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(54) IMPROVEMENTS IN OR RELATING TO ELECTROLUMINESCENT DISPLAY DEVICES

- (71) We, WESTERN ELECTRIC COMPANY, INCORPORATED of 222 Broadway and formerly of 195 Broadway, New York City, New York State, United States of America, a Corporation organised and existing under the laws of the State of New York, United States of America, 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 following statement:-
- The invention relates to light-emitting devices including an electrically operable light emitting element.
- Light-emitting diodes of the prior art have been used in making plug-in type devices that replace switchboard, key button or similar lamps. Such light-emitting diode devices offer a number of advantages over the conventional carbon and tungsten filament switchboard lamps. These advantages include greatly reduced power consumption, less burn hazard to personnel, preferred materials such as plastics, much longer life, higher reliability and reduced maintenance costs.
- However, these prior art devices are expensive owing to costly assembling techniques that involve complex, tedious, time consuming manual and single-device processing operations, and the use of expensive parts.
- Other disadvantages of the prior art devices include their lack of compactness and ruggedness. They are susceptible to coming apart; for example, various metal-to-metal and plastics-to-metal bonds have broken.
- Still another disadvantage of the prior art devices is their tendency to freely rotate in their sockets whereby proper electrical contacting to the devices is lost.
- The present invention to alleviate these problems provides a light emitting display device including an electrically operable light emitting element, said device comprising two elongated, spaced apart and coextensive contact members, the light emitting element being electrically coupled between adjacent ends of the members and an elongated insulating enclosure being formed about and between the contact members, the elongated outer edges of the members extending beyond the elongated sides of the enclosure so as to provide terminals for the device.
- Specific details of embodiments of the present invention will now be described by way of example and with reference to the accompanying drawings, in which:-
- Figure 1 is an enlarged perspective view of an assembled prior art light-emitting diode device that has a plug-in type slidebase;
- Figure 2 is an exploded view of the assembled device of Figure 1, showing the various piece parts from which the prior art device is made;
- Figure 3 is a cross-sectional view of a portion of the device of Figure 2 taken along lines 3-3 of Figure 2, showing the connections to a light-emitting diode chip;
- Figure 4 is a perspective view of an enlarged slidebase, plug-in type light-emitting diode device of one embodiment of the present invention;
- Figure 5 is a cross-sectional view of Figure 4 taken along lines 5-5 of Figure 4, showing the edges of a lead frame extending beyond flat surfaces of the slidebase of the device of Figure 4;
- Figures 6, 7 and 8 show various stages in the process of assembling the device of Figure 4;
- Figure 9 shows a second embodiment of the present invention;
- Figures 10, 11 and 12 show additional alternative embodiments of the present invention; and

Figure 13 is a schematic diagram, showing one manner in which the protective device of Figure 12 may be connected to provide electrical protection for a circuit.

To better understand the present embodiments of the invention and its advantages over the prior art, a light-emitting diode device, designated generally by the numeral 11 in Fig. 1, of the prior art will first be briefly described. The prior art device 11 is designed to replace a conventional carbon or tungsten filament switchboard or similar lamp on a one-to-one basis.

The device 11 includes a pair of conductive contacts 12 (Figs. 1 and 2) partly embedded within a molded, tapered insulator 13 and a plastics insulating sleeve 14 to which the contacts 12 are cemented, as shown in Fig. 1. The contacts 12, the insulator 13 and the sleeve 14 form a plug-in type slidebase for the device 11.

The device 11 also includes a light-emitting diode chip 17 (Fig. 3), one terminal of which is bonded to a reflector-shaped header 18 formed from, or bonded to, a lead 21. To connect the other terminal of the chip 17 to another lead 22, a wire 23 is bonded to such terminal and to such lead 22. A thin transparent compliant insulating coating (not shown) of a material such as a silicone rubber or an epoxy resin is preferably applied to the chip 17 after the bonding of the wire 23 thereto. A transparent insulating lens cap 26 is molded about the chip 17, the wire 23, the header 18 and the leads 21 and 22 such that the leads 21 and 22 extend from the cap 26. The cap 26 may be suitably dyed to achieve a desired colour.

