

## **SPECIFICATION**

### **Title of the Invention**

**SUNSHADE**

### **Field of the Invention**

[0001]

The invention relates to a sunshade, and particularly to the sunshade including a combination of a plurality of sunshade members having a structure such that a plurality of light-shielding surfaces and gaps are three-dimensionally arranged therein.

### **Description of the Related Art**

[0002]

There has already been proposed a sunshade formed by combining a large number of sunshade members having so-called a fractal structure as a solution to overcome the heat-island phenomenon being increasingly serious in urban areas, and also contribution to reduce power consumption.

Patent Literature 1: Japanese Patent No. 5066215

Patent Literature 2: Japanese Patent No. 5315514

Patent Literature 3: Japanese Patent No. 5763977

Non-Patent Literature 1: Sierpinski's forest: New technology of cool roof with fractal shapes

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[0003]

Here, "a fractal structure" refers to a structure having a plurality of clusters, the clusters forming a hierarchical structure and the shape of the clusters belonging to respective hierarchies resembling each other. Sierpinski tetrahedron is known as one of such self-similar solid figures.

A sunshade member embodying such the fractal structure is in itself very complicated in shape, and therefore will be described in detail below, on the basis of Patent Literature 2.

[0004]

First, as illustrated in FIG. 19, a sunshade member 1 has the fractal structure including four basic components 2, 3, 4 and 5, each of the basic components 2, 3, 4 and 5 in itself having the fractal structure formed in units of dihedrons 11, 12, 13 and 14 formed by symmetrically integrated triangles of a same shape.

[0005]

Each of the basic components 2, 3, 4 and 5 is formed by arranging the four dihedrons 11, 12, 13 and 14 laterally, depthwise, and vertically adjacent to each other, which appear quadrangular when seen from a plane, and include the first dihedron 11 located at a reference position, the second dihedron 12 provided to the right of the first dihedron 11, the third dihedron 13 provided behind the first dihedron 11, and the fourth dihedron 14 provided on the upper side of the first to

the third dihedrons 11, 12 and 13.

[0006]

The sunshade member 1 is formed by arranging the four basic components 2, 3, 4 and 5 laterally, depthwise, and vertically adjacent to each other, and includes the first basic component 2 located at a reference position, the second basic component 3 provided to the right of the first basic component 2, the third basic component 4 provided behind the first basic component 2, and the fourth basic component 5 provided on the upper side of the first to the third basic components 2, 3 and 4.

[0007]

As illustrated in FIG. 20 in an enlarged manner, the four dihedrons 11, 12, 13 and 14 forming the basic component 2 (the same goes for the other basic components 3, 4 and 5) have the same shape, each of the dihedrons 11, 12, 13 and 14 includes small-triangular plates 11a, 12a, 13a and 14a forming the front face, and small-triangular plates 11b, 12b, 13b and 14b forming the side face.

[0008]

The first dihedron 11 includes lower edges 21 and 22 located on the lateral plane to form the two sides of the square in the lateral direction and the depthwise direction, a common edge 23 extending diagonally upward from the intersection between the lower edges 21 and 22 and forming the ridge R, and upper edges 24 and 25 respectively located nearer and farther in depth and connecting the top end of the common edge 23 and the ends of the lower edges 21 and 22.

[0009]

The second dihedron 12 includes a lateral lower edge 21 which is a lateral extension of the lateral lower edge 21 of the first dihedron 11, a depthwise lower edge 22 which is parallel to the depthwise lower edge 22 of the first dihedron 11, a common edge 23 which is parallel to the common edge 23 of the first dihedron 11, and nearer and farther upper edges 24 and 25 which are respectively parallel to the nearer and farther upper edges 24 and 25 of the first dihedron 11.

[0010]

The third dihedron 13 includes a depthwise lower edge 22 which is a depthwise extension of the depthwise lower edge 22 of the first dihedron 11, a lateral lower edge 21 which is parallel to the lateral lower edge 21 of the first dihedron 11, a common edge 23 which is parallel to the common edge 23 of the first dihedron 11, and nearer and farther upper edges 24 and 25 which are respectively parallel to the nearer and farther upper edges 24 and 25 of the first dihedron 11.

