United States Patent [19]

Williams

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[54] **LIQUID COOLING APPARATUS**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **62/392;** 62/393; 62/394

[51] **Int. Cl.** **B67d 5/62**

[58] **Field of Search** 62/391, 392, 393, 394, 62/395, 396

[56] **References Cited**

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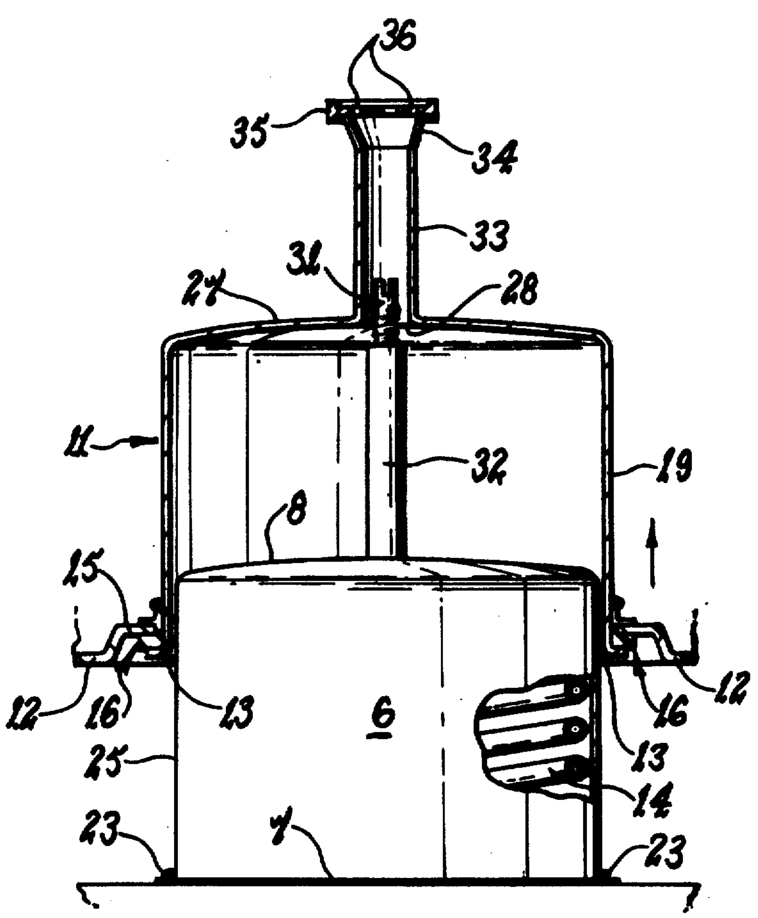
Attorney, Agent, or Firm—Diller, Brown, Ramik & Wight

[57] **ABSTRACT**

Liquid cooling apparatus including a liquid container, a refrigeration unit operable to maintain the temperature within that container between upper and lower levels, and a heat transfer element projecting into the container to draw heat from the container during operation of the refrigeration unit. A sleeve surrounds the heat transfer element and a liquid is contained within a space defined between the heat transfer element and the sleeve so as to form a jacket about the heat transfer element. The jacket liquid is selected so that it will freeze at or about the aforementioned lower temperature level and thereby provide an insulation against heat transfer, but will remain in a liquid state at temperatures above that lower level and below the aforementioned upper level so that it will act as a heat conductor in transferring heat from the liquid container to the heat transfer element.

