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(54) **Underground air conditioning system and method thereof for open air ground surfaces**

(57) Open-air, air-conditioned residential or recreational facility in a climatically hot environment, said facility comprising

(i) a physical boundary surrounding the area of said facility and elevating to a predetermined height above the ground surface of said facility, wherein said boundary is adapted for reducing the lateral exchange of air between the area inside said bound-

ary and the environment outside of said boundary; and

(ii) an electrically-powered cooling system for cooling the ground of said area and the air near the ground surface of said area.

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to an open-air, air-conditioned residential or recreational facility for a climatically hot environment. The invention further relates to a method of air-conditioning an open-air residential or recreational facility in a climatically hot environment.

BACKGROUND OF THE INVENTION

[0002] In climatically hot places like in tropical or subtropical environments, temperatures during day time often exceed 35° and even 40°C in the shadow. People living under such circumstances suffer significantly from the heat which frequently leads to health problems. In closed areas like buildings, air-conditioning may be used for reducing the temperature. In residential or recreational areas like parks, i.e. outdoors, no satisfactory cooling systems have been known.

[0003] It is therefore an object of the invention to provide an open-air, air-conditioned facility for a climatically hot environment.

DISCLOSURE OF THE INVENTION

[0004] Open-air, air-conditioned residential or recreational facility in a climatically hot environment, said facility comprising

- (i) a physical boundary surrounding the area of said facility and elevating to a predetermined height above the ground surface of said facility, wherein said boundary is adapted for reducing the lateral exchange of air between the area inside said boundary and the environment outside of said boundary; and
- (ii) a cooling system for cooling the ground of said area and/or the air near the ground surface of said area.

[0005] Said cooling system may comprise an air-conditioning refrigerating unit. Said cooling system may comprise a refrigerating unit and a coolant fluid. Said refrigerating unit may be capable of cooling said coolant fluid. Said coolant fluid may flow or circulate on the ground surface or below the ground surface of said area.

[0006] The invention also provides a method for air-conditioning an open-air residential or recreational facility (in the following briefly: "facility") in a climatically hot environment, comprising

- providing a physical boundary surrounding the area of said facility and elevating to a predetermined height above the ground surface of said facility, wherein said boundary is adapted for reducing the

lateral exchange of air between the area inside said boundary and the environment outside of said boundary; and

- operating an electrically-powered cooling system for cooling the ground of said area and/or the air near the ground surface of said area.

[0007] Preferred embodiments are defined in the sub-claims.

[0008] The inventor has surprisingly identified a way of conditioning the air in large, open-air territories like in residential or recreational locations. Surprisingly, it was found that it is possible to maintain a significant temperature difference between the outside and the inside of said boundary using a relatively low height of said boundary, since the cooled air stays near the ground and does not give rise to convection. Thus, the inventor has found a way of artificially creating a micro climate of reduced temperature applicable to town construction. The invention is of particular use in hot tropical or subtropical environments where a reduction of the air temperature even by some degrees represents a substantial improvement for people suffering from an exceeding heat. The cooling system of the invention cools the ground of the area of said facility and/or the air near the ground. Said physical boundary surrounding said area is of sufficient height for reducing lateral exchange of air between the area inside said boundary and the outside environment of said boundary, thus preserving the coolness achieved by the cooling system.

[0009] Said boundary reduces, preferably prevents, lateral exchange of air at least near the ground surface of said facility. The height up to which said lateral exchange of air may be reduced or prevented depends on the height of said physical boundary. The higher said boundary, the higher the height up to which said lateral exchange can be reduced and prevented. The height up to which coolness may be preserved inside said facility thus depends on the height up to which said lateral exchange of air is reduced or prevented by said physical boundary. Cool air produced near the ground inside said area has a higher density than uncooled air. Therefore, cooled air will stay at the bottom and has little tendency to mix with uncooled air above the cool air as long as wind or agitation is essentially absent. If cooling is continued at a sufficient power, a layer "(sea)" of cool air will form extending over the entire area of said facility. When cooling is continued at a sufficient power, the thickness of the layer of cool air increases. The thickness of the layer of cool air cannot extend beyond the height of said physical boundary. However, the thickness of the cool air layer can be as high as several (e.g. 2 or 3) stories of a building inside said facility.

