

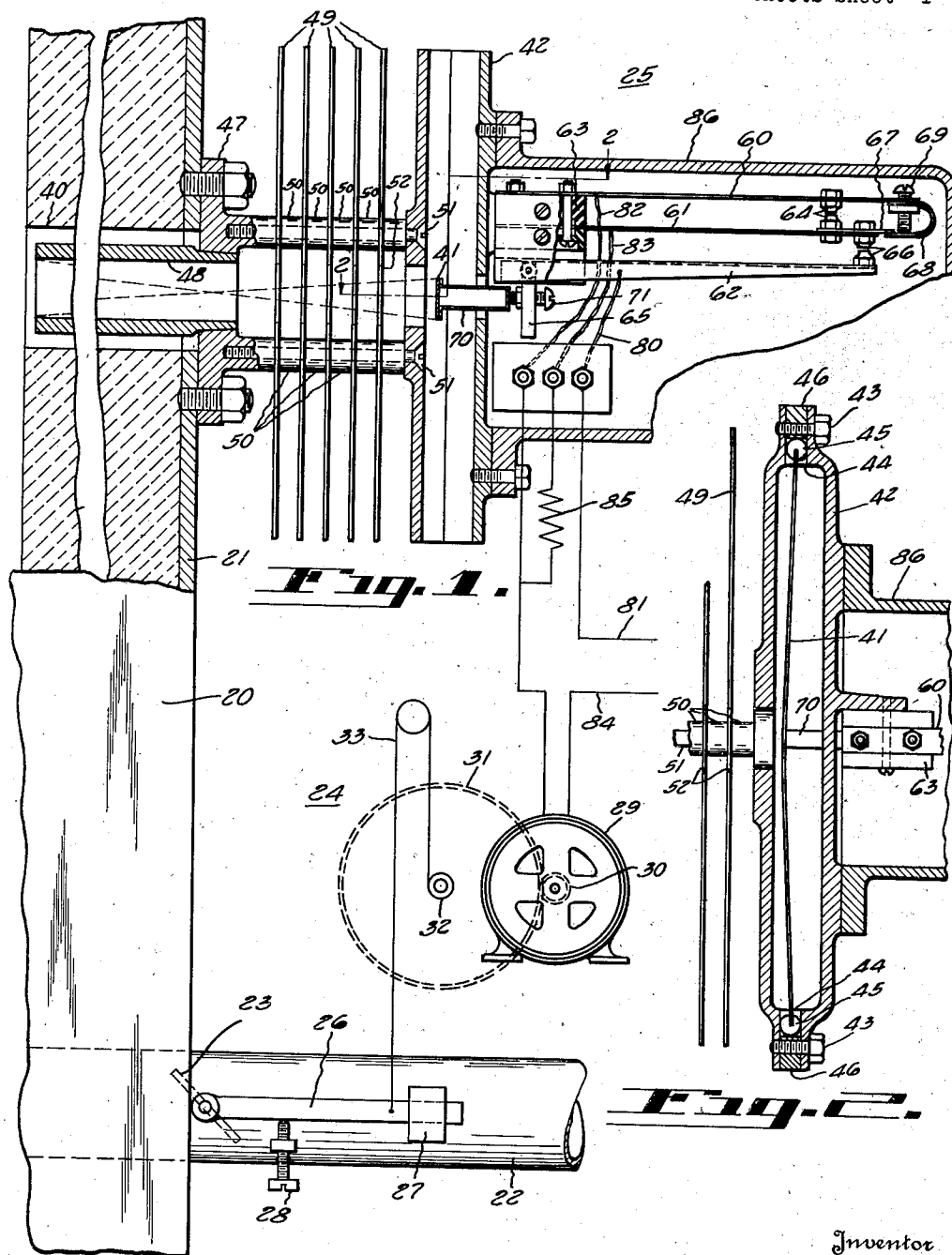
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H. F. SMITH
FURNACE CONTROL

