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(54) Cooling ceiling

Dachkühlung

Plafond réfrigérateur

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Description

TECHNICAL FIELD

[0001] The present invention relates to a system for heat regulation of spaces on board a ship. The invention particularly relates to a so-called cooling ceiling which supplies heat to or carries away heat from a cabin in, for example, a cruiser.

BACKGROUND ART

[0002] Water is many times more efficient than air when it comes to supplying/transferring heat energy. This is made use of, inter alia, in air-conditioning of cruisers for the purpose of reducing the space requirement for the air-conditioning equipment. In practice, the area of a tube which conducts water need only be made in a size which is about 1/300 as large as the corresponding area of an air duct and is still capable of transferring the same cooling or heating capacity due to the higher density and specific heat of the water. Water may equally be replaced by some other liquid cooling agent. In the following text, the term cooling water shall therefore be construed in a broad sense and comprise all liquid cooling agents.

[0003] In the ship-building industry and especially in cruisers, central air treatment of the cabins has to an increasing extent been abandoned in favour of semicentralized systems of the fan-coil type. Fan coils comprise a water/air heat exchanger (wax) and a small circulating fan. Such a unit is supplied with waterborne cooling (heating) effect and is preferably placed above the inner ceiling immediately underneath the deck positioned above, or in the toilet module of the cabin. Pretreated ventilating air is supplied to the cabin via the fan-coil unit or directly to the cabin from a centrally located air-treatment unit. Cold water from a cooling machine is supplied to the fan-coil unit from a system of tubes. The circulating fan causes the cabin air to circulate through the fan-coil unit, whereby the air is cooled or heated, according to the requirement. The ventilating air supplied to the cabin may be dried, humidified, cooled or preheated in the central unit.

[0004] In order to cool and/or heat air in buildings, so-called cooling ceilings have long been used. A cooling ceiling usually comprises a plurality of panels on which are fixed a tube coil for passage of a liquid cooling agent. Both the tube and the panel are made of metal to achieve good thermal conductivity from the cooling agent. In the summer time, a relatively cold ceiling surface is thus created (typically 14-17 °C) which absorbs the radiation heat of the warmer room air. A minor part of the heat transfer to the cold water in the tube coils takes place by convection. In the winter, the cooling ceiling may be fed with hot water such that the room air is heated by radiation heat which is supplied to the room air from the hot water via the ceiling panels. Pretreated air is supplied to the room to ensure the ventilation requirement. To a corresponding extent, air is carried away from the room for the purpose of ventilating out CO_2 and odorants. To avoid condensation on the cold tube coils or on the ceiling panels, the ceiling temperature is kept above the current dew-point temperature. This type of tempering is experienced as very comfortable, especially in the summer in that the body is cooled both by convection and radiation. In that way it is possible to raise the temperature in the room one or a few degrees without the indoor climate being experienced as worse than otherwise, which is positive from the energy-saving point of view. The cooling ceiling technique is especially well suited at great thermal loads as, for example, heat radiation from large window surfaces since the efficiency increases in relation to the radiation yield. In this way, the heat radiation is efficiently "sucked" up, from a window surface warmed by the sun, by the cooling ceiling without first heating the air in the room.

[0005] On board a ship moving in tropical waters, outer cabins are loaded by heavy radiation from a warm sea surface and from the sun. This is especially true for cabins with large glass surfaces towards the outer side and cabins with balconies. Usually, this heat load is regulated by the supply of large volumes of cold air or by circulating the cabin air through a so-called cooling battery in a fan-coil unit. These cabins would be suitable instead to regulate by means of cooling ceilings which removed much of this heat which otherwise has to be ventilated away. However, practical attempts have shown that considerable problems with condensation arise when warm and very moist air (typically 30 °C, 75% RH) rush into the cabin when the balcony door is opened. This air then encounters cooled ceiling panels, whereby the dew point of the air is passed and condensation on the tube coil or on the ceiling panel arises. Such condensation is not accepted by the ship-owners since in the long run this destroys the interior fittings. In addition, it increases the risk of water starting to drip from the ceiling. This is a situation that the passenger does not accept. Quickly shutting off the cooling water flow to the tube coil of the cooling ceiling does not help since the thermal mass is so large that condensation has time to arise before the cooling ceiling has been heated up by the air. The attempt showed that not even a method of supplying hot water to the cooling ceiling when the balcony door is opened could avoid condensation on the inner ceiling.

[0006] The document DE 4 032 113 discloses a heat transfer element with features than contribute to solve the problem of condensation.