[0010] The cool air inside said facility has a higher density than uncooled air outside said facility, leading to a higher air pressure at the ground inside said facility compared to outside said facility. Thus, the cool air inside said facility has a strong tendency to spread over

a large area for reducing the thickness of the layer of cool air, whereby the cool air would dissipate and get lost. In this invention, spreading of cool air is restricted to the area inside said facility by said physical boundary. Thus, the cool air is kept inside said facility. It is important that said physical boundary is free of significant openings (i.e. openings of a significant size) that would allow cool air from the inside to be pressed out to the environment. Cool air that is lost through openings in said boundary is replaced by uncooled air from above, whereby the layer of cooled air inside said facility becomes thinner and may vanish entirely. Said physical boundary should therefore not have openings that are (together) bigger than 2 m², preferably no openings that are (together) bigger than 3000 cm², more preferably no openings (together) bigger than 1000 cm², and most preferably no openings that are (together) bigger than 500 cm². Loss of cool air through minor openings may be compensated by an increased cooling power of said cooling system. Significant openings at a certain height of said physical boundary will lead to an effective height of said physical boundary at the height of said significant openings. Said facility may of course have an occludable opening like an emergency exit or a sluice (lock) for entering or exiting said facility.

[0011] Said facility preferably has no access opening for people or vehicles in said physical boundary. People or vehicles may access the inside of said facility e.g. via a tunnel leading from the outside of said facility to an underground level of said facility to the surface of said facility may be reached. The access tunnel should have an occludable door for avoiding loss of cool air through said tunnel. Said underground level may have facilities like a parking lot for vehicles. Alternatively, people or vehicles may access the inside of said facility via a passing that bridges said physical boundary. Such a passing may comprise a ramp on both sides of said physical boundary, said ramp leading up to the top of said physical boundary. Such a passing is well suited for giving vehicles like cars access to said facility.

[0012] Herein, "cool" means colder than in the absence of an operating cooling system in said facility. Notably, "cool" means colder than the temperature (measured in the shadow) of the environment outside said facility or above said facility at a height higher than the height of said boundary. If said cooling system cools the ground in said facility, the cooled ground will cool the air above the ground, thereby leading to a layer or sea of cooled air in said facility.

[0013] Herein, "inside said facility" or "inside said (physical) boundary" means the area surrounded by said physical boundary including the space above said area up to a height corresponding to the height of said physical boundary. "Outside said facility" or "outside said boundary" means the area including the space near said facility excluding the inside of said facility.

[0014] The facility of the invention is an open-air facility, i.e. it does not have a solid roof that would abolish

convection of air in the vertical direction inside said boundary. Of course, parts of said facility may be provided with means for preventing direct sunlight reaching the ground, like a canvas blind. Air-conditioning herein means a reduction of the temperature of the air inside compared to the air outside said facility under otherwise comparable conditions.

[0015] The area of the facility of the invention may be large enough for buildings like houses and recreational means like parks, lawn, trees, lakes, swimming pools etc. Preferably, the facility of the invention is not a stadium like a football stadium.

[0016] There are many possibilities of powering the electrically powered cooling system of the invention. The energy required for powering the electrically powered cooling system of the invention does in general not pose a problem in the climatically hot environments envisioned by the invention, since abundant solar energy is available, especially during the hottest periods of the day, for producing electrical power using a solar power plant.

[0017] A solar power plant is preferably located outside said facility for keeping heat generated by said solar power plant outside said facility. It is preferred to locate the solar light absorption devices of the solar power plant next to said boundary on the outside of said facility. The solar light absorption devices may be located such that hot air ascending from a hot surface of a solar light absorption device may ascend in close proximity to said boundary. At the top of said boundary, said hot air may thus form a cushion of upwardly flowing warm air separating air inside said facility from air in the environment of said facility. Such an air cushion helps to protect the air inside said facility from being agitated by wind (see Fig. 5).

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 is a schematic view on a facility according to the invention. Numeral 1 indicates buildings. 2 indicates a lawn. 3, 5, and 8 indicate a physical boundary. 4 indicates a lake of water acting as coolant. 6 indicates trees, hedges, and shrubs. 7 indicates a street.

Fig. 2 shows a wall as a physical boundary according to the invention. The wall is stabilized by a dam of soil or an earth bank on the outside of said facility.

Fig. 3 shows a building built on said physical boundary. The building forms part of the boundary of the invention. The refrigerated ground inside the facility extends into the ground floor of said building for additionally conditioning the air temperature inside said house.