1,697,209

Filed June 15, 1925

2 Sheets-Sheet 1



Inventor

Harry F. Smith

By Morehead and Fehr

Attorney

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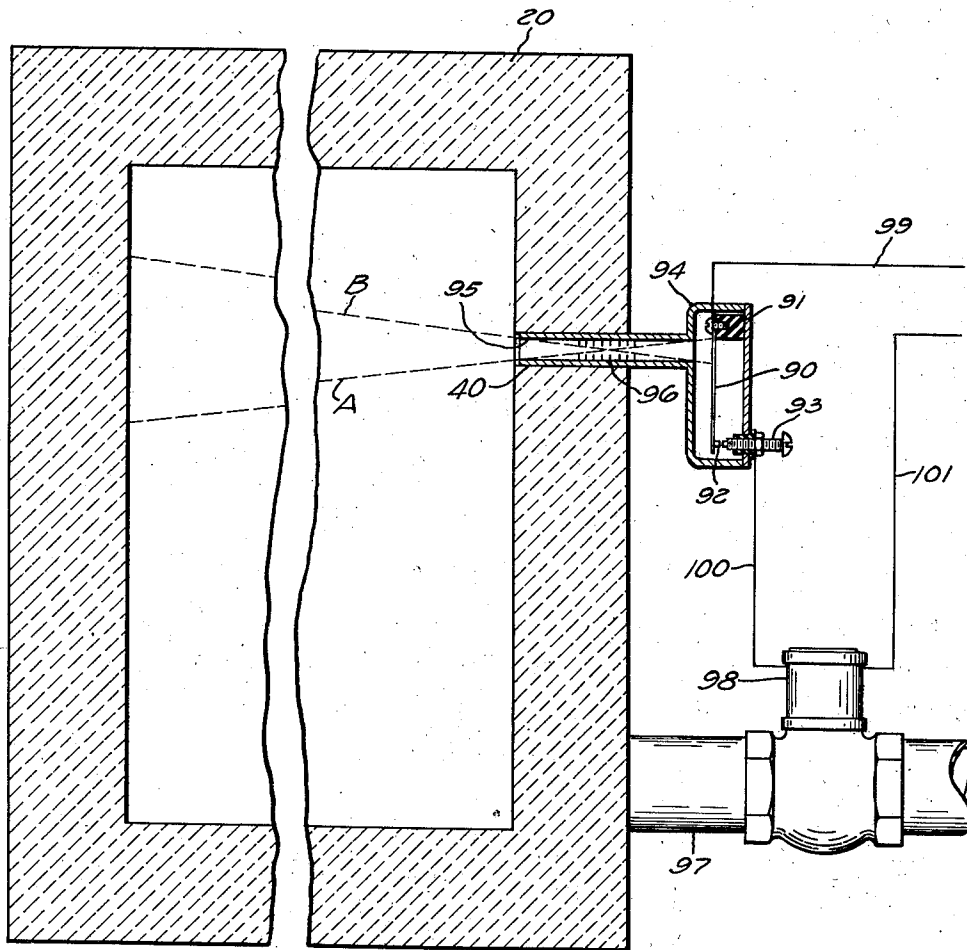
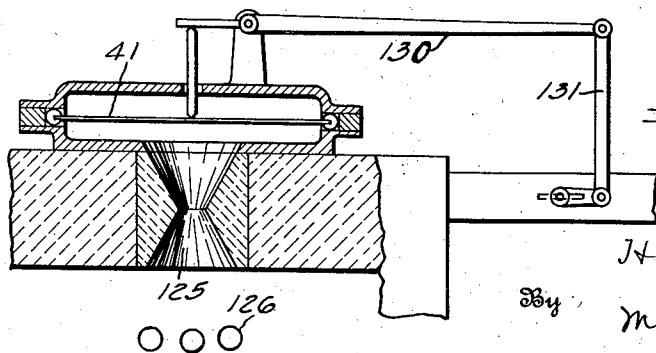
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H. F. SMITH

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2 Sheets-Sheet 2



Inventor

Harry F. Smith

By Marshal and John

Attorney

UNITED STATES PATENT OFFICE.

