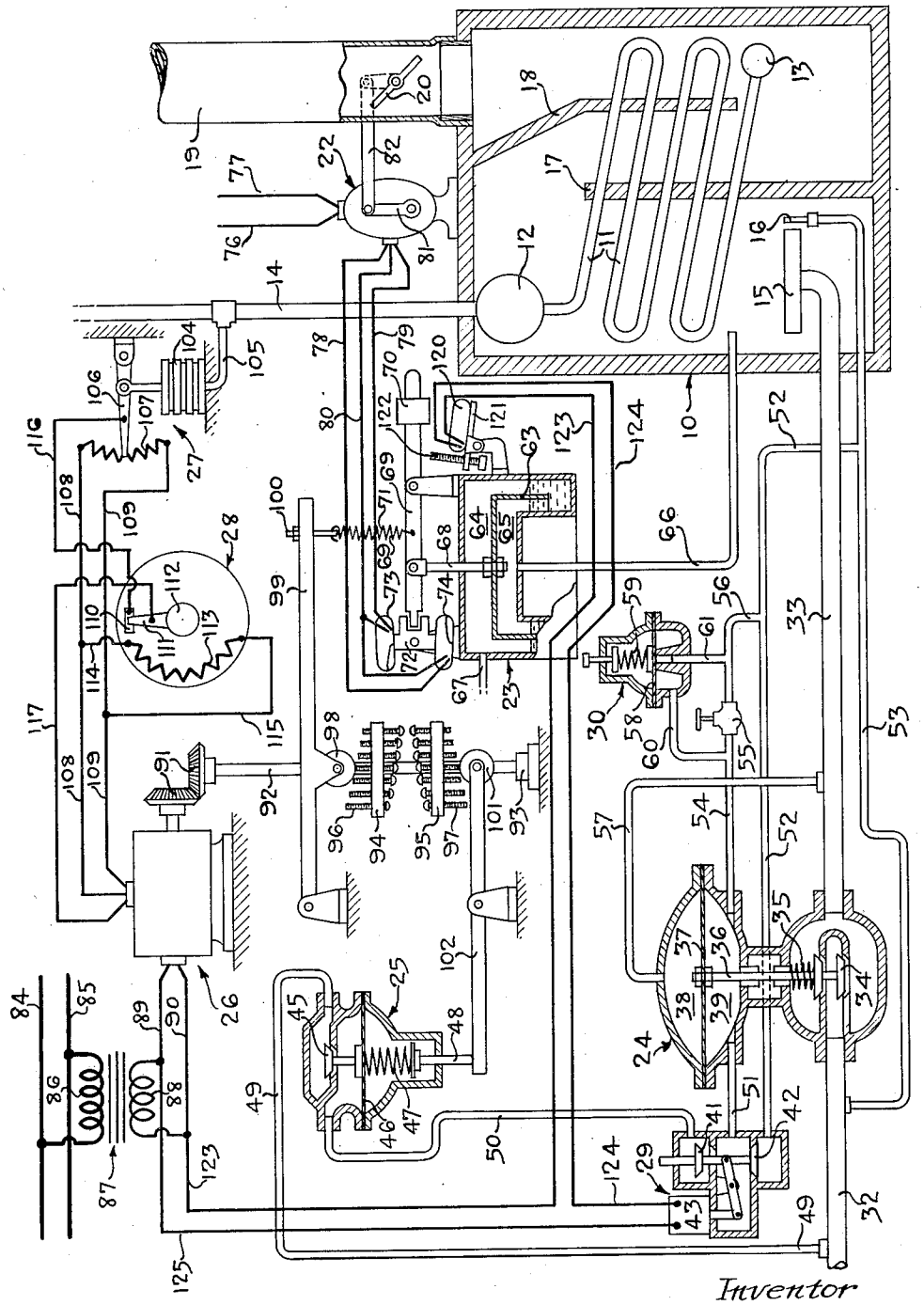
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COMBUSTION CONTROL SYSTEM

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COMBUSTION CONTROL SYSTEM

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This invention relates to combustion control systems and an object of this invention is to provide a combustion control system of unique construction wherein the proportionate amounts of gas and air may be suitably adjusted to maintain desired combustion conditions, wherein the rate of combustion may be automatically controlled in accordance with the load on the boiler or manually controlled, wherein the supply of gas to the main burner is shut off when the draft through the boiler becomes dangerously low and wherein the supply of gas to the main burner at dangerously high pressures is prevented.