A resistor 27 (Fig. 2) has its short terminal 28 soldered to the lead 22, which is the positive terminal of the device 11, while its long terminal 29 is soldered to one of the contacts 12. The lead 21 is soldered to the other of the contacts 12.

The prior art device 11 is subject to the aforementioned disadvantages. For example, the assembly of the prior art device 11 requires complex, tedious and time consuming manual operations. In these prior art assembling operations, each device 11 is assembled one at a time which greatly increases assembling costs.

In carrying out such assembling operations, the lens cap 26 (Fig. 3) is molded about the chip 17, the header 18, portions of the leads 21 and 22, and the wire 23 which is appropriately bonded to the chip 17 and the lead 22. In a separate processing operation the contacts 12 (Fig. 2) are formed and molded into the insulator 13 which separates the contacts 12 from each other. Then the resistor 27 is properly oriented and held while its short terminal 28 is soldered to the lead 22. Such orientation adds considerably to the assembling cost. The contacts 12,

which are partly embedded within the insulator 13, are then cemented to the sleeve 14 which, in turn, is cemented to the lens cap 26. These cementing steps require a curing operation to maximize bond strength. The lead 21 and the long terminal 29 of the resistor 27 are bent slightly outward and manually soldered to the inside of the contacts 12, as shown in Fig. 1. This soldering operation is a very difficult and tedious operation because of the small space between the contacts 12 into which a soldering iron and solder must be inserted. Also, excessive heating from the soldering operation often results in the contacts 12 breaking away from the sleeve 14, either during such soldering operation or during later use of the device 11.

In accordance with the present embodiment of the invention, a display device or light-emitting diode device 31, shown in Figs. 4 and 5, overcomes many of the disadvantages of the prior art. The device 31 can best be understood by describing the manner in which it is made.

Preferably, a plurality of the devices 31 is assembled by batch processing techniques. To this end, a plurality of side-by-side connected lead frames, each designated generally by the numeral 32 and shown in Fig. 6 are used. Each lead frame 32 includes a pair of elongated spaced apart parallel portions 33 and 34, the edges 36 and 37 (Figs. 4, 5 and 6) of which form terminals for the completed device 31 (Fig. 4). Each lead frame 32 also includes a header portion 38 and a lead portion 39, the header portion 38 being integral with the contact portion 34.

A plurality of the frames 32, only two of which are shown in Fig. 6, are interconnected by a plurality of support bars 41, 42 and 43, a main support strip 44, which is perforated for ease of handling, and a plurality of tie bars 45.

The lead frames 32 can be formed by a stamping process from an electrically conductive sheet, typically a copper, nickel and tin alloy. Usually, the frames are plated with such materials as nickel, silver and gold. The connected together frames 32 are substantially planar in configuration and form a frame strip which is pliable enough to be wound onto a reel without damage.

In the assembly of the device 31, one terminal of a light-emitting element or chip 46 (Fig. 6) typically formed from an appropriately doped semiconductor wafer, is bonded to a reflector 47 of the header portion 38 of each lead frame 32. While only one chip 46 is shown in Fig. 6 bonded to each frame, each frame can contain a plurality of chips 46 bonded to one or several header portions 38. A wire 48, advantageously gold, is bonded to the other terminal of the chip 46 and to the lead portion 39 of the lead frame

32, both the lead portion 39 and header portion 38 of the frame 32 being substantially coextensive in length. A thin transparent, compliant insulating coating (not shown) of a material such as a silicone rubber or an epoxy resin is applied to the chip 46 after the wire 48 is bonded to it.

A transparent insulating lens cap 49 is then formed over the chip 46, the wire 48, and the header and lead portions 38 and 39 of the lead frame 32. Advantageously, the lens cap 49 is formed by encapsulation using a casting technique or an injection or transfer molding technique with a suitable plastic such as that used in the prior art devices. The lens cap 49 is shaped to include a rounded top side, a flat bottom side, and a dependent solid cylindrical projection 51 surrounding portions of the frame header and lead portions 38 and 39.