HARRY F. SMITH, OF DAYTON, OHIO, ASSIGNOR TO THE GAS RESEARCH COMPANY, OF DAYTON, OHIO, A CORPORATION OF OHIO.

FURNACE CONTROL.

Application filed June 15, 1925. Serial No. 37,240.

The present invention relates to temperature or heat responsive mechanism, and particularly to mechanisms of this character adapted to indicate temperature conditions, or as a control for furnaces, ovens, and the like.

One of the principal objects of the invention is to provide a simple and effective temperature responsive mechanism, particularly adapted for indicating temperature conditions, as in a furnace, oven, or the like, and for effective control of one or more of the constituents of the combustion within such a furnace, or the like, to control temperature conditions therein.

Another object of the invention is the provision of a method for controlling furnace temperatures in accordance with the amount of radiant energy emitted from a predetermined heated area within the furnace work chamber; and a simple and effective apparatus for carrying that method into effect.

Other and further objects and advantages of the invention will be apparent from the following description when taken in connection with the accompanying drawings, in which—

Fig. 1 is a somewhat diagrammatic view, partly in elevation and partly in vertical section, of a preferred form of apparatus embodying the present invention;

Fig. 2 is a fragmentary, generally horizontal sectional view taken on the irregular section line 2—2 of Fig. 1;

Fig. 3 shows a modified form of the present invention; and

Fig. 4 shows still another slightly modified form of the invention.

While this invention relates generally to the utilization of radiant energy for effecting temperature indications or control, for purposes of description it is illustrated and described in connection with a gas fired furnace or oven, as embodied in controls for the fuel supply.

Referring to the drawings which show the furnace construction somewhat diagrammatically 20 indicates the wall of the furnace the temperature within which is to be controlled, and 21 designates the furnace shell which is preferably of conventional metallic construction. Fuel, or a mixture of fuel and air, is admitted to the work chamber of the furnace to be burned therein, through the fuel pipe 22. A fuel valve 23 pivotally supported in the fuel supply pipe 22 may be opened or closed

to increase or decrease the amount of fuel supplied to the furnace. The fuel valve is controlled by the valve operating means designated as a whole by the reference character 24, and the valve operating means is in turn controlled by the temperature responsive means, designated as a whole by the reference character 25, which temperature responsive means serves to cause opening or closing of the fuel valve 23 in accordance with the temperature of the furnace.

The valve operating means 24 includes a weight arm 26 secured to the valve 23 and a weight 27 mounted on the weight arm 26, which parts, due to their weight, normally tend to move the valve 23 towards its closed position. Closing movement of the valve is limited by means of an adjustable stop 28. A motor 29 is provided for opening the valve 23 or for holding it in any desired position. The motor operates through any desired speed reducing means such as pinion 30, gear 31, winding drum 32 and flexible cable 33 to raise the weight arm 26, thus opening the valve 23. Of course any other suitable form of reducing gearing may be used.

The motor circuit is provided with a resistance which may, or may not, be included in the motor circuit. The construction of the valve operating means 24 is such that when the circuit is closed through the motor 29, without resistance, the motor operates to cause the flexible cable 33 to be wound on the drum 32 and thereby opens the valve 23 against the resistance of the weighted arm 26. By inserting the resistance in the motor circuit the current through the motor may be so reduced that the motor torque is no longer sufficient to overcome the turning moment of the weighted arm, but will just balance this moment, and the motor will therefore stop and hold the valve 23 in whatever position it might happen to be at the time that the resistance is inserted in the motor circuit. Upon opening the motor circuit the motor armature is free to rotate, and such rotation takes place in a backward or valve-closing direction under the influence of the weighted arm 26. It is apparent that the valve operating mechanism 24 just described may be said to include weight controlled means for moving the valve 23 towards closed position, and motor controlled means for moving the valve towards valve-opening position. Of course in its broadest aspect the motor 29 constitutes

means for controlling the fuel valve, inasmuch as the motor either actively operates the valve or holds the valve in a given position, or permits the valve to move to some other position.

