

[54] PARACHUTE DRYING APPARATUS

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34/148; 34/158

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[58] Field of Search 34/15, 73, 75, 92, 148,
34/158; 244/142

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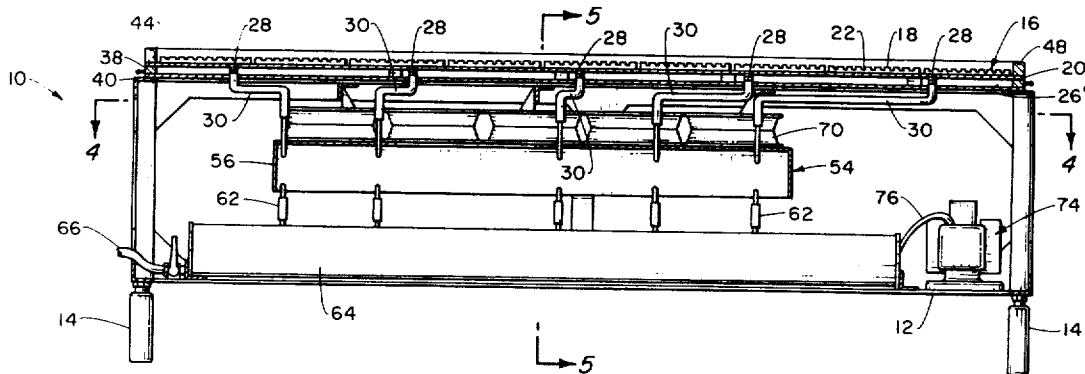
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[57] ABSTRACT

A parachute drying apparatus which employs an air-tight flexible cover positioned over a drying surface with the parachute to be placed in a confined area between the drying surface and the cover. The drying surface is divided into a plurality of separate plates with a heating element connected to each plate and being individually controlled as to temperature. A vacuum is to be drawn within the confined area resulting in the flexible cover being pressed down against the parachute firmly compacting the parachute material down to a minimal thickness over the entire drying surface. The parachute is thus at all times held into close physical contact with the heated drying surface, and therefore receives heat energy at a rapid rate by conduction. In this condition (vacuum and applied heat) the moisture is evaporated and expands with the resulting vapors being forced out of the drying compartment through a channel arrangement formed between the plates of the drying surface down into a condenser where it is condensed and then removed to a collecting tank.

20 Claims, 9 Drawing Figures



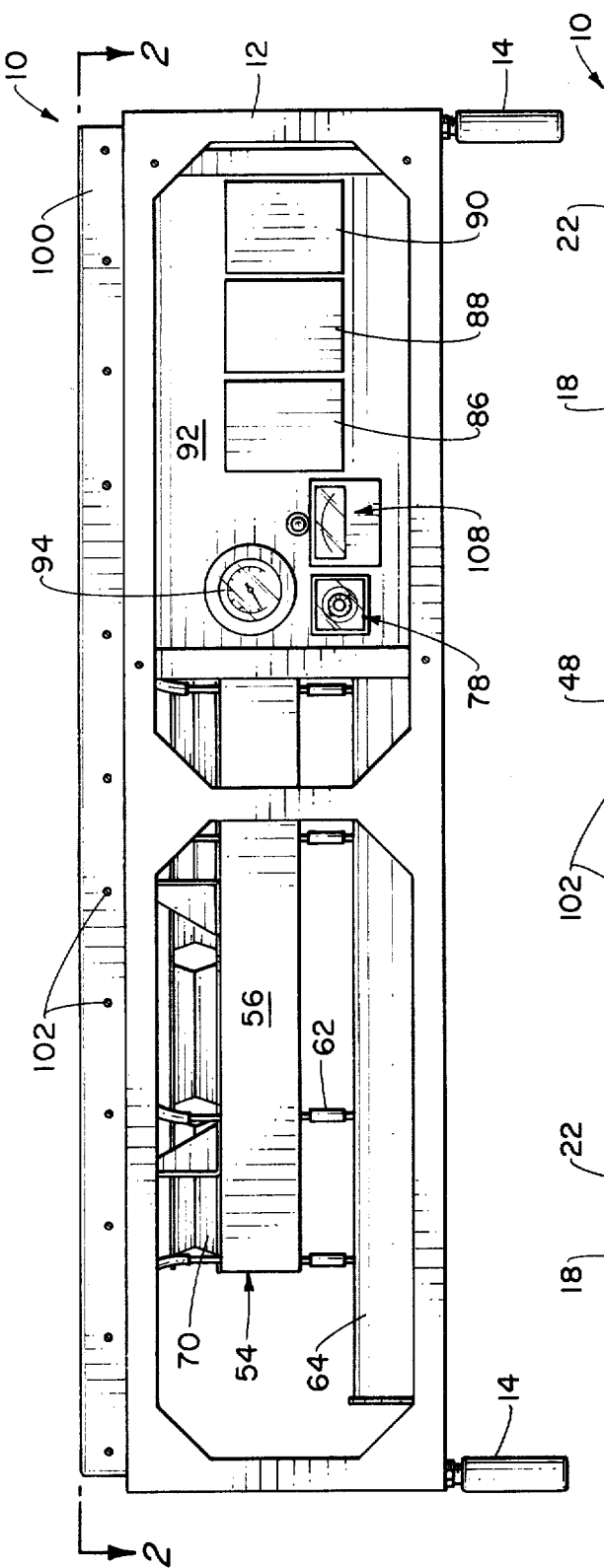


Fig. 1.

