March 21, 1950 H. J. FINDLEY 2,501,627

THERMOELECTRIC SELF-CONTROLLING COMBUSTION HEATING SYSTEM

Filed March 2, 1946 2 Sheets-Sheet 1

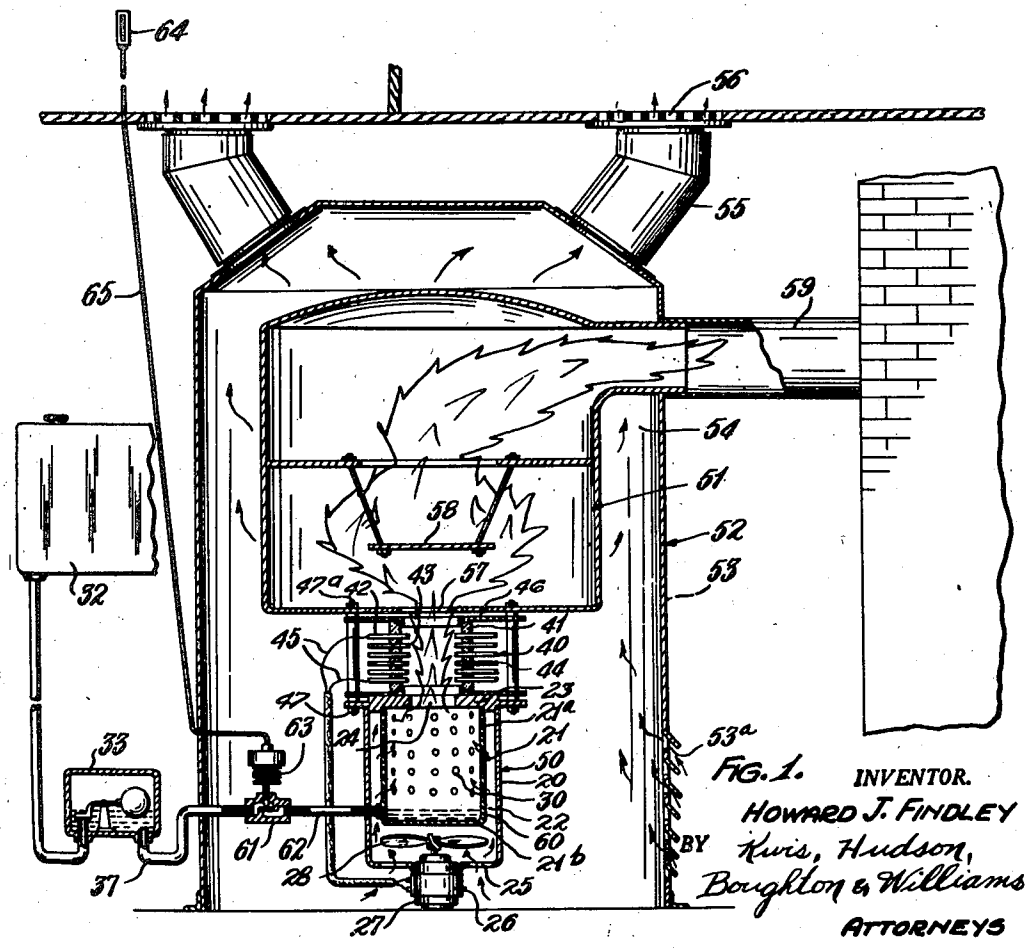


FIG. 1.

