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**F21V 31/00 33/00**

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**F4R** RPR R301 R325 R354 R417 R44Y R493

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**US 3952190 A** **US 20020093832 A**
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**WPI abstract 1997-482211 & DE 29710476U U**

(58) Field of Search:
UK CL (Edition V ) **F4R**
INT CL$^7$ **F21V**
Other: **ONLINE: WPI,EPODOC,JAPIO**

(54) Abstract Title: **Encapsulated lighting elements**

(57) A lighting system comprises one or more lighting elements 8, (eg LED's) which are hermetically encapsulated in a light-transmissive material. The lighting elements may be in the shape of bricks or paving stones and may be switched automatically in response to changes in ambient lighting conditions or the presence of hot bodies. The lighting system may be an architectural lighting system and may be available as a kit of parts.

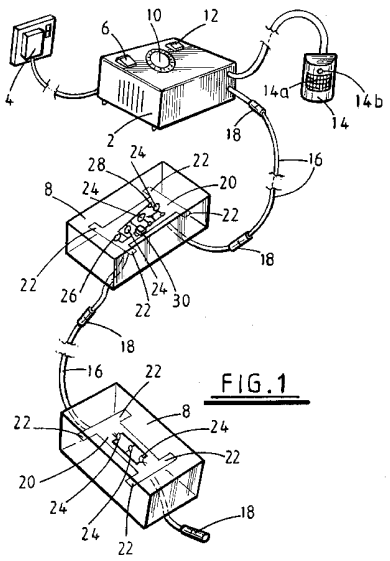


FIG.1

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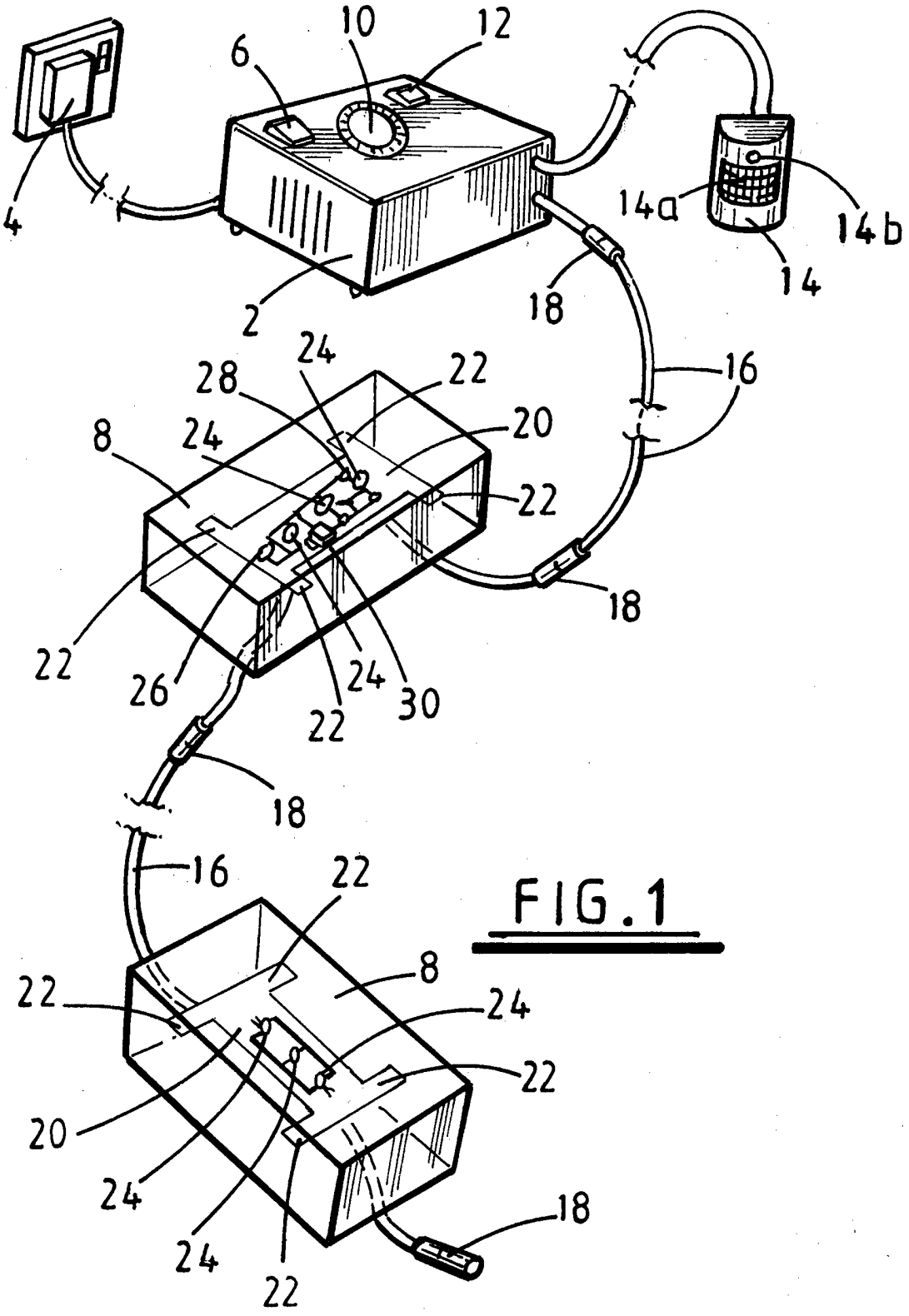
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.


