Nov. 7, 1944. H. J. FINDLEY 2,362,258

HEATING APPARATUS

Filed June 5, 1942 4 Sheets-Sheet 1

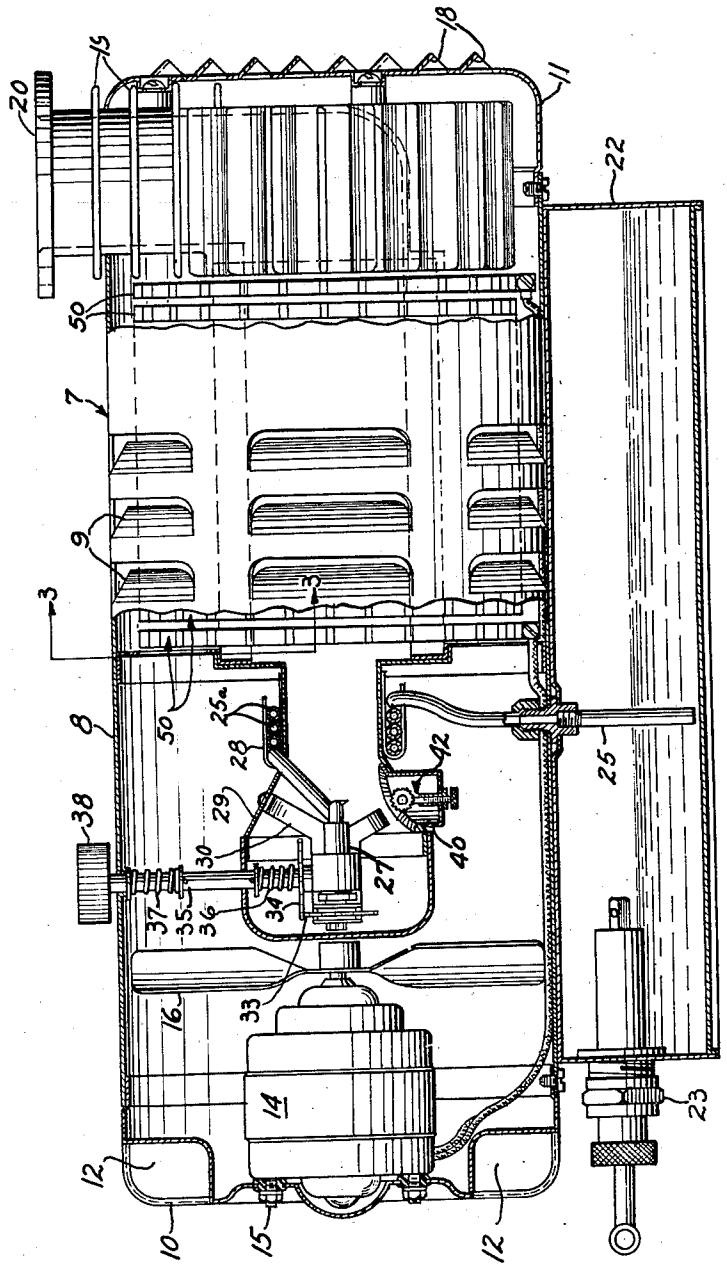


FIG. 1

INVENTOR.
HOWARD J. FINDLEY

BY John F. Stark
ATTORNEY

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HEATING APPARATUS

Filed June 5, 1942 4 Sheets-Sheet 2

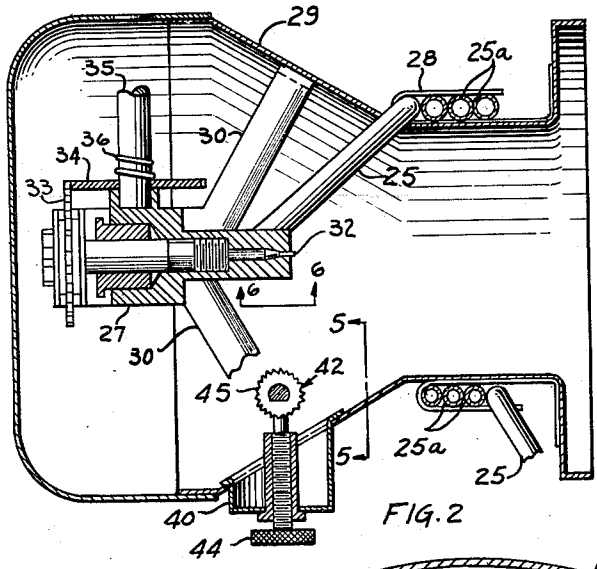


FIG. 2

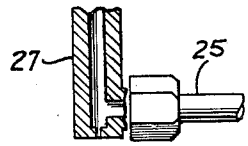