Fig. 4 shows an assembly of seven facilities according to the invention. The seven facilities are designated M1, M2, M3, M4, M5, M6, and M7, respectively. M1 may have a size of 10 000 m². M2 and M3 may have a size of 20 000 m², and the remaining facilities may have a size of 30 000 m². Straight lines indicate physical boundaries. Adjacent facilities share a common physical boundary. The assembly of several facilities sharing common boundaries has the advantage that wind has a less detrimental effect on the cool air layers inside the facilities compared to one large facility having an area equal to the sum of the areas of the small facilities M1 to M7. Numeral 20 indicates air-conditioning devices of facility M2. Numeral 22 indicates three air-conditioning devices of facility M6. Air-conditioning devices of the other facilities are indicated. The air-conditioning devices are located at said physical boundaries. Heat produced by said devices is conveyed to the outside of said facilities. Central facility M1 may have a cooling system that is capable of conveying heat generated by said cooling system to the outside of the assembly of facilities. This may e.g. be achieved by conveying the heat to the space above said facility and conveying the cool air produced by the air-conditioning unit to the ground of central facility M1. An air-conditioning unit of central facility M1 may e.g. be mounted at a building in facility M1 at a height higher than the height of said boundary. Generated heat may then be released to the outside of said facility and cool air may be conveyed down into the sea of cool air. Cool air lost from an air-conditioned building in a facility may feed the sea of cool air of said facility, thereby preventing loss of cool air from such an air-conditioned building.

Fig. 5 shows a cross-section through an element of the physical boundary placed on the ground (hatched). The physical boundary is capable of creating a cushion of hot air III capable of protecting the sea of cool air I and the air II above said sea of air I from wind coming from the right hand side. Roman capital numerals indicate various air layers that differ in air flow conditions and/or temperature. Dashed lines indicated frontiers between differing air layers. Arrows indicated the direction of air flow or wind. The inside of said facility is on the left side of the physical boundary. 32 indicates the right hand side of a hollow boundary element, made e.g. of steel, glass, or steel-glass construction. 34 indicates the left hand side of the hollow boundary element. 36 indicates the hollow inside of the boundary element. 40 indicates a transparent plate made of glass. 38 and 42 indicate openings to the inside of the hollow boundary element. 46 indicates an opening at the top of said boundary element. 44 indicates a dark or black layer under the glass plate

40. Back layer 14 may be a sun collector for generating electrical energy for powering said cooling system. Light from the sun will pass through glass plate 40 and hit on black layer 44. Black layer 44 absorbs sun light, whereby it heats up. The hot layer 44 heats up the air above said layer, which will ascend. Ascending hot air creates an air flow upwards in said hollow boundary element, whereby said boundary element functions like a chimney. Ascending air in the boundary element exits the boundary element at opening 16. Air may enter said boundary element at openings 38 and 42. The hot air ascending in said boundary element and being accelerated therein creates a cushion of flowing warm air indicated at III. Said cushion III directs wind coming from the left hand side upwards as indicated at IV. Thus, air layers I and II inside said facility are at least partially protected from wind by air cushion III.

As indicated by the location of the dashed line between air layer I and II, the thickness of the sea of cool air I can be less than the height of said boundary. The thickness of the sea of cool air I is at most as high as the height of said boundary.

DETAILED DESCRIPTION OF THE INVENTION

[0019] The facility of the invention may be large enough to include buildings like residential buildings, hotels or recreational facilities like swimming-pools, lawns, sport facilities etc. The facility may include an entire (urban) settlement. The area of said facility inside said physical boundary may have a size of at least 100 m², preferably at least 500 m², more preferably at least 2000 m², and most preferably at least 10 000 m². The area may however be even larger, e.g. 1 km². Preferred sizes are between 10 000 m² and 1 km², preferably 10 000 to 50 000 m². Instead of constructing one large facility, it is preferred to construct an assembly of several adjacent smaller facilities for reducing the risk of losing cooled air by wind. In such an assembly of facilities, adjacent facilities preferably share a common physical boundary. The number of facilities that may be arranged to form an assembly of facilities is not limited and may e.g. be 2 to 10, preferably, 4 to 8.

[0020] There are no limits regarding the shape of the facility of the invention. The shape may for example be round, rectangular, or cross-shaped. The shape of the facility is determined by the shape of said physical boundary. The buildings inside the facility may be arranged in any form of conventional settlements. Buildings inside said facility may be integrated into said boundary, e.g. such that the building forms part of said boundary.