[0011]

The fourth dihedron 14 includes a common edge 23 which is a diagonally upward extension of the common edge 23 of the first dihedron 11, a nearer upper edge 24 which is a diagonally upward extension of the nearer upper edge 24 of the second dihedron 12, a farther upper edge 25 which is a diagonally upward extension of the farther upper edge 25 of the third dihedron 13, a lateral lower edge 21 which is parallel to the lateral lower edge 21 of the first dihedron 11, and a depthwise lower

edge 22 which is parallel to the depthwise lower edge 22 of the first dihedron 11.

[0012]

In FIG. 20, the small-triangular plates 11a, 12a and 14a forming the front faces of the first, the second, and the fourth dihedrons 11, 12 and 14, respectively lie on a same plane (front face), and the small-triangular plate 12b forming the side face of the second dihedron 12 is bent toward the bottom face relative to the front face so as to form a small triangular through-hole 15 on the front face of the basic component 2.

In addition, the small-triangular plates 11b, 13b and 14b forming the side faces of the first, the third, and the fourth dihedrons 11, 13 and 14, respectively lie on a same plane (side face), and the small-triangular plate 13a forming the front face of the third dihedron 13 is bent toward the bottom face relative to the side face so as to form a small triangular through-hole 15 on the side face of the basic component 2.

As thus described, the basic component 2 has a dihedral shape including a dihedron main body constructed by joining, via the ridge R, two medium triangular plates 2a and 2b having the small triangular through-hole 15 at the central part thereof, and small-triangular plates (protrusions) 12b and 13a bent toward the bottom face relative to the medium triangular plates 2a and 2b.

[0013]

In the sunshade member 1 including the four basic components 2, 3, 4 and 5, the medium triangular plates 2a, 3a

and 5a forming the front face of the first, the second, and the fourth basic components 2, 3 and 5 lie on a same plane (front face), and the medium triangular plate 3b forming the side face of the second basic component 3 is bent toward the bottom face relative to the front face so as to form a medium triangular through-hole 6 on a large triangular part 1a of the front face.

In addition, the medium triangular plates 2b, 4b and 5b forming the side face of the first, the third, and the fourth basic components 2, 4 and 5 lie on a same plane (side face), and the medium triangular plate 4a forming the front face of the third basic component 4 is bent toward to the bottom face relative to the side face so as to form the a medium triangular through-hole 6 on a large triangular part 1b of the side face.

As a result, a sunshade member assembly 1 has a dihedral shape including a dihedron main body constructed by joining, via the ridge R, two large triangular plates 1a and 1b having the medium-triangular through-hole 6 at the central part thereof, and medium-triangular plates (protrusions) 3b and 4a bent toward the bottom face relative to the large triangular plates 1a and 1b.

[0014]

Therefore, the sunshade block, which is an assembly of the sunshade members 1 illustrated in FIG. 21, is obtained by regarding the sunshade members 1 as basic components, arranging four of the sunshade members 1 laterally, depthwise, and vertically in a manner similar to the basic components 2, 3, 4 and 5, and a sunshade of a required size may be obtained by

increasing the number of sunshade blocks to be used, as appropriate.

[0015]

When forming a sunshade using the sunshade members 1 described above, a sunshade unit is formed by preparing a large number of sunshade blocks having four of the sunshade members 1 coupled together, and preliminarily assembling respective sunshade blocks to a rectangular frame member.

In addition, the sunshade is formed by mounting and securing a plurality of sunshade units on a base frame supported by a plurality of legs.

[0016]

Orienting the ridge R of each of the sunshade members 1 included in the aforementioned sunshade block to the south side causes the sunbeam to be blocked by the sunshade members 1, and therefore allows for exhibiting sunshade effect.

In addition, each of the sunshade members 1 has a large number of triangular through-holes formed thereon, with the light-shielding surfaces being distributed in the 3-dimensional space, which allows for quickly releasing heat into the air via a gap provided between the light-shielding surfaces.

## **Summary of the Invention**

### **Problem to be solved by the Invention**

[0017]

However, the aforementioned prior art is structured such

that Sierpinski tetrahedron is designated as light-shielding surfaces to block through-hole parts when seen from the certain direction, but increases sunlight leaked from the through-hole parts and deteriorates sunshade performance at the position shifted from the certain direction in time zones not noon namely at 11:00 AM or 1:00 PM when trying to block sunlight at noon maximally.

