Abstract: A street lighting device (10) with a first light source (12) for illuminating the street plane (S) from above, the device (10) comprises a further light source (16) located at a position closer to the street plane (S) than the first light source (12). Sensor means (18) are present, these means being sensitive to the occurrence of conditions of reduced visibility, caused for example by the presence of fog or smoke. A control unit (20) connected to the sensor means (18) is capable of activating the second light source (16) in the presence of said conditions of reduced ambient visibility.

FIG. 2

Published: with international search report (Art. 21(3))
Technical field

The present description relates to street lighting devices. The description is particularly concerned with the possible application to street lighting in conditions of poor ambient visibility, caused for example by the presence of fog.

Description of the relevant prior art

A street lighting device of the most commonly used type (such as a lamp post) comprises a structure which supports at a certain height a light source intended to project light radiation downward toward the street plane.

As shown schematically in Figure 1 of the appended drawings, this form of lighting is such that, in conditions of reduced visibility, for example in the presence of fog or other atmospheric precipitation such as rain, snow or smoke, the lighting of the street plane is far from optimal. It may even be the case that visibility at the level of the street plane is worsened by the effect of the lighting. Even on lighted stretches of road, drivers may therefore always prefer to use any fog lamps which are available on their vehicles. The inventors have observed that any worsening of visibility as a result of the switching on of street lighting is due to the fact that, in these conditions, the degree of visibility of the street plane by an observer (such as a driver) can be modeled as the superimposition of two components, namely:

- a "signal" component, corresponding to the light emitted from the observed scene, which diffuses (back) toward the observer;

the light radiation originating from the source and from any vehicle headlights that may be present;
- a "noise" component, corresponding to the light from the source diffused by diffusion sources such as fog droplets, raindrops, snowflakes or particles of smoke.

5 Object and summary of the invention

The object of the invention is to overcome the problems arising from the unsatisfactory operation of street lighting devices in the conditions described above.

According to the invention, this object is achieved by means of a device having the characteristics specifically claimed in the claims below.

The claims form an integral part of the technical teachings provided herein in relation to the invention.

15 Brief description of the appended drawings

The invention will now be described, purely by way of non-limiting example, with reference to the appended drawings, in which:
- Figure 1 has been described above,
- Figure 2 shows one embodiment,
- Figures 3 to 5 show the operating principles of one embodiment, and
- Figures 6 and 7 show some developments of embodiments.

Detailed description of embodiments

The following description illustrates various specific details intended to provide a deeper understanding of the embodiments. The embodiments may be produced without one or more of the specific details, or may use other methods, components, materials, etc. In other cases, known structures, materials or operations are not shown or described in detail, in order to avoid obscuring various aspects of the embodiments.
The reference to "an embodiment" in this description is intended to indicate that a particular configuration, structure or characteristic described in relation to the embodiment is included in at least one embodiment. Therefore, phrases such as "in an embodiment", which may be present in various parts of this description, do not necessarily refer to the same embodiment. Furthermore, specific formations, structures or characteristics may be combined in a suitable way in one or more embodiments.

The references used herein are purely for convenience and therefore do not define the scope of protection or the extent of the embodiments.

In the drawings, the reference 10 indicates the whole of a street lighting device which, in the embodiment considered here, takes the form of a pole or lamp post provided at its upper end with a light source 12 which can, for example, be an LED lighting module (lamp or luminaire).

In various embodiments, the lamp 12, which is a first light source for lighting the street plane S from above, operates by projecting a light beam 12A downward toward the street plane.

For this purpose, the lamp 12 can be supported by a pole or column 14. It will be appreciated that the use of this specific suspension or support structure is not essential: various embodiments may, for example, make use of suspension on an overhead line, mounting on a gateway, support by means of a bracket affixed to the facade of a building, or other arrangements.

The reference 16 indicates another light source, which can also be an LED lighting module for example, and which is intended to serve as a further source of light radiation located in the lower part of the device 10 so as to be at a position closer to the street plane S than the first light source 12. In other words, the second light source is at a lower position than the first source 12.