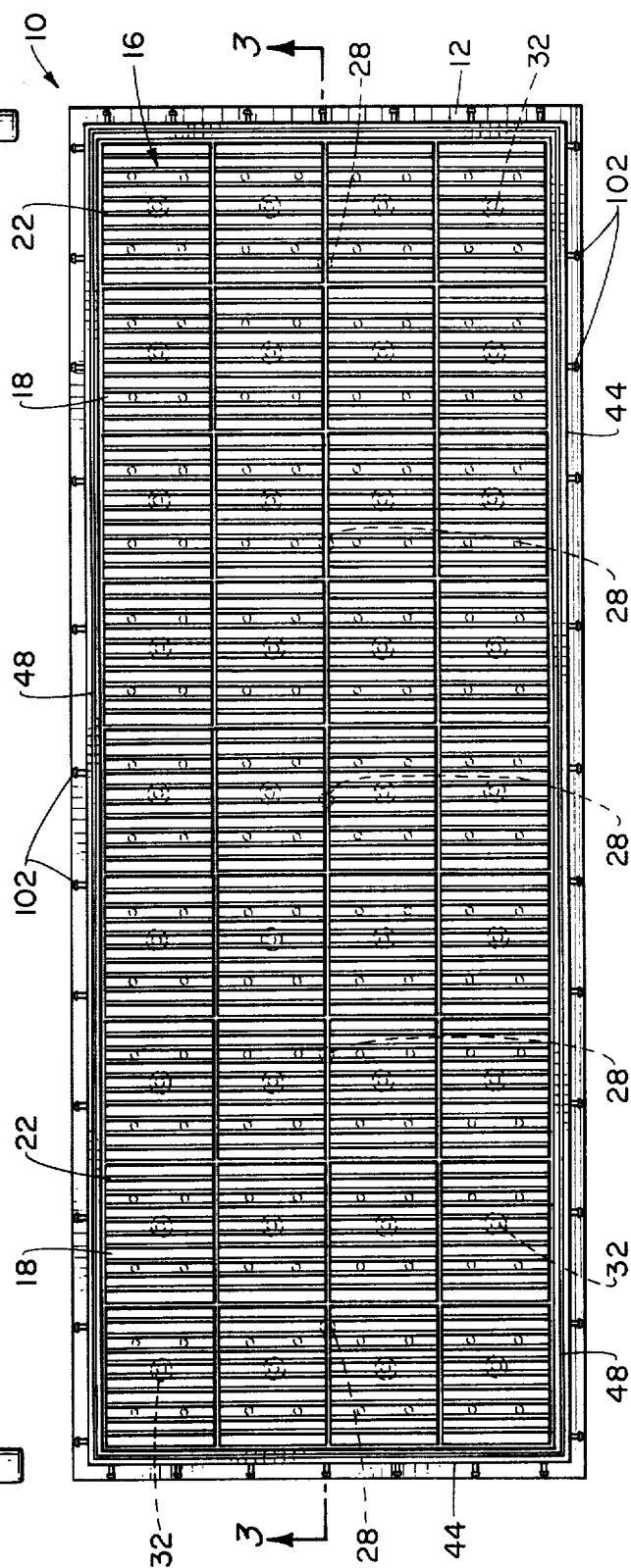


Fig. 2.

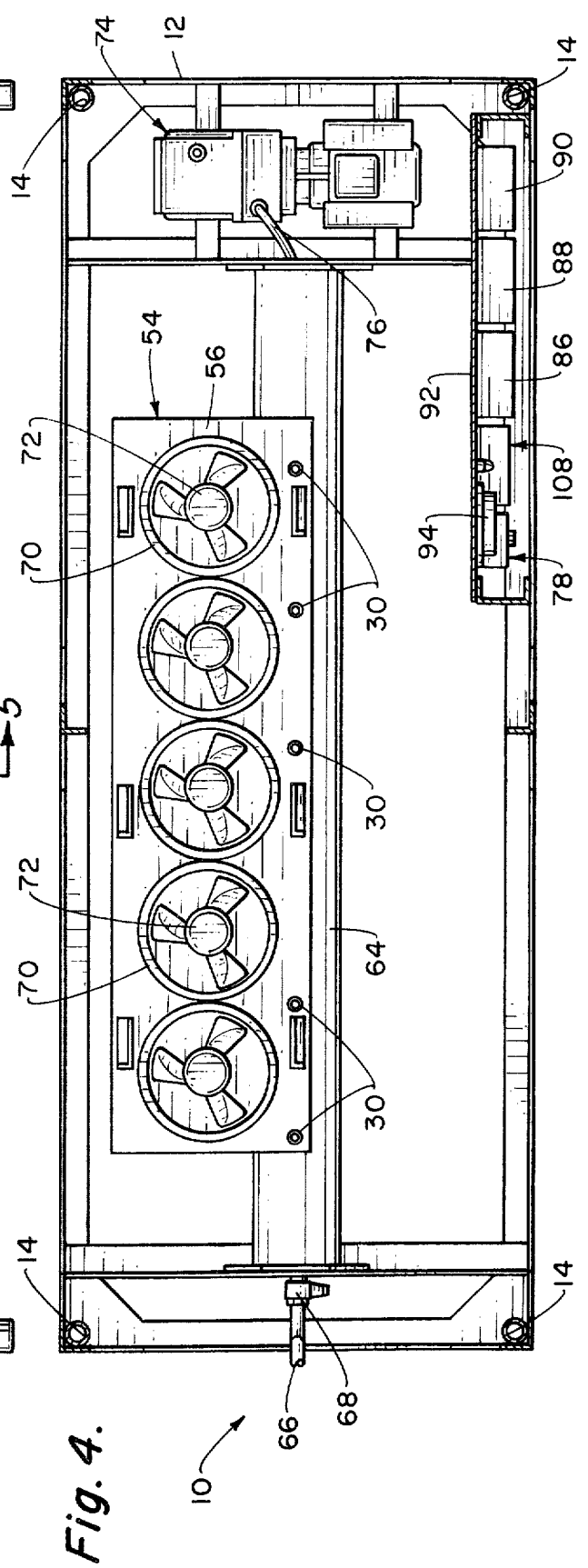
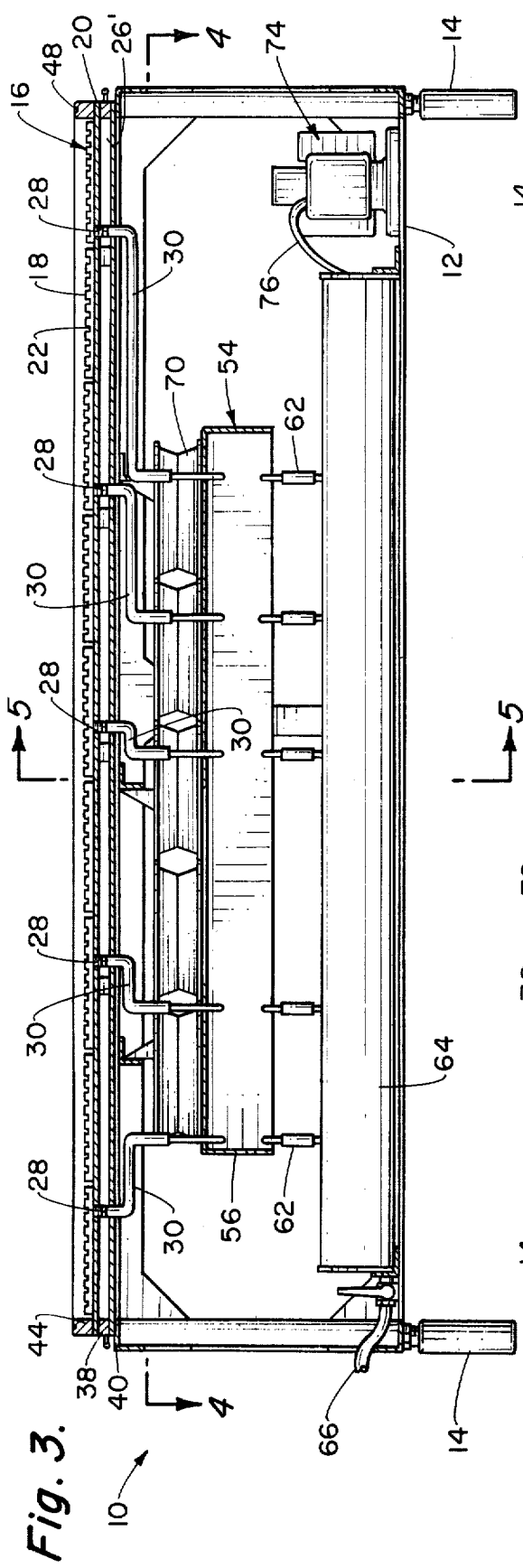


