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(54) DEVICE FOR DISPLAYING ALPHANUMERICAL CHARACTERS

(71) We, N.V. PHILIPS' GLOEI-
 LAMPENFABRIEKEN, a limited liability
 Company, organised and established under the
 laws of the Kingdom of the Netherlands, of
 Emmasingel 29, Eindhoven, the Netherlands,
 do hereby declare the invention, for which we
 pray that a patent may be granted to us, and
 the method by which it is to be performed,
 to be particularly described in and by the fol-
 lowing statement:—

The invention relates to a display device for
 displaying for example, alphanumerical char-
 acters and comprising a block of insulating
 material which is provided with cavities, at
 least one semiconductor electroluminescent
 diode being provided at the bottom of each
 cavity.

For displaying information or digital and
 alphanumerical data, devices are used which
 display the characters in a form composed of
 rectilinear luminescent elements. Electro-
 luminescent elements are used which are
 formed by diodes having semiconductor junc-
 tions when the displayed characters are re-
 quired to be observed from a distance and
 when several of the characters are required to
 be provided in the proximity of each other.
 In the case when groups of diodes are used,
 each diode fixed on a suitable support forms
 a punctiform light source which is transformed
 into an image, for example a rectangular
 image, by known means.

In order to realize this transformation, one
 of the most conventional methods is described
 in United States Patent Specification No.
 3,780,357.

According to the United States Patent
 Specification, each diode constituting the
 punctiform light source, is provided at the
 bottom of a cavity which is provided in a
 usually rectangular block of an insulating
 material which is usually manufactured from a
 synthetic resin which material for reasons of
 reliability, should be capable of withstanding
 temperatures above 100°C. This condition
 usually restricts the choice of insulating
 materials to polycarbonates, polyamides, poly-
 sulphones or to polyesters. In addition, how-
 ever, in order to give good or optimal reflec-

tion of radiations from the wall of each cavity,
 the material of the block should be white
 while each aperture, the shape optimally being
 approximately pyramidal, is filled with a dif-
 fusing epoxy resin which is usually coloured
 and which has the property of strongly adher-
 ing to the white synthetic material of the block.
 When the aforesaid differing requirements are
 taken into account, the choice of the synthetic
 resin of the block is restricted to the use of a
 polycarbonate to which a quantity of white
 pigment, for example, TiO₂, has been added
 so as to give the polycarbonate a white colour.

The method described in said United States
 Patent Specification has several disadvantages.

In order to ensure a good legibility of the
 displayed characters of the display device a
 strong contrast should be realized between the
 surface of the device and the light sources.
 The block comprising the cavities may thus be
 formed by a white polycarbonate having a
 large reflecting capacity which may even be
 reflected through a filter, if present. This re-
 sults in that the illuminated zones need to be
 truly delimited with respect to the dark zones,
 namely the illuminated zones and the dark
 zones of the major surface into which the
 cavities debouch and on which the displayed
 character is written. For this purpose it is
 necessary to cover the external surface of the
 major surface and usually the outer surface of
 the lateral walls of the block with at least a
 layer of dull paint for example, preferably dull
 black paint.

This paint, however, the cost-price of which
 is high, only poorly withstands mechanical
 and thermal influences and weather conditions,
 and in addition can easily be scratched. More-
 over, the paint only poorly withstands the in-
 fluence of chemical reagents and in particular
 has a poor resistance to solvents which are
 used in carrying out the method of manu-
 facturing the display device. In these circum-
 stances it is established that after a few mani-
 pulations or after a few hours in operation of
 the display device, the paint used has lost its
 originally favourable characteristics and may
 have even disappeared entirely in certain
 places.

Furthermore, it is clear that the provision of the black paint requires special measures to avoid the paint from penetrating into the cavities the walls of which must remain pure white in order to facilitate reflection of the radiation. Due to automation difficulties in the method of applying the paint it may be necessary to repeated the technique of applying the paint as many times as there are surfaces to be painted on each block.

Because of this it was established that if a layer of paint is required on a block the result is that the cost-price of the block is tripled.

One object of the present invention is to mitigate the aforesaid disadvantages.

For this purpose, the invention is concerned with the properties of chemical inertness of certain plastics materials with respect to the types of resin usually used in electronic devices for the transfer of radiation.