The structure of the elements and the combination of the elements that perform this mode of operation also form objects of this invention.

Other objects and advantages will become apparent to those skilled in the art upon reference to the accompanying specification, claims and drawing.

For a more thorough understanding of this invention reference is made to the accompanying single sheet of drawings, in which is diagrammatically disclosed the preferred form of my invention.

A boiler is generally designated at 10, and this boiler may include water tubes 11, a steam header 12 and a water header 13. Steam may be drawn from the steam header 12 through a suitable pipe 14 which leads to a point of use. The boiler is shown to be fired by a gas burner 15 which may be ignited by a continually operating pilot burner 16. The gases of combustion flow over the water tubes 11 through passes in the boiler formed by suitable baffles 17 and 18. The gases of combustion are taken from the boiler 10 by a suitable stack 19 and located in the stack 19 is a draft damper 20 which is adapted to be moved to a plurality of positions to control the draft through the boiler 10.

The draft damper 20 is adapted to be positioned by a floating motor generally designated at 22. This type of motor is old in the art and therefore a complete description thereof is not considered necessary. The floating motor 22 is controlled by a draft regulator generally designated at 23. This regulator 23 may be positioned in accordance with the static pressure existing within the boiler 10 or in accordance with the rate of flow of the gases of combustion through the boiler 10. The supply of gas to the gas burner 15 is controlled by a diaphragm gas valve generally designated at 24, and this diaphragm gas valve 24 is adjustably positioned by a pilot regulator generally designated at 25. The pilot regulator 25 and the static pressure regulator 23 are adjusted by a proportioning motor generally designated at 26. The proportioning motor 26 may be of the type shown and described in Patent No. 1,989,972 granted to Lewis L. Cunningham on February 5, 1935. The proportioning motor 26 may be positioned in any number of a plurality of positions by means of a pressure controller generally designated at 27 or by a manual controller generally designated at 28.

A three-way solenoid valve generally designated at 29 is adapted to close the diaphragm gas valve 24 to shut off the supply of gas to the burner 15 when the draft within the boiler 10 decreases to a predetermined value of when the rate of flow of the gases of combustion through the boiler 10 decreases to a predetermined value. A burner pressure safety controller generally designated at 30 controls the diaphragm gas valve 24 to prevent the gas pressure at the burner 15 from rising above a predetermined value.

A pipe 32 connecting into the diaphragm gas valve 24 conveys gas from some source, not shown, to the diaphragm gas valve 24. A pipe 33 connects the diaphragm gas valve 24 to the burner 15 to supply gas to the burner 15 when the valve 34 of the diaphragm gas valve 24 is opened. The valve 34 is biased to a closed position by a compression spring 35 and is connected by a rod 36 to a diaphragm 37 which forms an upper pressure chamber 38 and a lower pressure chamber 39.

The three-way solenoid valve 29 may comprise valves 41 and 42 operated by a solenoid 43, the arrangement being such that when the solenoid 43 is deenergized the valve 41 is open and the valve 42 is closed as shown in the drawing and when the solenoid 43 is energized the valve 41 is closed and the valve 42 is open. The pilot regulator 25 may comprise a valve 45 operated by a diaphragm 46. The valve 45 is biased towards an open position by means of a spring 47 which may be adjusted by means of a plunger 48.

Pipe 49 connects the gas supply pipe 32 to the pilot regulator 25 and the pilot regulator 25 is in turn connected by a pipe 50 to the upper portion of the three-way solenoid valve 29. The middle portion of the solenoid valve 29 is connected by a pipe 51 to the pressure chamber 39 of the diaphragm gas valve 24. The lower portion of the three-way solenoid valve 29 is connected by a pipe 52 to the pipe 53 which supplies gas to the pilot burner 16 from the gas supply line 32. The pressure chamber 39 of the diaphragm gas valve 24 is also connected by a pipe

54, an adjustable orifice 55 and a pipe 56 to the pipe 52. The pressure chamber 38 of the diaphragm gas valve 24 is connected by a pipe 57 to the pipe 33 which delivers gas to the main burner 15.

The burner pressure safety control device 30 may comprise a combined diaphragm and valve 58 which is biased to a closed position by means of an adjustable compression spring 59. Pipes 60 and 61 place this burner pressure safety control device 30 in parallel with the adjustable orifice 55.