Fig. 5.

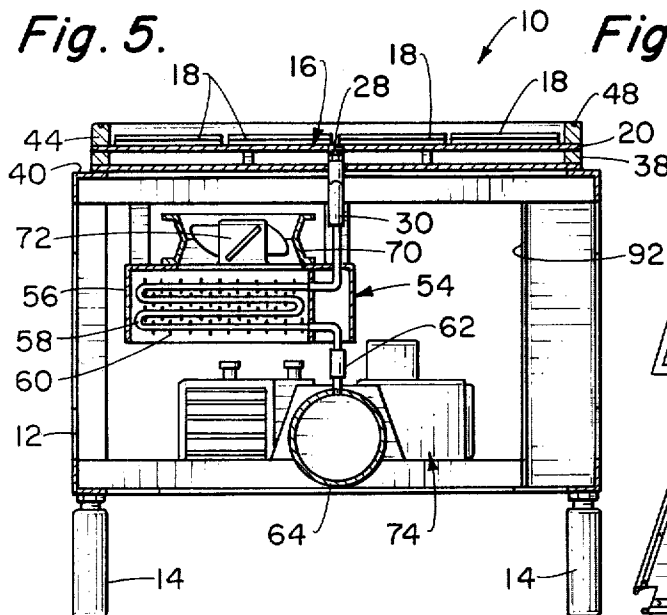


Fig. 6.

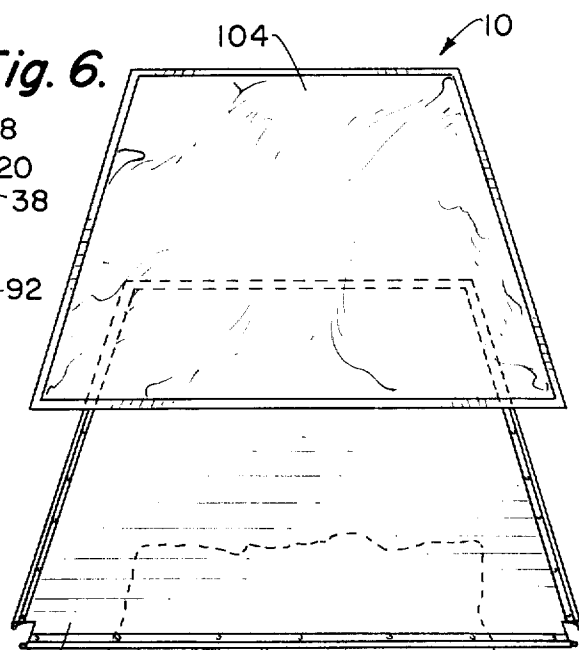


Fig. 7.

