The present invention relates to an illumination device (201, 301, 401, 501) comprising:

- a number of light sources arranged in at least a first group of light sources (203) and in a second group of light sources (205, 305), where said first group of light sources and said second group of light sources are individually controllable;
- a number of light collecting means (209), said number of light collecting means collect light from said first group of light sources and convert said collected light into a number of source light beams (211);

- at least one light guide (213, 313, 413, 513) comprising an input section (217, 317, 517) and an output section (219, 319, 419, 519), said light guide receives light generated by said second group of light sources at said input section and said transfer said received light to said output section, said output section being adapted to emit said received light at an area between at least two of said source light beams, wherein said light guide comprises a number of openings whereon said light collecting means are arranged and where said light output section constitutes the front area of said light guide.
Field of the Invention

The present invention relates to an illumination device comprising a number of light sources and a number of light collecting means arranged in a housing. The number of light collecting means collect light from at least one of the light sources and convert the collected light into a number of source light beams. The light source beams are emitted from said housing.

Description of the Invention

The object of the present invention is to solve the above described limitations related to prior art. This is achieved by an illumination device and method as described in the independent claims. The dependent claims describe possible embodiments of the present invention. The advantages and benefits of the present invention are described in the detailed description of the invention.

Description of the Drawing

Fig. 1a and 1b illustrate a prior art illumination device;

fig. 2a-2d illustrate an embodiment of an illumination device according to the present invention;

fig. 3a-3d illustrate another embodiment of the illumination device according to the present invention;

fig. 4 illustrates another embodiment of the illumination device of fig. 3a-3d;

fig. 5 illustrates an another embodiment of the illumination device according to the present invention;

fig. 6a and 6b illustrates possible embodiments of light guides which can be used in the illumination device according to the present invention;

fig. 7 illustrates a structural block diagram of an illumination device according to the present invention.

Detailed Description of the Invention

Light fixtures creating various effects are getting more and more used in the entertainment industry in order to create various light effects and mood lighting in connection with live shows, TV shows, sport events or as a part on architectural installation.

Entertainment light fixtures creates typically a light beam having a beam width and a divergence and can for instance be wash/flood fixtures creating a relatively wide light beam with a uniform light distribution or it can be profile fixtures adapted to project image onto a target surface. There is a tendency that more and more of this kind of fixtures are used in each show or each installation and the fixtures gets as a consequence more and more visible for the sectors or TV viewers. The light fixtures typically create the lighting effect at a distance from the light fixture itself and the light fixture is thus not as interesting and esthetic to look at. The fixture manufactures tries as a consequence to provide the fixtures with esthetic designs in order to make the fixtures more interesting to look at. However this is very difficult as the housing of the fixtures typical dependents on physical requirements defined by the technical specifications of the fixture such as optics, mechanics, electronics, cooling etc.

The LED component has further as a light source changed the look of most lighting luminaries, when using multiple LEDs to replace a single light source. This implies for all lighting industries - general, domestic, industrial, entertainment etc. The most visible change is that all multiple light sources are now exposed to the viewer and the light emits from a larger area. Now that most LED fixtures have visible LEDs, some customers dislike the look of multiple light dots. The dotted "funfair" look appears both on light fixtures which mixes the colors before the light is emitted from the housing and also of light fixtures where the colors are mixed in the air or at the wall. Instead a more uniform, even light exit is requested, to avoid the cheap looking "funfair" look with an extreme amount of light sources.

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sources and convert the collected light into a number of source light beams 113 (only one illustrated), which are emitted from the housing.