High pressure gas is delivered through the pipe 49 to the pilot regulator 25 and this pilot regulator 25 supplies gas at a constant pressure through the pipe 50, the three-way solenoid valve 29 and the pipe 51 to the pressure chamber 39 of the diaphragm gas valve 24. The pressure at which gas is supplied to this pressure chamber 39 may be adjusted by varying the compression in the spring 47, the arrangement being such that as the plunger 48 is moved upwardly to increase the compression in the spring 47 the pressure of the gas delivered to the pressure chamber 39 of the diaphragm gas valve 24 is increased. Gas is bled from the pressure chamber 39 of the diaphragm gas valve 24 through the pipe 54, the adjustable orifice 55, pipes 56, 52 and 53 to the pilot burner 16, and for a given setting of the adjustable orifice 55 the bleeding action is maintained substantially constant. Therefore, this controlled pressure in the pressure chamber 39 acts to bias the valve 34 towards an open position, the amount of biasing being dependent upon the pressure existing within the pressure chamber 39. Gas from the downstream side of the diaphragm gas valve 24 is supplied to the upper pressure chamber 38 thereof, and by reason of this gas pressure existing within the upper chamber 38 a pressure regulating action is obtained. Due to the above construction, with a given position of the plunger 48 of the pilot regulator 25, gas is supplied to the gas burner 15 at a constant pressure and by moving the plunger 48 of the pilot regulator 25 the pressure at which the gas is supplied to the main burner 15 may be adjusted.

Energization of the solenoid 43 closes the valve 41 and opens the valve 42 of the three-way valve 29, which stops the supply of gas to the lower pressure chamber 39 and connects this pressure chamber 39 through pipe 51, valve 42 and pipes 52 and 53 to the pilot burner 16 whereby the biasing or valve opening action of the pressure chamber 39 is immediately rendered ineffective and the valve 34 is closed by the spring 35. Three-way solenoid valve 29, therefore, acts as a safety device to cause closing of the valve 34 to stop the supply of gas to the gas burner 15 whenever the solenoid 43 is energized.

When the pressure in the pressure chamber 39 of the diaphragm gas valve 24 rises above a predetermined value as determined by the compression spring 59 of the burner pressure safety control device 30, the diaphragm 58 thereof is moved upwardly to establish direct communication between the pressure chamber 39 and the pilot burner 16 around the adjustable orifice 55. Therefore, when the pressure in the pressure chamber 39 rises above a predetermined value the adjustable orifice 55 is shunted to immediately relieve the pressure in the pressure chamber 39. This prevents the occurrence of undue pressures within the pressure chamber 39 of the diaphragm gas valve 34 whereby gas at too high a pressure is prevented from being delivered to the gas burner 15.

The static pressure regulator 23 comprises an enclosed chamber having an inverted bell 63 suspended therein. The bell 63 is sealed by a suitable liquid to define an upper chamber 64 and a lower chamber 65. If it be desired to operate the regulator 23 in accordance with the static pressure or vacuum in the boiler 10, the lower pressure chamber 65 is connected by a pipe 66 to a point adjacent the burner 15 in the boiler 10. If it is desired to operate the regulator 23 in accordance with the rate of flow of gases of combustion through the boiler 10, the pipe 66 is extended to a point in the furnace adjacent the stack 19 and a pipe 67 leading from the upper pressure chamber 64 is adapted to extend to a point adjacent the gas burner 15 in the boiler 10. The inverted bell 64 is suspended by a rod 68 which is in turn secured to a pivoted lever 69. The pivoted lever 69 is biased in one direction by means of a weight 70 and a tension spring 71. The weight 70 and the tension spring 71 tend to urge the bell 63 upwardly. If the regulator 23 is used as a static pressure regulator the static pressure or vacuum in the boiler 10 urges the bell 63 downwardly against the action of the biasing means, the arrangement being such that as the static pressure decreases (as the vacuum increases) the bell 63 is moved downwardly. As the static pressure increases (as the vacuum decreases) the bell 63 is moved upwardly by the biasing means 70 and 71. If the regulator 23 is used as a rate of flow regulator, an increase in the rate of flow causes downward movement of the bell 63 against the action of the biasing means 70 and 71 and a decrease in the rate of flow allows upward movement of the bell 63 by the biasing means 70 and 71. The lever 69 operates a pivoted switch carrier 72 which carries mercury switches 73 and 74. The arrangement is such that as the bell 63 is moved downwardly in response to an increase in draft as caused by an increase in vacuum or as caused by an increase in the rate of flow of gases of combustion, the switch 73 is closed and when the bell 64 moves upwardly in response to a decrease in draft, the switch 74 is closed. When the correct draft as determined by the correct vacuum or the correct rate of flow of gases of combustion is existing within the boiler 10, the mercury switches 73 and 74 are maintained in the positions shown in the drawing, whereby the circuits therethrough are broken.