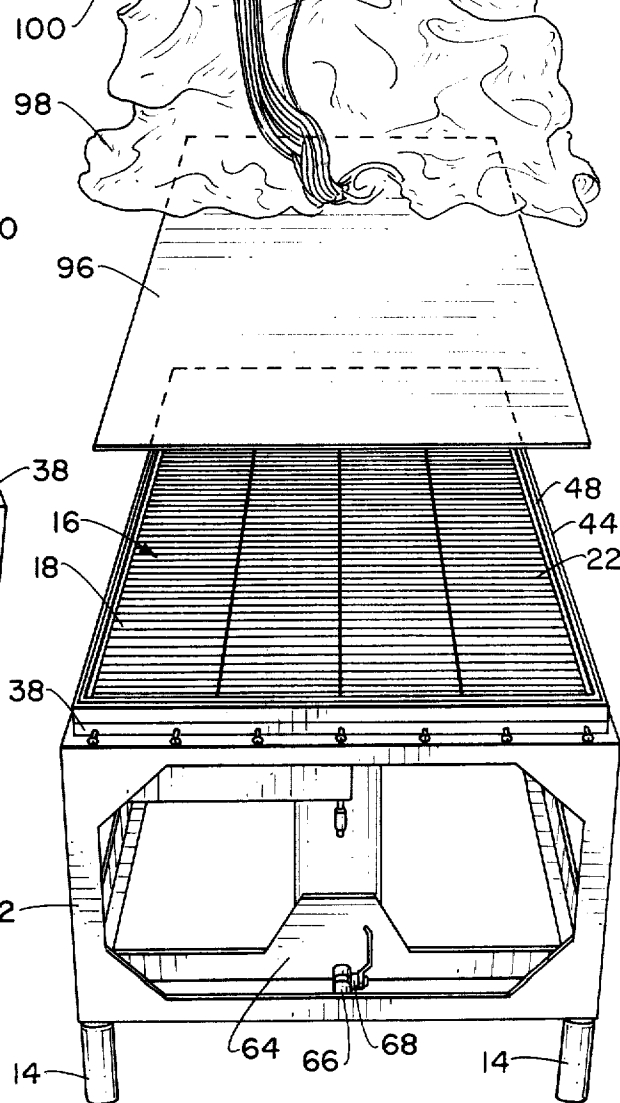
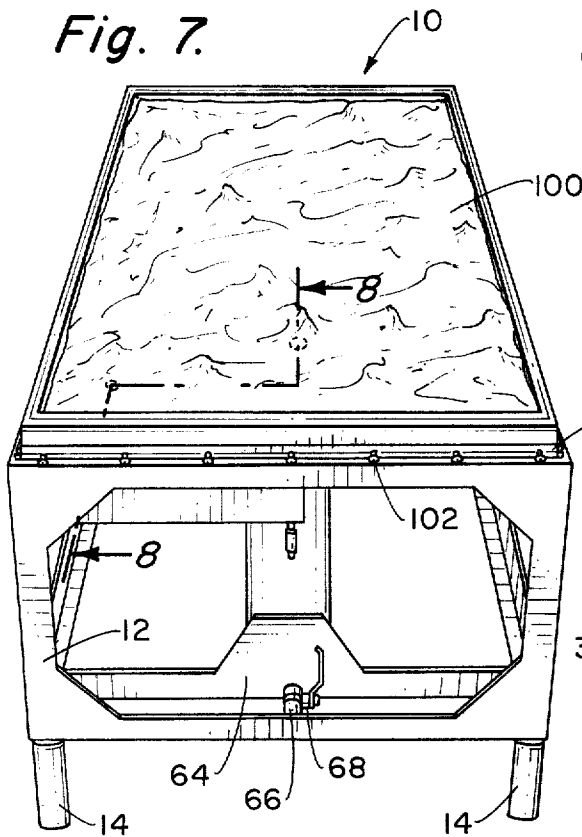


Fig. 8.

