

March 16, 1954

W. V. RIFLE
FURNACE CONTROL MEANS

2,672,291

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2 Sheets-Sheet 1

Fig. 1

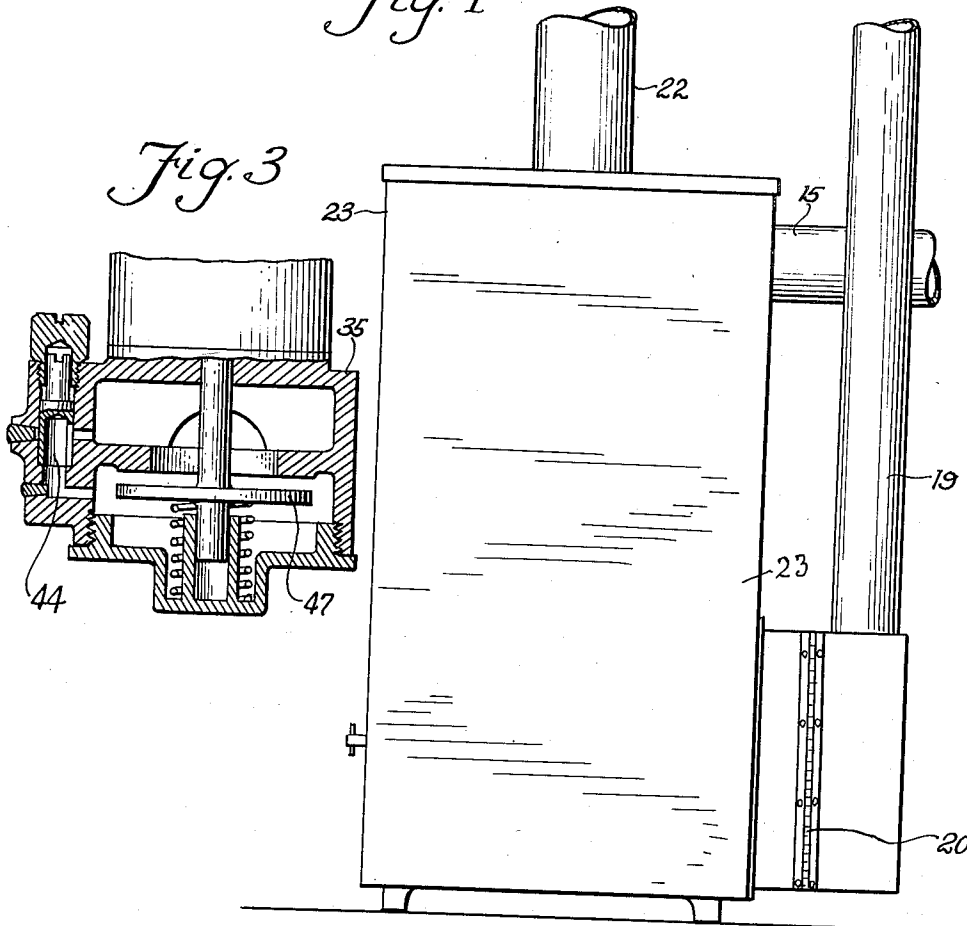
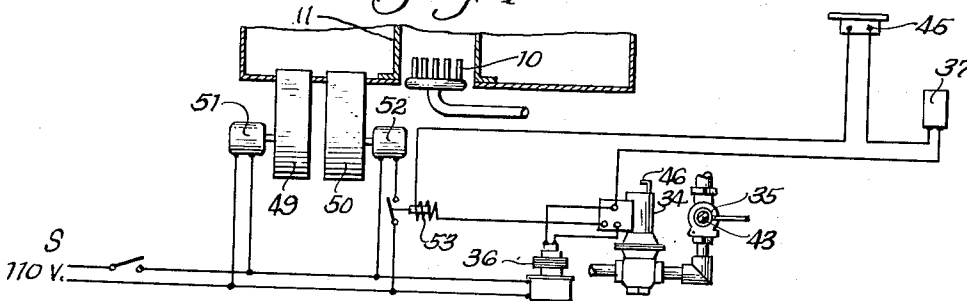


