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(54) TEMPERATURE CONTROLLED CABINET SYSTEM AND METHOD EMPLOYING A THERMAL BARRIER TO THERMALLY ISOLATE THE CABINET INTERIOR FROM THE AMBIENT ENVIRONMENT

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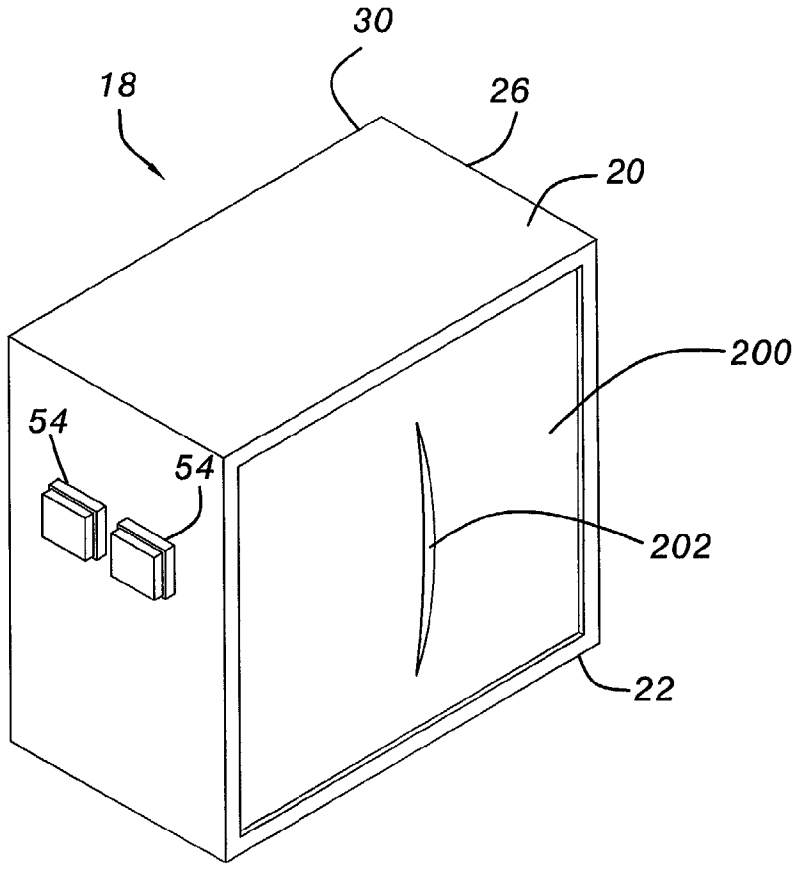
(57) **ABSTRACT**

A temperature controlled cabinet system of the present invention includes at least one heat pump, a controller assembly for controlling system operation and a temperature sensor for measuring a cabinet interior temperature. The heat pump heats and/or cools the cabinet interior to maintain the cabinet interior at a desired temperature in response to control signals from the controller assembly. The cabinet system further includes a thermal barrier to thermally isolate the cabinet interior from the ambient environment and permit access to medical items contained within the cabinet. The thermal barrier includes a plurality of strips that maybe arranged in various fashions (e.g., overlapped, spaced from each other a selected distance, etc.) to substantially impede or minimize heat exchange between the cabinet interior and ambient environment during intervals where the cabinet interior is exposed to that environment (e.g., intervals where at least one cabinet door is in an open state).



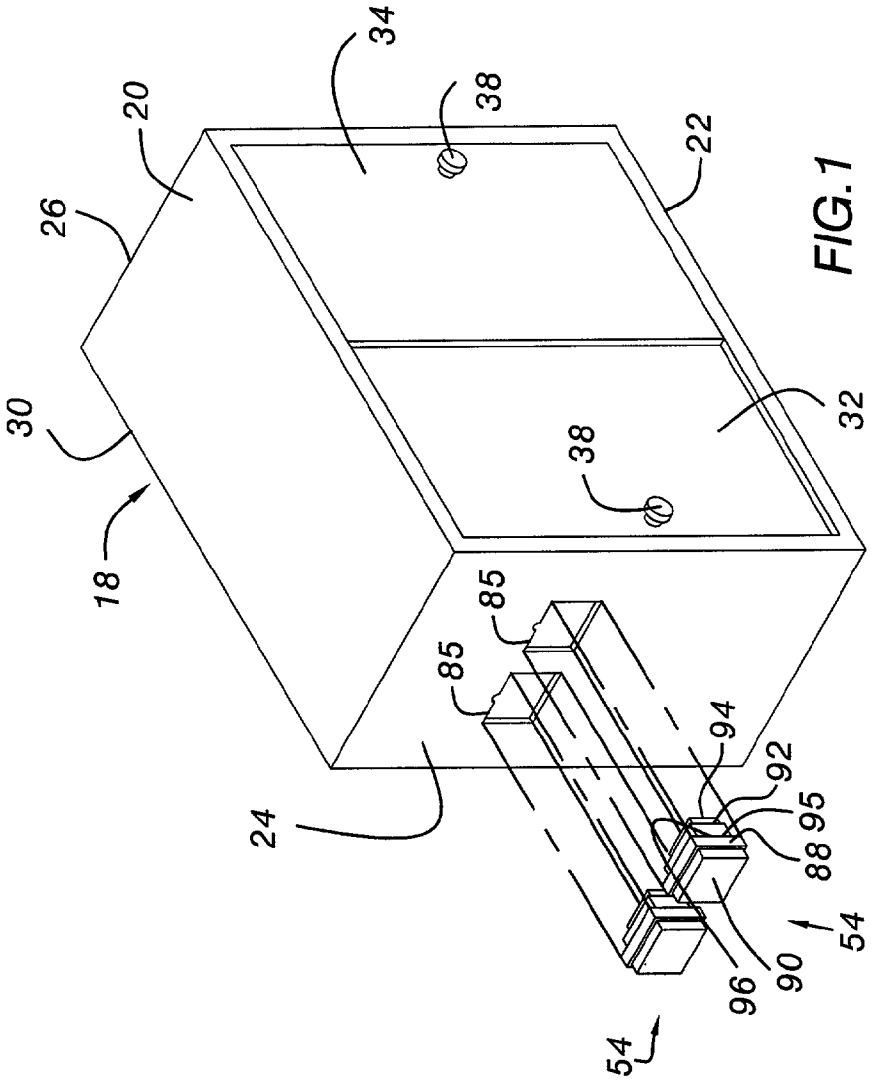


FIG. 1

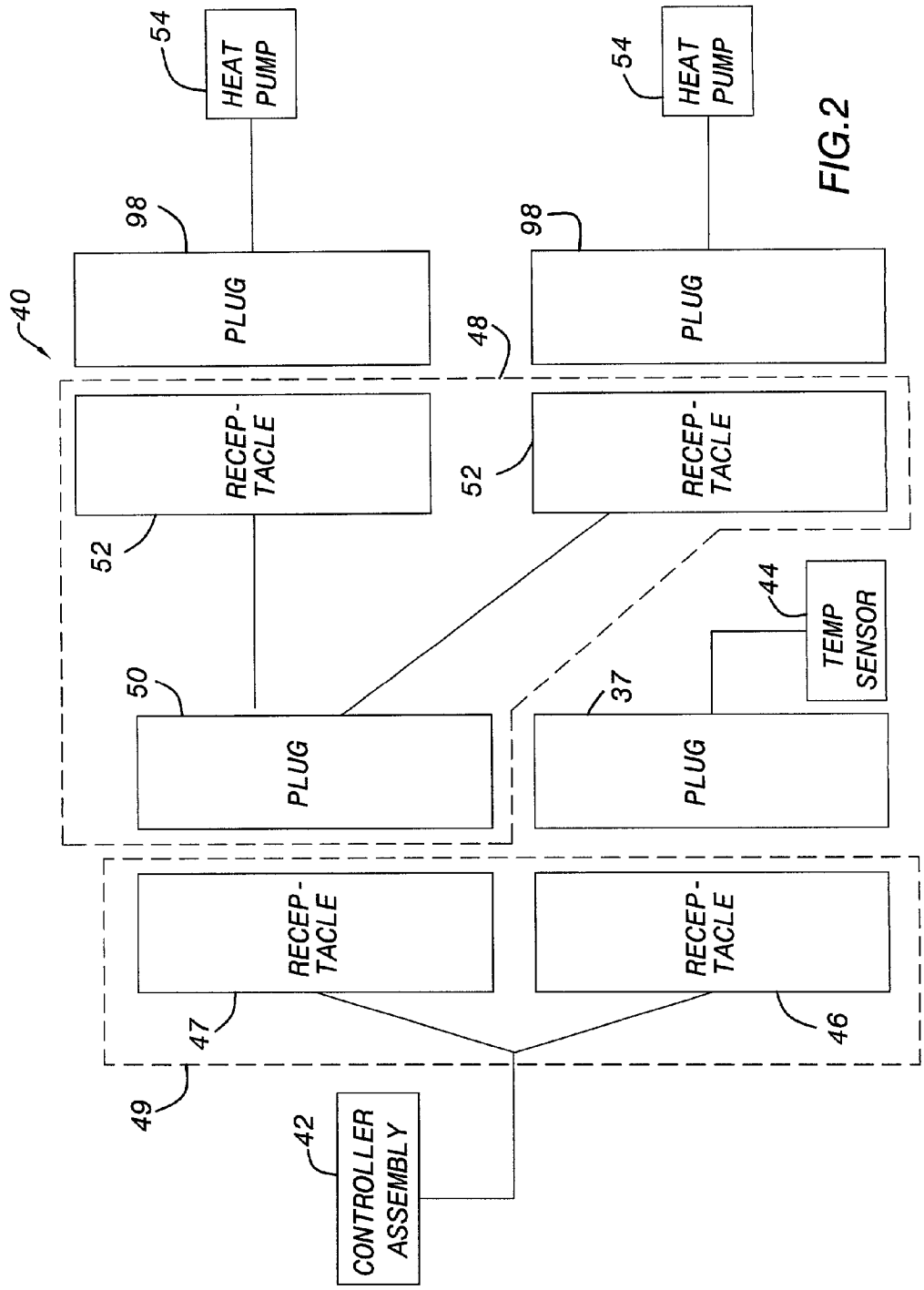

40
54
HEAT PUMP
54
HEAT PUMP
98
PLUG
98
PLUG
48
RECEP-TACLE
52
RECEP-TACLE
52
52
TEMP SENSOR
44
50
PLUG
37
PLUG
RECEP-TACLE
RECEP-TACLE
47
46
49
42
CONTROLLER ASSEMBLY

