

DESCRIPTION

Lighting system

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TECHNICAL FIELD

The present invention relates to a lighting device comprising a lighting panel, at least one light source, assigned to a narrow side of the lighting panel, for
10 coupling light into the lighting panel, and a reflector facing a flat side of the lighting panel, wherein the flat side of the lighting panel facing the reflector and/or the reflector is provided with a surface structure.

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PRIOR ART

Such lighting devices can be used in buildings or in outdoor spaces and can serve as room illumination,
20 decoration element or design element, with other uses however also being conceivable. In particular, such lighting devices can serve as a structural and/or decoration element of gaming and/or entertainment devices, such as casino machines or other operating
25 terminals.

In order to achieve a high luminosity without a blinding effect, the light emitted in such lighting devices by the at least one light source - for example
30 an LED band or an LED arrangement - is coupled on the narrow side into a relatively large-area lighting panel and emitted by way of the flat side thereof in an at least partly distributed manner. In order to obtain a uniform light distribution in the lighting panel
35 despite the narrow-side light feed, one flat side of the lighting panel can be provided with a light-scattering or light-refractive surface structure, which e.g. can be embodied in the form of printing on the surface. In particular, such a surface structure can be

provided in conjunction with a reflector facing the
aforementioned flat side of the lighting panel, said
reflector reflecting light emerging out of the lighting
panel from the aforementioned flat side into the
5 lighting panel or onto the flat side thereof such that
the light passes through the aforementioned surface
structure at least twice and, to this extent, is
scattered multiple times at the surface structure. The
light reflected into the lighting panel by the
10 reflector can emerge from the flat side of the lighting
panel lying opposite to the reflector.

A lighting device of the aforementioned type is known
from the document US 2012/0287631A1, according to which
15 a lighting panel in the form of an acrylic panel is
also covered a rear side by a reflector panel, wherein
the flat side facing the reflector of the
aforementioned panel is provided with a cloud-shaped
surface structure in the form of ink printing. The
20 aforementioned cloud-shaped surface structure should in
this case have an ever decreasing degree of filling -
i.e., so to speak, a reducing cloud density - with
increasing distance from the light source arranged on
the narrow side. From such a changing filling density
25 of the surface structure, the aforementioned document
expects light emission or light transmission, uniform
overall over the flat side, into an emission panel
placed on the front side in front of the aforementioned
acrylic panel.

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However, what was found in practice is that the
brilliance of the emitted light and the luminosity of
the lighting panel are relatively restricted in this
known lighting device and, overall, there is relatively
35 diffuse emission. The efficiency, particularly in the
edge regions of the lighting panel, is impaired as a
result of the surface printing becoming ever denser
toward the light sources.

SUMMARY OF THE INVENTION

Proceeding therefrom, the present invention is based on
5 the object of developing an improved lighting device of
the aforementioned type, which avoids the disadvantages
of the prior art and advantageously develops the
latter. In particular, a uniform, brilliant light
10 emission with high luminosity should be achieved by the
lighting panel, even with limited powers of the light
sources. Preferably, illumination to different sides of
the room or a good visibility from different locations
should be achieved.

15 According to the invention, the aforementioned object
is achieved by a lighting device in accordance with
claim 1. Preferred refinements of the invention are the
subject matter of the dependent claims.

20 Thus, it is proposed to form the surface structure
provided between reflector and lighting panel no longer
in a cloud-shaped manner but in the form of a line grid
made of continuous, crossing lines, said line grid
extending uniformly over the flat side of the lighting
25 panel facing the reflector and/or the reflector
surface. Surprisingly, high equalization of the light
emission from the lighting panel can also be achieved
by such a simple line grid, as a result of which it is
possible to avoid relatively large transmission losses
30 in the edge regions of the lighting panel, as were
known in the prior art.

