

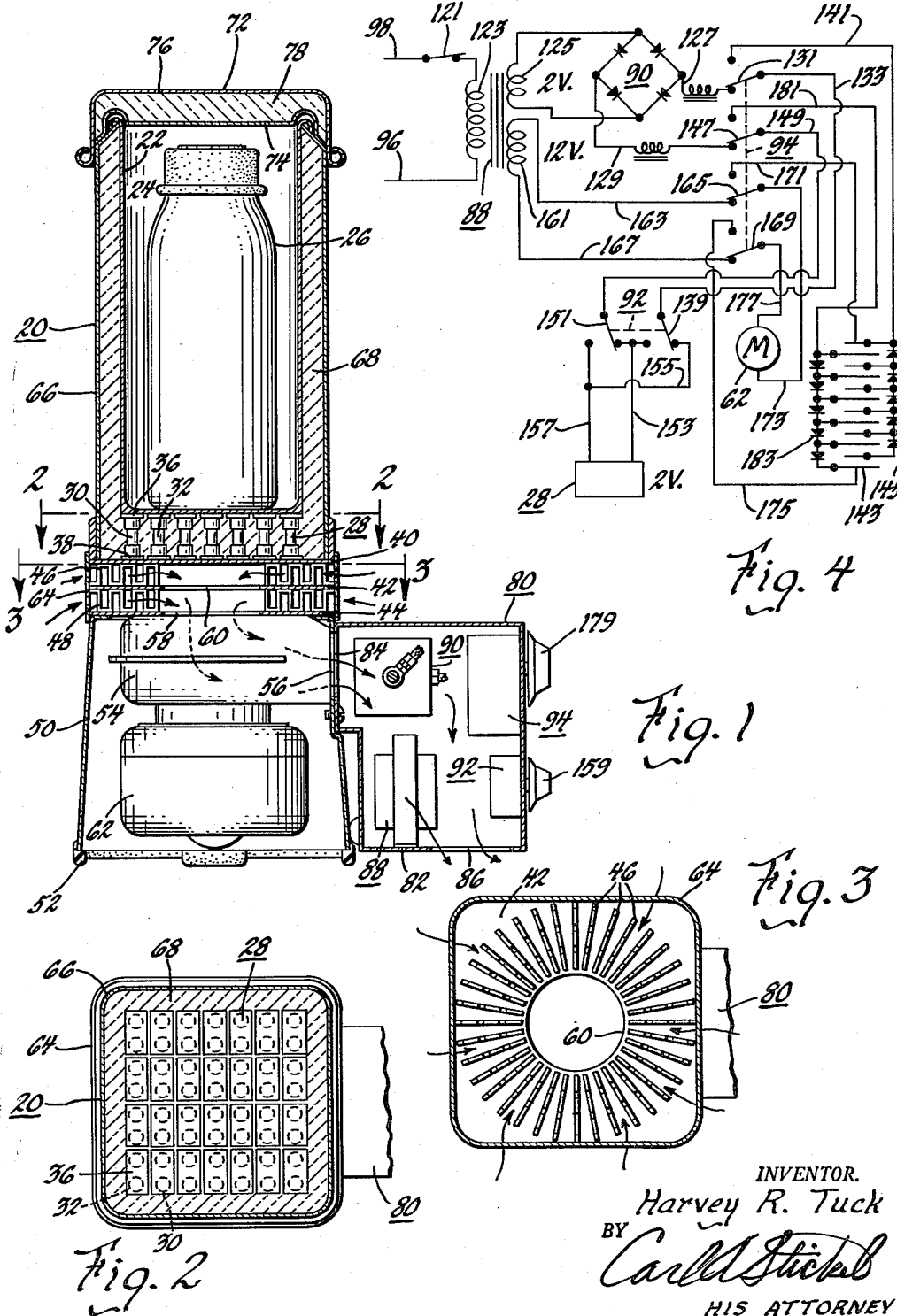
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REFRIGERATING APPARATUS

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REFRIGERATING APPARATUS

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This invention relates to refrigerating apparatus and more particularly to portable thermoelectric apparatus usable for a wide variety of purposes.

