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(54) Title: ROAD STUD

(57) Abstract: There is described a road stud for disposal in a road surface. The road stud comprises a housing and a partially transparent material arranged to at least partially block the passage of predetermined wavelengths of solar radiation into the housing. Thus, the present invention reduces the amount of solar radiation entering a road stud so as to reduce the internal road stud temperature and thereby allow any internal electronic components to function within the manufacturers specifications.

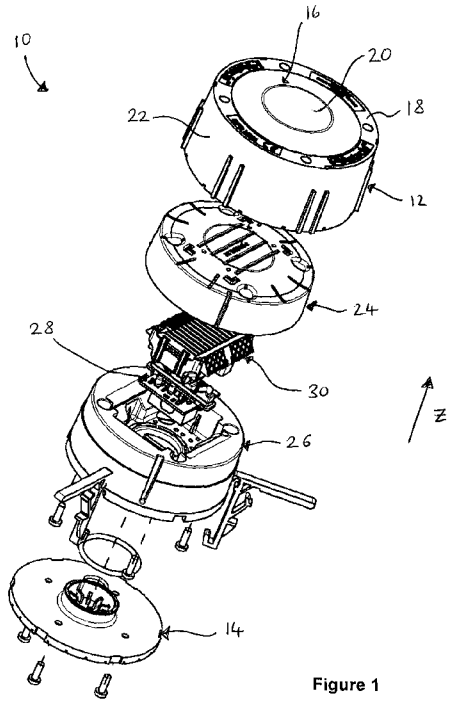


Figure 1

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ROAD STUD

FIELD OF THE INVENTION

The present invention relates to a road stud for disposal in a road surface.

BACKGROUND OF THE INVENTION

Road studs may be embedded in a road surface to clearly delineate lanes on the road during darkness. Road studs may generally be classed as "active" or "passive".

Passive road studs, or cat's eyes, simply provide a reflective function so as to reflect a vehicle's headlights back to the vehicle's driver. No power is required by passive road studs, but only a few such road studs are visible on the road ahead due to the requirement for a vehicle's headlights to fall upon each road stud for it to be visible to a driver.

In contrast, active road studs incorporate LEDs, for example, which act as a light source for drivers even in the absence of a vehicle's direct headlights on the road stud. Thus, active road studs can delineate road lanes much further ahead of a vehicle than is possible using passive road studs. Nonetheless, a power source is required to power the LEDs in active road studs.

One type of active road stud is the solar-powered road stud. Such road studs are particularly effective in tropical countries which receive a lot of sunshine. However, solar road studs used at latitudes close to the equator can reach internal air temperatures exceeding 120°C. As will be understood, electronic parts and batteries, etc. have great difficulty maintaining stability at these temperatures.

The present invention therefore seeks to provide an improved road stud suitable for use in tropical countries which provides various advantages over those of the prior art.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided a road stud for disposal in a road surface. The road stud comprises a housing and a partially transparent material arranged to at least partially block the passage of predetermined wavelengths of solar radiation into the housing.

Thus, the present invention reduces the amount of solar radiation entering a road stud so as to reduce the internal road stud temperature and thereby allow any internal electronic components to function within the manufacturers specification.

The road stud may further comprise a light source disposed within the housing, wherein the partially transparent material is substantially transparent to outgoing light from the light source. This ensures that the intensity and colour of the outgoing light from the light source are not affected by the partially transparent material. The light source may include one or more LEDs.

The road stud may further comprise a solar cell disposed within the housing, wherein the partially transparent material is arranged to allow the passage therethrough of some solar radiation to charge the solar cell. Thus, whilst some of the incoming solar radiation is blocked by the partially transparent material, there is other incoming solar radiation which is transmitted through the partially transparent material so as to charge the solar cell. In essence, this leads to a balance between charging the solar cell and reducing the internal temperature of the road stud. The solar cell may have its peak efficiency at a wavelength different from the predetermined wavelengths of solar radiation blocked by the partially transparent material. In other words, the predetermined wavelengths of solar radiation to be (at least partially) blocked are wavelengths at which the solar cell has a reduced efficiency. This provides an efficient way of reducing the internal temperature of the road stud whilst also allowing enough solar radiation into the road stud to charge the solar cell.

The partially transparent material may be substantially transparent to visible light. This enables visible light emitted by a light source within the road stud to be largely unaffected by its passage through the partially transparent

material. Hence a road user will discern no difference in the light emitted by the road stud due to the presence of the partially transparent material.

The partially transparent material may at least partially block ultraviolet light. For example, the partially transparent material may at least partially block ultraviolet light in the wavelength band 200-380nm.