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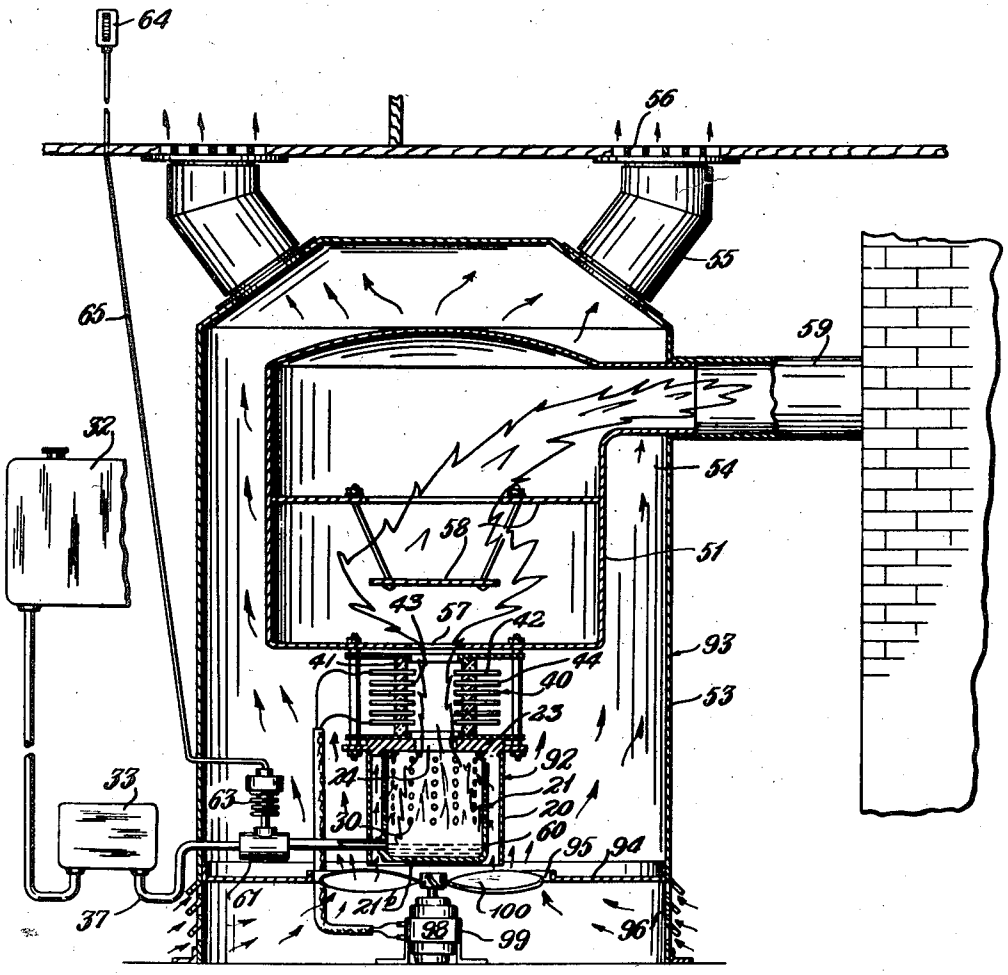


FIG. 2.

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UNITED STATES PATENT OFFICE

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THERMOELECTRIC SELF-CONTROLLING COMBUSTION HEATING SYSTEM

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5 Claims. (Cl. 126—116)

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This invention relates to fuel combustion and as one of its objects aims to provide novel apparatus with which the combustion of a fluid fuel, and particularly a liquid fuel, can be carried out in a more efficient and satisfactory manner than has been possible heretofore.

Another object of this invention is to provide an improved combustion and heating apparatus, wherein a thermoelectric generator is supplied with heat by the operation of a fuel burner and its electrical output drives air impelling means which operates to supply combustion air to the burner in a manner to accomplish an automatic control function.

Another object of the present invention is to provide a novel fuel burning apparatus involving the use of a thermoelectric generator which is supplied with heat by the operation of the burner and whose electric output drives an air impelling device which is operated so that air delivered thereby will be supplied to the burner as combustion air and the volume of the air thus supplied will be varied automatically by the action of the thermoelectric generator so as to suit the requirements of the burner.

A further object of the invention is to provide a novel apparatus of this character, in which the burner is hollow and the thermoelectrically operated air impelling means causes a flow of air through the burner in a direction toward the thermopile of the generator.