The valve operating means 24 and more particularly the motor 29 thereof, is in turn controlled by temperature controlled means 25, which latter, responding to changes in the furnace temperature, causes the opening or closing of the motor circuit or the insertion of a resistance therein to vary or maintain constant the amount of fuel admitted to the furnace. The furnace is provided adjacent the temperature control means 25 with a port 40 which extends through the furnace wall through which energy may be radiated from the heated furnace wall opposite to the exterior of the furnace. Associated with this port, outside of the furnace, is a form of temperature responsive apparatus which is so arranged and constructed that the radiant energy passing through the port 40 impinges upon a temperature responsive member which is preferably in the form of a bimetallic thermostatic strip 41, which is supported at its ends in a housing 42. The housing consists of front wall and back wall portions which are connected at their lateral vertical edges by suitable fastening means 43. The housing 42 is so formed as to provide a guide slot 44 at each side thereof to receive the ends of the thermostatic strip 41 which latter has secured thereto, at each end a cylinder-like bearing member 45 which is adapted to slide freely in the slot 44 and to permit a free bending movement of the thermostatic strip 41. The slots 44 are closed by stops 46.

The housing 42 is carried by a support 47 adapted to be secured to the outer wall or shell 21 of the furnace 20. The support 47 has a central aperture in which is rigidly secured a tube 48 which is adapted to extend into the port 40 in the furnace wall to any desired depth. Between the front of the support 47 and the housing 42 there is a stack of plates or shields 49 which are held in spaced apart relation by means of spacing washers 50, the housing 42 and plates 49 being rigidly secured to the support 47 by means of fastening bolts 51 which pass through the rear wall of the housing 42, plates 49 and the spacing washers 50. As shown in Fig. 1 the maximum amount of radiant energy impinging upon the thermostatic strip 41 is limited to the energy radiating from that portion of the furnace wall which is included between the diagonal lines, A—B. The amount of radiant energy impinging upon the thermostatic strip 41 depends of course upon the temperature of the interior wall of the furnace, but this amount may be varied as desired by varying the size of the aligned apertures 52 in the plates 49, the size of the aperture through the rear wall

of housing 42, and the size of the tube 48. The parts which limit the included angle between the diagonal dotted lines shown in Fig. 1 may be said to constitute a shield for the thermostatic strip since they shield the strip from undesirable radiation from hot bodies not included within the selected area within the furnace. The outer surface of the tube 48 is preferably polished or otherwise treated, so that it will absorb the minimum amount of radiant energy impinging upon it. And that part of the thermostatic strip upon which the radiant energy impinges is preferably blackened to be a good absorber of radiant energy. The transfer of heat energy by conduction from the tube 48 is also prevented by the use of plates 49 which, as shown, are in direct metallic contact with the tube 48 and so arranged as to receive therebetween air currents, which latter carry off any heat transferred to them either by radiation or conduction. The housing 42 is herein shown as open at both the top and the bottom whereby it forms a chimney for the passage of convection currents which cool the thermostatic strip 41. It will be understood of course that the convection currents through the housing 42 may be controlled as desired by varying the size of the openings at the top and bottom of the housing 42 or omitting either or both of them. The temperature of the thermostatic strip 41 will of course tend to vary somewhat according to the temperature of the air passing through the housing 42, but such variations are, in practice, not sufficiently large to have any materially disturbing effect. This is partly due to the fact that the transfer of heat from the thermostatic strip into the atmosphere varies directly with temperature differential while transfer of heat by radiation from the furnace wall to the thermostatic strip varies as the difference of the fourth powers of the absolute temperature of the hotter body and the absolute temperature of the colder body.