In an advantageous development of the invention, the
surface structure can have a mesh size which remains
35 substantially unchanged over the flat side of the
lighting panel and/or an unchanging degree of filling.
The surface structure can be embodied to have
approximately the same density in edge regions of the

panel as in a central region of the lighting panel and various edge regions of the lighting panel and/or of the reflector facing the lighting panel can have a uniformly dense surface structure or a substantially
5 equal grid density or mesh size independently of the arrangement of the light source - for example at only a narrow side of the lighting panel, or else at opposite narrow sides or a plurality of narrow sides of the lighting panel.

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Here, the grid lines of the grid structure can have a straight extent, with this however not being mandatory. By way of example, the continuous, crossing grid lines can also have an arcuate or e.g. a sinusoidal extent.

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In a development of the invention, the surface structure has a relatively thin embodiment and/or the degree of filling of the surface structure, i.e. the surface portion of the surface structure relative to
20 the unstructured surface portion and/or in relation to the overall area of the lighting panel, is relatively low. This can be achieved by a relatively large mesh size in the case of a relatively small line width. In a development of the invention, the surface structure can
25 have a degree of filling of approximately 1 percent to 25 percent, preferably 5 percent to 15 percent, of the overall surface of the flat side of the lighting panel, wherein the aforementioned degree of filling may also be provided if the surface structure is provided on the
30 reflector surface or on an intermediate layer or an intermediate panel, for example in the form of an intermediate film between the aforementioned lighting panel and the aforementioned reflector.

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In an advantageous development of the invention, the line grid can have a mesh size of 2 to 3 mm. A line width can be less than 0.5 mm, in particular approximately in the range from 0.01 to 0.2 mm.

Depending on the line profile, the line grid can have different crossing angles, wherein, preferably, the line profile is embodied in such a way that the crossing angles remain substantially unchanged over the flat side. In principle, a crossing angle of 90 degrees could be considered here, particularly if a straight line profile is provided. However, it was surprisingly found that a crossing angle deviating from 90 degrees is advantageous, in particular a crossing angle in the range from approximately 60 degrees to 80 degrees - or in the range from 100 degrees to 120 degrees when the complementary, larger crossing angle is considered. Even more multifaceted light scattering and hence a greater equalization can be achieved by such an intersection of the grid lines.

Advantageously, the grid lines are arranged at an angle relative to the narrow side of the lighting panel - or to the plurality of narrow sides of the lighting panel - by means of which the light is coupled into the lighting panel from the light source such that the grid lines extend neither parallel nor perpendicular to the aforementioned narrow side.

The grid structure can consist of printing on the panel and/or reflector surface, for example by means of suitable ink or printing color, wherein, however, a different embodiment, for example in the form of surface etching, engraving or milling or grinding, could also be provided where necessary.

Here, in an advantageous development of the invention, the grid lines are not black but have a light embodiment, in particular with a white color or a color similar to white. Transmission losses can be significantly reduced compared to dark or even black printing, but, surprisingly, it is nevertheless

possible to obtain a high equalization of the light distribution.

In principle, the light can be emitted from the lighting panel in different ways. In a simple development of the invention, the light can be emitted directly from the lighting panel into which the light is preferably coupled from the narrow side, in particular via the flat side of the lighting panel facing away from the reflector. Alternatively, or additionally, a further lighting panel and/or emission panel can be disposed downstream of the aforementioned lighting panel into which the light is coupled, for example in such a way that the light which emerges from the flat side of the first panel facing away from the reflector enters into the downstream panel, propagates further in this downstream panel and is emitted by this downstream panel or an even further downstream lighting panel. In particular, such an emission panel can sit with a flat side on the flat side of the lighting panel facing away from the reflector, into which the light is fed, preferably with two-dimensional contact between the two panel flat sides or, alternatively, also forming an intermediate gap.

Here, the lighting device can comprise one or more emission surfaces, wherein a panel flat side - of the first or of a downstream panel - facing away from the reflector, in particular, can serve as emission surface such that the light is emitted substantially across, in particular perpendicular to, the input coupling direction of the light, in which the light is coupled into the lighting panel on the narrow side.

