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**Nichols**

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(54) **LIGHTING DEVICE WITH VISIBLE LIGHT ILLUMINATION AND ULTRAVIOLET LIGHT ILLUMINATION THAT IS BROADER THAN THE VISIBLE LIGHT ILLUMINATION AND VEHICLE HAVING THE SAME**

*41/18* (2018.01); *F21Y 2113/13* (2016.08);  
*F21Y 2115/10* (2016.08)

(58) **Field of Classification Search**  
CPC ..... *F21S 41/13*; *F21S 41/141*; *F21S 41/18*;  
*B60Q 1/02*  
See application file for complete search history.

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**Related U.S. Application Data**

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(51) **Int. Cl.**  
*F21S 41/13* (2018.01)  
*B60Q 1/02* (2006.01)  
*F21S 41/141* (2018.01)  
*F21S 41/14* (2018.01)  
*F21Y 115/10* (2016.01)  
*F21Y 113/13* (2016.01)

(52) **U.S. Cl.**  
CPC ..... *B60Q 1/02* (2013.01); *F21S 41/13* (2018.01); *F21S 41/141* (2018.01); *F21S*

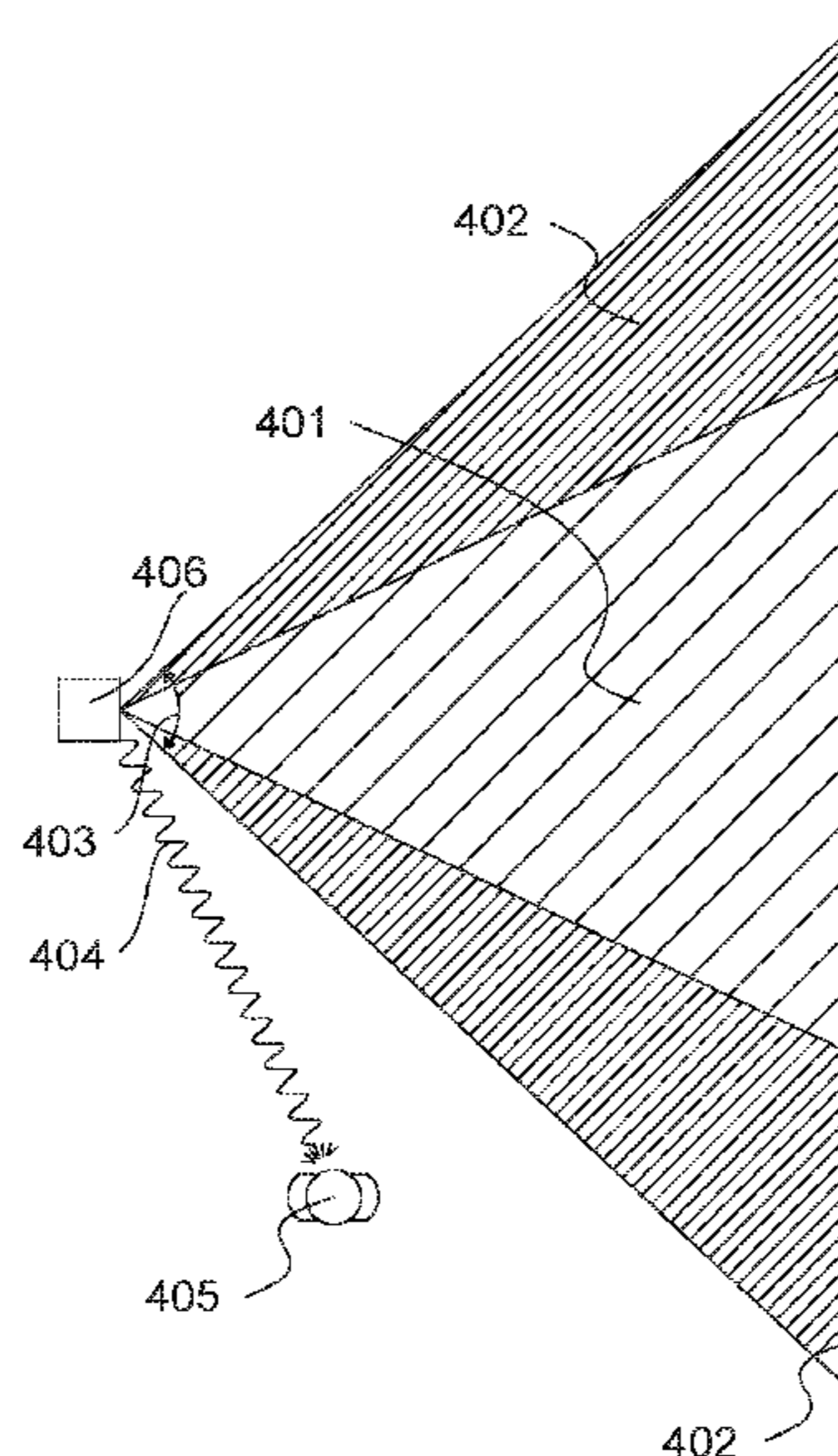
(56) **References Cited**  
U.S. PATENT DOCUMENTS  
4,970,628 A \* 11/1990 Bergkvist ..... *F21S 48/1186*  
362/263  
5,255,163 A \* 10/1993 Neumann ..... *F21S 48/1131*  
362/293  
6,122,093 A 9/2000 Lynam  
2004/0105264 A1 \* 6/2004 Spero ..... *B60Q 1/04*  
362/276