10
12
6
4
2
14a
14b
14
18
16
24
28
22
20
8
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22
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22
26
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16
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18

FIG.1

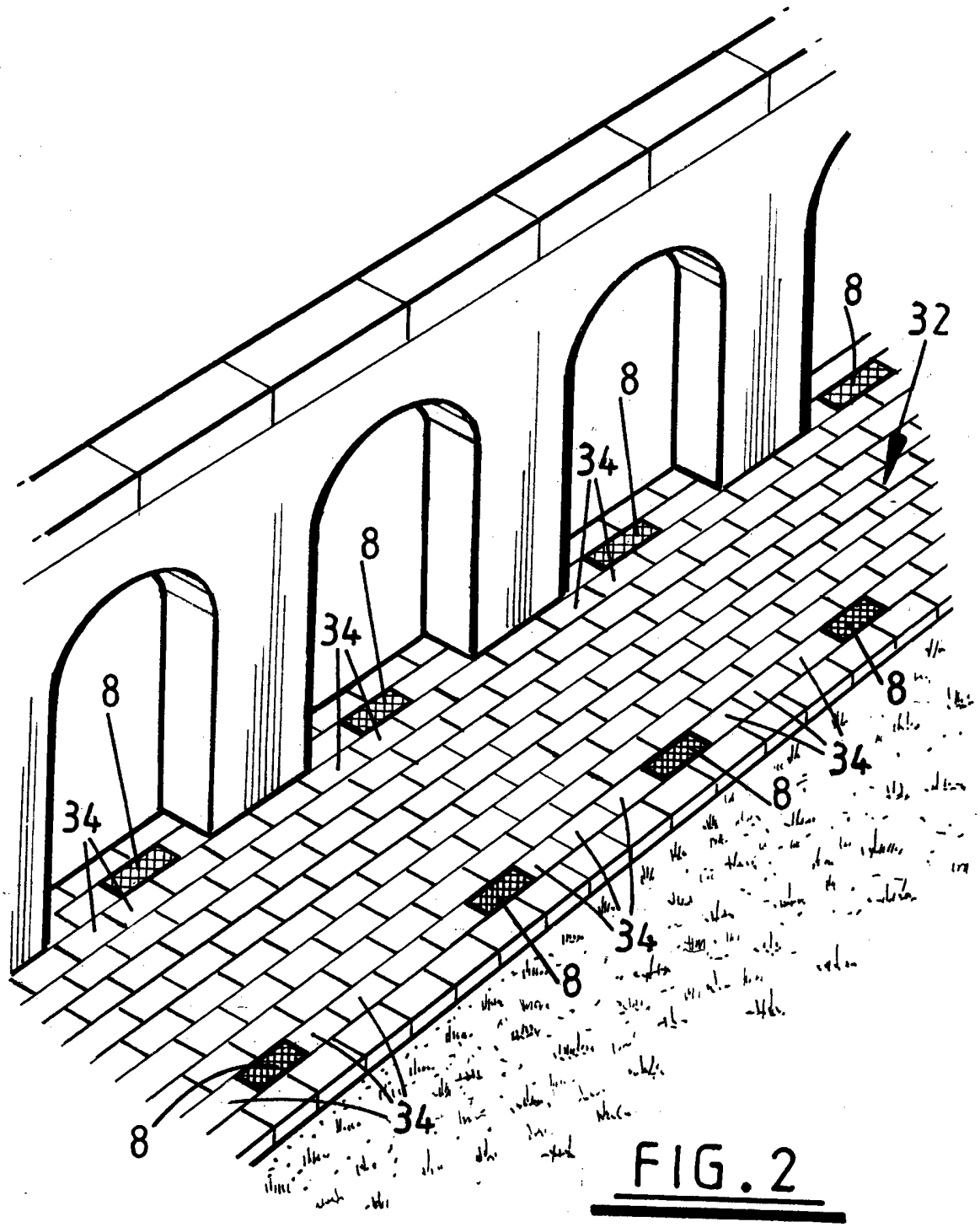