Additionally, if trying to maximize light-shielding performance at the end of July or at the beginning of August when sunlight is intense, light leaked from the through-hole parts increases and sun-shading performance deteriorates during the period before the middle of July or after the middle of August.

[0018]

In order to solve the aforementioned problems, the present invention aims at providing sunshade structure which hardly deteriorates its sun-shading performance even in time zones or seasons which are not time zones or seasons when sunlight is intense.

#### **Means for solving the Problem**

[0019]

To achieve the aforementioned object, a sunshade which, according to claim 1, is a sunshade including a plurality of sunshade blocks having arranged thereto, in alignment in a certain direction, a plurality of sunshade members having a plurality of light-shielding surfaces and a plurality of gaps

three-dimensionally arranged therein, and being structured so that, when observed from a predetermined light-shielding angle, the gaps are seen to be substantially shielded by respective light-shielding surfaces provided therebehind, and the sunshade members being formed by using a plurality of curved circular members produced by curving circular or oval plate materials, arranging the curved circular members such that the respective curved directions are aligned, and coupling the mutual ends with each other.

[0020]

The sunshade according to claim 2 is the sunshade of claim 1 further comprising: a plurality of sunshade units configured by assembling the sunshade blocks to a frame material with respective curved concave faces being in alignment in a certain direction; and a support structure which supports the sunshade units at a predetermined height from the ground.

[0021]

The sunshade according to claim 3 is the sunshade of claim 1 further comprising: a plurality of normal units configured by assembling the plurality of sunshade blocks to the frame material with respective curved concave faces being in alignment in a certain direction; a plurality of inverted units configured by assembling the plurality of sunshade blocks in a reversed manner to the frame material; and a support structure which supports the respective normal units and inverted units at a predetermined height from the ground, the normal units and inverted unit being arranged alternatively on the support

structure.

[0022]

The sunshade according to claim 4 is the sunshade of claim 2 or 3 further comprising an inclination means for mounting and securing the respective sunshade blocks between the frame material and support structure at a predetermined inclination angle relative to the ground.

This inclination means may be, for example, a means consisting of: a substrate arranged on the upper part of the support structure; a movable plate on which the unit of the sunshade members are mounted and secured; a hinge for rotatably securing the movable plate to the end of the substrate; and a spacer interposed between the substrate and the movable plate, in which inclination angles of the movable plate and the unit of the sunshade members are optionally adjustable by changing height of the spacer.

#### **Effects of the Invention**

[0023]

A sunshade according to the present invention is structured such that curved circular members forming light-shielding surfaces have circular or oval shapes that are surrounded by curved lines literally and their inflation parts overlap with each other between the ends of the curved circular members that are arranged on the upper side and the lower side.

This enables to alleviate deterioration of light-shielding performance due to changes of hours or seasons

more effectively than light-shielding surfaces of a conventional sunshades surrounded by linear lines.

#### **Best mode for carrying out the Invention**

[0024]

A sunshade according to the present invention is structured by combining a plurality of curved circular members 50, each of which is produced by curving an oval sheet material around the short axis (the short diameter) as illustrated in Fig.1 to Fig. 3. Respective convex surfaces 51 of the curved circular members 50 are aligned in a manner that face in the same direction.

[0025]

As illustrated in Fig. 1, (B) formed by joining the ends of each of short axes of one pair of the curved circular members 50 with each other is arranged on (A) formed by joining the ends of each of the long axes of one pair of the curved circular members 50 with each other, and the both ends of the long axis of each of the curved circular members 50 that are arranged on the upper side are joined to the vicinity of the both ends of the short axis of each of the curved circular members 50 that arranged on the lower side, namely four of the curved circular members 50 are combined three-dimensionally, which constitutes a basic component bloc 52.

[0026]

This basic component block 52 is "a sunshade member" which is a minimum unit for constituting a sunshade.

In this case, FIG. 2 illustrates that the one pair of curved circular members 50 that are arranged on the lower side are illustrated to have satin patterns for the convenience, which distinguishes them from the curved circular members 50 that are arranged on the upper side. Additionally, black spots in this figure represent joined parts.