[0021] The cooling efficiency (cooling power) to be used for the cooling system of the invention depends, apart from its power, from the level of lateral air ex-

change between the area inside said boundary and the environment outside said boundary. The exchange of air e.g. in case of wind, in turn, depends *inter alia* on the height of said boundary and the size of the area inside said facility. The size of said area, the height of said boundary, and said cooling system should be mutually adjusted to each other for allowing to achieve a desired air-conditioning effect. Preferably, they are mutually adjusted such that the air temperature near the surface of said area is at least 2°, preferably at least 5°, more preferably at least 7°C lower than the temperature in the outside environment during day time. (Temperatures and temperature differences are measured in the shadow under otherwise comparable conditions like distance from the ground.) Said cooling system should be capable of cooling the air near the ground surface of the area inside said facility to a temperature between 18° and 35°C, preferably between 25° and 35°C, more preferably to a temperature between 25° and 30°C.

[0022] Obviously, the lateral exchange of air between the area inside said boundary and the environment outside said boundary depends to a large extent on the presence or absence of wind. The above-mentioned temperatures and temperature differences relate to a situation where wind is essentially absent, preferably entirely absent. In the presence of wind, the air-conditioning effect of the facility of the invention will be worse than in its absence. However, in the presence of wind, heat is perceived as less stressing by humans. On the other hand, if a wind abates, the cooling effect of the facility of the invention will immediately return.

[0023] The height of said physical boundary should be the higher, the larger the size of said facility. Said boundary may have a height of at least 2 m, preferably at least 3 m, more preferably at least 4 m. For large sizes of said facility, the height may be even higher, e.g. between 5 and 20 m. Said physical boundary does not have to have the same height throughout. It may be higher at places where a stronger lateral air exchange is expected from the specific location or wind conditions at the specific site where said facility is constructed.

[0024] Said physical boundary may be made of any material capable of reducing, preferably preventing, lateral air exchange across said boundary. Said physical boundary does not have to be air impermeable provided it is capable of reducing said air exchange. It may comprise a woven (e.g. canvas) or a non-woven fabric. Further, it may be formed of a densely planted plants like trees and bushes. Preferably, said boundary is air impermeable. In an important embodiment, said physical boundary is a wall. Said boundary may further be made of at least one material selected from the group consisting of: concrete, brickwork, wood, glass, metal, and plastic. Houses of said facility may be part of said physical boundary, whereby the walls of said house form said boundary. If said boundary is a wall of a height of at least several meters, the wall may be strengthened by a dam or soil or by other strengthening means. Said boundary

may also be an earth wall. Said boundary may be made of different materials along its circumference. Natural conditions like rocks may be included in said boundary at a portion of said boundary. In a further embodiment, the physical boundary may be made of different materials in different heights. For example, the physical boundary may comprise a dam at the bottom and a wall constructed on said dam. If required, a woven fabric may be tented between masts on the top of said wall, e.g. for reducing a negative effect of wind on the air inside said facility.

[0025] Moreover, the ground surface of the area of said facility may be located like a valley below the surface of the outside environment, thereby reducing lateral exchange of air between the area inside said boundary and the environment of said boundary.

[0026] Said physical boundary surrounds the inside area of said facility. Preferably, said physical boundary surrounds the area of said facility completely. However, means for providing access to the inside of said facility are preferably provided. Such a means may be an opening. Preferably, the opening can be closed by a door for minimizing lateral air exchange between inside and outside. In another embodiment, there may be a way like a street going over the boundary, e.g. using a bridge. Further, access to the inside of said facility may be provided by a tunnel underneath said boundary.

[0027] In one embodiment, cool water as a coolant may be available e.g. form a cool fountain and electrical power is used for distributing said coolant to desired locations in said facility e.g. using an electrical pump. Said coolant may e.g. be pumped up to a certain level above the ground and then allowed to flow down (e.g. in drops) at various places thereby cooling the ground and the air inside said facility. In a preferred embodiment, said cooling system is an electrically-powered cooling system in that electricity is used for cooling down a coolant fluid (e.g. in a refrigerator using an electrical pump for making use of the Joule-Thomson effect).