Alternatively, or additionally, provision can also be made in a development of the invention of an emission surface which is aligned substantially across the flat side of the lighting panel such that the light is

emitted substantially parallel to the plane in which the light is coupled into the lighting panel on the narrow side. Advantageously, this emission surface with a transverse alignment is arranged offset from the incoming radiation plane such that the light coming from the light source assumes a step-shaped or stair-shaped propagation or emission path through the lighting panel.

By way of such an embodiment of the lighting panel or arrangement of the emission surface, the lighting device is able, so to speak, to shine around the corner and illuminate a spatial region to the side of the flat side of the lighting panel.

In an advantageous development of the invention there can be a multi-axis emission or the lighting device can have a plurality of chief emission directions which are preferably perpendicular to one another. In an advantageous development of the invention, the lighting panel and/or emission panel can have an emission surface formed by the flat side of the panel facing away from the reflector and at least one further emission surface formed by a narrow side of the aforementioned lighting panel and/or emission panel.

Advantageously, the aforementioned lighting panel and/or emission panel can comprise a narrow side which is surrounded by a device housing, with the light being coupled into the aforementioned panel by way of said narrow side, wherein, in particular, the at least one light source, for example in the form of an LED arrangement, can be arranged between an inner side of the aforementioned device housing and the aforementioned panel narrow side. In addition to this input coupling narrow side, the aforementioned lighting panel, or a downstream emission panel, can comprise a further panel narrow side which is not covered by the

aforementioned device housing and/or which projects out of the device housing and/or which is arranged in an exposed manner such that there can be light emission via this aforementioned further end side. The
5 aforementioned further panel narrow side can lie in the plane of the input coupling narrow side, but advantageously it can also be arranged offset in relation to the input coupling narrow side in a direction perpendicular to the panel flat side such
10 that an overall stair-shaped or step-shaped light course emerges through the panel or the panels between the light source and the aforementioned exit narrow side.

15 The lighting device can have various forms and embodiments. In an advantageous development of the invention, the lighting device can be embodied as a preferably arcuate portal in the style of a gate, which spans a clear space and/or has a self-supporting
20 embodiment. The portal can have a floor contact area or feet and can be able to be put up freely on the floor in a self-supporting manner. Alternatively, or additionally, the portal can be connected to a structure to be spanned, for example a gaming table, or
25 anchored thereon.

Advantageously, the portal can have a modular design and be assemblable from a plurality of portal parts, in particular straight base parts and at least one bent
30 and/or kinked connection part, wherein the portal parts are preferably contoured in such a way that the portal parts can be brought into holding engagement with one another in an interlocking manner, in particular are pluggable into one another, such that the portal parts
35 together form a stiff portal structure.

At least one display device for displaying information can be arranged on the portal, preferably in the region

of a portal top or upper restriction region, wherein, for example, two screens aligned toward opposite sides can be provided. The display device can be fastened to the portal or mounted at a different position.

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Advantageously, the portal can be used to span a gaming and/or entertainment machine such as a gaming table in a casino or gaming establishment, or else for spanning other structures to be highlighted, such as delivery
10 tables in warehouses, or else it can be used outdoors.

BRIEF DESCRIPTION OF THE DRAWINGS

Below, the invention will be explained in more detail
15 on the basis of a preferred exemplary embodiment and associated drawings. In the drawings:

figure 1 shows a cross section through a lighting
device along the line A-A in figure 4
20 according to an advantageous embodiment of the invention, said cross section showing the arrangement of a lighting panel in a device housing and the assignment of the light source to the lighting panel, and showing the
25 arrangement of a reflector at a panel rear side,

figure 2 shows a perspective plan view on the flat
side of the lighting panel from figure 1,
30 provided with a grid surface structure, said perspective plan view showing the line grid made of continuous, crossing grid lines,

figure 3 shows a frontal plan view of the line grid of
35 the lighting panel from figure 2, said frontal plan view elucidating the mesh size and line width,

figure 4 shows a side view of the overall arcuate lighting device and the arrangement thereof over a gaming table,

5 figure 5 shows a lateral plan view of the lighting device from figure 4,

figure 6 shows a perspective side view of a post-shaped portal base part of the lighting portal from figures 4 and 5,

figure 7 shows a perspective side view of an arcuate portal base part of the lighting portal from figures 4 and 5, which can be assembled with the post-shaped portal base part from figure 6, and

figure 8 shows a sectional view of a portal part from figure 6 or 7, which shows the integration of the lighting device functional components into the portal and the arrangement thereof in relation to one another.