FIG. 2

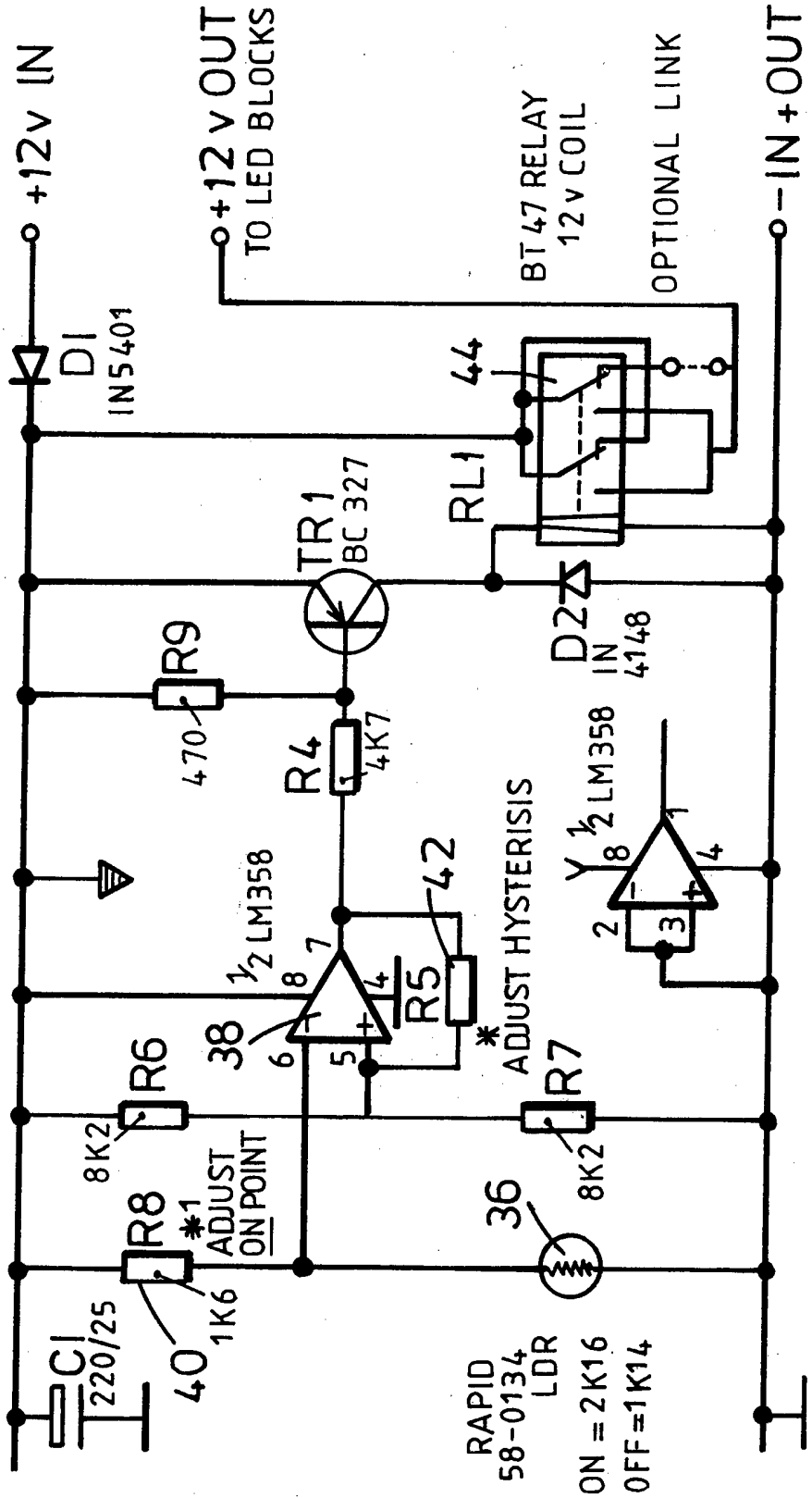
+12v IN
+12v OUT
TO LED BLOCKS
BT47 RELAY
12v COIL
OPTIONAL LINK
-IN+OUT
D1
IN5401
44
RL1
TR1
BC 327
D2
IN
4148
R9
470
R4
4K7
42
R5
*
ADJUST HYSTERISIS
½ LM358
38
R6
8K2
R8
*1
ADJUST
ON POINT
1K6
40
C1
220/25
36
RAPID
58-0134
LDR
ON = 2K16
OFF = 1K14
R7
8K2
Y ½ LM358

