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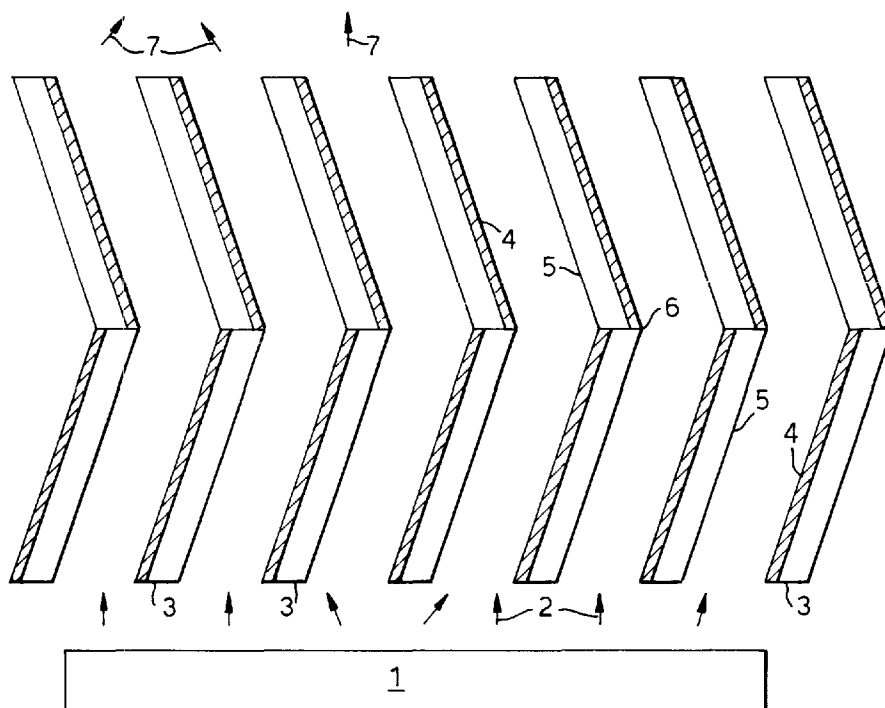
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(54) **A radio frequency interference shield**

(57) A radio frequency interference (RFI) shield comprises an electrically conductive baffle which is kept at ground potential in operation. The baffle comprises either a plurality of substantially parallel V-shaped elon-

gate members having a phosphor coated surface, or a phosphor coated mesh. The apparatus directs light emanating from the phosphor coated surface through the baffle thereby increasing the efficiency of the system.

Fig.1.



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Description

This invention relates to a radio-frequency interference (RFI) shield for a light source which emits UV light. The invention relates particularly, though not exclusively, to a shield for use with backlights for liquid crystal panels.

High intensity light sources, such as radio frequency excited plasma discharges, are attractive candidates for use in backlighting LCD displays requiring good contrast in bright conditions. However, when such displays are used adjacent sensitive electronic equipment (for example in the cockpit of an aircraft) the radio frequency interference which such lamps radiate can prove troublesome.

A known way of reducing radiated radio frequency energy from a source is to surround the source with a 'Faraday Cage'. Such cages can be solid metal or wire mesh, dimensioned so that efficient electromagnetic screening is achieved. Such apparatus, if solid, does not allow light to pass through; if formed by a wire mesh it reduces the intensity of visible light and any UV light emanating from the light source. However, any UV light emitted by the source in the latter case will still be largely transmitted and may cause eye damage to an observer.

Another way of reducing such RFI (described in JP-05-150214) is to provide a transparent layer of earthed conductive material, such as for example indium tin oxide (ITO) either on the envelope of the lamp or on a major surface of the LCD display. Unfortunately, to get a useful reduction in radiated RFI using this technique requires increasing the thickness of the ITO layer, resulting in a concomitant decrease in its optical transmission, and an increase in its susceptibility to cracking.