Although the thermoelectric principle has been known for seventy years, its practical use has been limited to measuring instruments. However, the simplicity and compactness of this system for producing heat and cold is attractive, especially for small lightweight portable devices.

It is an object of this invention to provide a lightweight, portable, compact, thermoelectric device capable of producing either heating or cooling upon standard electric energy supplies available in the home or in an automobile.

It is another object of this invention to provide a convenient, simple, low cost, easily manufactured, portable, thermoelectric device for heating or cooling which is attractive in appearance and easy to use.

These and other objects are attained by supporting the container to be heated or cooled on a thermocouple array which in turn is supported upon a finned heat transfer structure which in turn is supported upon a support, within which is supported a fan and motor unit connected to circulate air through the finned structure. An electric circuit is arranged to supply an efficient low voltage for the thermocouple array and a higher voltage for the fan motor from either the standard alternating current house supply or from the battery of an automobile.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

FIGURE 1 is a vertical sectional view through one form of thermoelectric device embodying my invention; FIGURE 2 is a transverse sectional view taken substantially along the lines 2—2 of FIGURE 1;

FIGURE 3 is a transverse sectional view taken substantially along the line 3—3 of FIGURE 1; and

FIGURE 4 is a wiring diagram showing the electric circuits for the thermoelectric device.

Referring now to the drawings and more particularly to FIGURE 1, there is shown as one example of my thermoelectric device an insulated container 20 containing an inner metal casing 22 enclosing a compartment 24 for containing devices to be heated or cooled, such as an infant's milk bottle 26. Other suitable uses would be containers for other liquids and foods or medicines requiring either cooling or heating. An infant's milk bottle must be kept cool until a short time before required for feeding and then it should be heated to the proper temperature for feeding.

Preferably, the inner container 22 is of sheet aluminum which may be drawn to form a seamless cylindrical container. The cylindrical container 22 is supported upon a thermocouple array 28 which includes rods 30 and 32 of dissimilar thermoelectric material connected alternately at opposite ends by linking strips 36 and 38 of copper or aluminum. The inner casing 22 is preferably heavily anodized for corrosion purposes and also for the purpose of providing an electrical insulation to prevent shorting from one of the linking strips 36 to another because of the series arrangement of the linking strips 36. For a good heat conduction, the upper faces of the linking strips 36 are preferably bonded to the lower face of

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the inner casing 22 by a good heat conducting cement, such as a very thin layer of epoxy resin cement.

Beneath the linking strips 38 is an air heat exchanger including three spaced parallel plates 40, 42 and 44 of aluminum. Between these plates 40, 42 and 44 are serpentine wire members 46 which are located between the plates 40 and 42 and the wire members 48 which are located between the plates 42 and 44. These serpentine wire members are each flattened at their tops and bottoms. They are also preferably of aluminum or steel, aluminum coated, and are bonded to the plates by aluminum soldering or brazing or some other suitable bonding means so as to provide a unitary structure. This structure also is anodized so as to provide it with an electrically insulating surface and to protect it from corrosion. This heat transfer structure is bonded to the lower face of the linking strips 38 by a suitable good heat conducting cement, preferably a thin layer of epoxy resin cement. The anodized surface of the upper plate 40 as well as the epoxy cement prevents shorting of the linking strips 38.

The heat transfer structure is supported upon a hollow base 50 provided with a rubber or plastic beading 52 on its lower edge upon which the entire device is mounted. Mounted within the hollow base 50 is a centrifugal fan 54 having its outlet extending to the opening 56 in the base 50. The fan 54 has a top central inlet opening directly communicating with the central openings 58 and 60 in the plates 44 and 42. The 12 v.-A.C.-D.C. series type electric driving motor 62 for the fan 54 is directly connected and supported by the housing of the fan 54. The periphery of the heat transfer structure may be enclosed by an ornamental grille 64 contacting the peripheries of the plates 40, 42, 44. The operation of the fan 54 in either direction of rotation will cause air to be drawn in through the ornamental grille 64 and through and around the serpentine wires 46 and 48 and between the plates 40, 42, 44 and through the openings 60 and 58 into the fan, and the air is discharged through the opening 56. This air flow removes heat from the heat transfer structure during the cooling operation and supplies heat thereto during the heating operation.

