

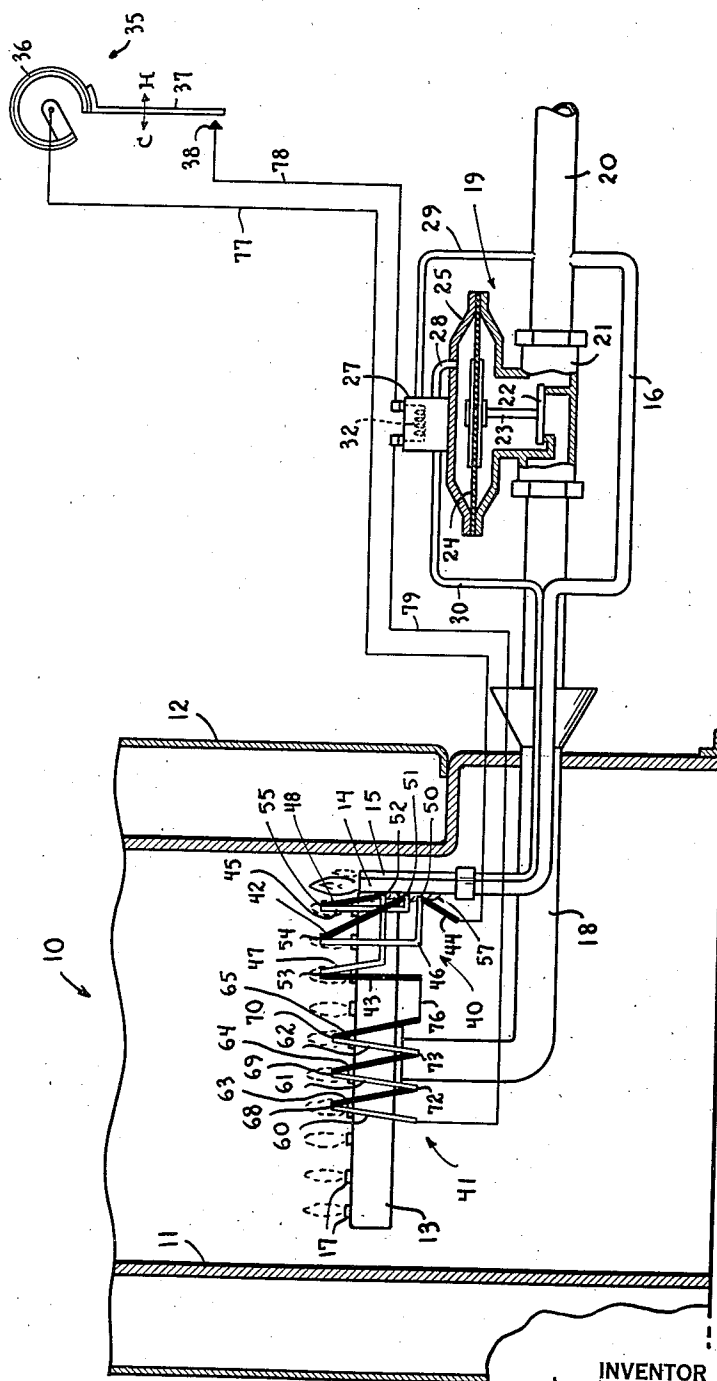
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BURNER CONTROL SYSTEM

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BURNER CONTROL SYSTEM

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The present invention relates to a burner control system and more particularly to one employing a thermoelectric device for controlling the flow of fuel to the burner, although the present invention could well be used with other types of temperature responsive mechanisms.