[0007] The cold water which is present on board is always kept at about 6-7 °C except in the winter when 12-13 °C is a frequently used temperature. These temperatures are controlled by the on-board cooling machine and by the need of being able to dehumidify the ventilating air to a sufficient extent before it is supplied to the interior of the ship. Supplying the cooling ceiling with water of a temperature of 6-7 °C would, admittedly, provide an efficient cooling device but is unsuitable since it would be experienced as very uncomfortable to have such a cold surface in the cabin or in some other space. In addition, the cooling ceiling would assume a temperature below the dew point of the cabin air and condensation would arise also without allowing exterior air into the space. From the points of view of comfort and condensation, a suitable temperature of the cooling ceiling would instead be about 15-10 degrees. To achieve this, the cooling water must have a temperature of about 12-15 degrees. This would mean that the water which has cost a great deal of energy to cool down would have to be reheated by an extra heat exchanger and hot water or electricity before it could be distributed to a cooling ceiling. There is a shortage of both hot water and electricity on board cruisers and other major passenger ships.

[0008] The space between the deck and the inner ceiling and which is available for a cooling ceiling is very limited and difficult to reach because of cabling, ventilating ducts, sprinkler systems and many other systems and components which also compete for this space. For this reason it is exceedingly difficult to coordinate in advance all the tube coils of the cooling ceiling with other on-board systems. Further, it is very difficult, from a purely physical point of view, to work in this narrow space with the laying of more or less prefabricated tube coils which are interconnected into large tube systems. The actual wiring operation must be carried out in this narrow space, which entails a risk of subsequent water leakage. Ships vibrate heavily all the time, which easily results in tube fractures. If copper tubes are used, special measures must be taken, such as hot-annealing etc., to avoid brittle fractures caused by vibrations.

[0009] According to one known embodiment of a cooling ceiling, this comprises a plurality of cooling panels of extruded aluminium, to which cooling water tubes are fixed on the upper side. The cooling water tubes are jointed at the ends so as to form a loop covering the ceiling surface and wherein both ends are connected to a cooling unit. The cooling panels then make direct contact with an inner ceiling of thin sheet. During mounting, the cooling panels thus have to be mounted first, whereupon the cooling tubes are jointed. This operation has to be carried out in the narrow space between the roof and the inner ceiling.

SUMMARY OF THE INVENTION

[0010] The object of the presents invention is to suggest solutions to a heat-regulation system for a ship' cabin which offers a higher comfort and which, in a better way than before, economizes on the available energy on board a ship. According to a first aspect of the invention, a cooling ceiling is suggested which, without the occurrence of condensation, offers passengers a comfortable indoor climate during voyages in tropical as well as arctic waters. The cooling ceiling shall be easy to install and dismantle so as to make possible access to and service of other components which are concealed by the ceiling. A second aspect of the invention relates to a method for heat regulation of a ship's cabin with the assistance of a cooling ceiling.

[0011] The above-mentioned object is achieved according to the invention by a cooling ceiling according to the characteristic features described in the characterizing portion of the independent claim 1 and by a method according to the characteristic features described in the characterizing portion of the independent method claim 6. Advantageous embodiments are described in the characterizing portions of the dependent claims.

[0012] According to the invention, a thermal resistance is introduced between the cooling agent and the ceiling panel, whereby the already existing cooling water on board the ship may be utilized. The resistance introduced implies that less heat per unit of time is transported from the cooling agent to the ceiling panel and vice versa. This thermal resistance is achieved by surrounding the cooling water with a thermal insulation, the thermal conductivity of which is inferior to that of, for example, copper. This is achieved by insulating the cooling water tube or by quite simply manufacturing the cooling water tube of a material which exhibits good thermal insulation. The cooling water tube is advantageously made of a polymer such as, for example, crosslinked polyethylene (XLPE). Such a tube is adapted to form a jointless coil over the ceiling. The available cooling water, which has a temperature of about 6-7 degrees, is then fed directly into such a tube coil without preheating. Since the polymer is much inferior to metal as thermal conductor, an outside temperature of the tube coil is obtained which results in condensation being avoided while at the same time the cooling ceiling temperature may be kept within 15-18 °C, which is ideal from the point of view of comfort.