The present invention provides a radio-frequency interference (RFI) shield, for a light source which emits UV light, comprising an electrically-conductive light-transmissive baffle, the baffle being arranged to transmit indirectly light from the source, and to reduce transmission through the baffle of RFI emanating from the light source in use, characterised in that the baffle includes a surface area comprising luminescent material.

This can provide the advantage of reducing the radiation of RFI to other sensitive apparatus whilst maintaining a useful intensity of light being transmitted through the baffle. The baffle may be made very conductive without adversely impacting the transmission efficiency.

Preferably, the baffle includes a reflective surface area which is arranged to face the luminescent area. Using this arrangement visible light emanating from the luminescent material can be directed through the baffle thereby increasing its efficiency.

The baffle advantageously comprises a plurality of elongate members each having a surface which is not parallel to the direction of transmission of light through the baffle, the elongate members being arranged to substantially prevent direct transmission of light from the

light source.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which

Figure 1 shows a cross section of a first embodiment, and

Figure 2 shows a cross section of a second embodiment.

Figure 1 shows a cross section of a radio frequency interference (RFI) shield for a light source (1) which emits UV light in addition to visible light. The light source in this figure is described in more detail in PCT/GB94/01919, and comprises a quartz envelope filled with a gas suitable for maintaining a glow discharge driven by an external electrode. Light (2) is emitted from the light source in operation towards an electrically-conductive light-transmissive baffle. This light includes UV light emanating from the plasma itself as well as visible light. The baffle comprises a plurality of elongate metal members (3) arranged such that the major surfaces of the elongate members are not parallel to the direction of transmission of the light through the baffle. The elongate members are arranged such that the light which is transmitted by the baffle has been reflected or scattered from at least two surfaces of the elongate members. Thus the light is transmitted indirectly through the baffle and light from the source is not directly transmitted.

The baffle includes a surface area (5) comprising a luminescent material. In the present example this is a thin phosphor layer deposited on selected areas of elongate member. The phosphor layer is constructed to convert incident ultraviolet light into longer wavelength visible light which is emitted or scattered diffusely by the layer. Preferably several different chemical compounds are present in the phosphor layer to give a plurality of different colours of emitted light.

The elongate members comprising the baffle shown in Figure 1 are arranged such that luminescent surface areas (5) face and are spaced from reflective surface areas (4). This arrangement can increase the visible-light transmission efficiency of the baffle. In the present example, the elongate members are made from sheet metal and have a generally V-shaped cross section. Each elongate member is connected electrically to ground potential in use, and adjacent members are substantially parallel with the points of the V's pointing in a direction perpendicular to the direction of transmission of light through the baffle. In the example shown in Figure 1, the V shaped elongate members are formed from two slats or louvres joined together along one edge (6). As an alternative, the slats may be separate so that there are no V shaped elongate members, but an array of horizontally spaced louvre shaped elongate members instead. A plurality of such arrays may be employed. Each array may be displaced vertically from the other (s) with respect to the light source. Each vertically dis-

placed array may also be displaced horizontally to give a plurality of staggered arrays which will work in substantially the same way as the example shown in Figure 1. Alternatively, or in addition, the elongate members comprising different arrays may be arranged to extend in different directions. For example, the elongate members may be substantially orthogonal in respective arrays, thereby providing continuous conductors in both the x and y axes with the direction of light transmission through the baffle forming the z axis. To provide good RFI suppression, each louvre must be connected to ground potential in use. The luminescent material may be fluorescent, or phosphorescent, or both.

As a further alternative to V-shaped elongate members, an additional slat may be added to each member to form a double V cross-section with the points of the two V's pointing in opposite directions. Two additional slats may be added to each V-shaped member to give a member having a W-shaped cross-section, and additional slats may be added to give a corrugated surface in cross-section which will transmit indirectly incident light via multiple scattering and reflection.

The apparatus shown in Figure 1 has been found to reduce the radiated electric field at a distance of 1 metre from an RF light source driven at 13.56 MHz by 40 dB (micro volts per metre).

