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CORRECTED PUBLICATION

(54) **COOLING ELEMENT WITH SUB-COOLING PROTECTION**

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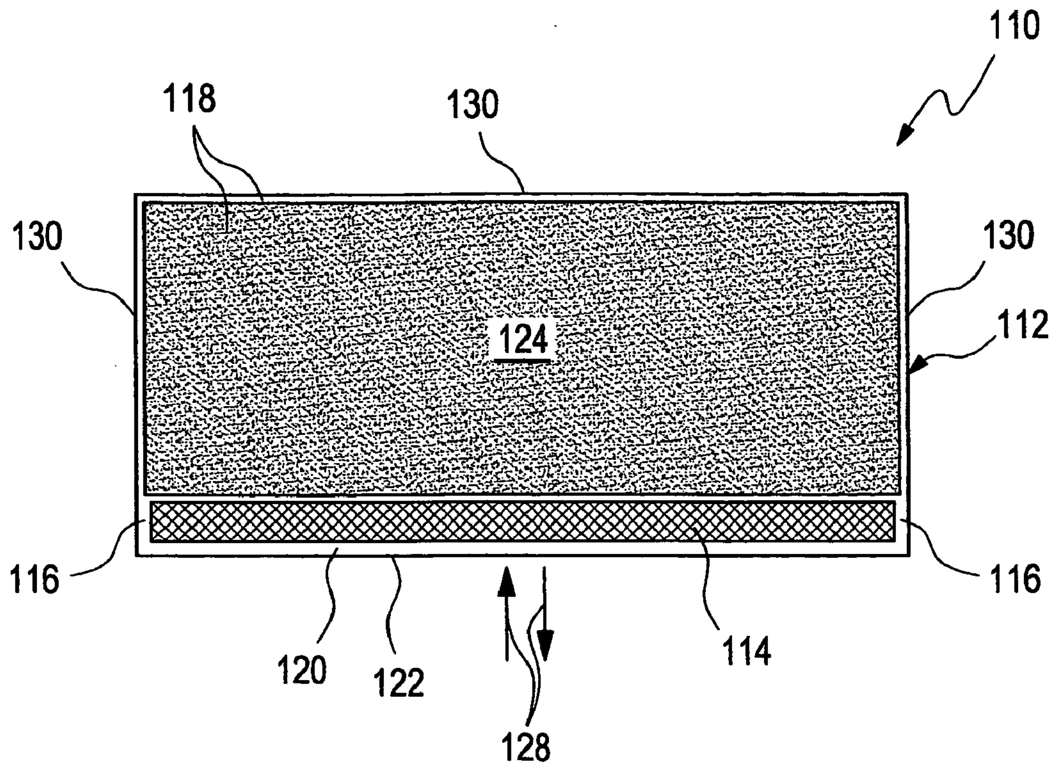
(57) **ABSTRACT**

A cooling element for cooling goods to be chilled is proposed, comprising a shell with at least one heat transfer wall for exchanging thermal energy with the goods. The cooling element further comprises at least one fluid space proximate to the heat transfer wall and at least one storage space separated from the fluid space by at least one separating element, wherein the storage space is configured to hold a supply of cooling medium in the solid aggregate state. The separating element is configured to substantially separate the supply of cooling medium in the solid aggregate state from the fluid space and to enable the cooling medium in the liquid aggregate state to pass over from the storage space to the fluid space.



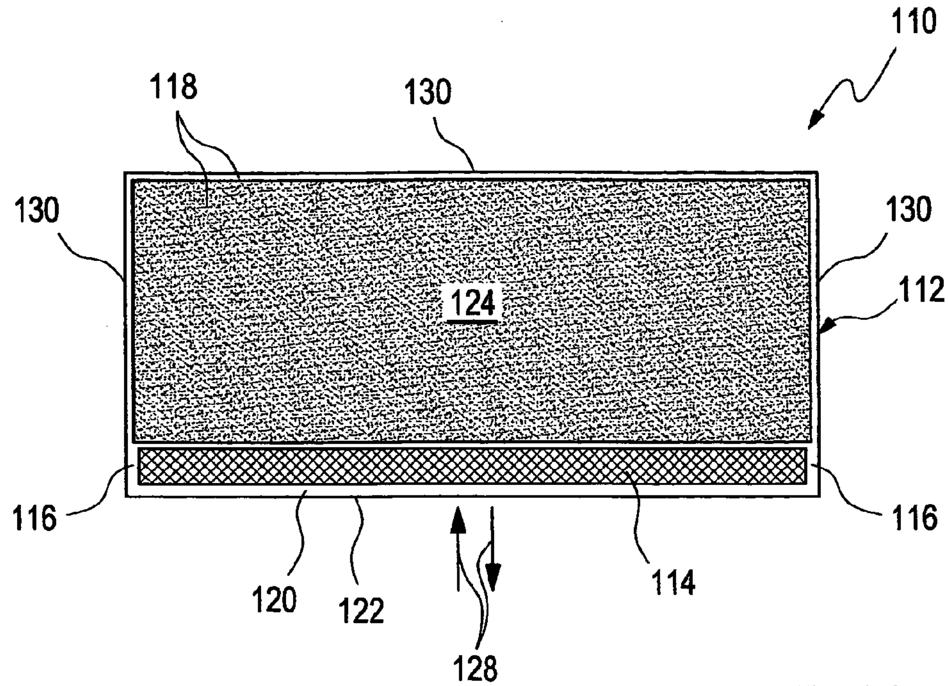

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Fig. 1 A

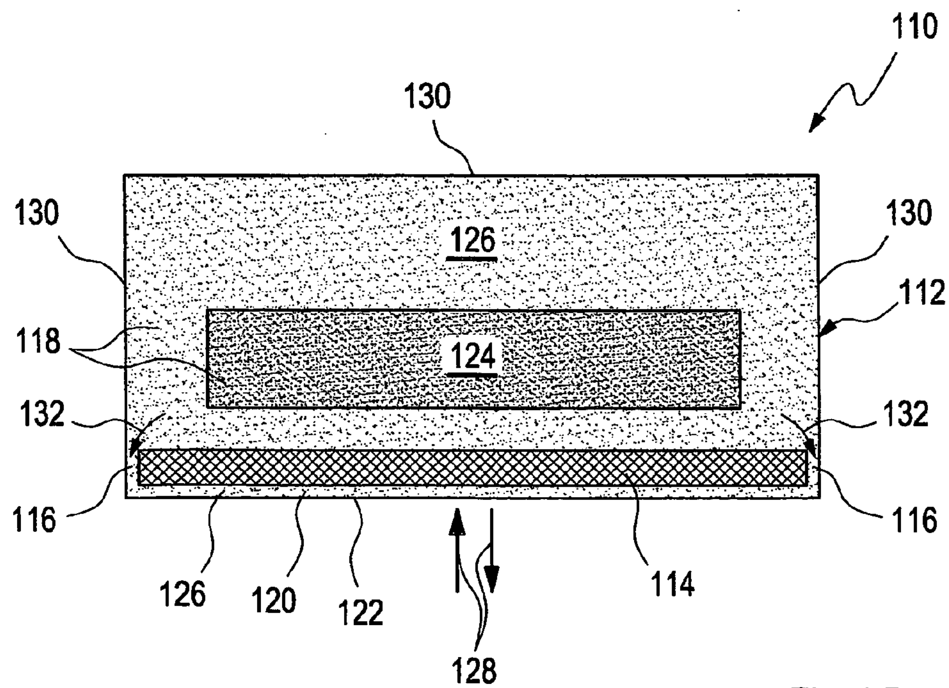
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Fig. 1 B

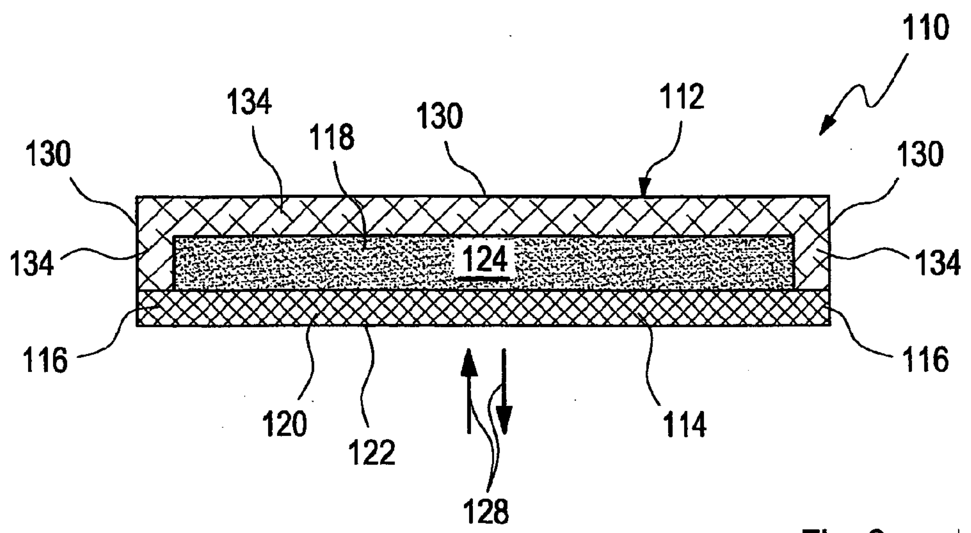
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Fig. 2