5 Claims, 5 Drawing Figures



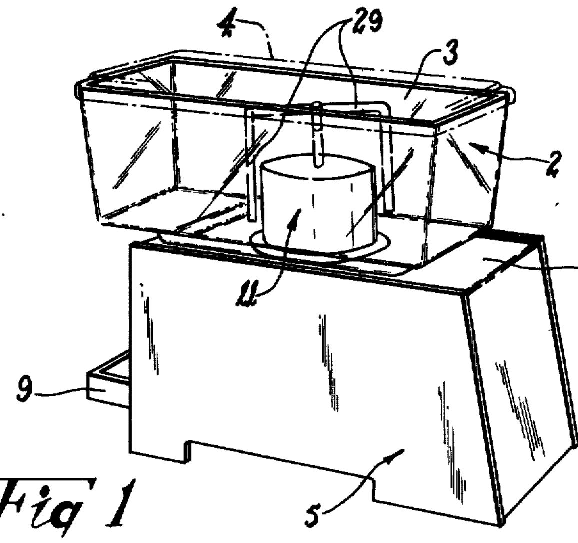


Fig 1

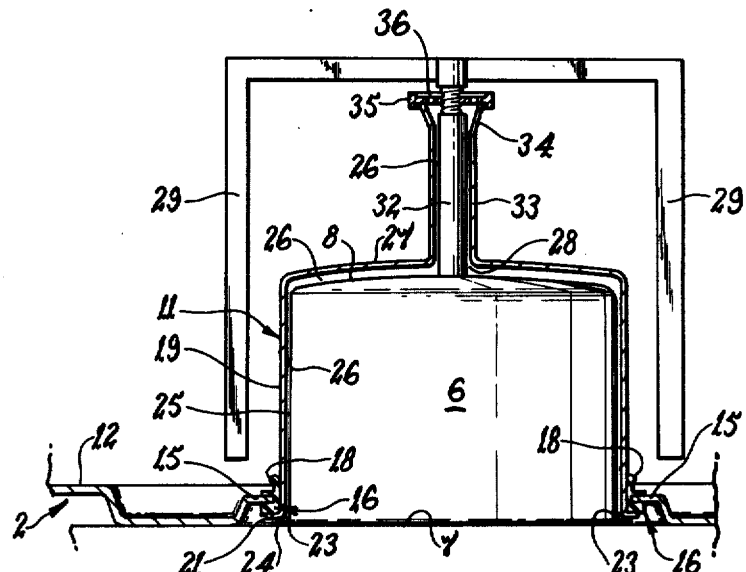


Fig 2

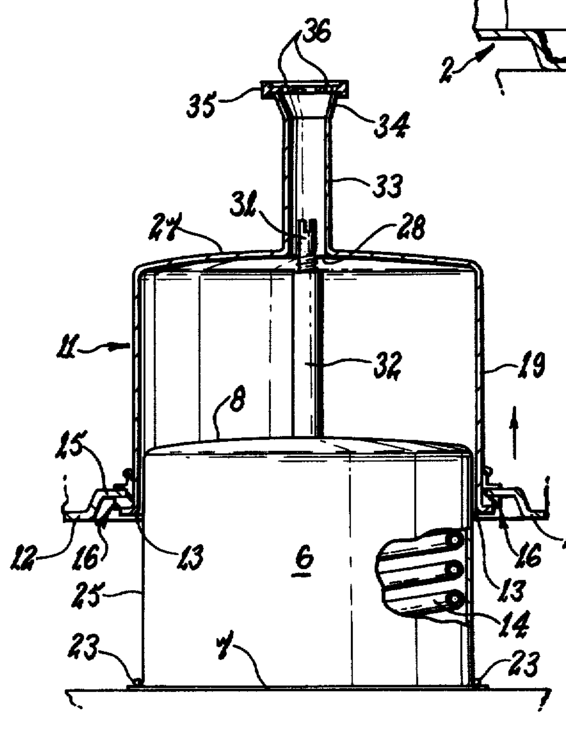


Fig 3

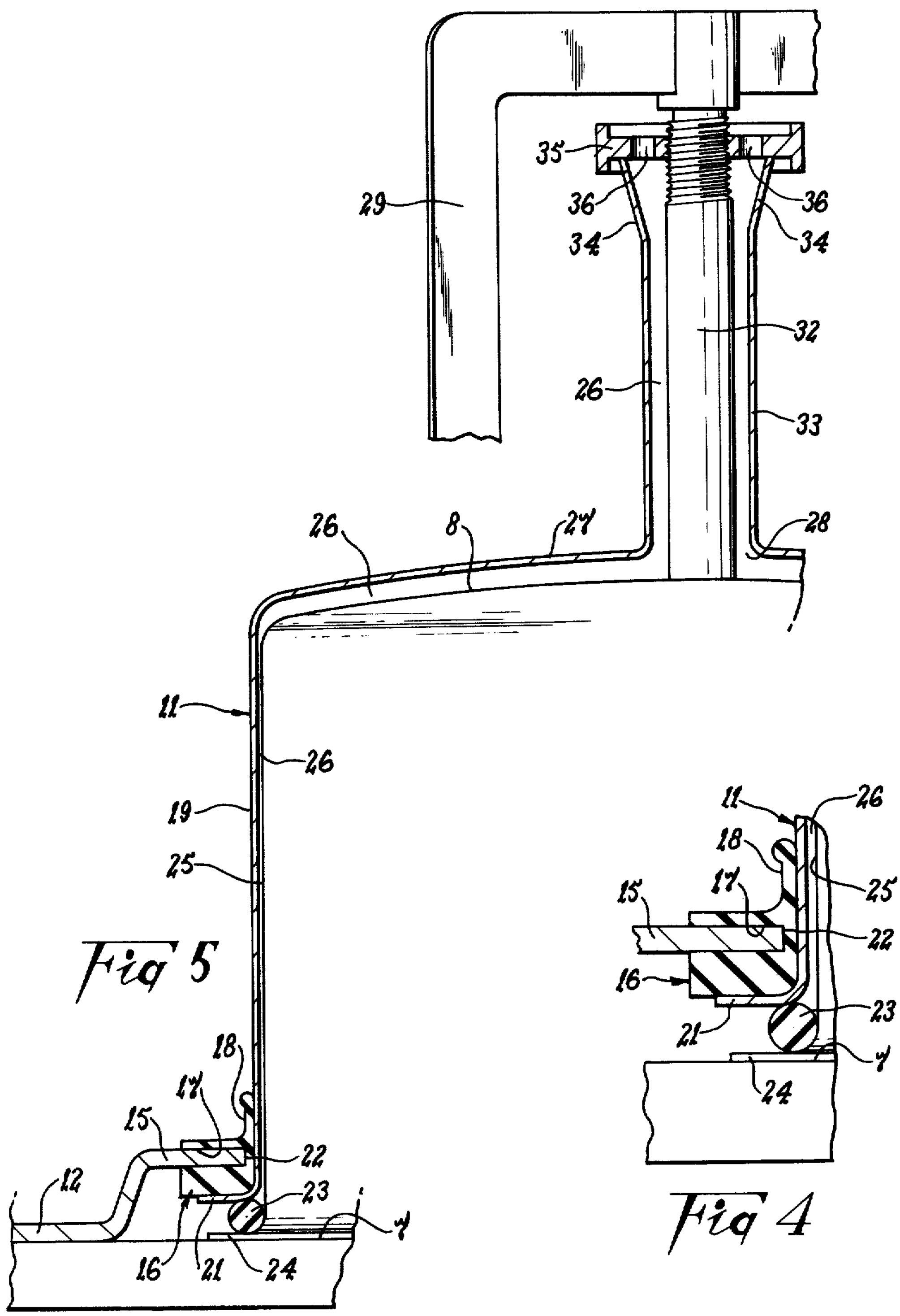

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Fig 4

LIQUID COOLING APPARATUS

This invention relates to apparatus or machines for cooling liquids, and is particularly concerned with such apparatus having a sleeved liquid container of the general kind shown in U.S. Pat. application No. 273,695, filed July 21, 1972 and now abandoned. That is, the liquid container is provided with a sleeve like member which fits over the heat transfer element (usually a dome or similar member) of the refrigeration unit, and is arranged so that a space is defined between the inside surface of the sleeve and the adjacent outside surface of the heat transfer dome.

One problem with apparatus as shown in U.S. Ser. No. 273,695 is that air is provided within the space between the heat transfer element and the container sleeve, and air is a poor conductor so that transfer of heat between the interior of the container and the heat transfer element is inhibited. Furthermore, in apparatus of the kind indicated, operation of the refrigeration unit is controlled through a thermostat device, and it is generally convenient to locate the sensor for that device within the heat transfer dome. Thus, the air space of the construction shown in application U.S. Ser. No. 273,695 also makes it difficult to achieve accurate control of the apparatus.

It is a principal object of the present invention to provide an arrangement which overcomes or at least alleviates the abovementioned problems, so that heat transfer between the interior of the container and the heat transfer element is relatively good, and temperature conditions within the liquid container can be easily and rapidly detected.