[0027]

The convex surfaces 51 or concave surfaces 56 of the curved circular members 50 included in each of the basic component block 52 serve as light-shielding surfaces of the sunshade.

As illustrated in Fig. 2, gaps  $\alpha$  are generated between the one pair of the curved circular members 50 that are arranged on the upper side, however, it is designed such that the gaps  $\alpha$  are shielded by the concave surfaces 51 of the curved circular members 50 that are arranged on the lower side when observed from a plane.

Furthermore, as illustrated in FIG. 3, gaps  $\beta$  derived from convexity are present between the curved circular member 50 that are arranged on the upper side and the curved circular members 50 that are arranged on the lower side.

[0028]

The curved circular member 50 whose materials are not especially limited is formed by synthetic resins, metals including aluminum or wood etc.

A circular plate material instead of the oval curved circular member 50 may be curved around its diameter to constitute the curved circular member.

[0029]

As a method of joining the curved circular member 50 which is not also especially limited, bonding or welding etc. may be selected depending upon materials of the curved circular member 50.

Further, in case of being made of synthetic resins, the basic component block 52 may be formed in a state of the curved circular members 50 being connected through injection molding from the beginning.

[0030]

In case of making the light-shielding surface oval, the ratio of the long axis to the short axis is preferably between 2 to 1 and 1 to 1 (a circle), and more preferably 3 to 2.

As the sun travels from the east to the west, installing the basic component block 52 with the long axis directed in the east-west direction increases an area of shielding light to the ground.

An excessively large long axis decreases overlap of the light-shielding surfaces in the north-south direction, and easily introduces direct sunlight when a season has changed and sun altitude has changed.

[0031]

As the curved shape of the light-shielding surface, the ratio of linear line length in the long axis direction and height of the central part is preferably between 2 to 1 and 4 to 1, and more preferably 3 to 1.

If this ratio is smaller than 2 to 1, the light-shielding

surface is nearly plane, and air convection is hardly generated, which increases temperature. If this ratio is larger than 4 to 1, the direct sunlight is easily introduced when a season has changed from midsummer and the sun altitude has changed.

[0032]

By combining these basic component blocks 52 according to a certain rule, a large-scale sunshade block having a fractal structure (self-similar shape) is formed.

At first, by combining four of the basic component blocks 52 as illustrated in Fig. 4(a), a middle-sized block 53 having 16 of the curved circular members 50 is formed as illustrated in Fig. 4(b).

[0033]

Specifically, (D) formed by joining the ends of the short axes that are arranged on the upper side of one pair of the curved circular members 50 with each other is arranged on (C) formed by joining the ends of the long axes of the curved circular members 50 that are arranged on the lower side of the other pair of the basic component blocks 52 with each other, and the both ends of the long axis of each of the curved circular members 50 that are arranged on the upper side are joined to the vicinity of the both ends of the short axis of each of the curved circular members 50 that are arranged on the lower side, which constitute the middle-sized block 53.

[0034]

As illustrated in Fig. 5(a), combining four of the middle-sized blocks 53 forms a large-scale block 54 having 64

of the curved circular members as illustrated in Fig. 5(b).  
[0035]

Specifically, (F) formed by joining the ends of the short axis of each of the curved circular members 50 that are arranged at the top tier of one pair of the middle-sized blocks 53 with each other is arranged on (E) formed by joining the ends of the long axis of each of the curved circular members 50 that are arranged at the lowest tier of the other pair of the middle-sized blocks 53 with each other.

Then, the both ends of the long axis of the curved circular members 50 that are arranged at the lowest tier of each of the middle-sized block 53 on the upper side are joined to the vicinity of the both ends of the short axis of the curved circular members 50 that are arranged on the top tier of each of the middle-sized blocks 53 on the lower side, which completes the large-scale block 54.

[0036]

A pored protrusion 55 is provided with the end of the long axis of each of the curved circular members 50 that are arranged at the both ends of the lowest tier of the large-scale block 54.

Similarly, the pored protrusion 55 is also provided with the end of the short axis of each of the curved circular members 50 that are arranged at the both ends of the top tier of the large-scale block 54.

These pored protrusions 55 may be attached after forming the large-scale block 54 but the curved circular member 50

having the pored protrusion 55 that is preliminarily formed at the end of the long axis or the end of the short axis may be used.