Fig. 4



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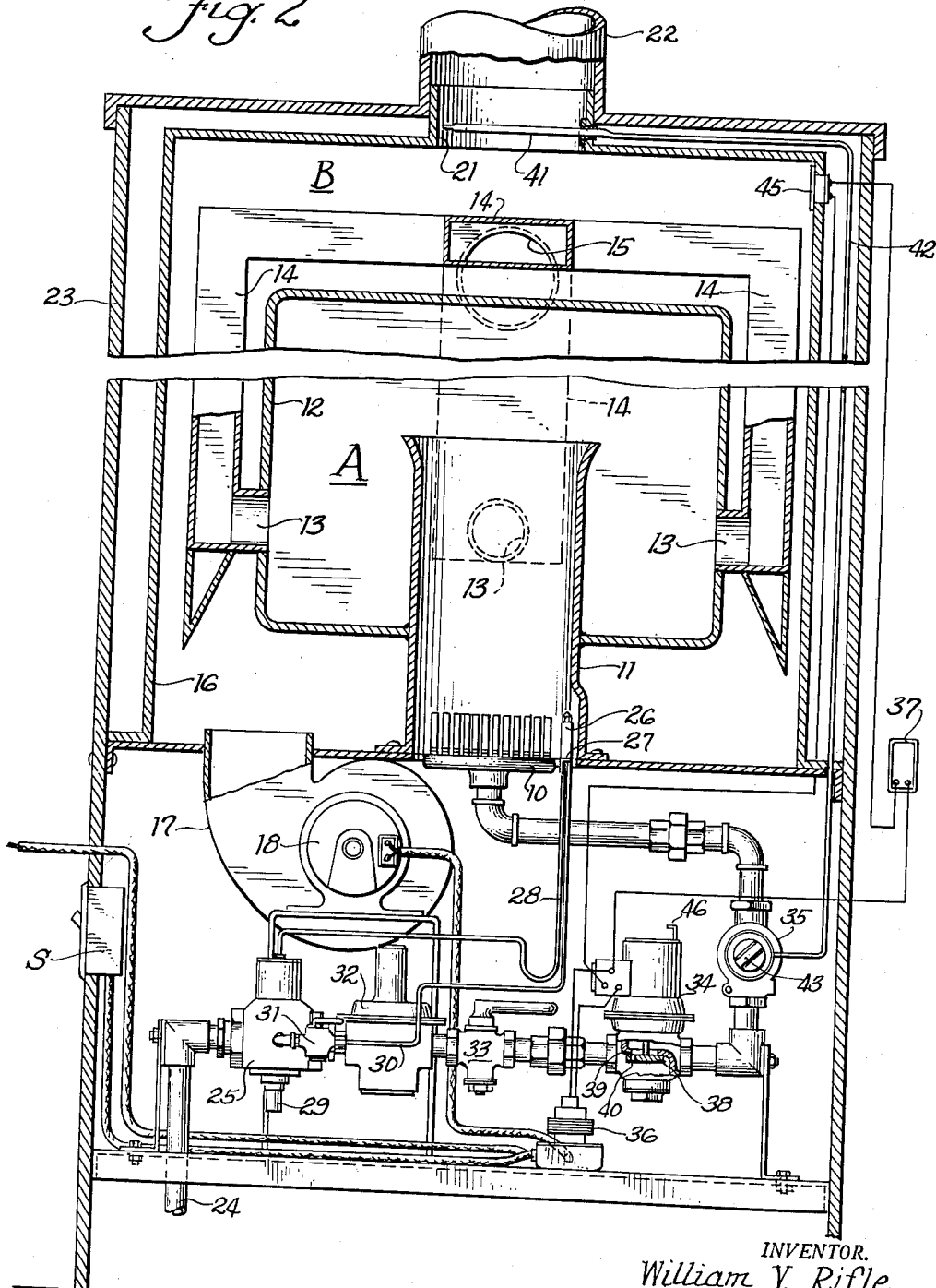
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2 Sheets-Sheet 2

Fig. 2



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FURNACE CONTROL MEANS

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2 Claims. (Cl. 236—9)

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This invention relates to composite control means for gas-fired hot air furnaces.