FIG. 6

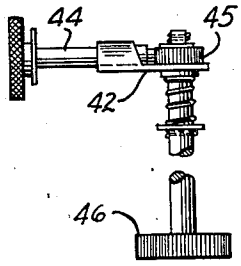


FIG. 5

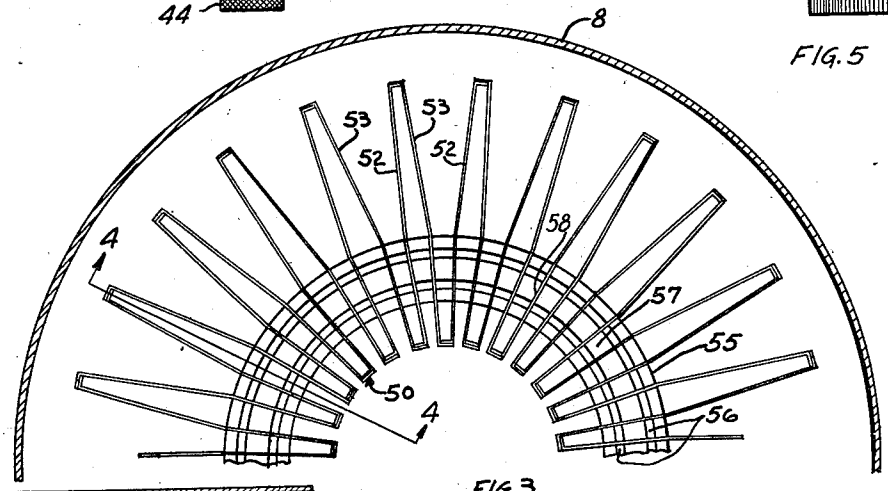


FIG. 3

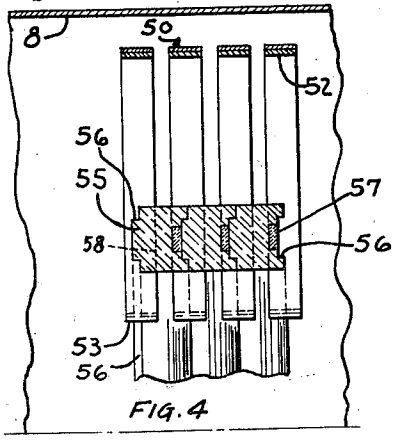


FIG. 4

BY

INVENTOR.
HOWARD J. FINDLEY
John F. Stark
ATTORNEY.

Nov. 7, 1944. H. J. FINDLEY 2,362,258

HEATING APPARATUS

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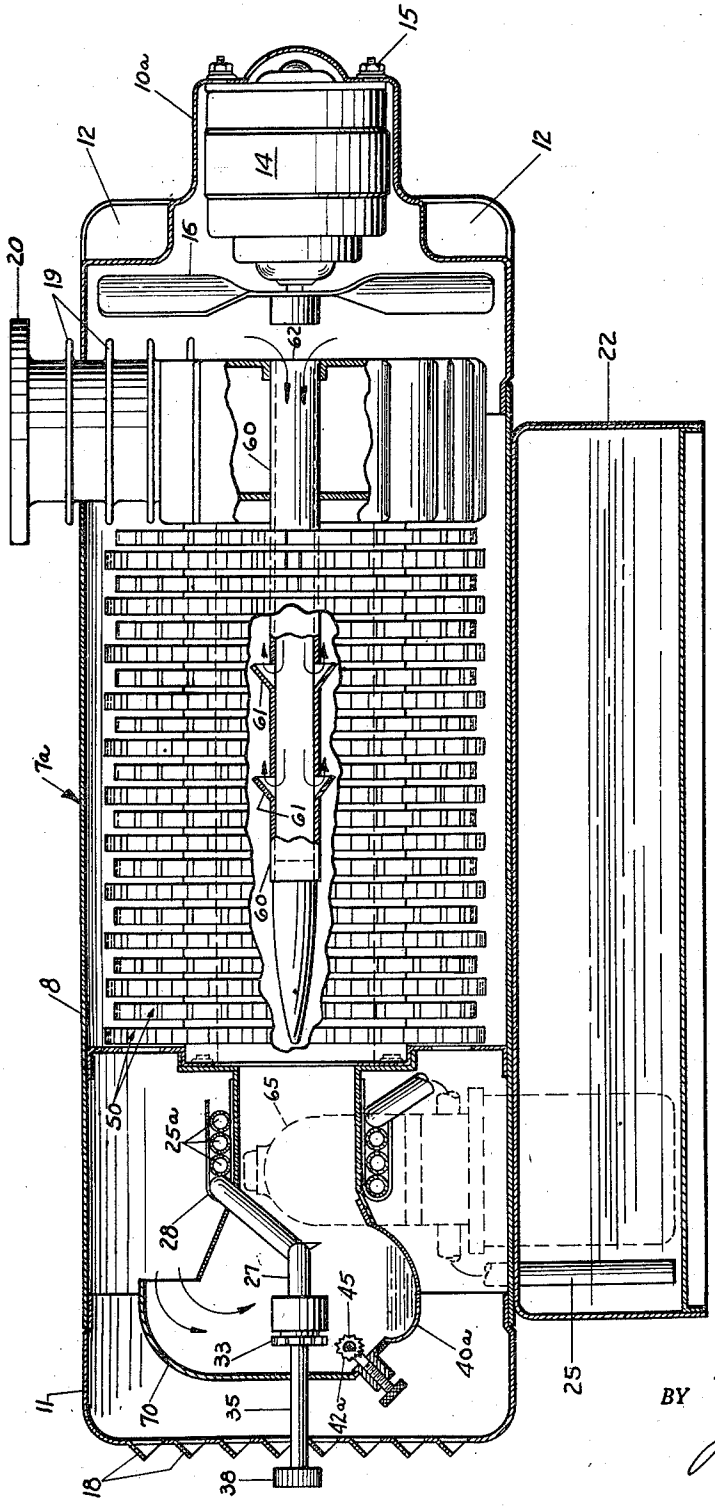