In fluid fuel burner control systems, particularly those concerned with gaseous fuels, it is customary to employ a pilot burner for igniting a second burner, usually the main burner. It is the usual practice with such systems to employ some means for interrupting the flow of fuel to the main burner when the pilot burner is extinguished. One common form of such a protective means employs a thermocouple responsive to the heat of the pilot flame and which generates a controlling current only when the thermocouple is heated by the pilot burner. These arrangements have the serious disadvantage that the power produced by the thermocouple is necessarily extremely limited. In order to maintain the resistance as low as possible, it is necessary to use relatively short elements for the thermocouple. When this is done, the cold junction is necessarily sufficiently close to the hot junction that it is unduly influenced by the main burner. This reduces the temperature difference between the hot and cold junctions of the thermocouple. This limitation on the amount of power generated by the thermocouple becomes extremely serious, where, as has been proposed, the thermocouple is employed to generate current for a temperature controlling system.

An object of the present invention is to provide a safety control system for a burner employing a pilot light, which safety control system will be quick in its response and relatively unaffected by the presence or absence of a main burner flame.

Another object of the present invention is to provide a burner control system employing thermoelectric means for detecting the condition of a pilot burner in which provision is made for increasing the output of the thermoelectric means in spite of the influence of the main burner.

A further object of the invention is to provide an arrangement of the type discussed in which the normally cold junction of the controlling thermocouple is located so as to be exposed to the main burner temperature but in which an additional thermocouple is provided which is operative upon the main burner temperature increasing to supplement the current supplied by the controlling thermocouple.

A further object of the invention is to provide

a burner control system involving a pair of burners in which there is a pair of thermocouples aiding each other, the hot junctions of the two thermocouples being exposed to the flames of the two burners respectively and in which the cold junction of the thermocouple normally affected by the first of the burners is exposed to the heat produced by the second of the burners.

Other objects of the invention will be apparent from a consideration of the accompanying specification, claims, and drawing, of which:

The single figure is a schematic illustration of a burner control involving my invention.

Referring to the drawing, a portion of a conventional gas furnace is illustrated and is indicated by the reference numeral 10. This furnace in the usual manner comprises the furnace 11 and a casing or jacket 12 surrounding the furnace. Disposed within the furnace is a main gas burner 13, a pilot burner 14, and a bleed gas burner 15. The pilot burner 14 is employed to ignite the main burner 13 and the bleed gas burner. The main burner 13 has the usual spuds 17.

A pipe 18 supplies gas to the main burner and is connected by a valve 19 with a main gas supply pipe 20. Pipe 20 leads to any suitable source of gas supply (not shown). The pilot burner 14 is connected by pipe 16 to the supply pipe 20 at a point on the inlet side of valve 19.

The valve 19 is illustratively shown as a diaphragm gas valve. While the details of this valve do not, by themselves, form part of the present invention, they are briefly described in order to understand more fully the operation of the system. The valve comprises a valve casing 21 having the usual partition wall providing a valve seat with which cooperates a valve disk 22. The valve stem 23 secured to valve disk 22 is connected to a diaphragm 24. An upper casing member 25 encloses the upper side of the diaphragm 24 so as to form with the valve casing 21, upper and lower pressure chambers. The lower pressure chamber is continuously exposed to the gas pressure in main supply pipe 20. The position of the valve disk 22 is varied by varying the gas pressure in the upper diaphragm chamber. The pressure in this chamber is controlled by a three-way pilot valve 27. This valve is of conventional structure and the details thereof have been omitted in order to simplify the drawing. Communicating with the valve chamber 27 is a pipe 28 connected to the upper diaphragm chamber, a pipe 29 connected to gas supply pipe 20, and a pipe 30 leading from pilot valve 27 to the bleed

burner 15. The valve 27 is electromagnetically operated and the coil of the electromagnet has been schematically shown in the drawing in order to illustrate more fully the electric connections of the system. In general, the pilot valve 27 is so arranged that when the coil 32 is energized, the gas above the diaphragm passes out through pipes 28 and 30 to the bleed burner 15 and further gas is prevented from entering the chamber above the diaphragm. The result is that the gas pressure acting beneath the diaphragm raises the valve disk 22 and admits gas to the main burner 13. When the coil 32 is deenergized, the flow of gas from pipe 28 to pipe 30 and hence to the bleed gas burner 15 is interrupted and gas is again permitted to flow from supply pipe 20 to pipe 28 and hence to the upper chamber above the diaphragm. This permits the supply gas pressure to be applied above the diaphragm to cause the valve disk 22 to again engage its seat.

