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Midkiff

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[54] **FUEL FEEDING METHOD AND APPARATUS**

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[52] **U.S. Cl.** .... **110/101 CD,** 236/15 B, 73/359

[51] **Int. Cl.** **F23k 3/22**

[58] **Field of Search** .... 110/101 R, 101 CD; 236/15 B; 73/359

[56] **References Cited**

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[57] **ABSTRACT**

The height of a cone, mound, or pile of fuel in the combustion area of a furnace is controlled by arranging a temperature sensor on a portion of a probe normally penetrating the burning fuel. When the fuel burns down sufficiently to expose the sensor to direct heat from the pile, a signal is sent from the sensor to a relay which opens a valve mechanism to feed fuel into the furnace. A timer may be used to limit the amount of fuel delivered.

9 Claims, 4 Drawing Figures

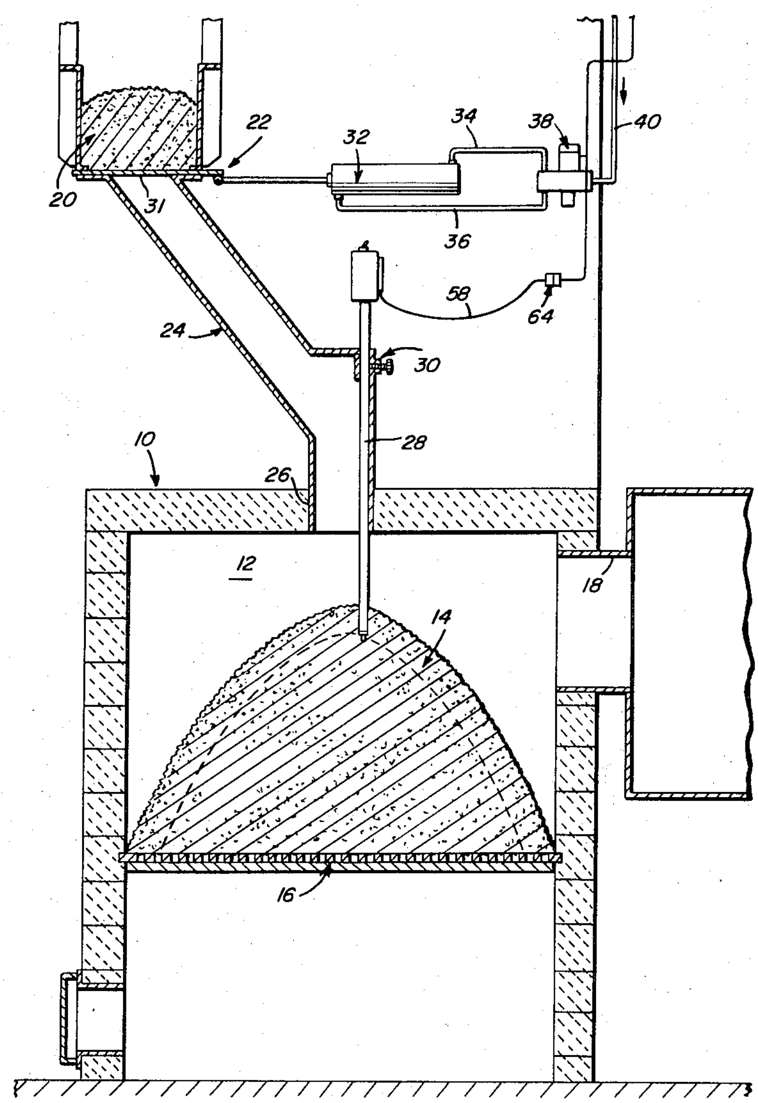


Fig. 1

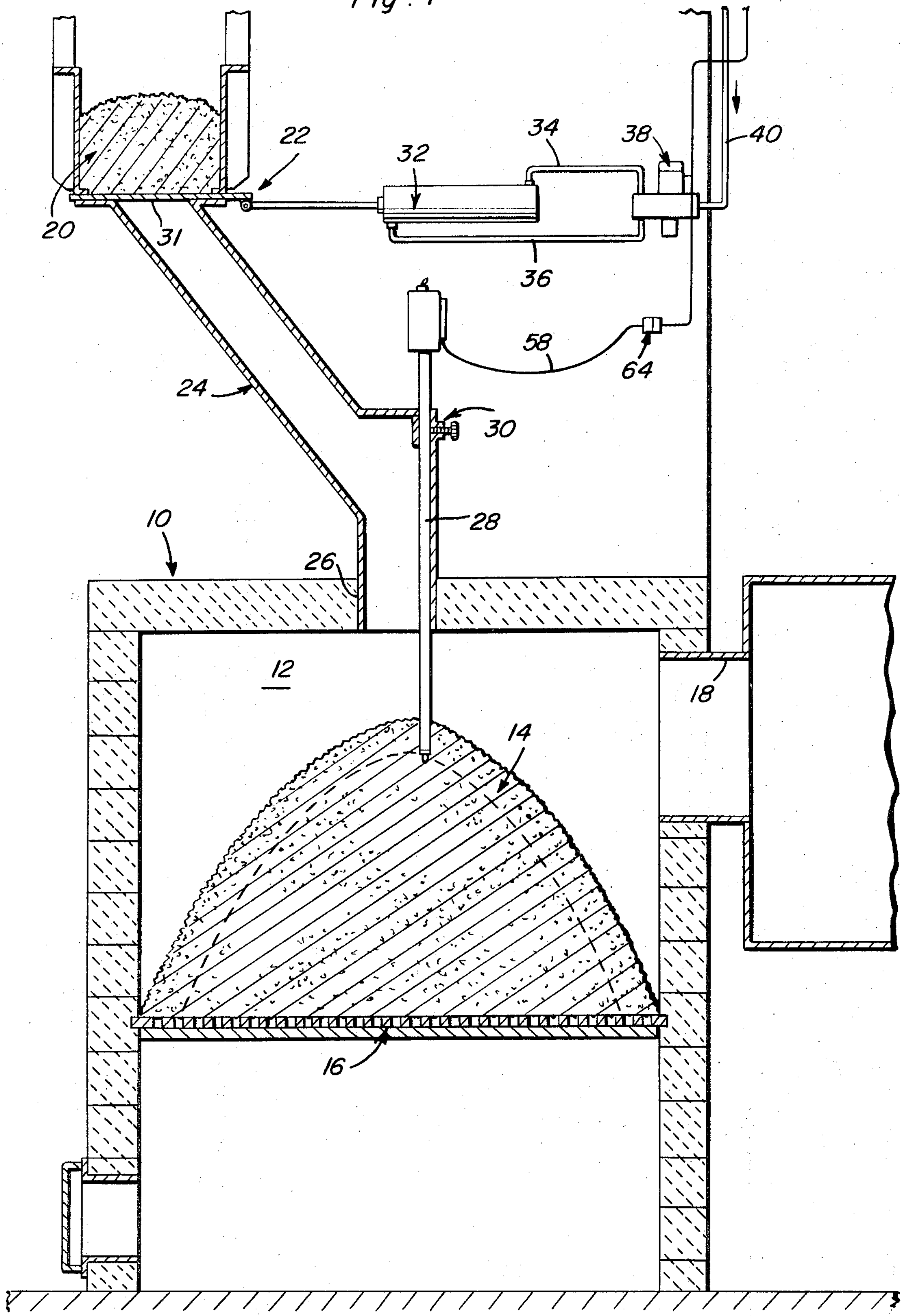


Fig. 2

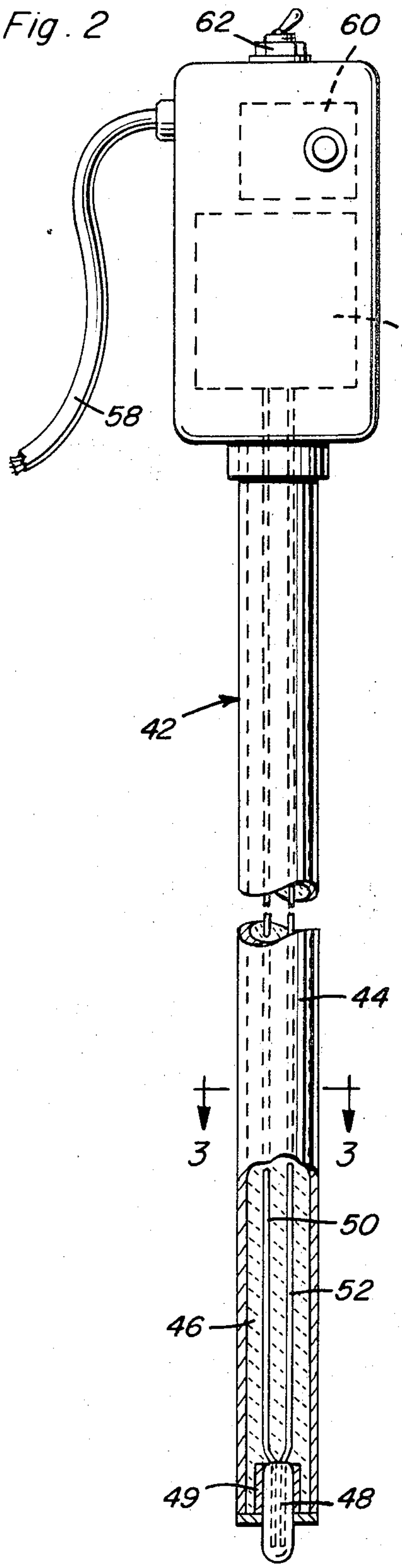


Fig. 3

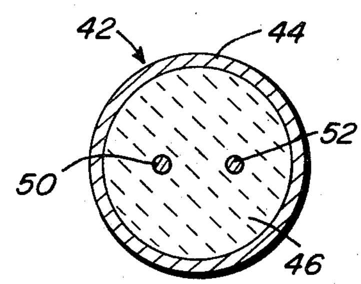
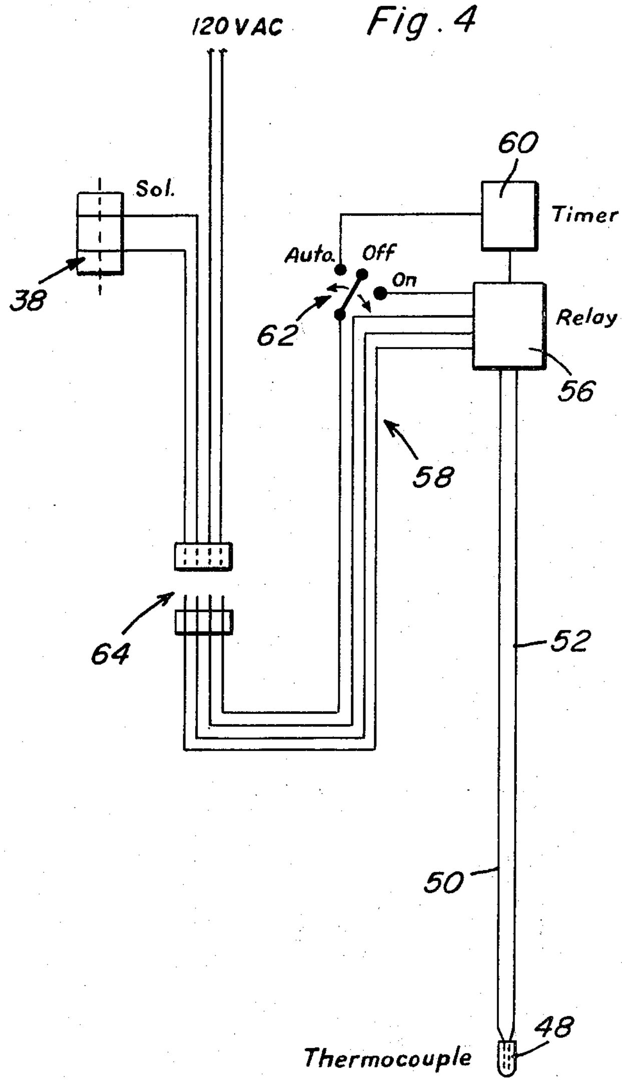


Fig. 4



FUEL FEEDING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to feeding a material on demand, and particularly to the regulation of the height of a cone, mound, or pile of fuel arranged in the combustion area of a furnace.