The space between the cylindrical inner casing 22 and the plate 40 and the outer sheet metal walls 66 is filled, preferably, with foamed polyurethane or epoxy plastic resin 68, preferably containing a halofluoro derivative of an aliphatic hydrocarbon, such as trichloromonofluoromethane or trichlorotrifluoroethane. This foamed plastic resin is preferably cast in place and surrounds and supports and holds in place the inner casing 22 and the thermocouple array between the bottom of the inner casing 22 and the plate 40. If desired, the outer sheet metal wall 66 may be omitted and the outer wall provided by a skin of the foamed plastic resin or the outer wall may be provided by a solid vinyl, epoxy or polyurethane resin sheet bonded to the foam plastic resin. The inner casing 22 is closed by an insulated lid 72 which may be provided with an inner sheet metal aluminum wall 74 and an outer plastic resin or sheet metal aluminum wall 76. Cast in between the walls 74 and 76 is a foamed plastic resin 78, preferably polyurethane or epoxy resin, preferably containing within its cells a halofluoro derivative of an aliphatic hydrocarbon, such as trichloromonofluoromethane or trichlorotrifluoroethane.

The alternate thermoelectric members designated by the reference character 32 may be designated as N type materials which may be of bismuth or bismuthtelluride (Bi_2Te_3) plus .5 percent iodine. The alternate members designated by the reference character 34 are the P type thermoelectric members which may be of antimony or which may be a mixture of bismuthtelluride (Bi_2Te_3) and antimonytelluride (Sb_2Te_3) in proportions ranging

from 50-50 to 90-10. Included in the P type thermoelectric material is .2 percent of arsenic.

The thermocouple array 28 and the electric motor 62 are supplied with suitable electric energy from the power pack 80 which includes a casing 82 mounted upon the side of the support 50 adjacent the outlet 56. The casing 82 has an inlet opening 84 registering with the outlet opening 56 of the fan 54 so that the discharge of the air from the fan 54 circulates air through the casing 82 to the outlet 86 thereof. The power pack 80 includes the major portion of the circuitry shown in FIGURE 4 including the transformer 88 used to reduce the supply energy to twelve volts for the electric motor 62 and two volts for the thermocouple array 28. Also located within the casing 82 is a full wave rectifier 90. Power pack also includes a reversing switch 92 for determining whether the interior of the casing 22 is to be heated or cooled and a control 94 for arranging the electrical circuits for connection to either a standard residential alternating current supply or to a 12 volt automobile battery.

Referring now to the wiring diagram of FIGURE 4, there are shown standard residential alternating current supply conductors 96 and 98 connecting through a switch 121 to the input winding 123 of the transformer 88. A two volt output winding 125 connects to the input terminals full wave rectifier 90. The output terminals of the full wave rectifier 90 are connected by the conductors 127 and 129 to terminals of the switch 94. These conductors 127 and 129 may each be provided with choke coils to smooth out the current flow.

The conductor 127 connects to a double throw switch 131 connecting through the conductor 133 to the double throw switch element 139 of the reversing switch 92. The other terminal of the double throw switch 131 connects to a conductor 141 which connects with one of the terminals of each cell of the twelve volt battery 143. To properly make this connection, rectifiers 145 are provided between the terminals of each of the cells of the twelve volt battery 143. The conductor 129 connects with one of the terminals of the double throw switch 147 which connects through the conductor 149 to the double throw switch 151 which is the second part of the double throw reversing switch 92 which may be operated by the knob 159. The double throw switches 139 and 151 have adjacent terminals connected by the conductor 153 to the first linking strip 38 of the thermocouple array 28 while the opposite terminals of the switches 139 and 151 are connected by the conductors 155 and 157 to the last linking strip 38 of the thermocouple array 28.