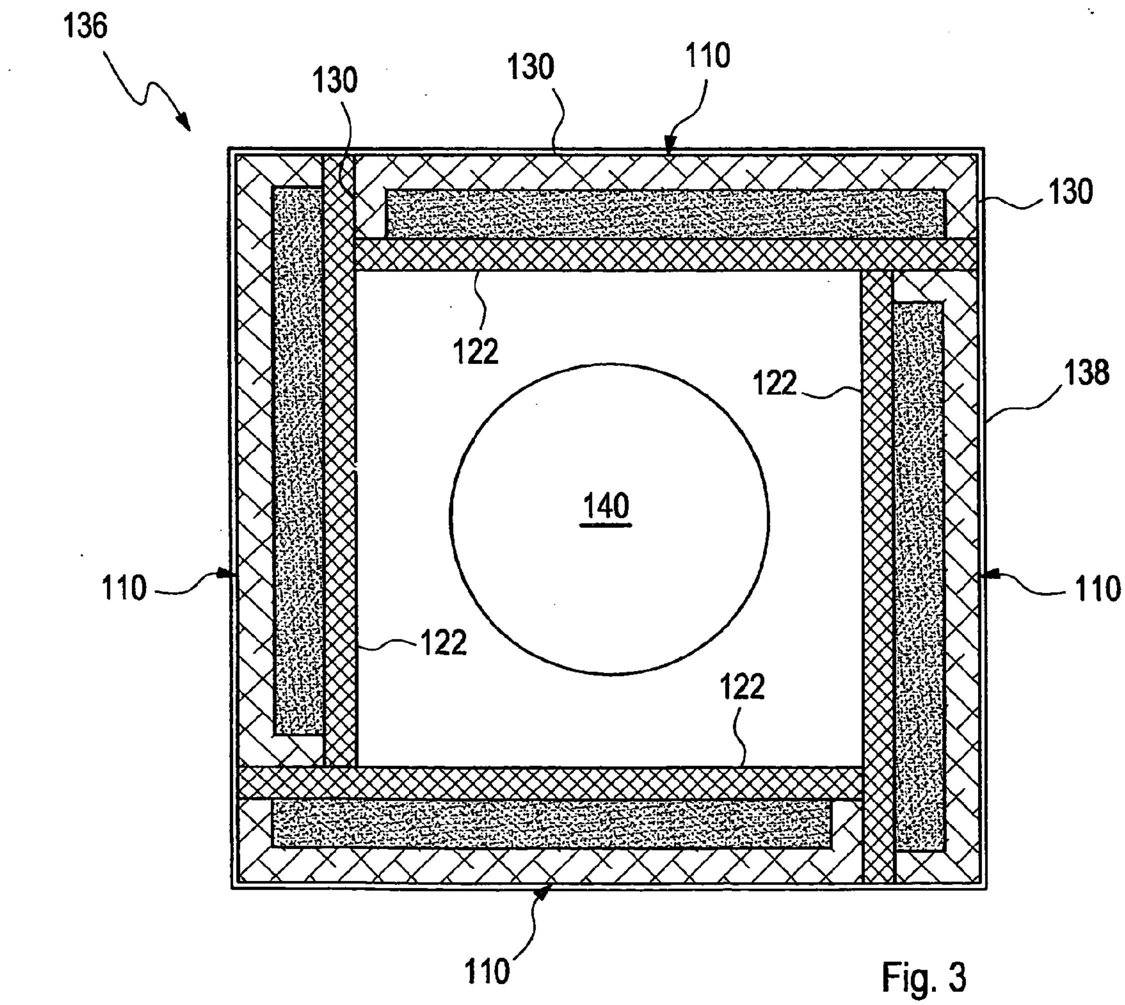
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Fig. 3

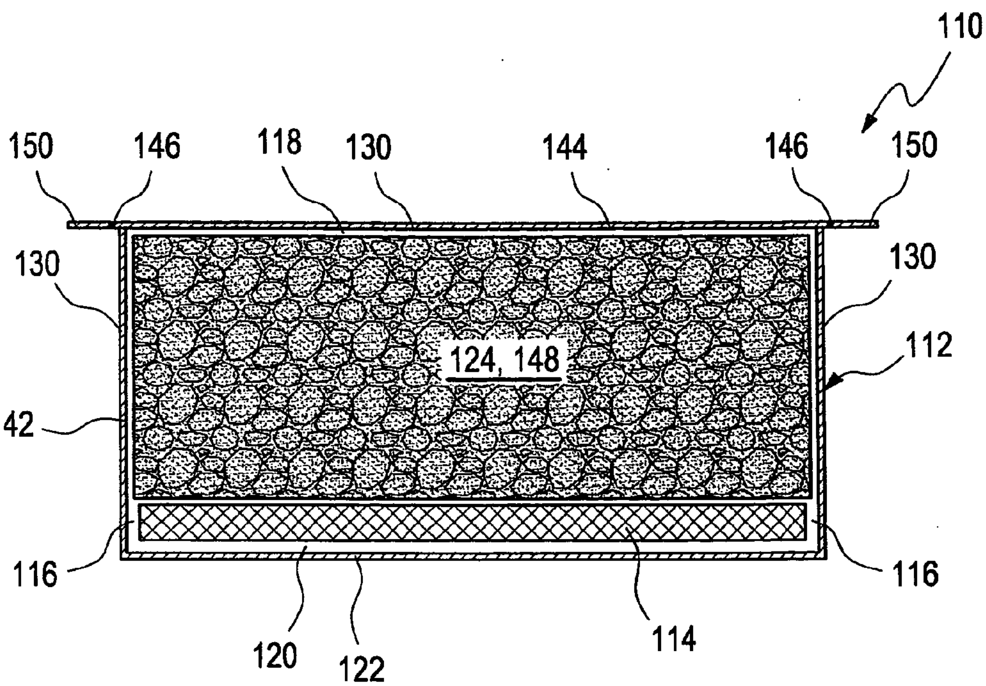
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Fig. 4 A

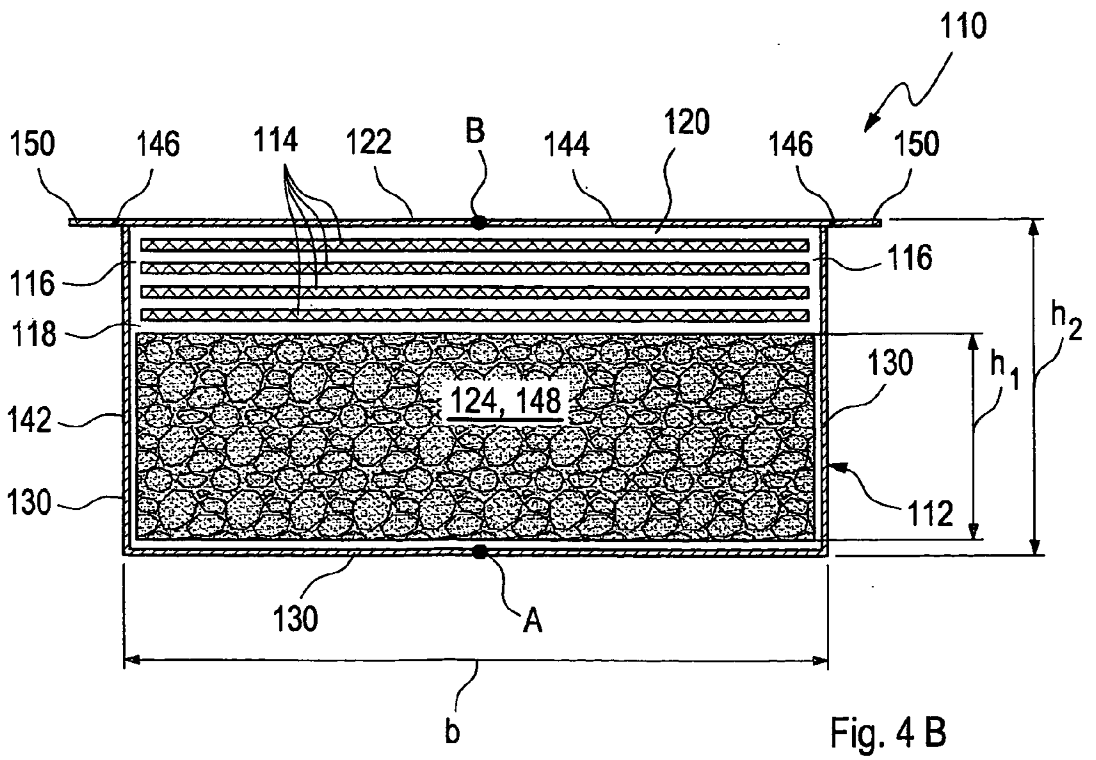
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Fig. 4 B

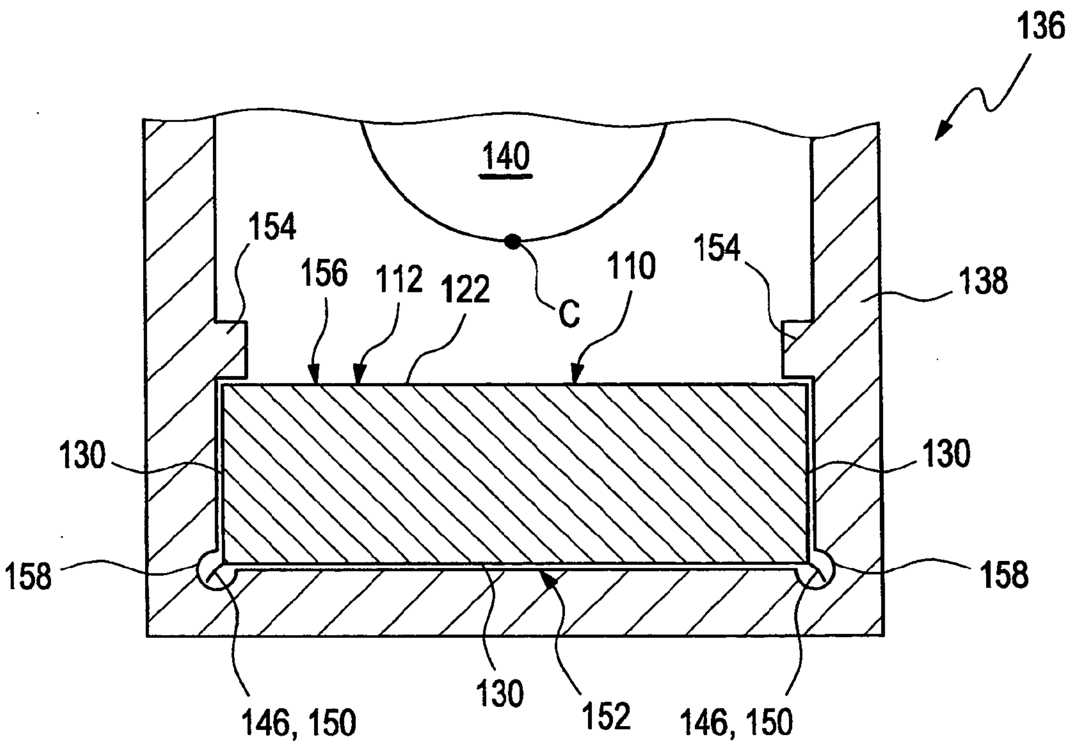
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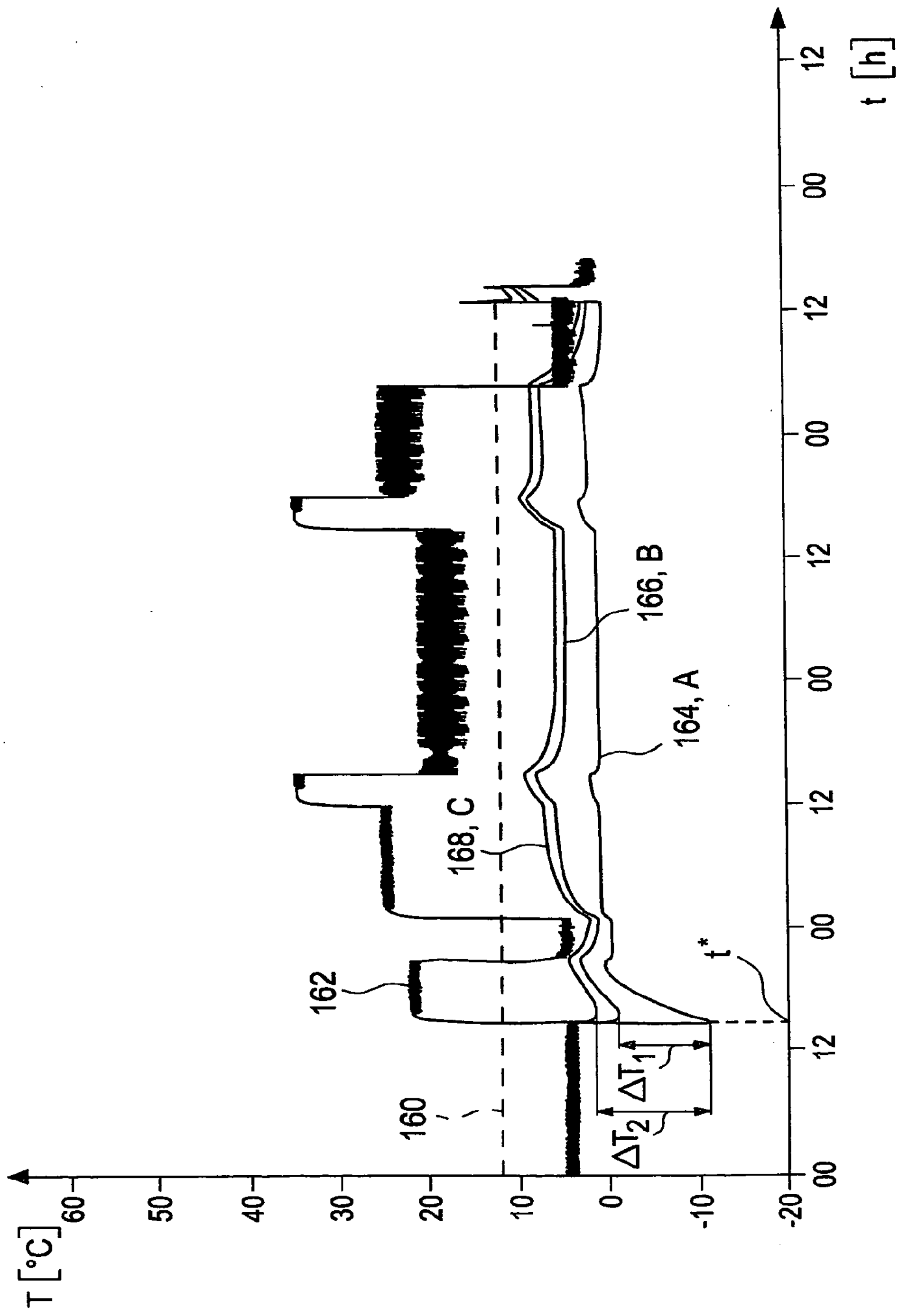
Fig. 5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166, B
168, C
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ΔT2
t*