In the illustrated embodiment the head housing 107 is a "bucket" shaped head housing 111 wherein a display 115 (visible from the rear side of the head), main PCB 117 (Printed Circuit Board), a fan 119, a heat sink 121, an LED PCB 123, and lens assembly are stacked. The lens assembly comprises a lens holder 125 and a lens array comprising the light collecting means 109. The head is rotatable connected to the yoke by two tilt bearings 127 and which are supported by the yoke 105. A tilt motor 129 is adapted to rotate the head through a tilt belt 131 connected to one of the tilt bearings 127. The yoke comprises two interlocked yoke shell parts 132 which are mounted to a yoke frame 134 where on the tilt bearings, tilt motor, pan motor and pan bearing are arranged. The LED PCB 123 comprises a number of LEDs emitting light and which in cooperation with the light collecting means 109 in the lens array generate a number of light source beams. The main PCB comprises controlling circuits and driving circuits (not shown) for controlling the LEDs as known in the art of illumination devices. The main PCB comprises further a number of switches (not shown) which extend through a number of holes in the head housing 111. The switches and display act as a user interface allowing a user to communicate with the moving head lighting fixture.

The yoke are connected to a pan bearing 133 rotatable connected to the base 103. A pan motor 135 is adapted to rotate the yoke through a pan belt 137 connected to the pan bearing 133. The base comprises 5-Pin XLR male 139 and female 141 connectors for DMX signals as known in the art of entertainment lighting; input 143 and output power 145 connectors, power supply PCB's (not shown) and fan (not shown). The fan forces air into the base through vent holes 147.

This prior art illumination device uses multiple LEDs to replace a single light source as known prior the introduction of the LED component as a widely used light source. However such illumination device changes its visible appearance as the multiple light sources are now exposed to the viewer and the light emits from a larger area. If the light luminaires are a color mixing version with single color LEDs, then all LED colors used are visible. However some customers dislike the look of multiple light dots. Instead a more uniform, even light exit is requested, to avoid the cheap looking "funfair" look with an extreme amount of light sources.

The illuminating device illustrated in fig. 1a and 1b is just one example of a prior art illumination device and the skilled person realize that a large number of different embodiments provided by a large number of manufactures exits.

Figures 2a-d illustrate a simplified embodiment of an illumination device according to the present invention. Fig. 2a is a top view and fig. 2b is a top view with the light guide 213 and light collecting means 209 re-
protrusions are adapted to fit above the light sources 205 of the second group and the input sections are situated at the bottom surface of the protrusions. The output sections constitute the front area of the light guide disc. The light entering the input sections is firstly internally reflected through the protrusions and is then reflected at angled reflection surfaces 222 in a direction substantially along the plane of the disc.

For instance as illustrated in fig. 2c the light source 205a belonging to the second group of light sources emits a number of light rays (illustrated as thin solid lines). The light rays enter the light guide 213 at input section 217a where after they experience internal reflection inside the light guide and are hereby guided to the output section 219a where the light rays are coupled out of the light guide 213. It is to be understood that only a small number of light rays are illustrated inside the light guide and that in total a large number of light beams will be emitted in a large number of directions as indicated by arrows 221. In a similar way the light source 205b belonging to the second group of light sources emits a number of light rays (illustrated as thin solid lines) which enter the light guide 213 at input section 217b and is coupled out of the light guide 213 at output section 219b. Further in fig. 2d light sources 205c and 205d generates light beams which is emitted from output sections 219c and 219d respectively. The result is that the areas between the light beams can be illuminated by the second group of light sources 205 and the dotted look the prior art light fixtures can be avoided.