2. Description of the Prior Art

Many methods of controlling the rate of feeding solid fuels such as hog fuel, saw-dust, planar shavings, and the like, into Dutch oven type boilers, and the like, have been used in the past. The old hand-fired method is the most common. Fuel travels along an overhead conveyor, and is selectively dropped through a chute into the top of the furnace by an operator manually controlling the flow of fuel with trap doors, and the like. Very poor control, especially of steam, and lots of smoke is the end result of these known approaches. Sight transmitters and receivers are being used which sight across the top of the fuel and maintain a desired fuel height by means of relays and air cylinders that actuate the fuel release mechanisms. The known arrangements of this kind function satisfactorily when used with single boiler installations and with single fuel piles per boiler. On multiple boiler installations and with two or more fuel cones or piles in each furnace, however, the installation of the sighting heads becomes increasingly difficult, and inordinately complex.

A thermostatically controlled sensing unit using a liquid such as water as a control source has also been proposed. Such a unit is shown in U.S. Pat. No. 3,298,338. This approach, however, requires a constant supply of water at high volume. Interruption of the water flow would most likely cause the unit to malfunction and could burn out the sensing bulb. Further, ecology pollution problems will frequently require that the heated water being discharged from the system be cooled before its ultimate disposal. This, of course, adds to the cost and decreases the economic efficiency of the system. This is also the case with the numerous valves, strainers, plumbing, and drain connectors required for the liquid flow system. In addition, it has been found that the probes continually fill up with lime deposits, and the like, and have to be cleaned frequently in order to maintain their sensitivity and prevent them from burning out. The heat is frequently so intense on the exposed portion of the probe—that is, the portion of the probe above the fuel pile—that the liquid, or water, temperature is raised sufficiently to actuate an associated thermostatic relay before the height of the pile is reduced enough for the sensing bulb to become exposed to the direct heat of the fuel pile. Thus, the fuel height may vary as much as two feet or more, when under ideal conditions the fuel cone height should not vary more than four to six inches. As a result, constant attendance is required to compensate for this problem and maintain the fuel cone height within optimum limits.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a simple, reliable, and more accurate method and apparatus for controlling the feed of fuel onto a cone, mound, or pile arranged in the combustion area of a

furnace for regulating the height of the cone, mound, or pile.

It is another object of the present invention to provide a thermostatic control for a furnace fuel feeding system.

It is yet another object of the present invention to provide a fuel feeding system that eliminates liquid plumbing and its associated valves and drain, can minimize the risk of burn-out, has substantially constant sensitivity, is rugged and of simple construction, is easy of installation, may be adjusted to vary a volume of fuel added in each operating cycle, requires a minimum of supervision, and generally reduces maintenance and increases efficiency of a plant with which the system is associated.

These and other objects are achieved according to the present invention by providing a thermostatic control having: a probe inserted into a combustion area of a furnace and normally having a portion penetrating a pile of burning fuel in the combustion chamber; a temperature sensor carried by the probe for sensing a temperature in the combustion area; and an arrangement regulated by the temperature sensor for feeding fuel into the combustion area in response to a signal from the temperature sensor indicative of the pile having decreased to a predetermined height exposing the temperature sensor to direct heat from the pile.

Advantageously, the temperature sensor is a thermocouple arranged on a portion of the probe normally penetrating the pile of burning fuel. A preferred embodiment of the probe itself has a tube provided with spaced ends and filled with a heat insulating material, such as a refractory material.

The fuel feeding arrangement advantageously includes a valve mechanism arranged for selectively blocking and unblocking a fuel flow path to the furnace, and a relay connected to the valve mechanism and to the probe temperature sensor. The relay is arranged for actuating the valve mechanism to unblock the fuel flow path in response to a signal received from the temperature sensor. A timer may be associated with the relay for interrupting the latter a predetermined length of time after a signal from the temperature sensor causes fuel to pass the valve mechanism. By adjusting the time delay caused by this timer to terminate the fuel flow, the height of the fuel pile can be maintained within desired limits.