\* cited by examiner

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(57) **ABSTRACT**  
A lighting device including an ultraviolet light source emanating ultraviolet light, a visual light source and a light directing device. The visual light source is coupled to the ultraviolet light source, and the visual light source emanates visual light. The light directing device is arranged to direct the visual light in a first direction primarily within an angle of illumination. The light directing device is further arranged to direct the ultraviolet light in an area wider than the angle of illumination.

**17 Claims, 1 Drawing Sheet**



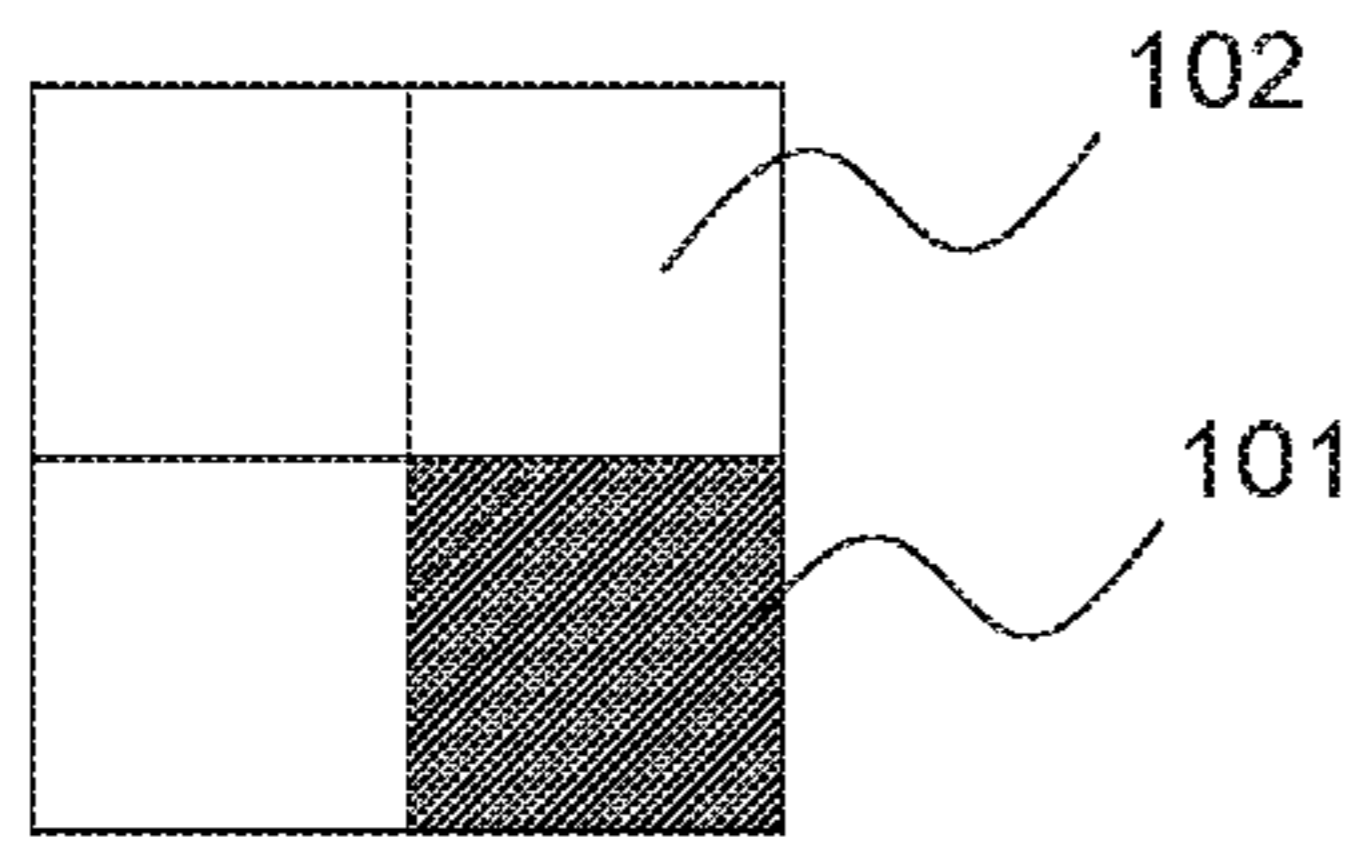


FIG 1

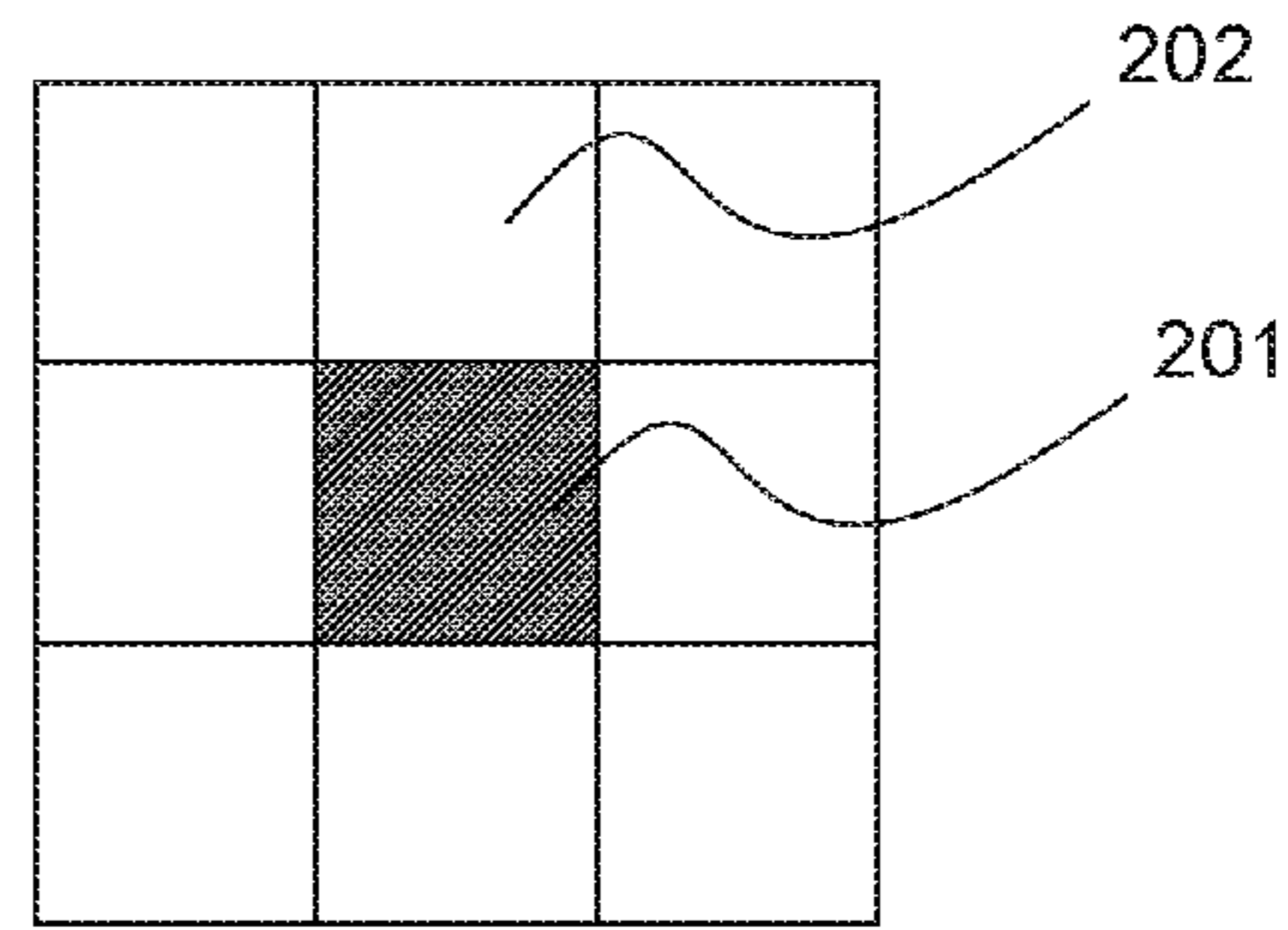


FIG 2