The output sections 219 are adapted to couple the light rays out of the light guide. This can for instance be achieved by adjusting the roughness of the surface of the light guide at the output sections whereby the light rays does not experience total internal reflection when they hit the rough surface and as consequence the light is coupled out of the light guide. Alternatively the surface of the light guide 213 can be treated with a material which will scatter the light hitting the output section. Another opportunity is to angle to bottom and top surface of the light guide relatively to each other, which results the fact the incident angle of the light rays traveling inside the light guide will change. The output sections can be adapted to couple the light out of the light guide in a homogenized way such that the entire front surface of the light guide disc appears as one homogenous illuminating surface. This can for instance be achieved by gradually modifying the roughness across the output sections such that only a small part of the light is coupled out at output sections close to the input sections, whereas a larger part of the light is coupled out of the light guide at areas farther from the input section. The light guide and output coupling can for instance be constructed using techniques known in the art of background lighting from TV displays and/or mobile phone displays. In the illustrated embodiment the light guide is shaped as a disc however it is be understood that the light guide can have any shape.
Figures 5a-5e illustrates another embodiment of an illumination device according to the present invention. Fig. 5a is a top view and fig. 5b is a top view with the light guides 513, collecting means 209 removed and diffuser regions 512 removed. Fig. 5c, 5d and 5e is cross sectional views along line E-E, F-F and G-G respectively. Like the embodiment illustrated in fig. 3a-3d the first group of light sources 203 (indicated as white quadrangles) is arranged on a PCB 207 with the light collecting means 209 arranged above the light sources and a number of source light beams 211 are hereby created. As in fig. 3a-3d a part of the light sources of the second group 205 (illustrated in black quadrangles) are mounted on the PCB 207 while another part 305 of the second group light sources are arranged on number of upward- ping PCBs 308 which are perpendicularly in relation to PCB 207. A number of light guides 514 (illustrated in detailing in fig. 6a and 6b) comprising an input section and output section is arranged above the PCB 207. The light guides 514 is adapted to receive light from at least one the second group light sources at the input section and to guide the received light to the output section 519, which is adapted to emit the received light at an area between at least two of the source light beams 211. In this embodiment the illumination device comprises a third group of light sources 504 (illustrated as cross-hatched quadrangles) arranged on the PCB 207 and a number of diffuser regions 512 arranged above the PCB 207 and between at least two light source beam. The diffuser regions 514 is adapted to receive light from at least one of the light sources of the third group of light sources and to diffuse the received light.

As illustrated in fig. 5c light source 205a and 205b emits a number of light rays (illustrated as thin solid lines) which respectively enters light guide 514a and 514b at input sections 517a and 517b and is coupled out of the light guide 514a and 514b at output sections 519a and 519b. As illustrated in fig 5d the source 305c and 305d emit a number of light rays (illustrated as thin solid lines) which respectively enter the light guide 514c and 514d at input section 517c and 517d and is coupled out of the light guides at output sections 519c and 519d. As illustrated in fig. 5e light sources 504a-d will illuminate the diffraction regions 512a-d and the light from these light sources will be diffused into many directions as illustrated by arrows 516a-516d. The consequence is that the dotted look of an illumination device as known in the prior art can be avoided and the illumination device can at the same time be used to create graphical light effects by controlling the second group of light sources.

The diffuser regions can for instance be embodied as one single solid body of a transparent material, which is adapted to diffuse light hitting the solid body. For instance by molding the solid body in transparent polymer and treating the surfaces such that they will diffuse light. The solid body can be contracted with a number of holes were in the light collecting means 209 and light guides 514 can be arranged.

The embodiment illustrated in fig. 6a and fig. 6b respectively illustrated the two types light guides used in fig 5a-5e. The light guide in fig. 6a correspond the light guides 514 (for instance 514c and 514d of fig. 5a-e) which are adapted to receive light form the light sources 305 arranged circumferentially around the PCB 207. The light guide is constructed of a transparent rod 601 comprising an input section 602 and an output section 603. The output section constitutes one surface of the rod and has been treated such that the light will be coupled out of this surface as illustrated by arrows 605. In this embodiment the light source 305 is a 4 in 1 LED light source comprising a red die R, Green die G, blue die B and white die W and can thus create a large amount of different color by using additive color mixing. The light rod assists also in mixing the colors from the 4 LED dies. The light guide in fig. 6b correspond the light guides 514 (for instance 514a and 514b of fig. 5a-e) which are adapted to receive light form the light sources 205 on the PCB 207. This light guide comprises a bend 606 which is adapted to reflect light coming from the input section towards the output section 603.