[0037]

FIG. 6 to FIG. 8 illustrate three-dimensional images of this large-scale block 54 (however, the pored protrusion 55 is omitted for the convenience of illustration).

As illustrated in FIG. 6, when observed from a plane, it can be understood that the large-scale block 54 has almost no gaps, and the gaps between the basic component blocks 52 that are arranged on the upper side are almost completely shielded by the light-shielding surfaces (the convex surfaces 51 of the curved circular members 50) of the basic component blocks 52 that are arranged on the lower side.

[0038]

On the other hand, as illustrated in FIG. 7, if a point of view is shifted diagonally, it can be recognized that many gaps 57 are present between the curved circular members 50 or the basic component blocks 52.

Further, as illustrated in Fig. 8, observation of the large-scale block 54 from the just beside direction reveals that many large gaps 57 are present between the curved circular members 50 or the basic component blocks 52, which secures enough breathability.

[0039]

In this invention, as the large-scale block 54 may be used in a state of being directed in the same direction as the

direction illustrated in FIG. 6 or may be used with turned upside down, the former shall be referred to as a normal block 60, and the latter shall be referred to as an inverted block 61, in order to distinguish both.

[0040]

FIG. 9 shows a three-dimensional image illustrating the inverted block 61, in which the concave surface 56 of each of the curved circular members 50 forms the light-shielding surface.

At the top tier of the inverted block 61, 8 of the curved circular members 50 formed by connecting the end of each of the long axes with each other are arranged. Further, at its lowest tier, 8 of the curved circular members 50 formed by connecting the end of each of the short axes with each other are arranged.

[0041]

By using a plurality of the large-scale blocks 54, and arranging and fixing them on a frame as the normal blocks 60 as illustrated in Fig. 6, a normal unit for the sunshade is formed.

Fig. 10 and Fig. 11 illustrate one example of a process of forming a normal unit 70.

[0042]

As illustrated in Fig. 10, a first frame member 74 which has four vertical leaf sash bars 73 arranged and secured in a manner spaced apart in parallel from each other by a predetermined interval within a quadrangular frame formed by a pair of vertical sash bars 71 and a pair of lateral sash bars

72 is prepared.

[0043]

By having mounted the two normal blocks 60 on each of the vertical leaf sash bars 73 of the first frame member 74 and inserting a screw through each of the pored protrusions 55 of the curved circular members 50 at the lowest tier, the two normal blocks 60 are screwed with the lateral sash bars 72 or the vertical leaf sash bars 73.

[0044]

On this occasion, a common bis is inserted through the pored protrusion 55 of one normal block 60 and the pored protrusion 55 of the other normal block 60, which are screwed with the vertical leaf sash bars 73.

As a result of the foregoing, a total of eight of the normal blocks 60 forming the first tier are secured to the first frame member 74, as illustrated in Fig. 11(a).

[0045]

Next, as illustrated in Fig. 11(b), the normal blocks 60 forming the second tier are mounted on an adjacent pair of the normal blocks 60.

On this occasion, the pored protrusion 55 of the curved circular member 50 at the lowest tier of the normal blocks 60 on the upper side is positioned with the pored protrusion 55 of the curved circular member 50 at the top tier of the normal block 60 on the lower side, and the respective holes are secured with a screw and a nut.

[0046]

Repeating the work results in completion of the normal unit 70 having a total of 13 of the normal blocks 60 mounted thereon (eight on the first tier, and five on the second tier) as illustrated in FIG. 11(c).

On this occasion, with regard to each of the normal blocks 60 forming the second tier, the pored protrusion 55 at the top tier of the anterior normal block 60 and the pored protrusion 55 at the top tier of the posterior normal block 53 are mutually joined via the screw and the nut.

[0047]

Fig. 12 illustrates the second frame member 75, which has two of the lateral leaf sash bars 76 arranged and secured in a manner spaced apart in parallel from each other by a predetermined interval within a quadrangular frame formed by a pair of the vertical sash bars 71 and a pair of the lateral sash bars 72.

[0048]

By having mounted the inverted blocks 61 on each of the lateral leaf sash bars 76 of the second frame member 75, and inserting the screw through each of the pored protrusion 55 at the lowest tier, and screwing it with the lateral leaf sash bar 76 or the vertical sash bar 71, the inverted blocks 61 are secured.