FIG.2

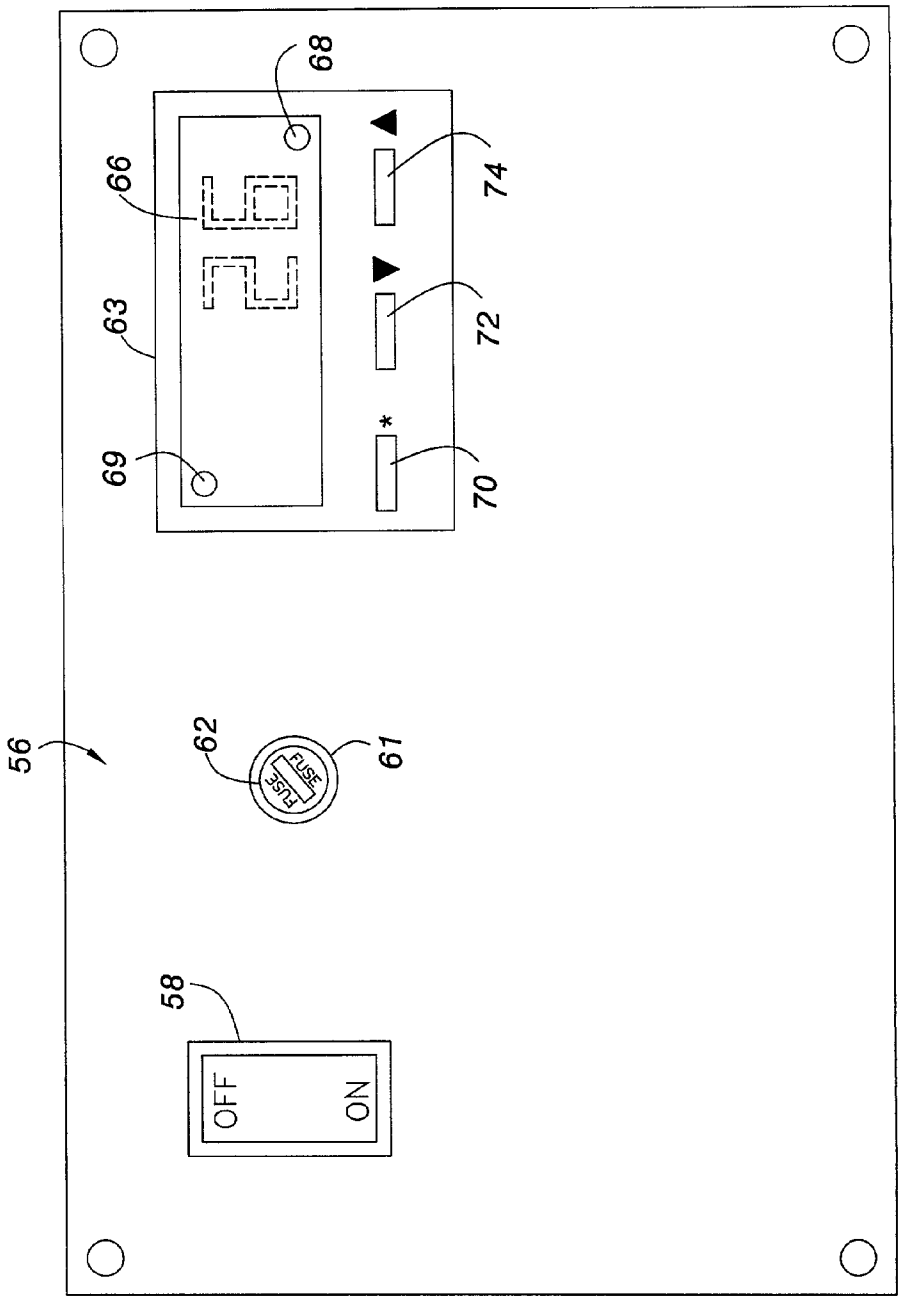


FIG.3

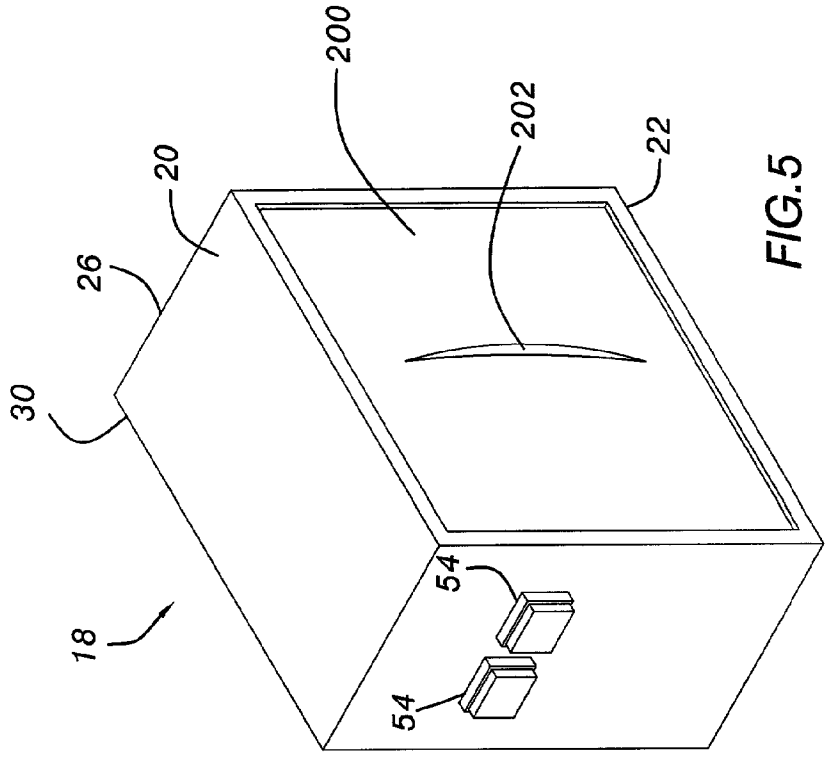


FIG.5

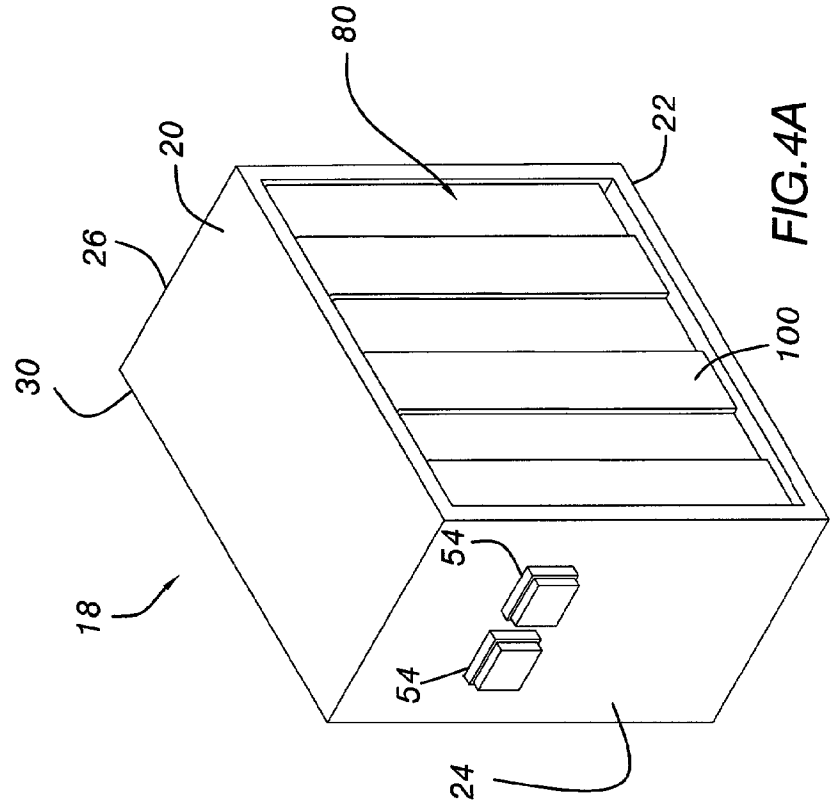


FIG.4A

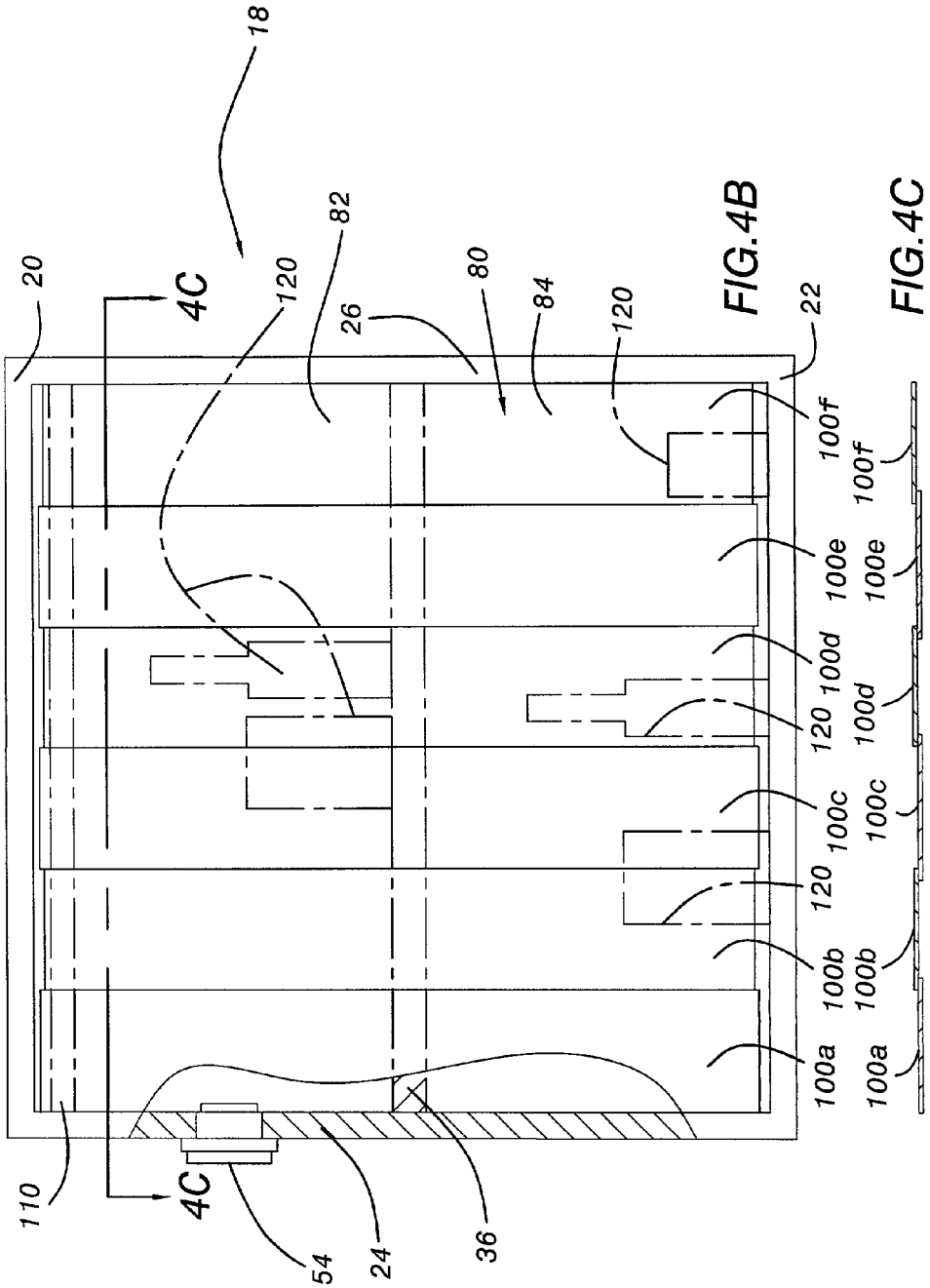

18
20
4C
120
82
26
80
84
120
22
100f
100e
100d
120
100c
120
100b
100a
110
4C
54
24
36