The partially transparent material may at least partially block infrared light. For example, the partially transparent material may at least partially block near-infrared light. In one embodiment, the partially transparent material at least partially blocks solar radiation in the wavelength band 660-1200nm, which includes some NIR light.

As background, it should be noted that electromagnetic radiation with a wavelength between 380 nm and 760 nm (which corresponds to a frequency range of 400THz to 790THz) is detected by the human eye and perceived as visible light. Other sources suggest a wavelength range of 390nm to 750nm or 380nm to 780nm for visible light. Other wavelengths, especially near infrared (NIR) and ultraviolet (UV) are also sometimes referred to as light, especially when the visibility to humans is not relevant. IR radiation may be considered as electromagnetic radiation with a wavelength of between about 700nm and 300μm, which equates to a frequency range between approximately 1THz and 430THz. Other sources suggest a wavelength range of 730nm to 1mm for IR radiation. Within this IR radiation band, NIR radiation may be considered as having frequencies from 120 to 400THz, which corresponds to wavelengths between 2,500 and 750nm. Other sources suggest that the NIR wavelength band starts at 760nm. UV radiation may be considered as electromagnetic radiation with a wavelength shorter than that of visible light, but longer than x-rays, in the range 10nm to 400nm. Other sources suggest a wavelength range of 13nm to 380nm for UV radiation.

The partially transparent material may comprise a substantially transparent material mixed with a dye, wherein the dye preferentially absorbs the predetermined wavelengths of solar radiation to be blocked. Alternatively, the partially transparent material may comprise a partially transparent ink printed onto a substantially transparent material. The substantially transparent material

may comprises a plastic material. The substantially transparent material may comprise a polycarbonate. Alternatively, the substantially transparent material may comprise glass.

The housing may further comprise a lower portion, wherein the lower portion of the housing is substantially white or light coloured so as to reduce absorption of incoming solar radiation by the road stud. This further reduces the internal temperature of the road stud.

The road stud may further comprise one or more components within the housing, wherein the one or more components are substantially white or light coloured so as to reduce absorption of incoming solar radiation by the road stud. This also acts to reduce the internal temperature of the road stud.

The road stud may further comprise a reflective element disposed beneath the partially transparent material, wherein the reflective element reflects incoming solar radiation so as to reduce the absorption of incoming solar radiation by the road stud. Again, this acts to reduce the internal temperature of the road stud.

An upper portion of the housing may comprise the partially transparent material.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is an exploded view of a solar-powered road stud in accordance with an embodiment of the present invention.

Figure 2 schematically illustrates a cross-sectional side view of the road stud of Figure 1 when disposed in a road surface.

Figure 3 shows the measured flux of solar energy arriving at the road stud (A), the measured flux of energy radiated by a white LED (B), and the measured flux of solar energy passing through two different partially transparent materials (C and D). The fluxes on the y-axis of the graph are truncated.

Figure 4 shows the transmission properties for exemplary dye IR 6131.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Figure 1 shows an exploded view of a solar-powered road stud 10 in accordance with an embodiment of the present invention. The road stud 10 comprises an external housing and various internal components.

The housing is made up of an upper housing 12 and a base 14, which together give the assembled road stud 10 a substantially cylindrical shape. It should be noted that any references to upper/lower parts and vertical/horizontal directions refer to the orientation in which the road stud 10 is intended to be disposed in a road surface 40 in use, as schematically illustrated in Figure 2. For reference, the upward vertical direction is shown by arrows Z in Figures 1 and 2.

The base 14 is substantially formed as a disc. The upper housing 12 comprises a top surface 16 of the housing. The top surface 16 is disposed substantially parallel to and opposite the base 14 when the road stud 10 is assembled. The top surface 16 is not completely flat, but instead comprises an outer, flat, horizontal annulus 18, and an inner convex portion 20 which protrudes slightly above the road surface 40 in use. This is best seen in Figure 2 which shows the road stud 10 disposed in a horizontal road surface 40. The convex portion 20 is partially transparent and acts as a lens, as described further below. The upper housing 12 further comprises a tubular skirt 22 which extends downwards from the outer periphery of the annulus 18. The base 14 is received within the lower end of the tubular skirt 22 when the road stud 10 is assembled.

As mentioned above, the road stud 10 further comprises various internal components which are contained within the housing, some of which are electronic components. In particular, the internal components include upper and lower casing components 24 and 26, a printed circuit board (PCB) and battery assembly 28, and a solar cell, reflector and light emitting diode (LED) assembly 30.

The two assemblies 28 and 30 are disposed between the upper and lower casing components 24 and 26. The casing components 24 and 26 ensure the correct relative positioning of the two assemblies. The upper casing component 24 is manufactured from a clear potting resin which is poured into the road stud

10 after assembly. The solar cell, reflector and LED assembly 30 is disposed below the transparent upper casing component 24.