It will be evident from Figure 2 that, by comparison with the lighting beam 12A of the first source 12 (which is projected onto the street plane S from a position which can be considered
azimuthal or approximately azimuthal), the beam of radiation 16A produced by the second source 16 reaches the street plane S from a lesser height and travels in a much more inclined, quasi-horizontal direction.

The inclination of the beam 16A depends on the height of mounting of the second light source 16. In some embodiments, this height is set at rather low levels, of the order of several tens of centimeters, for example at levels approximately equal to the height at which the fog lamps of motor vehicles are located with respect to the street plane. The values concerned may therefore fall within the range of 15 to 60 cm, for example.

The reference numeral 18 indicates a sensor capable of identifying the occurrence of conditions of reduced ambient visibility. The sensor can therefore be of the type known as a "twilight sensor", used to switch on lighting systems in the area of buildings in conditions of reduced ambient light levels.

While it can also be used to detect the occurrence of conditions of reduced ambient visibility and cause street lighting to be switched on (although this function may be served by a central "twilight" system controlling a plurality of devices), in various embodiments the sensor 18 is mounted at a certain distance from the first source 12 (in the proximity of the second source 16, for example), at a position such that it can be impinged upon by the radiation emitted by the first light source 12. Thus the sensor 18 can detect - when the source 12 is switched on - the fact that the light radiation emitted by the source 12 is subject to diffusion, for example by fog, smoke or other diffusion sources DS.

By adjusting the threshold of sensitivity of the sensor 18 (according to known principles), it is therefore possible to distinguish between:
- the situation shown schematically in Figure 3, in which the lamp 12 is assumed to be switched on, for example at night, in normal ambient and atmospheric conditions (in the absence of
fog or other phenomena having a negative effect on visibility); and
the situation shown schematically in Figure 4, in which it is again assumed that the lamp 12 is switched on, but this time in the presence of fog or other DS phenomena having a negative effect on visibility: this is because these phenomena invariably cause a reduction in the intensity of the light radiation which impinges upon the sensor 18, regardless of the intensity of radiation emitted by the source 12.

In the latter case (that is to say, when the sensor 18 detects the occurrence of conditions of reduced visibility), a control device 20 which receives the output signal of the sensor 18 acts on the light sources 12 and 16 by switching on the light source 16, as shown schematically in Figure 5.

As mentioned previously, the source 16 is closer to the street plane S than the source 12, and it can therefore light the street plane S more effectively, being assisted in this by the orientation of the beam 16A which it produces. These factors are also relevant for the possibility of making the edges of the street easier to identify, for example by drivers traveling along a street to which the plane S corresponds.

In various embodiments, the light radiation 16A emitted by the source 16 can have characteristics which are at least marginally different from those of the radiation 12A produced by the main light source 12.

In various embodiments, the auxiliary source 16 can generate a "warm" white radiation or a radiation having a colored component, such as a red component, which can be perceived as such and is therefore easier to distinguish as originating from a light source intended to improve visibility and safety in adverse atmospheric conditions.

In various embodiments, the module 20 can switch on the source 16 while keeping unchanged the intensity of the radiation produced by the first light source 12.