FIG.3

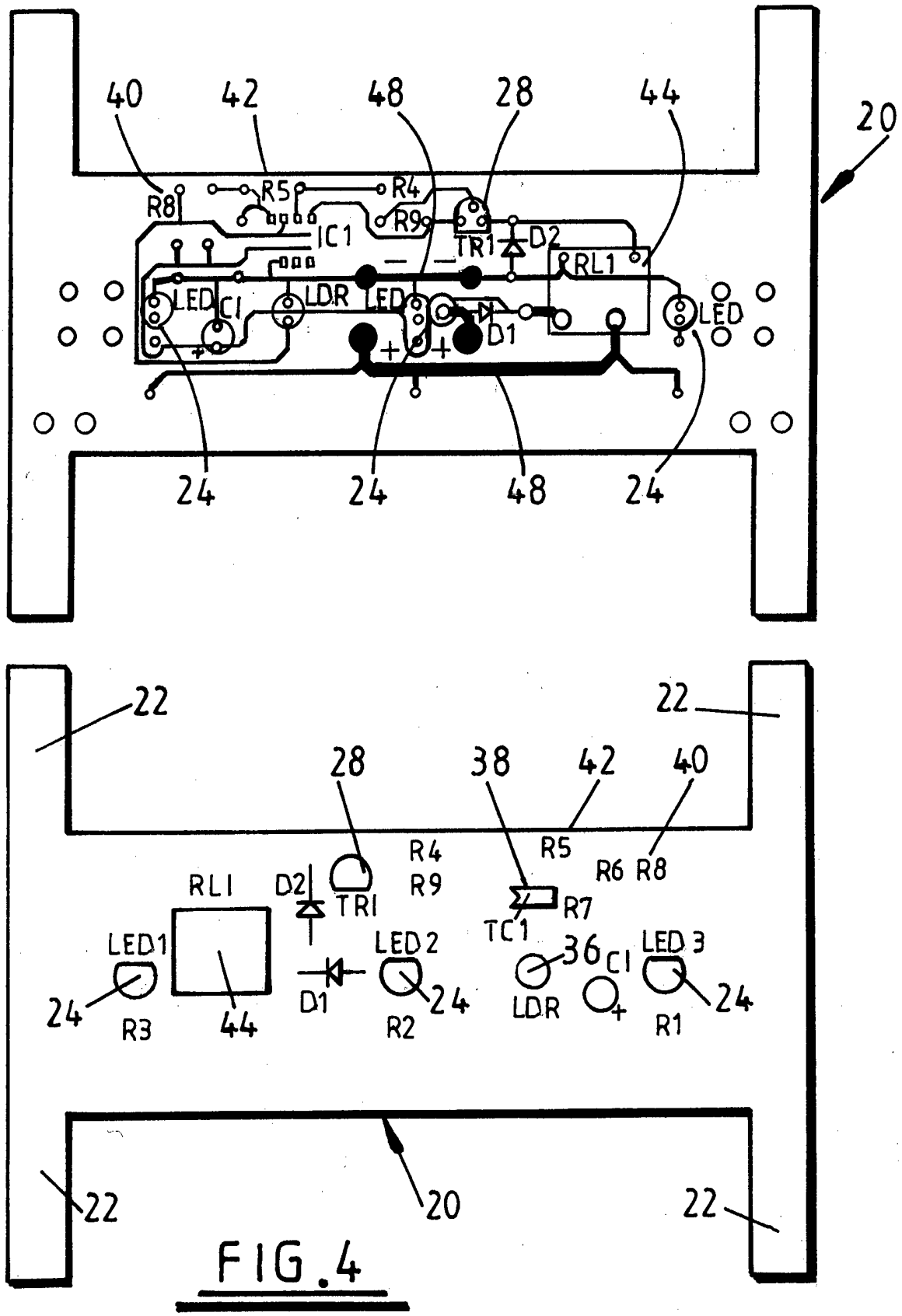
40
42
48
28
44
20
R8
R5
R4
R9
IC1
TR1
D2
RL1
LED
C1
LDR
LED
D1
LED
24
24
48
24
22
22
28
38
42
40
R4
R9
R5
R6
R8
RL1
D2
TR1
R7
TC1
LED1
LED2
36
C1
LED3
24
R3
44
D1
24
R2
LDR
R1
24
22
20
22

