Jan. 28, 1947. H. J. FINDLEY 2,415,005

THERMOELECTRIC GENERATING DEVICE

Filed June 23, 1943 3 Sheets-Sheet 1

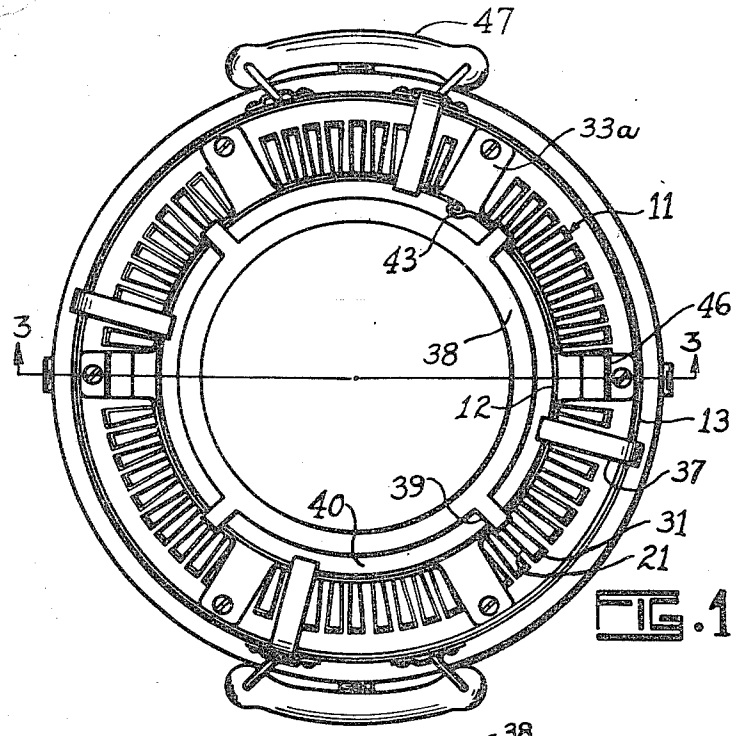

FIG. 1

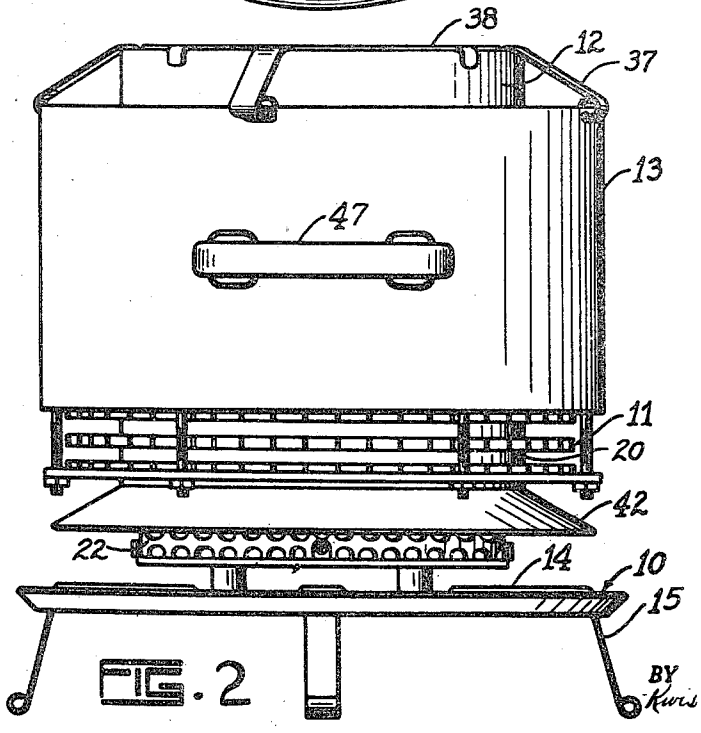

FIG. 2