Since, as has been mentioned, the diffusion of this radiation, by fog for example, is one of the causes of the possible worsening of visibility, in various embodiments the module 20
can act to reduce the intensity of the radiation produced by
the source 12 when the source 16 is switched on.
In various embodiments, the light sources 12 and 16 can be two
separate light generators (such as two LED-type "light
generators") which can be switched on selectively (with emission
levels which can be controlled, depending on the embodiment, in
on/off mode or with an emission intensity control or "dimming"
function).
In various embodiments, the light sources 12 and 16 can be two
different diffusion points for the light radiation produced by
a single light generator, located for example in the device 10.
In various embodiments, this single light generator can be
connected to the two sources 12 and 16 by optical waveguides,
with the provision of an optical switch that can be actuated to
vary selectively (in a complementary way, for example) the
intensity of the radiation sent toward the first source 12,
located at the "high" position, and the intensity of the
radiation sent toward the second source 16, located at the
"low" position. Optical switches of this type are known in the
technical field of fiber optic communications. However, it is
not essential to use fiber optics, since the propagation of
optical radiation from a single generator toward two (or more)
different diffusion sources 12 and 16 with selective variation
of the corresponding levels of relative intensity of the
radiation sent to the two diffusion points can also be achieved
by the propagation of optical radiation in free air. The
switching function can be provided according to various
principles, for example by using an electro-optical device
(such as a liquid crystal device) or by means of a mirror
and/or prism structure which is motorized and is therefore
selectively orientable.
Different choices may also be made regarding the possible
location of a single light radiation generator capable of
supplying a plurality of light sources 12 and 16.
In various embodiments, this generator can be located in the
upper part of the device 10, and can even form part of the
source 12, with provision for "tapping off" from the source 12
a selectively controllable quantity of radiation to be sent toward the source 16.
In various embodiments, this generator can be located in the lower part of the device 10, and can even form part of the source 16, with provision for "tapping off" from the source 16 a selectively controllable quantity of radiation to be sent toward the source 12.

Figures 6 and 7 refer to various embodiments in which part of the device 10 between the upper light source 12 and the lower light source 16 can be made from an optically diffusive (or illuminable) material which, in conditions of reduced visibility, can be activated, for example by diverting toward it some of the radiation produced by the light generator or generators which supply the sources 12 and 16, thereby making the structure of the device 10 luminous and thus more visible, as shown schematically in Figures 6 and 7.
Consequently, various embodiments can increase visibility, in the presence of fog or smoke for example, by preventing or at least minimizing the phenomenon of diffusion (scattering) of the light radiation produced by the light source 12 located at the upper end of the device 10. In the embodiments shown in Figures 6 and 7, the illumination of the support structure of the device 10 makes it possible to provide information on the direction of a street on which a plurality of devices 10 are located to a driver who has to drive a vehicle along the street, without directly interfering with his direction of view.
Naturally, the principle of the invention remaining the same, the details of construction and the forms of embodiment may be varied significantly with respect to those illustrated in the form of non-limiting examples only, without thereby departing from the scope of protection of the invention as defined in the attached claims.
CLAIMS

1. A street lighting device (10) with a first light source (12) for illuminating the street plane (S) from above, the device (10) comprising:
   - a second light source (16) located at a closer position to the street plane (S) than said first light source (12),
   - sensor means (18) sensitive to the occurrence of conditions of reduced ambient visibility, and
   - a control unit (20) connected to said sensor means (18) and capable of activating said second light source (16) in the presence of said conditions of reduced ambient visibility.

2. The device as claimed in claim 1, wherein said sensor means (18) are impinged upon by the light radiation (12A) emitted by said first light source (12) and are capable of identifying the presence of said conditions of reduced ambient visibility when the intensity of the radiation emitted by said first light source (12) and impinging upon said sensor means (18) falls below a given threshold level.

3. The device as claimed in claim 1 or 2, wherein said control unit (20) is configured for activating said second light source (16) and reducing the intensity of the light radiation emitted by said first light source (12) when said conditions of reduced ambient visibility are present.

4. The device as claimed in any of the preceding claims, wherein said second light source (16) is located at a height in the range from 15 cm to 60 cm above the street plane (S).

5. The device as claimed in any of the preceding claims, wherein said second light source (16) projects a lighting beam (16A) in a quasi-horizontal direction of propagation.
6. The device as claimed in any of the preceding claims, wherein said second light source (16) emits a warm white light radiation or a colored light radiation.

7. The device as claimed in any of the preceding claims, wherein said first light source (12) and said second light source (16) are separate light generators, preferably of the LED type.

8. The device as claimed in any of claims 1 to 6, comprising a single light generator, preferably of the LED type, whose light radiation is distributed selectively toward said first light source (12) and toward said second light source (16).

9. The device as claimed in claim 8, wherein said single light generator is one of said first light source (12) and said second light source (16).