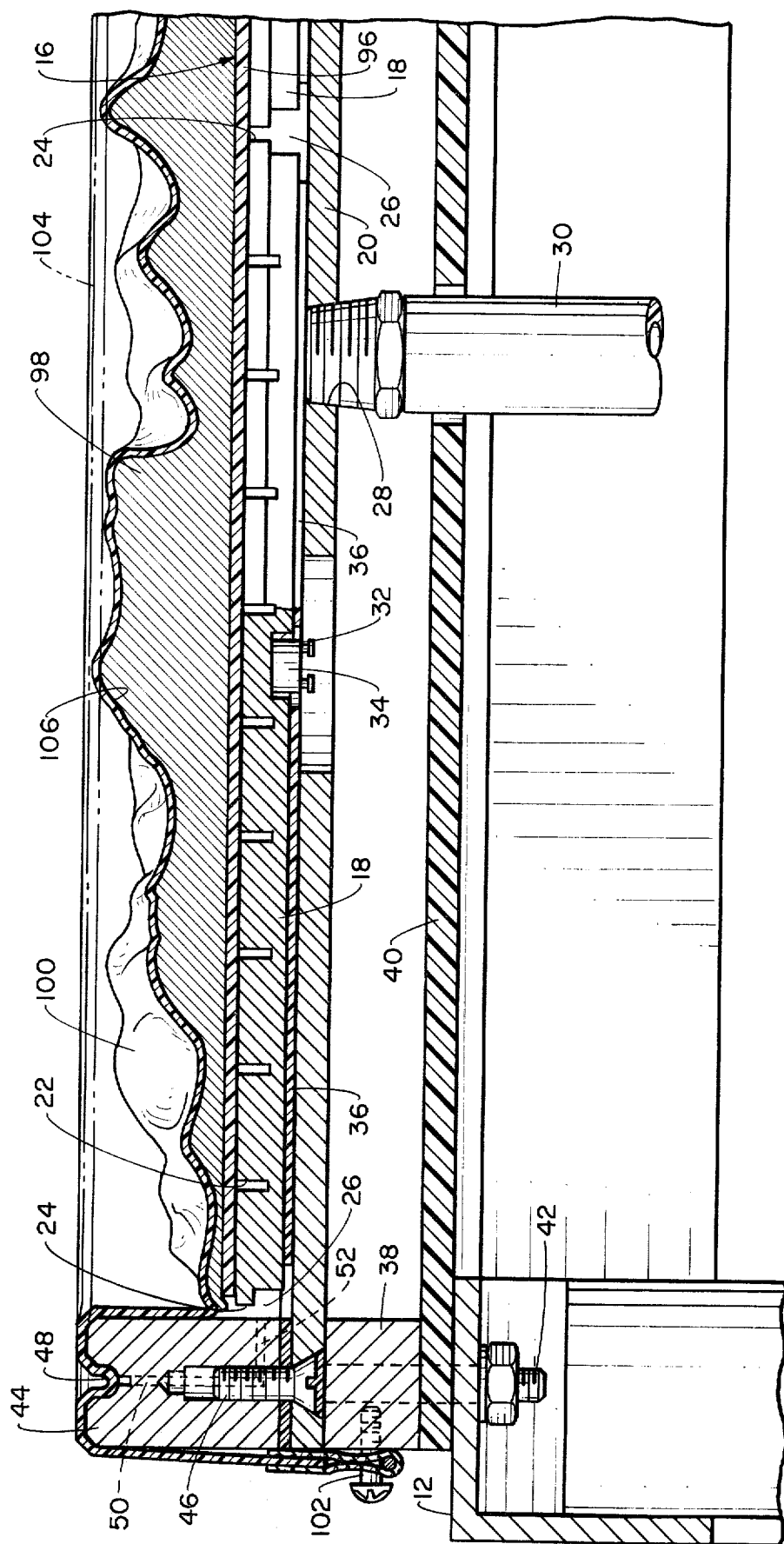
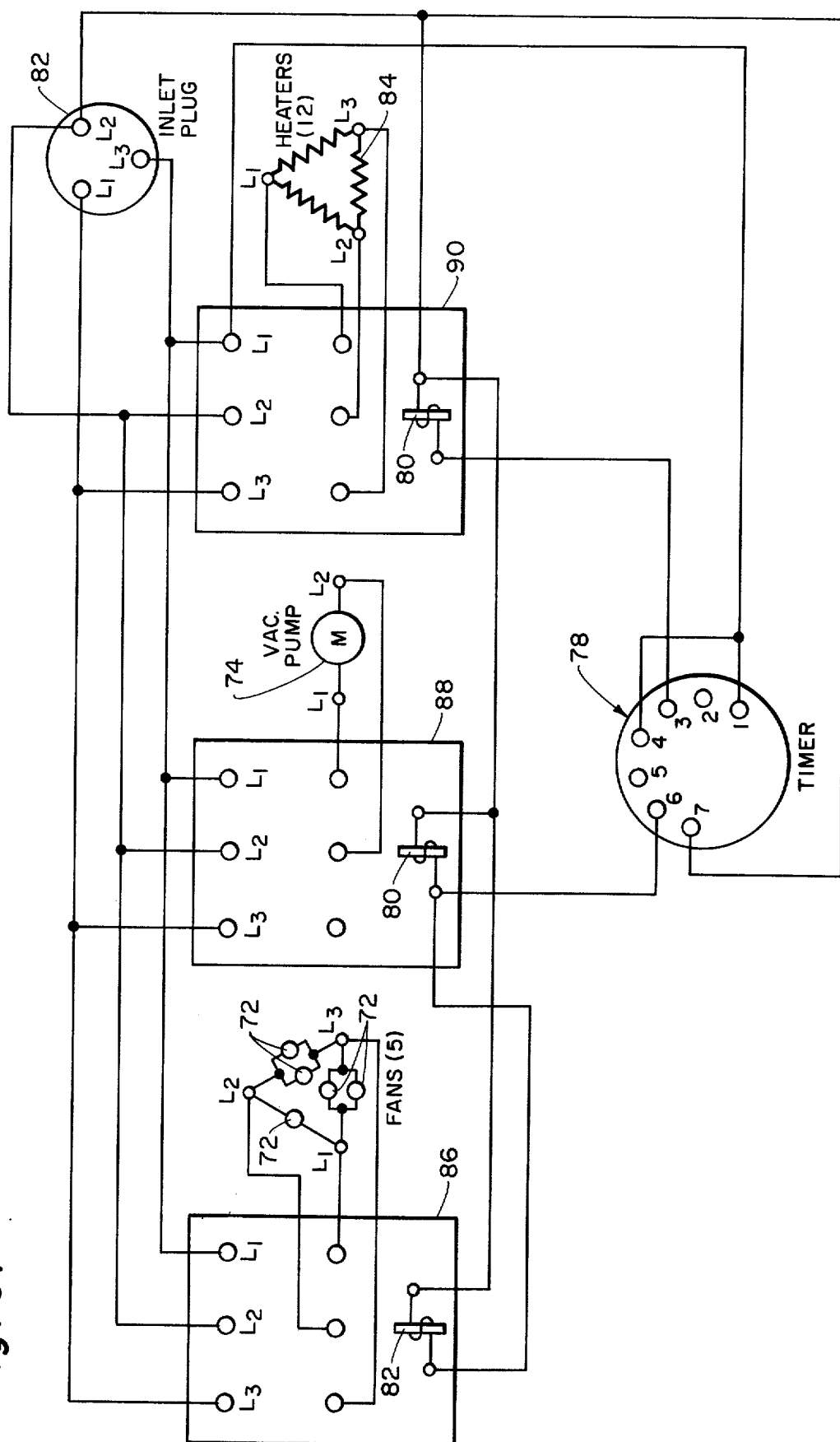


Fig. 9.



PARACHUTE DRYING APPARATUS

BACKGROUND OF THE INVENTION

The field of this invention relates to drying apparatuses and more particularly to a drying apparatus designed to perform efficient and quick drying of a parachute.

Parachutes are normally folded and placed within a pack until such time as they are ready for use. It has been found that if a parachute contains a certain amount of moisture, it may not open properly due to icing when used at high altitudes. The dampness in parachutes is particularly acute with military personnel stationed in tropical areas where the relative humidity of the air can reach extremely high levels, especially during the monsoon season. Although such conditions constitute a potential danger to military aircraft personnel, it has not been previously possible before this invention to effectively and within a reasonable period of time dry moist parachutes in such areas.

The commonly used method of drying parachutes is simply to hang and drape the parachutes inside tall structural towers erected on the local Air Force bases. In cooler climates heated air is blown through the towers to speed up the drying. In humid climates it is often necessary to apply expensive dehumidifiers inside the towers. The drying times by such means vary from 12 to 36 hours, and the results are, in many cases, barely acceptable. Another approach employs a cylindrical vacuum chamber, approximately three feet in diameter and three feet tall. The bottom and side wall are electrically heated to 180°F. The moist parachute is placed inside the chamber, draped or folded around an internal heater blanket. Heat and vacuum are applied. This method is slow and inefficient for the following reasons: (1) The drying area has a large volume (approximately 18 cubic feet) into which the evaporated moisture is allowed to expand. An equilibrium between water and vapor is soon reached and the drying process is now slowed down to the rate at which the vacuum pump is capable to remove water vapors from the chamber. Considering that 1 gallon of water expands to 1,700 gallons of vapor, it is easy to understand by this method is time consuming. (2) Heat transfer to the parachute is insufficient. Heat from chamber wall to chute can be transmitted by radiation only and at such low temperature levels radiation is nil. Convection is nil (vacuum). Heat by conduction takes place only in areas where the chute material touches the internal heater around which it is folded. The drying cycles obtained by this heavy non-portable equipment varies from ten to twenty hours.

It would be desirable to design a compact parachute drying apparatus capable of drying a wet parachute in a matter of minutes, independent of ambient temperature and humidity. The apparatus should be of weight and dimensions so as to allow airborne transport to localities where needed.