Next, the segments 53 and 54 of the bars 43 are removed, as by stamping, but it should be noted that, at this time, the segment 43' of the bar 43 is not removed. The significance of this is described hereinafter. Then, a pair of terminals 56 of equal length of a voltage dropping resistor 57 are welded to flag-shaped portions 59 of the contact portion 33 of the lead frame 32, as shown in Fig. 7. Since the terminals 56 of the resistor 57 are of equal length, the orientation and welding of the resistor 57 is simplified. The resistor 57, which is optional, allows the device 31 to be used over a wide range of operating voltages, typically, from about 6 to about 48 volts. If the resistor 57 is not incorporated in the device 32, the contact portion 33 of the frame 32 can be made identical to the contact portion 34.

After the welding of the resistor 57, if used, an insulating, solid enclosure 61 is formed about and bonded to the frame assembly 32, the enclosure 61 including an elongated slidebase 62 (Figs. 4 and 5) contiguous with the projection 51 of the lens cap 49 and having opposed flat surfaces 63 (Fig. 5). The slidebase 62 encloses the resistor 57 and portions of the contact portions 33 and 34 of the lead frame 32, the elongated edges 36 and 37 of the contact portions 33 and 34 extending radially outwardly beyond the flat surfaces 63 of the slidebase 62. Typically, the edges 36 and 37 extend approximately 15 mils beyond the flat surfaces 63 of the slidebase 62.

The enclosure 61 also includes a cylindrical portion 64 which surrounds and is bonded to the cylindrical projection 51 of the lens cap 49, the enclosure portion 64 being integrally connected to the slidebase 62. Thus, the enclosure 61 extends substantially the entire length of the frame assembly 32, is integrally bonded thereto, and results in a very rugged device 31.

Additionally, the slidebase 62 has a tapered end opposite the lens cap 49 to facilitate insertion of the slidebase into a switchboard lamp type or similar socket (not shown). The contact portions 33 and 34 are generally flat, rectangular members lying in a plane passing through the longitudinal axis of the slidebase 62. The edges 36 and 37 of the contact portions 33 and 34 are slidably engageable by contacts within the socket in which the device is inserted, and the leading edges of the contact portions 33 and 34 are inwardly tapered. The flat surfaces 63 of the slidebase 62 are effective to reduce the rotatability of the device 31 within its socket.

Preferably, the enclosure 61 is formed by encapsulation such as a casting technique or an injection or transfer molding process. The material used for the enclosure 61 is insulating and wear resistant. Typically, it is an opaque plastic material of known type. To securely lock the contact portions 33 and 34 of the lead frame 32 to the slidebase 62, a plurality of reverse taper sided notches 66 (Fig. 6) and a plurality of apertures 67 are formed in the portions 33 and 34.

After the enclosure 61 is formed, the portions (Fig. 8) of the support bars 41, 42 and 43, the main support strip 44, and the tie bar 45, which extend beyond the enclosure 61, are severed, preferably using a punch and die (not shown) to separate the devices 31 from each other. A plurality of indentations 69 are formed in the slidebase 62 to provide the punch and die with sufficient clearance for severing the bars 41 and 42 flush with the edges 36 and 37 of the contact portions 33 and 34. Another indentation 70 provides a similar clearance for severing the support bar 43' from the lead portion 39 (Fig. 4) of the lead frame 32. Within the indentation 70, a stub of the bar segment 43' remains. The indentation 70 and the stub portion 43' are useful as indicia means for properly orienting the device, such means being a permanent part of the device and not subject to being worn off as are the painted indicia means of the prior art devices.

Shown in Fig. 9 is an alternative embodiment of the invention. In this embodiment, a plurality of recesses 71 are formed in the contact portions 33 and 34. The recesses 71 are used to engage a plurality of detents (not shown) in the socket (not shown) in which the device is inserted to more securely hold the device in place.