FIG. 7

INVENTOR.
HOWARD J. FINDLEY
BY John F. Stark
ATTORNEY

Nov. 7, 1944. H. J. FINDLEY 2,362,258

HEATING APPARATUS

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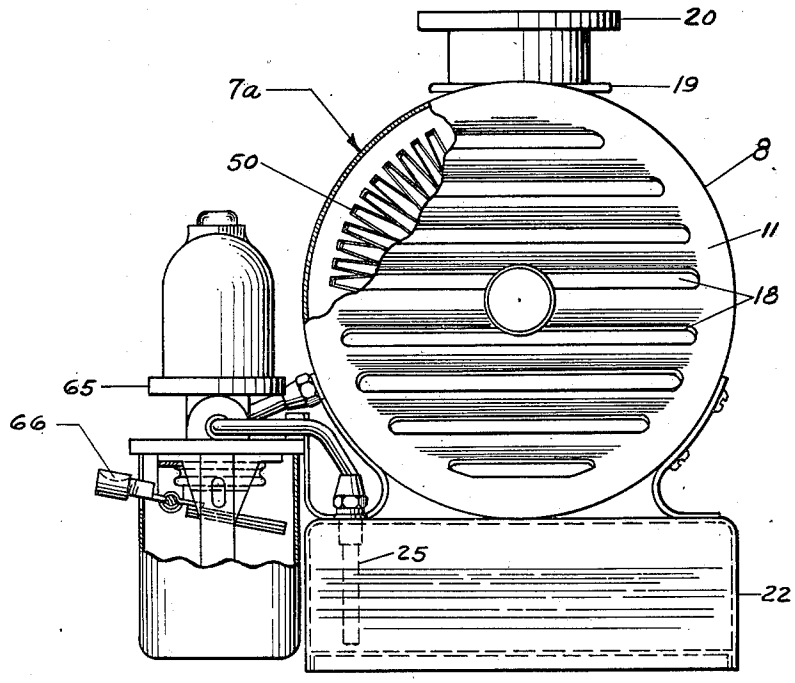


FIG. 8

INVENTOR.
HOWARD J. FINDLEY
BY John F. Stark
ATTORNEY.

Patented Nov. 7, 1944 2,362,258

UNITED STATES PATENT OFFICE

2,362,258

HEATING APPARATUS

Howard J. Findley, Shaker Heights, Ohio, assignor to Eaton Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

Application June 5, 1942, Serial No. 445,994

20 Claims. (Cl. 126—110)

This invention relates to space heaters in general, and, more particularly, concerns a fuel burning heater employing a thermoelectric generator therein.

Among the objects of the present invention is the provision of a fuel burning heater of the type having its own automatic and/or manual pressure fed fuel supply, self-contained ignition means, and a thermoelectric generator energized by the heat products of combustion of the burnt fuel and which generates electric energy to drive an air impelling means for moving air to be tempered past heat radiating means; the provision in a fuel burning heater with a thermoelectric generator, as described, of a novel burner or carburetting means and air impelling device so arranged in a casing as to provide a maximum temperature differential between the "hot" and "cold" junctions of the thermocouples of the thermoelectric generator whereby maximum heat-exchange efficiency is obtained for the thermocouple operation, and maximum heat-exchange dissipation or radiation is effected into the path of the air moved thereover by the air impelling means.

Another object of this invention is the provision in a fuel burning heater with a thermoelectric generator, as described, of a burner construction therefor including a novelly arranged coil for indirect preheating and partial vaporization of fuel supplied to the burner without being exposed to the hottest and most direct flame of the burner; the provision in a fuel-burning heater with a thermoelectric generator, as described, of an improved construction comprising novel refractory means for supporting the thermocouples in insulated relation and defining a combustion chamber longitudinally of the heater casing to segregate the "hot" and "cold" junctions of the thermopile; and the provision in a fuel-burning device for space heating, of a novel flame spreading and propagation element disposed in the combustion chamber of the thermoelectric generator thereof for substantially uniform heating of all the thermocouple elements therein.

A further object of this invention is the provision of a heating apparatus with a thermoelectric generating means which utilizes the thermocouple elements thereof as radiating fins to provide heat to be delivered by the heating apparatus, and a blower to be driven by an electric motor operated by the electricity generated by the thermoelectric generator, the blower moving a stream of air against one end of the thermocouples, which provide a dual purpose for the thermocouples. One purpose being the cooling of one end of the thermocouples and thereby generation of the electric current. The other purpose being the provision of using the same ends of the thermocouples as the heat radiating fins of a heat exchange unit.

Further and other objects and advantages of the invention reside in the novel combination and arrangement of parts about to be described, when taken in conjunction with the drawings forming a part of this specification, and are more particularly pointed 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 drawings like reference characters denote corresponding parts throughout the several views, and in which:

Fig. 1 is a vertical sectional view through one form of space heater with a thermoelectric generator illustrating the genus of the invention; and

Fig. 2 is a vertical sectional view and enlarged detail of the burner element shown in Fig. 1; and

Fig. 3 is an elevational view on the line 3—3 of Fig. 1 illustrating a preferred form of thermocouple construction and mounting means therefor; and

Fig. 4 is a sectional elevational view of the thermocouple mounting means shown in Fig. 3, taken on the line 3—3 thereof; and

Fig. 5 is an elevational view of a means for controlling operation of the burner ignition means externally of the heater casing, taken on the line 5—5 of Fig. 2; and

Fig. 6 is a sectional elevational view of a detail of the burner taken on the line 6—6 of Fig. 2; and

Fig. 7 is a vertical sectional view through a slightly rearranged heater with a thermoelectric generator, as in Fig. 1, but with the addition of a flame spreading element in the combustion chamber of the thermoelectric generator, and a combination manual or electric fuel pump; and

Fig. 8 is an end elevational view of the heater illustrated in Fig. 7.