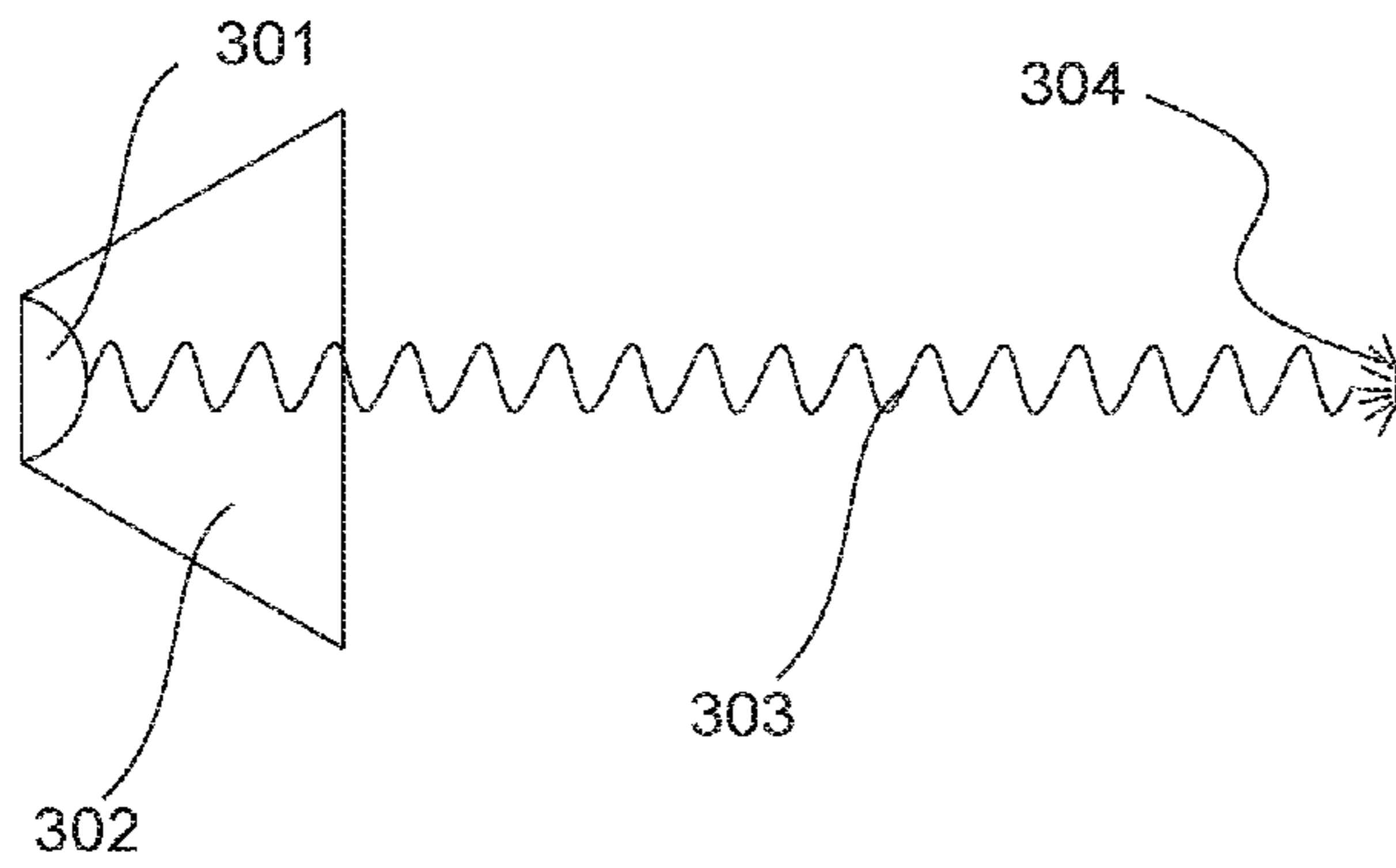


FIG 3

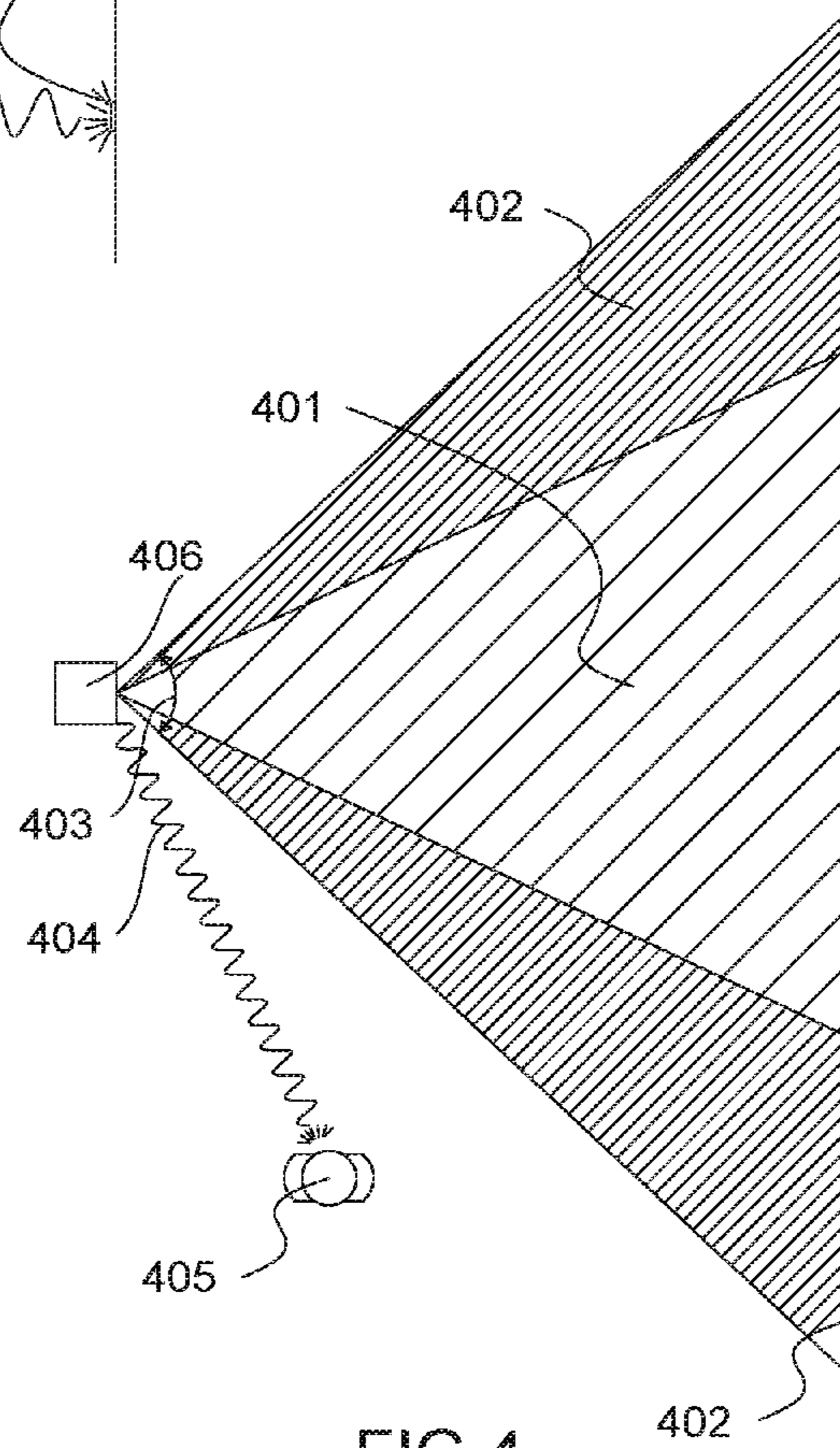


FIG 4

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**LIGHTING DEVICE WITH VISIBLE LIGHT  
ILLUMINATION AND ULTRAVIOLET LIGHT  
ILLUMINATION THAT IS BROADER THAN  
THE VISIBLE LIGHT ILLUMINATION AND  
VEHICLE HAVING THE SAME**

CROSS REFERENCE TO RELATED  
APPLICATIONS

This is a non-provisional patent application based on U.S. Provisional Application Ser. No. 62/190,376, entitled "LED LIGHTING PRODUCT, filed Jul. 9, 2015 which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to lighting for use in transportation and industrial equipment used in mining, construction, automotive, investigations, land surveying, emergency services in low light conditions.