[0013] Tubes of polymer or plastic are much lighter than tubes of metal, which is of importance on board a ship where weight is an optimization factor. In addition, plastic tubes are bendable and may easily be installed without prefabrication of coils, as is the case with metal tubes. Tubes of, for example, XLPE may be manufactured with a layer which prevents the penetration of oxygen. The oxygen content of the water may thus be kept low, thus preventing corrosion and the growth of microorganisms. Plastic tubes are very resistant to vibrations and withstand deformations and variations in temperature very well.

[0014] According to the invention, a continuous tube of, for example, XLPE is adapted to be fixed to a plurality of cooling panels so as to form a jointless coil for the cooling water. The cooling panels are made of a thin metal such as, for example, an extruded aluminium profile and are brought to make butt contact with the inner ceiling panels of thin sheet. The profile may be formed with a groove into which the tube may be simply pressed from below. In this way, neither the panel nor the cooling tube need to be installed from the narrow space above the inner ceiling, but the whole installation takes place from the cabin. The continuous plastic tube is fed from a reel. The finished coil is connected to other tube coils in the same space or directly to the water system from the cooling machine.

[0015] The cooling panel with its longitudinal slots for the cooling tube is attached directly to the deck or to the frame which sustains the ceiling panels. The cooling panel is arranged at such a relative height that it will make butt contact with the upper side of the respective inner ceiling panel when these are finally installed in the cabin or the space where the cooling ceiling has been installed. Several embodiments for the cooling panel and a plurality of cross-section profiles are possible. For example, an extruded aluminium profile with "resilient slots" for the XLPE tube may also comprise shallow dovetail slots for a magnetic polymer tape which provides increased contact between the panel and the cooling panel. Other profiles, such as resilient, openable or flexible may also be utilized.

[0016] When hot moist air from, for example, an opened balcony door streams into a cabin, this air first hits the inner ceiling panels since hot air rises in relation to the colder air. If the inner ceiling panel is cold, the air condenses into water droplets on the inner ceiling. According to one known method, the cooling water is shut off in such situations such that it no longer flows through the tube. The intention of this is for the ceiling to be rapidly heated so that no condensation takes place. The cooling ceiling with inner ceiling, cooling panels and tube coil with cooling water contains a large thermal mass which has a certain thermal inertia. This thermal mass cannot be heated in a simple manner in case of a temporary change of the thermal load. Thus, the method has proved to function less well in practice.

[0017] According to the invention, the problems with condensation can be avoided by separating the inner ceiling from the cooling panels, in addition to shutting off the cooling water. The inner ceiling consists of thin sheet panels which constitute only a small part of the total thermal mass. If this is separated from the rest of the thermal mass, the sheet may be rapidly heated by the inrushing hot air so that no condensation problems arise. The initial condensation which may have time to form on the panel surface disappears in a very short time because of energy supplied from the exterior air. A device which separates the panel from the cooling panel may comprise a flexible diaphragm which is placed between the panel and the holder profile. This diaphragm may be caused to expand with the aid of compressed air or other pressurized medium. An air gap of one or a few millimetres is sufficient to attain good thermal separation between the panel and the cold parts of the cooling ceiling. For reasons of fire protection and sound insulation, the inner ceiling is covered with a thick mineral wool insulation on the upper side. The mineral wool also functions as thermal insulation for the cooling ceiling and prevents condensation on the holder profile or the tube coil.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The invention will be described in greater detail by description of an embodiment with reference to the accompanying drawings, wherein

Figure 1 shows a section through a cooling ceiling according to the invention, including cooling tubes and inner ceiling,

Figure 2 shows a section through a cooling ceiling according to the invention, including cooling tubes and inner ceiling as well as thermal insulation and magnetic attachments for the ceiling,

Figure 3 shows a section of a cooling panel for a cooling ceiling according to the invention,

Figure 4 shows a section of a cooling panel comprising separating devices by means of which the inner ceiling may be temporarily separated from the cooling panel, and

Figure 5 shows a circuit diagram of the flow of cooling water and air.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0019] The cooling ceiling schematically shown in Figure 1 comprises a cooling panel 1 which is suspended from a primary supporting system 2 with an attachment device 3. The cooling panel 1 supports a cooling tube 4, in which flows a cooling liquid, which may be water. An inner ceiling 5 makes contact with the under side of the cooling panel and thermal butt contact with the cooling panel. The inner ceiling is formed with folded-in ridges 6, which are adapted to be fixed in angle brackets 7 belonging to a secondary supporting system 8, which may be the same as the primary supporting system 2. The ridges 6 are adapted to introduce a spring force into the inner ceiling, by means of which the inner ceiling is pressed against the cooling panel. The cooling panel, on its side, is formed with flanges 9, the under sides of which are plane and adapted to make butt contact with the equally plane inner ceiling. The cooling tube 4 is made of an insulating material, for example of a crosslinked polyethylene (XLPE).