According to the invention, the aforementioned problems are overcome by providing a liquid barrier between the heat transfer element and the sleeve of the liquid container. In one form of the invention as hereinafter described, that liquid is water, but it is to be appreciated that other liquids can be used. The liquid barrier forms a jacket about the heat transfer element, and the liquid is selected so as to remain in a liquid state during at least part (preferably a major part) of the cooling phase of the refrigeration unit, and is preferably such that it will freeze at or near the end of the cooling phase. When in the liquid state, the jacket liquid provides a heat conduction path between the heat transfer element and the container, and therefore aids in the coolinlg process. When in the frozen state however, the jacket liquid forms a heat seat or insulation such as to inhibit transfer of heat from the heat transfer element to the liquid container, and that is of significant advantage because it is to be expected that the heat transfer element will increqse in temperature at a faster rate than the body of liquid in the liquid container.

The following description refers in more detail to these essential features and further optional features of the invention. To facilitate an understanding of the invention, reference is made to the accompanying drawings where these features are illustrated in preferred form. It is to be understood however, that the essential and optional features of the invention are not limited to the specific forms of these features as shown in the drawings. In the drawings:

FIG. 1 is a semi-diagrammatic view of a typical cooling apparatus to which the invention may be applied;

FIG. 2 is an enlarged cross-sectional view of portion of the liquid container of the apparatus shown in FIG. 1;

FIG. 3 is a view similar to FIG. 2 but showing the liquid container being removed from the heat transfer element;

FIG. 4 is an enlarged cross-sectional view of the sealing arrangement between the heat transfer element and liquid container of the apparatus shown in FIG. 1; and

FIG. 5 is an enlarged cross-sectional view of part of the assembly shown in FIG. 2, and showing the liquid space between the liquid container and the heat transfer element.

Apparatus incorporating the invention may be generally as disclosed in U.S. Ser. No. 273,695 but the invention is also applicable to variations of that apparatus. In particular, the invention is applicable to any apparatus of the general type indicated in which the liquid container is mounted on the heat transfer element of the apparatus by means of a sleeve-like member. It will be convenient however, to describe the invention in relation to the typical arrangement as forming the subject of U.S. Ser. No. 273,695 and an example of which is shown in FIG. 1 of the accompanying drawings.

The liquid container 2 of the example apparatus is in the form of a substantially rectangular vessel having an open top 3, and a removable cover 4 may be provided to close that open top when required. Both the main body of the container 2 and the cover 4 may be made from a transparent plastics material. A housing 5 supports the container 2 and the usual refrigeration apparatus (not shown) and other mechanism as may be required can be mounted within that housing. The heat transfer element is preferably in the form of a dome 6 upstanding from the top wall 7 of the housing 5 — that is, it is generally cylindrical with a slightly convex upper surface 8. A liquid dispensing valve or tap (not shown) may be associated with the liquid container 2, and a laterally projecting drip tray 9 is secured to the housing 5 in a location beneath that valve or tap.

Mounting means for the container 2 includes a sleeve 11 or outer dome member which may be formed integral with the main body of the container 2, but in the preferred form shown is made as a separate component and projects into the container 2 through an aperture in the base wall 12 thereof so as to be arranged to fit over the heat transfer dome 6, which will be hereinafter referred to as the inner dome. The outer dome 11 is secured to the base 12 of the container 2 in liquid selaing relationship and has an open lower end which defines an opening 13 (see FIG. 3) through which the inner dome 6 projects into the outer dome 11. Both of the domes 6 and 11 are conveniently of substantially cylindrical shape with a slightly convex upper surface, although other shapes can be used. It is usually preferred to form the outer dome 11 of a metal such as stainless steel, as is also normally used for the inner dome 6.

The inner dome 6 need be no different to conventional arrangments insofar as its basic construction is concerned. That is, it may be secured to a top wall 7 of the housing 5 and may have a refrigerator coil 14 (see FIG. 3) secured to or contacting its inside surface so as to effect proper heat transfer.

Any suitable sealing arrangement may be provided at the lower end of the outer dome 11. In the preferred form shown most clearly in FIG. 5, the edge portion 15 of the container base 12 which defines the aperture therein, is stepped above the adjacent base surface and carries an outer seal gasket **16**. The gasket **16** has a continuous recess or groove **17** which receives the edge portion **15**, and an upper lip section **18** which is arranged to bear against the outside cylindrical surface **19** of the outer dome **11**. The outer dome **11** is provided with a laterally projecting flange **21** at its lower end which locates beneath the base edge portion **15** and bears against a lower surface of the gasket **16**. Preferably, the gasket **16** is compressed between the outside surface **19** of the outer dome **11** and the peripheral edge **22** of the container base aperture, and is formed of a suitable material for that purpose.