Another object of the invention is to provide a novel apparatus of the character referred to, in which the burner is a liquid fuel burner embodying a fuel pot and the thermoelectrically operated air supply means causes a flow of air across the pot and toward the thermopile of the generator.

Another object of this invention is to provide a novel fuel burning and air heating apparatus involving the use of a thermoelectric generator whose electrical output drives air impelling means which operates to supply combustion air to the burner as well as to cause a flow of air to be heated, through the apparatus, and in which the supply of fuel to the burner is continually modulated by temperature responsive means such that the operation of the apparatus can be controlled automatically in response to a single variable function.

Still another object of the present invention is to provide an improved fuel burning unit for delivering a burning fuel and air mixture into the combustion chamber of a heating apparatus and in which a hollow burner communicates with the

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combustion chamber through a hollow thermopile and an air impelling means operated by electric current from the thermopile causes a flow of air through the burner in a direction toward the thermopile and combustion chamber.

The invention can be further briefly summarized as consisting in certain novel combinations and arrangements of parts hereinafter described and particularly set out in the appended claims.

In the accompanying sheets of drawings

Fig. 1 is a vertical section, somewhat diagrammatic in character, showing one form of the improved combustion apparatus of this invention; and

Fig. 2 is a vertical sectional view similar to Fig. 1 but showing a form of the invention in which the air impelling means supplies air to both the fuel burner and the heating apparatus.

Fig. 1 of the drawings shows an embodiment of the invention in which a combustion unit 50 is being used for supplying heat to the combustion chamber 51 of a conventional hot air furnace 52. The furnace is shown in this instance as having an outer housing 53 disposed around the combustion chamber or air heater 51 so as to provide a passage 54 therebetween for an upward flow of the air to be heated. The housing 53 of the furnace may be connected with the rooms or spaces to be heated, as by means of the hot air conduits 55 which communicate with the rooms through suitable registers 56. The combustion chamber 51 has an inlet opening 57 thereinto and is provided with suitable internal baffles 58 and a smoke pipe or flue connection 59. The housing 53 has inlet openings or louvres 53a adjacent the bottom thereof for an inflow of the air to be heated and the air which is supplied to the burner 21 by the impelling device 26.

The burner unit 50 includes an elongated outer housing 20 and a hollow burner 21 disposed in the housing and spaced from the wall thereof so as to provide an annular air space or passage 22 therebetween. The housing and burner are connected with and supported by a plate or frame member 23 which forms a transverse inner or upper end wall for both the housing and the burner. The frame member 23 is provided with an opening 24 which forms an outlet opening for the hollow burner 21 and is disposed in substantial alignment with the inlet opening 57 of the combustion chamber 51 of the hot air furnace 52. The outer or lower end of the housing 20 is provided with one or more air inlet openings 25 which communicate with the air passage 22.

The unit 50 also includes, as an important part thereof, an electric air impelling device 26 which supplies combustion air to the burner 21 in the manner hereinafter explained. In this instance the air impelling device comprises an electric motor 27 and a fan or blower 28 driven thereby. The motor is here shown as being mounted on the lower end wall of the housing 20 with its shaft extending into the housing substantially coaxially thereof. The fan 28 is mounted on the motor shaft so as to be located in the lower end portion of the housing 20 just inwardly of the air inlet openings 25.

The burner 21 comprises a hollow burner member or body 21a which is here shown as being tubular or cylindrical in shape. The side wall of the hollow burner is provided with numerous openings or perforations 30 for a flow of combustion air from the space 22 into and through the burner toward the outlet opening 24. At its lower end the hollow burner is closed by a transverse end or bottom wall 21b which, in this instance, is shown as being imperforate. When the combustion unit 50 is adapted for use in an upright position as here shown, a fuel pot 60 is formed by the closed lower end 21b of the hollow burner member 21a.