In use, the convex portion 20 of the upper housing 12 acts as a lens to focus incoming solar radiation towards the solar cell of the solar cell, reflector and LED assembly 30. The solar cell is used to charge the battery, which in turn provides power to the LEDs under the control of circuitry on the PCB. The LEDs emit visible light. The convex portion 20 of the upper housing 12 acts as a lens to direct outgoing light from the LEDs of the solar cell assembly 30 towards road users so as to delineate lanes on the road during darkness. The solar cell may also be referred to as a solar panel or photovoltaic cell.

In prior art road studs, such as the Astucia SolarLite embedded road stud, a top surface of the road stud is entirely transparent to solar radiation so that the solar cell may be charged, and so that the chromaticity of the outgoing LED light is not affected. However, in tropical areas such as Saudi Arabia, Peru, Mexico and Africa, the large amount of incoming solar radiation can overcharge the solar cell and/or can lead to a very high internal temperature of the road stud.

In the present road stud 10, the upper housing 12 is partially transparent to solar radiation. In particular, the upper housing 12 is manufactured from a transparent material which is mixed together with a dye that blocks the passage of certain predetermined wavelengths of solar radiation. The transparent material on its own would allow the passage therethrough of UV, IR, NIR and visible solar radiation. The transparent material may be a transparent plastic, such as a transparent polycarbonate compound. For example, the transparent material may be a polycarbonate and polyester compound, such as GE Plastic "Xylex". Alternatively, the transparent material may be glass

The dye causes the upper housing 12 to preferentially absorb at least some of the solar radiation at the predetermined wavelengths. Thus, the dye acts to at least partially block the passage of certain wavelengths of light through the upper housing 12. More advantageously, the dye acts to substantially entirely block the passage of certain wavelengths of light through the upper housing 12. In a preferred embodiment, the dye comprises a metal complex

organic dye. More specifically, the dye comprises a metal complex organic dye from the Aminium family. Specific measures of the dye are mixed with the moulding plastic (e.g. the polycarbonate compound) before moulding the upper housing 12. Suitable ratios of dye and plastic are used to allow the specific LED chromaticity to pass through the dye and block all other wavelengths.

In an alternative embodiment, only the top surface 16 of the upper housing 12 is dyed to be partially transparent to solar radiation. In a further alternative embodiment, only a portion of the top surface 16 is dyed to be partially transparent to solar radiation; this dyed portion would still act to reduce the incoming solar energy, but by a smaller amount than if the entire top surface were manufactured from the dyed, partially transparent material. The tubular skirt 22 of the upper housing 14 is not required to be partially transparent since the tubular skirt 22 is not generally disposed in the optical path between the sun and the solar cell or LEDs.

In a preferred embodiment, the dye blocks light wavelengths between about 200nm and 380nm in the ultraviolet (UV) spectrum, and light wavelengths between about 660nm and 1200nm which are largely located in the infrared (IR) and near-infrared (NIR) light spectrum. Preferably 99.9% of light in these wavelengths is blocked by the presence of the dye. The amount of solar energy within the blocked regions represents about 35% above 660nm and 11% below 380nm, so a theoretical maximum total heat reduction within the road stud 10 would be around 46% in this case. Input solar energy to the solar cell is also reduced, but this has a reduced effect because the solar panel is less efficient in the IR and NIR wavelength bands than in the visible band. In other words, the dye does not block the wavelengths of solar radiation at which the solar cell is most efficient.

Using the preferred dye as described above, the dye blocks little or no light at wavelengths between 380nm to 660nm in the visible spectrum. Thus, the majority of incoming visible solar radiation is able to pass through the dyed, partially transparent, upper housing 12 to charge the solar cell. In addition, outgoing visible light from the LED is able to pass through the dyed, partially transparent, upper housing 12 without any change in chromaticity. Thus the

colour of the LED light visible to road users is not affected by the partial transparency of the upper housing 12.

It would alternatively be possible for the dye to block a certain amount of light in the visible spectrum. In this case, it may be necessary to increase the output of the LED to compensate for any blocked outgoing visible light from the LED, thereby ensuring that there is no reduction in the intensity of light visible to road users.

In the preferred embodiment, the dye is used to prevent heat build up within the road stud 10. Since the LED in the road stud 10 emits visible light, the dye is formulated and balanced so as to reduce incoming solar energy whilst having a negligible effect on the amount and colour of outgoing visible light from the LED. If no visible light emission by the road stud is required, then a different formula of dye can be used to match the solar cell charging requirements and to block all other wavelengths of light, thereby reducing the build up of heat within the road stud without impacting significantly on the charging of the solar cell. The dye can also be formulated to prevent overcharging of the solar cell in high sun radiation areas by increasing the blocking of certain NIR and IR wavelengths.

Thus, it should be clear that the wavelength bands to be blocked by the partially transparent material of the upper housing 12 may be varied from those specified above. For example, the dye could be formulated to at least partially block ultraviolet (UV) light wavelengths between about 300nm and 380nm, and infrared (IR) and near-infrared (NIR) light wavelengths between about 660nm and1500nm. Again, these are exemplary wavelengths ranges. Other wavelength ranges are envisaged within the scope of the present invention. For example, it would be possible to use a different dye to block only UV light, or only NIR light, rather than both UV and NIR.

As an example, Figure 3 shows the measured flux of solar energy arriving at an exemplary road stud 10 (see solid line A). Figure 3 also shows the measured flux of energy radiated by a white LED within the solar cell, reflector and LED assembly 30 of the road stud 10 (see dashed line B). The line of crosses C and the dotted line D show the measured flux of solar energy passing through two different, alternative, partially transparent materials used as the

upper housing 12 of the road stud 10. In particular, different dyes are applied to the polycarbonate compound in each of C and D. As can be seen from the line of crosses C, the dye used in this case blocks some of the output light from the white LED at the blue end of the visible spectrum. Thus, this dye would affect the outgoing colour of light from the LED which would visible to road users. Thus, the dye used in C would not maintain the chromaticity of the white LED, which makes the dye used in C less desirable. In contrast, as can be seen from the dotted line D, the dye used in this case allows the passage of all light from the LED through the upper housing 12 of the road stud 10. In other words, this dye does not block the wavelengths of light emitted by the white LED, and the chromaticity of the white LED is therefore maintained as the light passes through the partially transparent material of the upper housing 12 in this case. Nonetheless, the dye used in D blocks all UV light up to around 380nm and also blocks all NIR light with wavelengths above about 820nm. This is a preferred embodiment of the invention.

Testing on the road stud 10 has shown that the dye can provide a 20% reduction in heat transfer to the inside of the road stud 10, which significantly reduces the maximum internal temperature of the road stud 10. The testing was carried out in relatively low temperature/sun energy levels, so a higher reduction in heat transfer may be expected in higher temperatures/sun energy levels.

It should be noted that, rather than manufacturing the upper housing 12 from a dyed transparent material, the upper housing could alternatively be formed from a transparent material (such as a plastic or glass, as described above) with a layer of partially transparent ink printed on one surface (e.g. the lower surface) or with the partially transparent ink layer sandwiched between two transparent layers. Similar to the dye, the ink would act to block the passage therethrough of certain wavelengths (e.g. UV and NIR), but would allow transmission of other wavelengths (e.g. visible light). Furthermore, the ink layer need not cover an entire horizontal extent of the upper housing , but could instead be printed in a dot stencilled pattern, similar to that printed on car windscreens. Thus, some parts of the upper housing would be entirely transparent and other parts would be partially transparent with wavelength discrimination due to the presence of the ink

dots. The pattern could then be adjusted to reject to allow the passage of more or less light through the upper housing.

The method of manufacture of the upper housing 12 in a preferred embodiment will now be described in detail. It is to be understood that variations in the method of manufacture also fall within the scope of the present invention, and the described method is intended to be exemplary, rather than limiting.

In this embodiment, the entire upper housing 12 is manufactured from a two-part resin mixed with a dye which at least partially blocks IR and UV wavelengths. Use of a two-part resin mixture is standard in order to cure (i.e. harden) the resin. Moulds are used to form the resin mixture for the upper housing 12 into the desired shape.

In this embodiment, the two-part resin mixture is made up of the following two parts: (a) Cellanate M215 Modified Aliphatic Isocyanate, and (b) CELLACAST 24.670 polyurethane elastomer. Other resins may be used. The dye used in this embodiment is IR 6131. Figure 4 shows the transmission properties for this dye. Figure 4 shows that this dye at least partially blocks IR and UV wavelengths. Other suitable known dyes may be used in other embodiments.

Firstly, the moulds are placed into an oven to remove any moisture from the moulds. For example, the moulds may be placed in the oven at a temperature of 80°C or more for 16 hours or more.

Meanwhile, the ambient temperature (outside the oven) is recorded. In addition, the temperatures of the two individual parts of the resin (pre-mixing) are recorded. These temperature measurements are used later to enable us to identify particular stages of the curing process.