According to the present invention there is provided a display device which is suitable for displaying alphanumerical characters and comprising a block of insulating material which is provided with cavities, at least one semiconductor electroluminescent diode being provided at the bottom of each cavity, characterised in that each of the cavities provided in the block is filled with a light transmissive resin, the light transmissive resin and the insulating material of the block being chosen from two groups of materials which do not adhere together.

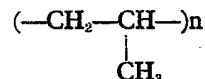
Since the resin filling the cavities in the block does not adhere to the insulating material constituting the block, an intermediate layer is formed between the block and the resin of the cavities. This layer performs the role of a mirror which reflects the light emitted by the electroluminescent diodes to the major surface of the display device.

The insulating material from which the block is formed advantageously may be impervious to light emitted by the electroluminescent diodes. In this manner the function of light conductor of each cavity of the block is intensified and the path of the radiation is fully bounded by the walls of each cavity from the bottom of the light emitting cavity.

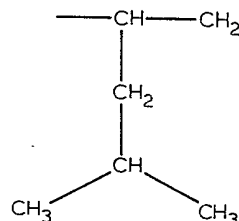
In these circumstances it is also unnecessary to provide a layer of black paint on the outer surfaces of the block. The transparent resin filling the cavities of the block may be an epoxy resin, such as, a polymerisable liquid epoxy resin of the cycloaliphatic type or of the bisphenol A type. The resin may be further selected for its properties of good transparency and good dielectricity. In this case the material of the block is a thermoplastics material which is selected either from the group of polyolefin polymers, such as, polyethylene or polypropylene, or from the group of halo-hydrocarbon polymers which contain fluorine such as, polyfluoroethylenes for example, polytetrafluoroethylene, the substances of the two groups having the property of not adhering to the trans-

parent resins, for example, the epoxy resins known so far to those skilled in the art.

Particularly suitable polyolefin polymers are on the one hand, polypropylene polymers of the low pressure polyethylenes having as its formula



and on the other hand, the polymer of methyl pentene of which the configuration of the elementary element is represented by the chain



of which one of the most frequently used forms is commercially available as TPX.

As regards the group of the polyfluoroethylenes, polytetrafluoroethylene which is commercially known as Teflon (a registered Trade Mark) is particularly suitable.

The thermoplastic materials generally are selected for their exceptional optical qualities and also for their behaviour at high temperatures. It has been established, for example, the aforesaid materials permit the display devices of the invention to operate at temperatures which are at least 20° higher than the operating temperatures which devices obtained from polycarbonate can withstand. Moreover, the thermoplastics materials comprising the aforesaid polyolefins and/or polyfluoroethylenes are insensitive to solvents and also to other chemical reagents which are commonly used in the conventional methods of manufacturing display devices, while in addition these materials have a considerable hardness. In order to improve the contrast, the thermoplastics material constituting the block may be coloured for example, by adding a quantity of carbon black to the thermoplastics material, so as to obtain a dark tint. In addition, in order to protect the thermoplastics material against ultraviolet radiation and to avoid the slow degradation of the material, the thermoplastics material may be covered with an ultraviolet radiation impervious layer such as a layer of carbon black.

By making the block of an insulating material comprising a thermoplastics material belonging to the groups of polyolefins and polyfluoroethylenes it is possible to use in the cavities of the block a transparent resin of the epoxy type which instead of having an amine hardener has an anhydride hardener. The use of an anhydride hardener was impossible when, prior to the present invention, the block was

obtained from a polycarbonate; for this material has the property of being attacked by anhydride hardeners.

It is known that it is possible by the use of an anhydride hardener instead of an amine hardener to avoid the progressive yellowing of the resin which occurs under the combined influence of the temperature and the ambient oxygen atmosphere.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawing in which:

Figure 1 is a perspective view of a display device according to the invention,

Figure 2 is a diagrammatic sectional view on an enlarged scale of a cavity of the display device according to the invention.

It is to be noted that, for clarity, the dimensions in the said Figures are considerably enlarged and are not drawn to the same scale.