2. Description of the Related Art

Traditionally low light conditions have presented a hazard to construction workers and the like, thus personal protective equipment is often used to promote visibility. The introduction of LED lighting technology has reduced much of the ultraviolet (UV) radiation emitted from an artificial source to near zero. While the efficiency of the LED lighting is very desirable, its use alters the spectral breadth of the light being produced. The lack of ultraviolet light degrades the effectiveness of safety markings placed on equipment and the clothing and safety equipment worn by personnel, in that many of such markings are designed to fluoresce, which requires the presence of UV spectral power.

Ultraviolet light is an electromagnetic radiation with a wavelength from roughly 10 nm (30 PHz) to 380 nm (750 THz), which is a shorter wavelength than that of visible light but longer than X-rays. UV radiation is present in sunlight, and also produced by electric arcs and specialized lights such as mercury-vapor lamps, tanning lamps, and black lights. Although the UV light lacks the energy to ionize atoms, long-wavelength ultraviolet radiation can influence chemical reactions, and causes many substances to glow or fluoresce.

In U.S. Pat. No. 6,122,093 there is disclosed a reduced ultraviolet radiation transmitting, safety protected electrochromic glazing assembly. The electrochromic glazing assembly has reduced UV radiation transmission and safety protection. The assembly may include at least a pair of glass or other elements confining an electrochromic medium therebetween. Ultraviolet radiation reducing means are incorporated for reducing ultraviolet radiation transmission through the assembly. A polymeric antilacerative layer is disposed on one surface of one of the glass elements for preventing lacerative injuries (Abstract). There is much prior art directed at the reducing of UV transmission, which is part of the problem that is addressed by the present invention.

What is needed in the art is a means of providing the needed ultraviolet radiation in conjunction with light of the visible light spectrum, to improve the fluorescing of reflectors in low light conditions.