Fig. 6

COOLING ELEMENT WITH SUB-COOLING PROTECTION

FIELD OF THE INVENTION

[0001] The invention relates to a cooling element for cooling goods to be cooled as well as a refrigerated container with a cooling element according to the invention. Furthermore, the invention relates to a method for cooling goods to be cooled using a cooling element according to the invention as well as a method for manufacturing a cooling element. Such cooling elements, refrigerated containers and methods may be used in particular in the field of pharmacy and medicine for the transport of pharmaceutical and/or medical samples. But also other applications are possible.

BACKGROUND ART

[0002] Cooling elements are used in a large number of fields and applications. As examples, which are, however, not concluding, various sciences such as chemistry and biology as well as medicine and medical engineering are here to be mentioned. Also in pharmacy, such cooling elements are used for example to keep and/or to transport drugs at an optimum temperature. Additionally, there are cooling elements which are used in households or cooling elements for the food industry.

[0003] Such cooling elements, commonly also called “cold packs”, usually have a flexible or rigid covering in which a cold-storing liquid (hereinafter also referred to as coolant) is introduced. If the cooling element is “loaded”, the cold-storing liquid is present in frozen state. Such liquid may be directly present in the covering or absorbed in a carrier substrate or storage medium. The latter frequently serves immobilization and has a positive effect on the shaping of the cooling element and on a possible cooling time. Prior to its use, the cooling element is pre-frozen for a pre-set duration. Such cooling elements generally have no own active cooling, in particular no power supply.

[0004] However, the disadvantage of such cooling elements or cold packs is that such pre-freezing or sub-cooling to a temperature below the target temperature of the goods to be cooled usually causes temperatures well below phase transition between the solid state of matter and the liquid state of matter of the coolant. Only by such sub-cooling of the cooling elements below the finally desired target temperature of the goods or the merchandise to be cooled, it is possible to maintain cooling over a longer period of time. From that point of view, such sub-cooling of the cooling elements is indispensable in many cases.

[0005] However, if one introduces such sub-cooled cooling elements in a package, there will first be a significant cooling through the sub-cooled cooling elements, among others, also in the area of the packing which contains the goods or the merchandise to be cooled. For many types of goods to be cooled, for example in the food industry and/or pharmacy, such sub-cooling of the goods to be cooled involves partly irreversible damage. When used in households or for food, freezer burn or other damage may occur. In the field of pharmacy or biology, sensitive samples and drugs may become completely useless by sub-cooling. Therefore, goods to be cooled usually have a target temperature at which they should be cooled, a maximum temperature which should not be exceeded permanently, as well as a tolerance threshold or minimum temperature below the target temperature within which damage does generally not yet occur.

[0006] Various solutions which can be used to avoid sub-cooling of the cooling good are known from the background art. Thus, JP 101 11 057 describes for example a cooling element which may be used in particular for vegetables. The cooling element has a foam element integrated in a common covering, which is introduced between the coolant present in closed spaces and the goods to be cooled in order to protect this way the goods to be cooled from sub-cooling as an insulating element.

[0007] The principle of inserting additional insulation layers between the cooling elements and the goods to be cooled as known from JP 101 11 057 is also used in big refrigerated containers in which cooling elements are initially introduced for example into an external insulating box close to the edges, and subsequently, a second smaller box made of insulating material is introduced into the still free lumen of such box, in which the goods to be cooled are finally included. Certainly, such “passive” insulation concepts reduce the described problem of initial sub-cooling of the goods to be cooled since the additional layer acts as a “buffer” to build up a temperature gradient between the cooling element and the goods to be cooled, but in such systems, significantly more costly and expensive work steps involving additional handling steps are required since both additional materials (for example an internal box or intermediate layers) and additional operations are required when packing the merchandise. A further disadvantage of purely passive buffer insulations is that the total service life of the cooling elements is comparatively low.

[0008] Also more complex cooling systems, which are as well to avoid the above-described problem of initial sub-cooling of the goods to be cooled, are known from the background art. Thus, for example EP 1 477 751 A1 describes an initial sub-cooling of the goods to be cooled through combination of a pre-frozen cooling element with a thermal regulation barrier with a liquid, which has a temperature above 0° C. Also such additional liquid thus acts as a thermal buffer. However, the disadvantages of such structure are comparable with the above-described disadvantages of JP 101 11 057. Again, a complex structure with additional handling steps is necessary. Furthermore, the total cooling duration is again limited through the pre-heated intermediate element.

[0009] Also WO 00/12409 describes a cooling package for sensitive goods to be cooled in which the goods to be cooled are at first covered with an internal layer with a water volume. Such internal layer is again covered with an external layer of a coolant, which is frozen and may have temperatures far below 0° C. The sub-cooled external layer must first cool down the internal water layer until the goods to be cooled themselves may be cooled. This way, the internal layer also acts as a thermal buffer, which mitigates initial “cold peaks”.

[0010] However, also the solution described in WO 00/12409 is comparably complex. It is always necessary to introduce two separated layers in two operations since such two layers must be differently thermally pre-treated to avoid a sub-cooling of the internal layer. Moreover, the internal layer, which again resembles a “pre-heated” layer, limits the entire useful life of the cooling element.

SUMMARY OF THE INVENTION

[0011] It is therefore an object of the present invention to provide a cooling element which at least largely avoids the disadvantages of known cooling elements. On the one hand, the cooling element is in particular to reduce or eliminate the known problem of an initial damaging sub-cooling of the temperature-sensitive goods to be cooled, in particular when introducing the goods to be cooled into a transport package or when introducing pre-frozen cooling elements into the transport packages. On the other hand, however, the cooling element is to be embodied as simply as possible and to at least largely avoid the need for additional work steps or additional material. Furthermore, the temperature transitions and temperature conditions within a package comprising the cooling element is to be defined as accurately as possible to be able to provide reliable information on the cooling temperature and cooling duration of the merchandise packed therein.

[0012] This object is achieved by the invention with the features of the independent claims. Advantageous further embodiments of the invention are marked in the sub-claims. The wording of all and any claims is hereby incorporated in this description by reference.

[0013] In contrast to the "buffer concepts" with simple insulation layer buffers or thermal buffer media as known from the background, the present invention is based on a targeted utilization of a phase transition of a coolant from the solid state of matter to the liquid state of matter. However, for the purpose of the present invention a "liquid state of matter" is generally to be understood as a fluid state of matter, that is a state of matter in which the coolant has a low viscosity and high plasticity, that is in particular, a fluidity and/or flowability. Besides liquid coolants, this may basically also be coolants in the gaseous state.

[0014] A main idea of the present invention is that, with known boundary conditions, a phase transition between the solid state of matter and the liquid state of matter always takes place at a known melting point and/or within a known melting range (according to the type of coolant or coolant mixture). The invention is based on the idea that it is possible to spatially separate the solid state of matter of the coolant and the liquid state of matter of the coolant within one cooling element. Accordingly, for example a supply of the coolant in the solid state of matter can be cooled down or sub-cooled nearly at any temperature as long as it is sufficiently thermally separated and/or insulated from the goods to be cooled. However, the liquid state of matter of the cooling medium, which has a temperature of at least the temperature of the melting point and/or melting range, may be enabled to get into closer thermal contact with the goods to be cooled by means of suitable devices, and thus to act as a heat-transfer medium between the goods to be cooled and the solid state of matter of the coolant.

[0015] Therefore, for the implementation of this idea, a cooling element which may be used for cooling goods to be cooled is proposed. As described above, the goods to be cooled may for example be taken from the field of sciences, medicine, pharmacy, food industry or from households. However, also other fields of application are conceivable. In particular, the goods to be cooled may comprise thermally sensitive goods which should not be cooled below a certain minimum temperature and/or below a tolerance threshold below a target temperature.