The transformer 88 is also provided with a second output winding 161 of twelve volts output which is connected by the conductor 163 to the double throw switch 165 and by the conductor 167 to the double throw switch 169. The double throw switch 165 has a second terminal connected by the conductor 171 to the upper terminal of the battery 143. The switch 165 has a third terminal connected by a conductor 173 to one terminal of the motor 62. The double throw switch 169 has a second terminal connected by the conductor 175 to the lower terminal of the battery 143 and a third terminal connected by the conductor 177 to the second terminal of the motor 62. The four switches 131, 147, 165 and 169 are all a part of the D.C.-A.C. switch 94 and are operated by the knob 179 to their upper positions shown in FIGURE 4 for operation upon the twelve volt battery 143 and to their lower positions shown in FIGURE 4 for operation upon energy received from the supply conductors 96 and 98. The switch 121 serves as an on/off switch for the alternating current supply through the conductors 96 and 98.

The third terminal of the switch 147 connects through the conductor 181 to the second terminals of each of the cells of the battery 143 which are separated by rectifiers or one-way current flow devices 183 so that

the battery 143 may be used to supply two volt current to the thermocouple array 28 and twelve volt current to the electric motor 62 and any other of the uses the battery 143 may be required to fulfill.

The wiring diagram of FIGURE 4 is shown with the switch 94 positioned for battery operation while the switch 92 is shown in position for the cooling operation. Electric energy is supplied from the conductors 96 and 98 through the closed switch 121 to the input winding 123 of the transformer 88. Two volt current is supplied from the output winding 125 through the full wave rectifier 90 and the conductors 127 and 129 and the switches 131 and 147 through the conductors 133 and 149 to the switches 139 and 151 of the heating or cooling switch 92. The switches 139 and 151 connect through the conductors 155, 157 and 153 to the thermocouple array 28. The passage of the current through the thermocouple array 28 in this direction causes the junctions bonded to the linking strips 38 to be heated and transmit heat through the strips 38 to the heat transfer unit including the plates 40, 42 and 44 and the wire fins 46 and 48.

This also causes the junctions bonded to the linking strips 36 to be cooled to cool through the strips 36 the inner casing 22 and its contents including the container 26. If it should be later desired to warm the container 26 and its contents, it is merely necessary to turn the knob 159 to move switch 92 to the opposite position in order to move the double throw switches 139 and 151 to the left, causing a reversal of the current flow through the conductors 153 and 157 and through the thermocouple array 28 to cause the linking strips 38 to be cooled. In this circumstance, the air drawn through the heat transfer unit by the fan 54 will be cooled and will transmit heat to the linking strips 38; whereas when the switch 92 is in the cooling position, the air drawn by the fan will be heated and heat will be removed from the linking strips 38.

When the apparatus is to be supplied by current from twelve volt car battery 143, the knob 179 is turned to move the switch 94 to its upper position as shown in FIGURE 4. This will connect the conductor 141 through the switch 131 and the conductor 133, the switch 139, the conductors 155 and 157 to the thermocouple array 28. This will also connect the conductor 181 through the switch 147, the conductor 149, the switch 151 and the conductor 153 to the other terminal of the thermocouple array 28. This will supply the thermocouple array with two volt direct current in the direction for cooling the inner casing 22. Current will also be supplied from the upper terminal of the battery 143 to the conductor 171, the switch 165 and the conductor 173 to the lower terminal of the fan motor 62. Current will also be supplied from the lower terminal of the battery 143 through the conductor 175, the switch 169 and the conductor 177 to the upper terminal of the fan motor 62. In this way, the current is supplied in parallel at a voltage of two volts from each cell of the battery 143 suitable for the thermocouple array 28 while the battery 143 is connected in its usual series relationship to provide twelve volts for the motor 62. This is made possible through the use of the rectifiers or one-way current devices 145 and 183 between each of the cells of the battery 143 as shown in FIGURE 4.

The device or apparatus is small, lightweight and portable. It can be used in the home on ordinary alternating current supply or it may be used in an automobile from the usual twelve volt car battery provided with the rectifying connections to each of the cells in parallel as shown in FIGURE 4.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. Thermoelectric apparatus including an inner casing

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enclosing a storage compartment, a thermocouple array having first type of junctions located adjacent to and in thermal exchange with said inner casing and a second type of junctions spaced from said inner casing, air heat transfer fin means adjacent to and in thermal exchange with said second type of junctions, fan means adjacent said fin means for circulating air into heat transfer relation with said fins and an electric motor for operating said fan means, heat and electrical insulating means extending round said inner casing and within said thermocouple array, an electrical circuit for supplying electrical energy to said electric motor and said thermocouple array, said air heat transfer means including a first metal plate adjacent said second type of junctions and a second plate remote from said junctions spaced from said first plate and fins extending between and connecting said first and second plates, said second plate having an opening therein, and said fan means being operably associated with said opening in said plate for circulating air between said plates and fins.