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FIG. 7

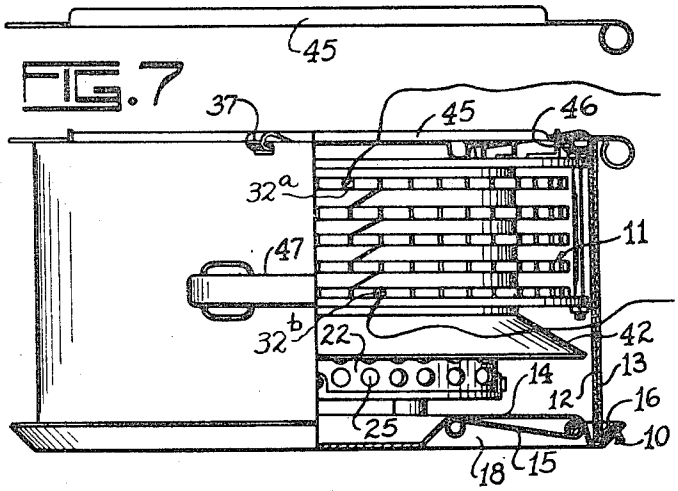

FIG. 4

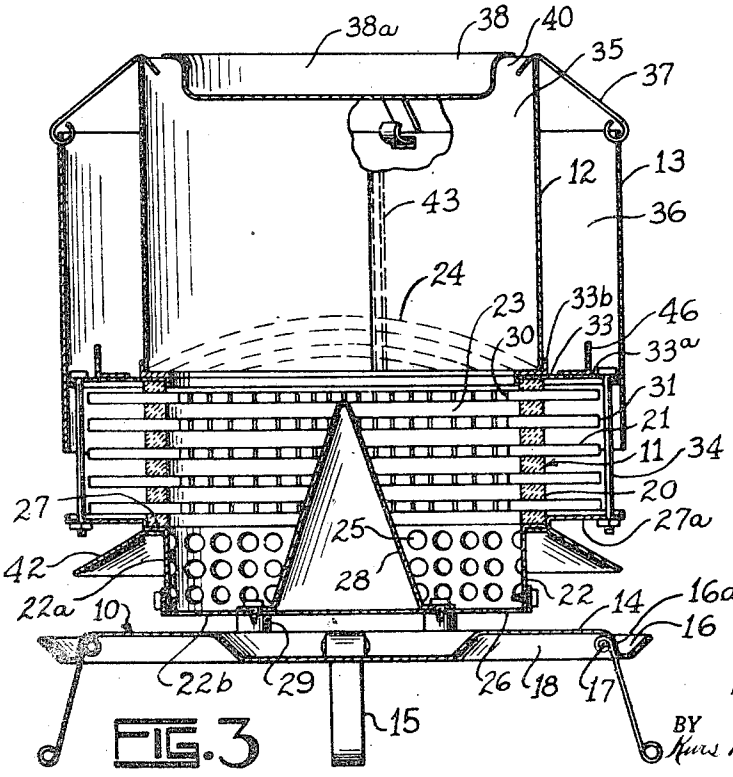

FIG. 3

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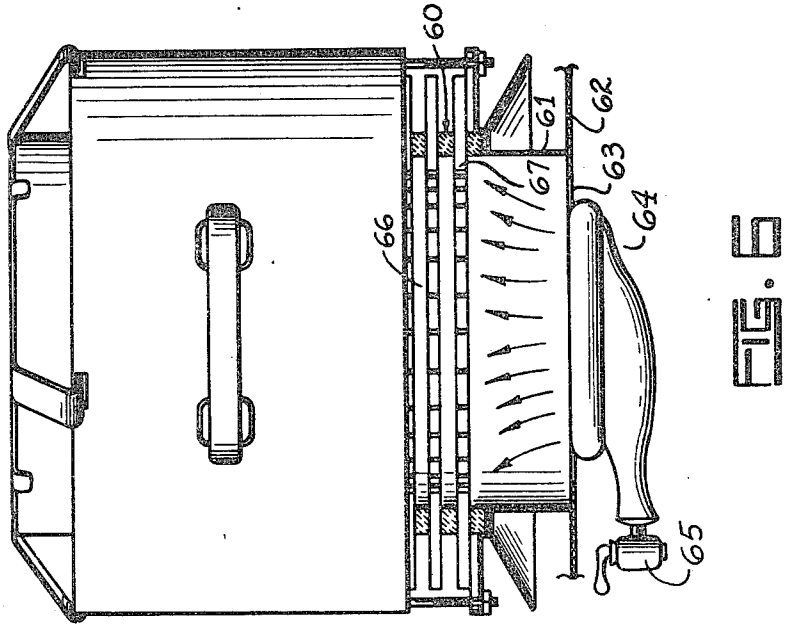