SUMMARY OF THE INVENTION

The present invention provides an integrated light featuring a UV source that is widely disbursed.

The invention in one form is directed to a lighting device including an ultraviolet light source emanating ultraviolet

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light, a visual light source and a light directing device. The visual light source is coupled to the ultraviolet light source, and the visual light source emanates visual light. The light directing device is arranged to direct the visual light in a first direction primarily within an angle of illumination. The light directing device is further arranged to direct the ultraviolet light in an area wider than the angle of illumination.

The invention in another form is directed to a vehicle having a lighting device including an ultraviolet light source emanating ultraviolet light, a visual light source and a light directing device. The visual light source is coupled to the ultraviolet light source, and the visual light source emanates visual light. The light directing device is arranged to direct the visual light in a first direction primarily within an angle of illumination. The light directing device is further arranged to direct the ultraviolet light in an area wider than the angle of illumination.

An advantage of the present invention is that UV spectral density is added to the visual light.

Another advantage of the present invention is that UV light is additionally directed to low light areas apart from the directed visual light.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic view of an embodiment of a multi-die LED chip with a UV emitter and visible light emitters as an assembly of the present invention;

FIG. 2 is a schematic view of another embodiment of a multi-die LED chip with a UV emitter and visible light emitters of the present invention;

FIG. 3 illustrates how an emitter of FIG. 1 or 2 radiates visible light and UV radiation that causes a surface to fluoresce from the UV radiation hence becoming more visible; and

FIG. 4 is a depiction of how the present invention causes a reflective surface in a low light condition to fluoresce.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrates embodiment of the invention, in one form, and such exemplification is not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE  
INVENTION

Referring now to the drawings, and more particularly to FIG. 1, there is shown a multi-die LED chip with a single UV emitter **101**, with the rest of the chip emitters **102** being primarily visible light emitters **102**.

In a like manner in FIG. 2 there is shown another multi-die LED chip configuration with a single UV emitter **201** in the middle and surrounded with adjacent emitters **202** that are in the visible spectrum. The chip arrangements of FIG. 1 or FIG. 2 can be used with a total internal reflectance (TIR) arrangement, a light directing device, such as a lens or a reflector **302** as shown in FIG. 3. An emitter **301** (of a configuration, for example, shown in FIG. 1 or 2) radiating visible light and UV radiation **303** in reflector **302** hits a fluorescent surface **304**. Surface **304** will fluoresce from the UV radiation **303** hence become more visible as illustrated with the lines emanating from surface **304**.

Now, additionally referring to FIG. 4 fixture **406** includes either emitters **101** and **102**, or emitters **201** and **202**, that

send out a beam **401** with a field of visual light illumination **402** having an angle of illumination **403**, and a further UV illumination **404** that is wider than angle **403** as illustrated in FIG. **4**. Illumination **404** is wider than beam area **401**, and wider than illumination area **403** so that fluorescent material **405** will be visually apparent outside of illumination angle **403**.

Visual spectrum Light Emitting Diodes are a growing technology. Intentionally they do not emit UV radiation and this is often seen as a benefit to most industries, however safety equipment is primarily designed to fluoresce upon being illuminated with UV light. Current visual spectrum LEDs do not excite fluorescent materials due to the lack of UV radiation emitted, hence introducing a UV emitting diode, as discussed herein, will improve fluorescence and in-turn improve visibility to thus improve safety. The present invention uses ultraviolet radiation from sources **101** and **201** in the wavelength range of 360 nm to 385 nm along with white light sources **102** and **202** specifically to improve safety in low light conditions.

An apparatus **301** or **406** emitting ultraviolet radiation **303**, **404** improves the fluorescence of personal protective equipment **304**, **405** in low light conditions. The source of the UV radiation **101**, **201** as well as the visible light source **102**, **202** are light emitting diodes (LED).

The UV sources **101**, **201** are shown combined with visible light source **102**, **202** on one substrate or the same die, as is abstractly illustrated in FIGS. **1** and **2**. The combined source may use lensing or reflectors **302** to provide direction. The LED sources may include a widened spectrum including UV light emitting sources **101**, **201** and visual light emitting sources **102**, **202**, for example, with a spectrum from 360 nm to 670 nm.