Power is supplied to the floating motor 22 by means of line wires 76 and 77 leading from some source of power, not shown. The floating motor 22 is connected by wires 78 and 79 to the mercury switches 74 and 73, respectively. The floating motor 22 is also connected by a wire 80 to both of the mercury switches 72 and 73. The floating motor 22 is adapted to operate the draft damper 20 through a crank 81 and a connecting rod 82. When the draft in the boiler 10 increases, the mercury switch 73 is moved to a closed position to complete a circuit for the floating motor 22 through the switch 73 and the wires 79 and 80 to operate the floating motor 22 to move the draft damper 20 towards a closed position to decrease the draft in the boiler 10. A decrease in the draft in the boiler 10 causes movement of the mercury switch 74 to a circuit closing position to complete a circuit therethrough and the wires 78 and 80 to operate the floating motor 22 to move the damper 20 towards an open position to in-

crease the draft in the boiler 10. Since the floating motor 22 is slow-acting, a condition of equilibrium will arise which maintains the mercury switches 73 and 74 in circuit-breaking positions whereby the draft damper 20 is positioned to maintain the desired draft in the boiler 10. The values of the vacuum or the values of the rate of flow of the gases of combustion in the boiler 10 may be adjusted by varying the tension in the biasing spring 71. Specifically, increasing the tension in the biasing spring 71 increases the value of the vacuum or the value of the rate of flow of the gases of combustion in the boiler 10. Vice versa, decreasing the tension in the biasing spring 71 decreases the values of the vacuum or the rate of flow of the gases of combustion in the boiler 10.

Line wires leading from some source of power, not shown, are designated at 84 and 85. The primary 86 of a step-down transformer 87 having a secondary 88 is connected across the line wires 84 and 85. The secondary 88 is connected by wires 89 and 90 to the proportioning motor 26 to supply electrical energy thereto. The proportioning motor 26 positions through suitable gearing 91 a rotatable shaft 92 which carries discs 94 and 95. The discs 94 and 95 are provided with a plurality of adjustable screws 96 and 97, respectively. The adjustable screws 96 and 97 provide adjustable cams in the manner shown in the drawing. The adjustable screws 96 operate a roller 98 carried by a pivoted lever 99 to which is connected by a suitable nut and screw arrangement 100 the biasing spring 71. Rotation of the shaft 92, therefore, causes adjustment of the biasing spring 71. The adjustable screws 97 operate a follower in the form of a roller 101 which is carried by a pivoted lever 102 which in turn abuts the plunger 48 of the pilot regulator 25. Rotation, therefore, of the shaft 92 causes movement of the plunger 48 of the pilot regulator 25 to adjust the gas pressures being delivered to the main burner 15.

The pressure regulator generally designated at 27 may comprise a pressure bellows 104 connected by a pipe 105 to the steam pipe 14 and this bellows 104 is adapted to operate a slider 106 with respect to a potentiometer coil 107. The arrangement is such that as the pressure increases the slider 106 is moved upwardly with respect to the potentiometer coil 107 and as the pressure decreases the slider 106 is moved downwardly. The ends of the potentiometer coil 107 are connected by wires 108 and 109 to the proportioning motor 26. The manual controller generally designated at 28 comprises a contact 110, a slider 111 operated by a suitable knob 112 and a potentiometer coil 113. The slider 111 is adapted to engage the contact 110 or the potentiometer coil 113. The ends of the potentiometer coil 113 are connected by wires 114 and 115 to the wires 108 and 109 leading to the proportioning motor 26. The slider 106 of the pressure controller 27 is connected by a wire 116 to the contact 110 of the manual controller 28 and the slider 111 thereof is connected by a wire 117 to the proportioning motor 26.