SUMMARY OF THE INVENTION

The parachute drying apparatus of this invention is designed to be totally contained within a single table unit, that table unit being positionable at any desired location and movable from one location to another. The parachute drying apparatus of this invention employs a drying surface composed of a table constructed of 36 in number of separate plate units arranged side

by side. These plates are mounted upon a base which forms part of the table frame construction. A groove arrangement is located between the plates. A flexible airtight cover is mounted upon the drying surface with the parachute located therebetween. The flexible cover can comprise a rubber composition or other similar composition. The edges of the flexible cover cooperate with the peripheral edge of the drying surface to form an airtight connection therebetween. The area between the flexible cover and the drying surface, in which the parachute is located, is defined as the confined area. Aperture means connects with the channels forming the drying surface. A vacuum from a vacuum source is applied through the aperture means into the channels into the confined area. This vacuum results in the flexible cover being tightly compressed upon the drying surface. Each of the plates within the drying surface includes a heating element. Each heating element is individually and independently controlled by a thermostat connected to each drying plate. The heating elements are wired in parallel. Each thermostat is preset so as not to exceed a predetermined temperature and to avoid spot "burning" of the parachute. The moisture contained within the parachute, because of the vacuum and the heating, is vaporized. The expanding vapors are forced (by their own expansion) to leave the confined area through the aperture means. The aperture means is connected to a condenser wherein substantial surface area is provided with condensing tubes. The vaporized moisture is caused to go through the tubes. A cooling medium through a blower system is provided wherein cooling air is passed over the condenser tubes. As a result, the vaporized medium is condensed into a liquid and this liquid is conducted into a collecting tank. The collecting tank is then emptied periodically. The peripheral edge of the drying surface includes a recess. The vacuum is applied also to this recess which causes the flexible cover to be drawn within the recess forming an airtight seal between the flexible cover and the peripheral edge of the drying surface. A thermal insulating blanket may be employed on top of the cover to prevent excess dissipation of heat energy within the confined area.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the parachute drying apparatus of this invention;

FIG. 2 is a plan view of the parachute drying apparatus of this invention taken along line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view through the parachute drying apparatus of this invention taken along line 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view through the parachute drying apparatus of this invention taken along line 4—4 of FIG. 3;

FIG. 5 is a cross-sectional view through the parachute drying apparatus of this invention taken along line 5—5 of FIG. 3;

FIG. 6 is an exploded isometric view of the parachute drying apparatus of this invention showing the placement of a parachute thereon for drying purposes;

FIG. 7 is an isometric view of the apparatus of this invention showing such in use drying a parachute;

FIG. 8 is a partial cross-sectional view through the parachute drying apparatus of this invention taken along line 8—8 of FIG. 7; and

FIG. 9 is an electrical schematic of the electrical wiring used to operate the parachute drying apparatus of this invention.

DETAILED DESCRIPTION OF THE SHOWN EMBODIMENT

Referring particularly to the drawings, there is shown the parachute drying apparatus 10 of this invention being formed generally in the shape of a table. The apparatus 10 includes a metal frame 12 which supports the structure making up the parachute drying apparatus. The frame 12 is of open construction, but may be made of a closed construction if preferred. Frame 12 includes a plurality of feet 14 which are adapted to come into contact with the floor or other surface upon which the apparatus 10 rests. The feet 14 are to be adjustable with respect to the frame 12 so as to locate the apparatus 10 in a substantially level condition upon the floor.

The apparatus 10 of this invention includes a drying surface 16. The drying surface 16 is formed of a plurality of rectangular plates 18 arranged in a side by side arrangement upon a base 20 of the frame 12. In actual use, it has been found to be preferable to use approximately 36 in number of the plates 18. However, a single plate containing machined grooves could be employed. Each plate 18 includes a plurality of spaced apart grooves 22 formed in the upper surface of each plate. Each of the grooves 22 extend about half-way through the thickness of the plate 18.

Each plate 18 includes a peripheral ledge 24 adjacent the upper surface of each plate. The grooves 22 extend beneath the bottom of the ledge 24. The ledges 24 function so that the plates can be positioned closely together with one another thereby forming a substantially solid and planar drying surface 16. Beneath each of the ledges 24 is formed a passage 26. The lower end of each of the grooves 22 communicate with each of the passages 26. It is to be understood that there is to be a passage 26 between each pair of plates 18 and also a passage 26 is formed about the outer periphery of the drying surface 16. The underside of each plate 18 includes a recess 32. Within the recess 32 is to be located a thermostat 34.

There is a center passage 26' which extends longitudinally across the center of the drying surface 16. In other words, arranged on each side of the passage 26' are two rows of nine in number of plates 18. Each of the other passages 26 feed into the central passage 26'. Formed within the base 20 and connecting with passage 26' are five in number of apertures 28. Each aperture 28 is screw threadingly connected to a conduit 30. The function of the conduits 30 (there being five in number) will be explained further on in the specification.

Attached to the under surface of each plate 18 is a layer 36 of reinforced silicone rubber. The rubber 36 is to be adhesively secured to each plate 18. There is to be a separate piece of rubber 36 for each plate. The rubber 36 rests directly against the base 20. Within the rubber is placed a metallic foil (not shown). The foil is electrically connected to thermostat 34. The foil functions as a heating element. The foil is normally produced by chemical milling to a flat configuration. The use of such foil placed within rubber layers is not new in itself. The foil functions to heat each plate 18. The thermostat 34 controls the maximum temperature that

each plate 18 is to achieve. In actual practice, the common type of parachute that is employed, is made out of nylon. It is found to be undesirable for nylon to be heated above 180°F. Therefore, each thermostat 34 prevents the temperature of its particular plate from exceeding 180°F. Because each separate plate 18 has its own thermostat, there are no "hot spots" which occur.

The base 20 is mounted by blocks 38 upon a lower base 40. The lower base 40 is secured by bolts 42 to the frame 12. The bolts 42 also function to bind together the base 20 and the blocks 38 to the lower base 40.