In conventional gas-fired hot air furnaces used for domestic heating such as in homes, stores, shops and the like, gas flow control valves which are responsive to the opening and closing of electrical circuits through wall thermostats are generally used. One such type control valve consists of a low voltage heating unit that is designed to cause expansion of a fluid within a container for effecting the closing of the valve, the heating element being in series circuit with the thermostat contacts, and after the thermostat closes, due to a drop in temperature to a point predetermined by the adjustment of the thermostat, the control valve closes, shutting off the supply of gas to the burner. In a furnace where such a control valve is employed, the burner supplies a maximum of heat when the valve is open but the flame is entirely off when the valve is closed, except for the pilot flame. Some such furnaces have controls for the blower motor which enable the motor to continue operation for a few minutes after the control valve has been closed whereby the residual heat of the furnace will be directed into the space being heated. Such controls may also delay a closing of the motor circuit following the re-opening of the gas control valve until the furnace has become sufficiently heated after a period of shutdown to avoid forcing cold air into the space to be heated. In such furnaces, where the outside temperature is low, such "on" and "off" operation of a furnace gives noticeable variations in the temperature of the heated space which is often considered objectionable.

In the present improvements, and as one of the primary objects thereof, such "on" and "off" operation of the furnace is avoided by the provision of controls which give a "high" and "low" flame at the burner, or a modulated or intermediate flame, the low flame providing sufficient heat, in conjunction with a continuously operating blower, to avoid the objectionable relatively abrupt changes in the temperature of the heated space even in severe winter weather and which is adequate in some instances of mild weather to provide all the heat required.

Another object of the invention is to provide a composite burner control means for a gas-fired hot air furnace which includes a primary control system consisting essentially of a wall thermostat and a gas valve of the type above mentioned, the opening and closing of which is controlled by the thermostat but which valve is so modified as to permit the maintenance of a low flame even

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when the valve is closed, and in conjunction with said primary control system a secondary or modulating control means whereby when said control valve is open the supply of fuel to the burner may be varied for modulating the rate of heat release.

Since the closing of the thermostat contacts of such a primary control means effects the opening of the gas control valve of the type above mentioned, the failure of the supply of electric current to the gas controls or a corroding of the contacts of the wall thermostat will result in the failure of the control valve to open or may cause the contacts to remain closed regardless of the satisfied demand for heat and hence, for use in such emergencies, the control valve under consideration is provided with a manually operable member for opening the valve and thus providing fuel to the burner. When such a valve has been opened manually because the electrical portion of the system has become inoperable either by reason of the failure of the current supply, corrosion of the thermostat contacts, or by reason of the breakdown of the transformer forming a part of the electrical control or for other reasons, a dangerous condition may exist since overheating of the furnace is likely, especially where the usual blower motor is inoperative by reason of the interruption of the electric power supply. Hence close attention must be given to such a control valve when manual operation thereof becomes necessary.

It is an object of the present invention to provide in conjunction with electrical control means for a domestic gas-fired hot air furnace a secondary control or modulating means which takes over the control of the supply of gas to the furnace burner whenever the electrical control means becomes inoperative due to interruption of the electrical power to the blower motor or to the transformer or breakdown of the transformer that supplies low voltage current to the thermostatically controlled circuit or circuits or by reason of the inoperability of the thermostat itself or under other unusual or non-normal conditions referred to hereinafter. When the improved secondary regulating means only is functioning after the main control valve has been opened manually, the demand for heat is supplied under automatic regulation to an extent consistent with safety of the heating apparatus. Under sole control of the secondary control means, the burner may not supply all the heat desired especially if the blower motor is inoperable and weather conditions are severe but the supply will be as great as safety to the furnace will permit. Hence by use of the improved sec-

ondary control means, automatic regulation of the furnace will be effected within a practical range of temperatures notwithstanding the total failure of supply of electrical power to the blower motor or to the primary control system. It is thus not necessary, where electrical control circuits have become inoperative to depend on manual "on" and "off" operation of the main gas supply control valve in order to avoid overheating the furnace or operating it at dangerous temperatures.

Another object of the invention is to provide a hot air furnace control system which includes a continuously operating blower during normal operations, and means providing a "high-low" gas flame and regulating means therefor avoiding abrupt changes in temperature of the heated space that is characteristic of "on" and "off" type gas heating equipment that is controlled primarily by a wall thermostat. The continuous operation of the blower, during the heating season, improves the air circulation within the home or other space being heated and avoids or minimizes the stratification of the air such as occurs in severe winter weather during intervals when no heat is being supplied by a furnace having a conventional control only of the type above referred to.