[0016] The cooling element comprises a covering which may be embodied in particular as a closed covering. As described in more detail below, such covering may comprise a flexible and/or rigid covering. Plastic materials, in particular plastic foils and plastic boards, are particularly suitable as materials for such coverings. Owing to their low permeability, in particular mixed plastics made of polyethylene and polyamide proved to be advantageous. The covering may also be embodied as a multilayer covering and may for example be differently embodied in different areas of the cooling element, for example in order to enable anisotropically a different heat transfer in different areas of the covering.

[0017] Thus, the covering has in particular at least one heat transfer wall for exchanging thermal energy with the goods to be cooled. For example, the covering may have exactly one heat transfer wall, for example a flat heat transfer wall. For example, such heat transfer wall may be one or several foil sides of a foil covering, for a example of a foil bag. The expression "for exchanging thermal energy with the goods to be cooled" is not necessarily to be understood as a direct thermal contact with the goods to be cooled, so that, for example, besides a direct contact with the goods to be cooled, also an interposition of further thermally insulating elements, such as foam or polystyrene elements and/or air or gas layers, may be possible.

[0018] For implementing the above-described basic idea of a spatial separation of the phases of the coolant, the cooling element has at least one fluid space adjacent to the heat transfer wall and at least one storage space separated from the fluid space. The fluid space and the storing space are separated by at least one separating element. The term "to separate" here refers to a mechanical retention of the solid phase of the coolant (see description below) and to keeping such solid phase away from the fluid space at least to a great extent. However, as set out below, the separation preferably also relates to a thermal separation, that is an at least partial thermal insulation.

[0019] For the purpose of the present application, the solid state of matter also includes a viscous state of a coolant in which the viscosity of the coolant is so high that the coolant, in such viscous state, cannot flow into the fluid space separated by at least one separating element. For the purpose of the present application, the liquid state of matter of a coolant also includes a liquid state of a coolant in which the viscosity of the coolant is so low that the coolant, in such liquid state, can flow into the fluid space separated by at least one separating element. Examples for such coolants may be for example paraffin or wax-like substances.

[0020] The storing space is arranged to take up a supply of coolant in the solid state of matter. For example, this may be one or several solid blocks of the coolant, which are able to adopt nearly any geometrical form. As set out below, the storing space may additionally have at least one storing element for receiving the supply of coolant, which is, however, not mandatory.

[0021] The separating element is arranged to keep the supply of coolant in the solid state of matter substantially away from the fluid space. In this context, "substantially" is intended to mean that the fluid space should preferably contain not more than 5%, preferably not more than 1% of the coolant in frozen state. As set out below in more detail with the help of examples, the keeping away of the solid state from the fluid space may take place through a simple mechanical retention which keeps voluminous fractions of the coolant in solid state away from the fluid space, for example by means of appropriately small sized fluid channels. However, coolant in liquid state of matter is to be enabled to pass over from the storing space to the fluid space.

[0022] By the concept according to the invention of at least partial spatial separation of the coolant in solid state and in liquid state, wherein preferably only the liquid coolant can get in closer thermal contact with the goods to be cooled, the above-described disadvantages of known cooling concepts are avoided in a skilful way. The supply of solid coolant may be sub-cooled at almost any temperature without any risk that the goods to be cooled may be damaged. Even so it is guaranteed that only such coolant which has changed to the liquid state of matter gets in closer thermal contact with the goods to be cooled, so that such coolant always has a known minimum temperature. Thus, in contrast to known "buffer concepts", the described structure enables long cooling durations with a high sub-cooling stability at the same time. Furthermore, the cooling element may be structured comparably simply, for example in contrast to the more complex multi-chamber systems of JP 101 11 057 or WO 00/12409. The handling of the cooling element, which may be developed as a single cooling element, is extremely simple as it may be sub-cooled as a whole in contrast to the separate pre-treatments of the multiple-unit structures described in WO 00/12409 and EP 1 477 751 A1.

[0023] The cooling element according to the invention may be advantageously further developed in different ways. These optional further developments may be realized individually or in combination.

[0024] Thus, the cooling element may have in the storing space, as described above, at least one storing element which is arranged to take up in whole or in part and to immobilize at least in part the supply of coolant. This way, a spatial concentration of the supply of coolant, in particular in the solid state of matter, may be facilitated for example in contrast to a solidification in the scope of individual solid particles not connected with each other, which may be retained with far more difficulty by the separating element.

[0025] Such immobilization, that is the reduction of spatial mobility by enlargement of a coherent, spatially concentrated mass, in particular of solid coolant, may take place in different ways. Thus, the storing element may for example take up the supply of coolant mechanically, by adsorption and/or by absorption. In particular, the storing element may have at least one spongy element, that is, an element with a plurality of pores for taking up the supply of coolant. The spongy element may have a material which is suitable for taking up the coolant, for example, by reason of its surface properties. Generally, the storing element may comprise, alternatively or additionally, a foam substrate, a plastic foam, in particular a melamine resin foam, a super-absorber, a swelling agent or similar materials. Alternatively or additionally, the storing element may also comprise other additives, for example wetting agents for better filling of the storing element with the coolant. Alternatively or additionally, the storing element may also comprise at least one immobilization medium which is arranged to thicken the coolant and to reduce this way the mobility of the coolant. For example, gelatine, agar-agar, pectin, polyvinyl alcohol or any similar medium may be used as immobilization medium.

[0026] The supply of coolant may be taken up in whole or in part in the storing element. The storing element may then be arranged to merely take up the solid supply of coolant, while the coolant in the liquid state of matter is to be enabled to circulate towards the fluid space. For this purpose, the storing element may for example have different retention properties for the coolant in the solid and liquid state of matter, so that, for example, a coolant which has changed to the liquid state of matter detaches easier from the storing element. For this purpose, for example surface properties of the storing element may be specifically adjusted. Alternatively or additionally, also volume changes during phase transition may be used. Thus, the supply of coolant may for example be sized in such way that it fully saturates the storing element in liquid state. During freezing, that is, during phase transition to the solid state of matter, for example a volume increase may then take place as it is the case for different coolants such as water. The "excess" volume may then for example be accumulated at the outside of the storing element and may easier change to the liquid state and circulate.

[0027] Further advantageous embodiments of the invention relate to the embodiment of the at least one separating element and to the embodiment of the enabling of an overflow of the liquid coolant into the fluid space. Thus, for example, the at least one storing space and the at least one fluid space may be connected by at least one fluid channel. Such at least one fluid channel may be embodied in different ways and should be dimensioned in such way that it prevents at least bigger pieces of the coolant in frozen state, i.e. in the solid state of matter, from passing over into the fluid space. For example, the fluid channel may be embodied in whole or in part in such at least one separating element. Thus, the fluid channel may for example penetrate the separating element in the form of at least one bore and/or at least one opening. Also a plurality of bores and/or openings is conceivable, for example in the form of a sieve. Also a porous separating element is conceivable, wherein, in this case, the pores should be embodied in such way that they enable a passing of the liquid coolant.

[0028] Alternatively or additionally, the at least one fluid channel may also be formed, for example, by a combination of the separating element and the covering and/or an additional component. For example, the fluid channel may be formed between the separating element and the covering. In order to keep the fluid channel open and/or to keep the fluid channel at certain dimensions, for example separating strips which are embodied between the separating element and the covering may be provided for this purpose. Such separating strips may for example be in whole or in part a component of the separating element and/or may be a component of the covering and/or may be at least in part be developed as an independent component. For example, the covering may be oversized, so that a flowing round the separating element by the liquid coolant is enabled. The use of separating strips suggests itself in particular in rigid coverings, but is also possible in flexible coverings. In this case, the separating strips act for example as spacers on the internal side of the covering. By these proposed possible embodiments of the fluid channels and/or the covering or the separating element, a particularly effective separation between the liquid and solid phase of the coolant may be realized, with a comparably simple and cost effective structure at the same time.

[0029] Further advantageous embodiments relate to the separating element. As described above, the separating element may in particular, alone or in interaction with the covering, form the at least one fluid channel. Furthermore, the separating element may for example comprise at least one leaf-shaped, plate-shaped or disc-shaped separating element, that is generally an element the lateral dimensions of which exceed its thickness by several times. In this case, at least one fluid channel embodied as a fluid gap for exchanging the fluid coolant between the storing space and the fluid space should be formed between the separating element and the covering. So, the coolant in liquid state may get into the fluid space by flowing round the leaf-, plate- or disc-shaped separating element. Instead of using a single leaf-, plate- or disc-shaped separating element, that is, an element the lateral dimensions of which exceed its thickness by several times, the use of a plurality of such elements is also conceivable. Thus, for example the separating element may comprise a plurality of stacked leaf-, plate- or disc-shaped separating elements. This plurality of such separating elements may for example require a multiple flowing round until the liquid coolant gets into the fluid space. This way or another way, a labyrinth structure or a labyrinth-like structure may be created and used as a separating element or as a component of the separating element. Moreover, a good thermal insulation between the coolant in the solid state of matter and the fluid space or the goods to be cooled may be achieved this way. A further advantage of the use of a plurality of individual separating elements is that, by varying the number and/or the thermal properties of the individual separating elements, the thermal properties, including in particular the thermally insulating properties such as thermal conductivity or thermal resistance, of the entire separating element structure may be adapted to different requirements in a simple way, for example by varying the number of the layers of individual separating elements.

[0030] The separating element may in particular be embodied as mechanically flexible. In particular, the separating element may comprise a nonwoven fabric, that is, a fabric which is neither woven nor knitted, in particular a plastic nonwoven fabric. In particular, the plastic nonwoven fabric may be a plastic nonwoven fabric made of extruded material with short-chain and long-chain portions and an amorphous structure. Nonwovens, in particular porous nonwovens, have proved to be well thermally insulating and may be optimally adapted to the required properties (for example a low wetting and/or uptake of the coolant) at the same time. In particular, the cooling element may comprise one or several layers of a flexible insulating layer, for example a flexible nonwoven. Furthermore, alternatively or additionally, extruded thermally insulating plastics, in particular polyethylenes, polystyrenes, polypropylenes, polyamides or other plastics or mixed plastics, may be used. Such extruded plastics, for example again plastic nonwovens, have particularly favourable properties as they are thermally insulating on the one hand and have a low proportion of air inclusions, which might reduce the above-described basic effect of the invention, on the other hand. Alternatively or additionally, the at least one separating element may also comprise one or several insulating elements, for example one or several evacuated supporting plates or insulating elements with gaseous insulation media. By adapting the materials and/or the embodiments of the separating element, for example the insulation capacity of the separating element, that is the thermal insulation of the storing space against the fluid space and/or against the cooling medium, may be influenced to a large extent. When using insulating nonwovens, this may for example take place in a simple way by choosing the number of layers of the nonwoven fabric.