FIG.4

**Title: Lighting system**

**Description:**

The present invention relates to lighting system.

Lighting systems are available in a variety of forms depending on their intended application and location. Broadly speaking, lighting systems can be classified as functional or architectural; the former, as their name suggests being for providing light for functional purposes (e.g. lighting a work surface or corridor); and the latter being for creating lighting effects and mood. The present invention is primarily concerned with architectural lighting elements.

Architectural lighting, as applied to the built environment, can be used for highlighting appealing features of architecture and planting. It can also be applied where functional lighting would suffice e.g. in walkways, but where aesthetic considerations are important, such as in museums, galleries and public gardens.

Architectural lighting normally requires a great deal of forethought to install effectively and it is often very difficult to retrofit such lighting to existing buildings in an aesthetically pleasing manner. The reason for this is that architectural lighting systems are not normally intended to be portable, and as such make use of buried or hidden wiring. Furthermore, installing the lighting elements themselves can involve digging up pathways etc and therefore requires the services of builders in addition to those of electricians.

Moreover architectural lighting systems need to be durable and capable of withstanding the prevailing elements. The cost of the lighting elements themselves tends to be quite high as a result of having to use corrosion and or impact resistant materials, waterproofing and so forth.

It is therefore an object of the present invention to provide a solution to one of more of the above problems.

According to a first aspect of the present invention, there is provided a lighting system comprising one or more lighting elements, wherein the one or more lighting elements are hermetically encapsulated in a light-transmissive material.

According to a second aspect of the present invention there is provided a kit of parts comprising one or more lighting elements, the one or more lighting elements being hermetically encapsulated in a light-transmissive material.

The lighting elements are preferably powered by a power source. The power source is preferably adapted for connection to a mains electricity supply. Most preferably, the power source comprises a step-down transformer and a rectifier such that the lighting elements can operate on low-voltage direct current. In a most preferred embodiment, the lighting elements operate using 12 volts DC. The power source may also comprise safety features such as a fuse or circuit breaker and or an earth connection.

The lighting elements may comprise bulbs. Preferably though, the lighting elements comprise light emitting diodes (LEDs) for reasons of

increased longevity and reduced power consumption and maintenance. Where LEDs are used, they may be of any type, although high intensity, narrow-angle LEDs may be preferred. The bulbs or LEDs may be any colour, although red, blue or white lights or LEDs are most preferred.