FIG. 6

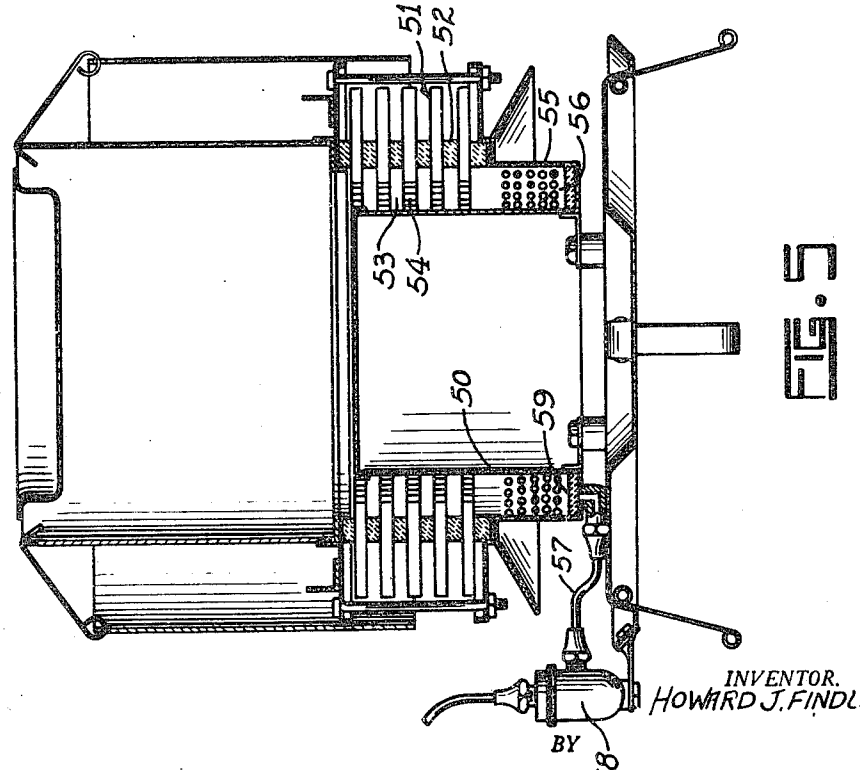

FIG. 5

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UNITED STATES PATENT OFFICE

2,415,005

THERMOELECTRIC GENERATING DEVICE

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

Application June 23, 1943, Serial No. 491,909

4 Claims. (Cl. 136—4)

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My earlier application Serial No. 484,085, filed April 22, 1943, discloses a portable thermoelectric generator having a housing member or hood which is liftable from a closed position to an open position in which it forms a stack. The present invention also relates to thermoelectric generators and aims to provide an improved construction for a device of this kind affording a simplified, relatively lightweight, thermoelectric generating unit which can be collapsed to a compact condition enabling it to be manually carried to a desired point of use.

Another object of my invention is to provide an improved thermoelectric generator of simplified construction which is readily adaptable for use with solid, liquid or gaseous fuels.

A further object of this invention is to provide an improved thermoelectric generator, of the character mentioned, having housing members which, in one position, form inner and outer stacks and which are movable to a collapsed position or location surrounding the thermopile.

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.

In the accompanying sheets of drawings,

Fig. 1 is a plan view showing an embodiment of my improved thermoelectric generator adapted for burning solid fuel;

Fig. 2 is a side elevation thereof;

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

Fig. 4 is a view, partly in elevation and partly in vertical section, showing the generator in its collapsed condition;

Fig. 5 is a vertical sectional view taken through a modified form of my generator showing the same adapted for burning liquid fuel;

Fig. 6 is an elevational view, partly in section, showing another modified form of my generator adapted for burning gaseous fuel; and

Fig. 7 is a side elevation of the combined locking bar and poker, showing the same in detached relation.

In proceeding with a more detailed description of my thermoelectric generator, I will describe first the embodiment shown in Figs. 1 to 3, inclusive, which is adapted for burning solid fuel. This thermoelectric generator comprises in general a base 10, an upright thermopile 11 extending above the base, and a pair of inner and outer housing members or stacks 12 and 13.