[0020] The cooling ceiling as shown in Figure 2 comprises, in all essentials, the same parts as the cooling ceiling according to Figure 1. A cooling panel 1 thus supports a cooling tube 4 and is arranged in butt contact with an inner ceiling 5. In the example shown, the cooling ceiling is formed with an insulation 10 of, for example, mineral wool which covers the upper side of the inner ceiling and the cooling panel. The purpose of the insulation is threefold. According to a first purpose, it shall insulate the cooling panel against heat transport such that moisture does not condense on the upper side of the cooling ceiling. According to a second purpose, the insulation shall function as a sound absorbent, whereby sound in the cabin is attenuated. According to a third purpose, finally, the mineral wool shall constitute a fire insulation. The cooling panel in the example is also designed with attachment devices 11 to rigidly secure the base against the cooling panel. These attachment devices may advantageously be arranged of magnetic tapes placed in dovetail-shaped slots in the cooling panel. The magnetic force which arises between the wedged-in magnetic tapes and the inner ceiling, which must be made of magnetizable sheet, is sufficient to create the thermal contact between cooling panel and inner ceiling. The magnetic tapes also make it exceedingly simple to dismantle the inner ceiling.

[0021] Figure 3 shows an advantageous embodiment of a cooling panel 4. In the example shown, the panel is made as a continuous profile of extruded aluminium. The profile is inversely symmetrical around a vertical section. Each side comprises a flange 9 with a plane under side adapted to make contact with an inner ceiling. Symmetrically around the cross section, the profile also comprises two claws, which are adapted to partly surround and secure a cooling tube. The claws have been given a thin profile to increase the elastic bendability such that the claws embrace the cooling tube with a spring force. The heat which is to be transported to or from the cooling tube must, in order to reach the inner ceiling, pass an area 13 at the root of the claws. This area may be dimensioned to impart to the transport route a desired thermal resistance such that a desired thermal inertia is achieved between cooling tube and inner ceiling. This possibility is available, in addition to the fact that the actual cooling tube as such contains a thermal inertia.

[0022] In cabins, where hot moist air may suddenly rush in, for example when a balcony door is opened, the inner ceiling must be rapidly heated in order for the condensation of the moist air not to take place on the inner ceiling. The inner ceiling, which is preferably made of a shin sheet, thus constitutes a very small thermal mass. Relatively seen, a very small amount of energy is required to heat up the sheet itself. To this end, as shown in the example according to Figure 4, the cooling panel is arranged with expansion devices, which temporarily break the thermal contact between cooling panel and inner ceiling. The expanding devices may be simply designed as an elastic hose 16 drawn in a longitudinally extending slot across the magnetic tapes 11. When the hose is brought to expand, for example by supplying compressed air, the magnetic tapes are brought to bulge outwards. This bulge results in the inner ceiling, despite a maintained magnetic contact, being moved away from the cooling panel. The inner ceiling thus exposed is rapidly heated up by the inrushing hot air, whereby the dew point is never passed and thus no condensation is deposited on the inner ceiling. At an initial stage, moisture may condense on the inner ceiling but rapidly evaporates when the inner ceiling is heated.

[0023] Figure 5 shows an example of a circuit diagram for connection of cooling water and air supply. A supply conduit 20 for cooling water distributes, under tropical conditions, water with a temperature of 6-7 °C. Under arctic conditions, hot water with a temperature of 30-50 °C is instead distributed. The cooling water is supplied to the cooling panels through a coil 21 composed of the cooling tubes. At the end of the coil, the cooling water passes through a heat-exchanger 22, a stop valve 23, before the water is returned along a discharge conduit 24. The stop valve is adapted to temporarily shut off the water supply when the climate in the cabin is rapidly changed. Conditioned air is supplied to the cabin through a supply channel 25. The air passes through the heat-exchanger 22 before it flows out into the cabin. This provides for good possibilities of tempering the supply air correctly and according to individual requirements. The air is returned in a return-air channel (not shown).

[0024] Installing traditional cooling ceilings in a plurality of cabins probably offers extensive installation work, not only because of all the activity that simultaneously goes on in a cabin. Traditional cooling panels with copper tubes must be prefabricated so as to fit exactly without colliding with other equipment. When the panels are in place, the cooling tubes must be jointed into a continuous coil. A cooling ceiling according to the invention offers a considerably simplified installation and increased safety against leakage of water. The cooling panels are cut into lengths and placed in their final positions, whereupon the plastic tube in the form of a continuous hose on a reel is pressed into the groove, provided for that purpose, in the panel. This work may very well be carried out at a late stage of the construction work.