FIG.4B

FIG.4C

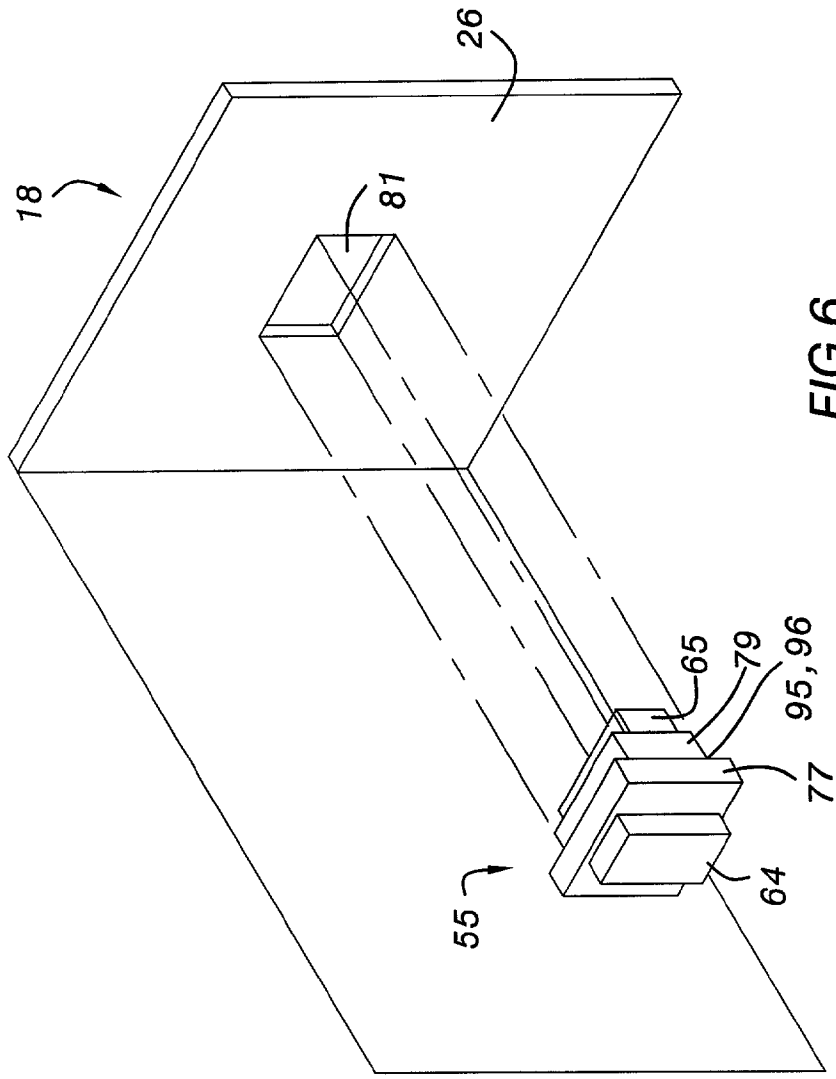
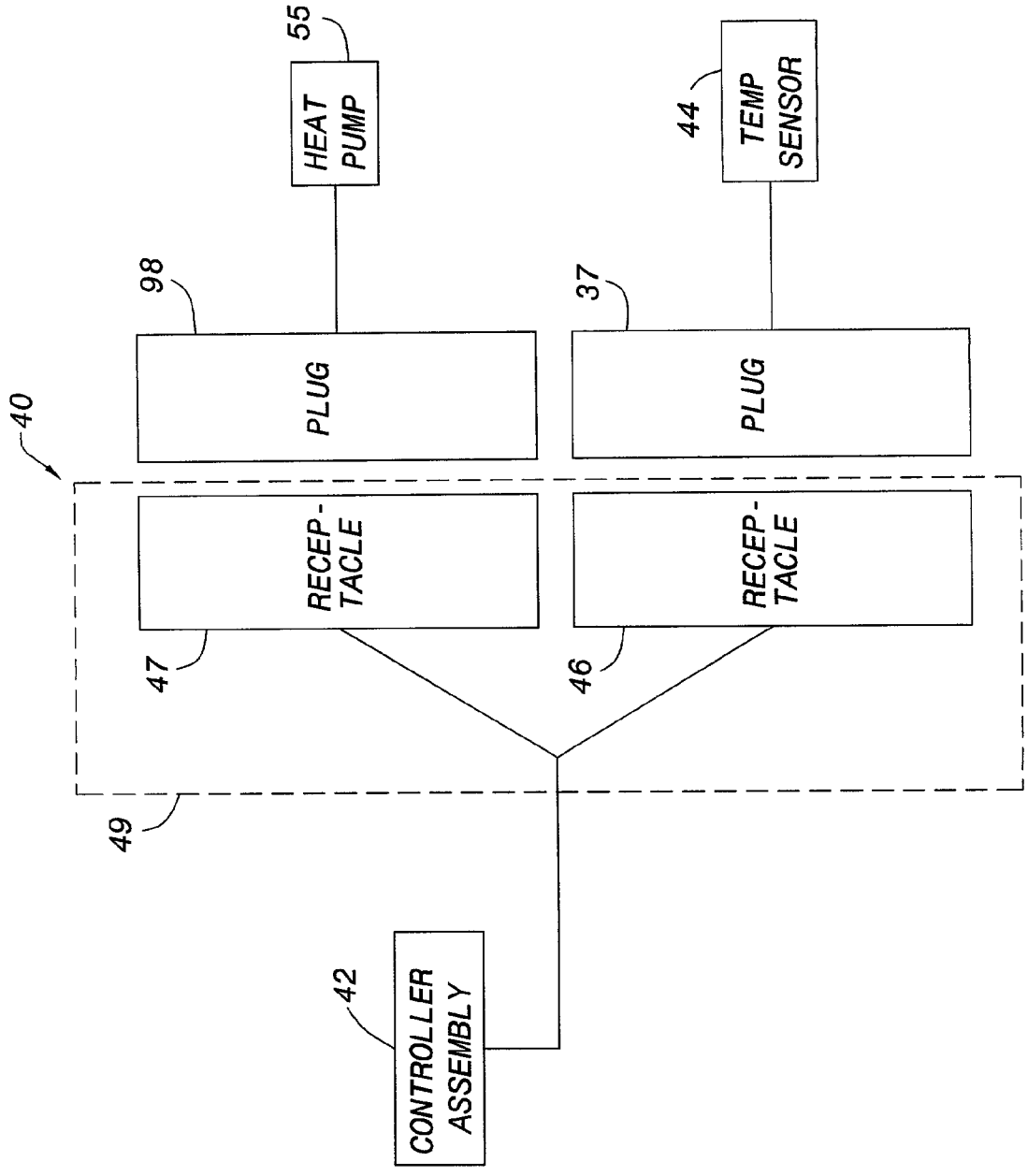


FIG.6

FIG.7


55
HEAT PUMP
44
TEMP SENSOR
98
PLUG
37
PLUG
40
RECEP-TACLE
RECEP-TACLE
47
46
49
42
CONTROLLER ASSEMBLY

TEMPERATURE CONTROLLED CABINET SYSTEM AND METHOD EMPLOYING A THERMAL BARRIER TO THERMALLY ISOLATE THE CABINET INTERIOR FROM THE AMBIENT ENVIRONMENT

BACKGROUND OF THE INVENTION

[0001] 1. Technical Field

[0002] The present invention pertains to temperature control systems. In particular, the present invention pertains to a temperature control system for installation within cabinets of ambulances or other medical vehicles to maintain cabinet interiors at appropriate temperatures for storing medical items (e.g., drugs and/or intravenous (IV) solution). The temperature control system employs a thermal barrier to thermally isolate a cabinet interior and corresponding medical items contained therein from the ambient environment during intervals where the cabinet interior is exposed to that environment (e.g., during intervals where at least one cabinet door is in an open state).

[0003] 2. Discussion of Related Art

[0004] Ambulances and other medical vehicles typically include cabinets to store medical items, such as drugs or intravenous (IV) solution, for use by medical personnel. These items are usually required to be maintained at specific temperatures. For example, IV solution is typically contained within IV bags and needs to be maintained at approximately body temperature in order to avoid thermal shock and injury to a patient. Similarly, certain drugs are required to be maintained at particular temperatures in order to lengthen their active life and/or be safely administered to patients. However, typical cabinets utilized in ambulances and other medical vehicles do not provide a temperature controlled environment, but rather merely store medical items. Further, the cabinets typically do not include a thermal barrier to thermally isolate the cabinet interior from the ambient environment when cabinet doors are in an open state. Thus, drugs or IV solutions that are initially thermally treated to have temperatures within their appropriate utilization temperature range may quickly attain temperatures outside that range when stored in cabinets lacking a thermal barrier and/or temperature control capability, thereby risking injury to the patient.

[0005] The related art has attempted to overcome these problems by utilizing various temperature controlled systems. For example, U.S. Pat. No. 5,217,064 (Kellow et al) discloses a temperature controlled pharmaceutical storage device including a substantially enclosed and thermally insulated structure having at least one port allowing access to an enclosed storage area. A thermopile heat exchange unit is provided for heating and cooling the storage area in response to signals provided by temperature sensors and a window detector. The storage area is maintained at a temperature between upper and lower predetermined limits, while a visual display is actuated in response to the temperature limits being exceeded for a predetermined length of time to warn that substances should be discarded immediately. The storage device may be mounted in an ambulance.