Next, the two parts of the resin are mixed in a ratio according to their specific weights. A specific weight ratio of 1:1.05 for the two resin parts is typical. 1 litre of the two-part resin mixture is then placed into a vessel having dimensions of 100mm diameter and 300mm depth, for example. The temperature of the resin mixture is then recorded. Again, this temperature measurement is used later to enable us to identify particular stages of the curing process.

The resin mixture is next placed under vacuum to remove substantially all air from the mixture. Once the air has been removed from the resin mixture, the resin mixture is removed from the vacuum chamber.

The two-part resin mixture undergoes an exothermic reaction. After removal from the vacuum chamber, the resin mixture is left undisturbed whilst the exothermic reaction takes place. In this embodiment, the resin mixture is left until the temperature of the resin mixture has reached 50°C due to the exothermic reaction. At this temperature, the resin mixture is at the 65% cure point. In other words, the resin mixture has undergone 65% of the temperature increase required for the resin to be cured (i.e. hardened).

At the 65% cure point, 10ml of dye is added to the 1 litre of resin mixture and thoroughly mixed in. In this embodiment, it is important that the dye additive be introduced into the resin mixture at the 65% cure point of the resin mixture. This point will vary with regards temperature and time which will depend on the bulk of the resin mixture, the ambient temperature, the vessel used for mixing, and the resin mixture ratio used. In alternative embodiments, the point at which the dye additive should be introduced into the resin mixture may vary between 60-70% of the cure point of the resin mixture.

Following this mixing step, the resin mixture is again placed under vacuum in order to remove any air that may have been added during the mixing process.

The moulds are then removed from the oven and allowed to cool. For example, the moulds may be left to cool at room temperature for four hours or more.

Once the moulds have cooled sufficiently, the resin mixture is poured into the moulds and allowed to settle at an ambient temperature of, say, 22°C for 1 hour. This settling step ensures that there is no shrinkage when the moulds are replaced in the oven.

The moulds filled with resin mixture are then placed into the oven set to 60°C degrees for 4 hours. After heating, the moulds are removed from the oven and allowed to cool for 4 hours at room temperature of 22 degrees, say.

Following cooling, the resin mixture should have set hard. The hardness of the resin mixture may be tested for quality control purposes. A minimum

hardness of 80 Shore D is usually required for the present road studs. The hardened resin mixture may then be tested to quantify the light absorption qualities.

The base 14 of the road stud 10 may be manufactured from a plastic, such as Nylon 6-6. Other materials are also envisaged. The base 14 may include blocking material to prevent the passage of heat radiation from the road into the road stud 10.

The upper casing component 24 may be manufactured from a clear potting resin with some added UV protection. The UV protection is provided by including an additive having varying amounts of catalyst depending on the amount of UV protection required. The resin may alternatively or additionally be provided with some added IR of NIR blocking capability if desired.

The lower casing component 26 is manufactured from a white plastic so as to reduce absorption of incoming solar radiation by the road stud 10 as compared to a similar black plastic component of the prior art. This is a further measure to reduce the internal temperature of the road stud 10 as compared to prior art road studs. In a preferred embodiment, the white plastic is Nylon 6-6. By using a white lower casing component 26, it is possible to reduce the internal temperature of the road stud 10 by 20% as compared to a similar road stud having a black lower casing component. It is possible that another light/pale colour (other than white) may alternatively be used for the lower casing component 24 so as to adjust the amount of heat retention required. Other internal components of the road stud 10 may also be manufactured from white or light-coloured plastic so as to further reduce the internal temperature of the road stud 10. For example, the base 14 may be manufactured from white or light-coloured plastic such as Nylon 6-6.

Alternatively, various components of the road stud 10 (e.g. the base 14 and/or the lower casing component 26) may be manufactured with a reflective outer surface (e.g. a chrome finish) rather than being manufactured from white plastic or similar. This would enable such components to reflect all wavelengths of incoming solar radiation, again reducing absorption of incoming solar radiation

by the components so as to keep the internal temperature of the road stud 10 down. Similarly, it would be possible to provide a reflective disc (e.g. a chrome disc) that covers everything below the top surface 16 of the upper housing 12. In this case, there would be a semi-transparent or polarised area of the chrome disc to allow light through to the solar cell below. In addition, the LED light output area of the chrome disc would either be open or have a similar transparent section applied to the disc. The same chrome finish principle could be applied to the lower surface of the upper housing 12.

Although preferred embodiments of the invention have been described, it is to be understood that these are by way of example only and that various modifications may be contemplated.

CLAIMS

1. A road stud for disposal in a road surface, the road stud comprising:
a housing; and
a partially transparent material arranged to at least partially block the passage of predetermined wavelengths of solar radiation into the housing.