The housing 42 carries on its front wall the electric switch apparatus for controlling the motor circuit, such switch apparatus being itself actuated by the thermostatic strip 41. The switch apparatus consists of an upper spring contact arm 60, a middle spring contact arm 61 and a lower contact arm 62, which is substantially inflexible during operation. Contact arms 60 and 61 are rigidly secured to the insulated supporting block 63 and carry cooperating contact points 64. The lower contact arm 62 is pivotally mounted below contact arm 61 in the insulated supporting block 63, and carries a downwardly extending arm 65 which is rigid with contact arm 62. Arms 61 and 62 carrying cooperating contact points 66. Contact arm 61 is provided at its outer end with a fiber insulating strip 67 which engages the down-turned hook member 68 car-

ried by the outer end of the contact arm 60. The hook member 68 is adjustable, by means of the adjusting screw 69, and limits the downward movement of the arm 61 to vary the clearances between the contact points 64 and 66. The thermostatic strip 41 carries thereon a contactor 70 which is adapted to engage the arm 65 through the adjustable screw 71. Contact arm 62 is connected through wire 80 to one side 81 of the motor circuit. Contact arms 60 and 61 are connected by wires 82 and 83 respectively with the other side 84 of the motor circuit which includes the motor 29. Wire 83 includes a resistance 85.

A cover 86 is secured to the front wall of the housing 42 in order to enclose and protect the contact arms and other mechanism just described.

The operation of the apparatus described as embodying the invention is substantially as follows: The gas valve 23 as shown is in its minimum open position in which it permits the continuous flow to the furnace of not less than the predetermined minimum amount of combustible fuel required for continuous operation of the furnace. Assuming now that the furnace is intended for operation between a predetermined lower and a predetermined upper limit of temperature, and that the furnace temperature has fallen below the upper limit, it will be evident that the curvature or bending of the thermostatic strip 41 will decrease owing to the fall of temperature within the furnace. Such straightening out of the thermostatic strip will result in a movement of the contactor 70 to the right and, if the movement is of sufficient magnitude, the closing of the contact points 66. Upon closing the contact points 66 an electrical circuit will be established through the motor from the wire 81 through wire 80, lower arm 62, contact points 66, middle arm 61, wire 83, resistance 85 and wire 84 to the other side of the circuit. With the resistance 85 in the circuit, the motor torque is not sufficient to actuate the valve 23. Further decrease in the furnace temperature to the lower predetermined limit results in lifting the middle arm 61 from the hook member 68 to cause the circuit to be closed through contact points 64, thereby short circuiting the resistance 85 and causing operation of the motor 29. The speed reducing gearing of the valve actuating means 24 is so constructed and arranged that the motor 29 may operate to slowly open the gas valve 23 to admit more fuel to the furnace until the furnace temperature is restored to the predetermined minimum above mentioned. Upon restoration of the furnace temperature to the predetermined minimum, the thermostatic strip causes separation of the contact points 64 to thereby reinsert the resistance 85 in the motor circuit. The motor torque is now reduced to such an

extent that it is incapable of further opening the valve 23, yet it is strong enough to hold the valve 23 in its open position against the valve-closing tendency of the weighted arm 26. This position of the gas valve 23 is maintained until the furnace temperature reaches the predetermined maximum at which point the thermostatic strip 41 causes separation of the contact points 66 to open the motor circuit. The motor armature is now free to rotate and under the influence of the weighted arm 26 it rotates backwardly thereby permitting closure of the gas valve 23 to its minimum closing position in which the arm 26 abuts the adjustable stop member 28.