[0006] U.S. Pat. No. 5,572,873 (Lavigne et al) discloses a carrier apparatus having an insulated structure with a drawer unit located therein. A primary thermal electric cooler heats and cools the pharmaceuticals located within the drawer unit, while a controller senses the temperature within the drawer unit and operates the thermal electric cooler to maintain the interior of the drawer unit at room temperature. The drawer unit includes an insulated refrigerated drawer having a thermal electric cooler operated by the controller to hold refrigerated drugs. The apparatus provides warnings of a temperature violation, and locks a door providing access to the drawer unit in response to detection of the temperature violation within drawers maintained at room temperature.

[0007] U.S. Pat. No. 5,924,289 (Bishop, II) discloses a temperature controlled cabinet system typically for use in ambulances and other medical vehicles. The cabinet system includes a temperature sensor for measuring the cabinet interior temperature, a controller assembly for controlling system operation and preferably two heat pumps disposed in the cabinet walls to heat or cool the cabinet interior. A control console within the controller assembly displays the actual cabinet temperature and facilitates entry of a desired temperature range into the system. The control console further displays cooling mode and heating mode indicator lights to indicate when the cabinet interior temperature has shifted out of the desired temperature range. The heat pumps include a pair of heat sinks disposed about a thermoelectric device (e.g., a Peltier chip) that heats one heat sink, while cooling the other heat sink based upon a voltage polarity or current flow direction applied to the device. The system controls the voltage polarity applied to the thermoelectic device to enable the heat pumps to heat or cool the cabinet interior based upon a comparison of the measured temperature with the desired temperature range.

[0008] In addition, various systems of the related art have employed thermal barriers in the form of coverings or curtains for varying applications. For example, U.S. Pat. No. 4,288,992 (Eliason) discloses a curtain structure for substantially covering an access opening of an open-sided, display type, refrigerated food cabinet. A first curtain comprises a flexible sheet prestressed to roll up and fixed at its upper edge to the ceiling of the cabinet inboard of the access opening. The first curtain maybe unrolled and its bottom edge attached to the floor of the cabinet to substantially block air movement into and out of the cabinet. A second curtain comprises a plurality of side-by-side, elongate strips of flexible transparent sheet material, fixed together at their upper ends and supported on the cabinet at the top of the access opening. The lower ends of the strips are free of each other and terminate slightly above the bottom of the access opening. The second curtain is spaced away from the closed position of the first curtain by an air layer providing a thermal barrier across the access opening when access to the interior of the cabinet is not needed. With the first curtain rolled up, the second curtain obstructs air movement into and out of the cabinet but permits visual and physical access to the interior of the cabinet through the access opening.

[0009] U.S. Pat. No. 4,296,792 (Gidge et al) discloses a transparent, flexible curtain with spaced access points for installation over an opening of a display type open refrigerator of the type used in retail food markets. The curtain includes a plurality of elongated, flexible, transparent panels secured at one end to the top or rear edge of the refrigerator cabinet and extending in overlapped relation across the cabinet opening. The curtain retains cold air within the refrigerator and allows food products to be clearly visible to

the customer. Goods are removed by the customer reaching in between adjacent panels which separate easily and return to a closed position when the customer's hand is withdrawn.

[0010] U.S. Pat. No. 4,746,029 (Tyner III, et al) discloses a cooler curtain for maintaining an air barrier between the opening of a storage facility and the surrounding atmosphere. A plurality of closely spaced, resilient self-closing curtain elements are relatively movable between a closed position in which the elements of a pair thereof are closely adjacent and collectively define an air barrier to impede air movement through a portion of the opening, and an open position in which the elements in the pair are spaced further apart to provide access therebetween to the storage unit through the opening. A drop-in removable insert frame structure is suspended over the horizontal, top opening of the storage facility to position the curtain elements over the front opening and top opening forming the air barrier. The plurality of self-closing curtain elements extend horizontally between the side rails of the frame over the top opening, and depend generally vertically from the front rail of the frame over the front opening. The frame structure may be recessed within the storage unit to permit closure thereof without removal of the cooler curtain. The curtain elements are secured by a retaining member to the underside of the frame by fastening means. In addition, the cooler curtain may be used to maintain the interior portion of a storage unit at significantly higher than room temperature for heating or food warming applications.

[0011] U.S. Pat. No. 5,431,490 (Edwards) discloses a vertical curtain having vertical slits defined therein and spaced thereacross. The slits open downwardly through the lower margin of the curtain and terminate upwardly a spaced distance below a curtain upper margin. The curtain upper margin is mounted on a margin of a refrigerated cabinet wall having an access opening formed therein. The refrigerated cabinet margin extends across the upper portion of the opening, while the curtain falls by gravity downwardly across the opening as a thermal and convection current barrier when the door for the access opening is opened.

[0012] U.S. Pat. No. 5,746,271 (DeCosta) discloses a doghouse having a heating and air conditioning unit installed therein, insulated walls and an insulated roof. Hinges connect the roof on one of its sides to the upright walls for easy access by the pet owner to the controls of the heating and air conditioning unit. The doghouse includes a flexible door covering with laterally overlapping parallel strips that are made from a heavy material so as to be minimally effected by tangling and frequent wind interaction. The strips are vertically hung from the upper part of the door opening to allow pets freedom of access in and out of the doghouse, while at the same time retaining the major portion of the climate controlled air within the insulated walls and roof of the doghouse during pet use.

[0013] The related art suffers from several disadvantages. In particular, the Kellow et al, Lavigne et al and Bishop, II systems may enable their system interiors and medical items (e.g., drugs, intravenous (IV) solution, etc.) contained therein to attain temperatures that are beyond the desired temperature range. This tends to occur during intervals where an operator accesses medical items stored by the systems or inadvertently leaves system doors in an open state, thereby exposing the system interiors to the ambient environment. Consequently, the medical items contained within the system interiors may attain temperatures that compromise their efficacy due to a heat exchange between the exposed system interiors and ambient environment. This problem is exacerbated when the temperature of the ambient environment differs significantly from the desired temperature maintained by the systems. In response to detection of the compromising temperatures, these systems may provide visual indications to the operator, while the Lavigne et al system may further prevent access to the stored medical items. However, since these measures concentrate on notification of, or precautionary measures subsequent to, occurrence of the compromising temperatures, the systems are not concerned with and do not provide a manner to prevent or minimize occurrences of that event.

[0014] Although certain systems described above employ thermal barriers in the form of coverings or curtains to maintain system interiors at desired temperatures, these thermal barrier systems suffer from several disadvantages, especially with respect to medical applications. In particular, the thermal barrier systems described above are configured for applications providing a suitable environment for various items (i.e., food products and pets) having relatively relaxed temperature requirements and therefore are generally not suitable for handling medical applications with rigid temperature constraints. Further, the Gidge et al and Eliason systems employ a curtain for a display type refrigerated cabinet containing food products. The curtain is utilized as the primary thermal barrier for the cabinet during extended time intervals within which consumers may access the food products. However, this enables substantial heat exchange between the refrigerated cabinet interior and ambient environment, thereby causing significant temperature fluctuations within the system interiors. With respect to medical applications, these fluctuations may readily permit medical items (e.g., drugs, intravenous (IV) solution, etc.) to attain temperatures that are beyond their required temperature range and compromise medical item efficacy. The DeCosta structure employs a covering or curtain as the primary thermal barrier and similarly permits the above heat exchange and temperature fluctuations within the structure interior. Further, the Tyner, III et al system employs a frame having curtain elements respectively covering front and top openings of a storage unit. Thus, this system basically includes additional access openings that facilitate enhanced heat transfer and temperature fluctuations within the storage unit interior during use and access of that interior.

[0015] The Edwards system employs a curtain in the form of a sheet having slits defined therein for mounting on upright refrigerators and freezers. However, the curtain tends to slightly obstruct closing of refrigerator and freezer doors, thereby enabling formation of gaps between the doors and corresponding units. These gaps may facilitate heat transfer and temperature fluctuations within the refrigerated interiors. Further, the curtain is typically displaced when the refrigerator and freezer doors are in a closed state, thereby creating deformities in the curtain over extended time intervals that degrade the effectiveness of the curtain as a thermal barrier.

OBJECTS AND SUMMARY OF THE INVENTION

[0016] Accordingly, it is an object of the present invention to precisely control temperature within ambulance or other

medical vehicle cabinets to maintain medical items contained therein at desired temperatures.

[0017] It is another object of the present invention to maintain a desired temperature within medical vehicle cabinets during time intervals in which at least one cabinet door is in an open state (e.g., during loading and unloading of medical items within the cabinet interior).

[0018] Yet another object of the present invention is to maintain a desired temperature within a cabinet interior during time intervals in which at least one cabinet door is in an open state by employing a thermal barrier within the cabinet in the form of a plurality of thermally insulated strips to thermally isolate the cabinet interior from the ambient environment.

[0019] The aforesaid objects may be achieved individually and/or in combination, and it is not intended that the present invention be construed as requiring two or more of the objects to be combined unless expressly required by the claims attached hereto.

[0020] According to the present invention, a temperature controlled cabinet system for maintaining a cabinet or other storage structure interior at a desired temperature includes at least one heat pump disposed within a cabinet wall, a controller assembly for providing a user interface and controlling system operation and a temperature sensor for measuring cabinet interior temperature. The heat pump is capable of heating and/or cooling the cabinet interior to maintain the cabinet interior at the desired temperature. The system is preferably directed toward cabinets disposed in ambulances and other medical vehicles in order to maintain medical items, such as drugs or intravenous solution, contained within the cabinets at their appropriate temperatures (e.g., 21° C.-26° C. for drugs, 35° C.-40° C. for IV solution). The cabinet system further includes a thermal barrier disposed toward and substantially covering the cabinet interior entrance to thermally isolate the cabinet interior from the ambient environment and permit access to medical items contained within the cabinet. The thermal barrier includes a plurality of strips that may be spaced from each other a selected distance, or be arranged in an overlapping fashion to substantially impede or minimize heat exchange between the cabinet interior and ambient environment during intervals where the cabinet interior is exposed to that environment (e.g., intervals where at least one cabinet door is in an open state).

[0021] The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of specific embodiments thereof, particularly when taken in conjunction with the accompanying drawings wherein like reference numerals in the various figures are utilized to designate like components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] **FIG. 1** is an exploded view in perspective of an exemplary temperature controlled cabinet system according to the present invention.