Thus, when coil 32 is energized, gas is admitted to the main burner 13 and when it is deenergized, this gas flow to the main burner is interrupted.

The energization of coil 32 is controlled in part by a room thermostat 35. This room thermostat comprises a bimetallic element 36 to which is secured a contact arm 37 adapted to be moved into engagement with the contact 38. As indicated by the legend, the bimetallic element 36 is so arranged that upon a drop in temperature the contact arm 37 is moved to the left into engagement with contact member 38. Upon a rise in temperature, the contact arm 37 is moved to the right out of such engagement.

The current for energizing coil 32 is supplied by a pair of thermopiles 40 and 41. As will be presently explained, these thermopiles not only supply the current for the operation of the control system but also supply this current in accordance with the presence or absence of a flame at the pilot burner and hence act to indicate whether or not the pilot burner is ignited.

Referring specifically to thermopile 40 which may be considered to be the main control thermopile, this thermopile comprises a plurality of elements 44, 42, 48 and 43 connected alternately and in series with a plurality of elements 46, 45, and 47. The elements 42, 43, 44, and 48 are formed of material having thermoelectric characteristics which are different from those of which elements 45 to 47 are formed. In other words, these elements form a plurality of thermocouples connected in series with each other so as to form junctions 50, 51, and 52 on the one hand, and junctions 53, 54, and 55 on the other hand. The junctions 50, 51, and 52 may for convenience be referred to as the hot junctions and the junctions 53, 54, and 55 as the cold junctions. The hot junctions 50, 51, and 52 are exposed to the flame of the pilot burner. These junctions may be exposed to the main flame of the pilot burner or to a runner flame 57 as illustrated in the drawing, but in any event, the hot junctions should be influenced less by the main burner than the cold junctions. The cold junctions 53, 54, and 55 are exposed to the flame of the main burner. It will be noted that these junctions are located a substantial distance above the spuds 17 so as to be exposed to a relatively hot portion of the main burner. However, the junctions 53, 54, and 55 are not located directly in the main burner flame and the thermopile 40 is preferably so located that these junctions are heated to approximately the same extent by the main burner flame as

junctions 50, 51, and 52 are heated by the pilot burner flame.

The thermopile 41 comprises a plurality of members 60, 61 and 62 and a further plurality of members 63, 64, and 65. The members 60, 61 and 62 are formed of the same material as members 45, 46, and 47 and the members 63, 64, and 65 are of the same material as members 42, 43, 44 and 48. The members 60 to 65 are connected together alternately in series so as to form junctions 68, 69, and 70 and junctions 72 and 73. The two extreme ends of members 60 and 65 together constitute a third junction. The junctions 68, 69 and 70 may be termed the hot junctions of thermopile 41 and the remaining junctions including junctions 72 and 73, the cold junctions.