[0028] The cooling system of the invention may be an electrically-powered refrigerating unit. Refrigerating units that may be used for the invention are known in refrigerating technology. Examples are conventional air-conditioning devices. The power of the refrigerating unit should be adjusted to the size of the facility to be air-conditioned. Several refrigerating units (like air-conditioning devices) may be run in parallel in said facility. The required number and power of refrigerating units can be determined by a man skilled in the art of heating engineering depending on the size of the facility, the temperature difference to be achieved, and other circumstances. Heat generated by the refrigerating unit (e.g. upon cooling of the coolant fluid) has to be conveyed to the outside of said facility. Said refrigerating unit(s) are preferably located close to said physical boundary such that the heat generated by the refrigerating unit can easily be conveyed to the outside environment of said facility (e.g. to the outer side of said boundary or to

the space above said facility). Most preferably, said refrigerating unit(s) may be integrated into said boundary. In general, said cooling system comprises many refrigerating units for providing sufficient cooling power. These refrigerating units may be arranged along said boundary, e.g. equally spaced. The cooled air produced by said refrigerating units is released to the inside of said facility. The cooled air may be released at the ground surface of the area of said facility. The cooled air may also be released at a predetermined height above the ground surface of said facility, e.g. at a height of 1 or 2 meters. In any case, the cooled air should be released at a height lower than the height of said physical boundary.

[0029] Alternatively or additionally, said cooling system may comprise a refrigerating unit and a coolant fluid cooled by said unit, whereby said coolant fluid flows or circulates on the ground surface or below the ground surface of said area. The cooling effect of said coolant may be based on the take up of heat by said coolant from the air or the ground inside said facility. Alternatively or additionally, the cooling effect may be based on a phase transition of the coolant e.g. evaporation of water as a coolant.

[0030] Said cooling system may comprise a coolant fluid that is cooled by said refrigerating unit(s). The type of coolant fluid depends on the cooling principle employed and may be any conventional coolant like a gas (e.g. natural or artificial air, carbon dioxide, nitrogen, propane, butane, fluorinated hydrocarbons etc.) or a liquid. The most preferred liquid coolant fluid is water. After having cooled the coolant fluid, the coolant fluid, notably water, may be allowed to flow on the surface of the area inside said facility. Water as a coolant fluid may form lakes or little rivers cooling the ground inside said facility and the air near the ground inside said facility. Evaporation cooling by water evaporation may contribute to the cooling effect. It is preferred to arrange the course of the coolant fluid such that it may circulate back to the refrigerating unit to be cooled again.

[0031] The cooling system may comprise a duct system like a pipe system for said coolant fluid. The duct system is preferably located below the surface of the area of said facility. Said duct system allows circulation of said coolant fluid. The duct system and the refrigerating unit may form a closed system for the coolant fluid, allowing circulation of said coolant fluid. The duct system should be installed just below the surface of the ground for allowing efficient thermal conduction between the duct system and the surface. Alternatively, the duct system may be an open system that releases cooled coolant fluid at selected locations in said facility. In the latter case, the coolant fluid may be air, nitrogen, or carbon dioxide, preferably air. If said duct system is a pipe system, the pipes are preferably made of metal.

[0032] The cooling system of the invention may make use of the Joule-Thomson effect for cooling the coolant fluid. The coolant fluid cooled using the Joule-Thomson

effect may be used directly for cooling said facility preferably in a closed system. Alternatively, the coolant fluid cooled using the Joule-Thomson effect is a primary coolant that cools a secondary coolant. Primary coolant fluids having a favourable Joule-Thomson effect for use in refrigerators are known in the art. The secondary coolant (e.g. water, air, etc.) may then be used (indirectly) for cooling said facility.

[0033] Said refrigerating unit should be capable of cooling said coolant fluid to a temperature between 0° and 30°C, preferably to a temperature between 5° and 25°C.

[0034] In the cooling system of the invention, various refrigerating units may be combined for achieving the desired cooling effect. For example, the cooling system may comprise air-conditioning refrigerating units and a refrigerating unit cooling a coolant fluid flowing or circulating on the ground surface or below the ground surface of said area. Further, the cooling system may comprise a device that produces and spreads aqueous fog, whereby heat is consumed upon transition of the fog to the gas phase.

[0035] Said refrigerating unit is most preferably an electrical refrigerating unit powered by a solar power plant, since solar energy is abundant in climatically hot environments, notably in sub-tropical environments like arab countries on the arabian peninsula.