Now having reference to the drawings, particularly Figs. 1 and 2 there is illustrated a vertical sectional view on the longitudinal axis of a space heater with a thermoelectric gen-

erator generally designated 7, according to the teaching of this invention. The heater 7 is encased in a tube or housing 8 with a plurality of louvers 9 pressed out of the periphery thereof, as shown, and opposite end pieces 10 and 11. The end piece 10 has a plurality of air inlet openings 12 pierced arcuately around the periphery thereof for induction of air to be tempered into the heater casing; and a motor 14 is supported by any suitable fastening means 15 centrally of the end piece for driving a fan 16 to move said air past the outer junctions of the thermopile to cool the same and the finned tube that is an extension of the combustion chamber in which is disposed the "hot" junction of the thermopile.

The opposite end piece 11, on the right hand side of Fig. 1, is suitably secured to the casing 8 and has a plurality of tempered air outlet openings 18 in the outer face thereof disposed beyond the large heat radiating finned tube 19 which has a flange end 20 for connection to any conduit means to conduct the exhaust gases of combustion to the atmosphere. A liquid fuel supply tank 22 is shown depending below the periphery of the heater casing 8 and may be used as the base upon which the unit rests. Disposed within the tank there is shown, in this instance, a manual pump means 23 for placing the fuel therein under pressure to be fed by the pipe line 25 to a burner 27 in the heater casing. It is not intended to be restricted to the manual pump disclosed as any other well known electric fuel pump or a magnetic pulsating-diaphragm pump could be used equally well, as will be evident hereinafter when more fully described.

The burner means 27 is fed from the pipe line 25 which has a section formed into several turns or coils 25*a*, supported by a strap 28, that is fixed to the Venturi-shaped burner housing 29. Short arms or legs 30 extended radially from the burner 27 support it in predetermined position in the throat of the housing 29. A needle valve 32 extended axially through the burner is projected from either end thereof and threaded therein for adjustment to secure a desired atomization or combustible mixture of liquid fuel and air. The rear end of the needle valve mounts a gear wheel 33 fixed normal thereto and which is adapted to mesh with a gear wheel 34 to secure the desired adjustment of the needle valve in the burner from outside the heater casing. The gear 34, to effect such operation, may be journalled on a shaft 35 rotatably supported adjacent opposite ends in the burner and the heater casing 8 and secured in operable position by coiled springs 36 and 37. A handle or knob 38 is secured to the outer end of the shaft 35, where it is easily accessible from outside the heater casing. In Fig. 6 is shown a detail of the manner in which the pipe line 25, which supplies presure fed fuel to the burner 27, is connected thereinto at the needle valve chamber just back of the valve outlet.

Dependent from a lower wall of the Venturi throat-shaped housing 29, when the heater is in its normal position of operation, as shown in Figs. 1 and 2, is a cup-shaped fuel well 40 and a manually controlled flint spark ignition means 42 in the top central portion thereof in line with the discharge end of the burner thereabove to receive liquid fuel thereon when the spark means is operated and the fuel valve is opened. The flint spark ignition means comprises an adjustably mounted flint member 44 and a star wheel 45 arranged to contact the same to produce a spark on relative rotation by means of the attached handle 46 from outside the casing 8, substantially in the manner of the usual cigarette lighter. It will be understood that other fuel ignition means might be substituted such as an electric spark, glow wire, etc., any of which could be generated from a separate source of electric power.

A thermo electric generator or so-called thermopile, composed of a series of thermocouples, is shown generally designated 50 in Fig. 1. The construction of the thermocouples and the mounting means therefor are shown in greater detail in Figs. 3 and 4. The thermopile 50 is arranged axially beyond the burner 27 and fills the tubular casing 8 in a generally star-shaped fashion, with a hollow axially disposed core to carry away the exhaust gases of combustion and which forms the combustion chamber in which the "hot" junctions of the thermocouples are disposed. The individual thermocouples are composed of unlike pieces of ribbon metal 52 and 53, in this instance of iron and constantan, or any other suitable combination of metals which when heated adjacent one end at the junction of the welded unlike metals produces a difference of potential or causes an electric current to flow therein; and by joining the several thermocouples in series a cumulative electromotive force is built up which is tapped by lead wires at either end of the thermopile connected to the ends of the ribbon metal of opposite polarity. These lead wires are connected to the terminals of the electric motor 14 as shown for energizing the same to drive the fan 16 which moves untempered air past the outer junctions of the thermopile to partially cool the same and temper the air, and further tempers such air by passage over and around the finned tube 19, which surrounds the heated exhaust gases discharged from the combustion chamber after passage over the "hot" junctions of the thermopile. It will be understood that the several thermocouples need not be all connected serially as in some instances it may be desirable to have two or more banks of thermocouples arranged for parallel connections.

In order to support the several thermocouples in insulated relation to each other and effectively seal the inner "hot" junctions thereof from the outer heat-radiating ends to produce the greatest temperature differential and hence promote the most efficient difference in electrical potential, there are shown in Figs. 3 and 4 a series of novel refractory rings. Each of these rings 55 has a series of concentric ribs or grooves 56 around its upper and lower periphery which are arranged to nest in each other to form a sealed tube in the casing 8 when assembled or stacked, in the manner shown in Fig. 4, and to define a small annular chamber therebetween for reception of a refractory cement or fire clay 57. A series of radially disposed slots 58, of a depth equal to one-half or more of the width of the thermocouple ribbon metals 52 and 53, are formed in the upper and lower faces of the porcelain rings and in which the individual thermocouples are disposed in series and insulated relation to each other with the junctions to be heated disposed radially inward adjacent the center of the tube in the combustion chamber and the outer heat-radiating junctions, to be cooled by the air blast of the fan 16, spaced radially outward thereby providing a dual purpose of heat-dissipation and heat-exchange to temper the air moved thereover. With an arrangement as shown the thermopile may be fabricated as a

sub-assembly in production quantities and assembled in the heater casing by providing a porcelain ring 55 at either end of the thermopile for sealing with the burner housing 29 at one end and the finned heat-radiating exhaust means 19 at the other end, and at the same time wire leads from the motor 14 are connected to opposite ends of the thermopile. In the form of the invention shown in Fig. 1 and above described, the air propelled by the fan 16 is discharged directly from the casing in the form of heated air and when so discharged is at the maximum temperature to which it is heated by the apparatus.

