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Petersen

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[54] **COOLING DEVICE**

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[58] **Field of Search** 62/530; 165/46

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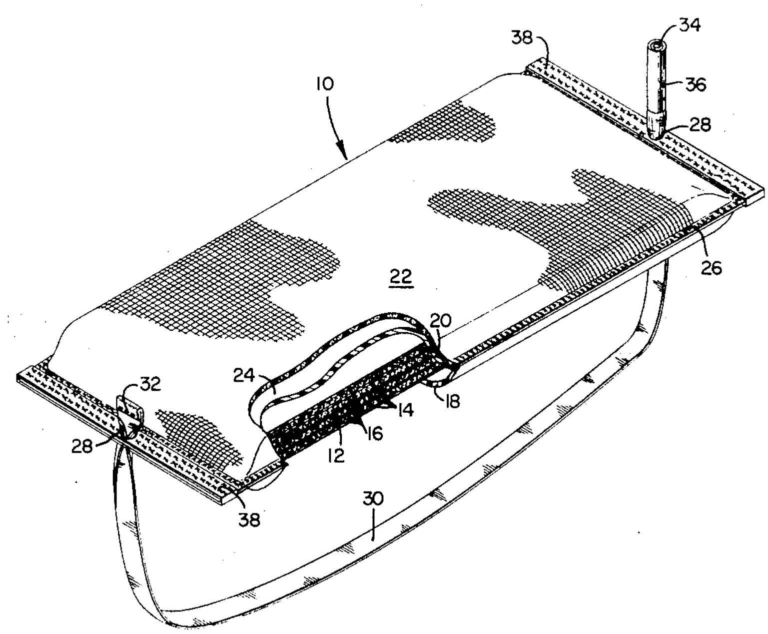
[57] **ABSTRACT**

A cooling device is provided having a core of a cold storing material sandwiched between two thin, flexible walls having different heat transfer rates such that one side of the cooling device is colder to the touch than the opposite side of the device.

3 Claims, 1 Drawing Figure



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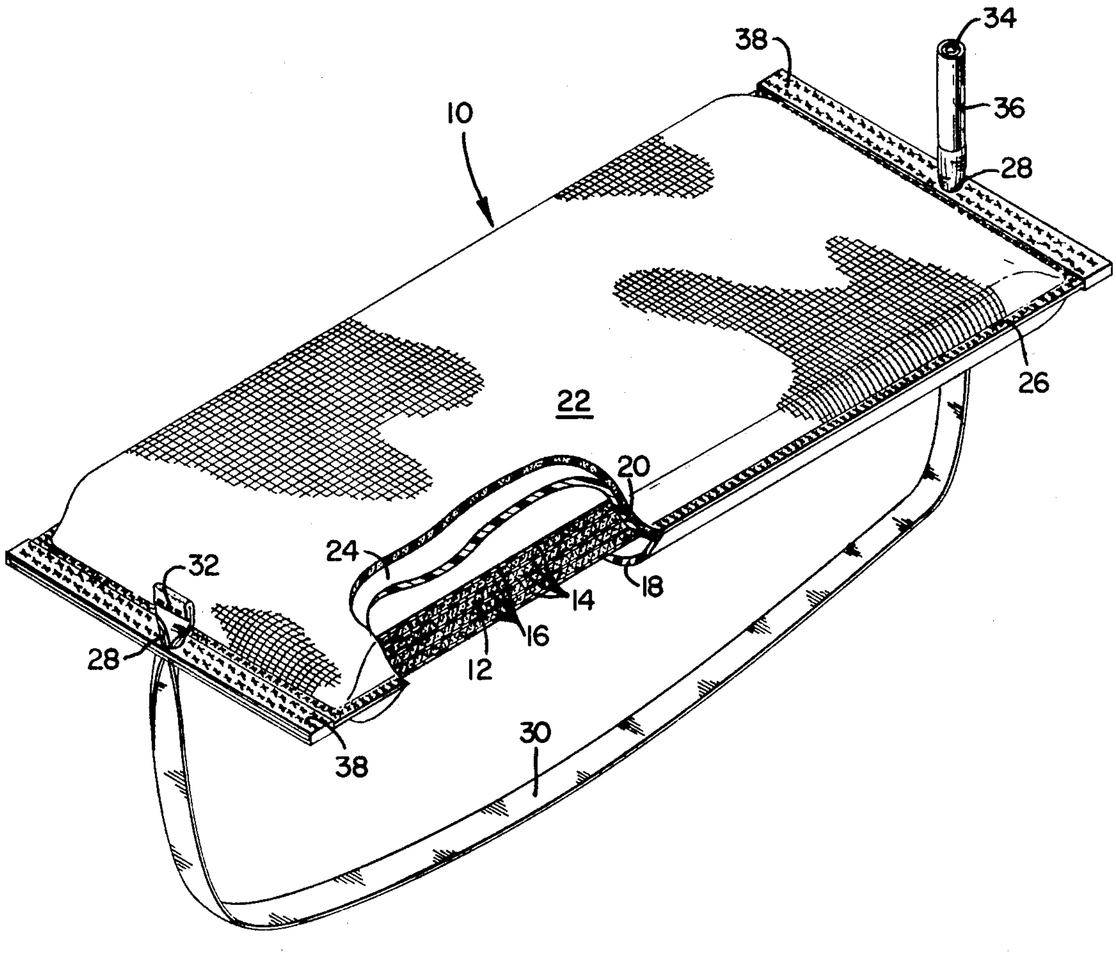