An inner seal **23** is provided between the lower end portions of the two domes **6** and **11**, and for that purpose the inner dome **6** is preferably provided with a laterally projecting flange **24** around its lower end similar to the flange **21** of the outer dome **11**. The inner seal **23** is preferably formed by a rubber O-ring located within the corner defined at the junction of the cylindrical wall **25** and flange **24** of the inner dome **6**, and the lower end of the outer dome **11** bears against the O-ring **23**. It will be appreciated that the O-ring **23** can be made of any appropriate material other than rubber.

With the foregoing arrangement, it is a relatively simple matter to remove and replace the liquid container **2**, and the seal **16** between the container **2** and outer dome **11** remains undisturbed during such operations (see FIG. **3**). If desired however, the outer dome **11** can be slid out of the aperture of the container base **12**, unless an adhesive has been used to secure the outer gasket **16** to that dome.

The outer dome **11** is dimensioned so as to fit over the inner dome **6** with clearance as shown most clearly in FIG. **5**, at least between the cylindrical side walls **19** and **25** thereof. It is preferred however, that the clearance space also extends between the upper walls **8** and **27** of the two domes **6** and **11**, and an opening **28** is provided through the upper wall **27** of the outer dome **11** to permit introduction of liquid **26** into the aforementioned space.

If the apparatus is to be used with cordials and other liquids requiring stirring or agitation to maintain a proper consistency, it is usual to provide a rotatable agitator **29** within the liquid container **2** and which is driven by a shaft **31** extending upwardly through the top wall **8** of the heat transfer dome **6**. In order to prevent ingress of liquid into the inner dome **6**, a tubular member **32** may project upwardly from the top wall **8** thereof to a plane above the normal liquid level in the container **2**, and the drive shaft **31** extends axially through the tubular member **32**. The agitator **29** may be of any appropriate form and is preferably releasably attached to the upper end portion of the drive shaft **31** so as to be readily removable therefrom.

In such an agitator construction, the outer dome **11** is also preferably provided with an upstanding tubular member **33** which corresponds generally to the inner dome member **32**, but is of larger diameter so as to slide over the inner dome member **32** with clearance as shown in FIG. **5**. That clearance forms a continuation of the aforementioned space between the domes **6** and **11** and provides a passage whereby liquid **26** can be introduced into that space. In order to facilitate that introduction, the upper end portion **34** of the outer dome tube **33** may be flared outwardly and upwardly to define a funnel-like entance section. If desired, the upper open end of the outer dome tube **33** may be at least partially closed by a nut **35** threadably mounted on the tubular member **32** and having at least one priming hole **36** formed therethrough communicating with the passage defined between the tubes **32** and **33**. Alternatively, a cap member may be slidably mounted on the tube **32**, and that member may or may not have a priming hole therethrough. A nut is generally preferred however, because that provides means whereby the liquid container **2** and outer dome **11** are positively retained in position relative to the inner dome **6**.

The thickness of the space between the two domes **6** and **11** and their tubes **32** and **33** may vary according to requirements. In a typical construction however, the clearance is less between the cylindrical walls **19** and **25** of the domes than at any other zone — for example, the space between the cylindrical walls **19** and **25** may be within the range of 1/32 to 1/16 of an inch, whereas the space between the top walls **8** and **27** and the tubes **32** and **33** may be within the range of ⅛ to ¼ inch.

It is also preferred that one or more capillary sensor tubes (not shown) of a thermostat device (not shown) are secured to the inside surface of the inner dome **6**, and that device is operatively connected to the refrigeration unit to control its operation in a known manner.

When apparatus as described is prepared for use, water or other suitable liquid **26** is introduced into the passage between the two dome tubes **32** and **33** and it is preferred that the water substantially fills the available space so as to reach up to the retaining nut **35**. Liquid requiring to be cooled is carried by the container **2**, and the refrigeration unit is started so causing a drop in temperature within and about the refrigeration coil **25** located within the inner dome **6**. The temperature of the inner dome **6** therefore falls because of its proximity with the refrigeration coil **25**, and a transfer of heat occurs between the inner and outer domes **6** and **11** through the conductor path formed by the water barrier or jacket **26**. As the outer dome **11** cools, it provides a heat absorption element for the body of liquid in the container **2**, and in that way the liquid is brought to a suitable temperature.