The lighting elements may be provided with a plurality of lights or LEDs, which may be used in sets. Each light or LED (or set thereof) may be a different colour such that different lighting effects can be obtained using the same lighting elements. A possible means for changing the colour of light emitted by the lighting elements may be by providing polarity-sensitive circuits such that a "forward" current operates one set of lights or LEDs and a "reverse" current operates a different set of lights or LEDs. Polarity sensitivity may be achieved by wiring each bulb or LED in series with a diode.

The bulbs or LEDs are preferably mounted on a circuit board. The circuit board, where provided, supplies power from an external source to the bulbs or LEDs via tracks thereon.

The circuit board and or power source may also comprise a switching means for the bulbs or LEDs including pressure sensitive switches, passive infra-red (PIR) detectors, timers and or light detectors.

In a preferred embodiment of the invention, the circuit board has a light detector circuit thereon such that the bulbs or LEDs are switched on or off automatically in response to changes in the ambient conditions (e.g. night or day). Light-dependent automatic switching may be achieved by way of a light dependent resistor (LDR) connected to an op-amp comparator and

transistor, which operates a relay switch. In this manner, a relatively low-power detection circuit can be used to switch a comparatively high-powered lighting circuit. This may have power saving advantages.

Where more than one lighting element is used, each lighting element may comprise a switching circuit. Preferably though, one lighting element has a switching circuit that is adapted to control the second and subsequent lighting elements in unison.

Additionally or alternatively, the lighting elements may be switched on or off via an external means such as a manual or time-dependent switch at the power source, a light detection circuit at the power source and or a PIR detector connected to the power source.

A PIR detector may be used to detect the presence of "hot bodies" such as people, animals or vehicles. The presence of such a hot body could be sensed by a PIR detector, which could switch the lighting elements on or off as required. This particular aspect of the invention may have advantages from a security or convenience perspective; such as for example automatically lighting a driveway as a car approaches or lighting a garden as an intruder enters it.

The lighting elements are encapsulated in a light-transmissive material, which is preferably a translucent or transparent material. The light-transmissive material is preferably colourless although tinted or coloured materials may equally be used. The light-transmissive material is preferably a

polymeric material, such as polyethylene, polypropylene, epoxy or polyester resin, or alternatively it may be a glass material.

The lighting elements are preferably manufactured by any suitable means including (in the case of thermo-polymers) injection moulding or (in the case of thermosetting-polymers) poured moulding techniques.

The circuit board is hermetically sealed within the lighting element, which may be achieved by positioning it at a desired location within the mould before introducing the light-transmissive material into the mould. To facilitate such a procedure, the shape of the circuit board may be adapted in such a way that it self-locates within the mould. This may be achieved by attaching or integrally forming limbs on the circuit board that engage with the mould at desired positions.

The lighting elements may be formed in the shape of common building elements such as bricks, beams or paving stones. Most preferably, the lighting elements are of substantially the same dimensions as common building elements such that building elements may be removed and substituted by a lighting element according to the present the invention.

The lighting elements are preferably made to be waterproof. In particular, it is preferred that electrical circuitry be sealed in. Thus, the lighting elements may be used under water or in situations where contact with water is likely, such as, for example, in ponds, swimming pools and bathrooms.

The lighting system of the present invention is preferably available in kit form, wherein each kit comprises a power source and at least one lighting element. Further lighting elements may be added, and to facilitate this, each lighting element may be provided with connectors such that expansion of the kit is possible. Additional expansion components may also be available such as PIR sensors, timing devices and polarity reversing means such that the lighting elements may be made to emit different colours of light.

The invention will now be illustrated by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of the various components of the invention;

Figure 2 shows in perspective view how the invention may be applied to a garden;

Figure 3 shows a circuit diagram for the invention; and

Figure 4 shows a circuit board layout for the invention.

In Figure 1 of the drawings, a power supply 2 is connected to a mains power source 4. The power supply has a manual switch 6 for isolating the power source 4 from the lighting elements 8. The power supply 2 comprises a step-down transformer (not shown) and a rectifier (not shown) to convert the mains power 4 into a 12V DC supply for driving the lighting elements 8. The power source 2 is also provided with a timer switch 10 and a circuit breaker 12. The power source 4 can also be switched using the PIR sensor 14, which

is adapted for sensing the presence of hot bodies 14a and ambient light intensity 14b.