Located on the upper surface of the base 20 about its periphery are edging blocks 44. The edging blocks 44 are secured by bolts 46 to the base 20. The upper surface of each edging block 44 includes a recess 48. A plurality of passages 50 are arranged throughout the edging blocks 44 and connect with the recesses 48. The passages 50 are connected by connecting passages 52 to one of the passages 26. The reason for the passages 50 and 52 will be explained further on in the specification.

Attached to the frame 12 and located within the confines of the drying apparatus 10 and underneath the drying surface 16 is a condenser assembly 54. The condenser assembly 54 includes a condenser housing 56 within which is mounted a plurality of condensing coils 58. Each of the coils 58 are to be formed of copper and are to be configured, in a conventional manner, to achieve a quite long length of coil. A plurality of conventional heat dissipating fins 60 are attached about the outer surface of each coil 58.

There are to be five such coils 58 employed, a single coil 58 connected to a single conduit 30. The free end of each coil 58 is connected to a conduit 62. Each of the conduits 62 extend within a collecting tank 64. The collecting tank 64 is basically of a cylindrical configuration and is attached to the frame 12 and located beneath the condenser housing 56. A drain conduit 66 is connected to within the collecting tank 64. A valve 68 is to be operable to effect draining of the collecting tank 64 through the drain conduit 66.

Mounted upon condenser housing 56 are a plurality (five in number) of fan housings 70. An opening is formed in each condenser housing and connects with each fan housing 70. An electrically driven fan unit 72 is mounted within each of the fan housings 70. The fan units 72 are to function to draw air through the open bottom of the condenser housing 56 over the coils 58 and move such through the fan housings 70.

Attached to the frame 12 is a vacuum pump assembly 74. The vacuum pump assembly is of conventional vacuum pump construction and is adapted to draw a vacuum through conduit 76 within the collecting tank 64. It is to be noted that conduit 76 connects into the collecting tank 64 adjacent the uppermost surface. The drain tube 66 connects into the collecting tank 64 adjacent the lowermost surface. The reason for this is that it is not desirable that the vacuum pump 74 draw in any liquid and the liquid will settle to the bottom of the collecting tank 64.

Referring particularly to FIG. 9 of the drawings, an electrical diagram of the operation of the drying apparatus of this invention is shown. Detailed description of the electrical interconnection is not believed to be necessary since such is deemed to be conventional and can be electrically connected in any one of numerous ways.

It is normally preferable that a timer 78 be employed to limit the drying cycle. The timer 78 is electrically connected to electric switches 80. With the time activated and electric current being supplied to the inlet plug 82, the fan 72, the pump 74 and the heating foils 84 are activated. The pump 74, as well as the fan 72 run continuously until deactivation by the timer 78. The heating foils 84 will also run continuously unless deactivated either by the timer 78 or its particular thermostat 34. If preferred, heaters can remain active from cycle to cycle during a given working period and then be switched off manually. This speeds up the drying time. The major portion of the electric circuitry for the apparatus 10 of this invention is mounted within electrical circuit boxes 86, 88, and 90 which are mounted upon plate 92 which is secured to the frame 12.

The operation of the apparatus 10 of this invention is as follows: Once the apparatus 10 is electrically activated, the vacuum pump 74 is activated as well as the fan 72 and the heating foils 84. A particular amount of time for the drying cycle is manually selected upon the timer 78.

A temperature gauge 94 is mounted within the plate 92 and is connected to a thermocouple mounted within approximately the center of the drying surface 16. The temperature gauge 94 is merely to give an indication of the temperature of the drying surface 16 strictly for the purpose of giving some visual interpretation of the drying temperature. The drying temperature throughout the drying surface 16 is controlled by the thermostats 34. Actually, the temperature ready by the gauge 94 can be exceeded in other areas of the drying surface 16 or can be substantially less than other areas of the drying surface 16 than that is indicated by the gauge 94.

Upon the drying surface 16 is located a pad 96. The pad 96 is to be constructed of a material which readily permits penetration of vaporized moisture. The function of the pad 96 is to absorb excessive sizing powder some times found in parachutes. If no sizing in the parachute, pad 96 is not used. The moist parachute 98 is then placed upon the pad 96 and then somewhat evenly distributed across the pad 96. A heavy flexible rubber cover 100 is then placed over the parachute 98 and over the edging blocks 44 and is connected by pins 102 to blocks 38 with the pins 102 passing through eyelets in the cover 100. The cover 100 is tightly drawn across the parachute 98. A thermal insulating cover 104 may be used if desired to prevent excessive dissipation of heat energy through the cover 100. The cover 104 is to be placed upon the upper surface of cover 100.

The vacuum drawn by the vacuum pump assembly 74 is drawn through the collecting tank 74, through the conduit 62 and into the condenser housing 56. The vacuum is then drawn through conduits 30 within passage 26' and then into passage 26. The vacuum is then conducted into the grooves 22 and into the confined area 106 within which the parachute 98 is located. As a result, the cover 100 is drawn very tightly against the parachute 98 squeezing such upon the pad 96 located upon the plates 18. In order to insure non-leakage of the vacuum about the edges of the drying surface, the vacuum is conducted through passages 52 and 50 into the recesses 48. This causes a portion of the cover 100 to be drawn into the recess 48 as shown in FIG. 8 of the drawings. This results in an extremely airtight connection being established between the cover 100 and the edging blocks 44.

At the same time as the application of the vacuum, the heating foils 84 raise the temperature of the plates 18 which is dissipated within the confined area 106. This application of heat to the parachute 98 combined with the vacuum causes the moisture contained within the parachute 98 to be vaporized. It is well known that vapor occupies a substantially greater space than does the condensed liquid. As a result, a substantial expansion occurs in the transformation of the moisture within the confined area 106 to vapor.

There is an extremely limited amount of space within the confined area 106 due to the squeezing (by the vacuum) of the cover 100 upon the parachute 98. The expanded vapor must seek an outlet and this outlet is provided by permitting the vapor to be conducted through the grooves 22 to within the passages 26 and then into the passages 26'. The vapor is then expanded through the conduits 30 into the condenser 54. At this point the vapor is no longer located within the confined area 106. At this point it is preferable to condense the vapor. By the vapor being conducted through the coils 58 and the coils being cooled by the passing of air thereacross by means of the fans 70, the vapor condenses back into liquid. This liquid is conducted by conduits 62 into collecting tank 64. When a sufficient amount of liquid is retained within the collecting tank 64, such is discarded through drain conduit 66.