[0023] **FIG. 2** is a block diagram of an exemplary temperature control system of the cabinet system of **FIG. 1**.

[0024] **FIG. 3** is a front view in plan of an exemplary control console of the temperature control system of **FIG. 2**.

[0025] **FIG. 4A** is a view in perspective of the cabinet system of **FIG. 1** having a thermal barrier disposed within the cabinet interior according to the present invention.

[0026] **FIG. 4B** is a front view in elevation and partial section of the cabinet system of **FIG. 4A**.

[0027] **FIG. 4C** is a view in section of the cabinet system thermal barrier taken along lines **4C-4C** in **FIG. 4B**.

[0028] **FIG. 5** is a view in perspective of the cabinet system of **FIG. 1** having an alternative thermal barrier disposed within the cabinet interior according to the present invention.

[0029] **FIG. 6** is an exploded view in perspective of an alternative embodiment of the temperature controlled cabinet system of **FIG. 1** having a single heat pump according to the present invention.

[0030] **FIG. 7** is a block diagram of an exemplary temperature control system of the cabinet system of **FIG. 6**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] An exemplary cabinet system of the present invention for use in ambulance or other medical vehicles to contain medical items (e.g., drugs or intravenous solution contained within IV bags) is illustrated in **FIG. 1**. Specifically, the system includes a cabinet **18**, a temperature control system **40** (**FIG. 2**), a support member **110** (**FIG. 4B**) and a thermal barrier **80** (**FIG. 4B**). Cabinet **18**, typically disposed along with a plurality of other cabinets within an ambulance or other medical vehicle interior, is similar in shape to a substantially rectangular box and includes top and bottom walls **20**, **22**, side walls **24**, **26** and rear wall **30**. The cabinet front typically includes doors **32**,**34**, preferably disposed between top and bottom walls **20**,**22** and side walls **24**,**26**. Each cabinet wall is substantially rectangular with top and bottom walls **20**, **22** having substantially similar dimensions. Side walls **24**, **26** have dimensions substantially similar to each other, while rear wall **30** is disposed between top and bottom walls **20**, **22** and side walls **24**, **26** such that the cabinet walls and doors collectively define a cabinet interior. It is to be understood that the terms "front", "rear", "top", "bottom", "side", "lower", "upper", "vertical", "horizontal", "width", "length" and the like are used herein merely to describe points of reference and do not limit the present invention to any specific configuration or orientation. Thermally insulating doors **32**,**34** are typically disposed at the front of the cabinet to enable placement and removal of medical items, such as drugs or intravenous solution bags, within the cabinet interior. By way of example only, cabinet **18** includes two substantially rectangular sliding doors **32**,**34**, however, the cabinet may include any quantity or type of doors at any location that open and close in any manner or direction. Further, the cabinet doors may be of any shape, while the cabinet interior may include any quantity of shelves to contain the medical items.

[0032] Doors **32**, **34** are each typically substantially rectangular having substantially similar dimensions wherein the height of each door is slightly less than the distance between top wall **20** and bottom wall **22**, while the width of each door is approximately one-half the width of the cabinet. Doors **32**, **34** are typically disposed one in front of the other to permit the doors to slide between the cabinet side walls and enable

access to the cabinet interior. By way of example only, door **34** is disposed in front of door **32** such that door **32** is slightly recessed toward the cabinet interior, while door **34** is substantially flush with the top, bottom and side wall edges. However, the doors may be disposed on the cabinet in any manner capable of permitting the doors to slide between the side walls. Alternatively, doors **32**, **34** may be attached to cabinet **18** via hinges such that the doors may pivot to an open or closed position. Doors **32**, **34** are typically secured to cabinet **18** via rails or tracks (not shown) disposed on the interior surface of top wall **20** and/or bottom wall **22**. The doors engage the tracks to slide between the cabinet side walls. Doors **32**, **34** each include a knob or handle **38** disposed toward the middle portion of each door **32**, **34** adjacent a vertical door edge closest to respective cabinet side walls **24**, **26**. Knobs **38** may be any conventional knobs, handles or recesses within the doors and may be disposed anywhere on the doors in any fashion. For example, knobs **38** maybe implemented by a handle having a substantially circular gripping portion attached to an elongated stem (e.g., as illustrated in **FIG. 1**) that provides sufficient distance between the gripping portion and the cabinet to enable an operator hand to manipulate the door.

[**0033**] Heat pumps **54** are typically placed within cabinet side wall **24** via openings **85**. By way of example only, two heat pumps are utilized in the exemplary cabinet system, however, the cabinet system may include any quantity of heat pumps, or any other type of thermal device placed at any location on the cabinet to maintain the cabinet interior at a desired temperature. Heat pumps **54** may be implemented by any conventional heat pumps or thermoelectric devices. By way of example only, the heat pumps each include an exterior heat sink **88** with corresponding axial fan **90**, an interior heat sink **92** with corresponding axial fan **94**, and an insulating layer **95** and a Peltier chip **96** (e.g., thermoelectric device) disposed between the exterior and interior heat sinks. Exterior heat sink **88** typically has larger dimensions than interior heat sink **92**. Heat pumps **54** are inserted into cabinet wall **24** via openings **85** with insulation **95** and Peltier chip **96** substantially coincident the wall, exterior heat sink **88** disposed exterior of the cabinet and interior heat sink **92** disposed within the cabinet interior.

[**0034**] Heat sinks **88** and **92** are substantially rectangular and are typically constructed of a thermally conductive material (e.g., metal). Fans **90** and **94** circulate air through channels or passages (not shown) defined in the heat sinks and back to the corresponding surrounding area. In particular, air within the cabinet interior traverses interior heat sink **92** and returns to the cabinet interior via fan **94**. The circulating air transfers thermal energy from the interior heat sink to the cabinet interior to heat or cool the cabinet interior and maintain a desired temperature. The air circulation for exterior heat sink **88** is substantially similar to that of heat sink **92** described above, except that the air is circulated with respect to the surrounding environment (e.g., external of the cabinet).

[**0035**] Heat pumps **54** utilize Peltier chip **96** (i.e., a solid state thermoelectric device) to heat and cool heat sinks **88** and **92**. This type of thermoelectric device typically includes an array of thermocouples that operate in accordance with the Peltier effect. Basically, the thermoelectric device obeys the laws of thermodynamics in a similar manner as mechanical heat pumps, refrigerators or other devices used to transfer heat energy, except that this device includes solid state electrical components instead of mechanical/fluid heating and cooling components. Specifically, when D.C. (i.e., direct current) electrical power is applied to a thermoelectric device having an array of thermocouples, heat is absorbed on a cold side of the thermocouples wherein the heat passes through the thermocouples to be dissipated on the hot side of the thermocouples. Heat sinks are typically disposed on the hot and cold sides of the thermocouples to respectively aid in dissipating heat to, or removing heat from, the adjacent environment. Whether the heat sinks absorb or dissipate heat is determined by the direction of current flow through, or voltage polarity applied to, the device in accordance with the Peltier effect.

[**0036**] Peltier chip **96** enables heat sinks **88** and **92** to dissipate and absorb heat based on the voltage polarity applied to that chip. In particular, the Peltier effect stipulates that when current passes across a junction between two different metals, heat is either absorbed or dissipated based on current flow in relation to junction voltage direction. Current opposing the voltage direction causes heating of the junction, while current flowing with the voltage causes junction cooling. For example, an electric current driven in a bimetallic circuit maintained at uniform temperature causes heat to be dissipated at one circuit junction and absorbed at the other junction. This phenomenon occurs since an isothermal electric current in a metal is accompanied by a thermal current. Since the electric current is uniform and the thermal currents vary between metals, the difference in thermal currents is dissipated at one junction and absorbed at the other junction to maintain uniform temperature. In other words, it is necessary to supply heat at one junction and extract heat at the other junction to maintain uniform temperature in a bimetallic circuit. Peltier chip **96** functions in a similar manner to dissipate heat to interior heat sink **92**, while absorbing heat (i.e., cooling) from exterior heat sink **88** based on the direction of current flow or voltage polarity received by the chip. When the current flow or voltage polarity is reversed, then heat is dissipated to exterior heat sink **88** and absorbed from interior heat sink **92**. For further examples of thermoelectric devices and their operation, reference is made to U.S. Pat. No. 5,315,830, incorporated herein by reference in its entirety.

[**0037**] An exemplary temperature control system for maintaining the cabinet interior at a specified temperature in order to accommodate medical items requiring certain storage temperature ranges is illustrated diagrammatically in **FIG. 2**. Specifically, temperature control system **40** includes a controller assembly **42**, a temperature sensor **44** interfacing a sensor plug type connector **37**, a controller wiring harness **49** including receptacle type connectors **46** and **47**, a heat pump wiring harness **48** including plug type connector **50** and receptacle type connectors **52**, and heat pumps **54**. The controller assembly includes a control console (**FIG. 3**) having a controller display that provides an indication of the temperature within the cabinet interior, while input devices disposed below the display enable programming of the controller **14** assembly and entry of a desired cabinet temperature as described below. Heat pumps **54** are typically installed within cabinet side walls as described above to heat and/or cool the cabinet interior based on control signals generated by controller assembly **42**. The heat pumps are each connected to a respective connector **52** of heat pump harness **48** via a plug type connector **98** wherein connectors

52 are connected to receptacle **47** of controller harness **49**, via connector **50**, to receive signals from controller assembly **42**. Receptacle **47** of controller harness **49** is connected to controller assembly **42** and conveys control signals to receptacle connectors **52**, via plug connector **50**, to control heat pumps **54**. Temperature sensor **44**, typically an RTD thermocouple, is disposed within the cabinet interior to measure cabinet interior temperature and to send a converted signal representing the temperature to the controller assembly. Temperature sensor **44** is connected to receptacle connector **46** of controller harness **49** via plug connector **37** wherein the controller harness interfaces the controller assembly to convey the temperature signals representing the cabinet interior temperature to the controller assembly.

[**0038**] Controller assembly **42** includes a control console described below having switches and a display for entering a desired temperature and displaying the current temperature of the cabinet interior. The controller assembly generates signals in a manner described below to control heat pumps **54** in response to a particular reading from sensor **44**. In other words, when the cabinet interior temperature exceeds a desired temperature, controller assembly **42** directs heat pumps **54** to cool the interior, while directing heat pumps **54** to heat the cabinet interior when the cabinet interior temperature is less than a desired temperature. Temperature control system **40** may be incorporated into new cabinets during manufacture, or may be retrofit into cabinets lacking temperature control capability to form a temperature controlled cabinet. For examples of the structure and operation of the heat pumps and this type of control system, reference is made to U.S. Pat. No. 5,924,289 (Bishop, II), the disclosure of which is incorporated herein by reference in its entirety. The cabinet system typically includes a preset temperature range of 21° C.-26° C. or 35° C.-40° C., however, any temperature or range may be programmed or entered into the system to maintain the cabinet interior at a suitable temperature for storing various medical or other items.