[0031] As set forth above, the separating element my have in particular thermally insulating properties to reduce or limit a direct heat transfer from the coolant in the solid state of matter in the storing space towards the goods to be cooled. Accordingly, it is particularly preferred if the separating element has a thermal conductivity from 0.01 W/(m*K) to 0.5 W/(m*K), particularly preferably in the range of 0.035 W/(m*K). For example, the separating element may contain for this purpose one or several appropriate insulating materials which produce the above-mentioned thermal conductivities alone or in combination. Alternatively or additionally, it is preferred if the separating element has a thermal resistance of at least 0.05 m^2K/W. Also for this purpose, one or several appropriate insulating materials and/or insulating media (such as gas-filled and/or evacuated plates), which produce the above-mentioned properties alone or in their combination, may be provided.

[0032] A further preferred embodiment of the invention is in that the separating element should take up a smallest possible proportion of the coolant in liquid and/or solid state. Such further development has the advantage that, when sub-cooling, the separating element takes up no or only an extremely small proportion of the coolant in solid state, which might then get into closer thermal contact with the goods to be cooled. Thus, many cooling elements are for example kept at room temperature to be then only sub-cooled prior to use. If the separating element had a great absorbing capacity for the liquid coolant, it would for example be already impregnated with the coolant prior to sub-cooling, which would then freeze within such separating element. In order to avoid this, it is particularly preferred if the separating element is embodied in such way that it is able to take up a maximum coolant proportion of 1%, preferably even less, for example a maximum of 0.2%.

[0033] Thus, the coolant may for example be a polar coolant or have at least one polar coolant component, the separating element having in this case preferably at least in sections hydrophobic properties. Thus, for example water may be used as a coolant, for example in combination with a hydrophobic nonwoven as separating element, so that a low uptake of the coolant in the nonwoven is ensured. However, in some cases it would also be obvious to use a non-polar coolant or at least a non-polar coolant component. In this case, it is preferred if the separating element has at least in sections hydrophilic properties.

[0034] The coolant may be embodied in different ways and may in particular, as described below, be adapted to the goods to be cooled. Generally, the coolant is to be a material with a suitable melting point and/or melting range, which is preferably arranged to take up latent heat during melting. Individual coolants or coolant mixtures may be used. In particular, the melting point and/or the melting range may be adapted to a large extent to optimum temperatures of the goods to be cooled. The coolant may have in particular water or alcohol as a polar component. Alternatively or additionally, the coolant may also comprise non-polar components, for example oils, fats, paraffins or similar non-polar liquids. While polar liquids are in particular used in a range up to 0° C., non-polar liquids may be used for example as coolants in the range of positive temperatures, in particular in the range of positive temperatures below room temperature.

[0035] Furthermore, the properties of the coolant may be influenced by one or several additives. In particular, through appropriate choice and/or concentration of such additives, the melting point or the melting range may again be adjusted, as well as other properties such as viscosity, polarity, wetting capacity or the like. Thus, in particular at least one salt and/or at least one sugar may be used as an additive. For example, sole-containing watery solutions, that is, salt-water solutions, for example saline solutions, may be used.

[0036] Further possible advantageous embodiments relate to the fluid space. In this context, a "space" is generally to be understood as at least one lumen which is able to take up liquid coolant. Also several connected or separated lumens are possible.

[0037] The fluid space, which adjoins the at least one heat transfer wall directly or by interposing additional thermally insulating elements, may be embodied in different ways. In particular, the fluid space may be arranged in whole or in part between the separating element and the heat transfer wall. Here, usually a fluid space of an extremely low thickness is sufficient, for example a merely small gap between the separating element and the heat transfer wall. In addition, the use of narrow dimensions for the fluid space and/or the fluid channel offers the advantage that capillary forces may be used to move liquid coolant from the storing space into the fluid space.

[0038] As an alternative or in addition to an embodiment of the fluid space between the separating element and the heat transfer wall, the fluid space may also be included in whole or in part in the separating element. In particular, the separating element may have for this purpose, for example in an area pointing to the heat transfer wall, a porous volume and/or grooves, hollows, bores or the like. Also other embodiments are possible.

[0039] A further embodiment relates to the covering. As described above, such covering may for example be embodied as a rigid or flexible covering and may for example comprise a foil covering. The covering may also be embodied as a multilayer covering. The covering may in particular comprise at least one insulating element which prevents and/or slows down at least in part a heat transfer via at least one wall of the covering. For such insulating elements, which may also be embodied as multilayer elements, for example thermally insulating plastic materials and/or natural materials, which are known to prevent a heat transfer, may be used. For example, foams, other kinds of porous materials or nonwoven fabrics may again be used for this purpose. Also woven materials or knitted materials may be used. It is particularly preferred if such insulating elements are arranged in an area of the covering which is different from the heat transfer wall. For example, the storing space may this way be thermally insulated and/or shielded against the environment, for example on the sides which are not pointing to the separating element or the fluid space. This way, it is ensured that a heat input into the coolant contained in the storing space may preferably exclusively or mainly take place via the liquid coolant from the fluid space. However, as also set out above, also the heat transfer wall may comprise to a lower extent such thermal insulation or an insulating element, so that also the heat transfer through such heat transfer wall is at least slowed down. This way, for example a coolant with a melting point or a melting range at the lower edge of the tolerance range of the goods to be cooled or even below such tolerance range may be chosen without any risk that the goods to be cooled may be damaged by sub-cooling. This way, the principle according to the invention may be combined with the traditional principles of the thermal buffer. Accordingly, besides purely passive insulating materials, such thermal buffer or the insulating element may by nature also comprise more complex insulating media such as liquids as described in WO 00/12409 and/or EP 1 477 751 A1. The at least one insulating element may in particular be directly adjacent to the covering at least in partial areas, so that no further fluid space is formed between the insulating element and the covering, in particular not in those areas of the covering which are not directly facing the goods to be cooled.

[0040] As described above, it is particularly preferred if the covering has a foil or is embodied as a foil covering. In this case, in particular mixed plastics have proved to be advantageous, in particular mixed plastics with at least one proportion of polyethylene and at least one proportion of polyamide (PE/PA plastics). Such mixed plastics have a particularly low passing capacity for usual coolants, in particular for watery coolants. This way, a sticking together of the cooling elements, for example by freezing "condensate water", can also be avoided when stacking the cooling elements during subcooling. The thickness of the foil or the covering may for example be in the range of several 10 to several 100 micrometers, for example at 50 micrometers.

[0041] Furthermore, the covering may have at least on mark for marking the heat transfer wall. Such marks may for example comprise imprints which facilitate a positioning or orientation of the cooling elements, so that it may be ensured that it is always the heat transfer wall and not the other walls which are pointing to the goods to be cooled. Alternatively or additionally, the covering may also have an asymmetric external form (for example the form of noses, beads, ridges, grooves or the like), which makes a reversed insertion of the cooling element in a refrigerated container at least visible and/or even prevents it at least in part. Such asymmetric form may for example be realized through an asymmetrically running welding seam in welded foil bags or pockets.

[0042] The covering may comprise in particular at least one deepened bottom part, in particular a foil pocket. Such foil pocket may for example be manufactured by a foil deep-drawing process. Furthermore, the covering may comprise at least a lid part welded to the bottom part. However, instead of welding, also other kinds of joining techniques of a positive, cohesive or non-positive kind are possible. The heat transfer wall may be embodied in particular either in the lid part and/or in a bottom surface of the bottom part opposite the lid part. In particular, it is preferred if the surface which forms the heat transfer wall in whole or in part is embodied as a surface which is as plane as possible. Also a more complex design is possible, for example with a internal storing space an with one or several fluid spaces arranged on the outside.

[0043] Besides the cooling element in one or several of the above-described embodiments, furthermore a refrigerated container for cooling goods to be cooled is proposed. The refrigerated container may in particular be closed in whole or in part and may for example be embodied for taking up one or several of the above-described goods to be cooled. In particular, the refrigerated container may be embodied as a transportable refrigerated container, in particular as a transport box. For this purpose, the refrigerated container may comprise for example wheels and/or handles and/or other kinds of transport devices which facilitate a transport of the refrigerated container.

[0044] The refrigerated container comprises at least one thermally insulating external container. Such external container may for example be embodied as a single-layer or multilayer container and may comprise in particular one or several thermally insulating materials. For example, this may be again porous plastics, foams or similar insulating materials. Also a multilayer structure is possible. Furthermore, the refrigerated container comprises at least one cooling element according to one or several of the above-described embodiments. Therein, the cooling element is arranged in the external container in such way that the heat transfer wall is pointing to the goods to be cooled.

[0045] In order to ensure such orientation or arrangement of the at least one cooling element (wherein preferably several cooling elements are taken up in the refrigerated container), the external container may have at least one seat for spatial fixing of the cooling elements. Such seat may comprise for example one or several inserts in which the at least one cooling element may be inserted. However, alternatively or additionally, also other kinds of fixing devices, for example bolts, flaps or other positive or non-positive types of joining are possible. Therein, the fixing is to be made in such way that, when a cooling element is taken up in the seat, the heat transfer wall of the cooling element is pointing to the goods to be cooled.

[0046] Furthermore, the refrigerated container and/or the seat may be embodied in particular in such way that all external surfaces of the covering of the cooling element, with the exception of the heat transfer wall, are separated from the goods to be cooled. For this purpose, for example at least one cover, which covers the lateral walls of the cooling elements, may be provided, so that merely a front side of the cooling element containing the heat transfer wall is pointing to the goods to be cooled. However, alternatively or additionally, a seat is also possible in such way that several cooling elements mutually shield their edges against the goods to be cooled, so that exclusively the heat transfer walls are in (direct or indirect) thermal contact with the goods to be cooled.

[0047] Furthermore, the refrigerated container may have at least one internal container arranged between the cooling element and the goods to be cooled. Such internal container may for example have certain mechanical properties, which cause for example a mechanical separation of the goods to be cooled from the cooling element, so that for example the goods to be cooled will not damage the cooling elements. Also a transport or an insertion of the goods to be cooled in the refrigerated container by means of the internal container is possible. Alternatively or additionally, the internal container may also have thermally insulating properties to create an additional "passive" buffer layer between the at least one cooling element and the goods to be cooled (wherein also several buffer layers may be provided by nature).

[0048] Besides the cooling element and the refrigerated container, furthermore a method for cooling goods to be cooled using at least one cooling element is proposed. Therein, a cooling element in accordance with one or several of the above-described embodiments is used, so that reference may be made to the above description for details of the cooling element.