An additional object of the invention is to provide a secondary control or modulating means for a furnace of the type mentioned which is adapted to effect regulation of the burner in instances where the primary regulating means would permit the temperature of the furnace to rise to a dangerous level or excessively heat the air, as for example when the wall thermostat of the primary regulating means fails to open due to a defect therein or where it is affected by a draft of cold air as from an adjacent open window. Under such conditions while the wall thermostat may be calling for heat, the secondary or modulating means of the present improvements will permit the supply of heat by the furnace at a rate consistent with safe furnace temperatures without closing the gas control valve of the primary control means as might occur where a conventional high limit switch is employed as the sole high-temperature cut out of the primary control system.

Another object of the invention is to provide a gas-fired furnace provided with control means affording high and low burner flames in conjunction with dual blower air circulating means comprising one continuously operating blower and a second blower that cuts in or out with high and low burner flames respectively, thereby providing less air circulation at low flame and maximum circulation at high flame.

Other objects of the invention relate to various features of construction and arrangement of parts which will be apparent from a consideration of the following specification and accompanying drawings, wherein:

Figure 1 is an elevational view of a gas-fired hot air furnace embodying the present improvements;

Fig. 2 is an enlarged elevational view showing the furnace heating chamber and combustion chamber in section and illustrating the apparatus constituting the primary control means as well as a secondary or modulating control means;

Fig. 3 is a broken view of a modulating valve shown partially in section; and

Fig. 4 is a diagrammatic view of a modified

furnace control with dual blowers for providing maximum and minimum air circulation during high and low flame periods.

In Figs. 1 to 3 of the drawings, a gas burner indicated generally by the numeral 10 is shown located within a vertical air duct 11 forming a part of a combustion chamber forming member 12. The hot gases from the flames of the burner rise into the combustion chamber A and heat the walls thereof while the exhaust gases pass through various ports 13 in the sides of the chamber walls and rise through ducts 14 which unite at the top of the member 12 and there communicate with an exhaust 15 which generally leads to a stack or chimney. Surrounding and spaced from the combustion chamber forming member 12 is a cylindrical enclosure 16 which constitutes the air heating chamber B and into which air is forced by a blower 17 operated by a motor 18 in the structure shown in Fig. 2. The air that enters the blower 17 is generally cool air that passes downwardly from the heated space which may be the room or rooms of a home, store, or the like, through a cold air return duct 19 which directs the air through a suitable air filtering means 20 to the intake of the blower 17. The air in moving upwardly through the heating chamber B contacts the heated walls of the member 12, as well as the ducts 14, and exhausts from the chamber through a port 21 which communicates with a duct 22 which forms a portion of the hot air delivery system that supplies the air to the heated space as through a register or registers (not shown) in the walls of the heated space. Surrounding the hot air chamber 16 and enclosing the gas valves forming part of the present composite control system is an exterior casing 23.

Fuel gas is supplied to the burner 10 from a pipe 24 from any suitable source and normally passes through a series of valves hereinafter to be described. One of such valves is a shutoff valve 25 which is opened by current generated by a thermocouple located in or adjacent a pilot burner 26, the thermocouple 27 supplying current through the conductors 28 to the valve 25 for opening it and holding it in open relation. The valve 25, as well as the thermocouple are of known construction and need not be specifically described since, per se, they form no part of the present improvements. The valve 25 is conventionally provided with a push button opening device 29 which, when opened, permits gas to pass into the tube 30 (when the manually operable valve 31 has also been opened) which gas is directed by the tube 30 to the pilot 26. When the pilot has been ignited, the thermocouple is heated to generate current which opens and holds the valve 25 open. In the event the pilot flame should be extinguished, the thermocouple will cease generating current and the valve 25 will close automatically shutting off the supply of all gas to the burner.

In series with the shutoff valve 25, there is shown a conventional gas pressure regulator 32 which may or may not be used and the construction of which is conventional and forms no part of the present improvements. After passing through the regulator 32, the gas passes through a main shutoff valve 33 when open and which is manually operable, and it then passes through a valve 34 which is electrically operated to open position against spring action and then to a modulating valve 35, whence it passes to the burner 10.