Altho the form of the invention herein described embodies motor controlled means for opening the valve 23, and weight controlled means for closing the valve 23, it should be understood that the invention is not limited to this specific arrangement of parts, but that the weight controlled means and the motor controlled means may be reversed or either type of means used to the exclusion of the other type.

Referring now to Fig. 3 which shows a modified form of the invention it will be seen that the temperature responsive means comprises a single thermostatic strip 90 secured at one end to the insulating block 91 and carrying at its free end contact 92 adapted to engage with the contact screw 93 which latter is adjustably mounted in non-conducting relation to the housing 94. The rear wall of the housing 94 has secured thereto a tube 95 adapted to extend into the furnace through the port 40 and provided on its interior with a suitable screen, or plurality of screens, 96 serving to limit the amount of radiant energy impinging upon the thermostatic strip 90 and protecting the latter against radiant energy emanating from points outside of the included angle shown by the dotted lines in Fig. 3. In this form of the invention the fuel pipe 97 is provided with an electro-magnetic valve 98, shown conventionally and of any suitable construction, which is included in the circuit 99, 100 and 101.

In the operation of this form of the invention the thermostatic strip 90 has but two operative positions, one being circuit-closing position and the other being circuit-open position. As the temperature in the furnace falls below the predetermined minimum value the thermostatic strip 90 closes the circuit 99, 100 and 101 to energize the electro-magnetic valve 98 thereby admitting more fuel to the furnace. Upon restoration of the furnace temperature the thermostatic strip 90 causes separation of the contacts 92 and 93 to open the valve circuit and thereby permit the valve to be restored to its minimum valve-opening position.

In Fig. 4 is shown a somewhat modified and differently positioned device. In this form

of the invention the temperature responsive element 41 is located on top the furnace, above a passage 125, which is of minimum diameter midway its length—enlarging each way from this minimum zone. As a result of this arrangement the element 41 is directly responsive to the temperature of the work itself—illustrated diagrammatically at 126. Because of the tapered arrangement of the passage 125 the element is subject to the heating effect of a greater area within the furnace, which makes for a more positive control. As a result the element may act directly upon one end of an operating lever 130, the other end of which is connected by suitable linkage 131 to the control. This gives a direct control of the gas valve without the intervention of electrical apparatus.

A further advantage of the present invention is that the temperature measuring or indicating apparatus is always at normal temperatures on the exterior of the furnace and is not subject to the deterioration and change in calibration as in high-temperature measuring apparatus which is placed within the heated zone of the furnace. In addition the invention is, of course, applicable to controlling any mechanism other than a furnace in accordance with temperature conditions. It is also applicable to the indicating and recording of temperature, heat value of gases, and the like.

From the foregoing it will be apparent that the present invention provides a novel method and apparatus for controlling furnace temperatures and one which is very sensitive owing to the fact that radiation from the luminous surfaces within the furnace varies as the difference of the fourth powers of the temperatures.

What is claimed is:

1. In an apparatus of the character described comprising a furnace adapted to be held within predetermined limits of temperature, means for supplying fuel to the furnace, said means including a valve for variably regulating the rate of supply of the fuel, motor controlled means for operating said valve in one direction of movement, weight controlled means for operating said valve in another direction of movement, said weight control means operating to actuate said valve when said motor circuit is broken, and means responsive to the temperature within said furnace for controlling the operation of said motor controlled means and said weight controlled means.

2. In an apparatus of the character described comprising a furnace adapted to be held within predetermined limits of temperature, means for supplying fuel to the furnace, said means including a valve for regulating the rate of supply of the fuel, motor controlled means for operating said valve to cause valve-opening movement thereof,

weight controlled means for operating said valve to cause valve-closing movement thereof, means responsive to a temperature below a predetermined minimum temperature within said furnace to energize said motor circuit to cause operation of said motor, and means responsive to a temperature above a predetermined maximum temperature within said furnace to break said motor circuit to permit operation of said weight controlled means.