The LED apparatus as described herein and shown in FIGS. **1-4** allows for improved fluorescence, which will improve safety for workers in the area, through better visibility of equipment. The equipment **405** may be reflective vests, road signs, road markers, traffic cones, reflective tape and a UV reactive painted surface.

Fixture **406** can be a vehicle **406** having multiple lights thereon with at least one having the characteristics discussed herein. Emitters **101** or **102**, and emitters **201** or **202**, send out a beam **401** with a field of visual light illumination **402** having an angle of illumination **403**, and a further UV illumination **404** that is wider than angle **403** as illustrated in FIG. **4**. Illumination **404** is wider than beam area **401**, and wider than illumination area **403** so that fluorescent material **405** will be visually apparent outside of illumination angle **403**. The field of illumination with the UV light is symmetrically arranged on both sides of angle **403** and is even continuously distributed throughout the wider angle.

While this invention has been described with respect to at least one embodiment, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

What is claimed is:

**1.** A lighting device comprising:

an ultraviolet light source emanating ultraviolet light;  
a visible light source coupled to the ultraviolet light source, the visible light source emanating visible light;  
and

a light directing device arranged to direct the visible light in a first direction primarily within an angle of illumination, the light directing device being further arranged to direct the ultraviolet light in an area wider than the angle of illumination, with the angle of illumination being centrally located within the wider area thereby causing the ultraviolet light to be symmetrically arranged relative to the area of illumination.

**2.** The lighting device of claim **1**, wherein the ultraviolet light source and the visible light source are on a common substrate.

**3.** The lighting device of claim **2**, wherein the ultraviolet light source is adjacent to a plurality of visible light sources.

**4.** The lighting device of claim **1**, wherein the ultraviolet light source emanates the ultraviolet light primarily in the wavelength 360 nm to 385 nm range.

**5.** The lighting device of claim **1**, wherein the ultraviolet light source combined with the visible light source emanates primarily in the wavelength 360 nm to 670 nm range.

**6.** The lighting device of claim **1**, wherein the ultraviolet light source and the visible light source are both light emitting diodes.

**7.** The lighting device of claim **1**, wherein the ultraviolet light is directed toward fluorescent material in a second direction apart from the angle of illumination.

**8.** The lighting device of claim **7**, wherein the fluorescent material is part of an item that is wearable by a person.

**9.** The lighting device of claim **1**, wherein the ultraviolet light continuously distributed across the wider area.

**10.** A vehicle having a light fixture coupled thereto, the light fixture comprising:

an ultraviolet light source emanating ultraviolet light;  
a visible light source coupled to the ultraviolet light source, the visible light source emanating visible light;  
and

a light directing device arranged to direct the visual light in a first direction away from the vehicle primarily within an angle of illumination, the light directing device being further arranged to direct the ultraviolet light in an area wider than the angle of illumination, with the angle of illumination being centrally located within the wider area thereby causing the ultraviolet light to be symmetrically arranged relative to the area of illumination.

**11.** The vehicle of claim **10**, wherein the ultraviolet light source and the visible light source are on a common substrate.

**12.** The vehicle of claim **11**, wherein the ultraviolet light source is adjacent to a plurality of visible light sources.

**13.** The vehicle of claim **10**, wherein the ultraviolet light source emanates the ultraviolet light primarily in the wavelength 360 nm to 385 nm range.

**14.** The vehicle of claim **10**, wherein the ultraviolet light source combined with the visible light source emanates primarily in the wavelength 360 nm to 670 nm range.

**15.** The vehicle of claim **10**, wherein the ultraviolet light source and the visible light source are both light emitting diodes.

**16.** The vehicle of claim **10**, wherein the ultraviolet light is directed toward fluorescent material in a second direction apart from the angle of illumination.

**17.** The vehicle of claim **16**, wherein the fluorescent material is part of an item that is wearable by a person.