[0049] The cooling element is chosen in such way that it has at least one coolant with a melting point and/or a melting range below a target temperature for cooling the goods to be cooled. However, such melting point and/or melting range is to be within a preset tolerance range below the target temperature, wherein also a range above a minimum temperature is to be comprised by the term "tolerance range". On the one hand, such tolerance range may be preset by the goods to be cooled themselves, for example by such tolerance range describing the range within which damage to the goods to be cooled by sub-cooling may not yet occur. For example, the tolerance range may comprise 1-15 Kelvin, particularly preferably approx. 1-5 Kelvin. If a further insulation is used additionally, for example one or several insulating layers and/or insulating elements between the cooling element and the goods to be cooled, however, the tolerance range may be further extended in a downward direction. Thus, the cooling element may have a temperature below the tolerance range, which may however be thermally separated by one or several additional insulating elements, which may for example be integrated in the cooling element and/or be arranged separately from the cooling element between the cooling element and the goods to be cooled. This way, it may be ensured that no damage is caused to the goods to be cooled.

[0050] In the method proposed according to the invention, the cooling element is first sub-cooled to a sub-cooling temperature below the target temperature and in particular below the tolerance range. Therein, the supply of coolant introduced into the storing space is brought to the solid state of matter and cooled to the sub-cooling temperature. Subsequently, the cooling element with its heat transfer wall is brought directly or indirectly into thermal contact with the goods to be cooled. Therein, "directly or indirectly" may mean that the heat transfer wall is directly in connection with the goods to be cooled and/or that one or several intermediate layers are introduced between the heat transfer wall and the goods to be cooled, for example vascular walls, packages, air or gas layers, thermally insulating layers or the like.

[0051] Thus, the pre-frozen cooling element contains the coolant in the storing space at first at a sub-cooling temperature, which is preferably far below the phase transition temperature. As the coolant is not yet able to enter the fluid space, the frozen coolant is still separated from the goods to be cooled at least by the separating element, the fluid space and the heat transfer wall. Thus, only an extremely low heat transfer takes places. This is particularly favoured if the at least one separating element has additionally thermally insulating properties such as by using the above-described non-woven fabrics with thermally insulating properties. Thus, a direct thermal contact between the solid, sub-cooled phase of the coolant with the side of the covering facing the merchandise is avoided, so that no damaging low temperatures are present on this side when inserting the cooling element.

[0052] In the course of time, the solid phase of the coolant is melting from the outside through heat input, so that also liquid coolant is present at the same time as the solid phase. Such liquid coolant, which has temperatures at or just above the melting temperature or the phase transition temperature, may now flow into the fluid space pointing to the goods to be cooled between the separating element and the covering or the heat transfer wall and attemperates such fluid space or the heat transfer wall accordingly. This way, a targeted and defined attemperation of the goods to be cooled at or just above the phase transition temperature may take place over a longer period of time, until the solid phase of the coolant is completely molten in the storing space.

[0053] It is particularly preferred, according to the coolant used, if the melting range is comprised in a range between −18° C. and 0° C. The sub-cooling temperature is preferably below such melting point or melting range, for example in a range between −18° C. and −20° C.

[0054] Besides the described method for cooling goods to be cooled using at least one cooling element, furthermore a method for manufacturing a cooling element is proposed. In particular, the cooling element may be a cooling element in accordance with one or several of the above-described embodiments, so that reference may be made to the above description for possible details and possible embodiments of such cooling element.

[0055] The proposed manufacturing method comprises the following process steps. However, the process steps are not necessarily required to be performed in the described order. Furthermore, one or several of the process steps may also be performed simultaneously or repeatedly.

[0056] In the proposed manufacturing method, at least one bottom part of a covering of the cooling element is manufactured. In particular, as set out above, this bottom part may be a foil pocket that is for example a pot-shaped or bowl-shaped pocket with one or several hollows. For such manufacturing, for example a foil deep-drawing process may be used.

[0057] Furthermore, at least one supply of coolant is introduced into the bottom part. Therein, the coolant may basically be introduced into the bottom part alone. However, alternatively, as described above, also a storing element may be introduced into the bottom part, which is filled with the coolant in whole or in part before or after introducing it. The storing element may be arranged to take up the supply of coolant in whole or in part and to immobilize it at least in part. Therein, the supply of coolant is preferably measured in such way that it may be substantially taken up completely in the storing element when in liquid state. Therein, "essentially completely" may also mean a slight excess or deficit, for example an excess or deficit of not more than 5%. Regarding possible embodiments of the storing element, reference may be made to the above description. Alternatively or additionally, also another kind of immobilization may be used. Thus, for example also another immobilization medium may be used, which is arranged to thicken the coolant and to decrease the mobility of the coolant this way. For example, gelatine, agar-agar, pectin or similar media may be used as immobilization media. Furthermore, for example by polycondensation reactions, for example of polyvinyl alcohols with acids, for example boric acid, matrixes may be formed, which serve as immobilization media.

[0058] Furthermore, at least one separating element, which element is embodied to divide an inner space of the covering into a storing space taking up the supply of coolant and a fluid space, is introduced into the bottom part, wherein the separating element is arranged to keep the supply of coolant in solid state substantially away from the fluid space and to enable the coolant in liquid state to pass over from the storing space into the fluid space. Regarding possible embodiments of the separating element, reference may again be made to the above description.

[0059] In a further process step, a lid part is finally put on the bottom part and joined to the bottom part. For example, the lid part may again comprise a foil lid or be a foil lid. Basically, suitable positive and/or non-positive and/or cohesive joining techniques can be considered as joining techniques to the bottom part. Particularly preferred is a welding of the lid part to the bottom part, for example along a welding seam.

[0060] The at least one heat transfer wall may either be formed in the lid part or in the bottom part. Accordingly, the order of introducing the supply of coolant and/or the optional storing element and the separating element may change with respect to the above-described order. For example, if a heat transfer wall is provided in the bottom part, the separating element may for example be introduced at first and the storing element and/or the supply of coolant subsequently. However, if the heat transfer wall is provided in the lid part, preferably the above-stated order may be used.

[0061] As described above, a wide range of coolants my be used, which may be adapted to the goods to be cooled in particular with respect to the melting point or the melting range. It is particularly preferred, as also set out above, if a coolant which has a lower density in the solid state of matter than in the liquid state of matter is used. The change of volume then caused by the change of the state of matter, that is, by the phase transition, may drive or favour the circulation of the liquid coolant through the fluid space.

BRIEF DESCRIPTION OF THE DRAWINGS

[0062] Further details and features of the invention result form the following description of preferred exemplary embodiments in connection with the sub-claims. Herein, each individual feature may be realized alone, or several features may be realized in combination with each other. The invention is not limited to the exemplary embodiments. The exemplary embodiments are schematically illustrated in the figures. Therein, the same reference numerals in the individual figure designate the same elements or elements with the same function or elements which correspond to each other regarding their functions.

[0063] FIG. **1**A shows a first exemplary embodiment of a cooling element according to the invention in sub-cooled state;

[0064] FIG. **1**B shows the cooling element in accordance with FIG. **1**A in a partly melted state;

[0065] FIG. **2** shows an cooling element alternative to FIG. **1**A;

[0066] FIG. **3** shows a first exemplary embodiment of a refrigerated container according to the invention;

[0067] FIG. **4**A shows a third exemplary embodiment of a cooling element according to the invention;

[0068] FIG. **4**B shows an exemplary embodiment analogous to FIG. **4**A of a cooling element according to the invention with a reversed structure;

[0069] FIG. **5** shows an illustration of a part of a refrigerated container with a seat for a cooling element according to the invention; and

[0070] FIG. **6** a temperature profile at different points of a refrigerated container equipped with a cooling element according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0071] In FIGS. **1** and **2**, a first exemplary embodiment of a cooling element **110** according to the invention is shown in a very schematic sectional view from the side. The cooling element **110** comprises a covering **112**, which is merely outlined in the Figures. For example, this may be a foil covering.

[0072] In the inside of the covering **112**, a separating element **114** is introduced. Such separating element **114** may for example comprise one or several layers of a hydrophobic plastic nonwoven, for example a nonwoven made of polystyrene, similar to nonwovens which are for example used in footfall sound insulations for floors. The separating element **114** is to have thermal insulation properties.

[0073] Therein, in comparison with the covering **112**, the separating element **114** is undersized in such way that a fluid channel **116** in the form of a gap is formed at the lateral edges of the separating element **114** between the separating element **114** and the covering **112**. Here and in other embodiments, the separating element **114** is preferably not firmly connected with the covering **112**, but formed as a "swimming" separating element **114** inside such covering **112**, which also facilitates in particular the manufacturing of the cooling element **110**.

[0074] The separating element **114** divides the inside of the covering **112** of the cooling element **110** into a storing space **118** and a fluid space **120**, which is sized significantly smaller compared to the storing space **118**. Therein, the fluid space **120** is merely formed as a thin gap between the separating element **114** and a heat transfer wall **122** of the covering **112**. In the exemplary embodiment shown in FIGS. **1**A and **1**B, the heat transfer wall **122** is the lower wall of the covering **112**. However, also other embodiments are possible, as described in more detail below.

[0075] Furthermore, a coolant **124**, **126** is introduced into the storing space **118**. Therein, FIG. **1**A shows a state in which the coolant is completely in the solid state of matter, which is referred to in the figures by reference numeral **124**. Such state in FIG. **1**A may for example be a sub-cooled state in which the cooling element **110** is sub-cooled to a temperature far below a phase transition temperature (melting temperature) of the coolant **124**, **126**. Therein, the coolant **124**, **126** in such sub-cooled state is preferably completely taken up in the storing space **118**. However, the fluid space **122** is preferably completely free of the coolant **124**, **126**.

[0076] The cooling element **110** shown in FIG. **1**A is brought into direct or indirect thermal contact with goods to be cooled, which are not illustrated in the figures, so that a heat exchange, which is referred to in the figures symbolically by reference numeral **128**, is possible via the heat transfer wall **122**. Preferably, the remaining lateral walls, which are referred to in the figures by **130**, are additionally thermally insulated, so that the heat exchange takes place almost completely via the heat transfer wall **122**.

[0077] By the heat input vial the heat exchange **128** into the cooling element **110**, the coolant **124**, **126** begins to melt, which generally takes place from the edge. The block of solid coolant **124** is melting, and liquid coolant **126** develops at first in the storing space **118**. For example, such liquid coolant may be a watery coolant and/or an alcoholic coolant, adding additives such as salts to adjust a melting point, if required. In such case, that is when using a polar coolant **126**, when using a hydrophobic separating element **114** at the same time, the separating element **114** virtually takes up no coolant **126**. Therefore, the liquid coolant **126** flows round the separating element **114** through the fluid channel **116**. In FIG. **1**B, such flowing round is symbolically marked with reference numeral **132**. Therein, the liquid coolant **126** enters into the fluid space **120** and may get into thermal contact with the goods to be cooled via the heat transfer wall **122**, so that a heat exchange **128** may take place.