The valve 34 constitutes a part of the primary

control system above referred to and is of known construction but the valve illustrated has been modified slightly to enable the present improved furnace operation to be made effective. Since the valve 34 is of known construction, it is not necessary to describe it in detail. However, when current is delivered to the valve 34 from a transformer 36 by reason of the closure of the contacts of a wall thermostat 37, a heating coil within the valve casing is energized which heats up a fluid in a container or boiler which thereupon expands and moves the valve closure member 38 to open position, that is, away from the seat 39, thus permitting the full supply of gas to pass through the valve 34 from left to right as viewed in Fig. 2. The modification of the valve 34 above referred to consists in providing a by-pass in the form of a drilled hole 40 in the closure member 38 whereby a predetermined volume of gas per hour can pass through the valve notwithstanding that the closure member 38 is in closed position. Other by-pass means may be provided. After passing through the valve 34, the gas passes through the valve 35 when the latter is open.

Valve 35 is of the gas regulating type and is normally open at room temperature but moves to or toward a closed position when a fluid in a bulb 41 is heated, the bulb communicating with the valve through a small diameter tube 42. In other words, the modulating valve 35 is of the type often used in controlling the temperature of ovens in domestic gas ranges. The valve 35 is provided with an adjustable member 43 and suitable associated graduations or indicia whereby the valve can be set to start closing at predetermined temperatures, that is, temperatures affecting the bulb 41. The bulb 41 preferably is located in or adjacent the hot air outlet 21 of the furnace whereby the hot air emerging from the heating chamber 13 will sweep across the bulb. When the temperature of the air affecting the bulb corresponds in temperature to the temperature setting of the adjustable member 43 of the valve 35, the valve will move toward closed position for reducing the flow of gas to the burner. The valve tends to maintain the temperature of the air affecting the bulb at that corresponding to the setting of the adjustable member 43 since the valve likewise will move toward open position by spring pressure, if the temperature of the air at the bulb drops below that indicated by the setting of member 43. The valve is thus of the regulating type, tending to supply the quantity of gas to the burner required for maintaining a selected temperature at the bulb.

The valve 35, however, is provided with a by-pass shown in Fig. 3, the by-pass being indicated by numeral 44, and having a flow capacity not less than that of by-pass 40 of valve 34. Hence, it will be seen that, notwithstanding the closure of the valve 34, as well as of the valve 35, a predetermined quantity of gas can flow to the burner. The capacities of the by-passes referred to are such as to maintain the burner at "low" flame. It has been found that by-passes in the two valves sufficient to permit the flow therethrough of approximately 15 cubic feet of gas per hour are usually adequate for maintaining the burner at low flame and thus supplying approximately 12,000 B. t. u. per hour where the gas gives approximately 800 B. t. u. per cubic foot. In greater capacity heating units, of course, or where gas of lower thermal capacity is used, larger by-passes may be used, but for furnaces for 5 and 6 room

dwellings, the by-passes mentioned have been found to be satisfactory.