With the manual controller 28 in the position shown in the drawing, the potentiometer operated by the pressure controller 27 is connected to the proportioning motor 26 in the manner disclosed in the above Cunningham patent. Upon an increase in pressure, the proportioning motor 26 is positioned in accordance with this increase to proportionately position the shaft 92 to decrease the tension in the spring 71 and decrease the compression in the spring 47 of the pilot regulator 25. This causes a decrease in the pressure of the gas being delivered to the gas burner 15 and a decrease in vacuum or rate of flow of the gases of combustion through the boiler 10. This allows the steam pressure to decrease to the desired value. When the steam pressure decreases, the slider 106 is moved downwardly with respect to the potentiometer coil 107 to operate the proportioning motor 26, which proportionately positions the shaft 92 in such a manner as to increase the tension in the spring 71 and increase the compression in the spring 47, the amount of increase in this tension and compression of the springs 71 and 47 being proportionate to the amount that the steam pressure lowers from the desired value. Increasing of the tension in the spring 71 in this manner increases the vacuum or the rate of flow of gases of combustion in the boiler 10 and increasing of the compression of the spring 47 proportionately increases the gas pressure of the gas being delivered to the gas burner 15. This increase in gas pressure and this increase in rate of flow of the gases through the boiler 10 raises the steam pressure to the desired value.

Movement of the slider 111 of the manual controller from the contact 110 into engagement with the potentiometer coil 113, breaks the connection between the slider 106 of the pressure controller 27 and the proportioning motor 26 thereby rendering the pressure controller 27 inoperative to control the proportioning motor 26. This also places the proportioning motor under the control of the manual controller 28 and movement of the slider 111 with respect to the potentiometer coil 113 causes operation of the proportioning motor 26 in the same manner as does movement of the slider 106 with respect to the potentiometer coil 107 of the pressure controller 27. In this manner, automatic control of the proportioning motor 26 is prevented and the proportioning motor 26 may be positioned manually.

The pivoted lever 69 of the draft regulator 23 is also adapted to operate a mercury switch 120 which is carried by a pivoted lever 121. The pivoted lever 121 also carries an adjustable screw 122 which is adapted to be engaged by the pivoted lever 69. The arrangement is such that when the vacuum decreases to a given value or when the rate of flow of the gases of combustion through the boiler 10 decreases to a predetermined value, the mercury switch 120 is tilted to a circuit-making position. This causes completion of a circuit from the secondary 88 through wire 123, mercury switch 120, wire 124, solenoid 43 and wire 125 back to the secondary 88. Completion of this circuit causes energization of the solenoid 43 to operate the three-way valve 29 to decrease the pressure in the pressure chamber 39 of the diaphragm gas valve 24 to stop the supply of gas to the main gas burner 15. Therefore whenever the draft through the boiler 10 becomes dangerously low, the supply of gas to the gas burner 15 is shut off.

By suitably adjusting the screws 96 and 97 forming the adjustable cams, the gas and air supplied to the boiler 10 may be proportioned with respect to each other so as to maintain a desired CO_2 content in the gases of combustion.

From the above it is seen that I have provided a combustion control system of unique construction wherein the proportionate amounts of gas

and air may be suitably adjusted to maintain desired combustion conditions, wherein the rate of combustion may be automatically controlled in accordance with the load on the boiler or manually controlled, wherein the supply of gas to the main burner is shut off when the draft through the boiler becomes dangerously low and wherein the supply of gas to the main burner at dangerously high pressure values is prevented.

Although I have shown for purposes of illustration one form of my invention, my invention is not to be limited thereby but is to be limited only by the scope of the appended claims and prior art.

I claim as my invention:

1. In a combustion control system, the combination of a furnace having fuel supplying means and draft regulating means, an adjustable controller responsive to the rate of fuel supply in control of said fuel supplying means, an adjustable controller responsive to the draft in the furnace in control of said draft regulating means, said controllers being adjusted with respect to each other for maintaining desired ratios of fuel supply and draft, automatic means responsive to a condition for simultaneously adjusting both controllers to increase or decrease the rate of combustion, said automatic means comprising cam means whereby said ratios can be maintained at desired values over a wide range of values of said condition.

2. In a combustion control system, the combination of a furnace having fuel supplying means and draft regulating means, an adjustable controller responsive to the rate of fuel supply in control of said fuel supplying means, an adjustable controller responsive to the draft in the furnace in control of said draft regulating means, said controllers being adjusted with respect to each other for maintaining desired ratios of fuel supply and draft, automatic means responsive to a condition for simultaneously adjusting both controllers to increase or decrease the rate of combustion, said automatic means comprising a cam and a manual adjustment therefor, said means being manually adjustable while automatically adjusting said controllers and manually operated means comprising a switch for rendering said automatic means inoperative and for manually controlling both controllers.