Best mode of the invention

[0036] Open-air, air-conditioned residential or recreational facility in a climatically hot environment, said facility comprising

- (i) a physical boundary surrounding the area of said facility and elevating to a predetermined height above the ground surface of said facility, wherein said boundary is adapted for reducing the lateral exchange of air between the inside of said facility (inside said boundary) and the environment outside of said boundary; and
- (ii) an electrically-powered air-conditioning refrigerating unit for cooling the air near the ground surface of said area;

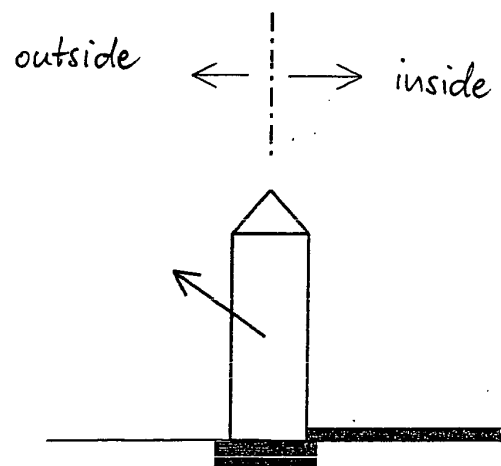
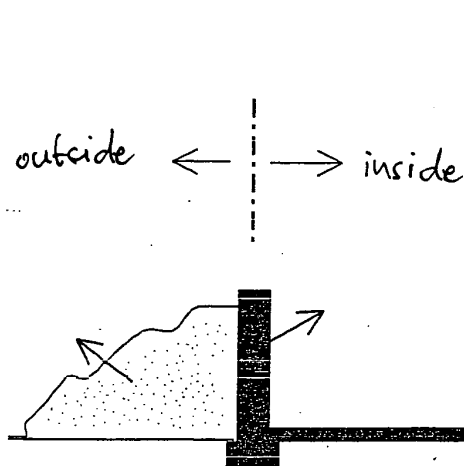
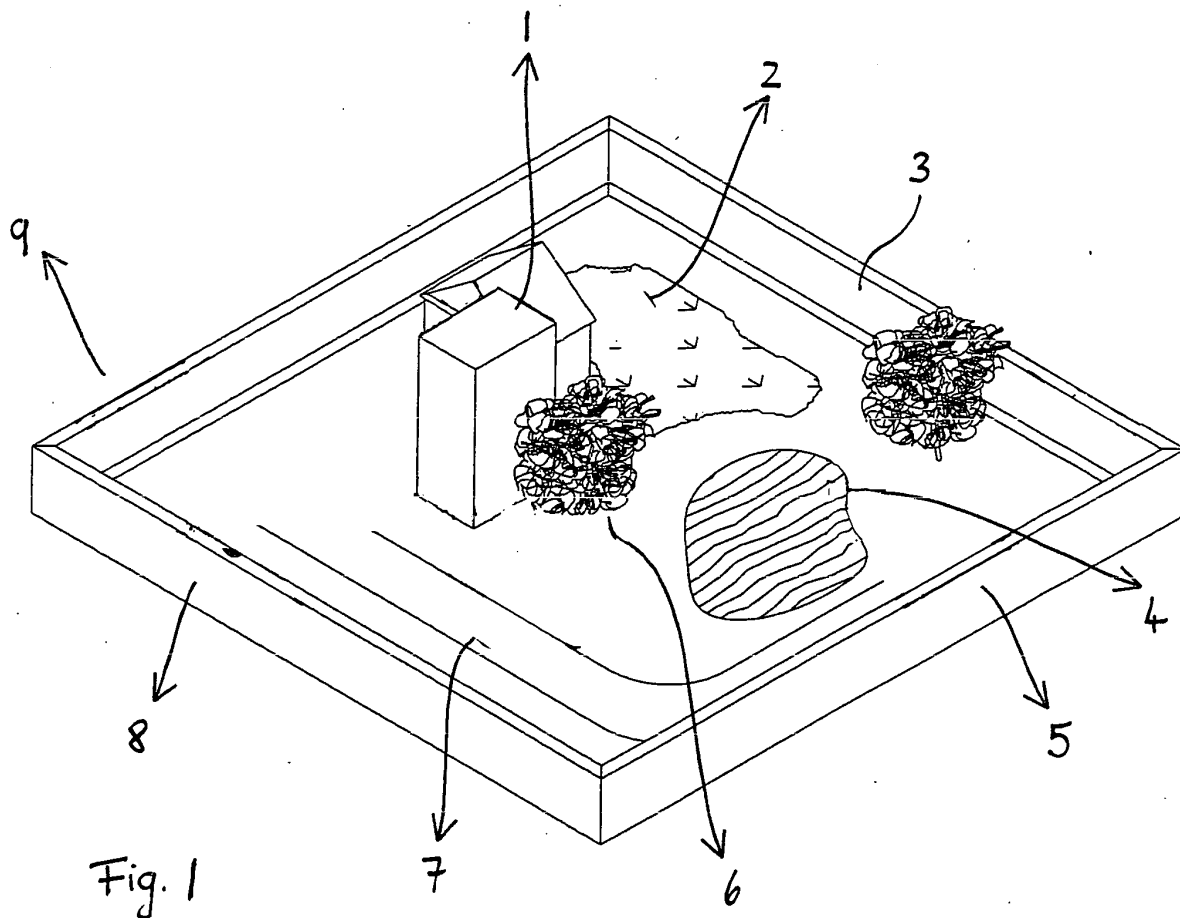
wherein said physical boundary surrounds said area completely without leaving an opening in said physical boundary that would allow significant loss of cooled air from said area to the outside of said area.