In the normal operation of the furnace, the member 43 of valve 35 may be set to the maximum open position, that is, in a position where the bulb 41 will not effect closure of the valve until the temperature of the air leaving the hot air chamber B is approximately 212 degrees F. The closing of the wall thermostat 37 in response to the demand for heat in the space being heated will cause the valve 34 to open. The opening of the valve, is gradual, that is, it requires several seconds to open, due to the fact that the current through the thermostat must effect the heating of the fluid in the boiler of the valve which, by reason of its expansion, moves the closure member 38 against spring action to open position. The gradual opening of the valve 34 avoids noise resulting from sudden combustion of gas common in some types of gas furnaces. When the valve 34 opens, valve 35 being already open, the flame will increase to its maximum value, that is, the flame will be high. In the form of the invention shown in Fig. 2, the motor 18 is designed to operate the blower 17 continuously so long as the main switch S is closed. When the temperature of the space being heated rises to that corresponding to the setting of the wall thermostat 37, the thermostat circuit will be opened and the valve 34 will close. The by-pass 40 will continue to supply gas through the valve however, and hence the flame will not be extinguished but will be reduced to low flame. The valve 34 and the control circuit including the wall thermostat, just above described, and a high temperature safety switch 45, constitute the primary control system above referred to. In Fig. 2 of the drawing, the safety switch 45, which is normally closed, is designed by its manufacturer to open thermostatically at relatively high temperature, for example 250 degrees F. Switches of the type referred to are of known construction and need not be described, one such type being manufactured by Spencer Thermostat Company, Attleboro, Mass., and known to the trade as a "Klixon" switch. This switch 45 is located at the top or dome of the heating chamber B or the hottest part of the furnace and is shown connected in series with the wall thermostat. The purpose of this high temperature switch is to open the circuit of the heating element of the valve 34 whenever the temperature of the furnace has reached the maximum considered safe. Normally, of course, the switch 45 does not function since the wall thermostat 37 will open the control circuit of the valve 34 before the temperature of the furnace effects the opening of the valve 45. However, should the contact members of the wall thermostat 37 stick or fail to open, thus tending to hold the valve 34 in open relation, the temperature of the furnace would continue to rise and should it rise, under those circumstances to the operating temperature of the switch 45, it will open and thus interrupt the control circuit of the valve 34 and permit the latter to close. Before the switch 45 opens, the temperature of the delivered air might also rise to a dangerous level. Assuming, however, that the wall thermostat functions as intended, it solely controls the operation of the valve 34 which supplies gas in maximum quantities to the burner upon demand for heat in the space being heated.

In the event of a failure of the supply of current to the transformer 36 or in the event of a breakdown of the transformer, the valve 34 will

close, thus shutting off the supply of gas to the burner except such as will pass through the by-pass 40. The valve 34 is provided with a manually operable member 46 by means of which the closure member 38 can be depressed manually. Depressing the member 46 forces the valve stem downwardly and thus moves the closure member 38 to open position which permits the maximum flow of gas through the valve. Hence, in the event of power failure, as above mentioned, or in the event of a breakdown of the transformer 36, or in the event of the corrosion of the contacts of the wall thermostat 37 to such an extent that the contacts will not close the circuit through the heating element of the valve 34, the latter may be opened manually by depressing the member 46. The construction of the valve 34 which permits the manual opening as described is well known and need not be described in detail, except that when the member 46 has been depressed manually to the required extent, it is retained in the depressed position by catch means which will be released upon re-establishment of the electrical circuit through the valve. Hence, in the event of the failure of valve 34 to open automatically, it may be manually opened whereby the maximum supply of gas can flow to the burner 10, since the valve 35 normally will have been opened by the lack of heat in the furnace. Since, in the event of such power failure, the thermostat 37, as well as the switch 45 will be inoperative, the supply of gas to the burner through valve 34 can be reduced by manual restoration of the plunger 46 to its normal upper position. Such manual control of the valve is troublesome, especially where it is located in the basement of a home. It is one of the purposes of valve 35 to take over the regulation of the flow of gas to the burner in the event of a failure in the electrical supply. When the current supply has been interrupted, the member 46 may be depressed manually to open the valve 34 to permit the maximum quantity of gas to pass through the valve. The valve 35 will permit such gas to flow to the burner until such time as the bulb 41 has been heated to a temperature corresponding to that for which the member 43 has been adjusted whereupon the expansion of the fluid in the bulb acting through the capillary duct 42 will move the closure member 47 of valve 35 toward closed position and thus reduce the supply of gas to the burner. Should the closure member 47 of valve 35 be moved to the fully closed position, the by-pass 44 thereof will still permit the flame to operate at "low" flame. The flame will, of course, increase as the valve 35 opens more fully in response to decrease in the temperature of the air affecting the bulb 41. This secondary control system comprising the valve 35 and the heat responsive bulb 41 thus will take over the automatic regulation of the furnace notwithstanding the failure of the primary system to control the furnace by reason of interruption of the supply of power to the transformer or to the motor. When the secondary control means has taken over the regulation of the furnace by reason of the interruption of the electrical power supply, the motor 18 will, of course, be inoperative and the flow of air through the furnace will be materially reduced and consequently the furnace will be less effective in delivering heat than where the motor is in operation. The calibration of the member 43 to provide for the delivery of the maximum amount of gas to the burner is such as to avoid extreme furnace temperatures which are considered dangerous and