Fig. 7 illustrates a block diagram of the illumination device according the present invention. The illumination device comprises a control unit 701 comprising a processor 703 and a memory 705. The first group of light sources 203 and the second group of light sources 205 is connected to the control unit 701 and is arranged according to the present invention. The processor acts as controlling means and is adapted to control the first group 203 of light sources and the second group 205 of light sources individually. Meaning the processing means can control one of the groups of light sources without controlling the other group of light sources. The controlling can for instance adapted to control the color and/or intensity of the light sources and can be based on any type of communication signals known in the art of lighting e.g. PWM, AM, FM, binary signals etc. The first 203 and second 205 group of light sources array can thus be controlled individually and independently of each other can thus be treated as two individually and independently groups of light sources. It is to be understood that the individually light sources of each groups be controlled by the same control signal, supplied with individual control signals and/or grouped in subgroups where each subgroup receive the same control signal.

In one embodiment the controlling means is adapted to control said first group of light sources based on an input signal indicative of a first target color of said first group of light sources. The input signal can be any signal capable of communication parameters and can for instance be based on one of the following protocols USITT DMX 512, USITT DMX 512 1990, USITT DMX 512-A, DMX-512-A including RDM as covered by ANSI E1.11 and ANSI E1.20 standards or Wireless DMX. ACN designates Architecture for Control Networks; ANSI E1.17 - 2006).
The input signal can for instance be indicative of a first target color can be any parameter defining the color of the light that the first group light sources shall generate, for instance RGB values, color coordinates in color maps etc. The controlling means can be adapted to control the second group of light sources based on the input signal indicative of the first target color of whereby the second group of light sources can be adapted generate substantial the same color as the color generated by the first group of light sources. However it is also possible to integrate a color scheme such that the color of the second array is adjusted such that the color of the second group of light sources is different but esthetic matches each other according to a predetermined color scheme. The input signal can also be indicative of a second target color and the color of the second group of light sources can be controlled based on this second target color parameter.

The skilled person realizes that the illumination device also can comprise a third group of light sources as illustrated in connection with fig. 5a-e. This group can be controlled in similar manners as the two other groups of light sources.

The second and third group of light sources can functions as background lighting with own DMX control and both color and intensity can be varied independently of the first group of light sources. They can also be intensity and color linked with primary LED color in a predetermined manner or has separate control for contrast colors or other intensity. This adjustment/control of the light sources can be done remotely from central control unit or at the fixture itself. The consequence is that a new light effect can be created as the area between the light beams can have another color emitted by the second group of light sources. This look can be dynamic if first group of light sources and the second group of light sources are individually controllable as known in the art of entertainment lighting.

It is noted that:

- the Invention applies to both multichip LEDs and single color LEDs.
- the Invention applies to both profile and wash luminaires.
- the invention applies to both light source technology.
- that the invention eliminates or minimizes the dotted look of an LED lighting fixture with multiple LED lenses exposed to the spectator.
- the second light source group can be used as new additional effect feature on the fixture and function both as an attention gimmick, but more importantly as an individual pixel when used in multiple unit setups. So it is both a mid-air beam and a lit up surface.
- the second light source group can also be used to indicate errors or other fixture status information.
- the invention creates a possibility of making the light/color visible from other angles than purely from the front.

- the secondary light source can be used as an interactive part of the fixture - reacting according to surroundings.
- the illumination device according to the present invention when the fixture is used in multiple unit set-ups (eg. a large scale matrix) the primary light source can be turned off or dimmed, so the fixture changes from being an automated mid-air beam to become a graphical pixel with a glowing non-blinding surface. Appropriate effect generator controls (eg. media servers) are then able to display video content or simple color waves / patterns on the complete fixture setup.
- the user will be able to run two individual light sequences or media content on the same fixture. - one content generated by the first group of light sources and another content generated by the second group of light sources.
- That error messages or fixture status can be communicated via colors, color combinations, flashes or other effects by the secondary light source that via an internal or external sensoring / tracking technology, the secondary light source can act according to a predefined reaction pattern (color, intensity or flashing). The input could be persona behavior, temperature changes, room light level, humidity etc.)