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COOLING DEVICE

The present invention relates to cooling devices and more particularly relates to devices for lowering temperature in the treatment of animals and humans.

Cooling devices have been used for many years in the treatment of animals and humans for relieving the discomfort of pain and swelling and for injuries suffered accidentally in athletics or as a result of other endeavors. Traditionally, these cooling devices have been variations of the well-known ice pack which is merely ice or a frozen water-alcohol mixture contained within a water impermeable bag or merely wrapped in a towel.

More recently, improvements have been made in these cooling devices such as by manufacturing a reusable container which contains a cold storing material in separated compartments to render the cooling device flexible at the joints between the compartments even when the material contained therein is in a frozen state. This desire for flexibly conforming the cooling device to the surface against which it is to be used in order to gain highest efficiency in heat transfer has also led to the use of various hydrophilic gels which contain large quantities of water and yet retain some degree of flexibility when frozen.

U.S. Pat. No. 3,545,230 to Morse is an example of one successful attempt at forming a flexible cooling device. This patent discloses that a hydrophilic gel containing a large quantity of water can be coated on an inert flexible substrate and, when frozen, will retain flexibility and can be conformed to the surface against which it is to be used. A plurality of such gel-substrate layers can be stacked and packaged within a flexible, liquid impermeable membrane to form the completed cooling device.

Each of the cooling devices heretofore used has had either a single cooling surface which could be placed against the surface to be cooled or has had a plurality of surfaces of the same material and thickness, each supplying the same degree of cooling. In using any one device, therefore, the user has had no freedom of choice in the amount of cooling to be applied while applications to different parts of the body, for different purposes, and the preferences of different individuals, would dictate that not the same degree of cooling would be desirable in every instance.

It is, therefore, an object of the present invention to provide a cooling device which has at least two surfaces providing different amounts of cooling.

It is a further object to provide such a device which can be molded in a frozen state to conform to various geometric shapes and which retains the imparted configuration.

It is still a further object to provide such a device including a securing means for easily attaching the device to the part of the anatomy where it is to be used.

These and other objects will readily become apparent to those skilled in the art in the light of the teachings herein set forth.

In its broad aspect, the present invention relates to a cooling device having at least one layer of a cold storing material sealed within a container formed from two thin, flexible walls having different heat transfer rates and which are secured to each other around their periphery. The walls may be formed from different thicknesses of the same material or from two different materials, the only criteria for use being that one wall should transfer heat at a lesser rate than the other thereby providing a cooling device having one side which will feel colder to the touch than the other.

The term "cold storing material" as used herein and in the appended claims refers to any material which may be chilled or frozen and will feel cold to the touch for a substantial time. This term encompasses, but is not limited to, such materials as water and water-alcohol mixtures, as well as the more recently used gel materials.

The invention will be further understood by reference to the accompanying drawing which is an isometric view, partially cutaway, of a cooling device in accordance with one embodiment of the invention.

Referring in detail to the drawing there is shown a cooling device generally designated **10**, comprising a relatively flat core of cold storing material **12** packaged between walls of different thermal conductivity.

The core of cold storing material **12** is a stack of four layers of reinforced hydrophilic gel, usually referred to as hydrogel, **14** each separated by a film **16**, such as polyethylene. The walls of cooling device **10** exhibit different thermal conductivity due to their fabrication from different materials and, in the embodiment shown in the drawing, each comprises a different number of layers of material. The bottom wall **18** is formed from a single layer of thin air-impermeable film such as 4 mil thick polyethylene film. The top wall **20** is formed from two thin films, an outer covering of air-permeable film **22** such as Tyvek, an air-permeable polyethylene film, and an inner layer **24** of thin air-impermeable film such as a blown polyethylene film.