[0078] By the illustrated phase transition of the coolant **124**, **126**, the nature of heat exchange **128** changes. While, in the sub-cooled state illustrated in FIG. **1**A, the goods to be cooled were thermally shielded against the sub-cooled solid coolant **124** by the thermally insulating separating element **114**, and a heat exchange could merely occur in a "passively buffered" way by the separating element **114**, in the partly frozen on state illustrated in FIG. **1**B, a buffering may occur by the liquid coolant **126**. Therein, heat is at first transferred from the goods to be cooled to the liquid coolant **126**, and from it then to the solid coolant **124** in the storing space **118**. This way, an optimum cooling is always ensured, with a protection from sub-cooling and thus a protection from damage at the same time, for example in the form of freezer burn. In FIG. **2**, a cooling element **110** comparable to the exemplary embodiment in FIGS. **1**A and **1**B, but slightly modified, is shown in a sectional view from the side. Therein, merely the sub-cooled state, analogous to FIG. **1**A, is illustrated for simplification purposes.

[0079] The exemplary embodiment of the cooling element **110** in accordance with FIG. **2** differs from the exemplary embodiment in accordance with FIG. **1**A by the fact that, as already mentioned above with respect to FIGS. **1**A and **1**B, the remaining walls **130** of the covering **112**, that is the walls that are different form the heat transfer wall **122**, are additionally thermally shielded by the insulating element **134**. Such insulating elements **134**, which preferably tightly fit to the covering **112** and/or are a component of such covering **112**, so that no additional fluid space **120** may be formed between such insulating elements **134** and the covering **112**, prevent or decrease a heat exchange through such remaining walls **130**. Thus, the heat exchange **128** with the environment or with the goods to be cooled occurs almost exclusively via the heat transfer wall **122**.

[0080] In FIG. **3**, a highly simplified exemplary embodiment of a refrigerated container **136** is shown in a sectional view from the top. In such exemplary embodiment, the refrigerated container **136** comprises a thermally insulated external container **138**, which thermally shields a heat input form the outside. For example, such external container **138** may comprise a foam and/or a polystyrene.

[0081] In the exemplary embodiment shown in FIG. **3**, four cooling elements **110** are arranged in the inside of the external container **138**. Therein, the cooling elements **110** in accordance with the exemplary embodiment shown in FIG. **2** are used by way of example in FIG. **3** for simplification purposes. However, also other embodiments of cooling elements **110** according to the invention are possible.

[0082] Therein, the orientation of the cooling elements **110** inside the refrigerated containers **136** is made in such way that the heat transfer walls **122** of the cooling elements **110** always point to the inside of the refrigerated containers **136**, that is to the goods to be cooled **140** taken up in the inside of the refrigerated container **136** and merely outlined in FIG. **3**. The remaining walls **130** of the cooling elements **110** preferably point completely either to the external container **138** or to an adjacent cooling element **110**, that is they are shielded against the goods to be cooled **140** or the inner space of the refrigerated container **136**.

[0083] In FIGS. **4**A and **4**B, further exemplary embodiments of cooling elements **110** are shown schematically in a sectional view from the side. The structure of such cooling elements **110** correspond largely to the structure of the cooling element **110** in FIG. **1**A, **1**B or **2**, and they have a covering **112**. In contrast to the preceding exemplary embodiments, such covering **112** is embodied as a two-part covering and has a hollowed bottom part **142** and a lid part **144**. Both parts **142**, **144** may for example be made of a PA/PE foil, for example with a foil thickness of 100 to 500 μm. Analogous to FIG. **2**, the covering **112** may additionally comprise one or several insulating elements **134**, which are not illustrated in FIGS. **4**A and **4**B. The bottom part **142** may for example be formed as a deep-drawn foil pocket. The lid part **144** and the bottom part **142** may for example be joined together along a welding seam **146**, for example a surrounding welding seam.

[0084] As a further contrast to the preceding exemplary embodiments, the cooling element **110** in the exemplary embodiment shown in FIGS. **4**A and **4**B, comprises a storing element **148**, which may for example take up the coolant **124** almost completely in the sub-cooled state illustrated in FIGS. **4**A and **4**B. Such storing element **148** may for example be embodied as a spongy element, that is, as a porous element with a high take-up capacity for the liquid or solid coolant **124**, **126**. For example, a foamed melamine resin may be used for this purpose. Therein, the storing element **148** preferably fills the storing space **118** substantially completely. For example, the storing element **148** may be introduced into the storing space **118** as a rectangular block or as a block with an circular cross-section.

[0085] As in the preceding exemplary embodiments, the separating element **114** adjoins the storing space **118**. Regarding the possible embodiments of such separating element **114**, reference may be made to the above description. Again, a fluid channel **116** may be formed between the separating element **114**, which may for example be embodied as a single- or multilayer hydrophobic nonwoven fabric, and the covering **112**. However, alternatively or additionally, the fluid channel **116** may also be embodied in another way, for example in the form of bores penetrating the separating element **114**, through pores, a sieve, spacers or the like.

[0086] In the exemplary embodiment in accordance with FIG. **4**A, the separating element **114** is symbolically shown as a single-layer separating element **114**, for example as a single layer of a nonwoven. However, in FIG. **4**B, a preferred embodiment is shown, in which the separating element **114** comprises four individual layers of a nonwoven, for example polystyrene nonwovens with a thickness of approx. 1 to 3 mm each, for example 2 mm. However, the multilayer embodiment may also be used in the exemplary embodiment in FIG. **4**A or in other exemplary embodiments.

[0087] The exemplary embodiment in FIGS. **4**A and **4**B mainly differ in the orientation of the heat transfer wall **122**. While, in the exemplary embodiment in FIG. **4**A, the heat transfer wall is a part of the bottom part **142** and is arranged opposite the lid part **144**, in the exemplary embodiment in FIG. **4**B, the heat transfer wall **122** is the lid part **144** or a part of such lid part **144**. Such different embodiments only differ insignificantly in function. However, since the foil projections **150** are used in many cases as a positioning aid, as explained in more detail below with the help of FIG. **5**, such different embodiment may be of practical importance to facilitate a correct orientation of the heat transfer wall **122** towards the goods to be cooled **140**. Additionally, the covering **112** may be printed in whole or in part, for example to mark the heat transfer wall **122** additionally and to avoid an incorrect insertion of the cooling element **110** in a refrigerated container **136**.

[0088] In FIG. **4**B, different measures of the cooling element **110** or of the components of such cooling element are illustrated schematically. Such measures may vary largely according to the field of application. For example, cooling elements were manufactured, which have a width b between 170 mm and 210 mm, for example a rectangular surface area with an edge length of 210 mm×170 mm. The height h_1 of the storing element **148** may also vary largely and may for example be approx. 40 mm. Also the total height h_2 may vary and may for example be around 50 mm.

[0089] For the cooling element **110** illustrated in FIG. **4**B, for example four layers of a polystyrene nonwoven with a thickness of 2.2 mm have proved to be advantageous. However, also other thicknesses may be used, for example thicknesses of 3 mm or 5 mm. In particular polystyrene nonwovens of the “SELITAC” brand from SELIT Dämmtechnik GmbH, Erbes-Büdesheim, Germany, which are also used for the purpose of footfall sound insulation in floors, were used for test samples. Such nonwovens have a thermal conductivity between 0.026 W/mK (effectively measured, according to DIN 52612) and 0.35 W/mK (classification by thermal conduction groups according to DIN 4108). The thermal resistances for nonwovens with a thickness of 2.2 mm or 3 mm or 5 mm are about 0.063 or 0.086 or 0.143 m^2K/W respectively (calculated from thermal conduction group according to DIN 4108) or about 0.085 or 0.115 or 0.190 m^2K/W respectively, (effectively measured thermal resistance according to DIN 52612). When using four nonwovens as separating element **114** with a thickness of 2.2 mm each, this results for example in a thermal resistance of 0.34 m^2K/W for the entire separating element **114**. However, also other constellations are of course possible.

[0090] In FIG. **5**, a part of a second exemplary embodiment of a refrigerated container **136** according to the invention is illustrated in a sectional view from the top. The refrigerated container **136** has again an external container **138**, which is here merely illustrated in part. Inside the external container **138**, pointing to the goods to be cooled **140**, a seat **152** for spatial fixing of the cooling element **110** is provided in the exemplary embodiment shown in FIG. **5**. Naturally, also several such seats **152** may be provided according to the use of a plurality of cooling elements **110**, wherein preferably at least one, if required, also several cooling elements may be put in each of such seats **152**.

[0091] In the exemplary embodiment shown in FIG. **5**, the seat **152** is embodied as an insert and comprises noses **154**, which serve as guide rails. At the same time, such noses **154** serve a thermal shielding of the remaining walls **130** of the covering **112** of the cooling element **110**. The cooling element **110** is merely illustrated schematically in FIG. **5** and may for example correspond to the cooling element **110** in accordance with the exemplary embodiment in FIG. **4**A. Therein, the heat transfer wall **122** points to the inside of the refrigerated container **136**.

[0092] In order to avoid or impede a mix up or reversed insertion of the cooling element **110** in the seat **152**, the covering **112** has an imprint **156**. Such imprint **156** may for example be located on the heat transfer wall **122** and my for example comprise a “this side inside” note. Alternatively or additionally, appropriate imprints may also be located on other sides of the covering.

[0093] In the exemplary embodiment shown in FIG. **5**, the seat **152** also has recesses **158**. Such recesses **158** serve to take up the foil projections **150** in the area of the welding seam **146**. A reversed introduction of the cooling elements **110** into the seats **152** is preferably not possible or only with difficulty because of the foil projections **150** and the recesses missing in the area of the noses **154**. This way or another way, preferably an asymmetry of the cooling element **110** may be used to avoid or at least to impede a reversed introduction of the cooling elements **110** into the seats **152**.

[0094] In FIG. **6**, an exemplary profile of temperatures inside a refrigerated container **136** is illustrated in a highly schematised way. With the help of such temperature profiles, the effects of the cooling element **110** according to the invention are to be explained.

[0095] In FIG. 6, the time t in hours is plotted on the x-axis. The illustrated units are 12-hour units each, i.e. one graduation mark on the scale is equivalent to 12 hours. The temperature in ° C. is plotted on the y-axis.