[0049]

On this occasion, the pored protrusion 55 of one inverted block 61 at the top tier and the pored protrusion 55 of the other adjacent inverted block 61 at the top tier are connected with

a screw and a nut.

As a result of the foregoing, a total of eight of the inverted blocks 61 forming the first tier are secured to the second frame member 75, as illustrated in FIG. 13(a).

[0050]

Next, the inverted blocks 61 forming the second tier are mounted on the inverted blocks 61 at the first tier, illustrated in FIG. 13(b).

On this occasion, by positioning the pored protrusion 55 of the curved circular member 50 at the lowest tier of the inverted block 61 on the upper side with the pored protrusion 55 of the curved circular member 50 at the top tier of the inverted block 61 on the lower side, and inserting the screw through the respective holes, the holes are secured with the nut.

Further, the pored protrusion 55 at the top tier of each of the inverted blocks 61 forming the second tier is mutually connected to the pored protrusion 55 at the top tier of the other inverted block 61 lateral thereto via the screw and the nut.

[0051]

Repeating the work results in completion of an inverted unit 77 having a total of 17 of the inverted blocks 61 mounted thereon (eight on the first tier, and nine on the second tier) as illustrated in FIG. 13(c).

[0052]

The normal units 70 and the inverted units 77 are preliminarily produced in a factory as many as needed, and

subsequently transported by truck to the installation site where they are assembled into a sunshade.

FIG. 14, in which a completed sunshade 80 is exemplified, illustrates a base frame 83 being mounted on a plurality of legs 82 set up perpendicular to an installation surface 81, and the normal units 70 and the inverted units 77 being secured thereon.

The normal units 70 and the inverted units 77 are lifted above the base frame 83 by a forklift or a truck mounted crane, and secured by a connector which is not illustrated.

[0053]

FIG. 15, which is a plan view of the sunshade 80, illustrates the normal units 70 and the inverted units 77 being alternately arranged in depthwise and lateral directions.

As thus described, arranging the normal units 70 including a plurality of the normal blocks 60 and the inverted units 77 including a plurality of the inverted blocks 61 in a so-called checked pattern results in engagement of a block protruding from one unit with an empty space in the other unit, thereby making it possible to efficiently form the light-shielding surfaces with narrowed gaps.

[0054]

The invention, however, is not limited to such a structure, and does not exclude formation of a sunshade using only a large number of sunshade units of either the normal units 70 or the inverted units 77.

In addition, when forming a sunshade using such sunshade units, although there is a possibility that gaps may occur at

some places of the light-shielding surface, it suffices to fill individual gaps by assembling additional sunshade blocks.

[0055]

In addition, the configuration of each sunshade unit is not limited to the foregoing and a wide range of variation is conceivable with regard to the number of, or the interval between the vertical leaf sash bars 73 or the lateral leaf sash bars 76, the number of, or the manner of installing the sunshade blocks to be installed or the number of tiers.

[0056]

As has been described above, orienting the long axis of each of the curved circular members 50 included in each sunshade block to the east-west side causes the sunbeam to be shielded by the convex surfaces 51 or the concave surfaces 56 of the curved circular members 50, and therefore allows for exhibiting sunshade effect. The direction of installation is not, however, limited to this.

[0057]

In addition, a large number of gaps 57 are formed between the curved circular members 50 or the basic component blocks 52 constituting a sunshade block, with the light-shielding surfaces being distributed in the 3-dimensional space, and the respective curved surfaces of the curved circular surfaces 50 causing convection of air, thus allowing for quickly releasing heat into the air via the gaps 57.

[0058]

The curved circular members 50 forming the

light-shielding surfaces have fundamentally "oval shapes" that are surrounded by curved lines literally and their inflation parts overlap with each other between the ends of the curved circular members 50 that are arranged on the upper side and the lower side (See FIG. 2).

This enables to alleviate deterioration of light-shielding performance due to changes of hours or seasons than light-shielding surfaces of conventional sunshade members surrounded by linear lines.

[0059]

FIG. 16 is a photograph of shade on the ground at culmination time in the beginning, middle and end of July in order to confirm sunlight-shielding performance of a conventional block structured by folding a tetrahedron along a diagonal line.