It has been found that an average parachute can be dried within 30 to 45 minutes using the apparatus of this invention. Once the parachute is dried, the cover 100 is removed, the dry parachute is removed and folded and the apparatus 10 of this invention is ready to be reused.

It has been found that a preferable size of the drying surface 16 is 4 feet by 8 feet. However, this is considered to be a matter of choice. The preferable amount of vacuum is 28 inches. Again, this is a matter of choice. The fast removal of the vapors (due to their own expansion) from the heated confined area expose them to a sudden temperature drop and results in rapid condensation. The heat of condensation is then absorbed by the aircooled condenser coils. This rapid condensation promotes further evaporation and removal of moisture from the confined area. The heat energy needed is amply supplied by conduction due to the firm and extended contact between the compacted parachute material and the heated plates.

It is also preferable that the amount of vacuum be visually observed so that it can be assured that the vacuum is maintained within a certain range. For this purpose, a conventional vacuum gauge 108 is employed which connects into the vacuum conduit 76. The vacuum gauge 108 makes it possible to readily visually observe the amount of vacuum at any given time.

What is claimed is:

1. The method of drying a parachute comprising the steps of:

- placing the parachute within a confined area;
- applying heat to the confined area;
- subjecting the confined area to a vacuum thereby causing moisture within the parachute to be vaporized;
- causing the vaporized moisture to move within a minimized volume;
- applying heat to the minimized volume expanding the vaporized moisture; and

removing the vaporized moisture from the minimized volume into an enlarged cooler volume due to the natural action of the expanding vaporized moisture to exceed the boundaries of the minimized volume.

2. The method as defined in claim 1 wherein after the removing step:

condensing the vaporized moisture which has entered the enlarged cooler volume.

3. The method as defined in claim 2 wherein the condensing step includes:

removing a significant portion of the heat of condensation.

4. The method as defined in claim 3 wherein after the condensing step:

collecting the resulting condensed liquid.

5. The method as defined in claim 1 wherein the confined area is defined by:

employing a hard planar surface upon which the parachute is to rest; and

employing a flexible cover over the parachute wherein the cover forms an airtight seal with the peripheral edge of the hard surface during application of the vacuum.

6. The method as defined in claim 5 wherein:

employing a thermal insulating blanket upon the flexible cover.

7. A parachute drying apparatus comprising:

a hard substantially solid planar inner surface, said surface having a peripheral edge;

a flexible airtight cover to extend over said surface forming a confined area between said cover and said surface;

said surface including aperture means defining a first chamber of minimal volume;

a vacuum source connected to said aperture means and adapted to provide a vacuum into said confined area;

heating means connected to said planar surface and adapted to supply heat into said confined area; and

moisture removing means for removing moisture from said confined area, said moisture removing means including a second chamber which is substantially greater in volume than said first chamber, whereby the vaporized moisture contained within said first chamber is caused to exceed the boundaries of said first chamber and expand into said second chamber.

8. The parachute drying apparatus as defined in claim 7 wherein:

said planar surface being formed of a plurality of metal plates, said metal plates being arranged in a substantially side by side relationship with respect to each other.

9. The parachute drying apparatus as defined in claim 8 wherein:

said peripheral edge having a recess, said recess being connected to said vacuum source, whereby with said cover positioned upon said surface and said vacuum is applied, a portion of said cover is drawn into said recess thereby forming an airtight seal between said cover and the peripheral edge of said surface.

10. The parachute drying apparatus as defined in claim 9 wherein:

said first chamber including a plurality of channels arranged between and beneath said plates.

11. The parachute drying apparatus as defined in claim 10 wherein:

said moisture removing means includes a condenser, said condenser adapted to receive the vaporized moisture from said second chamber, said condenser including structure to condense said vaporized moisture.

12. The parachute drying apparatus as defined in claim 11 wherein:

said structure including a plurality of fans to assist in cooling of said vaporized moisture.

13. The parachute drying apparatus as defined in claim 11 including:

a liquid collecting tank connected to said condenser, upon the vaporized moisture being condensed within said condenser, the resulting liquid is conducted into said collecting tank.

14. The parachute drying apparatus as defined in claim 13 wherein:

said vacuum being supplied through said collecting tank into said condenser and into said channels.

15. A parachute drying apparatus comprising:

a hard substantially planar inner surface, said surface having a peripheral edge;

a flexible airtight cover to extend over said surface forming a confined area between said cover and said surface;

said surface including aperture means;

a vacuum source connected to said aperture means and adapted to provide a vacuum into said confined area;

heating means connected to said planar surface and adapted to supply heat into said confined area;

moisture removing means for removing moisture from said confined area;

said planar surface being formed of a plurality of metal plates, said metal plates being arranged in a substantially side by side relationship with respect to each other; and

each of said plates having its own heating element, each said metal plate having its own thermostat, whereby the temperature of each said metal plate is individually controlled.

16. The parachute drying apparatus as defined in claim 15 wherein:

said heating element for each said plate being located within a layer of material, said layer of material being attached to each said plate, said thermostat being adapted to not permit said temperature to exceed 180°F.

17. The parachute drying apparatus as defined in claim 7 including:

a thermal insulating blanket placeable upon said flexible airtight cover, whereby said blanket is to decrease the dissipation of energy from said confined area.

18. In a parachute drying apparatus, a drying surface comprising:

a plurality of separate plates positioned together to form said drying surface; and

a heating means comprising a separate heating element for each said plate, a thermostat for each said plate to individually control the temperature of each said plate.

19. An apparatus as defined in claim 18 wherein:

said moisture removing means including a plurality of channels arranged between and beneath said

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plates, said channels being connected with said aperture means, whereby the vaporized moisture within said confined area is conducted through said channels and into said aperture means.

20. An apparatus as defined in claim 19 wherein: 5
said surface being positioned upon a base, said base

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including aperture means, said aperture means connecting with said channels, whereby vaporized moisture from above said drying surface is expandable into said channels and within said aperture means.

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