[**0039**] Controller assembly **42** controls system operation and includes a faceplate or control console **56** as illustrated, by way of example only, in **FIG. 3**. Specifically, control console **56** is substantially rectangular and includes a power (i.e., ON/OFF) switch **58**, fuse holder **61**, preferably including a fifteen amp fuse **62**, and a controller display **63**. Fuse holder **61** is generally disposed between power switch **58** and controller display **63** toward an upper portion of control console **56**, however, the control console may be of any shape with the power switch, fuse holder and display arranged on the control console in any fashion. Power switch **58** may be implemented by any conventional power switch, and by way of example only, is implemented by a substantially rectangular switch wherein depressing an end of the switch associated with "ON" or "OFF" attains the desired power distribution to the system. Fuse holder **61** may be implemented by any conventional fuse holder and is preferably implemented by a panel mount fuse holder typically suited to contain a fifteen amp fuse. Controller display **63** includes a light emitting diode (LED) or liquid crystal (LCD) temperature display **66** for displaying the temperature of the cabinet interior. Controller display **63** is generally configured to display four digits, however, the display may be implemented to display any number of digits. The controller assembly is typically programmable and provides the appropriate signals to the heat pumps to maintain the cabinet interior at the desired temperature.

[**0040**] Controller display **63** may further include cooling mode and heating mode indicator lights **68**, **69**, preferably disposed diagonally opposite each other to indicate when the interior cabinet temperature has shifted out of a desired temperature range. In particular, cooling mode indicator light **68** is disposed toward the bottom portion of temperature display **66** and indicates a cabinet interior temperature above the desired temperature range, while heating mode indicator light **69** is disposed toward the top portion of temperature display **66** and indicates a cabinet interior temperature below the desired temperature range. User interface buttons **70**, **72** and **74** are disposed below temperature display **66** and enable programming of the controller assembly and entry of a desired cabinet temperature. Buttons **70**, **72** and **74** are labeled with various indicia (e.g., a star, down arrow and up arrow) to distinguish the buttons and indicate button functions. Generally, button **70** labeled with a star is used for selection, while buttons **72** and **74** are used for manipulating data to be entered. The buttons may be arranged in any manner on controller display **63** and may include any indicia uniquely identifying each button. The control console is typically constructed of metal and may be disposed within an ambulance or other medical vehicle at any suitable location. The control console may alternatively be constructed of any other sufficiently sturdy material.

[**0041**] The controller assembly circuitry is generally mounted on the back of the control console and includes power switch **58**, fuse holder **61** with fuse **62** as described above, a programmable controller and switching circuitry. The controller maybe implemented by any conventional or other programmable controller, and receives commands from an operator via buttons **70**, **72**, **74** as described above. The switching circuitry controls the heat pumps in accordance with the controller to maintain the cabinet interior at the desired temperature. For an example of the structure and operation of controller assembly circuitry, reference is made to above-mentioned U.S. Pat. No. 5,924,289 (Bishop, II).

[**0042**] Doors **32**, **34** of cabinet **18** thermally isolate the cabinet interior from the ambient environment in response to the doors being in a closed state. However, when at least one of the cabinet doors is in an open state, the cabinet interior is exposed to and in thermal exchange relation with the ambient environment, thereby adversely affecting the cabinet interior temperature. Accordingly, the cabinet system of the present invention further includes a thermal barrier to thermally isolate the cabinet interior from the ambient environment (e.g., minimize or significantly impede the thermal exchange between the cabinet interior and ambient environment) and maintain the desired cabinet interior temperature in response to exposure of the cabinet interior to that environment (e.g., an open state of at least one cabinet door). An exemplary cabinet system thermal barrier is illustrated in FIGS. **4A-4C**. Specifically, cabinet **18** is substantially similar to the cabinet described above and includes heat pumps **54** disposed in side wall **24** to control the cabinet interior temperature. The heat pumps are preferably horizontally aligned within an upper portion of side wall **24**, but may be disposed at any suitable locations within any cabinet walls. The cabinet further includes thermal barrier **80** and support member **110** to suspend the thermal barrier within the cabinet interior. An optional shelf **36** may be removably

or otherwise attached to side walls **24**, **26** at intermediate sections thereof. The shelf is typically substantially rectangular and basically partitions the cabinet interior into upper and lower compartments **82**, **84** each for containing medical items **120** placed therein. The cabinet side walls each preferably include a groove or slot (not shown) for receiving shelf side edges, however, any suitable technique for supporting the shelf within the cabinet interior may be employed. The shelf extends for a distance slightly less than the distance between thermal barrier **80** and the cabinet rear wall to form passages for air flow between the upper and lower compartments. The passages enable heat pumps **54** to circulate thermally treated air between the upper and lower compartments for maintaining the cabinet interior at a desired temperature. Alternatively, each heat pump may be disposed in a cabinet wall coincident a corresponding compartment to thermally treat that compartment in substantially the same manner described above.

[**0043**] Support member **110** is recessed inwardly a slight distance from the cabinet interior entrance or side wall front edges and is preferably attached to and extends between upper sections of cabinet side walls **24**,**26**. The support member may be attached to the cabinet side and/or top walls via any suitable fastening mechanisms (e.g., brackets, bolts, etc.) and typically includes clasps or other fastening devices (not shown) to engage and suspend thermal barrier **80** within the cabinet interior. The support member may be of any shape or size, and may be constructed of any suitable materials.

[**0044**] Thermal barrier **80**, by way of example only, includes a plurality of flexible insulating strips **100***a*-**100***f* each having a substantially rectangular configuration. The strips are preferably constructed of a substantially transparent plastic material, while the longer dimension of each strip extends from support member **110** toward the cabinet bottom wall. The longer dimension or length of each strip is slightly less than the distance between the cabinet top and bottom walls, while the strip shorter dimension or width is substantially less than the cabinet width. However, the thermal barrier may include any quantity of strips of any shape or size and constructed of any suitable materials to thermally isolate the cabinet interior from the ambient environment. The strips are arranged to successively extend in a transverse direction across the cabinet interior entrance with the longer dimension edges of neighboring strips adjacent each other. A slot or opening (not shown) maybe defined toward the top edge of each strip to facilitate engagement of that strip by a corresponding support member clasp, thereby attaching the strip to the support member.

[**0045**] The thermal barrier strips are preferably arranged in an overlapping fashion and are manipulable relative to each other to facilitate passage of medical items **120** through the thermal barrier for placement and removal within the cabinet interior. By way of example only, strips **100***b*, **100***d* and **100***f* are recessed within the cabinet interior relative to strips **100***a*, **100***c*, **100***e*, and are partially covered by each of their neighboring strips. In other words, strip **100***a* partially covers strip **100***b*; strip **100***c* partially covers strips **100***b* and **100***d*; and strip **100***e* partially covers strips **100***d* and **100***f* (e.g., as shown in **FIG. 4C**). This arrangement prevents formation of gaps between adjacent strips and provides a thermal barrier toward the cabinet interior entrance that impedes heat exchange between that interior and the ambient environment, while permitting passage of medical items therethrough for placement and removal of those items within the cabinet interior as described above.

[**0046**] Thermal barrier **80** maybe disposed at any desired location within the cabinet interior. For example, the thermal barrier may be located adjacent the cabinet interior entrance to thermally isolate the cabinet interior from the ambient environment as described above. Alternatively, the thermal barrier maybe recessed inwardly from the cabinet interior entrance to partition the cabinet interior into a plurality of thermally isolated compartments. Additional heat pumps may be utilized to heat and/or cool each partitioned compartment within the cabinet interior in substantially the same manner described above. Further, the recessed thermal barrier may serve to insulate a compartment defined between the thermal barrier and the cabinet rear wall during intervals in which the cabinet interior is exposed to the ambient environment (e.g., intervals in which at least one cabinet door is in an open state). In effect, the cabinet interior section located adjacent the cabinet interior entrance (e.g., the section defined between the entrance and recessed thermal barrier) decreases the temperature differential between the compartment and ambient environment, thereby enhancing thermal barrier capability to maintain the compartment at desired temperatures for medical items contained therein when the cabinet interior is exposed to the ambient environment (e.g., when at least one cabinet door is in an open state).

[**0047**] The thermal barrier strips may be disposed within the cabinet interior in any desired arrangement (e.g., overlapping, non-overlapping, etc.) and at any suitable locations via any conventional or other fastening or suspension mechanisms. Moreover, the strips may be attached directly to the cabinet walls, or to any type of support structure mounted on or within the cabinet. In addition, the thermal barrier and corresponding supporting mechanisms may be installed in new cabinet structures or retrofitted into existing structures with or without temperature control capability in substantially the same manner described above to impede heat exchange between the cabinet interior and ambient environment.

[**0048**] An alternative embodiment of the thermal barrier for the cabinet system is illustrated in **FIG. 5**. Specifically, cabinet **18** is substantially similar to the cabinet described above for **FIGS. 1 and 4**A and includes a thermal barrier **200**. The thermal barrier is in the form of a generally rectangular sheet that substantially covers the cabinet interior entrance. The sheet is preferably constructed of the transparent material described above for thermal barrier **80** to allow medical items disposed within the cabinet to be visible, however, the sheet may be of any shape or size and may be constructed of any suitable materials. Thermal barrier **200** is typically attached to the cabinet interior top, bottom and side walls via any conventional or other fastening mechanisms (e.g., screws, adhesives, clasps, etc.) and includes an opening or slit **202** that extends a substantial distance between the cabinet top and bottom walls. The slit may be placed in a closed state to thermally insulate the cabinet interior, and may further be opened and expanded to permit items to pass therethrough during loading and unloading of the cabinet. The slit may alternatively be of any quantity, shape or size, may extend in any desired direction along the sheet for any desired distance, and may be of any

suitable configuration to permit passage of items therethrough while effectively thermally insulating the cabinet interior from the ambient environment. The cabinet may include a shelf as described above for **FIG. 4**B, while the sheet maybe disposed and employed within the cabinet in substantially the same manners described above for thermal barrier **80** (e.g., partition the cabinet interior into compartments, dispose the sheet at any suitable locations within the cabinet interior for additional thermal insulation, etc.).