[0060]

This conventional sunshade block is installed at an angle at which sunlight in the beginning of July can be shielded maximally, and thus cast shade in their almost all areas from which sunlight is hardly leaked in the beginning of July as illustrated in FIG. 16(a).

On the other hand, as illustrated in FIG. 16(b), it can be recognized that an area of shade decreases, and in proportion to this, an area of a filtered sunlight region  $\gamma$  expands when the middle of July comes.

When the end of July comes, as illustrated in FIG. 16(c), it can be seen that an area of the filtered sunlight region  $\gamma$

further expands and a light-shielding region retreats.

[0061]

On the other hand, FIG. 17 illustrates sunlight-shielding performance of the sunshade block formed by using the curved circular members 50, and shows photographs of shade on the ground at culmination time in the beginning, middle and end of July in the same manner as above.

[0062]

Also in this case, it can be confirmed that the sunshade block is installed at an angle at which sunlight in the beginning of July can be shielded maximally but hardly generates the filtered sunlight region  $\gamma$  while maintaining high light-shielding performance even when the middle and end of July come as illustrated in FIG. 17(b) and (c).

The following curved circular member 50 was used in this test.

long axis: 56 mm

short axis: 37.5 mm

height of convexity: 18.8 mm

[0063]

An example in which the normal units 70 and the inverted units 77 are provided and secured horizontally relative to the installation surface 81 was shown in the foregoing, but the normal units 70 and the inverted units 77 may be provided and secured at an optional inclination angle relative to the installation surface 81.

[0064]

FIG. 18 illustrates one example thereof, in which the normal units 70 and the inverted units 77 are provided on a movable plate 84 that is inclined at a predetermined angle and secured with via screws or the like which are not illustrated.

A tip of the movable plate 84 is rotatably secured to the base frame 83 via a hinge 85.

[0065]

A plurality of spacers 86 each of which has a trapezoid cross section are provided and secured between the basic frame 83 and the movable plate 84.

Namely, at a position close to the hinge 85, a first spacer 86a which is comparatively low is provided and secured, while on a rear end side of the movable plate, a third spacer 86c which is comparatively high is provided and secured. A second spacer 86b having medium height is provided and secured near the middle of both spacers.

The upper surface of each spacer 86 is formed as an inclined surface with an angle equivalent to an inclination angle of the movable plate 84.

Due to presence of these spacers 86, an inclination angle of the movable plate 84 is maintained constant, and the number of installed spacers or parts where they are installed are not especially limited.

[0066]

The inclination angle of the movable plate 84 can be easily adjusted by replacing each of the spacers 86 by a spacer having different height.

Namely, instead of the first spacer 86a to the third spacer 86c, by using spacers higher than the above spacers, the inclination angle of the movable plate 84 can be expanded, which is not, however, illustrated.

Alternatively, on the contrary, replacing each of the first spacer 86a to the third spacer 86c by a spacer lower than the above spacers, the inclination angle of the movable plate 84 can be reduced.

[0067]

In this way, making the inclination angle of the normal units 70 and the inversed units 77 variable provides an advantage that one type of large-scale block 54 (the normal blocks 60 and the inverted blocks 61) constituted by the curved circular members 50 having the same structure is available in various places in the world with different latitude.

For example, if providing the sunshade 80 at a position right on the equator, an angle of the movable plate 84 is lowered to the nearly horizontal level.

On the other hand, if providing the sunshade 80 in Japan located in the Northern Hemisphere, the inclination angle of the movable plate 84 is set to a large value.

[0068]

The inclination angle of the movable plate 84 is not especially limited but can be determined, for example, based on the following formula in the Northern Hemisphere.

■ The inclination angle of the movable plate 84 = latitude of a part where it is installed - 23.4 degrees (inclination of

the earth's axis)

An angle obtained by this formula refers to an inclination angle that is optimized for the sun altitude at the summer solstice at a part where it is installed. If, however, trying to shift the sun altitude matching with the optimum shielding angle of each of the sunshade members to the sun altitude of any time after the summer solstice, this can be attained by returning the inclination angle to the horizontal direction by 8 degrees monthly.

However, returning the inclination angle to the horizontal direction by 20 degrees or more decreases a rate of shielding direct sunlight at the summer solstice, which is not preferable.