A fuel feeding system according to the present invention controls the feed of fuel by placing a signal-transmitting temperature sensor in a pile of burning fuel arranged in a combustion area of a furnace, and supplying fuel to the furnace when the sensor transmits a signal indicative of the fuel pile being reduced to a level beneath the sensor.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings, forming a part hereof, wherein like numerals refer to like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary, partly schematic, vertical sectional view showing a furnace provided with a fuel feeding system according to the present invention.

FIG. **2** is a fragmentary, side elevational view, partly broken away and in section, showing a sensing probe according to the present invention.

FIG. **3** is a sectional view taken generally along the line 3—3 of FIG. **2.**

FIG. **4** is a schematic diagram showing an electrical wiring circuit according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** of the drawings shows a conventional furnace **10,** which may be an industrial furnace or incinerator, provided with a combustion area **12.** The furnace **10** illustrated in FIG. **1** of the drawings is a conventional underfired Dutch oven type of furnace having a firebox in front of a boiler (not shown), and constructed to permit maximum temperatures in combustion area **12** of, for example, 2,000°F. A fuel cone, mound, or pile **14** is arranged on conventional grates **16** in combustion area **12.** The solid line indicating the extent of pile **14** is the maximum height of the pile, while the dotted line is its minimum height. These heights may be adjusted as will be discussed below. A throat **18** provides a passage for the combustion flame (not shown) and gases into the heat transfer area of the boiler associated with the furnace. A conventional fuel conveyor **20** communicates by means of a trap-door kind of valve mechanism **22** with a fuel chute **24** leading to an opening **26** in the top of furnace **10.** A sensing unit **28** according to the present invention is adjustably mounted in chute **24** as by a conventional clamp **30** so as to extend through opening **26.**

Valve mechanism **22,** which is arranged for selectively blocking and unblocking the fuel flow path to the furnace as defined by conveyor **20** and chute **24,** is provided with a conventional trap-door gate **31,** a fluid motor **32,** which may be a conventional piston and cylinder motor, and fluid lines **34** and **36** connected to motor **32** for supplying actuating fluid, preferably air, to this motor. A, for example, solenoid operated fluid valve **38** of known construction is arranged between lines **34, 36** and a fluid supply line **40** for controlling flow in lines **34** and **36** in response to valve **38** being energized by an arrangement to be discussed below. Supply line **40** may be connected to any conventional supply of operating fluid, such as a conventional air compressor.

A probe **42** inserted into combustion area **12** of a furnace **10,** is so arranged that a portion thereof normally penetrates a pile of burning fuel, such as pile **14,** arranged in combustion area **12.** This probe **42** is formed by a tube **44,** preferably a cylindrical tube constructed from a high-strength non-magnetic nickel-chromium-iron alloy such as are commonly available on the market and can withstand temperatures up to 2,200°F. under appropriate conditions. It is to be understood that other, suitable materials may be substituted for this kind of metal if desired. A heat-insulating material **46** substantially fills tube **44** between the spaced ends of the latter, and a conventional thermocouple **48** is arranged in a sleeve **49,** which may be constructed from a material similar to that used for tube **44,** and is fastened to a closed end of tube **44** as by welding, and the like. If desired, thermocouple **48** may be entirely embedded in material **46,** but it has been found advantageous to arrange the thermocouple in a sleeve such as that designated **49** and have it extend beyond the end of sleeve **49** so as to be in direct contact with the fuel in pile **14.** Leads **50** and **52** of thermocouple **48** are embedded in and extend through material **46,** as can readily be seen from FIG. **3** of the drawings.

A housing is shown mounted on the top of probe **42** to cooperate with the latter in forming a sensing unit **28.** It is to be understood, however, that the equipment, to be set out immediately below, housed in housing **54** may be situated at a location remote from probe **42** and connected to the probe as by, for example, flexible, rubber covered, thermocouple wire of a conventional nature. A relay **56** is illustrated as arranged in housing **54,** and is connected to valve **38** of valve mechanism **22** and to thermocouple **48.** The particular connection of relay **56,** which may be a conventional temperature controller with a deviation indicator in the range of, for example, 0 to 1,400°F., is arranged for actuating valve **38** to unblock the fuel flow path through chute **24** in response to a signal from thermocouple **48.** A four-wire power cord **58** is shown extending from housing **54** to connect relay **56** to solenoid operated valve **38** and a conventional source of electric power. An optional feature of the present invention which may be advantageous under certain circumstances is the provision of a conventional timer **60** selectively connectible to relay **56** as by a single pole, double throw switch **62,** also of a conventional construction, for interrupting the circuit completed through relay **56** a predetermined time after a signal from thermocouple **58** causes relay **56** to close and pass fuel by valve mechanism **22.** A conventional four-line connector **64** (FIG. **1**) provides mating male and female connector elements to selectively connect sensing unit **28** to the remainder of the fuel feeding system.