Claims

1. Open-air, air-conditioned residential or recreational facility in a climatically hot environment, said facility comprising

- (i) a physical boundary surrounding the area of

- said facility and elevating to a predetermined height above the ground surface of said facility, wherein said boundary is adapted for reducing the lateral exchange of air between the inside of said boundary and the environment outside of said boundary; and
- (ii) an electrically-powered cooling system for cooling the ground of said area and/or the air near the ground surface of said area.
2. The facility according to claim 1, wherein said physical boundary surrounds said area without leaving an opening in said physical boundary that would allow significant loss of cooled air from said area to the outside of said area.
3. The facility according to claim 1 or 2, wherein said boundary surrounds said area completely and prevents lateral exchange of air near the ground surface of said facility.
4. The facility according to any one of claims 1 to 3, wherein said cooling system comprises an air-conditioning refrigerating unit.
5. The facility according to any one of claims 1 to 4, wherein said cooling system comprises a refrigerating unit and a coolant fluid, said refrigerating unit being capable of cooling said coolant fluid.
6. The facility according to any one of claims 1 to 5, wherein said cooling system is powered by a solar power plant.
7. The facility according to any one of claims 1 to 6, wherein said physical boundary is or comprises a wall of a height of at least 2 m, preferably at least 3 m, more preferably at least 4 m.
8. The facility according to any one of claims 1 to 7, wherein said physical boundary is made of at least one material selected from the group consisting of: soil, concrete, brickwork, wood, glas, metal, plastic, and a woven or non-woven fabric tented between masts.
9. The facility according to any one of claims 1 to 8, wherein the size of said area, the height of said boundary, and said cooling system are mutually adjusted such that the air temperature near the surface of said area is at least 2°, preferably at least 5°, more preferably at least 7°C lower than the temperature in the environment during day time.
10. The facility according to any one of claims 1 to 9, wherein said facility comprises a dark or black area on the outside of said facility at said physical boundary, said dark or black area being capable of absorbing sun light for heating up the air above said dark or black area and for producing a flow of warm air ascending outside said boundary, said flow of ascending warm air forming a cushion of flowing warm air at the top end of said boundary.
11. The facility according to any one of claims 1 to 10, wherein the area of said facility inside said boundary has a size of at least 100 m², preferably at least 500 m², more preferably at least 2000 m², and most preferably at least 10 000 m².
12. A method of air-conditioning an open-air residential or recreational facility in a climatically hot environment, comprising providing
- (i) a physical boundary surrounding the area of said facility and elevating to a predetermined height above the ground surface of said facility, wherein said boundary is adapted for reducing the lateral exchange of air between the inside of said boundary and the environment outside of said boundary; and
- (ii) an electrically-powered cooling system for cooling the ground of said area and the air near the ground surface of said area.