In the modification illustrated in Figs. 7 and 8 the same general construction of the heating apparatus previously described is shown but with the parts arranged in slightly modified order, and with the addition of a novel flame spreading or propagation element, and a unique combination manual and electromagnetic fuel pump means incorporated therewith. The flame spreading element generaly designated 60 comprises a hollow cylindrical tube, with a bullet-like nose on one end pointed toward the flame of the combusted fuel, and disposed substantially on the central axis of the combustion chamber within the thermopile 50. A plurality of louvered openings 61 struck up from the periphery of the element 60 with their open ends pointed in the direction of movement of the exhaust gases effect a purpose to be described. The opposite end 62 of the tube element 60 is arranged to extend adjacent the air inlet openings 12 in the end piece 10*a* of the heater casing and is opened to the atmosphere. Obviously, of course, if desired at higher altitudes or reduced atmospheric pressure areas a blower may be arranged over the atmospheric opening 62 and supercharged air and/or fuel be applied therein to produce more complete combustion and distribution. Furthermore, by the addition of louvered openings 61, in the element 60, disposed in the direction of movement of the exhaust gases of combustion, it was determined that practically complete combustion of all the fuel was effected. This is undoubtedly due to the additional oxygen supplied to the far end of the combustion chamber through the tube 60, and openings 61 therein disposed to be acted upon, to draw air therefrom by the aspirating action of the gases moving thereover.

It will be apparent that the air impelling means comprising the motor 14 and the fan 15 mounted thereon, have been moved to the opposite end between the exhaust tube 19 and the end of the casing 8. Likewise the end piece 11 with its tempered air outlet openings has been moved to the opposite or left hand end of the casing and the slightly modified end piece 10*a* has been drawn deeper to accommodate a support for the motor 14 and air inlet openings 12. This alteration was effected to provide better selective tempering of the heat generating coil 25*a* and the burner 27 upon starting the operation thereof, when raw cold fuel is supplied thereto, so as to bring it up to normal operating temperature more quickly by movement of heated air over and around the coil and burner. A deflector 70 located adjacent the burner 27 and preferably formed by a portion of the burner housing, acts as a deflecting means or scoop for diverting a portion of the air being propelled by the fan 16 into the burner housing. This diverted air is in a preheated condition and contributes to the efficient combustion of the fuel mixture. A fuel well 40*a* and ignition means 42*a* slightly modified from the previously described structures are used in a similar manner to effect their respective purposes. An added refinement also shown in this modification, which is equally applicable to the previously described construction, consists in staggering the star-like outer ends of alternate layers of the thermocouples in angular relation, so that the several layers of thermocouples are not disposed axially in line with one another, whereby the air to be tempered by passing over these junctions is caused to travel in a tortuous path for more effective wiping action in heat-exchange relation therewith, as best shown in Fig. 8.

The combination manual and electric fuel pump 65, shown attached to the left hand side of the fuel tank and communicated therewith at one end and with the pipe line 25 to feed the fuel and air mixing device 27, has been substituted for the previously described hand pump 23. By use of the novel design shown, in the present heating apparatus, the pump may be manually operated by means of a suitable lever 66 secured thereto to provide pressure feeding of the fuel to initiate operation of the heater. After the combustion chamber has reached normal operating temperature, sufficient current may be generated by the themopiles 50 of the thermoelectric generator to energize the pumping means 65 to thereafter cause normal pumping action. By use of this power means for energizing the fuel pump action a very desirable safety valve is created because the instant thermoelectric generation ceases or fails for any reason the fuel pump becomes disabled or cut off from its current source and no more fuel is pumped into the heater casing where it would soon overflow and present a serious fire hazard as in the case of an independent source of electric power for the pump, if no other automatic safety shut-off were used.

In operation: the heater is charged in this instance with liquid fuel, although other gaseous fuels could be used, which is initially put under pressure by the manual pump means 23; in the construction in Figs. 7 and 8 thermoelectric current thereafter supplies motive power. The burner is ignited by means of the handle 46, on flint ignition means 42 externally of the casing 8, after the fuel valve has been opened and raw fuel allowed to drip on the igniter and into the fuel well 40 proximate thereto. The burner 27 may be adjusted by the handle means 38 to secure the mixture and flame intensity desired. As the junctions of the thermopile in the combustion chamber of the thermoelectric generator become quickly heated the difference in temperature with the radially outward "cold" junctions thereof produces a difference in electrical potential and a current is caused to flow, which, by reason of leads from the motor 14 connected to the thermopile, then drives the fan 16 to assist in maintaining the outer junctions of the thermopile cool by wiping the heat therefrom and also moves air over and around the finned exhaust gas tube 19 and discharges highly tempered air from the casing through the adjacent outlet openings 18 in the end piece 11. Additionally, by reason of the casing louvers 9 being bent inwardly, movement of air by the fan 16 produces an aspirating action thereon to cause more air to be drawn into the casing to be heated. Operation of the construction shown in Figs. 7 and 8 is very similar, the direction of air movement being reversed end for

end, to effect the desirable heat-exchange action of the heated air to provide predetermined tempering of the burner and fuel pre-heating coil of the fuel supply coil, as previously described.

