point indicated by the numeral 92. Thus, the solenoid valve 90 is connected in the air tube 89 at a point between the main gas valve 11 and the air valve 91. In the case of a 100 h.p. steam generating unit, the main gas valve 11 may be a 3" valve, in which event the bleeder hole 86 would be 0.177" in diameter to maintain a static air pressure equal to about a 3" water column on the diaphragm 79 when the blower 15 is in operation; such pressure acting on the large area of the diaphragm 79 being adequate to open the valve 11 against the gas line pressure of 6" to 8" water column.

The air valve 91 is shown in cross-sectional detail in Fig. 3 and comprises a generally cup-shaped body 94 and a cover 95 forming a closure for the open end of said body, said cover being secured to said body by a plurality of cap screws 96. A boss 97 projects inwardly from the bottom wall of the body 94 and forms a guide for a valve stem 98. The valve stem 98 is conventionally grooved to receive split contractile snap rings 99 and 100. A disc 101 is disposed adjacent to snap ring 100 and a

compression spring **102** is disposed between the disc **101** and the snap ring **99**, whereby the disc **101** is mounted for axial movement on the stem **98** to permit over-travel of the stem **98** toward the right. A compression spring **103** is disposed in the cover **95** on the opposite side of the ring **100** and tends to maintain the disc **101** spaced away from a seat **104** formed on the cover **95**. In other words, the spring **103** tends to maintain the air valve **91** open at all times. The stem **98** projects to a point exteriorly of the valve body **94** and is adapted to be engaged by the end **4e** of the thermally responsive tube element **4c**, which is subject to the heat of the gases in the combustion chamber as well as the heat of the liquid being heated in the coil **3**, inasmuch as liquid discharged from the tube **4b** must reverse its direction of flow in the tube **4c** before it can flow into the discharge pipe **4f**. The arrangement is such that, should there be a failure of the water supply, the thermally responsive element **4c** will expand or elongate and urge the stem **98** toward the right, as viewed in Fig. 3, to effect engagement of the disc **101** with its seat **104** to prevent the flow of air under pressure through the valve **91**. Of course, as the air valve **91** closes, the pressure communicated to the chamber **87** of the gas valve **11** will drop, thereby permitting the main gas valve to close automatically and cut off the supply of gas to the burner and prevent burning out of the heating coil. The same result can be effected by the closing of the solenoid valve **90**, which will likewise function to shut off the flow of air to the pressure chamber **87**, as explained hereinafter.

A conventional electronic flame scanner control device **105** may be combined with the present air operated main gas valve **11** to control the main solenoid valve **90** through conductors **106** and **107**, but this is not essential for the reason that the solenoid valve **90** could be controlled by any other conventional means. Likewise, the pilot solenoid valve **21** may be connected through conductors **108** and **109** with the electronic control device **105**. Such electronic control devices utilize the principle of flame rectification or flame conduction, and are well known to those familiar with the art. Hence, there is no need for illustrating or describing such devices in detail herein. However either type of conventional control includes an electrode **110** placed adjacent the burner **7** and adapted to ignite the gas pilot **18**. The electrode **110** is connected with the electronic control device **105** by a conductor **110'**, which supplies current of high potential thereto, and arcs to ground on the pilot housing. Another electrode **111**, more commonly called a flame scanner rod, is connected to the electronic control device **105** by a conductor **111'**.

When the unit is started by manual operation of a push button on the control device **105**, or by automatic pressure switch control (not shown), current to the electrode **110** and pilot solenoid valve **21** are simultaneously supplied, so that gas is supplied to and the pilot **18** is ignited. The flame scanner electrode **111** is positioned for contact by the pilot flame and heating thereof causes electric current rectification or conduction and actuates, through the electronic control device **105** and conductors **106** and **107**, the solenoid valve **90** in the air line **89** to effect opening of the main gas valve **11**. In the event that the pilot **18** is unstable or flame rectification or conduction with the scanner rod **111** is not consistent, the electronic control device **105** will revert back to starting condition, closing the valve **90** and reestablishing ignition through the electrode **110** at the gas pilot **18**. If the unit is running at any time without proper flame rectification or conduction (depending upon which type of automatic electronic control device **105** is employed), the power source (electric current), which normally flows through a warp switch (not shown), is interrupted by opening of said switch and the unit is stopped after a period of about one minute.