The two thermopiles 40 and 41 are connected in series with each other to the coil 32 of control device 27 and under the control of thermostat 35. The circuit connecting these members together is as follows: through members 60, 63, 61, 64, 62, and 65 to conductor 76, to thermocouple members 43, 47, 48, 45, 42, 46 and 44, then to conductor 77, bimetallic element 36, switch blade 37, contact 38, conductor 78, coil 32, and conductor 79 back to thermocouple member 60. It will be noted from the foregoing circuit and from a comparison of the manner in which the thermocouples are connected in the circuit that the thermopiles 40 and 41 are connected in series so as to aid each other. In other words, the extreme right hand hot junction of the thermopile 41 is junction 70. The next junction will of necessity be a cold junction if the thermocouples are connected so as to aid each other. It will be noted that the members 43 and 65 which are of the same material are connected together by wire 76 so as to be in effect one continuous member. Thus, the first thermoelectric junction proceeding to the right is junction 53 which is a cold junction. The next succeeding junction is junction 52 which is a hot junction. Thus, when junctions 50, 51 and 52 are considered as hot junctions, the thermopiles are connected so as to aid each other. The junctions 68, 69, and 70 are preferably located adjacent a slightly cooler portion of the main burner than the cold junctions 53, 54, and 55. This is not absolutely essential but does offer certain advantages, as will be explained later. The lower ends, including the cold junctions, of thermopile 41 are located in as cool a position as possible. The fact that the hot junctions 68 to 70 are located adjacent a portion of the burner flame which is not quite so hot, makes it possible to place the cold junctions of the thermopile 41 in a lower portion of the furnace than would otherwise be possible. Inasmuch as the temperature within a furnace decreases very rapidly below the upper surface of the main burner, it is possible to place junctions 72 and 73 in a rather cool location. This tendency of the furnace temperature to decrease rapidly below the level of the main burner is due to the inflow of secondary air to support combustion. The temperature of this secondary air is sufficiently close to furnace room temperature that the region around cold junctions 72 and 73 tends to remain at all times at a substantially constant and relatively low temperature.

Operation

Let it first be assumed that the thermostat 35 is satisfied, as shown in the drawing, and that the pilot burner is ignited. Under these conditions, it is impossible for current to flow to coil

32 regardless of whether energy is generated by thermopiles 40 and 41. Consequently, as previously explained, the control device 27 is in such a position that communication is established between pipes 29 and 28 so that gas pressure exists above diaphragm 24 and valve disk 22 is maintained in closed position. Because of the valve disk 22 being closed, no gas flows to the main burner and this burner is unignited.

Let it be assumed that the pilot burner 14 is properly ignited. Under these conditions, the junctions 50, 51, and 52 are heated by the pilot burner flame 57. Due to the fact that the main burner is not in operation, junctions 53, 54, and 55 are relatively cold and all of the junctions of the thermopile 41 are cold. Consequently, the action of the thermopile 40 is that of a simple thermopile in which the hot junctions are heated and the cold junctions are maintained at a relatively low temperature, while thermopile 41 acts merely as a conductor. Under these conditions, if the room thermostat 35 now calls for heat, current is able to flow over the circuit previously traced. The thermopile 40 is designed to operate under these conditions to generate sufficient current to energize coil 32 so as to cause the latter to change the position of the pilot valve of control device 27. When this happens, as previously explained, gas flow between pipes 29 and 28 is interrupted and communication is established between pipes 28 and 30 to permit the gas above diaphragm 24 to pass to the bleed burner 14. The result of this is that the gas pressure above diaphragm 24 is relieved and valve 19 is opened to permit gas to flow to the main burner.

The gas flowing to main burner 13 is ignited by the pilot burner 14 in the usual manner. As soon as it becomes ignited, the cold junctions 53 to 55 begin to be heated. As these junctions become heated, the electromotive force developed by thermopile 40 decreases. Eventually, the point is reached at which the hot and cold junctions of thermopile 40 assume substantially the same temperature. If it were not for thermopile 41, the coil 32 would be deenergized and the main valve shut down. During this time, however, the hot junctions of thermopile 41 are also being heated by the main burner although to a slightly less extent. As previously pointed out, thermopiles 40 and 41 are connected to aid each other. Thus, as the electromotive force generated by thermopile 40 decreases, that generated by thermopile 41 increases. Because of the fact that the cold junctions of thermopile 41 are in a relatively cool location, the electromotive force generated by this thermopile is substantially equal to that normally generated by the thermopile 40 when the main burner is unignited. As a result, the total power supplied by the thermopiles 40 and 41 remains substantially constant, even though junctions 68 to 70 are not affected to the same degree by the main burner as junctions 53 to 55.