[0025] The thermal inertia in the cooling ceiling is dimensioned such that the available cooling water on board (Chilled Water) may be used directly. For that purpose, two parameters for dimensioning are available. The wall thickness and the material in the cooling tube may be utilized as well as also the geometrical shape of the profile of the cooling panel. Instead of a copper cooling tube, according to the invention a tube of a polymeric material is chosen. The thermal conductivity of the polymeric material is much inferior to that of copper. This implies that a thermal resistance is introduced between cooling agent and cooling panel. The resistance reduces the thermal flow such that a difference of about 8-12 degrees is obtained between the inner and outer sides of the cooling tube. By dimensioning the cross section of the cooling panel, the thermal resistance up to the inner ceiling may be further adjusted.

[0026] Normally, insulated channels are used for distribution of supply air (fresh air) in a cruiser since the air, which passes through a cooling battery in the central unit to be dehumidified and cooled, is very cold (about 11 °C in the summer). Without insulation, the cooling capacity would be lost and condensation would appear outside the channels. By instead distributing warmer air and then cooling the air immediately before it flows out into the respective spaces, non-insulated channels may be used between the central unit and the respective space. This results in the channel system becoming considerably less expensive, less voluminous and considerably lighter.

[0027] According to the invention, hot air is supplied in non-insulated channels in the cabin. A small convenient heat exchanger is connected in series with the coil in the inner ceiling at the respective space such that this heat exchanger is fed with return water from the cooling ceiling. If the cooling ceiling is then fed with water with a temperature of 6-7 degrees, the return water may be counted on to maintain a temperature of 9-10 °C after having passed through the tube coil. This water is allowed to continue through the heat exchanger and will then cool the supply air from, for example, 20 °C to 14 °C, which often is a suitable so-called undertemperature. The temperature of the return water has then risen to 13-14 °C, which is a suitable (necessary) return-water temperature to feed back to the cooling machine.

Claims

1. A cooling ceiling for a ship comprising a tube coil (4) through which a liquid cooling agent circulates, and an inner ceiling (5), **characterised in that** a cooling panel (1) supports the tube coil (4) and transports heat between the tube coil (4) and the inner ceiling (5), the tube coil (4) material has a thermal conductivity lower than that of copper, and that the tube coil (4) is applied to the underside of the cooling panel (1).

2. A cooling ceiling according to claim 1, **characterised in that** the tube coil (4) is made of a continuous tube of a polymeric material.

3. A cooling ceiling according to claim 1 or 2, **characterised in that** the tube coil (4) is made of a crosslinked polyethylene.

4. A cooling ceiling according to any of the preceding claims, **characterised in that** the cooling panel (1) comprises a separation device (11) which temporarily separates the inner ceiling (5) from the cooling panel (1) to avoid condensation problems.

5. A method for heat regulation of a cabin in a ship, wherein a cooling ceiling comprising a tube coil (4) through which a liquid cooling agent circulates, and an inner ceiling (5), **characterised in that** a cooling panel (1) supports the tube coil (4) and is adapted to provide a thermal transport between the cabin and the cooling agent, and that the tube coil (4) is brought to comprise a thermal insulation, whereby an increased flow resistance is imparted to said thermal transport, and that the tube coil (4) is applied to the cooling panel (1) from below.

6. A method according to claim 5, **characterised in that** the tube coil (4) is made of a continuous tube of polymeric material.

7. A method according to claim 5 or 6, **characterised in that** the inner ceiling (5) is temporarily brought to separate from the cooling panel (1) to avoid condensation problems.

8. Use of a cooling ceiling according to claims 1-4 or a method according to claims 5-7 in a cruiser.

Patentansprüche

1. Kühldecke für ein Schiff, umfassend eine Rohrschlange (4), durch die ein flüssiges Kühlmittel zirkuliert, und eine innere Decke (5), **dadurch gekennzeichnet, dass** ein Kühlfeld (1) die Rohrschlange (4) hält und Wärme zwischen der Rohrschlange (4) und der inneren Decke (5) transportiert, wobei das Material der Rohrschlange (4) eine Wärmeleitfähigkeit aufweist, die niedriger ist als die von Kupfer, und dass die Rohrschlange (4) an der Unterseite des Kühlblechs (1) angebracht ist.