FIG. **4** of the drawings shows a diagram of an electrical circuit for the present invention. Positioning of switch **62** to either the "auto" or "on" positions from the "off" position, and placing thermocouple **48** in a pile **14,** proper dimensioning of the components will cause an electrical signal to be generated by thermocouple **48** when pile **14** has burned down sufficiently to expose thermocouple **48** to direct heat from pile **14,** indicated by the broken lines in FIG. **1** of the drawings, which is sufficiently strong enough to actuate relay **56** and close a circuit from a conventional power source, such as any standard **120** volt ac source, through relay **56** and to the solenoid of valve **38** for energizing same and opening gate **31.** If timer **60** is included in the circuit, which otherwise would eliminate the need for the "auto" position of switch **62,** this timer may be set to open or interrupt the circuit through relay **56** after the lapse of a predetermined length of time. If timer **60** is not in the circuit, or switch **62** is set to the "on" position, relay **56** will interrupt the circuit after the fuel has cooled thermocouple **48** by piling up around same. Positioning of probe **42** by clamp **30** will also permit adjustment of the height of pile **14,** either independently or in conjunction with a timer.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

1. A thermostatic control for a furnace fuel feeding system comprising, in combination:

a. a probe arranged inserted into a combustion area of a furnace and normally penetrating a pile of burning fuel in the combustion area;

b. means carried by the probe for sensing a temperature in the combustion area; and

c. means regulated by the sensing means for feeding fuel into the combustion area in response to a signal from the sensing means, the signal being indicative of the pile having decreased to a predetermined height, the sensing means being a thermocouple arranged on a portion of the probe normally penetrating the pile of burning fuel, and the predetermined height exposing the thermocouple to direct heat from the pile.

2. A structure as defined in claim 1, wherein the probe includes a tube having spaced ends and filled with a heat insulating material, and the thermocouple is arranged adjacent an end of the tube.

3. A structure as defined in claim 1, wherein the means for feeding fuel includes:

i. a valve mechanism arranged for selectively blocking and unblocking a fuel flow path to the furnace; and

ii. a relay connected to the valve mechanism and the probe thermocouple, and arranged for actuating the valve mechanism to unblock the fuel flow path in response to a signal from the thermocouple.

4. A structure as defined in claim 3, wherein the valve mechanism includes a gate, a fluid motor connected to the gate, fluid lines connected to the fluid motor for actuating same, and a solenoid operated fluid valve connected to the relay and fluid lines and arranged for controlling flow in the lines as a function of an operating mode of the relay.

5. A structure as defined in claim 4, wherein the means for feeding fuel further includes a timer selectively connectible to the relay and arranged for interrupting the relay a predetermined time after a signal from the thermocouple causes fuel to pass by the valve mechanism.

6. A structure as defined in claim 5, wherein the timer and relay are mounted on the tube at the end spaced from the end adjacent the thermocouple to form a unit with the probe.

7. A structure as defined in claim 3, wherein the means for feeding fuel further includes a timer selectively connectible to the relay and arranged for interrupting the relay a predetermined time after a signal from the sensing means causes fuel to pass by the valve mechanism.

8. A method for controlling the feed of fuel into a furnace, comprising the steps of:

a. placing a signal-transmitting temperature sensor in a pile of burning fuel arranged in a combustion area of a furnace; and

b. supplying fuel to the furnace when the sensor transmits a signal indicative of the fuel pile being reduced to a level beneath the sensor.

9. A method as set out in claim 8, wherein placing step (a) includes the step of penetrating the sensor into an upper portion of the fuel pile, and the supplying step (b) includes the step of terminating the fuel supply after a predetermined length of time.

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