The base 10 may be in the form of a standard

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comprising a laterally extending pan or table portion 14 having a plurality of legs 15 connected therewith. The pan 14 may be formed of sheet metal or other appropriate material and has an annular groove or recess 16 formed therein around its outer edge which is adapted to receive the lower ends of the housing members 12 and 13 when the latter are in their closed or collapsed position as shown in Fig. 4. The legs 15 are connected with the under side of the pan 14 by hinged joints 17 enabling the legs to be folded to their collapsed position shown in Fig. 4. The pan 14 is recessed in the under side thereof, as indicated at 18, so as to provide a space or spaces into which the legs 15 are movable in their collapsed position. When the legs are in their extended position, as shown in Fig. 3, the sloping inner wall 16a of the grooved annular portion 16 forms a stop for limiting the outward movement of the legs. When the pan 14 is made of sheet metal, the forming of the groove 16 and the recessed portions 18 can be done by appropriate stamping or drawing dies and this will stiffen and strengthen the pan.

The thermopile 11 comprises an upright tubular member 20 carrying a plurality of thermocouples 21 and at its lower end having a fuel supporting basket or grate 22. The tubular member 20 is formed of a refractory or heat-resisting material, which is also electrically insulating, and defines or surrounds an upright combustion chamber 23 adapted to contain a quantity of solid fuel 24. The fuel supporting basket or grate 22 has an upright annular side wall 22a provided with perforations 25 and a transverse bottom wall 22b provided with perforations 26. The side wall 22a has an outwardly projecting lateral flange 27 thereon forming an annular seat for the lower end of the tubular member 20. The transverse bottom wall 22b carries an upright cone 28 which extends upwardly within the bed of fuel 24 and serves as a spreader or deflector for causing the fuel and ashes to be displaced laterally toward the perforations 25 and 26 as the fuel moves downwardly during the burning thereof. The thermopile 11 and the fuel supporting basket or grate 22 are supported on the base 10 by means of spacers 29 so as to maintain the transverse bottom wall 22b spaced from the pan 14.

The thermocouples 21 may be of any suitable construction and may comprise thermocouple elements formed of dissimilar metals and connected to provide internal or "hot" thermocouple junctions 30 and external or "cold" thermocouple junctions 31. The thermocouples 21 are sup-

ported by the tubular member 20, by being suitably mounted in appropriate openings thereof, in electrically insulated relation to each other and so that they extend through the wall of this member with the junctions 30 in an exposed condition in the combustion chamber 23 and with the junctions 31 lying outside of the hollow member 20. The thermocouples 21 are provided in considerable number and may be arranged in axially spaced, substantially parallel, annular groups as shown in the drawings. The thermocouples may be electrically connected in series, or in series-parallel, relation with each other depending upon the current and voltage characteristics desired at the terminals of the generator. The thermopile 11 may be held against the annular seat 27 by means of an annular clamping ring 33 engaging the upper end of the hollow member 20 and suitable clamping bolts 34 extending through the laterally projecting arms 33*a* and 27*a*.

With the thermoelectric generator in its open or operating condition, as shown in Figs. 1 to 3, inclusive, the housing members 12 and 13 serve as stacks at which time the inner member 12 extends above the thermopile 11 and forms a flue or passage 35 for combustion gases arising from the fuel bed 24 and the outer stack 13 is disposed in spaced relation around the inner stack to define an annular passage 36 for cooling air. The inner stack 12 is supported on the upper end of the thermopile 11 and is held against lateral shifting by the vertical flange 33*b* of the clamping ring 33. The outer stack 13 may be supported from the inner stack 12 as by means of a plurality of hooks 37 having a hinged connection with the upper end of the outer stack and have their hook ends in engagement with the upper edge of the inner stack. The inner stack 12 may be provided with a suitable cover 38 which is supported thereon by the projecting arms 39 and is of a size relative to the diameter of the inner stack to leave an annular space or series of arcuate slots 40 for the discharge of the combustion gases. The cover 38 may be dished to provide a recess 38*a* therein in which can be placed any material desired to be heated while the thermoelectric generator is in use.