For present purposes, it will be assumed that the gas pilot **18** is lit, and that the conventional electronic control **105** has energized the air control solenoid valve **90** to maintain the same in open position. Air under pressure is then diverted from the casing **14** through the air tube section **89c** to the inlet of the air valve **91**, which valve is normally maintained open by the spring **103**, as above pointed out, so that the air under pressure is further conducted through the tube section **89b** and the open solenoid valve **90** and thence through the tube section **89a** to the pressure chamber **87** in the main gas valve **11**. The air under pressure will act upon the diaphragm **79** and flex it upwardly, thereby raising the valve stem **38** and lifting the sealing member **33** out of engagement with the seat **32** to permit gas to flow through the pipe **10** to the burner **7**. The air bleed opening **86** will, of course, permit air under pressure to continuously escape from the chamber **87** to the atmosphere at a restricted rate. Normally, a pressure equivalent to only 3" of water is required to effect opening of the gas valve **11**, and the blower **15** is adequate to supply such low pressure at all times. The valve **11** will normally remain open so long as fuel is required to heat the liquid passing through the coil **3**. Should the steam demand on the steam generating unit **1** drop to the point where an excess of steam pressure develops in the steam separator **5**, such steam pressure will be effective through the conduit **66** to act upon diaphragm **59** causing the rod **53** to move downwardly into engagement with the roller **50** and actuate the lever **47** to move the valve stem **38** downwardly and thus positively shut off the flow of gas through the valve **11**. On the other hand, an independent control of the supply of gas to the burner is possible through the closing of the air valve **91** by the thermal expansion of the element **4c**, the latter acting on the stem **98** to engage the disc **101** with its seat **104**. Any excess expansion of the element **4c** cannot damage the valve **91** because of the loose mounting of the disc **101** on the stem **98** compensating for any valve stem over-travel. When the valve **91** is closed, the supply of air under pressure to the chamber **87** is cut off and pressure in said chamber is immediately reduced by the bleeding of the air from the chamber through the bleeder hole **86** until the pressure in the chamber **87** is reduced to atmospheric, thus permitting the valve **11** to close automatically.

A further and independent control of the gas valve **11** is provided through the solenoid valve **90** controlled by the conventional electronic flame scanning apparatus **105** which would de-energize the solenoid valve **90** and permit it to close in the event of flame failure. Hence, if the burner flame should go out for any reason, the solenoid valve **90** would be automatically closed, cutting off the supply of air under pressure to the chamber **87**, even though the blower **15** continues to operate, whereby closing of the valve **11** will be quickly effected through the bleeding of air under pressure to the atmosphere through the orifice **86**, as previously explained. Moreover, in the event of failure of the blower **15**, or manual shut down of the apparatus, there would be no air under pressure delivered to the chamber **87** and the valve **11** would automatically close to shut off the supply of gas to the burner **7**.

It will be clear from the foregoing that the present apparatus provides an "air interlock" control for the main gas valve **11**, which is independent of the usual and conventional controls, and which will prevent all gas from flowing to the combustion chamber **6** unless an adequate supply of air is being furnished to the combustion chamber.

It will be understood that, in the event that the pressure in the gas line connected to the inlet of the valve **11** should rise to about 12" water column pressure, such pressure would overcome the 3" water column pressure of the air in the chamber **87** acting on the diaphragm **79** tending to maintain the valve **11** open, with the result that the valve **11** will be closed, thereby automatically preventing

the delivery of gas at excessive pressure to the burner 7. This feature also constitutes a valuable safety control for the apparatus.