The fuel to be burned in the unit 50 is preferably a liquid fuel, although gaseous fuel could be burned if desired. A supply of the liquid fuel is contained in a suitable tank or reservoir 32 and is fed therefrom to a float chamber 33 having a suitable inlet. The inlet is controlled by a valve which is actuated by a float, so that a desired fuel level will be maintained in the float chamber. The float chamber 33 is connected with the pot 60 of the burner 21 by conduits 37 and 62 having therebetween a valve 61 for controlling the rate at which fuel is to be fed from the float chamber to the pot. The float chamber 33 is located at an elevation relative to the pot 31 such that it will maintain a safe fuel level in the pot in the event that the control valve 61 remains open.

Another important part of the combustion unit 50 consists in the thermoelectric generator or thermopile 40 which utilizes heat from the burner 21 and generates electric current for the operation of the air impelling device 26. In the embodiment of the invention illustrated in Fig. 1 the thermopile is located between the outlet opening 24 of the burner 21 and the inlet opening 57 of the combustion chamber 51. The thermopile 40 may comprise a tubular member 41 formed of refractory and electrically insulating material and a plurality of thermocouple elements, or groups of elements, 42 supported by the tubular member and extending through the wall thereof. The thermocouple elements 42 are constructed of suitable metals of a dissimilar character so as to provide groups of hot and cold thermocouple junctions 43 and 44. The hot junctions 43 are spaced along and around the inside of the tubular member 41 and the cold junctions 44 are spaced along and around the outside of this member. The thermocouple junctions are electrically connected in series, and the electric motor 27 of the air impelling device 26 is connected with the terminals of the thermopile by the pair of conductors 45.

The combustion unit 50, as above described, can be in the form of a self-contained unit or assembly, in which the thermopile 40 is supported by the frame member 23 and is held thereagainst by the retaining plate 46 and the clamping bolts 47.

This combustion unit can be mounted on the bottom wall of the combustion chamber 51, as by means of the extensions 47a of the bolts 47, so that the air impelling device 26, the hollow burner 21 and the thermopile 40 are in substantial coaxial alignment with the inlet opening 57 of the combustion chamber.

In the operation of the above described combustion unit 50, some of the liquid fuel is allowed to collect in the pot 60 and is ignited to cause an initial heating of the pot and the adjacent burner structure. After this initial heating, the fuel being supplied to the burner unit flows or drips onto the bottom of the heated pot from the conduit 62 and becomes vaporized and mixed with air which enters through the the openings 30. The fuel and air mixture burns with a sustained flame, and the flame and combustion gases are delivered from the burner through the outlet opening 24 and through the thermopile 40 into the combustion chamber 51.

The flame and gases passing through the thermopile 40 heat the inner junctions 43 while the outer junctions 44 are cooled by the surrounding flow of air in the passage 54. This temperature differential causes electric current to be generated in the thermocouple junctions and to be supplied to the electric motor 27 of the air impelling device 26. The rotation of the fan 28 by the electric motor 27 causes an inflow of air through the openings 25 into the air space or passage 22. The only outlet from the passage 22 is provided by the perforations 30 of the burner 21 and hence the air being moved by the fan 28 flows through these perforations into and through the burner in a direction toward the outlet opening 24 and the thermopile 40. The air thus flowing through the burner also flows over or across the pot 60 and becomes thoroughly mixed with the fuel vapors issuing from the pot.

In the fuel burning apparatus provided by this invention an important automatic control function is obtained by reason of the use of the thermoelectric generator 40 for operating the air impelling device 26. This thermoelectric generator cooperates with the burner in such a manner that it tends to maintain the burner at its most efficient operating condition in which the correct amount of combustion air is supplied and in which the fuel and air mixture is efficiently burned. In explanation of this automatic control function it is pointed out that if the combustion air being supplied by the impelling device 26 is in excess of that needed for the amount of fuel being fed to the burner, the excess air will cause a decrease in the temperature to which the inner junctions 43 of the thermopile are heated and this will cause a corresponding decrease in the electrical output of the thermoelectric generator. The decreased output of the thermoelectric generator will cause a decrease in the speed at which the fan 28 is driven by the motor 27 and the supply of air to the burner will be thereby decreased until it is the correct amount for the amount of fuel being fed, whereupon a stable and efficient operating condition will be maintained.