In the operation of the thermoelectric generator shown in Figs. 1 to 3 inclusive, the cover 38 is temporarily removed and solid fuel of any available kind, such as wood, coal, charcoal, peat or fibrous material, is placed in the combustion chamber 23 and maintained in a burning condition. A sufficient bed of burning fuel is maintained in the combustion chamber so that substantially all of the exposed internal thermocouple junctions 30 will be in direct contact with the burning fuel and will be heated thereby. The external thermocouple junctions 31 are simultaneously cooled by an upward flow of air through the annular passage 36, such cooling air being in direct contact with the external thermocouple junctions. A relatively high temperature differential can be thus maintained between the internal and external thermocouple junctions and a considerable amount of electrical current is generated in the thermocouple. This electric current can be used for any desired purpose such as charging storage batteries or operating signaling apparatus. The ash resulting from the combustion of the fuel 24 is discharged from the basket or grate 22 through the perforations 25 and 26 thereof. To protect the thermocouples 21 from radiant heat given off by the fuel supporting basket or grate 22, I may provide the lower end of the thermopile with an outwardly and downwardly extending shield 42 as shown in the drawings.

It will be seen from the above described construction of my thermoelectric generator that a relatively light weight unit is provided. When the generator is to be transported to a desired point of use, it is collapsed to the condition shown in Fig. 4, at which time the legs 15 are in their folded position and the stack or housing members 12 and 13 are in their collapsed or closed position surrounding the thermopile 11 and with their lower ends seating in the annular groove 16 of the base 10. The outer stack member 13 can be moved to this position by simply disengaging the hooks 37 and lowering this member to the position shown in Fig. 4. The inner stack member 12 is split longitudinally at one point thereof, as indicated at 43 in Fig. 1, so that it can be expanded or distorted and placed in a position lying inside of the outer stack member 13 as shown in Fig. 4. The stack members 12 and 13 can be retained in the collapsed position of Fig. 4 by means of a transverse locking bar 45 which is engageable in bayonet locking slots or recesses of a pair of clips 46 provided on the laterally extending legs 33*a*. The member 45 is completely detachable from the clips 46 and, when the thermoelectric generator has been set up for operation as shown in Figs. 1 to 3, inclusive, this member can be used as a poker for attending to the burning of the fuel. The outer stack member 13 is provided with one or more carrying handles 47 to facilitate the manual lifting and carrying of the generator.

In Fig. 5 of the drawings, I show a modified form of my thermoelectric generator which is adapted for the burning of liquid fuel such as kerosene, gasoline, crude oil or the like. In this modified form of my thermoelectric generator, a tubular member 50 extends upwardly inside the thermopile 51 and is spaced from the refractory tubular member 52 thereof to provide an annular combustion space 53 in which the exposed internal thermocouple junctions 54 are disposed. The thermopile 51 is supported by a perforated annular wall 55 which surrounds the hollow member 50 and cooperates therewith to define an annular fuel receiving space or well 56.

Liquid fuel is supplied to the well 56 by the fuel line 57 having a conventional valved float chamber 58 therein which limits the amount or level of fuel supplied to the well 56 so as to prevent flooding thereof. An absorbent member or wick 59 is provided in the well 56 for facilitating the burning of the fuel therein. The wick 59 may be a ring formed of any suitable porous material such as a ceramic body or a fibrous material or substance. During the burning of the liquid fuel, combustion air is supplied through the perforations of the annular wall 55 and the flame and combustion gases pass or extend upwardly in the combustion chamber 53 in direct contact with the exposed thermocouple junctions 54 therein. In other respects the thermoelectric generator of Fig. 5 is similar to that of Figs. 1 to 3 inclusive and the same reference characters have been applied to corresponding parts.

In Fig. 6, I show another modification of my thermoelectric generator in which the device is adapted for the burning of gaseous fuel. In this form of my thermoelectric generator, the thermopile 60 is supported by an imperforate upright

annular wall or ring 61 and the pan 62 of the supporting base is provided with a central opening 63 in which is disposed a suitable gas burner 64. During the operation of this modified form of my thermoelectric generator, a proper mixture of air and gaseous fuel is supplied to the burner through the connection 65 and, when ignited above the burner, it burns with a flame which extends upwardly in the combustion chamber 66 of the thermoelectric generator, with the flame and combustion gases in direct contact with the exposed thermocouple junctions 67.