10. The device as claimed in any of the preceding claims, comprising a support structure (14) of an illuminable material which can be activated by said control unit (20) in said conditions of reduced visibility.
INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/05Q757

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21S/08/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
F21S H05B F21K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>EP 0 574 359 Al (CAROLFI GIANNI [IT]) 15 December 1993 (1993-12-15) col umn 1, l line 32 - col umn 2, l line 53; fi gure -----</td>
<td>1,3</td>
</tr>
<tr>
<td>A</td>
<td>EP 0 516 527 Al (VALEO VISION [FR]) 2 December 1992 (1992-12-02) col umn 1, l line 15 - col umn 3, l line 8; fi gures 1-15 -----</td>
<td>2,3</td>
</tr>
<tr>
<td>A</td>
<td>FR 749 910 A (ALFRED BRACE) 1 August 1933 (1933-08-01) abstract; figure -----</td>
<td>1,4,5</td>
</tr>
</tbody>
</table>

Special categories of cited documents:

* "A" document defining the general state of the art which is not considered to be of particular relevance
* "E" earlier document but published on or after the international filing date
* "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
* "O" document referring to an oral disclosure, use, exhibition or other means
* "P" document published prior to the international filing date but later than the priority date claimed

Further documents are listed in the continuation of Box C.

Date of the actual completion of the international search
20 April 2011

Date of mailing of the international search report
28/04/2011

Name and mailing address of the ISA/
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk
Tel.: (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer
Albertsson, Gustav
## INTERNATIONAL SEARCH REPORT

### DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>DE 10 2007 061160 AI (SEMPERLUX AG LICHTTECHNISCHE W [DE]) 25 June 2009 (2009-06-25) abstract; figures 1,2</td>
<td>1,7-9</td>
</tr>
<tr>
<td>A</td>
<td>JP 2005 002773 A (TOSHIBA LIGHTING &amp; TECHNOLOGY) 6 January 2005 (2005-01-06) abstract; figure 1</td>
<td>10</td>
</tr>
<tr>
<td>A</td>
<td>CH 164 033 A (BRENNER EDUARD [CH]) 15 September 1933 (1933-09-15) page 4, left-hand col umn; figures 1-10</td>
<td>4-6</td>
</tr>
<tr>
<td>A</td>
<td>US 2 793 285 A (BRAINERD ARTHUR A) 21 May 1957 (1957-05-21) col umn 1 - col umn 2; figures 1-8</td>
<td>4,5</td>
</tr>
</tbody>
</table>

Form PCT/05/210 (continuation of second sheet) (April 2009)
## INTERNATIONAL SEARCH REPORT

**Information on patent family members**

### International application No

PCT/EP2011/05757

<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DE 69301195 D1</td>
<td>15-02-1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69301195 T2</td>
<td>12-09-1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DK 0574359 T3</td>
<td>06-05-1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2084481 T3</td>
<td>01-05-1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GR 3019335 T3</td>
<td>30-06-1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IT 227274 Y1</td>
<td>16-09-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5426574 A</td>
<td>20-06-1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 100932917 B1</td>
<td>21-12-2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NONE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0516527 A1</td>
<td>02-12-1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BR 9202003 A</td>
<td>12-01-1993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2069799 A1</td>
<td>30-11-1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69203538 D1</td>
<td>24-08-1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69203538 T2</td>
<td>11-01-1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2076014 T3</td>
<td>16-10-1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2676977 A1</td>
<td>04-12-1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 5185873 A</td>
<td>27-07-1993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5894272 A</td>
<td>13-04-1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 749910 A</td>
<td>01-08-1933</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NONE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 102007061160 A1</td>
<td>25-06-2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NONE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2005002773 A</td>
<td>06-01-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NONE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH 164033 A</td>
<td>15-09-1933</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NONE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2793285 A</td>
<td>21-05-1957</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NONE</td>
</tr>
</tbody>
</table>

Form PCT/ISA/210 (patent family annex) (April 2005)