[0069]

An inclination means of the normal units 70 and the inverted units 77 is not limited to the above-described combination of "the movable plate 84, the hinge 85, the base frame 83, and the spacer 86".

### **Brief Description of Drawings**

[0070]

FIG. 1 is a perspective view illustrating a basic component block;

FIG. 2 is a plan view illustrating a basic component block;

FIG. 3 is a side elevation view illustrating a basic component block;

FIG. 4 is an assembly view and a plane view of a

middle-sized block;

FIG. 5 is an assembly view and a plane view of a large-scale block;

FIG. 6 is a three-dimensional image of a normal block;

FIG. 7 is a three-dimensional image of a normal block;

FIG. 8 is a three-dimensional image of a normal block;

FIG. 9 is a three-dimensional image of an inverted block;

FIG. 10 is an assembly view of a normal unit;

FIG. 11 is a plane view illustrating a process of forming a normal unit;

FIG. 12 is an assembly view of an inverted unit;

FIG. 13 is a plan view illustrating a process of forming an inverted unit;

FIG. 14 is a side elevation view illustrating a sunshade formed using normal units and inverted units;

FIG. 15 is a plan view illustrating a sunshade formed using normal units and inverted units;

FIG. 16 is a view illustrating sunlight-shielding performance of a conventional sunshade block;

FIG. 17 is a view illustrating sunlight-shielding performance of a sunshade block according to the present invention;

FIG. 18 is a side elevation view illustrating a sunshade in which the normal units and the inverted units are provided and secured on a movable plate that is provided in an inclined manner;

FIG. 19 is a perspective view illustrating a conventional

sunshade member;

FIG. 20 is an enlarged perspective view of basic components of the conventional sunshade member; and

FIG. 21 is a perspective view illustrating a sunshade block assembled using four conventional sunshade members.

### **Explanation of references**

[0071]

|    |                                      |
|----|--------------------------------------|
| 50 | curved circular member               |
| 51 | convex surface                       |
| 52 | basic component bloc (sunshade unit) |
| 53 | middle-sized block                   |
| 54 | large-scale block                    |
| 55 | pored protrusion                     |
| 56 | concave surface                      |
| 57 | gap                                  |
| 60 | normal block                         |
| 61 | inverted block                       |
| 70 | normal unit                          |
| 71 | vertical sash bar                    |
| 72 | lateral sash bar                     |
| 73 | vertical leaf sash bar               |
| 74 | first frame member                   |
| 75 | second frame member                  |
| 76 | lateral leaf sash bar                |
| 77 | inverted unit                        |
| 80 | sunshade                             |

- 81     installation surface
- 82     leg
- 83     base frame
- 84     movable plate
- 85     hinge
- 86     spacer
- 86a   first spacer
- 86b   second spacer
- 86c   third spacer

## CLAIMS

1. A sunshade including a plurality of sunshade blocks having arranged thereto, in alignment in a certain direction, a plurality of sunshade members having a plurality of light-shielding surfaces and a plurality of gaps three-dimensionally arranged therein, and being structured so that, when observed from a predetermined light-shielding angle, the gaps are seen to be substantially shielded by respective light-shielding surfaces provided therebehind, and the sunshade members being formed by using a plurality of curved circular members produced by curving circular or oval plate materials, arranging the curved circular members such that the respective curved directions are aligned, and coupling the mutual ends with each other.

2. The sunshade according to claim 2 further comprising:  
a plurality of sunshade units configured by assembling the sunshade blocks to a frame material with respective curved concave faces being in alignment in a certain direction; and  
support structure which supports the sunshade units at a predetermined height from the ground.

3. The sunshade according to claim 1 further comprising: a plurality of normal units configured by assembling the plurality of sunshade blocks to the frame material with respective curved concave faces being in alignment in a certain

direction;

a plurality of inverted units configured by assembling the plurality of sunshade blocks in a reversed manner to the frame material; and

a support structure which supports the respective normal units and inverted units at a predetermined height from the ground,

the normal units and inverted unit being arranged alternatively on the support structure.

4. The sunshade according to claim 2 or 3 further comprising an inclination means for mounting and securing the respective sunshade blocks between the frame material and support structure at a predetermined inclination angle relative to the ground.