Further aspects and advantages of the invention may be appreciated from the following numbered clauses.

1. An illumination device comprising:

- a number of light sources arranged in at least a first group of light sources and in a second group of light sources, where said first group of light sources and said second group of light sources are individually controllable;
- a number of light collecting means, said number of light collecting means collect light from said first group of light sources and convert said collected light into a number of source light beams;
- at least one light guide comprising an input section and an output section, said light guide receives light generated by said second group of light sources at said input section and said transfer said received light to said output section, said output section being adapted to emit said received light at an area between at least two of said source light beams.

2. An illumination device according to clause 1 characterized in that said output section is adapted to diffuse said received light.

3. An illumination device according to clauses 1-2 characterized in that said illumination device com-
prises controlling means adapted to individually control said first group of light sources and said second group of light sources.

4. An illumination device according to clause 3 characterized in that said controlling means is adapted to control said first group of light sources based on an input signal indicative of a first target color.

5. An illumination device according to clause 4 characterized in that said controlling means are adapted to control said second group of light sources based on said first target color.

6. An illumination device according to clauses 3-4 characterized in that said input signal being further indicative of a second target color and in that said controlling means are adapted to control said second group of light sources based on said second target color.

7. An illumination device according to clauses 1-6 characterized in that said output sectors and said light sources of said second group of light sources are arranged in a predetermined pattern, such that each of said output sectors emits light from at least one of said light sources of said second group and in that said controlling means are adapted to control said light sources illuminating each output sector individually.

8. An illumination device according to clauses 1-7 characterized in that said number of light sources further is arranged in a third group of light source and in that said illumination device further comprises at least one diffuser region arranged between at least two of said source light beams, said diffuser region receives and diffuses light generated by said third group of light sources.

9. A moving head light fixture comprising:
   - a base
   - a yoke connected rotatable to said base,
   - a head connected to rotatable said yoke,
characterized in that said head comprises an illumination device according to clauses 1-8.

10. A method of controlling an illumination device comprising the steps of:
    - arranging a number of light sources in at least a first group of light sources and in a second group of light sources;
    - creating a number of light source beams by adapting a number of light collecting means to collect light from said first group of light sources and to convert said collected light into said number of source light beams;
    - guiding light generated by said second group of light sources to an area between at least two of said source light beams by using a light guide.

11. A method according to clause 10 characterized in that said step of guiding light guiding light generated by said second group of light sources to an area between at least two of said source light beams by using a light guide comprises the step of:
    - emitting light into said light guide through an input section;
    - transferring said light to an output section, said output section being positioned between at least two of said source light beams;
    - coupling said light out of said light guide through said output section.

12. A method according to clauses 10-11 characterized in that said method comprises the steps of:
    - controlling said first group of light sources based on a first target color;
    - controlling said second group of light sources on a second target color.

13. A method according to clauses 1-12 characterized in that said method comprises the steps of:
    - arranging said number of light sources arranged in third group of light sources;
    - illuminating an area between at least two of said light source beams by providing diffusing means between at least two of said light source beams and by adapting said diffusing means to receives light generated by said third group of light sources and diffuses said received light.

14. An method according to clauses 13 characterized in that said method comprises the steps of:
    - controlling said third group of light sources based on a third target color.