In another embodiment, the lens cap 49 and the enclosure 61 are formed at the same time and of the same material so as to provide a unitary assembly of the cap 49 and enclosure 61.

In still another embodiment, the enclosure 61 is formed of two or more preformed parts which are bonded together to enclose portions of the frame assembly 32. In general, however, the preferred embodiment utilizes

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izes an enclosure 61 which is molded directly about the device.

Referring now to Figs. 10, 11 and 12, other embodiments of the invention are shown. In Figs. 10 and 11 a protective element 73, which typically is a fusible wire, is shown electrically coupled between the contact portions 33 and 34 of the device. In Fig. 10 the element 73 is shown bonded to the flag-shaped portion 59 and an additional similarly shaped portion 74. In Fig. 11 the element 73 is shown bonded directly to the contact portions 33 and 34.

In Fig. 12, the protective element 73 is shown as being integral with the contact portions 33 and 34 of the lead frame 32.

Fig. 13 shows the device of Fig. 12 connected to an electrical circuit including a load 75 and a battery 77. Under normal load conditions, the protective element 73, i.e., a fuse, shorts out the device 31 which remains in its non-energised state. However, upon an overload condition occurring in the circuit, the protective element 73 melts, vaporizes or is otherwise destroyed, thus opening the circuit and energizing the device 31 from the battery 77. Thus, the device 31 not only provides circuit protection but also provides a clear and positive indication of the fact that an overload condition has occurred in the circuit of Fig. 10. This indication provides a quick and easy means to determine which of a large number of circuits, each having one of the devices 31 of Figs. 10-13 connected therein, has developed an overload condition and requires corrective action. Accordingly, the devices 31 of Figs. 10-13 find ready application in the protection of telephone circuits.

WHAT WE CLAIM IS:-

1. A light emitting display device including an electrically operable light emitting element, said device comprising two elongated, spaced apart and coextensive contact members, the light emitting element being electrically coupled between adjacent ends of the members and an elongated insulating enclosure being formed about and between the contact members, the elongated outer edges of the members extending beyond the elongated sides of the enclosure so as to provide terminals for the device.

2. A device as claimed in claim 1, wherein the contact members are disposed in opposite radial planes with respect to the

longitudinal elongated axis of the device.

3. A device as claimed in claim 1 or claim 2, wherein the contact members are flat and are disposed in parallel in the same plane passing through the longitudinal axis of the base.

4. A device as claimed in any one of claims 1-3, wherein a portion of one of the contact members extends beyond the enclosure so as to provide an indication of the orientation of the contact member for the device.

5. A device as claimed in any one of the claims 1-4, wherein a transparent electrically insulating lens is formed about the light-emitting element and the enclosure overlaps a portion of the lens.

6. A device as claimed in claim 5, wherein the lens and the enclosure are unitary and are formed of the same material.

7. A device as claimed in any one of the preceding claims, wherein the contact members are electrically shorted together by a protective means so that upon the occurrence of an overload condition in a circuit in which the contact members are serially connected, a short circuit between the contact members is opened to activate the light emitting element and provide an indication of the said overload.

8. A device as claimed in claim 7, wherein a current limiting device is connected in series with the light-emitting element.

9. A device as claimed in claim 8, wherein the current limiting device is a resistor.

10. A light emitting display device substantially as hereinbefore described with reference to Figs. 4 to 8 or any one of Figs. 9 to 13 of the accompanying drawings.

11. A method of making a light emitting display device according to any one of claims 1-10, substantially as hereinbefore described with reference to Figs. 4 to 8, or to any one of Figs. 9 to 13 of the accompanying drawings.

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3. A device as claimed in claim 1 or claim 2, wherein the contact members are flat and are disposed in parallel in the same plane passing through the longitudinal axis of the base.

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6. A device as claimed in claim 5, wherein the lens and the enclosure are unitary and are formed of the same material.

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