2. Kühldecke gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Rohrschlange (4) aus einem kontinuierlichen Rohr aus Polymermaterial hergestellt ist.

3. Kühldecke gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Rohrschlange (4) aus einem vernetzten Polyethylen hergestellt ist.

4. Kühldecke gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Kühlfeld (1) eine Trennvorrichtung (11) umfasst, die zeitweilig die innere Decke (5) von dem Kühlfeld (1) trennt, um Kondensationsprobleme zu vermeiden.

5. Verfahren zur Wärmeregulierung einer Kabine in einem Schiff, wobei eine Kühldecke eine Rohrschlange (4), durch die ein flüssiges Kühlmittel zirkuliert, und eine innere Decke (5) umfasst, **dadurch gekennzeichnet, dass** ein Kühlfeld (1) die Rohrschlange (4) hält und angepasst ist, einen Wärme-

transport zwischen der Kabine und dem Kühlmittel bereitzustellen, und dass die Rohrschlange (4) dazu gebracht wird, eine Wärmeisolierung aufzuweisen, wodurch dem Wärmetransport ein erhöhter Flusswiderstand verliehen wird, und dass die Rohrschlange (4) von unten an dem Kühlfeld (1) angebracht ist.

6. Verfahren gemäß Anspruch 5, **dadurch gekennzeichnet, dass** die Rohrschlange (4) aus einem kontinuierlichen Rohr aus Polymermaterial hergestellt ist.

7. Verfahren gemäß Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** die innere Decke (5) dazu gebracht wird, sich zeitweilig von dem Kühlfeld (1) zu trennen, um Kondensationsprobleme zu vermeiden.

8. Verwendung einer Kühldecke gemäß den Ansprüchen 1 bis 4 oder eines Verfahrens gemäß den Ansprüchen 5 bis 7 in einem Kreuzer.

Revendications

1. Plafond réfrigérant pour navire comprenant un serpentin (4) dans lequel circule un agent de refroidissement liquide, et un plafond intérieur (5), **caractérisé en ce qu'**un panneau réfrigérant (1) supporte le serpentin (4) et transfère de la chaleur entre le serpentin (4) et le plafond intérieur (5), **en ce que** le matériau du serpentin (4) a une conductivité thermique inférieure à celle du cuivre, et **en ce que** le serpentin (4) est appliqué contre la face inférieure du panneau réfrigérant (1).

2. Plafond réfrigérant selon la revendication 1, **caractérisé en ce que** le serpentin (4) est constitué d'un tube continu en matériau polymère.

3. Plafond réfrigérant selon la revendication 1 ou 2, **caractérisé en ce que** le serpentin (4) est fait d'un polyéthylène réticulé.

4. Plafond réfrigérant selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le panneau réfrigérant (1) comprend un dispositif de séparation (11) qui sépare temporairement le plafond intérieur (5) du panneau réfrigérant (1) afin d'éviter les problèmes de condensation.

5. Procédé de régulation thermique d'une cabine dans un navire, dans lequel un plafond réfrigérant comprenant un serpentin (4) dans lequel circule un agent de refroidissement liquide, et un plafond intérieur (5), **caractérisé en ce qu'**un panneau réfrigérant (1) supporte le serpentin (4) et est adapté pour assurer un transfert thermique entre la cabine et l'agent de refroidissement, **en ce que** l'on applique une isolation thermique au serpentin (4), grâce à quoi une résistance à l'écoulement accrue est appliquée audit transfert thermique, et **en ce que** le serpentin (4) est appliqué au panneau réfrigérant (1) par le dessous.

6. Procédé selon la revendication 5, **caractérisé en ce que** le serpentin (4) est constitué d'un tube continu en matériau polymère.

7. Procédé selon la revendication 5 ou 6, **caractérisé en ce que** l'on sépare temporairement le plafond intérieur (5) du panneau réfrigérant (1) afin d'éviter les problèmes de condensation.

8. Utilisation d'un plafond réfrigérant conforme aux revendications 1 à 4 ou d'un procédé conforme aux revendications 5 à 7 dans un navire de croisière.