IMPLEMENTING THE INVENTION

25 As shown in figures 4 and 5, the lighting device 1 can be embodied in the form of a lighting arc or lighting portal which can arc in the style of a doorframe or in the style of a doorway arch over a gaming table 12, for example in the form of a roulette table, or a different gaming or entertainment machine, or which can span a clear space 28. Here, the lighting device 1 can have a - loosely speaking - rectangular or box-shaped cross section, the flat sides of which extend to the outer sides and inner sides of the aforementioned lighting arc and the narrow sides of which can extend in the passage direction of the lighting arc. However, it is

understood that the lighting device can also have different contouring and different geometries.

As shown by figures 4 to 7, the gate or the portal 27,
5 into which the lighting device 1 is integrated, can have a modular design and be assemblable from a plurality of portal parts, in particular straight base parts 27a and 27d and at least one, or a plurality of, bent and/or kinked connection parts 27b and 27c,
10 wherein the portal parts 27a-d are preferably contoured in such a way that the portal parts 27a-d can be brought into holding engagement with one another in an interlocking manner, in particular are pluggable into one another, such that the portal parts 27a-d together
15 form a stiff portal structure.

As figures 1 to 3 show, the gate-shaped lighting device can comprise a plate-shaped, in particular plane, lighting panel 2 which can be arranged in a preferably
20 box-shaped device housing 3. As shown in figure 1, the device housing 3 can surround the narrow sides 13 and 14 of the aforementioned lighting panel 2 in particular and also cover a rear side or a rear-side flat side 8 with a housing wall 15.

25 As shown with a dashed representation in figure 1, two such lighting panels 2 can be integrated into the device housing 3, which lighting panels can advantageously be aligned toward opposite sides. If the
30 lighting device 1 is embodied in the form of a lighting arc or lighting portal, as is shown in figures 4 and 5, the aforementioned lighting panels 2 can be oriented toward the end sides of the lighting arc.

35 A light source 7 in the form of an LED band or another LED arrangement can be assigned to the aforementioned narrow sides 13 and 14 of the lighting panel 2 such that the light source 7 radiates light into at least

one of the aforementioned narrow sides 13 and 14 such that the light is coupled into the lighting panel. In particular, the light source 7 can be arranged directly opposite to the aforementioned narrow side 13 or 14, for example be fastened to the inner side of the device housing 3.

A reflector 5 is assigned to a flat side 8 of the lighting panel 2 facing the housing interior, said reflector capturing light emerging from the aforementioned flat side 8 and reflecting it into the lighting panel 2. The aforementioned reflector 5 can likewise have a panel-shaped or plate-shaped, in particular plane, embodiment and can sit directly on the aforementioned flat side 8 of the lighting panel 2 or be arranged with a slit-shaped distance therefrom. By way of example, the reflector 5 can form a reflector panel or it can be applied onto the flat side 8 in the form of a reflector film or reflector coating.

As figures 2 and 3 show, a surface structure 6 embodied as a line grid is provided on the flat side 8 of the lighting panel 2 facing the reflector 5, which line grid can consist of continuous, crossing grid lines 9 which may be printed onto the lighting panel 2, for example in the form of an ink or colored print. Advantageously, the aforementioned grid lines 9 or the surface structure 6 is/are embodied in white or a color which is similar to white or very light.

As figures 2 and 3 show, the grid lines 9 can have a straight profile and intersect under a crossing angle of approximately 60 to 80 degrees. The degree of filling of the surface structure 6 is advantageously relatively low, in particular embodied in the range set forth at the outset. By way of example, this can be obtained by the ratio, visible in the figures, of a relatively large mesh size to a relatively thin line

width. Advantageously, the mesh size can be in the range of a couple millimeters, e.g. 2 to 3 mm, while the line width can be only a fraction of a millimeter, for example in the range from 0.05 to 0.5 mm.