A second embodiment of the invention is shown in cross-section in Figure 2. In this example, the baffle comprises a reticulated sheet or mesh of electrically conductive material (12) placed in front of a light source (1) (as described previously) having a quartz window (10).

In this second embodiment, light from the source is transmitted partly directly and partly indirectly. The filaments comprising the mesh have a conductive core (12) and a luminescent surface layer (11), which in the present example is formed by coating the mesh with a thin phosphor layer.

The mesh is placed between two light-transmissive sheets. In the present example, one such sheet is constituted by the quartz envelope of the light source (10), and the other is a glass sheet (14) having a thin luminescent layer (13) deposited on a major surface of it. This assembly is placed behind a liquid crystal panel (16) to backlight the display in use. A polarizing sheet is placed between the glass sheet (14) and the display (16), as is well known for prior art liquid crystal displays.

In this example, the luminescent layer is produced by phosphor coating the glass sheet. The electrically-conductive reticulated sheet (or mesh) is connected to ground potential in use. The sheet or mesh will obstruct the light output of the light source, but this obstruction is ameliorated by coating the mesh with the luminescent layer (13). This layer down-converts incident UV light to visible light, and at the same time diffusely scatters any incident visible light. The thinly phosphor coated glass sheet (14) placed adjacent the mesh further diffuses the shadow of the mesh by scattering visible light. The re-

maining UV emission from the light source is also converted to visible light by the phosphor coating (13) on this sheet. In use, the electrically-conductive reticulated sheet or mesh is connected to ground potential.

The reticulated sheet may be relatively thick compared with the diameter of the reticulations. In particular it may, for example, take the form of a honeycomb of conductive 'tubes' each having a hexagonal cross section, the tubes being bundled together to form a substantially planar array which is light transmissive in a direction substantially perpendicular to the plane of the array.

The reflective surface may be specularly or diffusely reflective. A diffuse reflector may be formed by using a luminescent material such as, for example, a phosphor powder coating.

The RFI shielding apparatus described can satisfy the dual requirements of good transmission of visible light and good conversion of incident UV light to visible light.

The highest frequency of RF interference which such a shield will block will depend upon the wavelength of the radio waves, and how this compares with the spacing between adjacent elongate members. At 13 MHz a spacing of a few centimeters is much less than the wavelength, and hence the shield will be very effective. At higher frequencies it may be necessary to reduce the spacing between adjacent members to improve the shield performance.

In summary, a radio frequency interference (RFI) shield comprises an electrically conductive baffle which is kept at ground potential in operation. The baffle comprises either a plurality of substantially parallel V-shaped elongate members having a phosphor coated surface, or a phosphor coated mesh. The apparatus directs light emanating from the phosphor coated surface through the baffle thereby increasing the efficiency of the system.

Claims

1. A radio-frequency interference (RFI) shield, for a light source which emits UV light, comprising an electrically-conductive light-transmissive baffle, the baffle being arranged to transmit indirectly light from the light source, and to reduce transmission through the baffle of RFI emanating from the light source in use, characterised in that the baffle includes a surface area comprising luminescent material.
2. An RFI shield as claimed in claim 1 in which the baffle includes a plurality of luminescent areas arranged to face one another.
3. An RFI shield as claimed in claim 1 in which the baffle includes a reflective surface area.

4. An RFI shield as claimed in claim 3 in which the luminescent surface area(s) is (are) arranged to face the reflective surface area(s).
5. An RFI shield as claimed in any preceding claim in which the baffle comprises a plurality of elongate members each having a surface which is not parallel to the path of light from the said light source, the elongate members being arranged to substantially prevent direct transmission of light from the said light source.
6. An RFI shield as claimed in claim 5 in which each elongate member is provided with a generally V-shaped cross-section, adjacent elongate members being substantially parallel.
7. A radio frequency interference (RFI) shield for a light source, consisting of an electrically-conductive reticulated sheet or mesh including a luminescent surface layer, the sheet or mesh being arranged to transmit light from the light source and reduce transmission through the sheet or mesh of RFI emanating from the light source in use.
8. An RFI shield as claimed in claim 7 in which the electrically conductive sheet or mesh is provided between a pair of light transmissive sheets being arranged to face one another.
9. A radio frequency interference (RFI) shield substantially as described herein.
10. A light source provided with an RFI shield as claimed in any preceding claim.
11. A light source provided with an RFI shield as claimed in claim 8 in which the light transmissive sheet furthest from the light source does not transmit UV light.
12. A light source provided with an RFI shield as claimed in claim 8 and a UV filter on the opposite side of the shield to the light source.
13. A liquid crystal display including a light source as claimed in claim 10 or 11 or 12 for backlighting the display.