2. The road stud of claim 1 further comprising a light source disposed within the housing, wherein the partially transparent material is substantially transparent to outgoing light from the light source.

3. The road stud of claim 1 or claim 2 further comprising a solar cell disposed within the housing, wherein the partially transparent material is arranged to allow the passage therethrough of some solar radiation to charge the solar cell.

4. The road stud of claim 3 wherein the solar cell has its peak efficiency at a wavelength different from the predetermined wavelengths of solar radiation blocked by the partially transparent material.

5. The road stud of any preceding claim wherein the partially transparent material is substantially transparent to visible light.

6. The road stud of any preceding claim wherein the partially transparent material at least partially blocks ultraviolet light.

7. The road stud of claim 6 wherein the partially transparent material at least partially blocks ultraviolet light in the wavelength band 200-380nm.

8. The road stud of any preceding claim wherein the partially transparent material at least partially blocks infrared light.

9. The road stud of claim 8 wherein the partially transparent material at least partially blocks near-infrared light.

10. The road stud of any preceding claim wherein the partially transparent material at least partially blocks solar radiation in the wavelength band 660-1200nm.

11. The road stud of any preceding claim wherein the partially transparent material comprises a substantially transparent material mixed with a dye, wherein the dye preferentially absorbs the predetermined wavelengths of solar radiation to be blocked.

12. The road stud of any preceding claim wherein the partially transparent material comprises a partially transparent ink printed onto a substantially transparent material.

13. The road stud of claim 11 or claim 12 wherein the substantially transparent material comprises a plastic material.

14. The road stud of claim 13 wherein the substantially transparent material comprises a polycarbonate.

15. The road stud of any preceding claim wherein the housing further comprises a lower portion, and wherein the lower portion of the housing is substantially white or light coloured so as to reduce absorption of incoming solar radiation by the road stud.

16. The road stud of any preceding claim further comprising one or more components within the housing, wherein the one or more components are substantially white or light coloured so as to reduce absorption of incoming solar radiation by the road stud.

17. The road stud of any preceding claim further comprising a reflective element disposed beneath the partially transparent material, wherein the reflective element reflects incoming solar radiation so as to reduce the absorption of incoming solar radiation by the road stud.

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18. The road stud of any preceding claim wherein an upper portion of the housing comprises the partially transparent material.