The power supply 2 is connected to the lighting elements 8 via cables 16. Lighting elements 8 can be added or removed using connectors 18 provided at convenient locations.

Each lighting element 8 is formed in the shape of a paving block for reasons that shall become apparent later and has a circuit board 20 moulded therein. The circuit boards 20 have integral limbs 22, which enable them to self-locate at a desired position during manufacture. Each circuit board 20 has three LEDs 24 thereon which is connected to the power supply 2 via the tracks on the circuit board 20 and the cables 16.

The circuit board 20' in the first lighting element 8' in the chain also has a light detecting circuit thereon. An LDR 26 is compared with a reference on an op-amp comparator which output applies a voltage on a transistor 28, which controls a relay 30. Accordingly, a change in the ambient light intensity can cause the relay 30 to "trip" thereby automatically switching the LEDs 24 "on" or "off" in response to day or night.

Subsequent lighting elements 20 in the chain are electrically connected to the first lighting element 20', thus only one switching element 20' is required in order to switch all of the lighting elements 20.

Figure 2 of the drawings shows a pathway 32 being lit using the present invention. The invention has been installed by removing a row of existing paving blocks 34 and substituting certain blocks 34 for lighting

elements 8. The cables 16 (not shown) are laid where the removed blocks 34 have been lifted and are hidden from view by replacing the removed blocks 34. Because the lighting elements 8 are moulded in the shape of the existing paving blocks 34, direct substitution of one 34 for the other 20 is possible.

Figure 3 of the drawings is a circuit diagram for light-dependent switching aspect of the invention. The circuit comprises a light-dependent resistor (LDR) 36, which is used to vary an input voltage on an integrated circuit (IC) 38. The IC 38 acts a comparator that switches between an "on" and "off" state depending on the resistance of the LDR relative to pre-set resistors 40 and 42. The transistor T1 is used for switching the relay 44, which turns the LEDs (not shown) on or off. The value of resistor 40 determines the on switching point for the LEDs and the value of resistor 42 determines the off switching point for the LEDs.

Figure 4 of the drawings shows a circuit board 20 layout. The symbols on the circuit board 20 correspond to the symbols in the circuit diagram shown in Figure 3, the circuit being used to switch the LEDs 24 on or off as desired. Where switching is not required, the LEDs 24 are affixed to the circuit board 20 in addition to their corresponding power limiting resistors R1, R2 and R3. The "power lines" 48 are connected directly to the LEDs 24, rendering the circuit board 20 a mere distribution board. The power lines 48 are enlarged so that they can carry increased current, such that when multiple lighting elements 8 are chained together, or if there is a short circuit, the tracks 48 on the circuit board 20 are not burnt out.

**Claims:**

1. A lighting system comprising one or more lighting elements, wherein the one or more lighting elements are hermetically encapsulated in a light-transmissive material.
2. A lighting system as claimed in claim 1, wherein the lighting elements are powered by a power source, which is adapted for connection to a mains electricity supply.
3. A lighting system as claimed in claim 2, wherein the power source comprises a step-down transformer and a rectifier such that the lighting elements operate on low-voltage direct current.
4. A lighting system as claimed in claim 3, wherein the lighting elements operate on 12 volts direct current.
5. A lighting system as claimed in any one of claims 2, 3 or 4, wherein the power source further comprises safety features such as a fuse or circuit breaker.
6. A lighting system as claimed in any one of claims 1 to 5, wherein the lighting elements comprise one or more bulbs.
7. A lighting system as claimed in any one of claims 1 to 5, wherein the lighting elements comprise one or more light emitting diodes.
8. A lighting system as claimed in claim 7, wherein the LEDs are a high intensity, narrow-angle type.
9. A lighting system as claimed in any one of claims 1 to 8, wherein the lighting elements further comprise a circuit board.