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Advantageously, the mesh size can have an unchanging mesh size and/or an unchanging degree of filling over the whole area of the lighting panel 2 or the whole lighting panel portion provided with the surface structure 6, i.e. the density of the grid structure substantially does not change over the extent of the lighting panel 2.

By way of the aforementioned surface structure 6, the light, which wants to emerge from the lighting panel 2 via the flat side 8 toward the reflector 5 or which is reflected by the reflector 5 into the lighting panel 2, can be scattered and accordingly equalized.

Figure 1 shows a light source 7 on only one narrow side 13 of the lighting panel 2; however, provision can also be made of light sources 7 at a plurality of narrow sides. The narrow sides within the device housing 3 not provided with light sources 7 can have a mirrored embodiment so as to avoid transmission losses here.

The equalized light can emerge from the lighting panel 2 at the flat side of the lighting panel 2 lying opposite the reflector 5, as elucidated by the arrows 25 in figure 1, or it can enter into a downstream emission panel 4, which is, in particular, placed onto the lighting panel 2, said emission panel 4 having emission surfaces not surrounded in front of the device housing 3. Here, in particular, a flat side 16 of the lighting panel 2 and/or a flat side 26 of the aforementioned emission panel 4 which is distant from the reflector 5 can serve as an emission surface. The light emission from said flat side 26 is elucidated by

the arrows 21. Alternatively, or additionally, narrow
sides 17 and 18 of the emission panel 4 can form light
exit or emission surfaces, which can extend across, or
approximately perpendicular to, the surface-structured
5 flat side 8 of the lighting panel 2 and which can be
arranged offset in relation to the light entrance
narrow side such that the light emitted by the light
sources 7 can, so to speak, be emitted around the
corner through the lighting panel 2 and the emission
10 panel 4, as elucidated by arrows 22 and 23 in figure 1.
The beam path 19 through the lighting panel 2 and
emission panel 4 can have stair-shaped contouring, if
the chief input radiation direction and the
corresponding chief emission direction are considered,
15 cf. figure 1.

The lighting panel 2, the emission panel 4 and/or the
reflector panel 5 can consist of various materials, for
example a light-transmissive plastic such as Plexiglas
20 or glass in each case, wherein the reflector panel 5
may have a reflecting or mirroring coating. In
particular, the lighting panel 2 can be embodied as
scattering Plexiglas, the emission panel 4 as light
Plexiglas and/or the reflector panel 5 as mirroring
25 Plexiglas.

The lighting panel 2, the emission panel 4 and/or the
reflector panel 5 can be securely connected to one
another and/or joined on one another under mutual
30 bearing pressure, for example held on one another by
way of screws or other connecting elements such as
rivets, pins or the like, cf. figure 8. Advantageously,
the lighting panel 2, the emission panel 4 and the
reflector panel 5 can form a pre-assemblable assemblage
35 and be installed together.

As figure 1 and figure 5 show, stop elements 20 can be
attached to the emission surface of the emission panel

4, in particular on the flat side thereof, said stop
elements covering part of the emission surface and
preventing light emergence there. In particular, the
aforementioned stop elements 20 can have a mirrored or
5 at least strongly reflecting embodiment, for example in
the form of a chrome-plated or polished metal surface.

As figures 4 and 5 show, the lighting device 1 can be
combined with a display device, for example in the form
10 of a screen 24, in particular a flat screen or the
like. By way of example, such a screen 24 can be
arranged in an upper and/or easily visible region, in
particular in the region of the culmination point of
the lighting arc, wherein the screen 24 can be mounted
15 on the lighting device 1 or else separately therefrom.