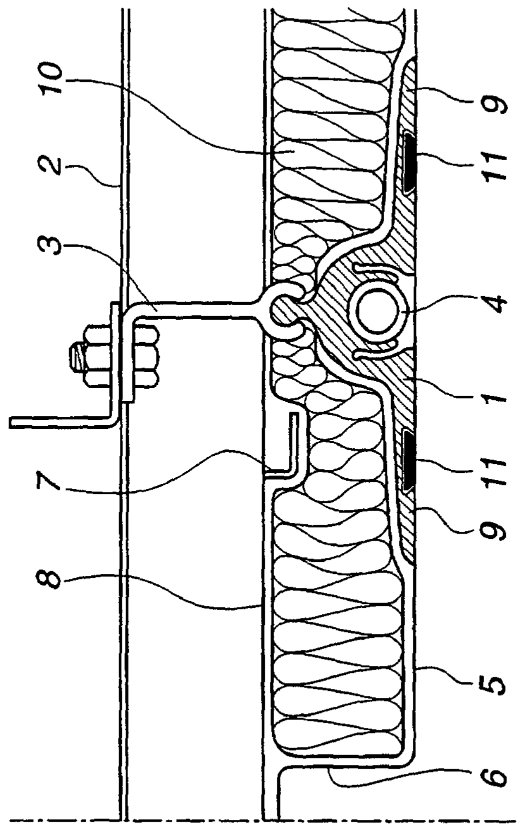

Fig. 2

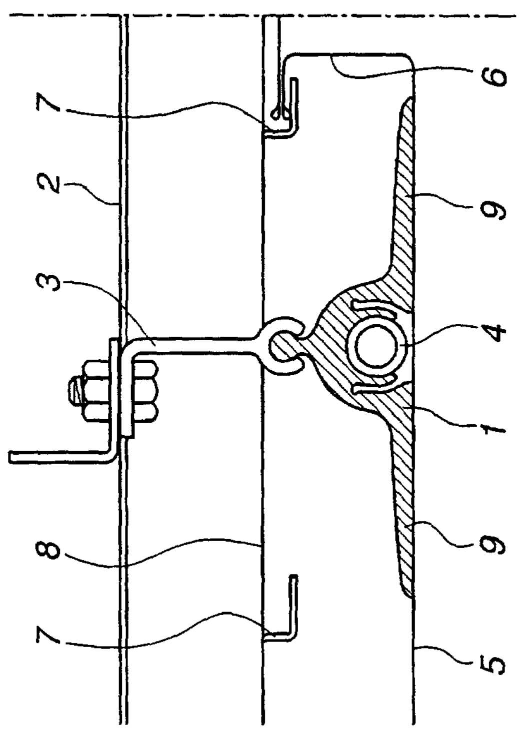

Fig. 1

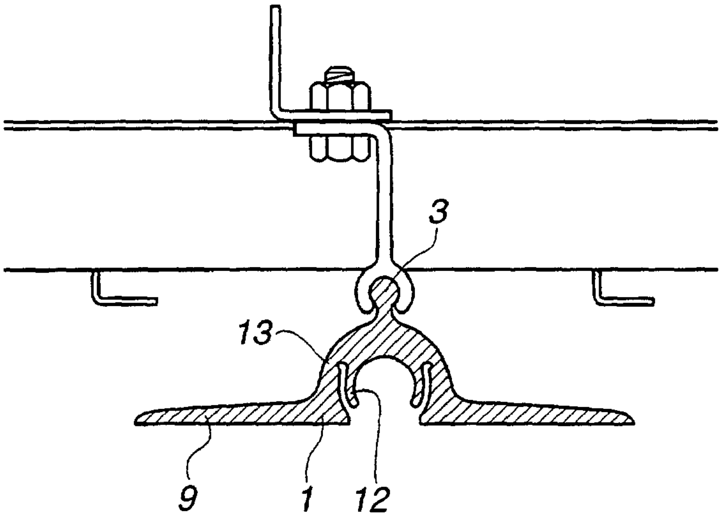