In the foregoing description and accompanying drawings it will now be readily understood that I have provided a simplified and lightweight construction for a thermoelectric generator which is adaptable for the burning of either solid, liquid or gaseous fuel. It will be seen also that my thermoelectric generator is so constructed that it can be collapsed to a compact condition in which it can be manually carried to a desired point of use.

While I have illustrated and described my improved thermoelectric generating devices in considerable detail, it will be understood of course that I do not wish to be limited to the particular details and arrangements herein disclosed, but regard my inventions as including all changes and modifications coming within the spirit of the invention and the scope of the appended claims.

Having thus described my invention, I claim:

1. In a thermoelectric generator, a base, an upright hollow thermopile supported thereon and having exposed internal thermocouple junctions distributed along and around the inside thereof and external thermocouple junctions distributed along and around the outside thereof, means adjacent the lower end of said thermopile for supporting solid fuel in burning condition in said thermopile in direct contact with said internal junctions, an inner stack extending above said thermopile in substantially coaxial relation therewith and forming a flue for combustion gases from said burning fuel, an outer stack surrounding said inner stack and thermopile and spaced therefrom to provide a passage for a flow of cooling air across said external junctions, and means for suspending said outer stack from said inner stack, said outer stack being movable to a collapsed position surrounding the thermopile and in engagement with said base, said inner stack being split longitudinally thereof and being movable to a collapsed position inside of and substantially coextensive with the outer stack.

2. In a thermoelectric generator, a base, an upright hollow thermopile supported thereon and having exposed internal thermocouple junctions distributed along and around the inside thereof and external thermocouple junctions distributed along and around the outside thereof, means for burning fuel so as to supply heat to said internal junctions, an inner stack extending above said thermopile in substantially coaxial relation therewith so as to form a flue for the combustion gases from the burning fuel, an outer stack surrounding said inner stack and external thermocouple junctions and spaced therefrom to provide a passage for a flow of cooling air across said external junctions, and means for suspending said outer stack from said inner stack, said outer stack being movable to a collapsed position surrounding the thermopile and in engagement with said base, said inner stack being split longitudinally thereof and being movable to a collapsed position inside of and substantially coextensive with the outer stack.

3. A portable thermoelectric generator comprising, an upright hollow thermopile having groups of exposed thermocouple junctions disposed in spaced relation on the inside and outside thereof, a base supporting said thermopile and having portions projecting laterally of the thermopile, means for burning fuel so as to supply heat to the inner group of thermocouple junctions, and a pair of movable inner and outer stacks supported by the thermopile and disposed in substantially coaxial relation therewith so that the inner stack extends above the thermopile and forms a flue for the combustion gases from said burning fuel and the outer stack surrounds the thermopile and forms a flue for air for cooling the outer group of thermocouple junctions, said outer stack being of a plan dimension so as to be movable to a collapsed position surrounding the thermopile and engaging the laterally projecting portions of said base and said inner stack being radially expansible so as to enable it to be moved to a collapsed position surrounding the thermopile and in coaxially nested relation to the collapsed outer stack.

4. A portable thermoelectric generator comprising, an upright hollow thermopile having groups of exposed thermocouple junctions disposed in spaced relation on the inside and outside thereof, a base supporting said thermopile and having portions projecting laterally of the thermopile, means for burning fuel so as to supply heat to the inner group of thermocouple junctions, a pair of movable inner and outer stacks supported by the thermopile and disposed in substantially coaxial relation therewith so that the inner stack extends above the thermopile and forms a flue for the combustion gases from said burning fuel and the outer stack surrounds the thermopile and forms a flue for air for cooling the outer group of thermocouple junctions, said outer stack being of a plan dimension so as to be movable to a collapsed position surrounding the thermopile and engaging the laterally projecting portions of said base and said inner stack being radially expansible so as to enable it to be moved to a collapsed position surrounding the thermopile and in coaxially nested relation to the collapsed outer stack, locking means on said thermopile adjacent the upper end thereof, and means having releasable engagement with said locking means and adapted to hold said stacks in their collapsed positions.

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