If the amount of air being supplied by the impelling device 26 is too small for the amount of fuel being fed, the fuel will be burned with a relatively shorter flame, and therefore, in more direct contact with the inner junctions 43 of the thermopile. This will result in an increase in the electrical output of the thermoelectric generator and a corresponding increase in the speed of the fan 28 and the volume of air be-

ing supplied to the burner. Because of this automatic control function of the thermoelectric generator the volume of air being supplied to the burner will be automatically varied as changes occur in the operation and heat output of the burner and the thermoelectric generator will at all times tend to maintain a stable operating condition in which the correct amount of air is being supplied for an efficient combustion of the fuel.

As shown in Fig. 1 the control valve 61 of the fuel supply line 62 leading to the pot 60 is an automatic valve actuated by means of an expansible and contractable bellows 63 which is connected with a temperature responsive bulb 64 by the tubing 65. The bulb 64 can be located in the room or space being heated by the furnace 52 so that the setting of the valve 61 will be automatically controlled in relation to a desired operating condition for the combustion unit. Thus the variation in the extent of opening of the valve 61 in response to changes in the temperature of the room being heated continually modulates the supply of fuel to the burner.

In the modified form of the invention illustrated in Fig. 2, the drawings show a combustion unit 92 which is generally similar to the combustion unit 50 of Fig. 1 and is located in an upright relation for serving a heating apparatus which, in this instance, is a warm air furnace 93. The furnace 93 is similar to the warm air furnace 52 of Fig. 1 with the exception that it is provided adjacent the bottom thereof with a transverse wall or partition 94 which has an opening 95 located beneath the combustion unit 92. The air inlet openings or louvres 96 of the furnace housing 53 are located below the partition 94 so that the air which enters the furnace through these louvres is required to pass upwardly through the opening 95 in order to reach the combustion unit 92 and the air heater 51.

In the combustion unit 92 the lower end of the housing member 20 is open and is disposed in adjacent, substantially coaxial, relation to the opening 95 of the partition 94. An electric air impelling device 98 is located beneath the open end of the housing member 20 and operates to supply combustion air to the burner 21 and to also supply air to be heated to the air heater 51. The impelling device 98 comprises an electric motor 99, which is connected in circuit with the thermopile 40 so as to be driven therefrom, and a propeller fan 100 connected with the motor shaft and located in the opening 95 of the partition 94. The fan 100 is of a size or capacity, such that when its motor 99 is driven from the thermopile 40, a portion of the air stream delivered thereby will flow into the housing 20 and will be supplied to the burner 21 as combustion air, and another portion of the air being delivered will flow upwardly in the furnace housing 53 in surrounding relation to the air heater 51 so as to be heated by the latter before passing upwardly through the ducts 55.

Since the air impelling device 98 is driven by electric current from the thermopile 40, it will be seen that the speed of this device will be automatically varied in accordance with changes occurring in the operating condition of the burner 21 in the manner previously explained above and, as a result thereof, the volume of combustion air being supplied to the burner and the volume of air being supplied to the air heater

51 will be automatically maintained at values appropriate for the operating condition of the burner and the rate at which the fuel is being supplied thereto.

In the form of the invention disclosed in Fig. 1, it should be noted that the housing 20 serves as a confining and directing means for the air delivered by the thermoelectrically operated air impelling means 26, such that substantially all of the air delivered by this impelling means will be supplied to the burner 21 as combustion air. Moreover, since the impelling means 26 is located on the side of the burner opposite from the outlet opening 24, the air thus supplied will be made to move through the burner in a direction toward the outlet opening and thermopile. This direction of movement for the air will also cause the flame and combustion gases to be directed or carried into the combustion chamber of the apparatus being heated. In Fig. 2 the housing 20 of the combustion unit 92 serves to confine and direct only a portion of the air delivered by the impelling means 98 since, as explained above, the impelling means also acts to impart movement to the air which is to be heated.