The display device shown in Figure 1 comprises a block 1 of insulating material comprising a black thermoplastics material: the material chosen is, for example, a polymer of methyl pentene of the TPX-type to which carbon black was added. Cavities 2 with a substantially pyramidal form, are provided in the block 1. In the most conventional form of the display devices, said devices comprise seven cavities 2 and said cavities are arranged in the block 1 so that two partially superimposed squares are formed at the surface of the block 1 to give a figure of eight shape.

The electroluminescent diodes 3 consisting of semiconductor crystals are provided in the lower part of the cavities 2 and are secured to a metal support or comb 4.

As shown in Figure 2, the cavities 2 are filled with a transparent resin comprising an epoxy resin 5. The resin used is, for example, a resin of the cycloaliphatic type to which a suitable hardener has been added, together with, if desired a filler powder which diffuses the light, and/or a dye.

The thermoplastics material constituting the block 1 and the epoxy resin 5 have the property of not adhering together. In these circumstances, an interface 6 which reflects the light emitted by the diode 3 is formed between the walls of the cavity 2 and the epoxy resin 5.

It is the formation of such a "mirror" which permits of replacing the white walls of the cavities by black walls which are manufactured from a material the cost-price of which is much lower.

WHAT WE CLAIM IS:—

1. A display device which is suitable for displaying alphanumerical characters and comprising a block of insulating material which is provided with cavities, at least one semiconductor electroluminescent diode being provided at the bottom of each cavity, characterized in that each of the cavities provided in the block is filled with a light transmissive resin, the light transmissive resin and the insulating material of the block being chosen from two groups of materials which do not adhere together.

2. A device as claimed in Claim 1, characterized in that the insulating material from which the block is formed is impervious to the light emitted by the electroluminescent diodes.

3. A device as claimed in Claim 1 or 2, characterized in that the cavities of the block are filled with an epoxy resin.

4. A device as claimed in Claim 3, characterized in that said epoxy resin is of the cycloaliphatic type.

5. A device as claimed in Claim 3, characterized in that said epoxy resin is of the bisphenol A type.

6. A device as claimed in any of the Claims 1 to 5, characterized in that said block is formed from a thermoplastics material belonging to the group of the polyolefins.

7. A device as claimed in Claim 6, characterized in that said thermoplastics material is polypropylene.

8. A device as claimed in Claim 6, characterized in that said thermoplastics material is a polymer of methyl pentene.

9. A device as claimed in any of the Claims 1 to 5, characterized in that said block is formed from a thermoplastics material belonging to the group of the polyfluoroethylenes.

10. A device as claimed in Claim 9, characterized in that said thermoplastics material is polytetrafluoroethylene.

11. A device as claimed in any of the Claims 1 to 10, characterized in that a quantity of carbon black is added to said insulating material from which said block is formed.

12. A display device substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

R. J. BOXALL,
Chartered Patent Agent,
Berkshire House,
168—173 High Holborn,
London, WC1V 7AQ.
Agent for the Applicants.

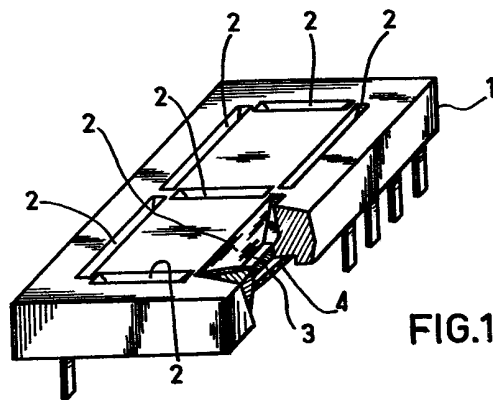


FIG.1

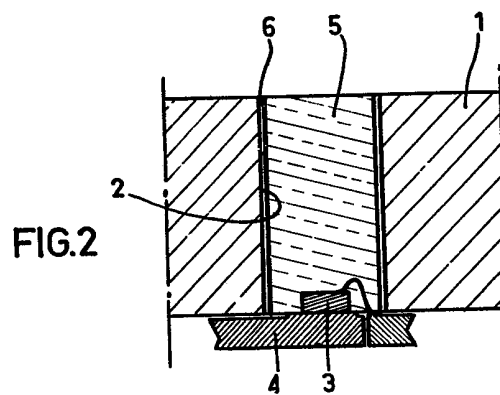


FIG.2