It will also be understood that in the event of any diaphragm failure, the valve 11 will close similar to a check valve due to the intermediate atmospheric chamber 77a and the direction of normal gas flow through the valve, allowing a safe failure.

It will be understood that various changes may be made in the details of construction and in the arrangement of the parts of the burner control system disclosed herein without departing from the principles of the invention and the scope of the annexed claims.

I claim:

1. Gas-fired apparatus, comprising: a burner; a gas supply valve connected with said burner for controlling the supply of gas thereto; a blower for supplying air under pressure to said burner, said gas supply valve including a seat and a valve disc cooperable with said seat to control the flow of gas through said gas supply valve to said burner, a diaphragm in said gas supply valve on the outlet side of said valve disc, a valve stem connecting said diaphragm with said valve disc, and means providing a pressure chamber on the side of said diaphragm remote from said valve disc; a conduit interconnecting said blower and pressure chamber for conducting air under pressure from said blower to said pressure chamber for effecting opening of said gas supply valve, an air shut-off valve connected in said conduit for shutting off the supply of air under pressure to said pressure chamber; and bleeder means establishing communication between said pressure chamber and the atmosphere for continuously bleeding a portion of the air under pressure from said pressure chamber to the atmosphere, whereby upon closing of said air shut-off valve, the pressure in said pressure chamber will be vented to the atmosphere and the gas supply valve will automatically close.

2. Gas-fired apparatus, comprising: a burner; a gas supply valve connected with said burner for supplying gas thereto; a blower for supplying air under pressure to said burner, said gas supply valve having an inlet, an outlet, a seat between said inlet and outlet, and a valve disc cooperable with said seat to control the flow of gas through said gas supply valve to said burner; a diaphragm on the outlet side of said valve disc; means operatively connecting said diaphragm with said valve disc; means providing a pressure chamber on the side of said diaphragm remote from said seat; a normally open air control valve having an inlet and an outlet and a seat between said inlet and outlet, a valve disc engageable with said last-mentioned seat, a stem connected with said last-mentioned valve disc, and spring means normally maintaining said last-mentioned disc out of engagement with its seat; a conduit connecting the inlet of said air valve with said blower; a conduit connecting the outlet of said air valve with said pressure chamber of said gas supply valve to effect opening of said gas supply valve when said blower is in operation; and a thermally responsive element active on the stem of said air valve to close the same against said spring pressure to shut off the air pressure to said pressure chamber of said gas supply valve to thereby allow said gas supply valve to close.

3. Gas-fired apparatus as defined in claim 2, in which the air control valve includes means compensating for overtravel of the thermally responsive element.

4. Gas-fired apparatus, comprising: a burner; a gas supply valve connected with said burner for supplying gas thereto; a blower for supplying air under pressure to said burner, said gas supply valve having an inlet, an outlet, a seat between said inlet and outlet, and a valve disc cooperable with said seat to control the flow of gas through said gas supply valve to said burner; a diaphragm on the outlet side of said valve disc; means operatively connecting said diaphragm with said valve disc; means providing a pressure chamber on the side of said diaphragm remote from said seat; a normally open air control valve having an inlet and an outlet and a seat between said inlet and outlet, a valve disc engageable with said last-mentioned seat, a stem connected with said last-mentioned valve disc, and spring means normally maintaining said last-mentioned disc out of engagement with its seat; a conduit connecting the inlet of said air valve with said blower; a conduit connecting the outlet of said air valve with said pressure chamber of said gas supply valve to effect opening of said gas supply valve when said blower is in operation; a thermally responsive element active on the stem of said air valve to close the same against said spring pressure to shut off the air pressure to said pressure chamber of said gas supply valve to thereby allow said gas supply valve to close; and an air shut-off valve connected in said last-mentioned conduit for shutting off the supply of air to said pressure chamber to effect closing of said gas supply valve independently of said thermally responsive element.

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