3. In an apparatus of the character described comprising a furnace adapted to be held within predetermined limits of temperature, means for supplying fuel to the furnace, said means including a valve for regulating the rate of supply of the fuel, motor controlled means for operating said valve to cause valve-opening movement thereof, weight controlled means for operating said valve to cause valve-closing movement thereof, means responsive to a temperature below a predetermined minimum temperature within said furnace to fully energize said motor circuit to cause operation of said motor, means responsive to a temperature above a predetermined maximum temperature within said furnace to break said motor circuit to permit operation of said weight controlled means, and means responsive to temperatures within said predetermined minimum and maximum temperatures to energize said motor circuit to a lesser degree to hold said valve in open position against the action of said weight controlled means.

4. In an apparatus of the character described comprising a furnace adapted to be held within predetermined limits of temperature, means for supplying fuel to the furnace, said means including a valve for regulating the rate of supply of the fuel, motor controlled means for operating said valve in one direction of movement, weight controlled means for operating said valve in another direction of movement, and a temperature control means responsive to temperatures within said furnace, said temperature control means including a circuit breaker in said motor circuit, means for closing said circuit breaker to cause operation of said motor when the temperature within said furnace moves beyond one of said predetermined limits, and means for opening said circuit breaker to permit operation of said weight controlled means when the temperature moves beyond the other of said predetermined limits.

5. In an apparatus of the character described comprising a furnace adapted to be held within predetermined limits of temperature, means for supplying fuel to the furnace, said means including a valve for regulating the rate of supply of the fuel, motor controlled means for operating said valve, and means responsive to the temperature of the furnace operative to close a circuit to said motor to cause continuous energizing thereof

while the temperature of the furnace is beyond one of said predetermined limits.

6. In an apparatus of the character described comprising a furnace adapted to be held within predetermined limits of temperature, means for supplying fuel to the furnace said means including a valve for regulating the rate of supply of the fuel, motor controlled means for operating said valve, and means responsive to the temperature of the furnace for controlling the motor, said means including a circuit breaker in said motor circuit adapted to be closed to cause continuous energization of the motor circuit tending to effect one way operation of the valve while the temperature of the furnace is beyond one of said predetermined limits, and a shunt resistance adapted to be connected in said motor circuit to reduce the degree of said energization to arrest such operation upon the restoration of the furnace temperature to said predetermined limit.

7. In an apparatus of the character described, adapted for measuring the temperature of a furnace having a port through the wall thereof, the combination of temperature responsive means actuated by radiant energy, means for supporting said temperature responsive means in position to receive thereon radiant energy radiated through said port from the interior of the furnace, and means for cooling said temperature responsive means.

8. In an apparatus of the character described, adapted for measuring the temperature of a furnace having a port through the wall thereof, the combination of temperature responsive means, means for supporting said temperature responsive means in position to

receive thereon radiant energy radiated through said port from the interior of the furnace and means for preventing undesirable radiation from impinging upon said temperature responsive means, and said last-mentioned means including a plurality of spaced apart screens having an aperture therethrough.

9. In an apparatus of the character described, adapted for measuring the temperature of a furnace, having a port through the wall thereof, the combination of temperature responsive means, a support for the temperature responsive means adapted to be secured to the outer wall of the furnace in position to permit radiant energy radiated through said port to impinge upon the temperature responsive means, means for shielding the temperature responsive device against undesirable radiation also carried by said support, and a tube carried by said support and adapted to project into the port in the furnace wall.

10. In an apparatus of the character described, adapted for measuring the temperature of a furnace, having a port through the wall thereof, the combination of temperature responsive means, a support for the temperature responsive means adapted to be secured to the outer wall of the furnace in position to permit radiant energy radiated through said port to impinge upon the temperature responsive means, a tube positioned in the port in the furnace wall, and heat dissipating members disposed in heat-transferring relation with said tube.

In testimony whereof I hereto affix my signature.

HARRY F. SMITH.