thus, by reason of the secondary control means, the furnace will operate at "high" and "low" flame automatically but safely. The provision of the cooperating by-passes in the valves 34 and 35, as stated above, provides for a low flame at the burner notwithstanding that both valves 34 and 35 are closed and hence in cold winter weather, with a motor 18 in operation, the supply of heat to the space being heated never completely terminates. As a result of the normally continuous movement of the cool air from the space being heated through the furnace and back to the space in conjunction with the high-low flame of the burner there is avoided the stratification of the cold and warmer air which is often noticeable where prior control systems of the type above mentioned are employed. As stated, the supply of some heat by reason of the low flame of the burner, notwithstanding that the circuit of the wall thermostat may be open reduces the rate of temperature fall in the space being heated and thus provides a more comfortable average temperature in such space.

Not only does the described secondary control system provide for automatic regulation of the furnace in the event of failure of the primary system to control the operation of the furnace, but the secondary system functions as a modulating means for reducing the temperature of the air delivered to the register or registers of the heated space. The regulating valve 35 even when set to the fully open position by adjustment of the member 43 will begin to close when the temperature of the air affecting the bulb 41 reaches a predetermined maximum determined by the calibration of the adjusting member, preferably about 212 degrees F. Hence notwithstanding the fact that the wall thermostat 37 is calling for heat, if the temperature of the air passing the bulb 41 into the hot air distributing duct 22 rises to the maximum predetermined by the adjustment of the member 43, the valve 35 will reduce the flow of gas to the furnace and prevent further rise in the temperature of the delivered air. Thus if the wall thermostat 37 should be affected by cold air from an open window, and maintain the valve 34 open, the modulating valve will begin to reduce the flow of gas to the burner when the air sweeping past the bulb 41 reaches a predetermined temperature.

If a gas-fired furnace not equipped with the present improvements is designed to supply heated air to six wall registers, for example, and several of the registers should be closed, a reduced volume of air will flow through the furnace but the thermostat might continue to call for heat after the temperature of the air issuing from the open register or registers has become dangerously high or until the high limit switch 45 has opened and cause the gas valve 34 to close, thereby interrupting the supply of heat. With the present modulating control means incorporated in the composite furnace control, the temperature of the air at the registers will not rise above that permitted by the setting of the valve 35. Such modulating action of the valve 35 is effective at temperatures below that at which the high temperature switch 45 will open the control circuit of the valve 34. The closure of the valve 34 reduces the flame to "low" or such as is supported by the volume of gas flowing through the by-pass 40 which materially reduces the delivery of heat to the heated space. Such reduction of heat would occur by the opening of the safety switch 45 but where the improved

modulating means are employed in conjunction with the primary control system, the adjustable member 43 of valve 35 can be set so as to reduce the size of the gas flame and so prevent a rise in furnace temperature such as will effect the opening of the switch 45. The modulating valve can thus assure delivery of a volume of heated air to the heated space at a temperature that varies between that afforded by the high and low flames of the burner and, while avoiding dangerous furnace temperatures as well as excessive hot air temperatures at the registers, permits continuous delivery of heat to the heated space.

For the purpose of reducing the rate of recirculation of air through the furnace during periods of low flame, the modified structure shown somewhat diagrammatically in Fig. 4 has been provided. In this structure, two blowers 49 and 50 are provided, operable by motors 51, 52 respectively. One of the motors, such as motor 51, is a continuously operable motor and is energized so long as the main switch S is closed. The motor 52 is turned on and off by a relay 53 which is closed to start the motor whenever the wall thermostat is closed and is opened when the wall thermostat opens. The control of the motor 52 by the wall thermostat provides for the delivery of the maximum volume of air to the furnace whenever the primary control circuit has opened the valve 34 and the flame is high, that is, the maximum flame or a flame that has been modulated by the secondary control means. With the dual blower structure, a reduced volume of air is forced through the furnace at low flame, that is, whenever the wall thermostat has effected the closure of the valve 34. The reduced rate of flow of air through the furnace at low flame insures higher temperature of the air issuing from the register or registers during such periods and avoids the cooling of the furnace to the point where the air issuing from the registers will be uncomfortably cool to those sitting close to the registers.