Inner layer **24** is required only in the instance where outer covering **22** is air-permeable and it is necessary to keep the cold storing material from drying out during storage and repeated use.

Since each of the films used in the embodiment of the invention shown in the drawing is a thermoplastic, the cooling device can be conveniently sealed by forming the top and bottom walls of a length and width slightly larger than the core of cold storing material **12** and joining the top and bottom wall around their entire periphery, outside the periphery of the cold storing material, by a heat seal **26**.

The heat sealing generally completes the fabrication of the cooling device except in some instances where the size or intended use of device dictates the desirability of including an attachment means for convenience of use. One particularly preferred optional attachment means is that shown in the drawing wherein two opposite ends of the device are extended a short distance beyond heat seal **26** and are provided with circular holes **28** through which are passed a flat elastic band **30** of a width substantially larger than the diameter of holes **28.** The differential in size between the width of elastic band **30** and the diameter of holes **28** causes the elastic band to be distorted where it passes through the holes and exert sufficient friction on the holes to keep the band from slipping through the holes without application of considerable force to overcome the friction. A positive control is thereby exercised on the continuous length of the elastic band between holes **28.** It can be tightened or loosened manually but will resist unwanted loosening during use. For further ease of use one end **32** of the band is folded upon itself transversely and sewn to prevent it from being pulled through its respective hole while the opposite end **34** is folded upon itself longitudinally and is capped with a tube **36** of polyethylene heat shrunk around the end permitting easy insertion into its respective hole.

To provide additional strength to the portion of the thermoplastic surrounding holes **28** it is desirable to reinforce the extended ends of the device such as by heat sealing to each end a strip of relatively thick thermoplastic **38** such as a strip of **30** mil thick polyethylene film.

The use of the cooling device shown in the drawings is quite simple. The device may be kept frozen in the freezer compartment of a refrigerator until required for use and can then be shaped to any convenient geometric configuration with the elastic tie tightened as much as desired. The device can then be applied where needed with the colder wall against the surface to be cooled. If this wall is found to be too cold, the device can be flexed in the opposite direction and the elastic band reversed to permit placement of the "warmer" side of the device against the surface to be cooled.

As will be apparent from the detailed description of the drawing, the novel cooling device of the invention consists of only three essential components, a front wall, a rear wall, and a cold storing material sandwiched between the front and rear walls and completely enclosed at the juncture of the front and rear walls around their periphery. Optionally, components such as moisture barriers, fasteners, etc., may be included as necessitated or dicated by the materials of construction, size or intended use of the cooling device.

The front and rear walls can be formed from one or more layers of any thin flexible sheet material which may be water permeable or water impermeable depending upon the nature of the cold storing material used and whether or not a moisture barrier is provided adjacent to the inside face of the wall. The front and rear walls may be formed from the same material in varying thicknesses or from different materials, the only criteria for selection being that one wall should transmit heat at a different rate than the other thereby rendering one surface of the device colder than the opposite surface. Such materials as thermoplastic films, paper, metal foils, woven and non-woven fabrics, natural and synthetic rubbers, etc. will all be useful in forming the walls of the cooling device of the invention, but thermoplastic films of homopolymers and copolymers of olefins such as ethylene and propylene, and vinyl chloride are particularly preferred since they may conveniently be heat sealed around their periphery to form the completed cooling device.

One particularly preferred pair of wall materials is that shown in the drawings, namely, a wall of polyethylene film on the colder side of the cooling device heat sealed to a wall of air permeable, or so-called breathable, polyethylene film on the warmer side of the cooling device. The air permeability of the warmer wall allows for some heat loss through air entrapped in the pores of the film and does not permit the high heat transfer rate which is possible by conduction through a thin, non-porous polyethylene film. The non-porous film side therefore feels colder to the touch than the porous side of the device.

The cold storing material of the invention is likewise not limited to any particular chemical composition and may be merely water or a water-alcohol mixture sealed between the walls of the cooling device. As stated previously, it is desirable that the cooling device be plyable when frozen and have the ability to conform to various geometric configurations. Since such properties are not possessed by ice or a frozen water-alcohol mixture, unless a cooling device comprising a plurality of individual, separated compartments is used, gels similar to those of U.S. Pat. No. 3,545,230 are the preferred cold-storing materials of the invention.