From the foregoing disclosures it will be apparent there has been described novel self-contained fuel burning units for vehicle heating or air tempering including among other things, the object and advantages of the invention first enumerated. It will be seen also that the heating apparatus herein disclosed provides a novel form of air heater which is manually portable and contains its own supply of fuel and wherein the air impelling means which is driven by power from the thermoelectric generator moves a relatively large volume of air through the thermoelectric generator in heat exchange relation thereto and such that all, or the major portion of, the air thus moved is discharged directly from the casing, while such air is at the maximum temperature to which it is heated by the apparatus. It is not intended to be limited, however, to the specific concrete embodiments of the invention shown, which are merely for purposes of illustration, as many modifications will now be suggested to those skilled in the art to which it is related, and formal changes may be made without departing from spirit and substance of the invention as defined by the scope of the following claims.

What I claim is:

1. A self-contained air heating apparatus comprising in combination, a heater casing and means attached to said casing and adapted to contain a supply of pressure fed fuel, means in said casing communicated with the fuel for blending a combustible mixture of fuel and air, a thermoelectric generator formed with an elongated hollow combustion chamber therein, said combustion chamber being located to receive said combustible mixture and having inner and outer junctions of dissimilar metals with the inner junctions disposed in said combustion chamber in the path of the combustible fuel, an exhaust tube connected to said combustion chamber for discharge of exhaust gases of combustion, air impelling means driven by thermoelectric power generated by combustion of fuel in the combustion chamber of said thermoelectric generator and operable to move air past the outer junctions of said thermoelectric generator, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

2. A self-contained air heating apparatus comprising in combination, a heater casing including means attached thereto and adapted to contain a supply of fuel, burner means in the casing arranged to mix a combustible mixture of fuel and air, a thermoelectric generator formed with an elongated hollow combustion chamber therein and having inner and outer junctions of dissimilar metals with the inner junctions disposed in said combustion chamber in the path of the combustible fuel, said thermoelectric generator including multiple layers of thermocouples with the outer junctions of each layer staggered with respect to the junctions of adjacent layers to impart a tortuous path to air moved therethrough, an outlet means to discharge the exhaust gases of combustion, air impelling means energized by thermoelectric power generated by said thermoelectric generator and operable to move untempered air over the outer staggered junctions thereof, means for diverting a minor portion of the propelled air during its travel through the casing, and means for directly discharging the major portion of the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

3. A self-contained air heating apparatus comprising in combination, a heater casing and means attached to said casing and adapted to contain a supply of fuel, burner means in the casing arranged to be manually adjusted from outside the heater casing to mix a combustible mixture of fuel and air, ignition means arranged adjacent the fuel burner to ignite the fuel, a thermoelectric generator formed with an elongated hollow combustion chamber therein and having inner and outer junctions of dissimilar metals with the inner junctions disposed in said combustion chamber in the path of the combustible fuel, an outlet means to discharge the exhaust gases of combustion, air impelling means energized by thermoelectric power generated by said thermoelectric generator and operable to move untempered air over the outer junctions thereof in heat-exchange relation, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

4. A self-contained air heating apparatus comprising in combination, a heater casing including means attached thereto and adapted to contain a supply of liquid fuel, burner means in the casing arranged to be manually adjusted from outside the heater casing to mix a combustible mixture of liquid fuel and air, ignition means arranged adjacent the fuel burner to ignite the liquid fuel, a well disposed beneath said ignition means to receive liquid fuel incident to operation thereof, a thermoelectric generator formed with an elongated hollow combustion chamber therein and having inner and outer junctions of dissimilar metals with the inner junctions disposed in said combustion chamber in the path of the combustible fuel, an outlet means to discharge the exhaust gases of combustion, air impelling means energized by thermoelectric power generated by said thermoelectric generator and operable to move untempered air over the outer junctions thereof in heat-exchange relation, means for diverting a minor portion of the propelled air during its travel through the casing, and means for directly discharging the major portion of the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

5. A self-contained manually portable air heater comprising in combination, a heater casing including means attached thereto and adapted to contain a supply of fuel, burner means in the casing arranged to mix a combustible mixture of fuel and air, a Venturi shaped throat member arranged to support said fuel burner in predetermined position in the throat thereof, a thermoelectric generator formed with an elongated hollow combustion chamber therein and having inner and outer junctions of dissimilar metals insulated from each other with the inner junctions disposed in said combustion chamber in the path of the combustible fuel flowing from the throat of said Venturi member, outlet means to discharge the exhaust gases of combustion, air impelling means energized by thermoelectric power generated by said thermoelectric generator and operable to move untempered air over the outer junctions thereof in heat-exchange relation, and means for directly discharging the propelled air

from said casing while such air is at the maximum temperature to which it is heated by the heater.

6. A self-contained manually portable air heater comprising in combination, a heater casing including means attached thereto and adapted to contain a supply of liquid fuel, burner means in the casing arranged to mix a combustible mixture of liquid fuel and air, a Venturi shaped throat member arranged to support said liquid fuel burner in predetermined position in the throat thereof, a thermoelectric generator formed with an elongated hollow combustion chamber therein and having inner and outer junctions of dissimilar metals insulated from each other with the inner junctions disposed in said combustion chamber in the path of the combustible fuel flowing from the throat of said Venturi member, a heat absorption coil disposed around the Venturi shaped member in front of the burner to provide limited pre-heating and vaporizing of the liquid fuel between the supply source and the fuel burner, outlet means to discharge the exhaust gases of combustion, air impelling means energized by thermoelectric power generated by said thermoelectric generator and operable to move untempered air over the outer junctions thereof in heat-exchange relation, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the heater.