3. In a combustion control system, the combination of a furnace having fuel supplying means comprising an adjustable pressure regulator and draft regulating means, an adjustable controller responsive to the rate of fuel supply in control of said fuel supplying means, an adjustable controller responsive to the draft in the furnace in control of said draft regulating means, said controllers being adjusted with respect to each other for maintaining desired ratios of fuel supply and draft, automatic means responsive to a condition for simultaneously adjusting both controllers to increase or decrease the rate of combustion, means operative to move said pressure regulator in closing direction for preventing the supply of an excess quantity of fuel, and means responsive to a decrease in draft for stopping the supply of fuel to said furnace by closing said pressure regulator.

4. In a combustion control system, the combination of a furnace having fuel supplying means and draft regulating means, an adjustable controller in control of said fuel supplying means, an adjustable controller in control of said draft regulating means, said controllers being adjusted with respect to each other for maintaining desired ratios of fuel supply and draft, manually adjustable cam means for adjusting said first mentioned controller, manually adjustable cam means for adjusting said second mentioned controller, and automatic means responsive to a condition for operating said cam means whereby said manually adjustable controllers are adjusted to increase or decrease the rate of combustion, said manually adjustable cam means providing adjustments whereby responses transmitted by said cam means when operated by said condition responsive means can be varied.

5. In a combustion control system, the combination of a furnace having fuel supplying means and draft regulating means, an adjustable controller in control of said fuel supplying means, an adjustable controller in control of said draft regulating means, said controllers being adjusted with respect to each other for maintaining desired ratios of fuel supply and draft, an adjustable cam means for adjusting said first mentioned controller, an adjustable cam means for adjusting said second mentioned controller, automatic means responsive to a condition for operating said cam means whereby said controllers are adjusted to increase or decrease the rate of combustion in accordance with changes in the condition by proportionately varying the draft and the supply of fuel, means for preventing the supply of an excess quantity of fuel, and means responsive to a decrease in draft for stopping the supply of fuel to said furnace.

6. In a combustion control system, the combination of a furnace having a burner for gaseous fuel and a draft damper, an adjustable pressure regulator in control of the supply of fuel to said burner, power means for operating said draft damper, an adjustable pressure responsive controller in control of said power means, control means for adjusting said pressure regulator and said pressure responsive controller, automatic means responsive to changes in a condition for controlling said control means whereby the rate of combustion is varied in accordance with changes in the condition by proportionately varying the draft and the supply of fuel, and means for moving said pressure regulator to a closed position when the draft decreases to a predetermined value.

7. In a combustion control system, the combination of a furnace having a burner for gaseous fuel and a draft damper, an adjustable pressure regulator in control of the supply of fuel to said burner, power means for operating said draft damper, an adjustable pressure responsive controller in control of said power means, control means for adjusting said pressure regulator and said pressure responsive controller, automatic means responsive to changes in a condition for controlling said control means whereby the rate of combustion is varied in accordance with changes in the condition by proportionately varying the draft and the supply of fuel, means for moving said pressure regulator to a closed position when the draft decreases to a predetermined value, and means for preventing the pressure of the gaseous fuel at the burner from exceeding a predetermined value.

8. In a combustion control system, the combination of a furnace having a burner for gaseous fuel and a draft damper, an adjustable pressure regulator in control of the supply of fuel to said burner, power means for operating said draft damper, an adjustable pressure controller in con-

trol of said power means, manually adjustable cam means for adjusting said pressure regulator, an adjustable cam means for adjusting said pressure controller, and means responsive to changes in a condition for simultaneously operating said manually adjustable cam means whereby the rate of combustion is varied in accordance with changes in the condition by proportionately varying the draft and the supply of fuel, said manually adjustable cam means providing adjustments whereby the operative relationship between said condition responsive means and said pressure regulator and said power means can be varied.

9. In a combustion control system, the combination of a furnace having a burner for gaseous fuel and a draft damper, an adjustable pressure regulator in control of the supply of fuel to said burner, power means for operating said draft damper, an adjustable pressure controller in control of said power means, an adjustable cam means for adjusting said pressure regulator, an adjustable cam means for adjusting said pressure controller, means responsive to changes in a condition for simultaneously operating said cam means whereby the rate of combustion is varied in accordance with changes in the condition by proportionately varying the draft and the supply of fuel, means for moving said pressure regulator to a closed position when the draft decreases to a predetermined value, and means for preventing the pressure of the gaseous fuel delivered to the burner from exceeding a predetermined value.

DOUGLAS H. ANNIN.

CERTIFICATE OF CORRECTION.

Patent No. 2,197,171. April 16, 1940.

DOUGLAS H. ANNIN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, second column, line 8, claim 4, strike out the words "manually adjustable" and insert the same before "cam means" in line 7, same claim; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 2nd day of July, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.