Let it now be assumed that the thermostat 35 becomes satisfied. The energizing circuit for coil 32 is now interrupted so that valve 19 is closed. This interrupts the flow of gas to the main burner, so that it is extinguished. The thermopiles 40 and 41 then cool down to the previous condition described in which junctions 50, 51 and 52 are the only junctions that are heated.

The operation which has been described so far is the normal operation of the system. The vari-

ous abnormal conditions for which the system is designed will now be described. The simplest abnormal condition is that of the pilot burner being extinguished along with the main burner at the time that the thermostat calls for heat. It is obvious that under these conditions, both thermocouples 40 and 41 will be unheated throughout and that there is no source of power for energization of the coil 32. Consequently, the valve 19 will not be opened. Thus a flow of gas to the main burner is prevented because of the absence of any pilot flame to ignite it.

Let the case now be considered in which the main burner and the pilot burner have both been ignited and the pilot burner is extinguished while the main burner continues in operation. It is generally desirable under these conditions to terminate the operation of the main burner as its operation in the absence of a pilot flame may result in hazardous conditions. As soon as the pilot burner goes out, the junctions 50 to 52 are no longer heated by the pilot burner. The only heat that these junctions receive is the relatively small amount of heat they receive from the main burner by convection, radiation, and conduction. In any event, the junctions 53, 54, and 55 which are heated to a relatively high degree by the main burner will be at a much higher temperature than junctions 50 to 52. As a result, an electromotive force is generated which is opposite in polarity to that generated by thermopile 41. Moreover, even though the normally hot junctions (now the cold junctions) are heated to a certain extent by the main burner, the total electromotive force generated by thermocouple 40 will be very close in magnitude to that generated by thermopile 41 due to the fact that the hot junctions 53 to 55 are adjacent a hotter part of the main burner flame than junctions 68 to 70. As a result, the voltage generated by thermopile 40 will overcome the voltage generated by thermopile 41 so as to cause deenergization of coil 32. Thus, the coil 32 will be very quickly deenergized so as to cause closure of valve 19 upon the pilot burner being extinguished even though the main burner is in operation.

It will be seen from the above that regardless of whether the main burner is in operation or not, the extinguishment of the pilot burner insures prompt deenergization of the coil 32. Furthermore, the total power generated by thermopiles 40 to 41 can be considerably greater than that generated by a thermopile whose hot junctions are all located adjacent the pilot flame and whose cool junctions are located in as cool a location as possible. Inevitably, in such a case, the cool junctions are affected to a considerable extent by the main burner flame. This is necessary, as previously explained, because of the fact that the thermocouples must be of relatively short length and that in order to locate the hot junctions adjacent the pilot burner flame, it is necessary to have the cold junctions at a point where the main burner will affect their temperature. With the present arrangement, no attempt is made to protect the cool junctions from the main burner flame so that the thermopile may be relatively short. The auxiliary thermopile does not have to be located near a pilot burner and consequently can be so located that the cold junctions are in a relatively cool place.

While I have shown a specific embodiment of the invention, it is to be understood that this is

for purposes of illustration only and that the invention is to be limited only by the scope of the appended claims.

What I claim is:

1. In combination, first and second sources of heat, an electrically operated control device, and a plurality of thermocouples effectively connected to said device in series with each other, the hot junction of one thermocouple being exposed to the first source of heat and the cold junction to the second source of heat, and the hot junction of the other thermocouple being exposed to the second source of heat and the cold junction being located in a region having a relatively low temperature in respect to either source of heat so that said thermocouples are effective to energize said device when either the first source alone or both sources of heat are active but are ineffective to energize said device whenever said first source of heat is inactive.