CLAIMS

1. A lighting device comprising:
 - a lighting panel having a flat front surface, a flat rear surface and a peripheral narrow side edge,
 - a housing supporting the lighting panel and surrounding at least a portion of the peripheral narrow side edge of the lighting panel,
 - at least one light source, assigned to a narrow side of the lighting panel, for coupling light into the lighting panel,
 - an emission panel having a flat rear surface oriented adjacent the lighting panel front surface, and a front surface and side edge, not surrounded by the housing, for emitting light, and
 - a reflector facing a flat rear surface of the lighting panel, wherein at least one of: a) the flat rear surface of the lighting panel facing the reflector,
 - b) the reflector, and
 - c) an intermediate layer between the reflector and the lighting panelis provided with a surface structure,
 - wherein the surface structure is embodied as a line grid made of continuous, crossing grid lines.
2. The lighting device as claimed in claim 1, wherein the surface structure has a mesh size which remains unchanged over the flat side of the lighting panel and/or an unchanging degree of filling.
3. The lighting device as claimed in claim 1, wherein the surface structure has a degree of filling of 3 percent to 25 percent, of the overall surface of the flat side of the lighting panel.
4. The lighting device as claimed in claim 1, wherein the surface structure has a mesh size in the range from 2 to 3 mm.
5. The lighting device as claimed in claim 1, wherein the grid lines have a line width of less than 0.5 mm.

6. The lighting device as claimed in claim 1, wherein the grid lines have a straight extent.

7. The lighting device as claimed in claim 1, wherein the grid lines cross at a crossing angle of 60 degrees to 80 degrees.

8. The lighting device as claimed in claim 1, wherein the grid lines have a white embodiment.

9. The lighting device as claimed in claim 1, wherein the grid lines extend inclined at an acute angle in relation to the at least one narrow side, by means of which the light from the light source is coupleable into the lighting panel.

10. The lighting device as claimed in claim 1, wherein a flat side, facing away from the reflector, of the lighting panel and/or of an emission panel disposed downstream of the lighting panel forms a light exit and/or emission surface.

11. The lighting device as claimed in claim 1, wherein a narrow side, extending across the flat side, of the light panel and/or of the downstream emission panel forms a light exit and/or emission surface.

12. The lighting device as claimed in claim 1, wherein a multi-axis emission is provided and the lighting device has a plurality of chief emission directions, wherein, a first chief emission direction is aligned perpendicular to the flat side of the lighting panel and a further chief emission direction is aligned substantially parallel to the flat side of the lighting panel.

13. The lighting device as claimed in claim 1, wherein the housing covers a portion of the lighting panel narrow side so that the at least one light source is arranged between an inner side of the housing and the lighting panel narrow side.

14. The lighting device as claimed in claim 1, wherein the lighting panel or the downstream emission panel has a panel narrow side, which forms a light exit and/or emission

surface and which is arranged in an exposed manner relative to the device housing in such a way that light is emittable to the surroundings of the housing.

15. The lighting device as claimed in claim 1, wherein the panel narrow side forming a light exit and/or emission surface is arranged offset with respect to the panel narrow side by means of which light is coupleable into the lighting panel, in a direction perpendicular to the flat side of the lighting panel.

16. The lighting device as claimed in claim 1, wherein the light from the at least one light source has, at least in part, a stair- or step-shaped light path through the lighting panel and/or the downstream emission panel.

17. The lighting device as claimed in claim 1, wherein the lighting device is embodied as an arcuate portal, which spans a clear space and/or has a self-supporting embodiment.

18. The lighting device as claimed in claim 1, wherein the portal has a modular design and is assemblable from a plurality of portal parts, in particular straight base parts and at least one bent and/or kinked connection part, wherein the portal parts are contoured in such a way that the portal parts can be brought into holding engagement with one another in an interlocking manner, in particular are pluggable into one another.

19. The lighting device as claimed in claim 17, wherein at least one display device for displaying information is provided on the portal in the region of a portal top or upper restriction region, having two screens aligned toward opposite sides.

20. A portal for spanning a gaming and/or entertainment machine such as a gaming table, further comprising a lighting device as claimed in claim 1.