Fig. 3

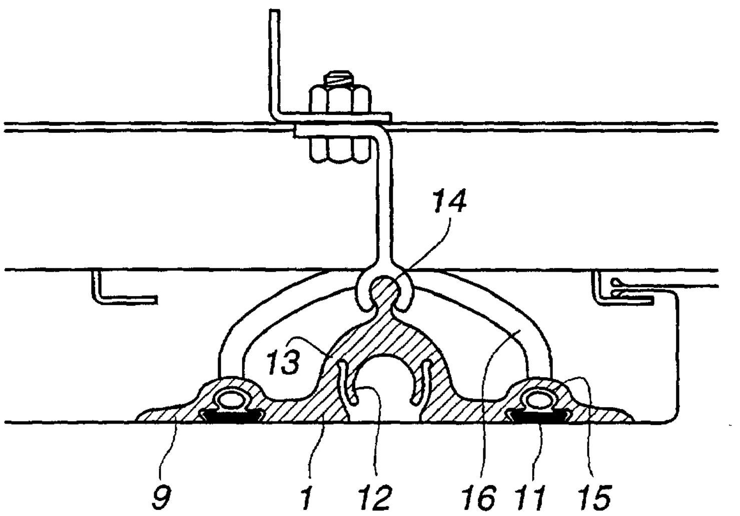

Fig. 4

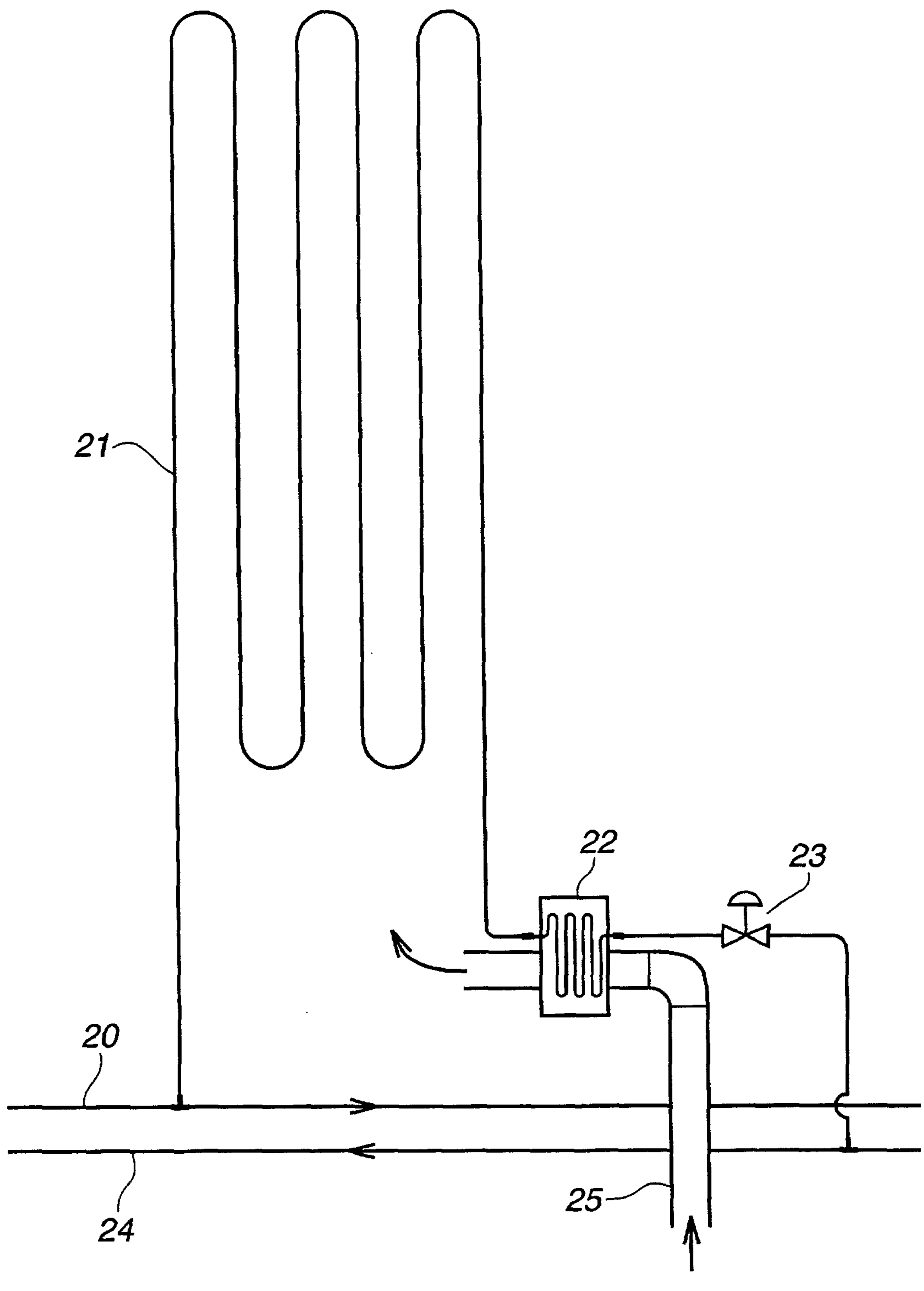

Fig. 5