Fig.1.

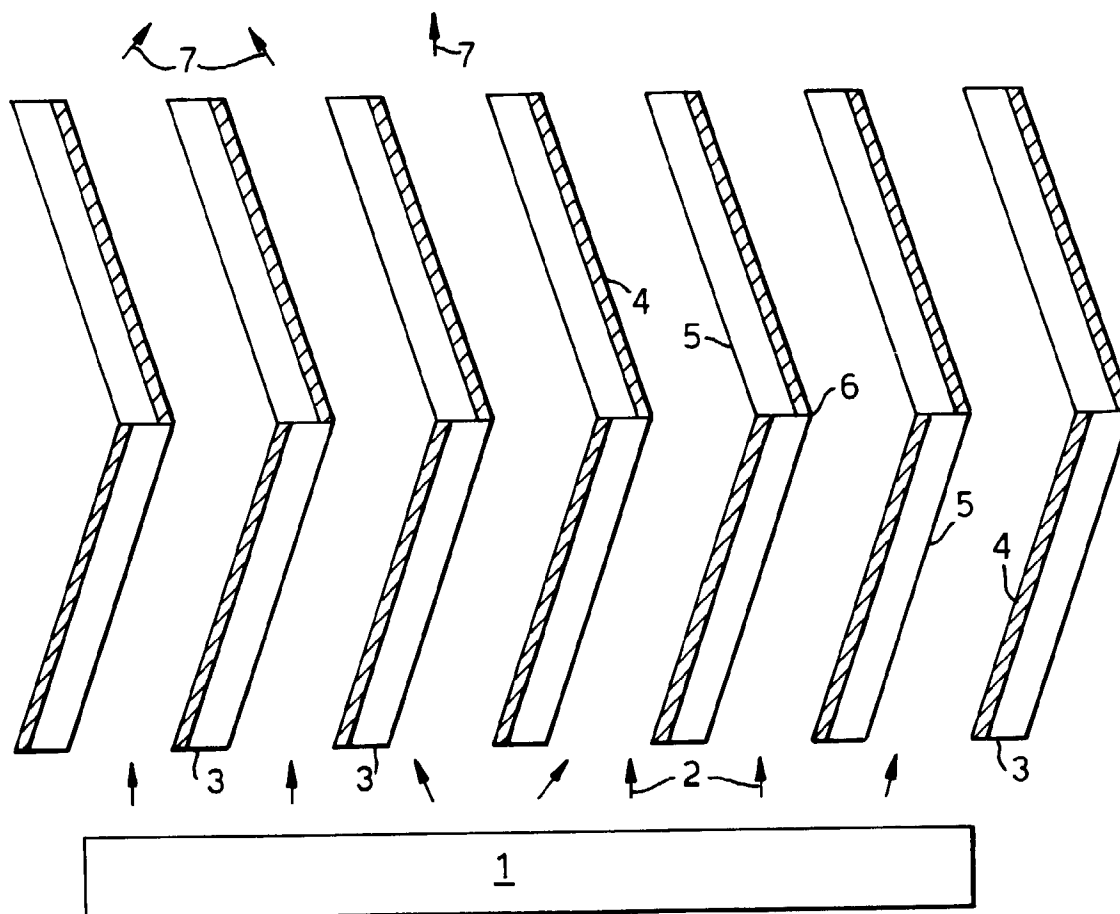


Fig.2.