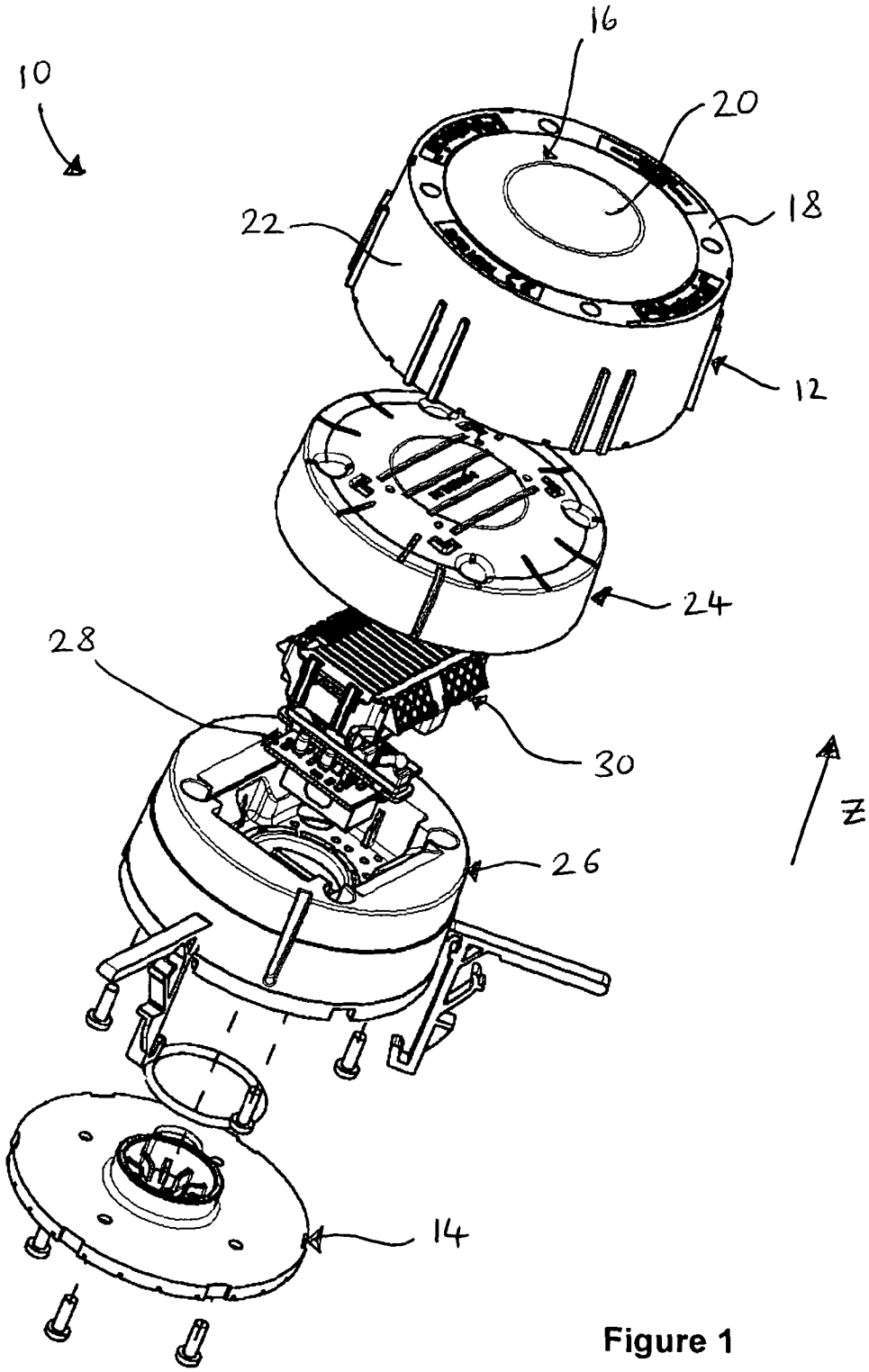


Figure 1

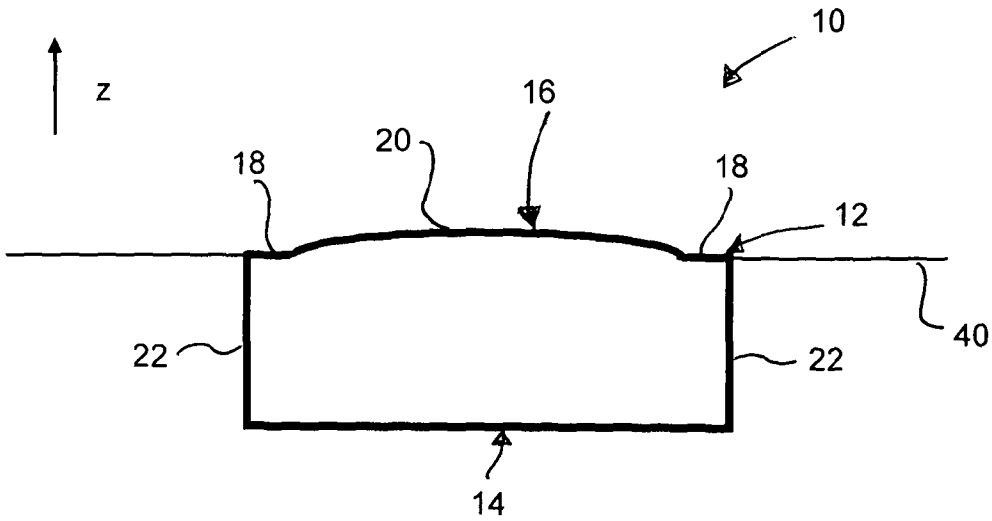


Figure 2

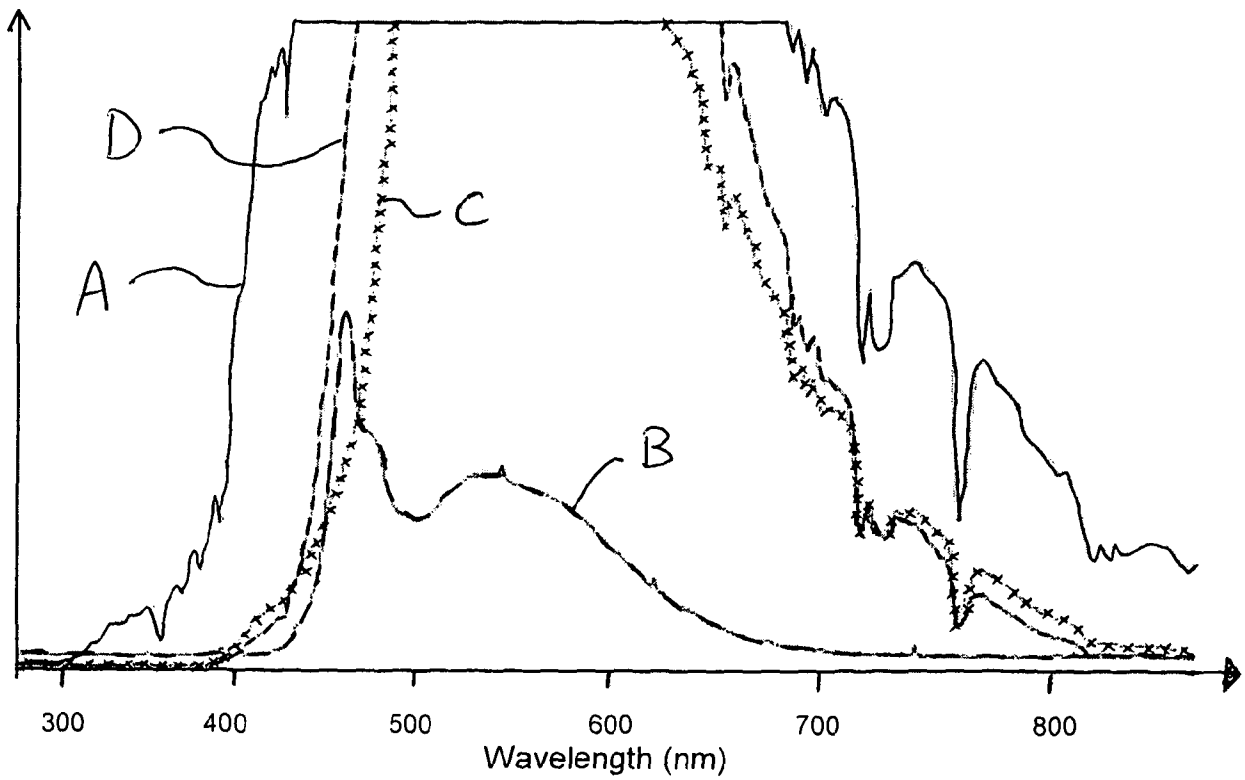


Figure 3

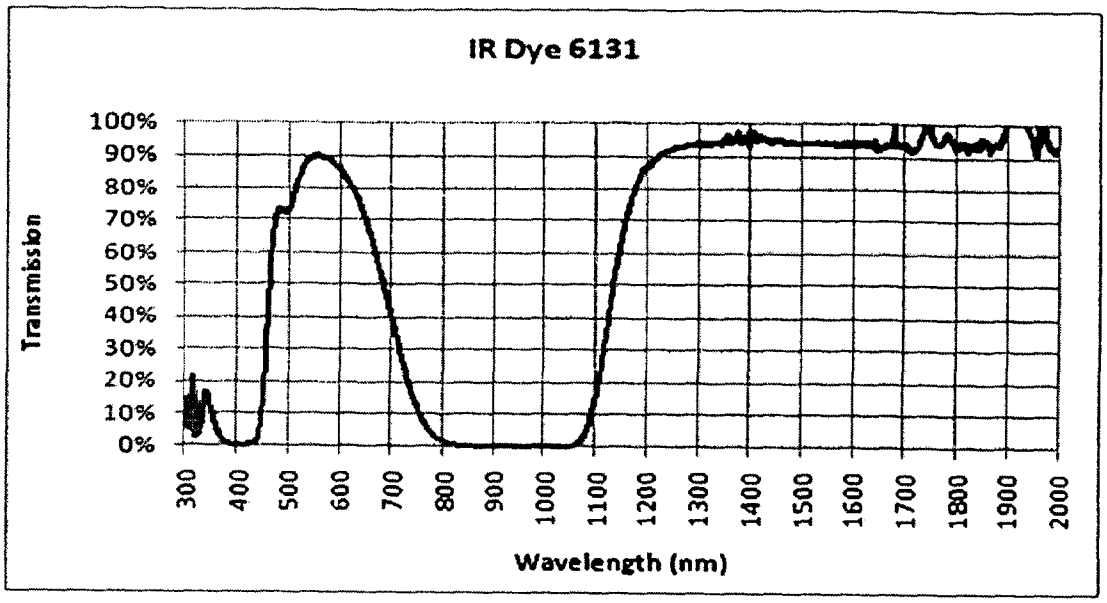

IR Dye 6131
Transmission
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Wavelength (nm)

Figure 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2011/000922

A. CLASSIFICATION OF SUBJECT MATTER
INV. E01F9/06
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)
E01F

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 940 626 A1 (ERNI ERNST R [CH]) 8 September 1999 (1999-09-08) paragraphs [0021] - [0025]; figures	1,2, 5-10, 15-18
X	US 6 155 703 A (RIZKIN ALEXANDER [US] ET AL) 5 December 2000 (2000-12-05)	1,2, 11-14
Y	column 3, lines 20-67; figures	3,4
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☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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