These gels possess many desirable advantages not available with cooling devices containing water or other liquids. For example, the cooling media does not melt to a liquid but remains as a gel which can then be refrozen and used repeatedly. This is a particular advantage since rupture of the outer enclosure will not result in the spillage of any significant amounts of liquid. Moreover, porous materials can be used in the outer walls of the cooling device without liquid leakage. Useful gels are formed from a polymer, including copolymers, and a liquid such as water which are combined into an insoluble gel. The gel is preferably prepared in the form of a continuous reinforced tape which can then be cut at predetermined intervals, e.g., 12 inches, and if desired piled in multiple layers. The product is then enclosed and sealed in its flexible covering.

Since there is essentially no free water present in the finished device, either before or after freezing, the configuration does not change after repeated freeze-thaw cycling. For example, upon melting, the material does not flow to the lowest part of the package but remains in its original geometry. Due to the flexible aspect of the cooling device it can be formed to the shape of the surface to be cooled, which substantially improves heat transfer rates. Moreover, as previously indicated, there is no danger from the outer covering rupturing since there is essentially no liquid phase to leak out. The material can be manufactured in many different shapes without destroying flexibility so that the physical dimensions of the product can be tailored to the requirements for use.

The method of manufacturing and using specific hydrophilic gels in flexible cooling devices is set forth in detail in previously mentioned U.S. Pat. No. 3,545,230.

In practice, a wide variety of hydrophilic gels can be employed with the only requirement for use being that the particular gel selected be capable of retaining relatively large quantities of liquid which can be easily transferred from a liquid to a solid state by simple cooling procedures. If the liquid does not enter the solid state then it is impossible to take advantage of its latent heat of fusion, thereby reducing the efficiency of the cooling device. Although numerous liquids can be employed, water is preferred in order to take advantage of its large latent heat of fusion (144 B.t.u. per pound). Water can be employed as the sole liquid or mixtures of water and other liquids, such as alcohols, or solutes can be employed.

Illustrative hydrophilic gels which are useful in the cooling device of this invention can be prepared by appropriate techniques from the following starting materials, among others: poly(ethylene oxide), polyvinyl pyrrolidone, polyacrylamide, anionic polyacrylamide, polyvinylalcohol, maleic anhydride-vinylether copolymers, polyacrylic acid, ethylene-maleic anhydride copolymers, polyvinylether, dextran, gelatin, hydroxy propyl cellulose, methyl cellulose, carboxymethyl cellulose, hydroxyethyl-carboxymethyl cellulose, hydroxyethyl cellulose, propylene glycol alginate, sodium alginate, polyethyleneimine, polyvinyl alkyl pyridinium halides, polyproline, natural starches, casein, proteins, polymethacrylic acid, polyvinylsulfonic acid, polystyrene sulfonic acid, polyvinylamine, poly-4-vinylpyridine, polymerized monoesters of olefinic acids, polymerized diesters of olefinic acids, acrylamide and difunctional polymerizable materials, and the like.

It should be noted that the gels useful in the instant invention are not limited to the use of the starting materials listed above, but include copolymers of one or more of the aforementioned compounds or materials similar to these. For example, copolymers of ethylene oxide and minor or major amounts of other alkalene oxides can also be used.

In most instances, the gel need only contain the insoluble swollen polymer and liquid, e.g., water. If desired, however, it can also include other materials to control the physical and chemical properties of the gel such as freezing point, chemical stability, color, smell, crystal size and growth rate.

Although a single reinforced layer exhibits optimum conformability to the surface being cooled, it is sometimes necessary or desirable to have a greater cooling capacity than can be conveniently obtained in a single layer. This can be achieved by the formation of a multilayer cold storing material.

It has been observed that optimum flexibility and other desirable features are exhibited when the layers of gel are separated from each other by a thin film of an inert material. The frozen layers are then permitted to slide easily over each other and contribute even greater flexibility than that possessed by multi-layers of the gel alone.

In practice, gels can be made of any practical thickness, width or length. Cooling devices of 20 layers of gel and higher have been made and found to have good flexibility.

The type of separator used to separate the gel layers is not narrowly critical and a wide variety of materials can be utilized. The only requirement of the separator is that it be flexible at reduced temperature and compatible with the gel. The separator can be applied to the surface of the gel and includes such materials as silicone surfactants, cetyl alcohol and the like. Any of the numerous products currently on the market can be employed with satisfactory results. For example, separators can be composed of polyethylene, polypropylene, polystyrene, polyvinylchloride, polyethylene terephthalate, metal foils, and the like.

The flexible cooling device of the invention can be manufactured as a single use disposable product or a reusable device. If the device is meant to be disposable the outer enclosure can be a laminate with insulating material such as cloth, polymer foams, paper, and the like, on the outside.