Because of the thin nature of the water jacket **26**, it is susceptible to freezing, but the arrangement is preferably such that freezing does not occur until the temperature of the body of liquid in the container **2** is at or about the predetermined desired temperature. When the jacket **26** turns to ice, conductivity between the inner and outer domes **6** and **11** is reduced, and the inner dome **6** reaches the temperature at which the thermostat device functions to de-energize the refrigeration unit. The jacket **26** will thereafter return to its liquid state because of its thin nature and communication with atmosphere through the priming holes **36**, and in that liquid form the jacket **26** provides an effective conductor path through which the thermostat sensor is able to quickly and accurately respond to temperature changes of the liquid body within the container **2**. Thus, the refrigeration unit will be re-energized before the temperature of the liquid body increases to an undesirable level.

If the temperature of the inner dome **6** increases more rapidly than does the temperature of the liquid body in the container **2** — and that is likely because of the relatively large volume of the liquid body — the frozen jacket **26** provides a heat sink or insulation which delays transfer of that temperature increase to the liquid body within the container **2.**

It will be appreciated from the foregoing description that the invention provides an improved heat transfer and sensing arrangement for apparatus of the kind indicated. The apparatus described enjoys the advantage of the apparatus according to U.S. Ser. No. 273,695 in that ice does not form on the outside of the outer dome **11.**

Many variations of the apparatus particularly described, are available. For example, the seal between the outer dome **11** and the liquid container **2** may be as described in U.S. Ser. No. 273,695. Furthermore, the inner and outer domes may have an upper metal to metal seal as described in that earlier application, and in that event access to the clearance space may be gained through an access tube extending upwardly from the top wall of the outer dome adjacent to its outer edge, or through a closable opening in that wall.

In addition. the apparatus may be arranged so that the barrier or jacket between the two domes retains its liquid state during all phases of operation. That may be achieved by increasing the thickness of the jacket and/or increasing the "cut-out" temperature of refrigerator unit.

Finally, it is to be understood that various alterations, modifications and/or additions may be introduced into the constructions and arrangemets of parts previously described without departing from the spirit or ambit of the invention.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Liquid cooling apparatus including a liquid container having a plurality of walls; a sleeve secured to one of said walls and projecting into said container to define a cavity within said container; a heat transfer element located in said cavity and being operable during a cooling phase of said apparatus to draw heat from said liquid container; said sleeve and said heat transfer element being relatively dimensioned so that a space is defined between their adjacent surfaces; and a liquid contained within said space to form a jacket about said heat transfer element; said jacket liquid being such as to form a heat conduction path between said sleeve and said heat transfer element during at least part of said cooling phase, and said jacket liquid being such that it will freeze near the end of said cooling phase and in the absence of liquid freezing within said container so as to inhibit transfer of heat between said heat transfer element and said liquid container.

2. Liquid cooling apparatus including a liquid container having a plurality of walls; a sleeve secured to one of said walls and projecting into said container to define a cavity within said container; a heat transfer element located in said cavity and being operable during a cooling phase of said apparatus to draw heat from said liquid container; said sleeve and said heat transfer element being relatively dimensioned so that a space is defined between their adjacent surfaces; and a liquid contained within said space to form a jacket about said heat transfer element; said jacket liquid being such as to form a heat conduction path between said sleeve and said heat transfer element during at least part of said cooling phase, said heat transfer element including a cylindrical shell and a refrigeration coil located within that shell, said coil forming part of refrigeration means which is operated during each of several cooling phases to lower the temperature of said coil below ambient temperature, said sleeve being cylindrical and having an open end secured about the opening formed in said lower wall of said container, sealing means between said sleeve and said shell adjacent said opening so as to close one end of said space, and an end wall of said sleeve extends across at least part of a top surface of said shell and is spaced therefrom so that portion of said space is defined between said end wall and said top surface.

3. Apparatus according to claim **2** wherein an agitator is located within said liquid container and is mounted on a rotatable shaft extending through both said top surface of the shell and said sleeve end wall, and a tubular member extends upwardly from said end wall to contain at least part of the portion of said shaft projecting above said heat transfer element shell.

4. Apparatus according to claim **3,** wherein said jacket liquid space extends between said tubular member and said shaft.

5. Apparatus according to claim **4** wherein a removable closure member cooperates with said tubular member to at least partially close the upper end of said jacket liquid space.

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