7. A self-contained manually portable air heater of the internal combustion type comprising in combination, a heater casing having cool air inlets, a fuel supply tank attached to said casing and including pump means arranged to move fuel from said tank to the casing, means comprising a carburetting device for mixing a combustible mixture of fuel and air in the casing, spark ignition means disposed adjacent said burner to ignite fuel therein, a thermoelectric generator arranged to have one portion heated by the combustion of said fuel to thereby generate thermoelectric power, an outlet means to exhaust the gases of combustion communicated with the heated portion of said thermoelectric generator and disposed adjacent the air discharge outlets in the heater casing, air impelling means consisting of an electric motor and fan mounted adjacent the casing cool air inlet openings and energized by power from said thermoelectric generator to move untempered air across another portion of the thermoelectric generator in heat-exchange relation, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the heater.

8. In a fuel burning space heater of the internal combustion type, the combination of a fuel and air mixing device, a thermoelectric generator having a combustion chamber formed therein supplied with a combustible mixture by said device, a heat radiator connected to receive the heated gases of combustion from said combustion chamber, means for moving air past said thermoelectric generator and heat radiator consisting of an electric motor and fan driven by thermoelectric power generated by the heat of combustion of said gases, air diverting means adjacent the fuel and air mixing device and adapted to divert a portion of the tempered air into said mixing device, and means for directly discharging the major portion of the propelled air from said casing while such air is at the maximum temperature to which it is heated by the heater.

9. In a fuel burning space heater of the internal combustion type, the combination of a fuel and air mixing device, a heat absorption coil disposed adjacent said fuel mixing device to provide limited pre-heating and vaporizing of raw fuel being fed thereto, a thermoelectric generator having a combustion chamber formed therein supplied with a combustible mixture by said device, a heat radiator connected to receive the heated gases of combustion from said combustion chamber, means for moving air past said thermoelectric generator and heat radiator consisting of an electric motor and fan driven by thermoelectric power generated by the heat of combustion of said gases, air diverting means adjacent said mixing device and coil and adapted to divert a portion of the tempered air into said mixing device, and means for directly discharging the major portion of the propelled air from said casing while such air is at the maximum temperature to which it is heated by the heater.

10. In an air heater of the internal combustion type, the combination of a body having air inlets, tempered air outlets, and a fuel and air mixing device therein, a fuel tank connected with said body and adapted to contain a supply of liquid fuel, a thermoelectric generator in said body having an elongated hollow combustion chamber formed therein supplied with a combustible mixture by said device, an exhaust means connected to receive the waste gases of combustion from said combustion chamber, means for moving cooling air around the outer portions of the combustion chamber formed in said thermoelectric generator in heat-exchange relation and discharging the major portion of such air from the tempered air outlets of said body in the form of heated air, said air moving means consisting of an electric motor and fan driven by thermoelectric power generated by the heat of combustion in said thermoelectric generator, and an electrically driven fuel pump utilizing electric current from said generator and operable to deliver fuel from said tank to said mixing device.

11. A fuel burning space heating apparatus comprising in combination, a casing, a fuel and air mixing device therein, a thermoelectric generator in said casing formed with an elongated hollow combustion chamber therein supplied with a combustible mixture by said device, a fuel tank attached to said casing and adapted to contain a supply of liquid fuel, a plurality of thermocouples in said generator arranged with one set of junctions thereof in the combustion chamber and having the opposite ends of the junctions disposed outwardly therefrom in a heat-radiating manner, means connected to receive heated gases from said combustion chamber and exhaust the same, air impelling means energized from power generated by said thermoelectric generator to move air in heat-exchange relation past the outer heat-radiating junctions of said thermocouples, and an electrically driven fuel pump utilizing electric current from said generator and operable to deliver fuel from said tank to said mixing device.

12. A fuel burning space heating apparatus comprising in combination, a casing provided with a pressure fed fuel supply means, a fuel and air mixing device therein, a thermoelectric generator in said casing formed with an elongated hollow combustion chamber therein supplied with a combustible mixture by said device, a plurality of thermocouples in said generator arranged with one set of junctions thereof in the combustion chamber and having the opposite ends of the

junctions disposed outwardly therefrom in a heat-radiating manner, an exhaust means connected to receive heated gas from said combustion chamber and exhaust the same, air impelling means in the casing adapted to be driven by current from said thermoelectric generator and operable to cause a flow of air to be heated through the casing and around said combustion chamber, and said pressure fed fuel supply means comprising a combination manual fuel pump to initiate operation of the heater and electric pumping means therein energized by the thermoelectric generator upon reaching operating temperature.

13. A fuel burning space heating apparatus comprising in combination, a casing provided with a pressure fed fuel supply means, a fuel and air mixing device therein, a thermoelectric generator in said casing formed with an elongated hollow combustion chamber therein supplied with a combustible mixture by said device, a plurality of thermocouples in said generator arranged with one set of junctions thereof in the combustion chamber and having the opposite end of the junctions disposed outwardly therefrom in a heat-radiating manner, an exhaust means connected to receive heated gases from said combustion chamber and exhaust the same, air impelling means in the casing adapted to be driven by current from said thermoelectric generator and operable to cause a flow of air to be heated through the casing and around said combustion chamber, said pressure fed fuel supply means comprising a combination manual fuel pump to initiate operation of the heater and electric pumping means therein energized by the thermoelectric generator upon reaching operating temperature, said pumping means so constructed and arranged with relation to its supply of electric current that failure of the thermoelectric generator causes cessation of further pumping action, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