In the two forms of the invention herein disclosed natural draft is used in initially starting up the burner, and although the natural draft effect provides for only a small flow of combustion air it is sufficient for the burning of enough fuel to cause the thermopile to start producing electric current. Once the thermopile starts delivering electric current and the electrically driven air impelling means starts to function, the increased supply of combustion air and the resulting increase in the output of electric current are cumulative in effect and in a very short time interval the thermopile will reach its rated output for a given rate of fuel supply and the air impelling means will then be driven at a speed to deliver a full flow of combustion air to the burner for the given fuel supply rate. When the air impelling means has reached its maximum speed for the given fuel supply rate, the volume of combustion air then being supplied by natural draft will be such a small factor in relation to the forced draft action of the air impelling means, that it can be ignored. In the case of the form of the invention shown in Fig. 2, the air impelling means also delivers air to be heated in streams whose volumes will be substantially in proportion to the given fuel supply rate.

From the foregoing description and the accompanying drawings it will now be readily understood that this invention provides an improved construction for a fuel burning unit in which the air impelling means for supplying combustion air to the burner is operated by electric current generated thermoelectrically, and hence, the unit is not dependent upon an available external source of electric current but can be used in rural areas or other remote places where there is no such available external source of electric current. Moreover, it will be seen that the use of the thermopile for operating the air impelling means provides for an automatic control function which tends to maintain a stable and efficient operating condition for the unit and in which the supply of fuel to the burner is continually modulated by temperature responsive means such that the operation of the apparatus can be controlled automatically in response to a single variable function.

Although the improved fuel burning apparatus of the present invention has been illus-

trated and described herein in considerable detail, it should be understood that the invention is not to be regarded as correspondingly limited but includes all changes and modifications coming within the scope of the appended claims.

Having thus described my invention, I claim:

1. In heating apparatus of the character described, a housing having therein a hollow heating member and an air passage extending in heat-exchange relation to said member and including an inlet for the air to be heated and an outlet for delivering the heated air into a space to be heated and whose temperature is to be controlled, a fuel burner having an inlet for combustion air and being operable to deliver a burning fuel and air mixture, a hollow thermopile forming a conduit between said burner and said hollow heating member for directing the burning fuel and air mixture into the latter and having thermocouple junctions adapted to be heated by said burning mixture for the generation of electricity, means for supplying fuel to said burner, an air impeller operable to supply combustion air to said burner, a variable speed electric motor electrically connected with said thermopile to be energized therefrom and mechanically connected with said impeller for driving the same such that combustion air is supplied to said burner at a rate corresponding substantially with the electric power delivered by said thermopile and substantially with an optimum combustion condition of operation for the burner, and temperature responsive control means effective on the fuel supply means and operable to continually modulate the supply of fuel to said burner in response to temperature variations occurring in said space.

2. In heating apparatus of the character described, a housing having therein a hollow heating heating member and an air passage extending in heat-exchange relation to said member and including an inlet for the air to be heated and an outlet for delivering the heated air into a space to be heated and whose temperature is to be controlled, a fuel burner having an inlet for combustion air and being operable to deliver a burning fuel and air mixture, a hollow thermopile forming a conduit between said burner and said hollow heating member for directing the burning fuel and air mixture into the latter and having thermocouple junctions adapted to be heated by said burning mixture for the generation of electricity, means for supplying fuel to said burner, air impelling means having one portion operable to supply combustion air to said burner and another portion operable to cause a flow of air through said passage to said space, variable speed electric motor means electrically connected with said thermopile to be energized therefrom and mechanically connected with said impelling means for driving the same such that combustion air is supplied to said burner at a rate corresponding substantially with the electric power delivered by said thermopile and substantially with an optimum combustion condition of operation for the burner, and temperature responsive control means effective on the fuel supply means and operable to continually modulate the supply of fuel to said burner in response to temperature variations occurring in said space.

3. In heating apparatus of the character described, a housing having therein a hollow heating member and an air passage extending in heat-exchange relation to said member and including an inlet for the air to be heated and an outlet for delivering the heated air into a space to be heated and whose temperature is to be controlled, a fuel burner operable to deliver a burning fuel and air mixture and comprising a pair of inner and outer hollow burner members having a combustion air space therebetween, said outer burner member having an inlet for combustion air and said inner burner member having numerous openings for admitting combustion air thereinto from said combustion air space, a hollow thermopile forming a conduit between said burner and said hollow heating member for directing the burning fuel and air mixture into the latter and having thermocouple junctions adapted to be heated by said burning mixture for the generation of electricity, means for supplying fuel to said inner burner member, an air impeller located adjacent the air inlet of said outer burner member and operable to supply combustion air to said combustion air space for delivery into said inner burner member through said openings, a variable speed electric motor electrically connected with said thermopile to be energized therefrom and mechanically connected with said impeller for driving the same such that combustion air is supplied to said burner at a rate corresponding substantially with the electric power delivered by said thermopile and substantially with an optimum combustion condition of operation for the burner, and temperature responsive control means effective on the fuel supply means and operable to continually modulate the supply of fuel to said burner in response to temperature variations occurring in said space to be heated.

4. In heating apparatus of the character described, a housing having therein a hollow heating member and an air passage extending in heat-exchange relation to said member and including an inlet for the air to be heated and an outlet for delivering the heated air into a space to be heated and whose temperature is to be controlled, a fuel burner operable to deliver a burning fuel and air mixture and comprising a pair of inner and outer hollow burner members having a combustion air space therebetween, said outer burner member having an inlet for combustion air and said inner burner member having numerous openings for admitting combustion air thereinto from said combustion air space, a hollow thermopile forming a conduit between said burner and said hollow heating member for directing the burning fuel and air mixture into the latter and having thermocouple junctions adapted to be heated by said burning mixture for the generation of electricity, means for supplying fuel to said inner burner member, an air impeller having one portion operable to supply combustion air to said combustion air space for delivery into said inner burner member through said openings and another portion operable to cause a flow of air around said burner and thermopile and through said passage to said space to be heated, a variable speed electric motor electrically connected with said thermopile to be energized therefrom and mechanically connected with said impeller for driving the same such that combustion air is suppiled to said burner at a rate corresponding substantially with the electric power delivered by said thermopile and substantially with an optimum combustion condition of operation for the burner, and temperature responsive control means effective on the fuel supply means and operable to continually modulate the supply

of fuel to said burner in response to temperature variations occurring in said space to be heated.

5. In heating apparatus of the character described, a housing having therein a hollow heating member and an air passage extending in heat-exchange relation to said member and including an inlet for the air to be heated and an outlet for delivering the heated air into a space to be heated and whose temperature is to be controlled, a fuel burner operable to deliver a burning fuel and air mixture and comprising a pair of inner and outer hollow burner members having a combustion air space therebetween, said outer burner member having an inlet for combustion air and said inner burner member having numerous openings for admitting combustion air thereinto from said combustion air space and said inner burner member also including a pot means adapted to contain a quantity of liquid fuel, a hollow thermopile forming a conduit between said burner and said hollow heating member for directing the burning fuel and air mixture into the latter and having thermocouple junctions adapted to be heated by said burning mixture for the generation of electricity, a fuel conduit for supplying liquid fuel to the pot means of said inner burner member, a valve in said fuel conduit, an air impeller located adjacent the air inlet of said outer burner member and operable

to supply combustion air to said combustion air space for delivery into said inner burner member through said openings, a variable speed electric motor electrically connected with said thermopile to be energized therefrom and mechanically connected with said impeller for driving the same such that combustion air is supplied to said burner at a rate corresponding substantially with the electric power delivered by said thermopile and substantially with an optimum combustion condition of operation for the burner, and temperature responsive control means effective on said valve to continually vary the extent of opening thereof in response to temperature variations occurring in said space to be heated.

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