2. Thermoelectric apparatus including a means to be cooled, a thermocouple array having a first type of junctions located adjacent to and in thermal exchange with said means to be cooled and a second type of junctions spaced from said means to be cooled, air heat transfer fin means adjacent to and in thermal exchange with said second type of junctions, fan means adjacent said fin means for circulating air into heat transfer relation with said fins and an electric motor for operating said fan means, heat and electrical insulating means extending around said inner casing and within said thermocouple array, an electrical circuit for supplying electrical energy to said electric motor and said thermocouple array, said electric circuit having connections extending from said electric motor to the terminals of a multiple cell battery, said circuit also having connections extending from said thermocouple array in parallel to the individual cells of said multiple cell battery, said circuit having unidirectional current devices in the parallel connections to said individual cells.

3. Thermoelectric apparatus including an inner casing enclosing a storage compartment, a thermocouple array having a first type of junctions located adjacent said inner casing and a second type of junctions spaced from said inner casing, air heat transfer fin means adjacent to said second type of junctions, a thin electrical insulating heat conducting means extending between and thermally connecting said first type of junctions and said inner casing and between and thermally connecting said second type of junctions and said fin means, fan means adjacent said fin means for circulating air into heat transfer relation with said fins and an electric motor for operating said fan means, heat and electrical insulating means extending around said inner casing and within said thermocouple array, an electrical circuit for supplying electrical energy to said electric motor and said thermocouple array, and said electrical circuit including a transformer and rectifier means located in the air stream of said fan means.

4. Thermoelectric apparatus including an inner casing enclosing a storage compartment, a thermocouple array

having a first type of junctions located adjacent said inner casing and a second type of junctions spaced from said inner casing, air heat transfer fin means adjacent to said second type of junctions, a thin electrical insulating heat conducting means extending between and thermally connecting said first type of junctions and said inner casing and between and thermally connecting said second type of junctions and said fin means, fan means adjacent said fin means for circulating air into heat transfer relation with said fin means and an electric motor for operating said fan means, a unitary foamed plastic resin heat and electrical insulating means cast around and bonded to said inner casing and bonded to and extending continuously within said thermocouple array to structurally connect said thermocouple array with said inner casing, and an electrical circuit for supplying electrical energy to said electric motor and said thermocouple array.

5. Thermoelectric apparatus including an inner casing enclosing a storage compartment, a thermocouple array having a first type of junctions located adjacent to and in thermal exchange with said inner casing and a second type of junctions spaced from said inner casing, a thin metal plate parallel and adjacent to and in thermal exchange with said second type of junctions, a second thin metal plate spaced from the first plate and having an aperture therein, wire fins extending between and bonded to the plates extending outwardly from said aperture, fan means operably associated with said aperture for circulating air between the plates, and an electrical circuit for supplying electrical energy to said thermocouple array and said fan means.

6. Thermoelectric apparatus including an inner casing enclosing a storage compartment, a thermocouple array having first type of junctions located adjacent to and in thermal exchange with said inner casing and a second type of junctions spaced from said inner casing, air heat transfer fin means adjacent to and in thermal exchange with said second type of junctions, fan means adjacent said fin means for circulating air into heat transfer relation with said fins and an electric motor for operating said fan means, heat and electrical insulating means extending around said inner casing and within said thermocouple array, an electrical circuit for supplying electrical energy to said electric motor and said thermocouple array, said air heat transfer means including a first metal plate adjacent said second type of junctions and a second plate remote from said junctions spaced from said first plate and fins extending between and connecting said first and second plates, said second plate having an opening therein, and a centrifugal fan mounted adjacent one face of said second plate and having its axis and having a side entrance aligned and connecting with said opening in said second plate.

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