2. In a burner control system, a pair of burners, a first of said burners serving to ignite the second burner, an electrically operated device for controlling the delivery of fuel to the second burner, and a plurality of thermoelectric devices connected to said electrically operated device and controlling the energization of said device, one of said thermoelectric devices being operative in accordance with the difference between the temperatures adjacent the flame portions of said first and second burners, and the other being operative in accordance with the difference between the temperature adjacent the flame portion of the second burner and a region of relatively constant temperature and hence supplementing the output of said first named thermoelectric device as said output decreases due to the operation of said second burner.

3. In a burner control system, a main burner, a pilot burner, an electrically operated device for controlling the supply of fuel to said main burner, and a plurality of thermocouples connected to said device in series with each other, the hot junction of one thermocouple being exposed to the heat of the pilot burner and the cold junction to the heat of the main burner, and the hot junction of the other thermocouple being exposed to the heat of the main burner and the cold junction being located in a region having a relatively constant temperature so that said thermocouples are effective to energize said device when either the pilot burner alone or both the main and pilot burners are ignited but are ineffective to energize said device whenever said pilot burner is extinguished.

4. In a burner control system, a main burner, a pilot burner, an electrically operated device for controlling the supply of fuel to said main burner, and a pair of thermocouples connected to said device in series with each other, the hot junction of one thermocouple being exposed to the heat of the pilot burner and the cold junction of said thermocouple to the heat of the main burner, and the hot junction of the other thermocouple being exposed to the heat of the main burner and the cold junction being located in a region having a relatively constant temperature, said thermocouples being so positioned with respect to the main burner that the hot junction of said last named thermocouple is heated to a lesser extent by said main burner than the cold junction of said first named thermocouple, said thermocouples being effective to energize said device when either the pilot burner alone or both

the main and pilot burners are ignited but are ineffective to energize said device whenever said pilot burner is extinguished.

5. In a burner control system, a pair of burners, a first of said burners serving to ignite the second burner, an electrically operated device for controlling the delivery of fuel to said second burner, a thermoelectric device controlling the energization of said electrically operated device, said thermoelectric device being operative in accordance with the difference between the temperatures adjacent two portions thereof, one of which is closer to the first burner than the other and the other of which is substantially affected by the heat of said second burner, and means automatically operable upon the second burner being ignited so as to raise the temperature of the other portion of the thermoelectric device to apply to said electrically operated device an electromotive force of sufficient magnitude to compensate for the decrease in magnitude of electromotive force generated by said thermoelectric device.

6. In a burner control system, a pair of burners, a first of said burners serving to ignite the second burner, an electrically operated device for controlling the delivery of fuel to said second burner, a thermocouple controlling the energization of said electrically operated device and having its hot junction located closer to said first burner than its cold junction and its cold junction being heated appreciably by said second burner, and means automatically operable upon the second burner being ignited so as to raise the temperature of the cold junction of said thermocouple to apply to said electrically operated device an electromotive force of sufficient magnitude to compensate for the decrease in magnitude of electromotive force generated by said thermocouple.

7. In a burner control system, in combination, a main burner, a pilot burner for igniting the main burner, a device in control of the flow of fuel to the main burner, a first temperature responsive means having two portions adapted to be respectively heated by the main and pilot burners and arranged to provide a force the direction and extent of which depends upon the relative temperatures of said two portions to provide a substantially zero force when said portions are equally heated, a force in a first direction when the portion exposed to the pilot burner is hotter than the other portion and a force in a second direction when the portion exposed to the pilot burner is less hot than said other portion, a second temperature responsive means subjected to main burner heat arranged to provide a substantially zero force when said main burner is extinguished and to provide a force in said first direction when said main burner is lighted, and means associating said temperature responsive means and said device whereby substantially no force is provided for said device when both burners are extinguished, a force in said first direction is provided for said device by said second temperature responsive means when both burners are ignited, a force in said first direction is provided for said device by said first temperature responsive means when the pilot burner only is lighted, and substantially no force for said device is provided as a result of the interaction of said forces in said first and second directions when the main burner is lighted and the pilot burner is extinguished.

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