14. A self-contained air heating apparatus comprising in combination, a casing having air inlet openings, a thermoelectric generator including multiple thermocouples positioned within the casing, a combustion chamber, a hollow flame spreading tube within said combustion chamber, a burner directing the flame towards said tube, means for supplying fuel to said burner including a tank attached to said casing and adapted to contain a supply of fuel, said tube provided with peripheral openings to enable air to be passed therethrough to said flame, one end of said thermocouples being cooled by a stream of air delivered through said casing in heat-exchange relation to said thermocouple ends, air impelling means driven by electric current from said generator and operable to propel such stream of air across said thermocouple ends, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

15. A self-contained portable air heating apparatus of the character described, comprising a pair of spaced coextending tubular members defining a combustion chamber and a passage of air to be heated, one of said members being a casing having air inlet openings and the other having a wall formed of refractory material, a plurality of thermocouples extending through said wall and having junctions disposed in said combustion chamber and other portions extending into the air passage, a fuel burner for supplying heated gases to said combustion chamber, an elongated fuel tank adapted to contain a supply of fuel for said burner and attached to the lower portion of said casing, said thermocouples serving to conduct heat from the combustion chamber to said air passage, air impelling means in said casing adapted to be driven by electric current from said thermocouples and operable to create a flow of air to be heated through said air passage in contact with the thermocouple portions therein, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

16. A self-contained portable air heating apparatus of the character described, comprising an elongated outer casing, a tubular member extending substantially coaxially in said casing and having a refractory wall defining a combustion chamber, said wall being spaced from said outer casing to provide a passage for air to be heated, a plurality of thermocouples extending through said refractory wall and having exposed thermocouple junctions located in said combustion chamber and other portions extending into the air passage, said thermocouple serving to conduct heat from the combustion chamber to said air passage, fuel and air mixing means adapted to deliver a blast of burning fuel into said combustion chamber in direct contact with the junctions therein, an elongated tank adapted to contain a supply of fuel and extending along the lower portion of said casing and forming a base for supporting the apparatus, air impelling means in said casing adapted to be driven by electric current from said thermocouples and operable to create a flow of air to be heated through said passage in direct contact with the thermocouple portions therein, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

17. A self-contained portable air heating apparatus of the character described, comprising an elongated outer casing, a tubular member extending substantially coaxially in said casing and having a refractory wall defining a combustion chamber, said wall being spaced from said outer casing to provide an annular passage therebetween for air to be heated, a plurality of thermocouples extending through said wall and having junctions located in said combustion chamber and other portions extending substantially radially outwardly into the air passage for conducting heat from the combustion chamber to said passage, a fuel-burning means located to deliver heated gases into said combustion chamber, an elongated fuel tank adapted to contain a supply of fuel and extending longitudinally of said casing along the lower portion thereof so as to form a base for supporting the apparatus, air impelling means in said casing adapted to be driven by electric current from said thermocouples and operable to create a flow of air to be heated along said passage in surrounding relation to said wall and in direct contact with the thermocouple portions in said passage, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

18. A self-contained air heating apparatus of the character described, comprising a pair of spaced coextending tubular members defining a combustion chamber and a passage for air to be heated, one of said members forming a casing

having air inlet openings and the other having a wall formed of refractory material, a plurality of thermocouples extending through said wall and having junctions disposed in said combustion chamber and other portions extending into the air passage for conducting heat from the combustion chamber to said air passage, a burner located to deliver burning fuel into said combustion chamber, a tank attached to said casing and adapted to contain a quantity of fuel, a pump adapted to be driven by electric current from said thermocouples and operable to supply fuel from the tank to said burner, air impelling means adapted to be driven by electric current from said thermocouples and operable to create a flow of air to be heated through said air passage in contact with the thermocouple portions therein, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

19. A self-contained portable air heating apparatus of the character described, comprising a pair of spaced coextending tubular members defining a combustion chamber and a passage for air to be heated, one of said members being a casing having an air inlet opening and the other having a wall formed of refractory material, a plurality of thermocouples extending through said wall and having junctions disposed in said combustion chamber and other portions extending into the air passage for conducting heat from the combustion chamber to said air passage, a burner tube communicating with said combustion chamber, a burner in said tube adapted to deliver burning gases into said combustion chamber, means for supplying fuel to said burner including an elongated tank adapted to contain a supply of fuel and extending along the lower portion of said casing and forming a base for supporting the apparatus, an impelling means adapted to be driven by electric current from said thermocouples and operable to create a flow of air to be heated through said passage in contact with the thermocouple portions therein, means for directing a minor portion of the heated air from said passage into said burner tube, and means for directly discharging a major portion of the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

20. A self-contained portable air heating apparatus of the character described, comprising an elongated casing having air inlet openings, a tubular combustion chamber extending axially in said casing and having a refractory wall spaced from the casing to define a passage for air to be heated, a plurality of thermocouples extending through said wall and having junctions disposed in said combustion chamber and other portions extending into the air passage for conducting heat from the combustion chamber to said air passage, a burner located at one end of said combustion chamber and adapted to deliver burning gases thereinto, means for supplying fuel to said burner including an elongated tank adapted to contain a supply of fuel and extending along the lower portion of said casing and forming a base for supporting the apparatus, an exhaust member in the casing and communicating with the other end of said combustion chamber for receiving combustion gases therefrom, air impelling means in the casing adapted to be driven by electric current from said thermocouples and operable to create a flow of air to be heated through said passage and across said thermocouple portions and exhaust member, and means for directly discharging the propelled air from said casing while such air is at the maximum temperature to which it is heated by the apparatus.

HOWARD J. FINDLEY.