[**0049**] Operation of the cabinet system is described with reference to FIGS. **1-3** and **4**A-**4**C. Initially, power to the system is initiated by actuating power switch **58** on control console **56**. Fans **91**, **94** are initiated with temperature display **66** showing the cabinet interior temperature measured by temperature sensor **44** with indicator lights **68**, **69** disabled. Doors **32**, **34** may be opened via knobs **38** to allow access to the cabinet interior for placing medical items therein. Flexible strips **100***a*-**100***f* are selectively displaced from each other by an operator to provide an opening within thermal barrier **80** for placement of medical items within the cabinet interior. The controller assembly is subsequently programmed to a desired temperature in accordance with the particular medical items placed within the cabinet interior. For example, the controller assembly is typically programmed to a set point of 21° C. for drug storage. Alternatively, the controller may be programmed to a set point of 35° C. for IV solution storage. Each set point may be programmed via buttons **70**, **72**, **74**. During normal or standby mode when the cabinet temperature resides within the desired range, temperature display **66** indicates the actual cabinet temperature measured by temperature sensor **44**, while fans **90**, **94** circulate air through the respective heat sinks **88**, **92** as described above.

[**0050**] In response to the measured cabinet interior temperature exceeding the desired temperature range, cooling mode indicator light **68** in the lower portion of the controller display flashes. Controller assembly **42** provides signals to thermoelectric device **96** to enable interior heat sinks **92** to cool the cabinet interior as described above. Conversely, when the measured cabinet interior temperature falls below the desired temperature range, heating mode indicator light **69** disposed in the upper portion of the controller display flashes. Controller assembly **42** provides signals to thermoelectric device **96** to enable heat transfer from exterior heat sinks **88** to interior heat sinks **92** to heat the cabinet interior. This process continues as described above to maintain the cabinet interior temperature within the desired temperature range. The medical items may be removed from the cabinet interior through the thermal barrier for administration to patients. In effect, the thermal barrier thermally isolates the cabinet interior from the ambient environment, thereby permitting doors **32**, **34** to remain in an open state for extended time intervals with decreased risk of the cabinet interior attaining temperatures outside the desired temperature range.

[**0051**] Alternatively, temperature control system **40** maybe implemented using a single large heat pump **55** in substantially the same manner described above as illustrated in FIGS. **6-7**. Specifically, system **40** includes heat pump **55**, and controller assembly **42**, temperature sensor **44**, and controller wiring harness **49** each as described above. The temperature sensor is connected to the controller assembly via controller wiring harness **49** in substantially the same manner described above for the dual heat pump system, while heat pump **55** is directly connected to the controller assembly via the controller harness (e.g., since the heat pump harness is not required). The single heat pump system is substantially similar to, and functions in substantially the same manner as, the dual heat pump system described above, except that a single heat pump is utilized to maintain the cabinet interior at the desired temperature.

[**0052**] Heat pump **55** includes a configuration similar to that described above in **FIG. 1** for heat pumps **54**. In particular, heat pump **55** includes insulation layer **95** and Peltier chip **96** each disposed between interior and exterior heat sinks **77**,**79** wherein fans **64**,**65** are disposed adjacent the respective heat sinks. The heat sinks of pump **55** are substantially similar to but have larger dimensions than the respective heat sinks of heat pumps **54** wherein interior heat sink **77** of heat pump **55** corresponds to exterior heat sink **88** of heat pump **54** and is disposed within the cabinet interior, while exterior heat sink **79** of heat pump **55** corresponds to interior heat sink **92** of heat pump **54** and is disposed on the cabinet exterior. In other words, the alternative embodiment includes an interior heat sink that has larger dimensions than exterior heat sink **88** of heat pump **54** (e.g., the heat sinks of heat pump **54** are basically switched in the alternative embodiment).

[**0053**] Installation of system **40** with a single heat pump **55** within cabinet **18** is described. Specifically, system **40** and heat pump **55** are installed in cabinet side wall **26** in substantially the same manner described above for the system having heat pumps **54**, except that the large interior heat sink is disposed within the cabinet interior, while the small exterior heat sink is disposed on the cabinet exterior. An opening **81** for heat pump **55** is defined in side wall **26** in order to accommodate the heat pump. Once heat pump **55** is installed within the cabinet side wall, the heat pump is connected to harness **49** via receptacle **47**, while temperature sensor **44** is connected to receptacle **46**. This is substantially similar to the connections described above for the dual heat pump system, except that plug **98** from heat pump **55** is directly connected to receptacle **47** since the heat pump harness is not required when utilizing a single heat pump. Controller harness **49** is also connected to the controller assembly. Once the heat pump is installed, the controller assembly is installed at a suitable location within the vehicle as described above. Subsequent to installation, the system is operated in substantially the same manner described above, while a thermal barrier may thermally isolate the cabinet interior from the ambient environment when the cabinet interior is exposed to that environment (e.g., when at least one cabinet door is in an open state) as described above.

[**0054**] It will be appreciated that the embodiments described above and illustrated in the drawings represent only a few of the many ways of implementing a temperature controlled cabinet system and method employing a thermal barrier to thermally isolate the cabinet interior from the ambient environment.

[**0055**] The cabinet may be any type of enclosed structure, preferably utilized in ambulances or other medical vehicles, and may include any quantity of drawers, shelves or other storage arrangements of any shape or size, wherein cabinets having shelves may include any quantity of doors opening in any direction. The cabinet may be of any shape or size, and

may be constructed of any suitable materials. The cabinet may be installed within vehicles or stationary structures (e.g., medical facility, etc.), and may contain any quantity of any types of medical or other items. The cabinet may include any quantity of doors or other access devices that may be of any shape or size, may be constructed of any suitable materials and may be manipulable in any suitable direction to provide access to the cabinet interior. The doors may each include any quantity of any type of handle disposed at any suitable locations for manipulation of that door. The doors may be attached and manipulable relative to the cabinet via any conventional or other fastening devices (e.g., tracks, hinges, etc.), and may further be substantially transparent or include a window of any shape or size disposed at any suitable locations to enable viewing of medical or other items placed within the cabinet.

[0056] The cabinet may include any quantity of heat pumps and temperature sensors, and may be partitioned into any quantity of compartments that may be individually controlled (e.g., each compartment may be associated with a heat pump and temperature sensor). The heat pumps may be installed at any location on the cabinet capable of heating and cooling the cabinet interior. Similarly, the controller assembly and/or console may be installed at any appropriate location on the cabinet and/or within the vehicle or stationary structure capable of operating the system. Further, any quantity of heat pumps, temperature sensors or other devices may be utilized. The heat pumps may be installed within the cabinet at any orientation to provide enhanced air flow. The heat pumps may be implemented by any quantity of any conventional or other heat pump type devices. The heat sinks may be implemented by any sufficiently thermally conductive material and may be of any quantity, shape or size. The heat sinks may be disposed within the heat pump at any orientation to enhance air flow and heat pump efficiency. The heat pump and controller wiring harness may utilize any wiring capable of conveying signals, while the plug and receptacle type connectors may be implemented by any quantity of any type of conventional or other connectors capable of establishing connections. The cabinet system may alternatively facilitate connections directly with wires or other medium without the use of wiring harnesses.

[0057] The Peltier chip may be implemented by any circuitry or other thermoelectric or electromechanical devices having thermodynamic characteristics capable of transferring thermal energy between the heat sinks. The insulation layer may include any conventional insulation, such as foam. The fans may be implemented by any quantity of any conventional fans or other devices of any shape or size and capable of circulating air. The temperature sensor maybe implemented by an RTD thermocouple or any other temperature sensor capable of providing temperature signals to the controller.

[0058] The control console may include any quantity of conventional switches or buttons for the power switch, and may include any quantity of any conventional or other type of fuse holder and fuse to protect the controller assembly circuitry. The temperature display may be an LED or LCD display, or any other mechanism for indicating temperature and the system mode. The indicator lights, display and console may be of any color, shape or size. The console components may be arranged and/or disposed on the console in any fashion, while the console may be constructed of metal or other suitable sturdy material. The controller display may be disposed at any suitable location on the console. The temperature display may display any desired information and include any quantity of digits. The controller display may include any quantity of indicator lights of any shape, size or color and disposed at any suitable locations on the display. Further, the controller display may include any quantity of any type of buttons or data entry devices to program the controller in any manner for a desired temperature.

[0059] The controller may be implemented by any quantity of conventional controllers, microprocessors or any other analog or digital circuitry capable of processing a temperature signal from any quantity of temperature sensors and generating control signals for any quantity of heat pumps. The controller may be programmed to maintain the cabinet interior and/or any quantity of thermally isolated compartments at any corresponding desired temperature, or within any corresponding desired temperature range. The switching circuitry may include any quantity of any type of conventional or other solid state switches (e.g., transistors, etc.) and relays or other circuitry or components that are capable of supplying control signals to any quantity of heat pumps. The components may be arranged in any fashion to provide the proper signals to the heat pumps. The controller assembly may alternatively include any quantity of controllers to control any quantity of corresponding heat pumps.

[0060] The strip thermal barrier may include any quantity of strips of any size or shape and constructed of any suitable materials. The strip thermal barrier may be fastened to the support member and/or directly to any of the cabinet walls or shelves via any quantity of any conventional or other fastening devices (e.g., clasps, hooks, etc.). The strips may each include any quantity of slots, openings or corresponding fastening devices for engagement with the support member and/or cabinet walls or shelves. The support member may be of any quantity, shape or size, and maybe constructed of any suitable materials. The support member maybe disposed at any locations internal or external of the cabinet, and may be attached to any cabinet walls or shelves via any conventional or other fastening devices (e.g., brackets, bolts, etc.). The strips may be constructed of any suitable transparent, translucent or opaque materials, and may be arranged in any fashion (e.g., separated by any desired distance, overlapped in any desired fashion, etc.). The strips maybe manipulable relative to each other and/or the cabinet in any fashion to permit passage of items therethrough for placement and removal within the cabinet interior. Alternatively, the support member may include a mechanism to pivot, shift or rotate the strips (e.g., similar to mechanisms for manipulating vertical or other blinds) to provide passages between or through the strips for access to the cabinet interior.

[0061] Any quantity of thermal barriers and/or shelves may be disposed within the cabinet interior to partition that interior into thermally isolated compartments. The compartments may receive thermally treated air from the cabinet heat pumps, or each compartment may be associated with any quantity of corresponding heat pumps and temperature sensors for individual temperature control of those compartments by a controller as described above.