[0096] Therein, goods to be cooled **140** are presumed, which have a typical limit **160**, which is shown as a broken line in FIG. **6**. This limit **160** should not or not permanently be exceeded (for example for not more than a preset total period of time) and thus represents for example a maximum temperature for storing. Such limit may for example be about 12° C., which is a usual value for typical drugs. However, generally, such limit **160** is largely dependent on the type of goods to be cooled **140**.

[0097] Curve **162** describes an outside temperature profile in a climatic chamber in which a refrigerated container **136** was introduced. The illustrated profile of the outside temperature **162** is subject to variations, which may for example be conditional on the time of the day. The illustrated temperature profile is for example a temperature profile which corresponds approximately to a summer profile.

[0098] Furthermore, three measured temperature curves **164**, **166** and **168** are illustrated. Therein, curve **164** shows the temperature profile on an uninsulated outside of the covering **112** on a wall **130** of the covering **112** different from the heat transfer wall. For example, this may be the point marked with A in FIG. **4**B. As set out above, in FIG. **4**B, the cooling element **110** is surrounded by a generally uninsulated covering **112**, however also an at least partly insulated embodiment being conceivable. However, in the present case be it presumed that the temperature profile **164** was recorded for an uninsulated covering **112**, so that such temperature profile **164** approximately reflects the temperature profile in the area of the storing element **148**.

[0099] However, curve **166** describes the temperature curve on the heat transfer wall **122**. For example, this may be a measurement at the point which is symbolically marked with B in FIG. **4**B. Curve **168** finally describes a temperature profile on a sample arranged in direct proximity of the cooling element **110**, for example of the goods to be cooled **140** in FIG. **5**. For example, this may be a measurement at the point of the goods to be cooled **140** marked with C in FIG. **5**.

[0100] At a moment which is symbolically marked with t* in FIG. **6**, a sub-cooled cooling element **110** is introduced into the refrigerated container **136**. For example, the cooling element **110** may be sub-cooled to a temperature of approx. −12° C. For samples or goods to be cooled **140** which may not fall below a certain tolerance threshold or a minimum temperature of 0° C. such cold shock might already lead to destruction. However, as shown by a comparison of curves **164** and **166** or **168**, such effect is mitigated by the embodiment according to the invention of the cooling element **140**. The temperature at point B merely decreases to just below 0° C. (curve **166**), while the temperature on the goods to be cooled **140** at point C (curve **168**) remains above 0° C. also directly after introducing the cooling elements **110**. Despite the heavy sub-cooling of the cooling element **110**, which ensures a sufficient thermal store inside the cooling element **110**, thus the initial temperature peak is buffered according to the invention. The amount of the differential temperatures ΔT_1 or ΔT_2 in FIG. **6** may for example be adjusted by a suitable choice of the separating element **114**, for example a nonwoven thickness and/or a nonwoven material. This way, the cooling element may be very exactly adapted to the tolerance threshold of the goods to be cooled **140**.

[0101] Such buffering of the initial sub-cooling, as shown in FIG. **6**, would basically also be possible with a purely passive thermal insulation such as the passive thermal insulations known from the background art. In such passive thermal insulations by introducing insulation materials between the actual cooling element and the goods to be cooled **140**, curve **168** would, however, be shifted and follow curve **164** with a nearly parallel shape and thus reach the temperature limit **160** already after a short period. Thus, the cooling element **160** would only be usable for a comparably short duration and would have to be sub-cooled anew subsequently. In particular, in case of longer transports or storing, this would be a significant disadvantage.

[0102] However, in the cooling element **110** according to the invention, the curves **166** or **168** do not follow curve **164** parallel, but approach such curve and show a flatter shape. This is due to the fact that, according to the invention, by an increasing heat input into the cooling element **110**, an increasing amount of liquid coolant **126** develops, which causes an improved heat transfer between the goods to be cooled **140** and the solid coolant **124** serving as actual thermal store in the fluid space **120**. Hereby, the distance between curves **164** and **166** or **168** decreases significantly.

[0103] Such curve shape shows that, on the one hand, a big thermal storage may be created in the cooling element **110** through significant sub-cooling without causing damage to the goods to be cooled **140**. On the other hand, the heat transfer between the cooling element **110** and the goods to be cooled **140** is embodied as temporally changeable, which causes a prolongation of the maximum useful life of the cooling element **110**.

LIST OF REFERENCE NUMERALS

[0104] **110** cooling element
[0105] **112** covering
[0106] **114** separating element
[0107] **116** fluid channel
[0108] **118** storing space
[0109] **120** fluid space
[0110] **122** heat transfer wall
[0111] **124** coolant, solid
[0112] **126** coolant, liquid
[0113] **128** heat exchange
[0114] **130** remaining walls
[0115] **132** flowing round
[0116] **134** insulating element
[0117] **136** refrigerated container
[0118] **138** external container
[0119] **140** goods to be cooled
[0120] **142** bottom part
[0121] **144** lid part
[0122] **146** welding seam
[0123] **148** storing element
[0124] **150** foil projection
[0125] **152** seat
[0126] **154** noses
[0127] **156** imprint
[0128] **158** recesses
[0129] **160** temperature limit (upper limit)
[0130] **162** external temperature
[0131] **164** temperature profile, uninsulated outside, A
[0132] **166** temperature profile, heat transfer wall, B
[0133] **168** temperature profile, goods to be cooled, C

What is claimed is:

1. A cooling element for cooling goods to be cooled, comprising:

a covering with at least one heat transfer wall for exchanging thermal energy with the goods to be cooled, wherein the cooling element comprises furthermore

at least one fluid space adjacent to the heat transfer wall and

at least one storing space separated from the fluid space by at least one separating element, wherein the storing space is arrange to take up a supply of coolant in a solid state of matter,

wherein the separating element is arranged to

e1) keep the supply of coolant in the solid state of matter substantially away from the fluid space and

e2) to enable the coolant in a liquid state of matter to pass over from the storing space to the fluid space.

2. The cooling element according to claim **1**, wherein the storing space has at least one storing element, wherein the storing element is arranged to take up in whole or in part and/or to immobilize at least in part the supply of coolant.

3. The cooling element according to claim **2**, wherein the storing element has at least one spongy element, wherein the spongy element comprises a plurality of pores for taking up the supply of coolant.

4. The cooling element according to claim **2**, wherein the storing element comprises at least one of the following materials: a plastic foam; a melamine resin foam; a superabsorbent polymer; and a foam substrate.

5. The cooling element according to claim **2**, wherein the storing element comprises at least one immobilization medium, wherein the immobilization medium is arranged to thicken the coolant, wherein the immobilization medium comprises at least one of the following media: gelatine; agar-agar; pectin; and condensed polyvinyl alcohols.

6. The cooling element according to claim **1**, wherein the storing space and the fluid space are connected by at least one fluid channel, wherein preferably the fluid channel comprises at least one of the following fluid channels: at least one fluid channel penetrating the separating element, in particular at least one bore and/or one pore channel; at least one fluid channel formed by a separating strip between the separating element and the covering.

7. The cooling element according to claim **1**, wherein the separating element comprises at least one leaf-shaped, one plate-shaped or one disc-shaped separating element, wherein at least one fluid channel embodied as a fluid gap for exchanging liquid coolant between the storing space and the fluid space is formed between the separating element and the covering.

8. The cooling element according to claim **1**, wherein the separating element comprises a plurality of stacked leaf-shaped, plate-shaped or disc-shaped separating elements.

9. The cooling element according to claim **1**, wherein the separating element comprises at least one of the following elements: a nonwoven; a plastic nonwoven; an extruded thermally insulating plastic; an extruded polyethylene; an extruded polystyrene; an extruded polypropylene; an extruded polyamide; and an evacuated support plate.

10. The cooling element according to claim **1**, wherein the separating element is mechanically flexible.

11. The cooling element according to claim **1**, wherein the separating element has thermally insulating properties, preferably at least one of the following properties:

a thermal conductivity from 0.01 W/(m*K) to 0.5 W/(m*K), or in the range of 0.035 W/(m*K); and

thermal resistance of at least 0.05 m^2K/W.

12. The cooling element according to claim **1**, wherein the separating element is embodied in such way that it is able to take up a maximum coolant proportion of 1% or of 0.2%.

13. The cooling element according to claim **1**, further comprising:

a coolant with a polar coolant component, wherein the separating element has at least in sections hydrophobic properties, or

a coolant with a non-polar coolant component, wherein the separating element has at least in sections hydrophilic properties.

14. The cooling element according to any claim **1**, wherein the fluid space is embodied in at least one of the following ways: the fluid space is arranged in whole or in part between the separating element and the heat transfer wall; the fluid space is contained in whole or in part in the separating element, or in a porous volume of the separating element.

15. The cooling element according to claim **1**, further comprising at least one of the following coolants: water; a briny watery mixture; an alcohol; an oil; a fat; a paraffin; and a liquid with at least one additive.

16. The cooling element according to claim **1**, wherein the cooling element has at least one insulating element, wherein the insulating element prevents at least in part a heat input via at least one wall of the covering, or at least one wall different from the heat transfer wall.

17. The cooling element according to claim **1**, wherein the covering has at least one mark for marking the heat transfer wall and/or the covering has an asymmetric external form, which makes a reversed insertion of the cooling element in a refrigerated container at least visible and/or prevents it at least in part.

18. A refrigerated container for cooling goods to be cooled, comprising: at least a thermally insulating external container and at least a cooling element according to claim **1**, wherein the cooling element is arranged in the external container in such way that the heat transfer wall points to the goods to be cooled, wherein preferably the external container has at least one seat for spatially fixing the cooling element, in such way that, when a cooling element is taken up in the seat, the heat transfer wall of the cooling element points to the goods to be cooled.

19. A method for cooling goods to be cooled using at least one cooling element according to claim **1** directed to a cooling element, wherein the cooling element is chosen in such a way that it has at least one coolant with a melting point and/or melting range below a target temperature for cooling the goods to be cooled, wherein the melting point and/or melting range is within a preset tolerance range below the target temperature, wherein the cooling element is sub-cooled to a sub-cooling temperature below the target temperature and in particular below the tolerance range, and wherein the cooling element with its heat transfer wall is subsequently brought directly or indirectly into thermal contact with the goods to be cooled.

20. A method for manufacturing a cooling element, comprising the following steps:

manufacturing at least one bottom part or a foil pocket, of a covering of the cooling element;

introducing at least one supply of coolant into the bottom part;

introducing at least one separating element into the bottom part, wherein the separating element is embodied to divide an inner space of the covering into a storing space taking up the supply of coolant and a fluid space, wherein the separating element is arranged to keep the coolant in the solid state of matter substantially away from the fluid space and to enable the coolant in the liquid state of matter to pass over from the storing space to the fluid space; and

at least one lid part is put on the bottom part and joined to the bottom part.

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