As a reusable cooling device, the outer enclosure can be a pair of thermoplastic films heat sealed around their edges. An attachment device can also be provided for securing the cooling device to the area to be cooled.

While the present invention is not limited to any particular attachment device, it has been found that an inexpensive and convenient attachment device can be formed, as shown in the drawings, by providing circular holes at two opposite ends of the cooling device and by passing through the holes a flat elastic band which has a width substantially larger, preferably at least double, the diameter of each hole. The elastic band should be somewhat longer than the distance between the holes and can be provided on one end with a knot, or similar stop, to prevent that end from slipping its corresponding hole. The other end of the elastic band can be tapered to allow it to pass easily through the hole on the opposite end of the cooling device. The band can be adjusted by pulling the tapered end through its hole until the desired length of elastic band is provided between the holes. The elastic will tend to maintain that predetermined length during use due to the friction between the compressed elastic band and the hole which maintains the flat band in a distorted shape.

If one or both of the walls of the cooling device are formed from a porous material it may be desirable to include an inner wrapper of an air and moisture impermeable material which will act to keep the gel from drying out. A similar moisture barrier would also be employed if water or other liquid material were used as the cold storing material of the invention in combination with a porous outer covering. This barrier can easily be provided by inserting a thin thermoplastic, such as a polyvinylidene chloride film, adjacent to the inner side of the porous wall. The barrier can then be sealed with an appropriate water insoluble adhesive or heat sealed around the periphery of the device to keep the cold storing material of the device from contacting the porous outer wall.

For certain applications it might also be desirable to include a strengthening or a reinforcing material either within the gel or around the periphery of the cooling device. Such can be accomplished by embedding in the hydrophilic gel materials such as nylon gauze, rayon mesh, dacron, cellulose or other textile products or fibers.

To provide additional strength for any securing means employed it is usually desirable to extend two opposing edges of the cooling device some distance beyond the encapsulated cold storing material and to reinforce same, such as by heat sealing or gluing thereto a sheet of material which is relatively more rigid than the materials used in forming the walls of the cooling device.

The cooling device of the invention can be made in a wide variety of sizes, thicknessess, and shapes ranging from 1 millimeter thickness or less to several inches or more in thickness as well as lengths and widths ranging from one inch or less to one foot or more.

The cooling device of the invention can also be sterilized, if desired, by many of the known techniques, for example, autoclaving, irradiating, etc.

The following examples are intended to further illustrate the invention and are not intended, in any manner, to limit its scope.

EXAMPLE 1

A cooling device in accordance with the invention was fabricated from a 5 ply core of poly (ethylene oxide) coated on a Mylar backing and irradiated to produce a hydrophilic gel. The core measured 2 ½ × 9 inches and was packaged in a 3 ½ × 11 1/9 inch envelope.

The completed cooling device consisted of, starting from the outside of the warmer side, two layers of 3–4 mil Tyvek film, a layer of 4 mil low density polyethylene film, a layer of 2 mil Saranex, the core of gel, a layer of 2 mil Saranex, 2 layers of 1 ¼ mil low density polyethylene film and a layer of 4 mil low density polyethylene film. The thermoplastic layers were all heat sealed to each other around their periphery outside the edges of the core in the manner shown in the drawings.

The completed cooling device was stored at about −10°F. for several days and the temperature of each side was measured upon removal from the freezer.

The procedure for measuring the temperature involved the use of matched thermocouples which were pressed against the sides of the cooling device with equal pressure. The thermocouples were each backed by a 2 mil polyethylene bag filled with 500 ml of water warmed to 100°F. The water bags acted as heat sinks and simulated actual use conditions.

After 1 minute a temperature difference of 10°F. was recorded; the "warm" side reading 75°F. and the "cold" side reading 65°F. After 4 minutes, the readings were 72.5°F. and 64.5°F., respectively.

EXAMPLE 2

The test described in Example 1 was repeated with a cooling device measuring 8 × 3 inches, but otherwise identical to that of Example 1. The initial temperature difference observed was 7.5°F.

From the above it can be seen that the present invention provides a cooling device which offers the user a choice of the amount of cooling to be applied without sacrificing any of the desirable convenience features, such as flexibility, of cooling devices which were previously available.

While the present invention has been described with particularity, it will be obvious that it is susceptible to changes, modifications and alterations without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A cooling device comprising at least one layer of a cold storing material sealed within a container of two flexible thermoplastic walls heat sealed to each other around their common periphery, one of said walls being breathable film, and the other of said walls being an air-impermeable film.

2. A device according to claim **1** wherein the walls are of polyolefinic film.

3. A device according to claim **2** wherein the walls are of polyethylene film.

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