10. A lighting system as claimed in any one of claims 1 to 8, further comprising switching means.

11. A lighting system as claimed in claim 10, wherein the switching means is a manual switch.

12. A lighting system as claimed in claim 10, wherein the switching means is automatic.

13. A lighting system as claimed in claim 11, wherein the switching means is pressure sensitive switch.

14. A lighting system as claimed in claim 11, wherein the switching means is a passive infra-red detector.

15. A lighting system as claimed in claim 11, wherein the switching means is a timer switch.

16. A lighting system as claimed in claim 11, wherein the switching means is a light detector.

17. A lighting system as claimed in claim 14, wherein the switch is activated by the presence of hot bodies.

18. A lighting system as claimed in claim 15, wherein the switch is activated by changes in ambient light intensity.

19. A lighting system as claimed in any one of claims 1 to 18 , wherein the light-transmissive material, is colourless

20. A lighting system as claimed in any one of claims 1 to 18, wherein the light-transmissive material, is tinted or coloured.

21. A lighting system as claimed in any one of claims 1 to 20, wherein the light-transmissive material is a polymeric material.

22. A lighting system as claimed in any one of claims 1 to 20, wherein the light-transmissive material is glass.

23. A lighting system as claimed in any one of claims 1 to 22, wherein the lighting elements are formed in the shape of building elements.

24. A lighting system as claimed in claim 23, wherein the lighting elements are formed in the shape of bricks.

25. A lighting system as claimed in claim 23, wherein the lighting elements are formed in the shape of paving stones.

26. A lighting system as claimed in claim 23, 24 or 25, wherein the lighting elements can be used as direct substitutes for building elements.

27. A kit of parts comprising one or more lighting elements, the one or more lighting elements being hermetically encapsulated in a light-transmissive material.

28. A kit of parts as claimed in claim 27, further comprising a power source.

29. A kit of parts as claimed in claim 28, wherein the power source is a step down transformer.

30. A kit of parts as claimed in claim 28 or 29, wherein the power source delivers substantially 12 volts direct current to the lighting elements.

31. A kit of parts as claimed in any of claims 27 or 30, wherein the lighting element or elements are connected to one another and the power source by way of cables and connectors.

32. A kit of parts as claimed in any of claims 27 or 31, further comprising switching means.

33. A kit of parts as claimed in claim 32, wherein the switching means is automatic.

34. A kit of parts as claimed in claim 33, wherein the switching means is triggered by a passive infra-red detector.

35. A kit of parts as claimed in claim 32, wherein the switching means is triggered by a light detector.

36. A lighting system substantially as hereinbefore described, with reference to and as illustrated in the accompanying drawings.

37. A kit of parts substantially as hereinbefore described, with reference to and as illustrated in the accompanying drawings.

| | | | | |
|---|---|---|---|---|
| **Application No:** | GB 0302453.6 | 13 | **Examiner:** | Colin Clarke |
| **Claims searched:** | 1-37 | | **Date of search:** | 10 July 2003 |

# Patents Act 1977 : Search Report under Section 17

**Documents considered to be relevant:**

| Category | Relevant to claims | Identity of document and passage or figure of particular relevance | |
|---|---|---|---|
| X | 1,2,7,9,21, 27 at least | US 20020089849 A | LAMKE see whole document |
| X | 1,2,7,23-27 at least | GB 2380539 A | METCALFE & ROGERS |
| X | 1,2,21,23-27 at least | US 4570207 | TAKAHASHI |
| X | 1,2,7,9,21, 27 at least | US 20020093832 A | HAMILTON see whole document |
| X | 1,23-27 at least | GB 2039936 A | WATKINS |
| X | 1-6,21, 27-31 at least | US 3995152 | CHAO |
| X | 1,2,19,21, 27 at least | US 3952190 | PERKINS |
| X | 1,2,7,9-11 23-27 at least | US 20020030992 A | LEFEBVRE see figs 9 & 10 |
| X | 1,2,10,12,16,18-21, 23-27 at least | Derwent Abstract 1997-482211 & DE 29710476U U | |

Categories:

| | | | |
|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
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| & | Member of the same patent family | E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |

**Field of Search:**

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

F4R

Worldwide search of patent documents classified in the following areas of the IPC[7]:

F21V

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO