

Nov. 21, 1944.

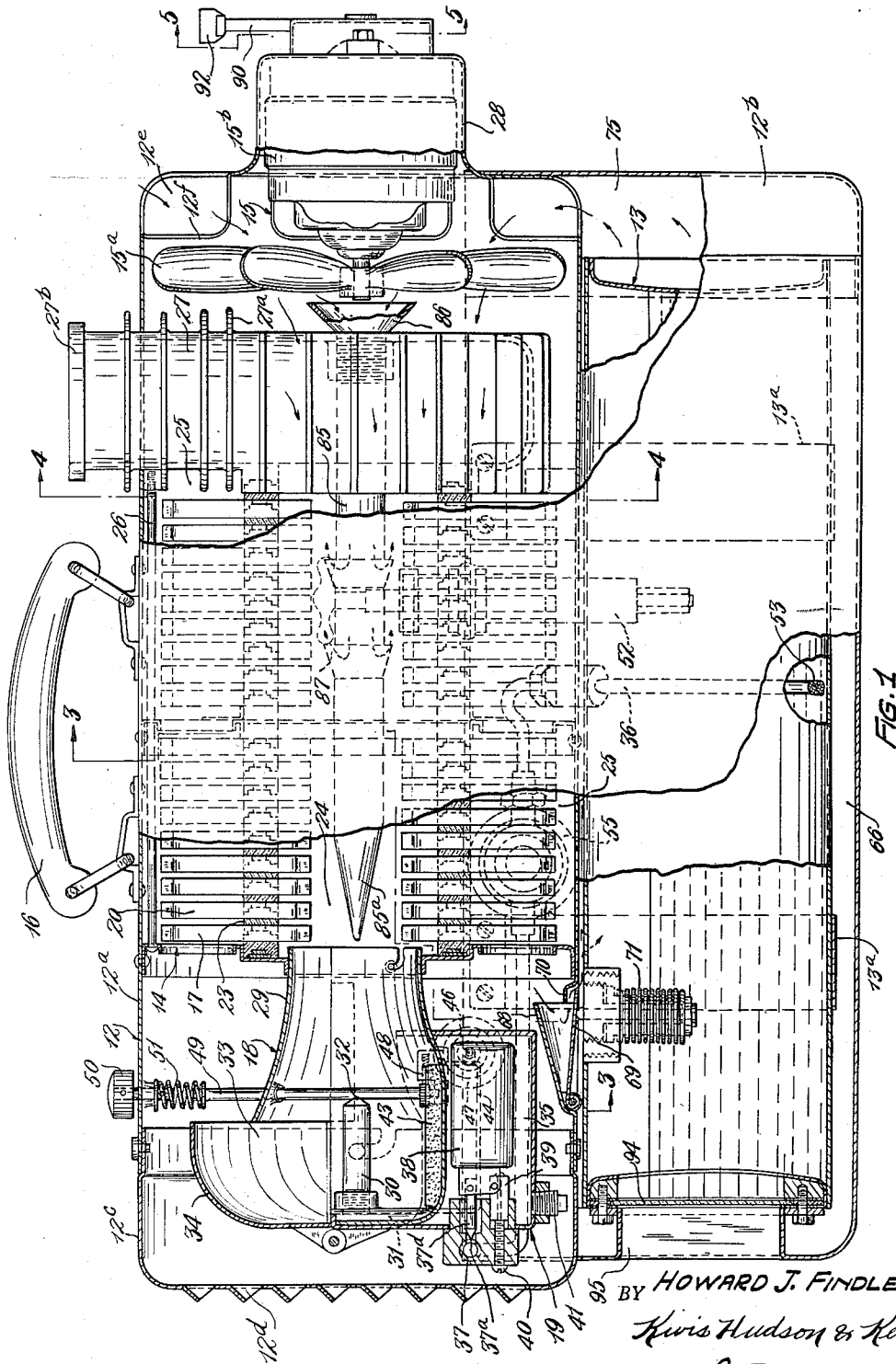
H. J. FINDLEY

2,363,168

HEATER

Filed Oct. 8, 1942

4 Sheets-Sheet 1



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Nov. 21, 1944.

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2,363,168

HEATER

Filed Oct. 8, 1942

4 Sheets-Sheet 2

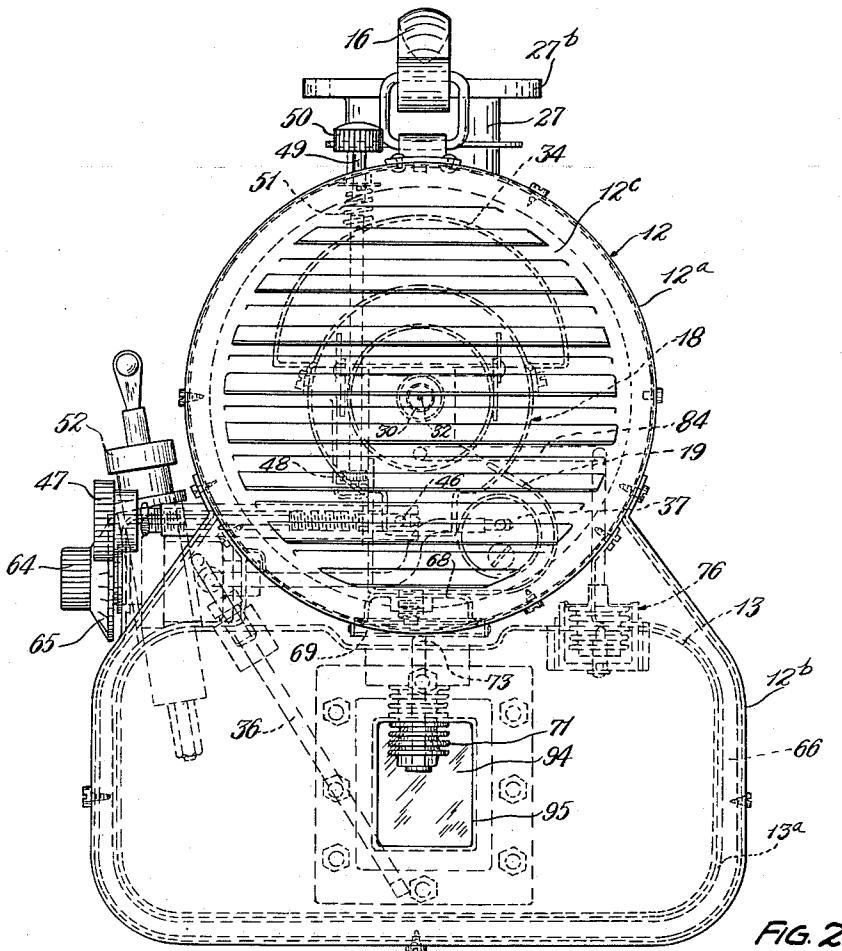


FIG. 2

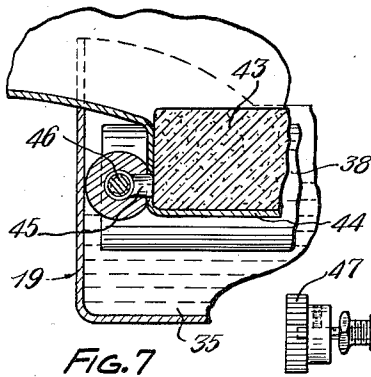


FIG. 7

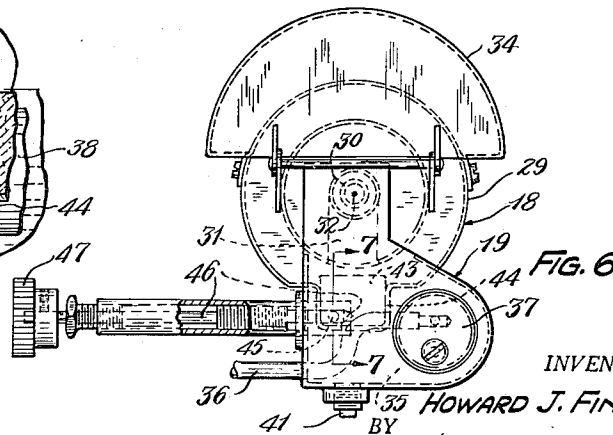


FIG. 6

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2,363,168

HEATER

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4 Sheets-Sheet 3

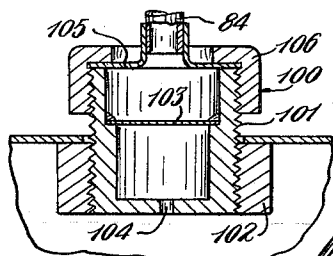


FIG. 11

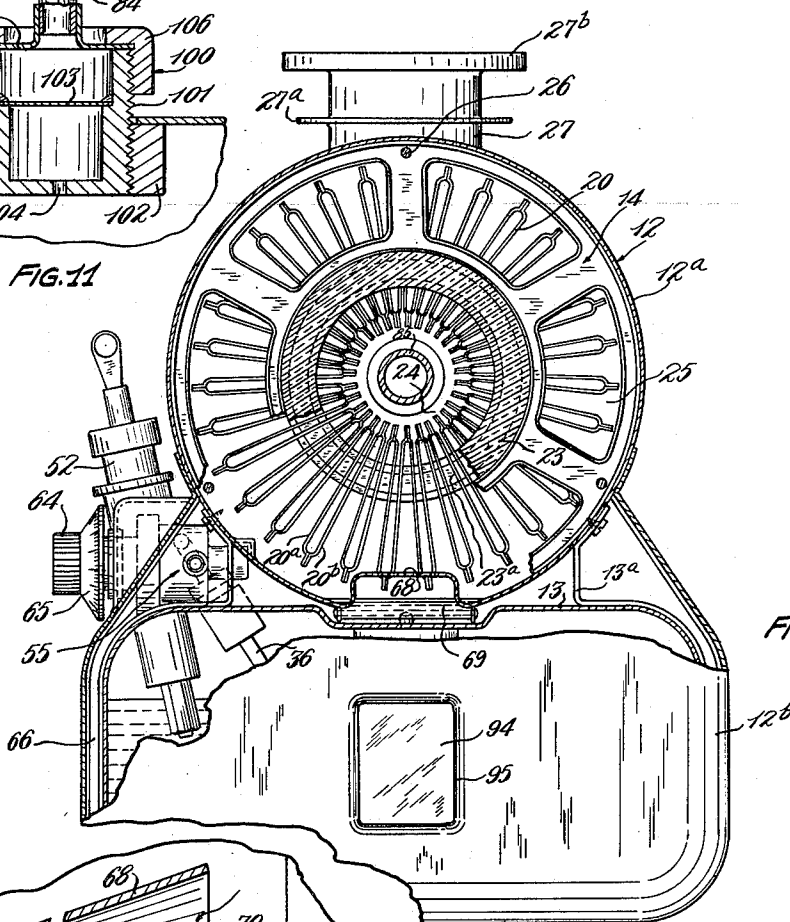


FIG. 3

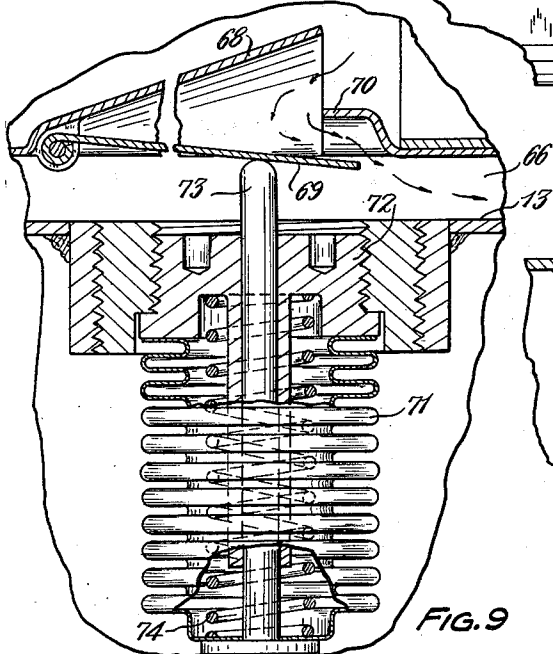


FIG. 9

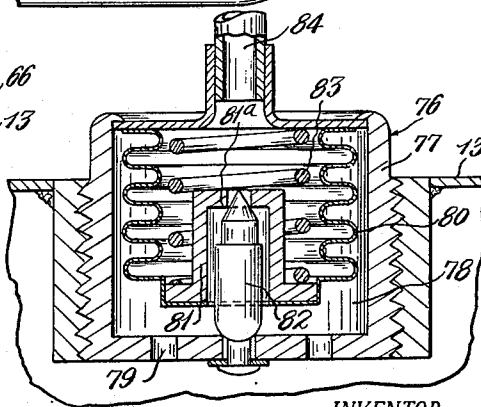


FIG. 10

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HEATER

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4 Sheets-Sheet 4

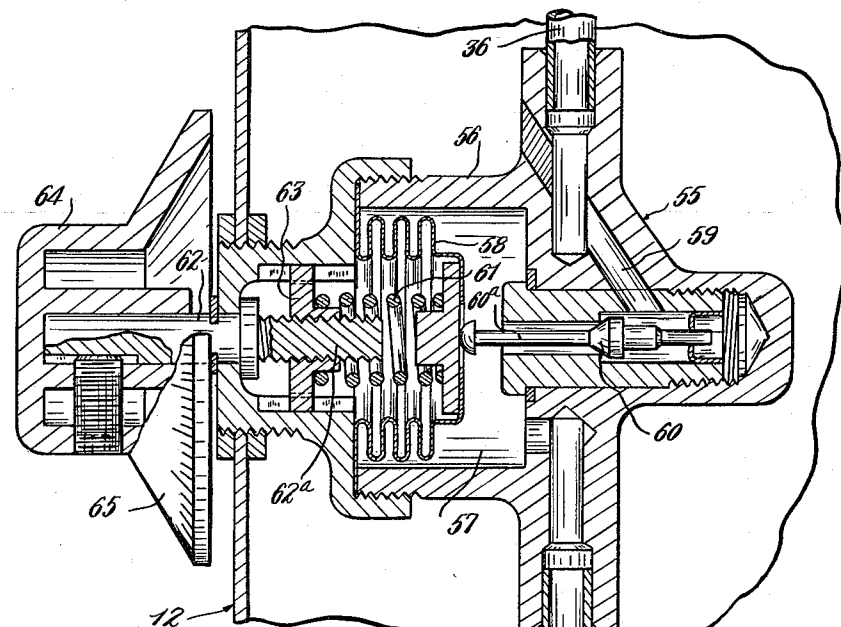


FIG. 8

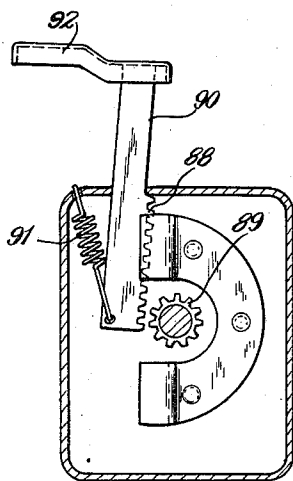


FIG. 5

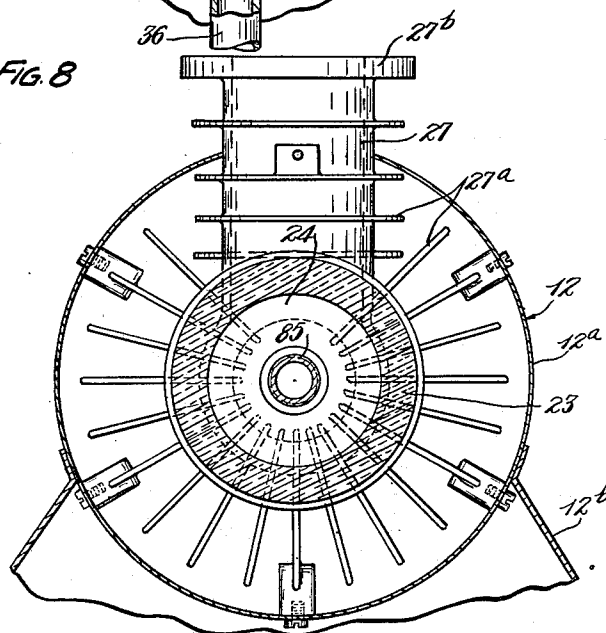


FIG. 4

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UNITED STATES PATENT OFFICE

2,363,168

HEATER

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land, Ohio, a corporation of Ohio

Application October 8, 1942, Serial No. 461,350

18 Claims. (Cl. 126—110)

This invention relates to heating apparatus, and more particularly, to an improved form of space heater of the kind embodying a thermoelectric generator.

An object of this invention is to provide an improved heater of this kind embodying a fuel burning means and a tank adapted to contain fuel under pressure, and wherein novel means is employed for controlling the pressure in the tank and the feeding of fuel to the burner in a manner to obtain a safe and efficient operation of the heater.

Another object of the invention is to provide an improved heater of the character referred to in which a controlled flow or circulation of heated air is used to heat the fuel tank for generating pressure therein.

A further object of my invention is to provide an improved heater of this character in which a fuel vaporizer located between the burner and tank embodies a float-actuated valve for controlling the fuel.

Yet another object of my invention is to provide an improved heating apparatus of this character in which an adjustable pressure-reducing means located between the fuel tank and the vaporizer serves as a means for controlling or determining the rate of heat output of the apparatus.

It is also an object of my invention to provide improved heating apparatus of the kind referred to in which novel means is employed for preliminarily heating the burner.

My invention also aims to provide improved heating apparatus of this kind in which a blower operated by current from the thermoelectric generator delivers a stream of heated air from the apparatus and circulates heated air in contact with the fuel tank for generating pressure therein.

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

A thermoelectric generator having a thermopile embodying a construction of the type herein disclosed but not claimed, is claimed per se in copending application Serial No. 481,450, filed April 1, 1943.

In the accompanying sheets of drawings:

Fig. 1 is a side elevation showing my improved heater with portions thereof broken away;

Fig. 2 is an end view of the heater;

Fig. 3 is a transverse sectional view taken through the heater on line 3—3 of Fig. 1;

Fig. 4 is a partial transverse sectional view taken on line 4—4 of Fig. 1;

Fig. 5 is a transverse sectional view taken on line 5—5 and showing the motor-starting device;

Fig. 6 is an end view, with portions broken away, showing the vaporizer and burner in detached relation;

Fig. 7 is a detail view taken on line 7—7 of Fig. 6 and showing the float chamber and wick holder;

Fig. 8 is a sectional view taken through the pressure-regulating means;

Fig. 9 is a detail view on a larger scale and in section showing means for diverting and controlling the air which heats the fuel tank;

Fig. 10 is a detail view on a larger scale and in section showing means for relieving excess pressure in the fuel tank; and

Fig. 11 is a sectional view showing another device for relieving excess pressure in the fuel tank.

As shown in the drawings, my improved heater comprises in general a casing 12, a fuel tank 13, a thermoelectric generator 14, and an air-flow creating means 15 adapted to be operated by electricity produced by the thermoelectric generator.

The casing 12 may be formed of sheet metal and may comprise a cylindrical section 12a, which houses the thermoelectric generator 14 and the air-flow creating means 15, and a depending substantially rectangular section 12b which is connected with the cylindrical section and forms a base upon which the heater may rest. This rectangular section houses the fuel tank 13 which is adapted to contain fuel under pressure, preferably a liquid hydrocarbon fuel such as gasoline. The housing section 12a is provided at one end with a detachable cover 12c having louvred openings 12d through which the heated air is discharged and at its other end has spaced openings 12e which admit the air to be heated and may be formed by shearing the metal of the casing and deflecting the portions 12f thereof inwardly. At the top of the casing 12 I may provide a suitable handle 16 by which the heater may be conveniently carried.

The thermoelectric generator 14 comprises a thermopile 17, which will be described next, a burner 18, and a fuel vaporizer 19. The thermopile 17 is made up of a relatively large number of thermocouples 20 which are connected in series with each other so that the voltage generated

therein will be cumulative. The thermocouples comprise flat bars or elements 20a and 20b of dissimilar metals, such as steel and constantan, which have their ends connected together as by welding. These thermocouples extend radially and are arranged in groups so that the couples of each group form an annular series. The annular groups or series of thermocouples are placed side by side and are electrically connected in series relation to form the substantially cylindrical shaped thermopile 14. These annular groups of thermocouples are supported by refractory rings 23 having radial grooves 23a in which the elements 20a and 20b engage with the elements extending substantially radially with respect to the longitudinal axis of the thermopile.

The group or sleeve of assembled refractory rings 23 defines an axially extending, substantially cylindrical combustion chamber 24 into which the inner or "hot" ends or junctions of the thermocouples 20 project. In assembling the refractory rings 23, suitable cement may be used therebetween to connect the rings with each other and to enable the same to form a gas-tight wall for the combustion chamber 24. The annular space 25 between the refractory rings and the outer wall of the casing 12 forms an axially extending passage for the air which is to be heated. The outer or "cold" ends or junctions of the thermocouples 20 project into the air passage 25 so that while serving as elements for conducting heat outwardly from the combustion chamber 24, they will at the same time be cooled by the air which is to be heated. The annular groups of thermocouples and the refractory rings are held in assembled relation by a plurality of circumferentially spaced, axially extending clamping bolts 26. The thermopile 14 can be made up as a preformed unit and then assembled into the heater.

To prevent or retard the deteriorating action of the hot combustion gases on the thermocouples, I provide them with a suitable protective covering. For this purpose I apply to the thermocouples, as by a suitable plating operation, a coating formed either of nickel or chromium or a coating formed of both nickel and chromium. When this protective covering is employed, it is applied at least to the thermocouple portions which extend into the combustion chamber 24, but it can be applied to all portions of the thermocouples if desired.

At one end of the combustion chamber 24, in this instance, at the right-hand end as seen in Fig. 1, I provide an exhaust fitting 27 with which the thermopile 14 is connected but is electrically insulated therefrom. The exhaust fitting 27 may be of cast metal or other suitable material and has a plurality of heat-radiating fins 27a thereon which project into the air passage 25. The space or chamber in the exhaust fitting 27 forms a continuation of the combustion chamber 24 and conducts the exhaust gases or products of combustion to a flue or other conduit which may be connected with the flanged end 27b of the exhaust fitting.

The air-flow creating means 15 may comprise a fan or blower 15a carried by the shaft of an electric motor 15b. The motor may be mounted in an axial projection 28 of the casing 12 so that the axis of rotation of the fan 15a is substantially coincident with the longitudinal axis of the combustion chamber 24. The fan 15a causes air to be drawn into the casing through the openings 12e and to flow through the passage 25 and

to be discharged in a heated condition through the louvred openings 12d of the cover 12c.

The burner 18 comprises a flared tube or sleeve 29 and a burner nozzle 30 extending axially thereof. The burner tube 29 has its smaller end connected with the thermopile 14 so as to communicate with the combustion chamber 24 at the end thereof opposite that to which the exhaust fitting 27 is connected. The larger end of the burner tube 29 supports the burner nozzle 30 and contains a passage 31 through which vaporized fuel is supplied to the nozzle. The inner end of the nozzle 30 is provided with a suitable orifice 32 which directs the vaporized fuel into the combustion chamber 24. During the operation of the heater, this vaporized fuel being discharged through the orifice 32 burns as a sustained flame which extends into or through the combustion chamber 24 and heats the inner junctions of the thermocouples 20 to a relatively high temperature.

The portion of the burner tube 29 just above the nozzle 30 is cut away to provide an opening 33 to admit air to the burner for combustion purposes. The air thus admitted to the burner has already been heated by its passage through the thermopile and combines readily with the vaporized fuel. A supercharger action can be obtained in the operation of the burner by providing the burner tube 29 with an air scoop 34 which is arranged to deflect air inwardly through the opening 33. The air scoop 34 may be hinged to the burner tube 29 so that by removal of the cover 12c of the casing, access can be had to this scoop which can be swung to the left to an ineffective position. When the scoop 34 has been swung to its ineffective position, access through the opening 33 can be had to the inside of the burner for inspection or lighting.

The fuel vaporizer 19 is disposed below the burner tube 29 and is connected therewith so as to form a fluid-tight float chamber 35 with which the vapor passage 31 leading to the nozzle 30 communicates. Liquid fuel from the tank 13 is supplied to the float chamber 35 by the piping 36, the fuel being forced through this piping by pressure in the tank. The piping 36 communicates with the float chamber through a valve 37 comprising a passage 37a and a valve element 37b controlling such passage. This valve element is connected with a float 38 so as to be actuated thereby in response to variations in the level of the fuel in the float chamber and to be closed when a predetermined fuel level is reached. The float may be pivotally mounted on a suitable support 39 which is connected with the float chamber by the screw 40. The float chamber may have a drain and cleanout plug 41 in the bottom thereof.

For priming purposes, that is, preliminarily heating the burner tube 29, nozzle 30, and the vaporizer 19 when the heater is to be placed in operation, I provide a wick 43 with which either liquid or vaporized fuel can be burned so that the flame therefrom will heat the parts mentioned. The wick 43 should be made of an incombustible porous material which also has a capillary action similar to that of fabric wicks. I prefer to use a block of ceramic material for this purpose, although porous metal could also be used. The ceramic wick 43 may be supported in a pan-like recess of a wick holder 44 which extends into the float chamber 35 in depending relation to the burner tube 29. Near the bottom of the wick holder 44 and at a point below

the highest fuel level of the float chamber 35, there is a fuel inlet opening 45 which admits liquid fuel to the wick holder and wick from the float chamber. A shut-off valve 46 actuated by a knob 47 controls the passage 45. When the heater is to be placed in operation, the valve 46 is opened a sufficient distance to feed the necessary amount of fuel to the wick from the float chamber. The fuel on the wick is ignited, and after the burner tube, nozzle, and vaporizer have been heated to the desired degree, the valve 46 is closed to prevent further feeding of fuel to the wick. Upon the closing of the valve 46 the vapor being generated in the vaporizer begins to issue from the orifice 32 and burn with a sustained flame. Flooding of the wick holder with excess fuel, either during the priming operation or if the priming valve 46 should be accidentally opened while the heater is not in operation, is prevented by the float valve 37.

In igniting the fuel on the wick 43, a flame may be applied thereto as by inserting a lighted match through the opening 33 after removal of the cover 12c and swinging of the air scoop 24 to its ineffective position. Instead of lighting the wick 43 in this way, I may provide mechanical igniting means such as a flint-type sparking device 48 having a shaft 49 and an operating knob 50 located outside of the casing 12. The shaft 49 may include the accelerating spring 51 usually embodied in sparking devices of this kind.

As stated above, liquid fuel is supplied from the tank 13 to the float chamber of the vaporizer through the piping 36 and the float valve 37. Pressure for initially feeding the fuel to the vaporizer may be generated in the tank by forcing air thereinto by means of the manually operated pump 52. After the heater has been warmed up and is in normal operation, the pressure in the fuel tank is obtained by supplying heat to the tank to cause fuel vapor to create a pressure therein, as will be presently explained.

The pressure in the fuel tank, whether in the form of compressed air or fuel vapor, forces the liquid fuel through the strainer 53 into the piping 36. The pressure maintained in the fuel tank 13 may be on the order of twenty-five pounds per square inch, which is considerably higher than the fuel pressure desired at the float valve 37. For reducing the pressure of the fuel from the tank pressure to that desired at the float valve, which may be on the order of five pounds per square inch, I provide a pressure-reducing valve 55 in the piping 36.

As shown in Fig. 8, this pressure-reducing valve 55 comprises a housing 56 having a diaphragm chamber 57 in which is a flexible diaphragm or bellows 58. The fuel enters the housing through the passage 59 at a point beneath a valve element 60 and normally urges this valve element toward its seat. The stem 60a of the valve element engages the bellows 58 so that opening and closing of the valve will be responsive to the pressure differential between the fuel in the passage 59 and that in the diaphragm chamber 57. If the pressure in the fuel chamber 57 drops, the spring 61 disposed in the bellows will expand the latter and shift the valve 60 away from its seat to permit an increased flow of fuel. If the fuel pressure in the chamber 57 increases, it contracts the bellows 58, which permits the fuel pressure in the passage 59 to shift the valve 60 toward its seat and thus de-

crease the valve opening and the flow of fuel therethrough.

The setting or calibration of the pressure-regulating valve 55 can be varied according to the rate at which it is desired to supply fuel to the vaporizer, or, in other words, in accordance with the rate of heat output desired from the heater. Such adjustment or calibration may be accomplished by rotating the valve stem 62 to thereby shift the nut 63 on the threaded portion 62a of the stem to vary the compression of the spring 61. The valve stem 62 carries a knob 64 having a graduated portion 65 cooperating with a suitable pointer or reference line. The graduations 65 represent different heat output values in B. t. u.'s for the heater, and when the knob 64 is moved to the setting for the desired heat output, the corresponding opening of the valve 60 will permit the necessary flow of fuel from the tank 13 to the vaporizer 19 to generate and maintain such desired heat output.

As shown in Figs. 1, 2, and 3, the sections 12a and 12b of the heater casing cooperate with the side, top, and bottom walls of the fuel tank 13 to provide an air space or passage 66 therebetween. The fuel tank is firmly held against shifting in the casing by means of the straps 13a which extend around the tank and have their upper ends connected to the casing section 12a. Adjacent the left-hand end of the fuel tank 13 I provide an air diverting means by which heated air from the passage 25 is diverted into the space 66 for heating the fuel tank. This diverting means comprises a scoop or deflector 68 and a hinged valve or damper 69 controlling the air intake opening beneath the scoop. When the valve 69 is lifted into engagement with the stop 70, the intake opening is closed and the entry of heated air into the passage 66 is prevented. When the valve 69 is permitted to drop away from the stop 70, heated air is directed into the passage 66 in an amount dependent upon the extent to which the valve 69 has been moved away from the stop 70.

The position of the air valve 69 is controlled automatically according to the pressure in the tank 13, which is, of course, a function of the amount of heat being supplied to the tank. For this purpose I provide a bellows 71 which extends into the fuel tank and has its upper end anchored to a plug 72 which is carried by the top wall of the tank. A stem or plunger 73 having its lower end connected with the inner end of the bellows slidably extends through the plug 72 and its outer end engages the valve 69. A spring 74 contained in the bellows tends to expand the bellows and retract the stem 73 to permit opening of the valve 69. As pressure builds up in the fuel tank, the bellows is contracted against the action of the spring 74, thereby lifting the stem 73 and shifting the valve 69 toward its stop 70.

The heated air which has been diverted into the passage 66 by the scoop 68 travels along the fuel tank 13 toward the right, as seen in Fig. 1, to the space 75 adjacent the right-hand end of the tank, from which space it is withdrawn by the fan 15a and redelivered through the passage 25 of the thermoelectric generator. The action of the fan 15a in withdrawing air from the space 75 facilitates the flow of air through the passage 66 and tends to produce a continuous circulation of hot air in contact with the fuel tank, the amount of the air flow being automatically determined by the position of the valve 69, which

in turn is controlled by the pressure in the fuel tank.

To prevent the building up of an excessive pressure in the fuel tank, I provide the same with a pressure-relief device 76, as shown in Figs. 2 and 10. This pressure-relief device includes a plug member 77 mounted on the wall of the fuel tank and containing a diaphragm chamber 78 which communicates with the tank through the holes 79. A bellows 80 contained in the chamber 78 is responsive to pressure in the fuel tank and its movable inner end carries a cup-like member 81 having a valve seat 81a thereon. A stationary valve element 82 is connected with the inner end wall of the plug 77 and extends into the cup-like member 81 for cooperation with the valve seat 81a. A compression spring 83 contained in the bellows 80 tends to expand the bellows and hold the valve seat 81a against the element 82. When the pressure in the fuel tank exceeds a desired or predetermined value, the bellows 80 is contracted against the action of the spring 83 to lift or separate the seat 81a from the stationary valve element 82 and permit excess pressure to be discharged from the tank through the pipe 84. Since the excess pressure which is thus released from the fuel tank may be in the form of combustible vapor, I extend the pipe 84 upwardly into the combustion chamber 24 so that the vapor will be burned before being discharged into the atmosphere.

Instead of using the pressure relief device 76 above described, I may employ another form of relief device 100, as shown in Fig. 11. The latter device comprises a hollow plug 101 which is screwed into a threaded opening 102 of the fuel tank and carries a frangible disk 103. The inner end of the plug has a small opening 104 therein which connects the recess of the plug with the interior of the tank. The disk 103 may be made of metal or other suitable material and may be soldered or otherwise held in the plug recess so as to close the passage through the plug. The escape pipe 84 may be soldered in an opening in a disk 105 which is connected with the plug 101 by means of the coupling 106. When the pressure in the fuel tank exceeds a predetermined value, it ruptures the frangible disk 103 and excess pressure is thereupon relieved through the pipe 84.

It may be desirable in the operation of my heater to introduce additional or secondary air into the combustion chamber 24 for a more complete combustion of the fuel. For this purpose I may provide a tubular member or aspirator 85 extending into the combustion chamber 24 substantially centrally thereof. The member 85 may be carried by the exhaust fitting 27 and may have a frusto-conical air scoop 86 located just in front of the fan 15a. The additional air which enters the member 85 may be discharged therefrom into the combustion chamber at one or more points therealong by providing this member with hooded openings 87. These openings may be formed by deflecting the wall of the member 85 outwardly at the desired points and in such a manner that the movement of flame and combustion products along the combustion chamber 24 will tend to draw the additional air through the hooded openings by an injector action. The member 85 may be of a length to extend to a point near the smaller end of the burner tube 29, and this portion of the member 85 may be in the form of a closed tapered end 85a. The member 85 also serves other useful purposes

such as a flame spreader. The member 85 can be omitted, if desired, in which case the combustion chamber 24 can be made correspondingly smaller in diameter to bring the "hot" junctions of the thermocouples 20 more directly into the path of the flame and products of combustion.

In the operation of my heater, pressure is first generated in the tank 13 by means of the air pump 52. The pressure-regulating valve 55 is then adjusted to the setting corresponding with the heat output rate desired. The priming valve 46 is then opened by rotating the knob 47 to permit fuel to flow from the float chamber 35 through the passage 45, into the wick holder 44. The fuel on the wick 43 is then ignited, and when the burner and vaporizer have been heated to the desired temperature, the priming valve 46 is closed. Thereafter the liquid fuel which enters the vaporizer is vaporized in the float chamber and is supplied through the passage 31 in a continuous stream to the nozzle 30. The vaporization of fuel in the float chamber 35 creates a pressure therein which causes the vapor to be discharged through the orifice 32 of the burner nozzle 30 so as to direct a flame or stream of burning vapor into the combustion chamber 24. The pressure generated in the vaporizer also tends to retard the flow of liquid fuel through the float valve 37, and during the operation of the heater there may or may not be a pool of liquid fuel in the vaporizer. Usually the liquid fuel enters the float chamber intermittently in small quantities and is immediately converted into vapor, and at this time the float is at its lowest position and the float valve remains open. The back pressure thus created in the float chamber assists the pressure-regulating valve 55 in controlling the supply of fuel to the vaporizer.

The burning of fuel in the combustion chamber 24 in contact with the "hot" junctions of the thermocouples heats these junctions to a temperature which is relatively high as compared with the temperature of their outer or "cold" junctions, and an electric current is generated in the thermopile as a result of this temperature differential. The voltage of the generated current will increase gradually as the operating temperature of the heater rises and will assume a substantially steady value as the heater reaches the operating temperature for which the pressure-regulating valve 55 has been set. The current generated in the thermopile is supplied to the motor 15b and operates the latter to drive the fan 15a. The motor 15b will start running and will increase in speed as the voltage generated in the thermopile 14 increases.

To reduce the time required for the heater to reach its normal operating condition, it is usually desirable to start the fan 15a manually so as to cause a flow of cooling air in contact with the outer junctions of the thermocouples and to supply combustion air to the burner. For this purpose I may employ a starting device for the motor 15b which may be in the form of a rack 88 and pinion 89. The pinion is mounted on the motor shaft and the rack 88 is carried by a plunger 90. The plunger is capable of tilting movement, as well as axial movement, and these combined movements cause the rack 88 to first engage the pinion 89 and to then cause rotation or spinning of the pinion. A tension spring 91 connected with the inner end of the plunger acts thereon at an angle to the plunger axis such that upon release of the plunger after a working stroke, the spring

will first disengage the rack 88 from the pinion 89 and will then retract the plunger. A pressure plate or lever member 92 may be provided at the outer end of the plunger 90 so that when pressure is applied thereto by the thumb of the operator, the rack 88 will first swing into engagement with the pinion and the succeeding inward movement of the plunger will cause rotation of the motor armature and the fan 15a.

For observing the fuel level in the tank 13, I may provide the end wall thereof with a window or gauge 94. The corresponding wall of the lower section 12b of the casing is provided with an opening 95 through which the gauge or window may be observed.

From the foregoing description and the accompanying drawings, it will now be readily understood that I have provided an improved heater which is very compact and which can be conveniently moved to a selected position for heating a desired space or for supplying heat to a desired device or mechanism either by the blast of heated air delivered from the louvred openings of the casing or by the blast of hot exhaust gases being discharged from the exhaust fitting 27, or by a combination of these hot blasts. It will also be seen that my heater embodies a thermoelectric generator which supplies electric current to the fan-operating motor and also embodies means whereby heat from the thermoelectric generator may be safely utilized to generate pressure in the fuel tank. Since a substantially constant pressure is maintained in the tank, it will be seen that variation in the level of the fuel will not affect the rate at which fuel is supplied to the burner. Moreover, it will be seen that there will be no occasion for fuel to drip from the burner when the operation of the heater is discontinued because at this time the pressure-regulating valve is manually closed to serve as a shut-off valve, and whatever fuel is in the vaporizer is consumed at the burner. If fuel leaks past the pressure-regulating valve, it will be held by the float valve and will not drip from the burner.

While I have illustrated and described my improved heater in more or less detail, it will be understood, of course, that I do not wish to be limited to the particular arrangements and details of construction herein disclosed, but regard my invention as including such changes and modifications as do not constitute a departure from the spirit of the invention and the scope of the appended claims.

Having thus described my invention, I claim:

1. A heater of the character described comprising a casing having an air passage therein, a combustion chamber, a burner adjacent said combustion chamber, a thermopile in said casing and having portions thereof in heat-exchange relation to said air passage, said thermopile being adapted to receive heat from the combustion chamber for the generation of electricity and to deliver heat to the air in said passage, means utilizing electricity from said thermopile and operable at a speed which is dependent upon the voltage generated in the thermopile for causing a corresponding flow of air through said passage, a tank adapted to contain a supply of liquid fuel under pressure, means for conducting fuel from said tank to the burner, a pressure-regulating valve in said conducting means, and means for adjusting said regulating valve in accordance with the rate of heat output desired from the heater.

2. In heating apparatus of the character de-

scribed, a casing having therein a combustion chamber and a passage for air to be heated, a thermopile having portions thereof in heat-exchange relation to said air passage, said thermopile being adapted to receive heat from the combustion chamber and to supply heat to the air to be heated, means utilizing electricity from said thermopile and operable to cause a flow of air through said passage, a burner adjacent the combustion chamber, a tank adapted to contain fuel under pressure and to supply fuel to said burner, and means for causing heated air from said passage to contact said tank for generating pressure therein.

3. In heating apparatus of the character described, a casing having therein a combustion chamber and a passage for air to be heated, a thermopile arranged to receive heat from the combustion chamber and to supply heat to the air to be heated, a burner adjacent the combustion chamber, a tank adapted to contain fuel under pressure and to supply fuel to said burner, means operated by electric current generated by said thermopile and arranged to create a flow of air through said passage, and means enabling the air-flow creating means to cause heated air to contact said tank for generating pressure therein.

4. In a heater of the character described, a casing, a thermoelectric generator in the casing including a fuel burning means, a motor driven fan operated by electric current from said generator for causing heated air to be discharged from the casing, and a tank adapted to contain a supply of fuel under pressure and to supply fuel to said burning means, said tank and casing having portions cooperating to provide a passage for a flow of heated air in contact with the tank for generating pressure therein.

5. In a heater of the character described, a casing, a thermoelectric generator in the casing including a fuel burning means, a motor driven fan operated by electric current from said generator for causing heated air to be discharged from the casing, a tank adapted to contain a supply of fuel under pressure and to supply fuel to said burning means, said tank and casing having portions cooperating to provide a passage for a flow of heated air in contact with the tank for generating pressure therein, and means responsive to the pressure in said tank for automatically controlling the flow of heated air in said passage.

6. In a heater of the character described, a casing, a thermoelectric generator in the casing including a fuel burning means, a motor driven fan operated by electric current from said generator for causing heated air to be discharged from the casing, a tank adapted to contain fuel under pressure and to supply fuel to said burning means, said tank and casing having portions cooperating to provide a passage for a flow of heated air in contact with the tank for generating pressure therein, a valve controlling said passage, and means for actuating said valve in response to pressure variations in said tank.

7. In a heater of the character described, a casing, a thermoelectric generator in the casing including a fuel burning means, a tank adapted to contain fuel under pressure and to supply fuel to said burning means, said tank and casing having portions cooperating to provide a passage for a flow of heated air in contact with the tank for generating pressure therein, a motor driven fan operated by electric current from said gen-

erator and arranged to cause a stream of heated air to be delivered from said casing, said passage having a discharge opening adjacent the suction side of said fan, and an air scoop at the inlet end of said passage and extending into the stream of heated air.

8. In a heater of the character described, a casing, a thermoelectric generator in the casing including a fuel burning means, a tank adapted to contain fuel under pressure and to supply fuel to said burning means, said tank and casing having portions cooperating to provide a passage for a flow of heated air in contact with the tank for generating pressure therein, a motor driven fan operated by electric current from said generator and arranged to cause a stream of heated air to be delivered from said casing, said passage having a discharge opening adjacent the suction side of said fan, an air scoop at the inlet end of said passage and extending into the stream of heated air, a valve controlling said inlet end of the passage, and means responsive to pressure variations in the tank for actuating said valve.

9. In a heater of the character described, a casing, a thermoelectric generator in the casing including a fuel burning means and an air passage, a motor driven fan operated by electric current from said generator for causing a flow of air through said passage, a tank adapted to contain a supply of fuel under pressure and to supply fuel to said burning means, said tank and casing having portions cooperating to provide a second passage for a flow of heated air in contact with the tank for generating pressure therein, air diverting means arranged to divert heated air from the first passage into said second passage, and means responsive to the pressure in the fuel tank for controlling the action of said diverting means.

10. In heating apparatus of the character described, a casing having an air passage therein, a thermopile having portions thereof in heat-exchange relation to said passage, a fuel burning means adapted to supply heat to said thermopile for generating electricity and heating the air in said passage, means utilizing electricity from said thermopile and operable to cause a flow of air through said passage, a tank adapted to contain liquid fuel and to supply fuel to said fuel burning means, a float-actuated valve adapted to control the passage of fuel from said tank to said fuel burning means, and means for diverting heated air from said passage into contact with said tank to generate pressure therein.

11. In heating apparatus of the character described, a casing having an air passage therein, a thermopile having heat-conducting portions extending into said passage, a fuel burning means adapted to supply heat to said thermopile for generating electricity and heating the air in said passage, means utilizing electricity from said thermopile and operable to cause a flow of air through said passage, a tank adapted to contain liquid fuel under pressure, a vaporizer adapted to receive liquid fuel from said tank and to supply vaporized fuel to said fuel burning means, a float-actuated valve for controlling the passage of fuel to the vaporizer from said tank, and means for diverting heated air from said passage into contact with said tank to generate pressure therein.

12. In heating apparatus of the character described, a casing having an air passage therein, a thermopile having portions thereof in heat-ex-

change relation to said passage, a fuel burning means adapted to supply heat to said thermopile for generating electricity and heating the air in said passage, means utilizing electricity from said thermopile and operable to cause a flow of air through said passage, a porous wick for use in preliminarily heating said fuel burning means, a tank adapted to contain liquid fuel and to supply such fuel to said fuel burning means and said wick, and means for diverting heated air from said passage into contact with said tank to generate pressure therein.

13. In heating apparatus of the character described, a casing having an air passage therein, a thermopile having portions thereof in heat-exchange relation to said passage, a fuel burning means adapted to supply heat to said thermopile for generating electricity and heating the air in said passage, means utilizing electricity from said thermopile and operable to cause a flow of air through said passage, a tank adapted to contain liquid fuel, means for supplying fuel from said tank to said fuel burning means, a ceramic wick adapted to be supplied with fuel for use in preliminarily heating said fuel burning means, and means for diverting heated air from said passage into contact with said tank to generate pressure therein.

14. In a heater of the character described, a casing having an air passage therein, a thermoelectric generator including a fuel burner, said thermoelectric generator being adapted to produce electricity and to deliver heat to the air in said passage, means utilizing electricity from said thermoelectric generator and operable to cause a flow of air through said passage, a tank adapted to contain a supply of liquid fuel, a vapor generator connected with said burner and tank and including a float chamber, a wick for use in preliminarily heating said burner, said wick being arranged to receive fuel from the float chamber, and means for diverting heated air from said passage into contact with said tank to generate pressure therein.

15. In a heater of the character described, a casing having an air passage therein, a thermoelectric generator including a fuel burner, said thermoelectric generator being adapted to produce electricity and to deliver heat to the air in said passage, means utilizing electricity from said thermoelectric generator and operable to cause a flow of air through said passage, a tank adapted to contain a supply of liquid fuel, a vapor generator connected with said burner and tank and including a float chamber, a wick holder extending into the float chamber and containing a wick for use in preliminarily heating said burner, a valve adapted to be opened to permit a flow of fuel into the wick holder from the float chamber, and means for diverting heated air from said passage into contact with said tank to generate pressure therein.

16. A portable heating device comprising, an elongated casing having an air passage therein, a fuel tank in the lower portion of said casing, a thermopile extending longitudinally in said casing in heat-exchange relation to said air passage, a burner in said casing at one end of said thermopile and operable to supply heat to the latter, means for supplying fuel to the burner from said tank, a motor driven blower in the casing at the other end of said thermopile and operable by electric current from the thermopile for causing a flow of air through said passage, and means for diverting heated air from said passage into

contact with said tank to generate pressure therein.

17. A manually portable heating device comprising, an elongated casing having an air passage therein and having carrying means attached thereto, a fuel tank in the lower portion of said casing, an elongated hollow thermopile extending longitudinally in said casing in heat-exchange relation to said passage, a burner in said casing at one end of said thermopile and operable to supply heat to the latter, means for supplying fuel to the burner from said tank, a motor driven blower in the casing at the other end of said thermopile and operable by electric current from the thermopile for causing a flow of air through said passage, and means for diverting heated air from said passage into contact with said tank to generate pressure therein.

18. A portable heating device comprising, an elongated casing having an air passage therein, a fuel tank in the lower portion of said casing, an elongated hollow thermopile extending longitudinally in said casing in heat-exchange relation to said air passage, a burner in said casing at one end of said thermopile and operable to deliver heated gases through the latter in one direction, means for supplying fuel to the burner from said tank, a motor driven blower in the casing at the other end of said thermopile and operable by electric current from the thermopile for causing a flow of air through said passage in a direction opposite to said gases, and means for diverting heated air from said passage into contact with said tank to generate pressure therein.

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