15. An method according to clauses 12-14 characterized in that said method comprises the steps of:
    - determining at least said second target color and/or at least said third target color based on said first target color.
• a number of light sources arranged in at least a first group of light sources (203) and in a second group of light sources (205, 205a, 205b, 205c, 305, 305c, 305d), where said first group of light sources and said second group of light sources are individually controllable;
• a number of light collecting means (209), said number of light collecting means collect light from said first group of light sources and convert said collected light into a number of source light beams (211);
• at least one light guide (213, 313, 413, 513) comprising an input section (217, 317, 517) and an output section (219, 319, 417, 519), said light guide receives light generated by said second group of light sources at said input section and transfers said received light to said output section, said output section being adapted to emit said received light at an area between at least two of said source light beams;

characterized in that said light guide comprises a number of openings wherein said light collecting means are arranged and where said output section are provided at the front area of said light guide and arranged between at least two of said openings.

2. An illumination device according to claim 1 characterized in that said light guide comprises a circumferential wall and that said a circumferential wall of said light guide (313) constitutes said input section (317).

3. An illumination device according to claims 1-2 characterized in that said light guide comprises a number of protrusions (220) protruding backward from said light guide, said protrusions are adapted to fit above said light sources (205) of said second group and said input sections are situated at the bottom surface of said protrusions.

4. An illumination device according to claim 3 characterized in that said light entering said input sections at said bottom of said protrusions is internally reflected through said protrusions and reflected in a direction substantially along the plane of said light guide at an angled reflection surface (222)

5. An illumination device according to claims 1-4 characterized in that said output section is adapted to diffuse said received light.

6. An illumination device according to claims 1-5 characterized in that said illumination device comprises controlling means adapted to control said first group of light sources based on a first target color and to control said second group of light sources based on a second target color.

7. An illumination device according to claim 6 characterized in that said controlling means are adapted to determine said second target color based on said first target color.

8. An illumination device according to claims 1-7 characterized in that said output sectors and said light sources of said second group of light sources are arranged in a predetermined pattern, such that each of said output sectors emits light from at least one of said light sources of said second group and in that said controlling means are adapted to control said light sources illuminating each output sector individually.

9. A moving head light fixture comprising:
o a base (103)  
o a yoke (105) connected rotatable to said base,  
o a head (107) connected to rotatable said yoke,  
characterized in that said head comprises an illumination device according to claims 1-8.

10. A method of controlling an illumination device comprising the steps of:

• arranging a number of light sources in at least a first group of light sources and in a second group of light sources;
• creating a number of light source beams by adapting a number of light collecting means to collect light from said first group of light sources and to convert said collected light into said number of source light beams;
• guiding light generated by said second group of light sources to an area between at least two of said source light beams;

characterized in that said method comprises the step of:

• arranging said light collectors in a number of openings of said light guide; and

wherein said step of guiding light generated by said second group of light sources to an area between at least two of said source light beams by using a light guide comprises the steps of:

• emitting light into said light guide through an input section;
• transferring said light to an output section, said output section are provided at the front area of said light guide and arranged between at least two of said openings;
• coupling said light out of said light guide through said output section.
11. A method according to claim 10 characterized in that said step of emitting light into said light guide comprises the step of emitting light through a circumferential wall of said light guide (313).

12. A method according to claims 10-11 characterized in that said step of emitting light into said light guide comprises the step of emitting light through a bottom surface of a protrusion protruding backward from said light guide.

13. A method according to claim 12 characterized in that said step of transferring said light to an output section comprises the steps of:

   • internally reflecting said light through said protrusion, and
   • reflecting said light in direction substantially along the plane of said light guide at an angled reflection surface (222).

14. A method according to claims 10-13 characterized in that said method comprises the steps of:

   • controlling said first group of light sources based on a first target color, and
   • controlling said second group of light sources based on a second target color.

15. An method according to claim 14 characterized in that said method comprises the step of determining at least said second target color based on said first target color.
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The present search report has been drawn up for all claims.

1 Place of search
The Hague

50 Date of completion of the search
13 January 2016

51 Examiners
Soto Salvador, Jesús
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 13-01-2016.

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