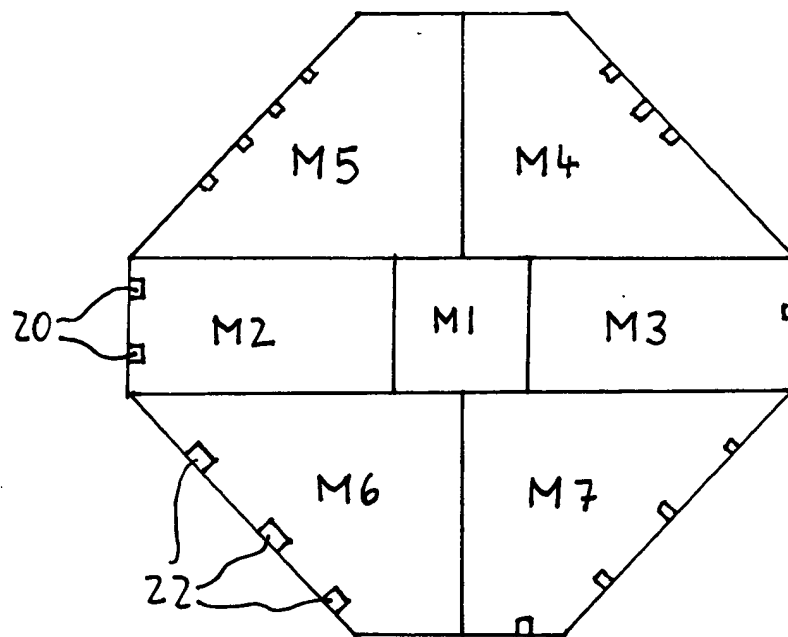


Fig. 4

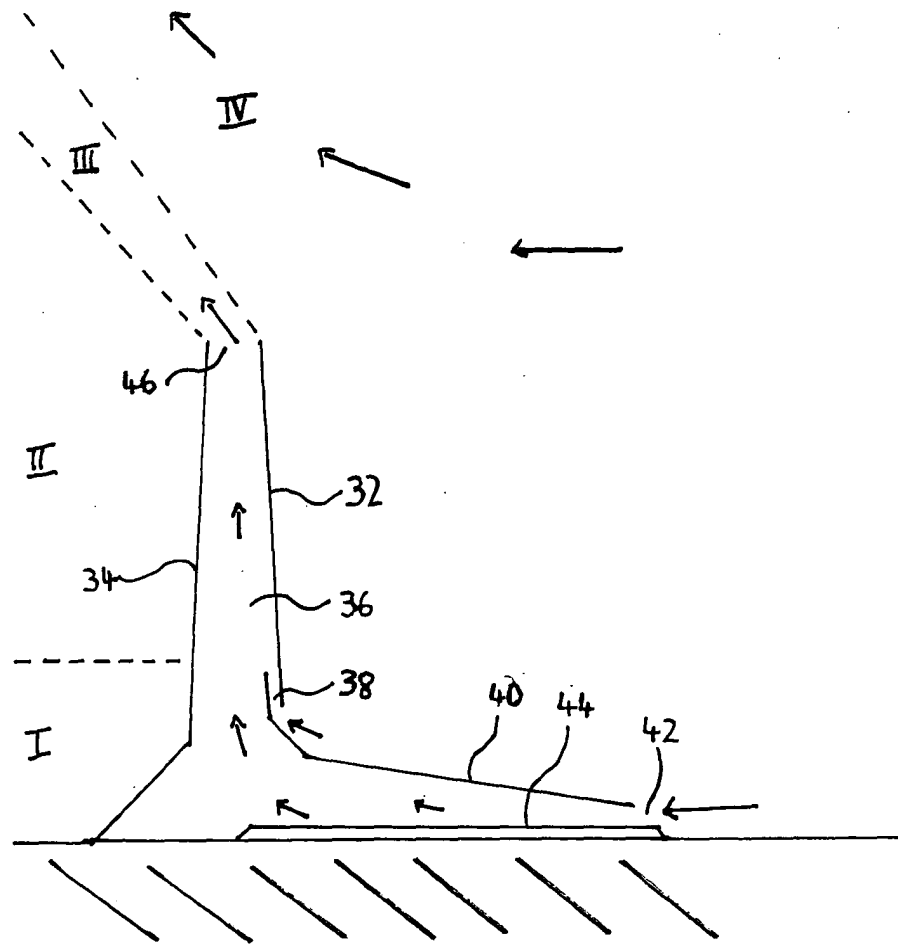


Fig. 5



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 02 8131

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			F24J E01C A01B B01D F24F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 March 2005	Examiner Valenza, D
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 02 8131

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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07-03-2005

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