[0062] The thermal barriers may be implemented by any thermal barrier capable of impeding transfer of heat between

the cabinet interior and the external environment surrounding the cabinet system. The thermal barriers may permit medical or other items to pass therethrough in any manner (e.g., by passing through or around the barrier). The slit thermal barrier may include any quantity of openings or slits having any orientation and configuration that permits passage of items through the barrier. The sheet may be of any shape or size and may be constructed of any suitable materials. The slit thermal barrier may be attached to the cabinet interior at any desired locations via any conventional or other fastening mechanisms (e.g., screws, adhesives, clasps, etc.). The slit may be of any quantity, shape or size, may extend in any desired direction along the sheet for any desired distance, and may be of any suitable configuration to permit passage of items therethrough.

[0063] The thermal barriers may be disposed adjacent a cabinet interior entrance, or recessed inwardly therefrom at any selected distance to partition the cabinet interior into at least two thermally isolated compartments. The cabinet system of the present invention may include any quantity or combination of any types of thermal barriers within the cabinet interior, where the thermal barriers maybe disposed adjacent each other or at separate locations within the cabinet interior. For example, two thermal barriers may be placed within the cabinet interior to separate the interior into two or more thermally isolated compartments. The thermal barriers may be affixed externally of the cabinet system, where the thermal barriers may be attached to the external surface of any of the cabinet front or other edges to cover the cabinet interior entrance.

[0064] The cabinet system of the present invention may be implemented in new vehicle or other cabinets as an option, or mounted in existing cabinets lacking temperature control and thermal barrier capability. The system may be factory set to various temperatures, however, any temperature may be programmed into the system as described above.

[0065] It is to be understood that the temperature controlled cabinet system of the present invention may utilize any types of cabinets, heating and cooling devices, appropriate controllers and associated circuitry, and thermal barriers to control temperature of and thermally isolate medical items contained within a cabinet interior.

[0066] From the foregoing description it will be appreciated that the invention makes available a novel temperature controlled cabinet system and method employing a thermal barrier to thermally isolate the cabinet interior from the ambient environment wherein a cabinet system containing medical items and employing temperature control to maintain those items at a desired temperature further includes a thermal barrier to impede heat transfer between the cabinet interior and ambient environment during intervals where the cabinet interior is exposed to that environment.

[0067] Having described preferred embodiments of a temperature controlled cabinet system and method employing a thermal barrier to thermally isolate the cabinet interior from the ambient environment, it is believed that other modifications, variations and changes will be suggested to those skilled in the art in view of the teachings set forth herein. It is therefore to be understood that all such variations, modifications and changes are believed to fall within the scope of the present invention as defined by the appended claims.

What is claimed is:

1. A temperature controlled cabinet system for storing medical items and maintaining said medical items within a desired temperature range comprising:

a cabinet to receive at least one medical item within a cabinet interior and including at least one door to provide access to said cabinet interior;

at least one heat pump partially disposed within said cabinet interior to heat or cool said cabinet interior;

a temperature sensor disposed within said cabinet interior to measure a cabinet interior temperature and to generate a temperature signal indicating said measured cabinet interior temperature;

a controller assembly to enable selection and entry of said desired temperature range into said system and to generate control signals to control each of said at least one heat pump, wherein said controller assembly controls each of said at least one heat pump to heat or cool the cabinet interior as required in response to a comparison of said temperature signal received from said temperature sensor with said selected temperature range to maintain said cabinet interior within said selected temperature range; and

a thermal barrier disposed between said at least one door and a rear wall of said cabinet to impede heat exchange between said cabinet interior and the ambient environment and maintain temperature of said cabinet interior and said at least one medical item contained therein when said cabinet interior is exposed to that environment;

wherein said thermal barrier is configured to facilitate passage of said at least one medical item through said thermal barrier and to retain heat within said cabinet interior in response to said cabinet interior temperature exceeding a temperature of the ambient environment and impede heat from said ambient environment accessing said cabinet interior in response to said cabinet interior temperature being below said ambient environment temperature.

2. The system of claim 1, wherein said thermal barrier is disposed adjacent at least one door.

3. The system of claim 1, wherein said thermal barrier is disposed within said cabinet interior a selected distance from said at least one door to partition said cabinet interior into a plurality of thermally isolated compartments.

4. The system of claim 1 further including a support member disposed between at least one door and said cabinet rear wall to engage and support said thermal barrier within said cabinet interior.

5. The system of claim 1, wherein said thermal barrier includes a plurality of elongate strips.

6. The system of claim 5, wherein said plurality of strips are arranged in an overlapping fashion to form said thermal barrier.

7. The system of claim 5, wherein said plurality of strips are arranged with each strip positioned a selected distance from a neighboring strip to form said thermal barrier.

8. The system of claim 1 further comprising a plurality of thermal barriers each disposed within said cabinet interior to partition said cabinet interior into a plurality of thermally isolated compartments.

9. A method of maintaining an interior of a cabinet within a desired temperature range, wherein said cabinet stores at least one medical item and includes at least one door to provide access to said cabinet interior, a temperature sensor, a controller assembly to control system operation, at least one heat pump to heat or cool said cabinet interior, and a thermal barrier disposed between said at least one door and a cabinet rear wall, said method comprising the steps of:

(a) receiving said desired temperature range for said at least one medical item entered into said controller assembly;

(b) with said temperature sensor, measuring a temperature within said cabinet interior and generating a temperature signal indicating said measured cabinet interior temperature;

(c) with said controller assembly, comparing said temperature signal received from said temperature sensor to said desired temperature range;

(d) controlling each of said at least one heat pump, via said controller assembly, to heat or cool said cabinet interior as required in response to said comparison of said temperature signal with said desired temperature range to maintain said cabinet interior temperature within said desired temperature range;

(e) with said thermal barrier, impeding heat exchange between said cabinet interior and the ambient environment and maintaining temperature of said cabinet interior and said at least one medical item contained therein when said cabinet interior is exposed to that environment by retaining heat within said cabinet interior in response to said cabinet interior temperature exceeding a temperature of the ambient environment and impeding heat from said ambient environment accessing said cabinet interior in response to said cabinet interior temperature being below said ambient environment temperature.

10. The method of claim 9, wherein step (e) further includes:

(e.1) with said thermal barrier disposed adjacent at least one door, impeding heat exchange between said cabinet interior and the ambient environment and maintaining temperature of said cabinet interior and said at least one medical item contained therein when said cabinet interior is exposed to that environment.

11. The method of claim 9, wherein step (e) further includes:

(e.1) forming a plurality of thermally isolated compartments within said cabinet interior by disposing said thermal barrier within said cabinet interior a selected distance from said at least one door.

12. The method of claim 9, wherein said cabinet further includes a support member disposed between at least one door and said cabinet rear wall, and step (e) further includes:

(e.1) supporting said thermal barrier within said cabinet interior via said support member.

13. The method of claim 9, wherein said thermal barrier includes a plurality of elongate strips, and step (e) further includes:

(e.1) forming said thermal barrier by arranging said strips in an overlapping fashion.

14. The method of claim 9, wherein said thermal barrier includes a plurality of elongate strips, and step (e) further includes:

(e.1) forming said thermal barrier by positioning each strip a selected distance from a neighboring strip.

15. The method of claim 9, wherein said cabinet includes a plurality of said thermal barriers, and step (e) further includes:

(e.1) forming a plurality of thermally isolated compartments within said cabinet interior by disposing said thermal barriers within said cabinet interior.

16. A method of maintaining an interior of a cabinet within a desired temperature range via a temperature control system, wherein said cabinet stores at least one medical item and includes at least one door to provide access to said cabinet interior, and said temperature control system includes a temperature sensor, a controller assembly to control system operation, at least one heat pump to heat or cool said cabinet interior, and a thermal barrier disposed between said at least one door and a cabinet rear wall, said method comprising the steps of:

(a) retrofitting said temperature control system into a pre-existing cabinet lacking temperature control capability;

(b) receiving said desired temperature range for said at least one medical item entered into said controller assembly;

(c) measuring a temperature within said cabinet interior via said temperature sensor disposed within said cabinet interior;

(d) controlling each of said at least one heat pump, via said controller assembly, to heat or cool said cabinet interior as required to maintain said cabinet interior temperature within said desired temperature range, wherein said controller assembly controls each of said at least one heat pump in response to a comparison of said measured cabinet interior temperature with said desired temperature range;

(e) impeding heat exchange between said cabinet interior and the ambient environment, via said thermal barrier, and maintaining temperature of said cabinet interior and said at least one medical item contained therein when said cabinet interior is exposed to that environment.

17. A temperature controlled cabinet system for storing medical items and maintaining said medical items within a desired temperature range comprising:

storage means to receive at least one medical item within an interior of said storage means and including at least one access means for providing access to said interior;

at least one thermal means partially disposed within said interior for heating or cooling said interior;

temperature means disposed within said interior to measure an interior temperature and to generate a temperature signal indicating said measured interior temperature;

controller means for enabling selection and entry of said desired temperature range into said system and for generating control signals to control each of said at least one thermal means, wherein said controller means controls each of said at least one thermal means to heat

or cool said interior as required in response to a comparison of said temperature signal received from said temperature sensor with said selected temperature range to maintain said interior within said selected temperature range; and

thermal insulation means disposed between said at least one access means and a rear portion of said storage means for impeding heat exchange between said interior and the ambient environment and maintaining temperature of said interior and said at least one medical item contained therein when said interior is exposed to that environment;

wherein said thermal insulation means facilitates passage of said at least one medical item through said thermal insulation means and retains heat within said interior in response to said interior temperature exceeding a temperature of the ambient environment and impedes heat from said ambient environment accessing said interior in response to said interior temperature being below said ambient environment temperature.

18. The system of claim 17, wherein said thermal insulation means is disposed adjacent at least one access means.

19. The system of claim 17, wherein said thermal insulation means is disposed within said interior a selected distance from said at least one access means to partition said interior into a plurality of thermally isolated compartments.

20. The system of claim 17 further including support means disposed between at least one access means and said rear portion to engage and support said thermal insulation means within said interior.

21. The system of claim 17, wherein said thermal insulation means includes a plurality of elongate strips.

22. The system of claim 21, wherein said plurality of strips are arranged in an overlapping fashion to form said thermal insulation means.

23. The system of claim 21, wherein said plurality of strips are arranged with each strip positioned a selected distance from a neighboring strip to form said thermal insulation means.

24. The system of claim 17 further comprising a plurality of thermal insulation means each disposed within said interior to partition said interior into a plurality of thermally isolated compartments.

25. The system of claim 1, wherein said thermal barrier includes at least one opening to facilitate passage of said at least one medical item through said thermal barrier.

26. The method of claim 9, wherein said thermal barrier includes at least one opening, and step (e) further includes:

(e.1) facilitating passage of said at least one medical item through said thermal barrier via said opening.

27. The system of claim 17, wherein said thermal insulation means includes at least one opening to facilitate passage of said at least one medical item through said thermal insulation means.

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