It will be understood from the above description that the improved gas-fired furnace control means comprises, in combination, a primary control means consisting of a conventional wall thermostat and a known gas control valve that is moved to open or closed position by the closing and opening of the thermostat, which valve however has been provided with a by-pass, such as indicated at 40 in Fig. 2, to provide for a low flame even when the thermostat is not calling for heat and a secondary or modulating control means that can take over the automatic control of the furnace in the event of the failure of the primary control means and which also can effect a modulation of the flame when said gas control valve is open. Such modulating action of the high flame not only provides a safety factor by avoiding overheating of the furnace and excessive heating of the air delivered to the registers but the modulating means may reduce the size of the flame in the furnace gradually as the temperature of the air passing through the furnace reaches a predetermined degree notwithstanding that the wall thermostat is calling for heat and thus prolong the periods of operation of the furnace between the low flame periods and providing a more stable temperature level in the heated space.

By means of the composite control means provided, a more uniform supply of heat to the heated space can be provided which is especially

desirable in severe winter weather. For example, let it be assumed that it is desirable to maintain the temperature of the space at approximately 72° F. The wall thermostat 37 may be set to open at a few degrees above 72°, say 75°, and the adjustable member 43 of valve 35 can be adjusted to become operable when the temperature of the furnace is correlative to heated space temperature of 72°. When the temperature of the space rises to 72°, the valve 35 will begin to close for modulating the flame at the burner whereby the temperature of the space will not rise above 72° unless the weather should moderate, in which case the temperature of the space will rise and at 75° the wall thermostat would open and effect closure of the valve 34 and reduce the gas supply to provide a low flame. The effect of modulating the flame, as described, at a temperature below the setting of the cut-out temperature of the wall thermostat is to prolong the periods of operation of the furnace at a heat releasing rate above that provided by the low flame and thereby maintain a more uniform average temperature in the heated space. The improved control thus provides not only a high-low flame operation of the burner but effects modulation of the high flame to intermediate flames which provide less heat than the high flame but more heat than the low flame. Likewise, the secondary control system functions as a safety control for the furnace when it is under the regulation of the primary control means and can take over the control of the furnace upon failure of the primary control means to function as intended. During such periods of inoperability of the blowers as during interruption of electrical power to the primary control means, it is desirable to remove the filters to insure better gravity circulation of the air during sole control by the secondary system.

When the valve member 35 is set at a relatively high temperature and the wall thermostat is set at a relatively low cut-out temperature whereby the modulating means does not become effective, the furnace will be controlled only by the primary control means and under such conditions of operation, the high-low flame arrangement described, in conjunction with the dual blower arrangement shown in Fig. 4 providing for maximum circulation at high flame and minimum circulation at low flame, provides a supply of heat sufficiently uniform in moderate weather as to avoid the discomforts resulting from the stratification above described.

While I have shown and described the presently preferred structure of the improved composite furnace control means, changes may be made therein within the spirit of the invention defined by the following claims.

I claim:

1. In combination with a gas fired hot air furnace provided with a gas burner, a gas line for supplying gas thereto, a primary control means for the gas comprising an electrically controlled self-closing valve having a by-pass opening and movable to open position under electrical influence of a thermostat, a wall thermostat located in the heated space served by the furnace for controlling the operation of said valve to open position to provide a maximum gas flame, a high temperature safety switch located in said furnace and responsive to excess temperatures therein, said safety switch being electrically connected to said self-closing valve and thermostat and operable to close

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said valve in the event of mechanical failure of said thermostat, said valve being manually operable to a latched open position whereby gas can be supplied to the burner during periods of interruption of electrical current to the control means, a secondary control means comprising a second valve in said gas line located between said first valve and said burner, heat responsive means located at the furnace outlet for the heated air for effecting adjustment of said second valve responsive to temperatures of the heated air issuing from the furnace for varying the flow of gas through said second valve to effect modulation of the burner flame during periods when the first mentioned valve is maintained open through manual control, and by-pass means in said second valve cooperating with said first mentioned by-pass for supplying gas to the burner when either or both valves are closed.

2. In a gas fired furnace as set forth in claim 1,

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means for circulating air to be heated through the furnace at a maximum rate during periods of high flame and at a reduced rate during a period of low flame.

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